EXHIBIT D

Johnson and Sedlack Comment Letter with Attachments

Johnson & Sedlack
ATTORNEYS at LAW

Raymond W. Johnson, Esq., AICP, LEED GA
Carl T. Sedlack, Esq. Retired
Abigail A. Smith, Esq.
Kimberly Foy, Esq.
Kendall Holbrook, Esq.

26785 Camino Seco, Temecula, CA 92590

E-mail: EsqAICP@gmail.com

Abby.JSLaw@gmail.com
Kim.JSLaw@gmail.com
Kendall.JSLaw@gmail.com
Telephone: (951) 506-9925
Facsimile: (951) 506-9725

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VIA US MAIL AND EMAIL

John Oquendo
Associate Planner
County of San Bernardino
Land Use Services Department
385 N. Arrowhead Avenue
San Bernardino, CA 92415-0182
John.oquendo@lus.sbcounty.gov

RE: Initial Study/ Mitigated Negative Declaration for Pacific Industrial/Bloomington Truck Terminal Project, Conditional Use Permit (P201300121), Tentative Tract Map (TT 19448)

Greetings:

On behalf of concerned area residents and Center for Community Action and Environmental Justice, I hereby submit these comments on the Mitigated Negative Declaration (MND) and Initial Study (IS) for, and in opposition to, the Bloomington Truck Terminal Project, Conditional Use Permit (P201300121) to develop a 708,240 sf industrial building to be used as a high cube warehouse distribution facility on 36.70 acres, with a Tentative Tract Map (TT19448) to subdivide 54.3 acres into two parcels (the "Project").

General Comments:

Preparation of an Environmental Impact Report ("EIR") is absolutely essential for this Project. The California Environmental Quality Act ("CEQA") was adopted as a disclosure and transparency document. The theory is that by providing a document that adequately describes the environmental consequences of a project to decision makers and the public, the decision makers will make a rational decision based upon the true environmental consequences of the project and if they do not, the electorate can hold them accountable for their decisions. The core of this statutory structure is the adequacy of the document as an informational document.

The EIR requirement is the "heart of CEQA." (State CEQA Guidelines § 15003(a). An EIR is required for any proposed project that may have a significant effect on the environment. (Public Resources Code § 21100 (a)) A lead agency may prepare a MND for a proposed project only when: (1) revisions in the project would avoid or mitigate the potentially significant project effects to a point where *clearly* no significant effects would occur; and (2) there is no substantial evidence in light of the whole record that the project as revised *may* have a significant effect on the environment. (State CEQA Guidelines § 15070 (b))

The adoption of a MND for the Project is improper where, as here, there is substantial evidence in the record of a fair argument of significant environmental impacts as a result of the project. The Project is likely to have significant impacts that were not adequately addressed in the MND. Specifically, there is a fair argument that the project will have significant impacts to/from, at least, air quality/health risks, traffic, greenhouse gas emissions, noise, biological resources, hydrology/water quality, noise, utilities, and regional and cumulative impacts. (Note also: page 5 of the Initial Study fails to check any impacts as "potentially significant," despite finding the project could have a significant environmental effect absent mitigation.)

Additionally, the conclusions in the IS/MND are unacceptably conclusory and not based on substantial evidence. For example, the entire aesthetics portion of the IS finds no or less than significant aesthetic impacts would result from the Project, but fails to support this finding with any evidence or citation to supporting documents.

The potentially significant impacts of this Project are also not shown to be mitigated below a level of significance. Moreover, CEQA requires that, if mitigation is adopted for a project, all proposed mitigation measures are fully enforceable and certain to occur. The mitigation proposed with this Project is vague, uncertain, and unenforceable and improperly deferred.

Lastly, the IS/MND was not circulated to the State Clearinghouse as required for this Project of local and regional significance.

As discussed below, the MND prepared for this Project fails to disclose and evaluate significant effects as required by CEQA. Preparation of an EIR is needed as the Project will result in potentially significant impacts, and mitigation has not been incorporated to clearly reduce such impacts below a level of significance.

Project Summary

The Project proposes to develop a 708,240 sf industrial building to be used as a high cube warehouse distribution facility on 36.70 acres, with a Tentative Tract Map (TT19448) to subdivide 54.3 acres into two parcels (the "Project"). The proposed warehouse will contain 20,000 sf of ancillary office space. The Project site consists of a T-shaped 36.7 ac portion of an existing 54.2 ac freight transfer facility, which will be separated from the existing development through tentative tract map TT19448. The Project would include 104 truck bays/ doors.

The freight transfer facility currently contains three industrial buildings totaling 197,771 sf with paved areas for truck, trailer, and passenger vehicle parking. 131,171 sf of the existing building area would be razed for construct the proposed Project.

The Project site is located on the north side of Slover Avenue, west of Linden Avenue, south of the I-10 freeway in the community of Bloomington. The Project site is also immediately south of Southern Pacific Railroad improvements. Surrounding land uses include the freight transfer facility, railroad and I-10, vacant land, single- and multi-family residential, and industrial. The closest residences are to the west approximately 100 feet from the Project's boundary. Additionally, residences to the southeast are approximately 600 ft from the Project's property line, and to the south approximately 160 ft from the property line.

The General Plan Land Use designation for the site is IC (Community Industrial), which permits the development of warehouse distribution facilities larger than 80,000 sf subject to approval of a Conditional Use Permit. Truck bays and corresponding loading areas are located along the east and west elevations of the proposed building.

Aesthetics

There is absolutely no substantial evidence in the IS/MND to support the claim that impacts to aesthetics will be no impact or less than significant.

Traffic/ Transportation

The traffic study prepared for the Project and IS/MND section regarding traffic are completely deficient in considering the Project's traffic impacts. Traffic impacts are potentially significant, and the IS/MND completely fails as an informational document.

The Project trip generation rates used in the traffic study are flawed. The Project relies on ITE rates for overall trip generation, vehicle fleet mix was based on the Fontana Trip General Study which greatly underestimates the percentage of heavy trucks accessing the site. SCAQMD recently recommended in 2012 that truck trip percentage *not* be generated from the Fontana study or ITE rates. SCAQMD recommends a trip rate of 2.57 trips/ 1,000 sf and 40% trucks for evaluating single high cube warehouse projects to provide a worst-case assumption consistent with CEQA. ("High-Cube Warehouse Truck Study: Technical Working Group" (March 8, 2012), < http://www.aqmd.gov/ceqa/Warehouse/WarehouseTWG30812.pdf>.) For this 708,240 sf, the Project would be expected to generate 1,820 trips per day of which 728 were trucks. This is well above the traffic study's projected 1,190 trips per day of which only 243 are trucks.

Applying the ratio of 2, 3, and 4+ axle trucks for truck distribution used in the traffic study to the 728 truck trips generated by the use of SCAQMD recommended trip generation, PCE trips would amount to: 1,572 PCE trips (4+Axle trucks), 262 PCE Trips (3- Axle), and 109 (2-Axle). With the 1,092 passenger car trips, the total PCE Trip Generation for the Project would be 3,035. This is almost double the estimate of the traffic study of 1,560 PCE trips. Moreover, the Net PCE trips over the existing building is 2,104, over three times the 629 Net PCE trips estimated (when compared with 70% traffic of the existing freight facility). As evidenced, the traffic study greatly understates Project trip generation and PCE trips.

The traffic study considers impacts at only seven intersections, four of which are driveways to the Project and all of which are directly adjacent to the Project. The traffic study did not evaluate any impacts to I-10 on- or off-ramps or I-10 highway segments, or intersections more distant from the Project site despite the fact that the Project would operate as a high cube distribution warehouse and thus have trucks traveling along such roadways and highways. The air quality analysis assumes an average travel distance of 40 miles, whereas the traffic study seems to assume an average travel distance of one block. At the very least, the traffic study and IS must be updated to evaluate impacts at the following intersections:

- Cedar Ave./ Slover Ave.
- Sierra Ave./ Slover Ave.
- Slover Ave./Production Ave.
- Slover Ave./Laurel St.
- Slover Ave./Alder Ave.
- Slover Ave./ Tamarind Ave.
- Slover Ave./ Orchard St.
- Slover Ave./ Valencia St.
- Cedar Ave. and I-10 on- and off-ramps
- Sierra Ave. And I-10 on- and off-ramps
- I-10 and I-15 Junction
- I-10 and I-215 Junction

The traffic study also wrongly fails to consider impacts along roadway segments, instead looking only to intersection delays. The traffic study fails to consider roadway capacities. The traffic study and IS must also be updated to evaluate impacts for at least the following roadway/highway segments:

- I-10 highway segments en route to expected destinations.
- The length of Slover Ave. between Cedar Ave. and Sierra Ave.
- Locust Ave. to Slover Ave.
- Linden Ave. to Slover Ave.

The traffic study assumes equal amounts of passenger cars will travel east and west, but that no traffic will travel south beyond Slover Ave. Given the residences south of Slover, this assumption is not supported.

The figures in the traffic study are also inaccurate, labeling intersection 7 as Maple/Slover where intersection 7 is Linden/Slover. (See, eg. Figures 5, 6, 7, etc.) Figure 8 incorrectly labels this Linden/Slover intersection as Dwy 3/Slover. Figures 12, 13, etc show vehicles exiting Maple from north of Slover where, with the Project, Maple north of Slover will no longer exist.

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Existing peak traffic volumes without the Project on Slover Ave. traveling west are up to 491 PCEs am west of Locust; traveling east on Slover Ave., existing peak traffic volumes are up to 426 PCEs. Opening year without the Project would be up to 520 PCE traveling west. These peak volumes would likely increase *substantially* given a fair estimation of Project traffic, and with cumulative traffic as discussed below.

The traffic study and IS fail to consider future traffic with the Project. General Plan Buildout with and without the Project should be evaluated and disclosed.

The miniscule scope of the traffic study also results in completely understated cumulative traffic impacts. Because the traffic study limits to only seven intersections, only **two other projects** were included in the cumulative impact analysis as also potentially effecting those intersections. The geographic scope of the traffic study and scope of the cumulative impact analysis must be expanded.

Construction traffic impacts are also not evaluated or mitigated. As construction traffic impacts may be significant, the following mitigation measures must be incorporated:

1. Provide temporary traffic controls such as a flag person, during all phases of construction to maintain smooth traffic flow.
2. Provide dedicated turn lanes for movement of construction trucks and equipment on- and off-site.
3. Reroute construction trucks away from congested streets and sensitive receptor areas.
4. Configure construction parking to minimize traffic interference.
5. Prior to the issuance of a grading and building permit, the applicant shall submit verification that a ridesharing program for the construction crew has been encouraged and will be supported by the contractor via incentives or other inducements.
6. Minimize construction worker trips by requiring carpooling and providing for lunch onsite.
7. Provide shuttle service to food service establishments/commercial areas for the construction crew.
8. Provide shuttle service to transit stations/multimodal centers for the construction crew.
9. Improve traffic flow by signal synchronization.
10. Work with Caltrans to ensure adequate LOS at impacted on- and off-ramps.

Mitigation for operational impacts may include several of the measures detailed within the air quality section of this letter, such as ride sharing programs. Other mitigation may include road improvement requirements; however, given the absence of needed information in the MND, the necessary requirements are uncertain.

For operational traffic impacts, until the traffic study is re-prepared, adequate mitigation for traffic impacts may not be formulated and incorporated into the Project. Traffic impacts to state highway facilities will likely remain significant and unavoidable as a result of delays by Caltrans in making improvements, no plan for no future improvements, and/or no alternative mechanism by which mitigation fees are paid in lieu of directly improving these state highway facilities. Traffic impacts should be deemed significant and an EIR prepared for the Project.

Furthermore, the inadequate analysis of this Project's potential traffic impacts renders the other studies of the IS/MND deficient and inaccurate. The air quality analysis, health risk analysis, noise study, etc. must be updated to accurately reflect this Project's effects to traffic.

Air Quality

The CalEEMod estimates for air quality impacts find that short term regional construction emissions may be less than significant *if mitigated*, as the model was run as "Mitigated Construction." The IS and air quality study, however, fails to incorporate any mitigation measures to achieve this level of emissions beyond the emissions control measures required by SCAQMD Rule 403. Absent mitigation, construction air quality impacts will be significant. There is no reasoning or support provided in the air quality analysis or is for using CalEEMod outputs for "Mitigated Construction" instead of unmitigated construction. Unmitigated construction outputs would likely show exceedences of the short term regional thresholds for at least NOx and ROG, and LST Impacts for at least NOx, PM10, and PM2.5.

The use of SCAQMD LST modeling for a 4.0 acre site is also inappropriate. As stated by SCAQMD, "The LST mass rate look-up tables only apply to projects that are less than or equal to five acres.…In the event that the project area exceeds five acres, it is recommended that lead agencies perform project-specific air quality modeling for these larger projects." (http://www.aqmd.gov/ceqa/handbook/lst/lst.html, *see also,* http://www.aqmd.gov/ceqa/handbook/lst/Method_final.pdf at p. 3-3 ["Large industrial projects… are beyond the scope of these LST lookup tables."]) The fact that 4.0 ac may be disturbed a day is immaterial. Project specific modeling must be prepared for this potential impact, particularly where residential uses are located in close proximity to the Project site.

The IS also presumes grading would be unnecessary for the most part since the Project has been previously graded. However, the south-central portion of the site is currently in use a detention basin so that some grading and potentially the import of soils to raise that portion of the site will likely be needed. The IS/MND fails to address this issue.

Operational: The operational impacts of the Project need to be reevaluated accounting for the substantial understatement of trips and truck trips in the traffic study. Ambient air quality at the Project site often exceeds state or federal standards for O3, PM2.5, and PM10, and the Project will likely result in increases above these exceedences regionally and locally.

Similar to the above discussion construction emissions, the use of LSTs for a 5 acre site is unsupported where the Project site is far in excess of 5 acres. Project specific modeling of LSTs must occur.

The cumulative impact discussion in the air quality analysis is deficient and fails to at all quantify this Project's predicted cumulative effects. The air quality analysis fails to list any projects that would cumulatively result in construction air quality impacts. Even not accounting for the use of mitigated modeling, the Projects disclosed construction emissions are very near to regional thresholds for at least NOx and ROG, and LST thresholds for at least NOx, PM10, and PM2.5, so that a small increase in emissions from cumulative projects could easily lead to an exceedence of these thresholds.

Regarding cumulative operational impacts, the air quality analysis finds the Project *would* exacerbate non-attainment of air quality standards in the Basin and contribute to adverse cumulative air quality impacts. (Air Quality analysis p. 56.) The IS and air quality analysis, however, fail to quantify these impacts or show that mitigation *will* reduce these impacts below a level of significance.

Reliance on the AQMP for projections of cumulative impacts is inappropriate in determining the Project's cumulative air quality impact locally. The IS and air quality analysis fails to quantify or disclose local cumulative impacts.

Mitigation adopted to reduce the Project's air quality impacts restates, for the most part, existing requirements, e.g.: MM III-1 which for the most part combines SCAQMD, County, and CARB requirements; MM III-2, which provides the manner of compliance with SCAQMD guidelines; MM III-2 which includes some SCAQMD regulations; MM III-4 which implements SCAQMD guidelines; etc. The IS should clarify what mitigation measures are independent of existing rules and requirements.

As the Project will result in significant construction and operational impacts not disclosed or adequately mitigated in the IS/MND, an EIR is absolutely needed to evaluate Project air quality effect. Additionally, the following mitigation measures should be incorporated:

<u>CONSTRUCTION</u>

1. Gravel pads must be installed at all access points to prevent tracking of mud onto public roads.
2. Install and maintain trackout control devices in effective condition at all access points where paved and unpaved access or travel routes intersect (eg. Install wheel shakers, wheel washers, and limit site access.)
3. All roadways, driveways, sidewalks, etc., should be completed as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.
4. Pave all construction roads.
5. Pave all construction access roads at least 100 feet on to the site from the main road.
6. The maximum vehicle speed on unpaved roads shall be 15 mph.
7. Limit fugitive dust sources to 20 percent opacity.
8. Require a dust control plan for earthmoving operations.
9. When materials are transported off-site, all material shall be covered, effectively wetted to limit visible dust emissions, and at least six inches of freeboard space from the top of the container shall be maintained.

10. All streets shall be swept at least once a day using SCAQMD Rule 1186 certified street sweepers utilizing reclaimed water trucks if visible soil materials are carried to adjacent streets.
11. The contractor or builder shall designate a person or persons to monitor the dust control program and to order increased watering, as necessary, to prevent transport of dust offsite.
12. Post a publicly visible sign with the telephone number and person to contact regarding dust complaints. This person shall respond and take corrective action within 24 hours.
13. Extend grading period sufficiently to reduce air quality impacts below a level of significance.
14. The simultaneous disturbance of the site shall be limited to five acres per day.
15. Adequate watering techniques shall be employed to mitigate the impact of construction-related dust particulates. Portions of the site that are undergoing surface earth moving operations shall be watered such that a crust will be formed on the ground surface, and then watered again at the end of each day. Site watering shall be performed as necessary to adequately mitigate blowing dust.
16. Any vegetative cover to be utilized onsite shall be planted as soon as possible to reduce the disturbed area subject to wind erosion. Irrigation systems required for these plants shall be installed as soon as possible to maintain good ground cover and to minimize wind erosion of the soil.
17. Any on-site stockpiles of debris, dirt or other dusty material shall be covered or watered three times daily.
18. Apply non-toxic soil stabilizers according to manufactures' specifications to all inactive construction areas (previously graded areas inactive for ten days or more).
19. Any site access points within 30 minutes of any visible dirt deposition on any public roadway shall be swept or washed.
20. Excavating and grading operations shall be suspended during first stage ozone episodes or when winds exceed 25 mph as instantaneous gusts. A high wind response plan shall be formulated for enhanced dust control if winds are forecast to exceed 25 mph in any upcoming 24-hour period.
21. Prohibit truck idling in excess of five minutes both on- and off-site.
22. Implement activity management techniques including a) development of a comprehensive construction management plan designed to minimize the number of large construction equipment operating during any given time period; b) scheduling of construction truck trips during non-peak hours to reduce peak hour emissions; c) limitation of the length of construction work-day period; and d) phasing of construction activities.*
23. Develop a trip reduction plan to achieve a 1.5 AVR for construction employees.*
24. Require high pressure injectors on diesel construction equipment.*
25. Restrict truck operation to "clean" trucks, such as a 2007 or newer model year or 2010 compliant vehicles.*
26. All diesel powered construction equipment in use shall require control equipment that meets, at a minimum Tier IV emission requirements. In the event Tier IV equipment is not available, diesel powered construction equipment in use shall require emissions control equipment with minimum of Tier III diesel standards.*

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27. Require the use of CARB certified particulate traps that meet level 3 requirements on all construction equipment.*
28. Utilize only CARB certified equipment for construction activities.*
29. The developer shall require all contractors to turn off all construction equipment and delivery vehicles when not in use and/or idling in excess of 3 minutes.*
30. Restrict engine size of construction equipment to the minimum practical size.*
31. Use electric construction equipment where technically feasible.*
32. Substitute gasoline-powered for diesel-powered construction equipment.*
33. Require use of alternatively fueled construction equipment, using, e.g., compressed natural gas, liquefied natural gas, propane, or biodiesel.*
34. Use methanol-fueled pile drivers.*
35. Install catalytic converters on gasoline-powered equipment.*
36. Use electricity from power poles rather than temporary diesel or gasoline power generators.*
37. Require the use of Alternative Diesel Fuels on diesel equipment used. Alternative diesel fuels exist that achieve PM10 and NOx reductions.
38. Electrical powered equipment shall be utilized in-lieu of gasoline-powered engines where technically feasible.*
39. All forklifts shall be electric or natural gas powered.*
40. Any construction equipment using direct internal combustion engines shall use a diesel fuel with a maximum of 0.05 percent sulfur and a four-degree retard.*
41. Suspend use of all construction equipment operations during second stage smog alerts.*
42. Demonstrate proper inspection and maintenance of construction equipment.*
43. Employ a construction site manager to verify that engines are properly maintained and keep a maintenance log.*
44. Consolidate truck deliveries when possible.*
45. Establish a staging zone for trucks that are waiting to load or unload material at the work zone in a location where diesel emissions from the trucks will have minimum impact on abutters and the general public.
46. Locate construction equipment away from sensitive receptors including, fresh air intakes to buildings, air conditioners and operable windows.
47. Require all diesel trucks used by construction contractors at the site, or for on-road hauling of construction material, to be post-2007 models or 2010 compliant vehicles.
48. Diesel portable generators shall not be allowed at the construction site.
49. Use to the extent technologically feasible hybrid and fuel efficient construction equipment and support vehicles. (e.g. pick up trucks.)*
50. Use a Heavy-Duty Off-Road Vehicle Plan to ensure compliance with construction mitigation measures, incorporating the use of at least hourly meters on equipment; documentation of the serial number, horsepower, manufacturing age, fuel, etc. of all onsite equipment; and daily logging the operating hours of equipment.
51. All off-road diesel-powered construction equipment greater than 50 hp shall meet Tier 3 off-road emissions standards. In addition, all construction equipment shall be outfitted with BACT devices certified by CARB. Any emissions control device used by the contractor shall achieve emissions reductions that are no less than what could be achieved by a Level 3 diesel emissions control strategy for a similarly sized engine as defined by CARB regulations.

52. By January 1, 2015, all off-road diesel-powered construction equipment greater than 50 hp shall meet Tier 4 emissions standards, where available. In addition, all construction equipment shall be outfitted with BACT devices certified by CARB. Any emissions control device used by the contractor shall achieve emissions reductions that are no less than what could be achieved by a Level 3 diesel emissions control strategy for a similarly sized engine as defined by CARB regulations.
53. A copy of each unit's certified tier specification, BACT documentation, and CARB or AQMD operating permit shall be provided at the time of mobilization of each applicable unit of equipment.
54. During Project construction, the applicant will be required to solicit bids that include use of energy and fuel efficient fleets.*
55. During Project construction, the applicant will be required to solicit preference construction bids that use BACT, particularly those seeking to deploy zero- and/or near zero emission technologies.*
56. During Project construction, the applicant will be required to use the minimum feasible amount of GHG emitting construction materials that is feasible.*
57. During Project construction, the applicant will be required to use cement blended with the maximum feasible amount of flash or other materials that reduce GHG emissions from cement production to the extent feasible.*
58. Require preparation of a traffic control plan.*
59. Provide temporary traffic controls such as a flag person, during all phases of construction to maintain smooth traffic flow.*
60. Provide dedicated turn lanes for movement of construction trucks and equipment on- and off-site.*
61. Reroute construction trucks away from congested streets and sensitive receptor areas.*
62. Configure construction parking to minimize traffic interference.*
63. Prior to the issuance of a grading and building permit, the applicant shall submit verification that a ridesharing program for the construction crew has been encouraged and will be supported by the contractor via incentives or other inducements.*
64. Implement a carpool program for construction workers.*
65. Minimize construction worker trips by requiring carpooling and providing for lunch onsite. *
66. Provide shuttle service to food service establishments/commercial areas for the construction crew.*
67. Provide shuttle service to transit stations/multimodal centers for the construction crew.*
68. Develop a Low-impact Construction Commuting Plan for all tradespersons to utilize during Project construction. This Plan shall address the home to office/shop commute and office/shop to jobsite commute and increase carpooling and other commuting efficiencies during construction.*

OPERATIONAL EMISSIONS

1. All fleet vehicles and all heavy duty trucks entering the property must meet or exceed 2010 air quality emissions standards, specified in Cal. Code of Regulations Title 13, Art. 4.5, Chapter 1, Section 2025. Results, including backup data shall be reported to the Planning Department semi-annually.*

2. (ALTERNATIVELY from 1 above) The operator of the primary facilities shall incorporate requirements or incentives sufficient to achieve at least 20% per year (as a percentage of previous percentage, not total trips) increase in percentage of long haul trips carried by 2010 compliant trucks carriers until it reaches a minimum of 90% of all long haul trips carried by 2010 compliant trucks. Results, including backup data shall be reported to the Planning Department semi-annually.*
3. The operator of the primary facilities shall become SmartWay Partner.*
4. The Project shall meet SmartWay 1.25 ratings.*
5. The Project shall use only freight companies that meet SmartWay 1.25 ratings.*
6. (ALTERNATIVELY from 4, 5 above) The operator of the primary facilities shall incorporate requirements or incentives sufficient to achieve at least 20% per year (as a percentage of previous percentage, not total trips) increase in percentage of long haul trips carried by SmartWay carriers until it reaches a minimum of 90% of all long haul trips carried by SmartWay 1.0 or greater carriers. Results, including backup data shall be reported to the Planning Department semi-annually.*
7. All spaces utilizing refrigerated storage, including restaurants and food or beverage stores, shall provide an electrical hookup for refrigeration units on delivery trucks. Trucks incapable of utilizing the electrical hookup for powering refrigeration units shall be prohibited from accessing the site. All leasing documents shall include these requirements and provide that violation of those provisions will constitute a material breach of the lease that will result in the termination of the lease. Because of the fact that these terms of the lease are designed to benefit the public, the public shall be considered to be a third party beneficiary with standing to enforce the requirements of the lease.*
8. Install catalytic converters on gasoline-powered equipment.*
9. Where diesel powered vehicles are necessary, require the use of alternative diesel fuels. Alternative diesel fuels exist that achieve PM10 and NOx reductions. Electrical powered equipment should be utilized in-lieu of gasoline-powered engines where technically feasible.*
10. Utilize electrical equipment for landscape maintenance.*
11. All forklifts shall be electric or natural gas powered.*
12. Utilize electric yard trucks, yard goats, and hostlers. Prohibit the use of diesel powered yard trucks, yard goats, and hostlers.*
13. Prohibit idling of trucks for periods exceeding three minutes both on warehouse property and on nearby streets.*
14. Provide electrical vehicle (“EV”) and compressed natural gas (“CNG”) vehicles in vehicle fleets.*
15. Charge reduced or no parking fee for EVs and CNG vehicles.*
16. Install EV charging facilities for a minimum of 10% of all parking spaces.*
17. Install a CNG fueling facility.*
18. Provide preferential parking locations for EVs and CNG vehicles.*
19. Implement parking fee for single-occupancy vehicle commuters.*
20. Plant shade trees in parking lots to provide minimum 50% cover to reduce evaporative emissions from parked vehicles.*
21. Plant at least 50 percent low-ozone forming potential (Low-OFP) trees and shrubs, preferably native, drought-resistant species, to meet city/county landscaping requirements.*

22. Plant Low-OFP, native, drought-resistant, tree and shrub species, 20% in excess of that already required by city or county ordinance. Consider roadside, sidewalk, and driveway shading.*
23. Orient 75 percent or more of homes and buildings to face either north or south (within 30 degrees of N/S) and plant trees and shrubs that shed their leaves in winter nearer to these structures to maximize shade to the building during the summer and allow sunlight to strike the building during the winter months.*
24. Provide grass paving, tree shading, or reflective surface for unshaded parking lot areas, driveways, or fire lanes that reduce standard black asphalt paving by 10% or more.*
25. Prohibit gas powered landscape maintenance equipment within residential, commercial, and mixed-use developments. Require landscape maintenance companies to use battery powered or electric equipment **or** contract only with commercial landscapers who operate with equipment that complies with the most recent California Air Resources Board certification standards, or standards adopted no more than three years prior to date of use or any combination of these two themes.*
26. Implement parking cash-out program for non-driving employees.*
27. Require each user to establish a carpool/vanpool program.*
28. Provide preferential parking for carpool/vanpool vehicles.*
29. Provide subsidies or incentives to employees who use public transit or carpooling, including preferential parking.*
30. Provide secure, weather-protected bicycle parking for employees.*
31. Provide direct, safe, attractive pedestrian access from project to transit stops and adjacent development.*
32. Provide direct safe, direct bicycle access to adjacent bicycle routes.*
33. Provide showers and lockers for employees bicycling or walking to work.*
34. Connect bicycle lanes/paths to city-wide network.*
35. Design and locate buildings to facilitate transit access, e.g., locate building entrances near transit stops, eliminate building setbacks, etc.*
36. Construct transit facilities such as bus turnouts/bus bulbs, benches, shelters, etc.*
37. Provide a display case or kiosk displaying transportation information in a prominent area accessible to employees.
38. Provide shuttle service to food service establishments/commercial areas.*
39. Provide shuttle service to transit stations/multimodal centers.*
40. All buildings shall be constructed to LEED Gold standards.*
41. Buildings shall exceed Title 24 requirements by 20%.*
42. Design buildings for passive heating and cooling and natural light, including building orientation, proper orientation and placement of windows, overhangs, skylights, etc.*
43. Construct photovoltaic solar or alternative renewable energy sources sufficient to provide 100% of all electrical usage for the entire Project.*
44. Install an ozone destruction catalyst on all air conditioning systems.*
45. Construct renewable energy sources sufficient to offset the equivalent of 100% of all greenhouse gas emissions from mobile sources (internal combustion engines) for the entire Project. *
46. Purchase only green/ renewable power from the electric company.*
47. Install solar water heating systems to generate all hot water requirements.*
48. Require all on-site vehicles to use zero or near-zero emission technology.*

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49. Require the installation of sufficient alternative fueling infrastructure such as electric charging, CNG/LNG, hydrogen, etc.; for all trucks on-site and/or within close proximity to the site. Employ these technologies and phase-in further use. (e.g. 10% by 2015, 20% by 2020, etc.)*
50. Provide a phase-in schedule and goals for the introduction of zero or near zero emission technology trucks that visit the site, beginning with 10% upon completion of construction and increasing to at least 20% within 5 years, etc.*
51. The facility operator shall maintain a log of all trucks entering the facility to ensure that, on average, the daily truck fleet meets the quantities and emissions disclosed in the MND. The facility operator shall, on average, ensure that trucks entering the facility are limited to the quantity disclosed in the MND. The log of trucks shall be available for inspection by County Staff at any time.*
52. If higher truck volumes are anticipated to visit the site than analyzed in the MND, the operator shall seek, and the lead agency shall commit to, re-evaluate the additional impacts through CEQA prior to determining to allow or disallow this higher activity level.
53. The facility operator shall ensure that onsite staff in charge of keeping a daily log and monitoring for excess idling be trained and certified in diesel health effects and technologies. (For example, by requiring attendance at CARB approved courses.)
54. Limit project operations to non-refrigerated warehouse types of trucks and appurtenances.
55. Require tenants upon occupancy that do not already operate 2007 and newer trucks to apply in good faith for funding to replace/retrofit their trucks such as Carl Moyer, Prop 1B, VIP, HVIP, and SOON funding programs, as identified on SCAQMD's website (http://www.aqmd.gov). Should funds be awarded, the tenant shall be required to accept and use them.
56. Restrict overnight parking in residential areas. Establish overnight parking within the warehouse/distribution center where trucks can remain overnight.
57. Establish areas within the facility for truck repairs to ensure well-maintained vehicles and reduce travel for repairs.
58. For all warehouse uses of the proposed Project, the loading docks shall be designed to accommodate SmartWay trucks. For example, the aerodynamic equipment for trailers may include use of "Boat Tails" that attach to the end of the trailer and may potentially be incompatible with loading bays designed with certain dock shelters. (http://www.epa.gov/smartway/technology/designated-tractors-trailers.htm) Proof of compliance shall be provided in building plans prior to the issuance of building permits and subject to on-site verification prior to occupancy.*
59. The Project is required to reduce waste by 15 percent through a waste diversion program that requires recycling and composting from some or all uses on the Project site. This will be required by the County prior to issuances of building permits.*
60. All Project buildings must be constructed to allow for easy, cost-effective installation of solar energy systems in the future, using such "solar-ready" features as: Clear access without obstructions (chimneys, heating and plumbing vents, etc.) on the south sloped roof; Designing the roof framing to support the addition of solar panels; and Installation of electrical conduit to accept solar electric system wiring.*

61. Prior to the issuance of a certificate of occupancy, the applicant shall provide the developer/ operator with information regarding energy efficiency, solid waste reduction, recycling, motor vehicle-related greenhouse gas emissions, and water conservation best practices. The applicant shall also publicize information regarding solid waste reduction and recycling best practices to developers and tenants. Finally, the applicant shall encourage the use of alternative transportation methods among its tenants, including bus transit, vanpools, carpools, and car- and ridesharing programs.

HEALTH RISKS

The IS/MND utterly fails to adequately disclose and assess health risk impacts as the health risk portion of the air quality analysis relies on the deficient traffic study. The health risk assessment must be updated to assume 40% of the vehicles accessing the site are trucks and to assume higher trip generation pursuant to SCAQMD guidance. The health risk assessment must also evaluate potential health risks caused by increased traffic from the Project off-site, using an accurate projection of traffic trips and vehicle fleet mix, and considering the omitted intersections listed above. Health risk impacts are not shown to *clearly* be less than significant, and in fact are likely significant and unmitigated.

The HRA assumes just10 minutes of idling onsite. SCAQMD regularly recommends HRAs evaluate 15 minutes of idling onsite to account for idling/stacking upon entry/exit, as well as at idling at dock doors and parking. (*See e.g*. Letter from SCAQMD to City of San Bernardino Re: Draft Environmental Impact Report (Draft EIR) for the Proposed National Orange Show Industrial Project <http://www.aqmd.gov/ceqa/igr/2012/February/DEIRorangeshow.pdf> p. 4 paragraph 7.) Project health risks must be reevaluated accounting for 15 minutes of onsite idling. The health risk impacts of this Project are likely to be significant where the closest residences to the Project site are just 100 feet from the Project property line.

The IS fails to evaluate health risks from trucks traveling among truck routes to/from the Project site. The health risk impacts of this Project along these routes are likely to be individually and cumulatively significant where trucks from this Project and others in the vicinity would pass adjacent to and in the vicinity of many residences and nearby Bloomington High School on their way to I-10 along Slover, Cedar, and Sierra Avenues.

The IS and air quality analysis fail to estimate or evaluate the cumulative health risk impacts of this Project. There is no evidence cumulative health risk impacts would be less than significant, particularly where the air quality analysis acknowledges the Project would exacerbate nonattainment for PM10, PM2.5, and O3. Any reevaluated health risk assessment for this Project must consider impacts from cumulative past, present, and probable future projects that would contribute to health risk impacts in the Project area.

Where *existing* health risk impacts in the Project area are estimated up to 906 cancers per million according to SCAQMD's MATES III study, an accurate health risk assessment that discloses potential impacts to the public and decision-makers is absolutely essential. (MATES III Interactive Map, http://www3.aqmd.gov/webappl/matesiii/) The IS/MND fails to provide the public and decision-makers with needed information and an accurate assessment of the Project's individual and cumulative health risk impacts. Such effects are likely significant.

Diesel PM is known to cause immune system effects; reproductive, developmental, and endocrine effects; nervous system effects; and lung health problems, as recognized by the County in the General Plan. Immune system effects include increased allergic inflammatory responses and suppression of infection fighting ability. Diesel PM has also been associated with reproductive effects such as decreased sperm production, changes in fetal development, low birth weight and other impacts. Diesel PM exposure may also cause impairment to the central nervous system. (*The Health Effects of Air Pollution on Children*, Michael T. Kleinman, Ph.D, Fall 2000, <http://aqmd.gov/forstudents/health_effects_on_children.html#WhyChildren>; *See also, Diesel and Health in America: the Lingering Threat*, Clean Air Task Force, February 2005, <http://www.catf.us/resources/publications/files/Diesel_Health_in_America.pdf>)

With regards to respiratory and cancer effects of diesel PM, SCAQMD has stated the following:

> "Diesel particles consist mainly of elemental carbon and other carbon-containing compounds… Diesel particles are microscopic…Due to their minute size, diesel particles can penetrate deeply into the lung. There is evidence that once in the lung, diesel particles may stay there for a long time.
>
> In addition to particles, diesel exhaust contains several gaseous compounds including carbon monoxide, nitrogen oxides, sulfur dioxide and organic vapors, for example formaldehyde and 1,3-butadiene. Formaldehyde and 1,3-butadiene have been classified as toxic and hazardous air pollutants. Both have been shown to cause tumors in animal studies and there is evidence that exposure to high levels of 1,3-butadiene can cause cancer in humans…
>
> Diesel emissions may also be a problem for asthmatics. Some studies suggest that children with asthma who live near roadways with high amounts of diesel truck traffic have more asthma attacks and use more asthma medication.
>
> Some human volunteers, exposed to diesel exhaust in carefully controlled laboratory studies, reported symptoms such as eye and throat irritation, coughing, phlegm production, difficulty breathing, headache, lightheadedness, nausea and perception of unpleasant odors. Another laboratory study, in which volunteers were exposed to relatively high levels of diesel particles for about an hour, showed that such exposures could cause lung inflammation." (*The Health Effects of Air Pollution on Children, supra*; *See also, Mira Loma Commerce Center EIR No. 450, Air Quality, Section 4.*)

Furthermore, infants, children, and the elderly are more susceptible to diesel PM and its associated health impacts. With regards to infants and children, increased susceptibility to TACs and diesel PM exists for a variety of reasons. Children are generally more active than adults, have higher respiration rates, and inhale more pollutants deeper into the lung. Children also have more lung surface area in proportion to their body size and inhale more air pound for pound when compared to adults, taking in 20 to 50 percent more air and associated air pollutants than adults. When compared to adults, children spend more active time outdoors in polluted air environments and exert themselves harder than adults when playing outside. Importantly, this exposure to high pollutant levels in children occurs while their lungs are still developing, and therefore has more severe impacts on this sensitive group. (*The Health Effects of Air Pollution on Children, supra*.)

This increased susceptibility to air pollutant emissions for children has resulted in the California EPA Office of Environmental Health Hazard Assessment ("OEHHA") weighting cancer risk by a factor of 10 for exposures to carcinogens from birth to two years old, and by a factor of 3 for exposures from 2 years old to 15 years old. (*Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures*, California EPA OEHHA Air Toxicology and Epidemiology Branch, April 2009, p. 3. <http://www.oehha.ca.gov/air/hot_spots/pdf/TSDCPFApril_09.pdf.>) Additionally, recent studies conducted by SCAQMD's Brain and Lung Tumor and Air Pollution Foundation have found a specific connection between exposure to diesel PM and brain cancer in children. (Annual Meeting of the Brain & Lung Tumor and Air Pollution Foundation, April 2, 2010, <http://www.aqmd.gov/hb/2010/April/100425a.htm>)

In addition to an increased risk of cancer, the effects of diesel PM on children include slowed lung function and growth, increased emergency room visits, increased incidences of asthma and bronchitis, crib death, asthma respiratory infections, allergic symptoms, and asthma hospitalizations. (*Diesel and Health in America: the Lingering Threat, supra*.) An accurate projection of health risks is thus particularly necessary here where the Project is located in close proximity to Bloomington High School and many residences.

The following mitigation measures should be incorporated to reduce the health risk impacts of the Project:

1. The Project applicant shall fund the purchase, installation and maintenance of in-home air filtration systems for residential parcels impacted by the Project (once the HRA is updated to incorporate accurate traffic predictions, idling time, etc.) at a total cost of $1,700 per parcel. The air filtrations systems shall be selected by the owners of each parcel in consultation with SCAQMD.
2. Require enhancement of landscaping to provide a vegetative buffer zone along the eastern, western, and southern Project boundaries. Trees which reduce diesel particulate matter shall be planted in this buffer zone, examples of which include California Pepper Trees and Bottlebrush Trees. Sycamore trees may also be planted along with drought tolerant plants.
3. Create a buffer zone of at least 1,000 feet between warehouse/distribution center and sensitive receptors. Prohibit the placement of loading docks and truck routes within this area.
4. Design the Project so that any check-in point for trucks is well inside the facility property to ensure that no trucks queue outside of the facility.
5. Avoid locating Project entry/ exit points and driveways near closest residences and other sensitive receptors.
6. Design the Project so that interior vehicular circulation shall be located away from sensitive receptors. Require the Project clearly specify on the facility site primary entrance and exit points.
7. Require the Project to establish specific truck routes and post signs between the Project and the freeway/primary access arterial that achieves that objective and eliminate trucks from traversing residential areas.

8. Provide food, fueling, truck repair, and a convenience store onsite.
9. Require signage identifying where food, lodging, and entertainment can be found when not available onsite.
10. Require the installation of electric hook-ups to eliminate idling of main and auxiliary engines during loading, unloading, and when trucks are not in use.
11. Restrict idling within the facility to less than 3 minutes. Post signs within the facility stating that no idling in excess of 3 minutes is permitted.
12. Install clean fueling stations at the Project site.
13. Provide pamphlets to all truck drivers about the health effects of diesel particulates, the benefits of minimizing idling time, CARB regulations, and the importance of not parking in residential areas.
14. Require the posting of signs outside the facility providing a phone number which neighbors may call if there is an air quality issue. Require response to such calls within 24 hours.

GHGs

As the GHG estimates are based on "mitigated" construction emissions, yet the Project requires no construction mitigation; and operational emissions that substantially underestimate mobile source emissions, the GHG emissions estimates must be reevaluated and are presently unsupported by substantial evidence. It is likely GHG impacts will be significant. The Project should be required to install solar PV sufficient to generate enough energy to power at least the Project building.

The Climate Change Impact Analysis also indicates that the Project is consistent with the County's Greenhouse Gas Emission Reduction Plan based on the point system therein. The Climate Change Impact Analysis is, however, out of date as it was prepared in June 2013 based on Title 24 2008 standards. New Title 24 2013 standards have since been prepared and go into effect this year. The MND/IS should determine if the Project is consistent with the County's Greenhouse Gas Emission Reduction Plan based on the new Title 24 standards.

Biological Resources

The Biological Resources Report found impacts to birds protected under the Migratory Bird Treaty Act and/ or CDFG Code §§ 3503-3801 may occur, and that a pre-construction nesting survey should be required to avoid these effects. No mitigation in the form of avoiding construction during the nesting season, performing a pre-construction nesting survey, and avoidance of nests if found is required in the IS/MND. The Project thus results in potentially significant and unmitigated impacts to protected bird species.

Cultural Resources

The determination that cultural resources will be less than significant is unsupported by any evidence or references. The added conditions are insufficient to reduce potential effects below significance where they do not provide for a monitor onsite during Project construction and do not permit the diverting of construction to allow investigation and either avoidance or recovery of any find.

Hydrology/Water Quality

The Preliminary Drainage Report and Preliminary Water Quality Management Plan prepared by C&V Consulting, Inc. were not included with the IS/MND. Without these documents it is impossible to determine whether the IS/MND accurately finds that no hydrology/water quality impacts may occur based on substantial evidence.

The Project will be served by a septic system. There is no evidence septic will be adequate to service this Project.

The Project will develop significantly more impervious area than currently exists onsite. There is no evidentiary support for the finding the Project will not deplete groundwater through interfering with groundwater recharge.

Two detention basins presently exist onsite including one just west of center on the south side of the site, and one in the southeastern corner. The Project building would be constructed on the site of the bigger, central detention basin. At the very least, the drainage pattern of the site would thus need to be altered—a potentially significant impact. The IS/MND does not make any mention of these basins in evaluating impacts to hydrology/water quality; instead the detention basins are mentioned only in the evaluation of impacts to biological resources. The claims that the Project will not substantially alter the existing drainage patter on site, increase the rate of runoff, contribute to runoff, or degrade water quality are not supported where the IS/MND fails to disclose how drainage and runoff will be adequately dealt with in lieu of these detention basins. Impacts to hydrology and water quality are potentially significant and unmitigated.

Noise

Preparation of an EIR is needed to quantify, disclose, and mitigate the noise impacts of this Project to the extent feasible.

The IS/MND fails to disclose noise standards, exceedences thereof, or increases in ambient noise over existing levels.

The noise impact analysis (noise study) evaluates noise levels using varying measures which render apples to apples comparisons impossible. The noise study should be updated to permit such comparisons.

The noise study finds Project construction will result in noise levels up to 85 dBA at residences located near the Project, yet no mitigation is required for this noise impact. 85 dBA is well above the County's noise level standards for residences of 60 dBA CNEL, 75 dBA Lmax. Additionally, 85 dBA is a substantial increase in ambient noise levels in the Project area where such levels are presently a maximum of 57.9 dBA Leq 20 min. The noise study also improperly fails to evaluate these temporary noise increases over ambient levels, or find them to be significant. The requirement that construction be limited to daytime hours does not reduce these significant noise impacts experienced by residents during those hours. Construction noise impacts should be considered significant and unmitigated as they exceed noise standards and cause substantial increases in ambient noise, and no mitigation is adopted to reduce these effects below significance.

The following mitigation measures must be adopted to reduce impacts from construction noise:

1. During construction, install construction noise barriers with a minimum STC rating of 20 around the site. An example of an acceptable barrier would be fencing covered with a quilted blanket (STC rating of 27).

2. Where technically feasible, utilize only electrical construction equipment

3. During construction, the developer shall require that all contractors turn off all construction equipment and delivery vehicles when not in use and prohibit idling in excess of 3 minutes.

4. Direct construction traffic away from sensitive receptors to the extent possible.

5. Locate any stockpiles, materials, and construction equipment at the furthest distance possible from sensitive receptors.

Operational noise onside may exceed nighttime standards if more than 10 trucks idle at the same time on the west side of the Project site. The noise study thus suggests mitigation be adopted to reduce operation of dock doors on the west side of the site to achieve at least a 5dBA reduction in noise.

Operational noise onside may exceed nighttime standards if more than 16 trucks idle at the same time on the east side of the Project site. The noise study thus suggests mitigation be adopted to reduce operation of dock doors on the east side of the site to achieve at least a 4dBA reduction in noise.

Operational noise onside may exceed nighttime standards if more than 8 refrigerated trucks idle at the same time to the southeast of the Project site. The noise study thus suggests mitigation be adopted to reduce operation of dock doors on the southeast side of the site to achieve at least a 7dBA reduction in noise.

Not all of this proposed mitigation was incorporated into the Project.

Moreover, these noise predictions *only* include noise from truck operation. Parking lot activity, fans, etc. will increase noise from the Project site as well, requiring further decreases of truck or other noise to adequately reduce noise levels below significance. Also, noise from the Project site may exceed the 55 dBA L50 standard for daytime as well incorporating these other noise sources. The MND fails to evaluate total noise impacts from operation on the Project site; and it is clear such impacts may be significant and are not adequately mitigated.

The noise study fails to evaluate operational Project noise increases over ambient levels for stationary sources.

Traffic noise increases may be up to 2.9dBA at 50 feet on Locust Ave. north of Slover Ave. where noise levels are presently low, at 43.5 dBA CNEL. Under CEQA, consideration must be given to the magnitude of any noise increase, the existing ambient noise levels, and the location of noise-sensitive receptors in order to determine if a noise increase represents a significant adverse environmental effect. This is because noise impacts may be greater if substantial increases occur in a relatively quiet area, or if noise is added to an existing high noise level in a manner that increases noise to a problem/tipping point level. (*See, e.g., Gray v. County of Madera* (2008) 167 Cal.App.4th 1099, 1122-23.) The 2.9 dBA increase should be considered a significant impact as this substantial increase occurs in a relatively quiet area, and may thus be noticeable.

Cumulative noise impacts are not considered in the MND. Also, traffic noise impacts are limited to just those few intersections adjacent to the Project site without consideration for areas of higher traffic to be used by the Project (e.g. I-10 on- and off-ramps).

The following additional mitigation should be incorporated to reduce operational noise impacts from the Project.

1. Provide upgraded windows with a minimum Sound Transmission Class (STC) rating of 34 for all buildings, and/or require the installation of double-paned windows for residences impacted by the Project.

2. Keep new driveways away from noise sensitive receptors to the extent possible.

3. Require the use of rubberized asphalt for construction of all roadways and parking areas.

4. Maintain quality pavement conditions that are free of bumps, pot holes, pavement cracks, differential settlement in bridge approaches or individual pavement slabs, etc.

5. Require resurfacing of roads adjacent to the Project or to be used by the Project.

<u>Utilities and Service Systems</u>

The determinations that the Project would not result in significant impacts to utilities and service systems is conclusory and unsupported by evidence included with the IS/MND. For example, there is no evidence or reasoning showing the existing on-site septic system is sufficient to serve the project. There is also no evidence the Mid-Valley landfill has sufficient capacity to accommodate the Project.

There is also no evidence West Valley Water District has determined there will be adequate water to serve the Project. No water supply assessment was prepared for this Project, and the IS/MND fails to disclose the Project's project water demand. There is no evidence the Project will not significantly deplete water supplies where any assurances by West Valley Water District or evidence supporting those assurances is not provided. A WSA may be needed.

The additional mitigation measures are available to reduce Project caused water supply impacts:

1. Use only recycled water for landscaping purposes. Require installation of a recycled water line to the Project.

2. Utilize low water intensive turf or artificial turf. Minimize the use of turf/ artificial turf to recreational areas.

3. Install only ultra-low-flow plumbing fixtures in all buildings.
4. Install only dual flush toilets, which allow users to choose a larger or smaller flush as needed.
5. Require drip irrigation for landscaping where technically feasible.
6. Require mulching or equivalent organic ground cover to reduce water needs for all landscaped areas.

Cumulative Impacts

The cumulative impact assessment for this Project is absolutely unacceptable and negligible. For most potential Project effects, cumulative projects were not at all considered. Where cumulative effects were evaluated, only two cumulative projects were considered. There is no evidence that limited consideration of just these two cumulative projects is appropriate, particularly for impacts to traffic, air quality, and other effects that are larger in scope and which cumulative projects from further away may cause individually insignificant to become cumulatively considerable.

Cumulative effects of the Project should be deemed significant for at least traffic, air quality, noise, utilities, and GHGs, among others. An EIR is essential to adequately consider such impacts.

Conclusion

Thank you for your consideration of these comments and the attached material.

Sincerely,

Raymond W. Johnson
JOHNSON & SEDLACK

<u>Attachments</u>

1. Google Map printout of site
2. California Air Resources Board. (October 24, 2008) *Preliminary Draft Staff Proposal, Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases under the California Environmental Quality Act.*

3. "White Paper of Potential Control Strategies to Address Cumulative Impacts from Air Pollution," SCAQMD, August 2003.

4. "AQMD Guidance Document for Addressing Air Quality Issues in General Plans and Local Planning," <http://www.aqmd.gov/prdas/aqguide/doc/aq_guidance.pdf>, May 6, 2005.

5. Air Resources Board "Emissions Inventory Methodology and Results"

6. "Final- Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds," SCAQMD, October 2006.

7. California Air Pollution Control Officers Association. (January 2008) *CEQA & Climate Change: Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act*.

8. Bay Area Air Quality Management District. (December 7, 2009) *California Environmental Quality Act Guidelines Update, Proposed Thresholds of Significance*.

9. U.S. Department of Transportation, Federal Highway Administration. (August 2006) *Construction Noise Handbook, Chapter 4.0 Construction Noise Criteria and Descriptors.*

10. U.S. Department of Transportation, Federal Highway Administration. (August 2006) *Construction Noise Handbook, Chapter 9.0 Construction Equipment Noise Levels and Ranges.*

11. U.S. Department of Housing and Urban Development. (March 1985) *The Noise Guidebook.*

12. Suter, Dr. Alice H., Administrative Conference of the United States. (November 1991) *Noise and Its Effects*.

13. Federal Interagency Committee on Urban Noise. (June 1980) *Guidelines for Considering Noise in Land Use Planning and Control*.

RAYMOND W. JOHNSON, Esq., AICP LEED GA
26785 Camino Seco
Temecula, CA 92590
(951) 506-9925
(951) 506-9725 Fax
(951) 775-1912 Cellular

Johnson & Sedlack, an Environmental Law firm representing plaintiff environmental groups in environmental law litigation, primarily CEQA.

City Planning:

Current Planning

- Two years principal planner, Lenexa, Kansas (consulting)
- Two and one half years principal planner, Lee's Summit, Missouri
- One year North Desert Regional Team, San Bernardino County
- Thirty years subdivision design: residential, commercial and industrial
- Thirty years as applicants representative in various jurisdictions in: Missouri, Texas, Florida, Georgia, Illinois, Wisconsin, Kansas and California
- Twelve years as applicants representative in the telecommunications field

General Plan

- Developed a policy oriented Comprehensive Plan for the City of Lenexa, Kansas.
- Updated Comprehensive Plan for the City of Lee's Summit, Missouri.
- Created innovative zoning ordinance for Lenexa, Kansas.
- Developed Draft Hillside Development Standards, San Bernardino County, CA.
- Developed Draft Grading Standards, San Bernardino County.
- Developed Draft Fiscal Impact Analysis, San Bernardino County

Environmental Analysis

- Two years, Environmental Team, San Bernardino County
    - Review and supervision of preparation of EIR's and joint EIR/EIS's
    - Preparation of Negative Declarations
    - Environmental review of proposed projects
- Eighteen years as an environmental consultant reviewing environmental documentation for plaintiffs in CEQA and NEPA litigation

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Representation:

- Represented various clients in litigation primarily in the fields of Environmental and Election law. Clients include:
  - Sierra Club
  - San Bernardino Valley Audubon Society
  - Sea & Sage Audubon Society
  - San Bernardino County Audubon Society
  - Center for Community Action and Environmental Justice
  - Endangered Habitats League
  - Rural Canyons Conservation Fund
  - California Native Plant Society
  - California Oak Foundation
  - Citizens for Responsible Growth in San Marcos
  - Union for a River Greenbelt Environment
  - Citizens to Enforce CEQA
  - Friends of Riverside's Hills
  - De Luz 2000
  - Save Walker Basin
  - Elsinore Murrieta Anza Resource Conservation District

Education:

- B. A. Economics and Political Science, Kansas State University 1970
- Masters of Community and Regional Planning, Kansas State University, 1974
- Additional graduate studies in Economics at the University of Missouri at Kansas City
- J.D. University of La Verne. 1997 Member, Law Review, Deans List, Class Valedictorian, Member Law Review, Published, Journal of Juvenile Law

Professional Associations:

- Member, American Planning Association
- Member, American Institute of Certified Planners
- Member, Association of Environmental Professionals
- Member, U.S. Green Building Council, LEED GA

Johnson & Sedlack, Attorneys at Law
26785 Camino Seco 12/97- Present
Temecula, CA 92590
(951) 506-9925

Principal in the environmental law firm of Johnson & Sedlack. Primary areas of practice are environmental and election law. Have provided representation to the Sierra Club, Audubon Society, AT&T Wireless, Endangered Habitats League, Center for Community Action and Environmental Justice, California Native Plant Society and numerous local environmental groups. Primary practice is writ of mandate under the California Environmental Quality Act.

Planning-Environmental Solutions
26785 Camino Seco 8/94- Present
Temecula, CA 92590
(909) 506-9825

Served as applicant's representative for planning issues to the telecommunications industry. Secured government entitlements for cell sites. Provided applicant's representative services to private developers of residential projects. Provided design services for private residential development projects. Provided project management of all technical consultants on private developments including traffic, geotechnical, survey, engineering, environmental, hydrogeological, hydrologic, landscape architectural, golf course design and fire consultants.

San Bernardino County Planning Department
Environmental Team 6/91-8/94
385 N. Arrowhead
San Bernardino, CA 92415
(909) 387-4099

Responsible for coordination of production of EIR's and joint EIR/EIS's for numerous projects in the county. Prepared environmental documents for numerous projects within the county. Prepared environmental determinations and environmental review for projects within the county.

San Bernardino County Planning Department
General Plan Team 6/91-6/92
385 N. Arrowhead
San Bernardino, CA 92415
(909) 387-4099

Created draft grading ordinance, hillside development standards, water efficient landscaping ordinance, multi-family development standards, revised planned development section and fiscal impact analysis. Completed land use plans and general plan amendment for approximately 250 square miles. Prepared proposal for specific plan for the Oak Hills community.

San Bernardino County Planning Department
North Desert Regional Planning Team
15505 Civic 6/90-6/91
Victorville, CA
(619) 243-8245

Worked on regional team. Reviewed general plan amendments, tentative tracts, parcel maps and conditional use permits. Prepared CEQA documents for projects.

Broadmoor Associates/Johnson Consulting
229 NW Blue Parkway
Lee's Summit, MO 64063
(816) 525-6640 2/86-6/90

Sold and leased commercial and industrial properties. Designed and developed an executive office park and an industrial park in Lee's Summit, Mo. Designed two additional industrial parks and residential subdivisions. Prepared study to determine target industries for the industrial parks. Prepared applications for tax increment financing district and grants under Economic Development Action Grant program. Prepared input/output analysis of proposed race track Provided conceptual design of 800 acre mixed use development.

Shepherd Realty Co.
Lee's Summit, MO 6/84-2-86

Sold and leased commercial and industrial properties. Performed investment analysis on properties. Provided planning consulting in subdivision design and rezoning.

Contemporary Concepts Inc.
Lee's Summit, MO 9/78-5/84
Owner

Designed and developed residential subdivision in Lee's Summit, Mo. Supervised all construction trades involved in the development process and the building of homes.

Environmental Design Association
Lee's Summit, Mo.
Project Coordinator 6/77-9/78

Was responsible for site design and preliminary building design for retirement villages in Missouri, Texas and Florida. Was responsible for preparing feasibility studies of possible conversion projects. Was in charge of working with local governments on zoning issues and any problems that might arise with projects. Coordinated work of local architects on projects. Worked with marketing staff regarding design changes needed or contemplated.

City of Lee's Summit, MO
220 SW Main
Lee's Summit, MO 64063
Community Development Director 4/75-6/77

Supervised Community Development Dept. staff. Responsible for preparation of departmental budget and C.D.B.G. budget. Administered Community Development Block Grant program. Developed initial Downtown redevelopment plan with funding from block grant funds. Served as a member of the Lee's Summit Economic Development Committee and provided staff support to them. Prepared study of available industrial sites within the City of Lee's Summit. In charge of all planning and zoning matters for the city including comprehensive plan.

Howard Needles Tammen & Bergendoff
9200 Ward Parkway
Kansas City, MO 64114
(816) 333-4800 5/73-4/75
Economist/Planner

Responsible for conducting economic and planning studies for Public and private sector clients. Consulting City Planner for Lenexa, KS.

Conducted environmental impact study on maintaining varying channel depth of the Columbia River including an input/output analysis. Environmental impact studies of dredging the Mississippi River. Worked on the Johnson County Industrial Airport industrial park master plan including a study on the demand for industrial land and the development of target industries based upon location analysis. Worked on various airport master plans. Developed policy oriented comprehensive plan for the City of Lenexa, KS. Developed innovative zoning ordinance heavily dependent upon performance standards for the City of Lenexa, KS.

Google Maps

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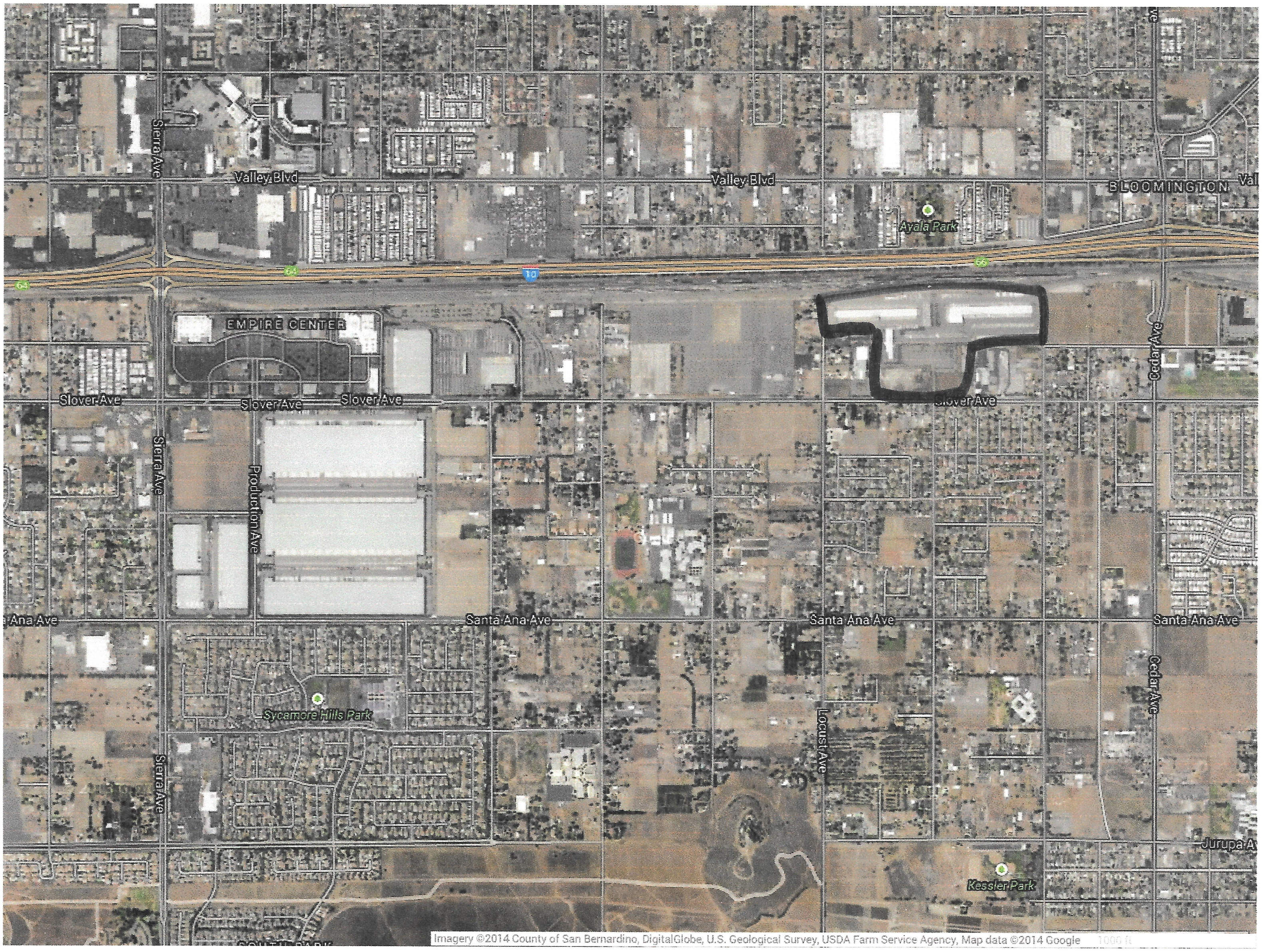

https://www.google.com/maps/@34.0606132,-117.4006003,3463m/data=!3m1!1e3

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California Air Resources Board

Preliminary Draft Staff Proposal

Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases under the California Environmental Quality Act

Released: October 24, 2008

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(October 24, 2008)

DOCUMENT AVAILABILITY

Electronic copies of this document and related materials can be found at: http://www.arb.ca.gov/cc/localgov/ceqa/ceqa.htm. Alternatively, paper copies may be obtained from the Board's Public Information Office, 1001 I Street, 1st Floor, Visitors and Environmental Services Center, Sacramento, California, 95814, (916) 322-2990.

For individuals with sensory disabilities, this document is available in Braille, large print, audiocassette or computer disk. Please contact ARB's Disability Coordinator at (916) 323-4916 by voice or through the California Relay Services at 711, to place your request for disability services. If you are a person with limited English and would like to request interpreter services, please contact ARB's Bilingual Manager at (916) 323-7053.

DISCLAIMER

This preliminary draft proposal has been reviewed by the staff of the Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation of use.

(October 24, 2008)

Preliminary Draft Staff Proposal

ARB CONTACTS

Mr. Kurt Karperos, Chief
Air Quality and Transportation Planning Branch
Planning and Technical Support Division

Mr. Douglas Ito, Manager
SIP and Local Government Strategies Section
Planning and Technical Support Division

Air Resources Board
P.O. Box 2815
Sacramento, California 95812

Website: http://www.arb.ca.gov/cc/localgov/ceqa/ceqa.htm

ARB STAFF PROJECT TEAM

Jeannie Blakeslee, Lezlie Kimura, Leslie Krinsk, Esq.,
Kyriacos Kyriacou and Jamesine Rogers

Reviewed and approved for distribution by: Lynn M. Terry, Deputy Executive Officer

(October 24, 2008)

Preliminary Draft Staff Proposal

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INTRODUCTION

Climate change is one of the most serious environmental problems facing the world, the United States, and California today. In this State, climate change already is impacting our coastlines, water supplies, agriculture, and public health, and putting millions of acres of forested land at increased risk of fire. These adverse effects will only increase in number and intensity if we do not promptly and substantially reduce pollution of the atmosphere with greenhouse gases (GHGs).

California law provides that climate change is an environmental effect subject to the California Environmental Quality Act (CEQA).[1] Lead agencies therefore are obligated to determine whether a project's climate change-related effects may be significant, requiring preparation of an Environmental Impact Report,[2] and to impose feasible mitigation to substantially lessen any significant effects.[3] Determining significance, however, can be a challenging task. Accordingly, the Governor's Office of Planning and Research in its June 2008 Technical Advisory, "CEQA and Climate Change,"[4] asked the Air Resources Board (ARB) to make recommendations for GHG-related thresholds of significance – identifiable benchmarks or standards that assist lead agencies in the significance determination.[5]

With this Staff Proposal, ARB staff is taking the first step toward developing recommended statewide interim thresholds of significance for GHGs that may be adopted by local agencies for their own use. The task that ARB staff is undertaking is, however, a limited one. Staff will not attempt to address every type of project that may be subject to CEQA, but instead will focus on common project types that, collectively, are responsible for substantial GHG emissions – specifically, industrial, residential, and commercial projects.[6] ARB staff believes that thresholds in these important sectors will advance our climate objectives, streamline project review, and encourage consistency and uniformity in the CEQA analysis of GHG emissions throughout the State.

Staff intends to make its final recommendations on thresholds in early 2009, in order to harmonize with OPR's timeline for issuing draft CEQA guidelines addressing GHG emissions[7] and to provide much needed guidance to lead agencies in the near term.

Public, stakeholder, and local lead agency participation is essential to the success of this project. ARB staff believes that the comment and feedback it receives, along with

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[1] Senate Bill 97, Public Resources Code, § 21083.05.
[2] California Code of Regulations, tit. 14, § 15064, subd. (f)(1).
[3] Id., § 15021, subd. (a)(2).
[4] See: http://opr.ca.gov/download.php?dl=ceqa/pdfs/june08-ceqa.pdf
[5] Id., § 15064.7, subd. (a).
[6] The collective greenhouse gas emissions from the industrial, residential and commercial sectors, together with the transportation sector, represent approximately 80% of the statewide greenhouse gas emissions inventory in 2004.
[7] See Senate Bill 97, Public Resources Code § 21083.05 (providing that draft guidelines are due June 1, 2009).

additional data and analyses, can form a body of evidence that lead agencies may rely on in adopting thresholds of significance consistent with ARB staff's recommendations.

Because the schedule is expedited, staff's recommendations must necessarily be interim and subject to review and revision as more information becomes available.[8]

BACKGROUND

Significance Under CEQA

A significant effect on the environment means a substantial, or potentially substantial, change in the environment caused directly or indirectly by the project.[9] The incremental effect of a project can be significant when it is cumulatively considerable – that is, when the effect is added to that of other past, present, and reasonably foreseeable probable future projects that also contribute to the problem.[10]

To streamline and facilitate consistency in the significance determination, the CEQA Guidelines[11] encourage agencies "to develop and publish thresholds of significance that the agency uses in the determination of the significance of environmental effects."[12] A threshold of significance is an identifiable quantitative, qualitative or performance level that marks the division between an impact that is significant and one that is not. A threshold of significance gives rise to a presumption, which can be rebutted by evidence that the threshold should not apply to a particular project.

Thresholds of significance must be supported by "substantial evidence." This does not mean that there is one best threshold. In CEQA, substantial evidence "means enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached."[13]

Climate Change and GHG Thresholds of Significance

"The capacity of the environment is limited, and it is the intent of the Legislature that the government of the state take immediate steps to identify any critical thresholds for the health and safety of the people of the state and take all coordinated actions necessary to prevent such thresholds being reached."[14] But where should a threshold of significance be set for GHG emissions and climate change? This question can be answered only after considering the nature of the environmental problem.

[8] ARB staff intends to monitor the implementation of thresholds that are adopted as a result of this process for effectiveness. In the same time frame as the update of the AB 32 Scoping Plan, staff intends to revisit its recommendations and to modify them if necessary.
[9] California Code of Regulations, title 14, §§ 15064, subd. (d), 15382.
[10] *Id.*, § 15355, subd. (b).
[11] Id., § 15000, et. seq.
[12] *Id.*, § 15064.7, subd. (a).
[13] *Id.*, § 15384, subd. (a).
[14] Public Resources Code, § 21000, subd. (d).

There is a scientific consensus that human activities, chief among them the burning of fossil fuels, profoundly affect the world's climate by increasing the atmospheric concentration of GHG beyond natural levels. Contributing additional GHG pollution to the atmosphere leads to higher global average temperatures, changes to climate, and adverse environmental impacts here in California and around the world.[15] Climate change, caused by "collectively significant projects taking place over a period of time[,]"[16] is a quintessential cumulative impact.

The experts tell us that an additional increase in global average temperatures of just 2 degrees Celsius (3.6 degrees Fahrenheit) is very likely dangerous.[17] With a 2 degree Celsius increase, disastrous effects become likely, including more extreme and more frequent severe weather, more wildfires, greater frequency of droughts and floods, rapid and higher sea level rise, and increased habitat destruction and extinctions.[18] These environmental effects will undoubtedly lead to serious economic, political, and national security disruptions.

In order to reduce the risk of dangerous climate change, we must stabilize atmospheric levels of GHGes at approximately 450 parts per million (ppm) by mid-century.[19] We are fast approaching this limit. Since the beginning of the industrial era, atmospheric concentrations of carbon dioxide, the primary GHG, have climbed to their highest point in the last half-million years, increasing from just under 300 ppm at the turn of the last century, to over 380 ppm today, and rising at about 2 ppm per year.[20]

In response to the challenge of climate change, California has taken a leadership role by committing to reduce its GHG emissions to 1990 levels by 2020 (about a thirty percent reduction in business-as-usual emissions in 2020) and to eighty percent below 1990 levels by 2050.[21] The latter target is consistent with the scientific consensus of the reductions needed to stabilize atmospheric levels of GHGs at 450 ppm by mid-century. Assembly Bill 32, the Global Warming Solutions Act of 2006, codifies the 2020 reduction

[15] There is a large body of authoritative sources on the causes and current and projected impacts of climate change. An extended discussion of climate change is beyond the scope of this Staff Proposal. For additional information, ARB recommends the Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) and, in particular, the IPCC's "Frequently Asked Questions," available at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-faqs.pdf and the 2006 California Climate Action Team's Report to the Governor and Legislature, available at: http://www.climatechange.ca.gov/climate_action_team/reports/index.html.

[16] See California Code of Regulations, tit. 14, § 15355, subd. (b).

[17] See IPCC 4th Assessment Report, Working Group II, Summary for Policymakers, Figure 2, available at: http://www.ipcc.ch/graphics/graphics/ar4-wg2/jpg/spm2.jpg (chart showing global impacts at various temperature increases); California Climate Change Center, Our Changing Climate: Assessing the Risks to California (2008) at p. 15, available at http://www.energy.ca.gov/2006publications/CEC-500-2006-077/CEC-500-2006-077.PDF (chart showing impacts in California at various temperature increases.)

[18] *Id.*

[19] See IPCC 4th Assessment Report, Working Group III, Summary for Policymakers at p. 17, available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-spm.pdf.

[20] IPPC 4th Assessment Report, Working Group I, Figure FAQ 2.1, available at: http://www.ipcc.ch/graphics/graphics/ar4-wg1/jpg/faq-2-1-fig-1.jpg.

[21] Executive Order S-03-05

target and charges ARB with development of a Scoping Plan to map out how the State will achieve this target, including regulatory, voluntary, and market-based mechanisms beginning in 2012.[22]

There is strong need, however, to aggressively address GHG emissions right now. The pollution we contribute to the atmosphere today will continue to have climate impacts for years, decades, and, in some cases, millennia to come. And the longer we delay in addressing the problem, the more we risk being unable to meet our climate objective. CEQA provides a mechanism that is independent of AB 32 through which lead agencies can begin immediately to reduce the climate change-related impacts of the projects that come before them.

<u>What Type of Threshold is Appropriate</u>?

Some have suggested that because of the need for urgent action and the uncertainty of the precise “tipping point” for dangerous climate change, any contribution of GHGs to the atmosphere may be significant – a so-called “zero threshold.”

ARB staff believes that for the project types under consideration, non-zero thresholds can be supported by substantial evidence. ARB staff believes that zero thresholds are not mandated in light of the fact that (1) some level of emissions in the near term and at mid-century is still consistent with climate stabilization and (2) current and anticipated regulations and programs apart from CEQA (e.g., AB 32, the Pavley vehicle regulations, the Renewable Portfolio Standard, the California Solar Initiative, and the commitment to net-zero-energy buildings by 2020 (residential) and 2030 (commercial)) will proliferate and increasingly will reduce the GHG contributions of past, present, and future projects.

But any non-zero threshold must be sufficiently stringent to make substantial contributions to reducing the State’s GHG emissions peak, to causing that peak to occur sooner, and to putting California on track to meet its interim (2020) and long-term (2050) emissions reduction targets. ARB staff believes that the preliminary interim approaches outlined in this Staff Proposal are consistent with these objectives.

RECOMMENDED THRESHOLDS – CONCEPTUAL APPROACH

ARB staff believes that different GHG thresholds of significance may apply to projects in different sectors. Two primary reasons that sector-specific thresholds are appropriate are: (1) some sectors contribute more substantially to the problem, and therefore should have a greater obligation for emissions reductions, and, (2) looking forward, there are differing levels of emissions reductions expected from different sectors in order to meet California’s climate objectives. We also believe that different types of thresholds **–** quantitative, qualitative, and performance-based **–** can apply to different sectors under the premise that the sectors can and must be treated separately given the state of the science and data. A sector-specific approach is consistent with ARB’s

[22] Health and Safety Code, § 38500, et. seq.

Proposed Scoping Plan. Consequently, the Staff Proposal takes different, although harmonious, approaches to setting thresholds for different sectors.

The attached flowcharts describe ARB staff's preliminary interim threshold concepts for two important sectors: industrial projects (**Attachment A**) and residential and commercial projects (**Attachment B**). The objective is to develop thresholds for projects in these sectors that will result in a substantial portion of the GHG emissions from new projects being subject to CEQA's mitigation requirement, consistent with a lead agency's obligation to "avoid or minimize environmental damage where feasible."[23] ARB staff is working on a proposal for an interim approach for thresholds for transportation projects and large dairies. Electricity generation is another sector where clarity is needed in the near term. The California Energy Commission (CEC) recently began a public process for identifying an approach for assessing the significance of GHG emissions from power plant projects. CEC staff anticipates concluding that work in Spring 2009.[24]

ARB staff's proposed recommendations for GHG thresholds address projects for which local agencies are typically the CEQA lead agency. In addition to the CEC, other State agencies also serve as lead agencies under CEQA. ARB is coordinating with these State agencies on their approaches to thresholds of significance.

[23] California Code of Regulations, title 14, § 15021.
[24] The CEC adopted an Order Instituting Informational Proceeding on October 8, 2008 to address GHG emissions in power plant licensing cases: http://www.energy.ca.gov/ghg_powerplants/notices/2008-10-06_PROPOSED_GHG_CEQA_OII.PDF.

REQUEST FOR PUBLIC COMMENT

ARB staff believes that the concepts in this Staff Proposal can be further developed into interim thresholds of significance. However, staff recognizes that additional analyses and data are needed to fill in some of the blanks, and to understand how the thresholds will operate in the real world.

Comments on all aspects of the Staff Proposal are encouraged. In particular, ARB seeks the active participation of local lead agencies. Staff has identified a few questions to solicit public comment, but this list is not exhaustive.

- Will the recommended approaches have any unintended consequences, for example, encouraging the piecemealing of projects?

- As set out in the attachments to the Staff Proposal, staff proposes to define certain performance standards (*e.g.*, for energy efficiency) by referencing or compiling lists from existing local, State or national standards. For some sub-sources of GHG emissions (*e.g.*, construction, transportation, waste), ARB staff has not identified reference standards. How should the performance standards for these sub-sources be defined?

- Are any of the industrial, residential, or commercial project types eligible for categorical exemptions likely to contribute more significantly to climate change than staff's preliminary analysis indicates?

- For residential and commercial projects, staff has proposed that the GHG emissions of some projects that meet GHG performance standards might under some circumstances still be considered cumulatively considerable and therefore significant. What types of projects might still have significant climate change-related impacts?

(October 24, 2008)

ATTACHMENT A
Preliminary Draft Proposal for Industrial Projects

1. The project is exempt under existing statutory or categorical exemptions.

No

2. (a) The project meets both of the below minimum performance standards, or includes equivalent mitigation measures:

Construction

- Meets an interim ARB performance standard for construction-related emissions.

Transportation

- Meets an interim ARB performance standard for transportation.

AND

(b) The project, with mitigation, will emit no more than ~7,000 metric tons CO2e/yr from non-transportation-related GHG sources (which addresses ~90% of industrial sector GHG emissions). Includes:

- Combustion-related components/equipment;
- Process losses (fugitive, working, evaporative, etc.);
- Purchased electricity; and
- Water usage and wastewater discharge

No

3. Project will have significant GHG impacts. An EIR must be prepared and all feasible GHG mitigation measures implemented.

Yes ***Yes*** ***Yes***

Presumption of less than significant impacts related to climate change

Presumption of significant impacts related to climate change

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Preliminary Draft Proposal for Industrial Projects

Introduction

CEQA guidelines provide that thresholds of significance can be qualitative, quantitative, or in the form of performance standards. ARB staff's objective is to develop a threshold of significance that will result in the vast majority (~90% statewide) of the greenhouse gas (GHG) emissions from new industrial projects being subject to CEQA's requirement to impose feasible mitigation. ARB staff believes this can be accomplished with a threshold that allows small projects to be considered insignificant. ARB staff used existing data for the industrial sector to derive a proposed hybrid threshold. The threshold consists of a quantitative threshold of 7,000 metric tons of CO2 equivalent per year (MTCO2e/year) for operational emissions (excluding transportation), and performance standards for construction and transportation emissions.

The goal of this effort is to provide for the mitigation of GHG emissions from industrial projects on a statewide level. Over time, implementation of AB 32 will reduce or mitigate GHG emissions from industrial sources. Once such requirements are in place, they could become the performance standard for industrial projects for CEQA purposes. ARB staff intends to pursue this approach in conjunction with development of the regulatory requirements for industrial sources in the Proposed AB 32 Scoping Plan. Staff is proposing the use of a quantitative significance threshold at least until such time that performance standards, such AB 32 regulatory requirements, are in place to ensure mitigation of significant impacts of GHG emissions from projects in the industrial sector.

The performance standards are largely self explanatory and similar to the approaches proposed for residential and commercial projects. The method for deriving the quantitative aspect of the threshold warrants further explanation.

Technical foundation for proposed quantitative aspect of the threshold

Based on the available data, ARB staff found that for the industrial sector, small projects – defined as the portion of new projects that, when viewed collectively, were responsible for only a relatively small amount of emissions – could be allowed to proceed without requiring additional mitigation under CEQA. The question for ARB staff was what line divides these small projects from the rest of the projects that should undergo mitigation to achieve the larger environmental objective.

ARB decided to construct a representative small project and to estimate that project's expected emissions. First, ARB considered the common sub-sources of GHG emissions in the industrial sector. The four main broad emission categories and their approximate statewide contribution to GHG emissions from industrial facilities other than power plants are:

Category	MMTCO2e/year	Percent (%)
Combustion processes	70	63 %
Process Losses (evaporative, fugitive, working, etc.)	15	13 %
Purchased Electricity	18	17 %
Water Use and Wastewater Treatment	7	7 %

As the table indicates, GHG emissions from industrial sources are dominated by combustion emissions. To ensure that significant industrial emissions would be captured by the proposed threshold, ARB staff evaluated industrial boilers because they are a very common piece of equipment, are essential in many energy-intensive industries, and are a top contributor to industrial combustion emissions.

A recent comprehensive survey of industrial boilers by Oak Ridge National Laboratory[25] found that boilers with an input capacity of 10 MMBtu/hr or greater correspond to 93 percent of total industrial boiler input capacity. Based on this data, ARB staff used a natural gas boiler input capacity benchmark of 10 MMBtu/hr which equates to emissions of 4,660 MTCO2e/yr. This capacity benchmark defines a significant combustion source.

As shown in the above table, combustion processes account for 63 percent of the statewide GHG emissions from industrial facilities. Process losses, purchased electricity, and water use and water treatment account for the remaining 27 percent of emissions. Staff applied these proportions to the benchmark combustion emissions estimate (4,660 MTCO2e/yr). The result is an overall emissions estimate of approximately 7,000 MTCO2e/yr for a representative small project that accounts for the four main categories in the table above.

Based on the available data, staff believes that the 7,000 MTCO2e/year benchmark can be used to effectively mitigate industrial projects with significant GHG emissions.

[25] Characterization of the U.S. Industrial/Commercial Boiler Population, Energy, and Environmental Analysis, Inc. submitted to Oak Ridge National Laboratory, available at:: http://ww.eea-inc.com/natgas_reports/BoilersFinal.pdf.

(October 24, 2008)

ATTACHMENT B
Preliminary Draft Proposal for Residential and Commercial Projects

1. The project is exempt under existing statutory or categorical exemptions.

No

Yes

2. The project complies with a previously approved plan that addresses GHG emissions, satisfies (15064(h)(3)), and has all of the following attributes:

- Meets a community level GHG target consistent with the statewide emissions limit in AB 32 and, where the plan will apply beyond 2020, Executive Order S-3-05;
- Is consistent with a transportation-related GHG reduction target adopted by ARB pursuant to SB 375.
- Includes a GHG inventory and mechanisms to regularly monitor and evaluate emissions;
- Includes specific, enforceable GHG requirements;
- Incorporates mechanisms that allow the plan to be revised in order to meet targets; and
- Has a certified final CEQA document (see 15152(f)).

No

Yes

3. (a) The project meets all of the below minimum performance standards, or includes equivalent mitigation measures.

Construction

- Meets an interim ARB performance standard for construction-related emissions;

Operations

- Meets an energy use performance standard defined as CEC's Tier II Energy Efficiency goal;
- Meets an interim ARB performance standard for water use;
- Meets an interim ARB performance standard for waste;
- Meets an interim ARB performance standard for transportation;

<u>AND</u>

(b) The project, with performance standards or equivalent mitigation, will emit no more than X metric tons CO2e/yr (criteria to be developed).

No

Yes

4. Project will have significant GHG impacts. An EIR must be prepared and all feasible GHG mitigation measures implemented.

Yes

Presumption of less than significant impacts related to climate change

Presumption of significant impacts related to climate change

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Preliminary Draft Proposal for Residential and Commercial Projects

Introduction

CEQA guidelines provide that thresholds of significance can be qualitative, quantitative, or in the form of performance standards. ARB staff's objective is to develop a threshold for residential and commercial projects that will substantially reduce the greenhouse gas (GHG) emissions from new projects and streamline the permitting of carbon-efficient projects. To achieve this, staff's preliminary recommendation is to develop a threshold based on clear and stringent performance standards.

Performance standards will address the five major emission sub-sources for the sector: energy use, transportation, water use, waste, and construction. For the energy use performance standard, staff recommends reliance on the California Energy Commission's (CEC) Tier II Energy Efficiency standards for solar energy incentive programs. These standards are consistent with what is needed to meet the state's goal of zero net energy buildings and are continuously updated to reflect energy efficiency best practices. For the remaining sub-sources (water, waste, etc.), staff intends to compile benchmark performance standards as part of its final threshold recommendation. Projects may alternatively incorporate mitigation equivalent to these performance standards.

Staff recognizes that a substantial body of measures to address GHG emissions exists through programs like LEED, GreenPoint Rated, and the California Green Building Code. As work on performance standards moves forward, staff intends to make use of these projects.

In addition, staff proposes that a presumption of non-significance apply only to projects whose total net emissions, after meeting the performance standards or equivalent, are below a specified level. Staff proposes to develop this emissions level as part of its final threshold recommendation.

Discussion of Flow Chart

Box 1: In general, categorical exemptions will continue to apply.

Based on its preliminary analysis, ARB staff believes that projects described in CEQA's categorical and statutory exemption provisions (Articles 18 and 19 of the California Code of Regulations, title 14) will not interfere with achieving the objective to minimize emissions from new projects in this sector. GHG emissions from residential and commercial projects that are described in the categorical exemption language appear to be relatively small from a GHG perspective. For example, staff's preliminary analysis indicates that emissions from a project qualifying for the statutory infill project exemption (Cal. Code Regs., tit. 14, § 15195) will emit approximately 1,600 metric tons (MT)CO2e/yr. Staff believes such infill projects represent some of the largest projects described in the exemption provisions. ARB staff expects to provide additional analyses to support a lead agency's determination that the GHG impact of these project types is less than significant. Staff invites the public and stakeholders to provide further evidence on the application of categorical exemptions to residential and commercial projects.

Box 2: If GHGs are adequately addressed at the programmatic level, the impact of certain individual projects can be found to be insignificant.

As OPR noted in its June 2008 Technical Advisory:

> CEQA can be a more effective tool for greenhouse gas emissions analysis and mitigation if it is supported and supplemented by sound development policies and practices that will reduce greenhouse gas emissions on a broad planning scale and that can provide the basis for a programmatic approach to project-specific CEQA analysis and mitigation…. For local government lead agencies, adoption of general plan policies and certification of general plan EIRs that analyze broad jurisdiction-wide impacts of greenhouse gas emissions can be part of an effective strategy for addressing cumulative impacts and for streamlining later project-specific CEQA reviews.

ARB staff encourages local agencies to take advantage of a programmatic approach to address climate change, consistent with existing law.

If a project complies with the requirements of a previously adopted GHG emission reduction plan or mitigation program that satisfies California Code of Regulations, title 14, section 15064(h)(3), and includes the attributes specified in that provision and Box 2, the lead agency may determine that the project's GHG impacts are less than significant with no further analysis required. Examples of plans that may satisfy this provision include Climate Action Plans incorporated into General Plans that have inventories, an emissions target, suites of specific and enforceable measures to reach that target, monitoring and reporting, and mechanisms to revise the plan to stay on target. Moreover, a prior EIR that "adequately addressed" climate change may be used for tiering purposes. (See Cal. Code Regs. tit. 14, § 15152.)

Box 3: Projects that meet performance standards, or include equivalent mitigation, can be found to be insignificant.

The threshold incorporates performance standards requiring carbon efficiency for each major sub-source of emissions from projects in these sectors. Provided they are set at a sufficiently stringent level, performance standards will dramatically reduce GHG emissions and promote a transition toward zero and low emission projects. In most cases, ARB staff expects that performance standards will need to reach beyond current State mandates by a substantial amount, given that GHG emission reduction goals have not yet been adequately incorporated into State programs. Staff anticipates that performance standards will become more stringent over time.

ARB staff has identified the California Energy Commission's Tier II Energy Efficiency goals as an appropriate performance standard for energy use. Under State law, the CEC is required to establish eligibility criteria, conditions for incentives, and rating standards to qualify for ratepayer-funded solar energy system incentives in California. As part of this effort, the CEC establishes energy efficiency standards for homes and commercial structures, and requires new buildings to exceed current building standards by meeting Tier Energy Efficiency goals. CEC's Tier II Energy Efficiency goals will continue to be updated to achieve energy efficiency best practices, and are consistent with what is needed to meet the California Public Utilities Commission Strategic Plan goals of zero net energy buildings. Currently, the CEC's proposed guidelines for the solar energy incentive program recommend a Tier II goal for residential and commercial projects of a 30 percent reduction in building combined space heating, cooling, and water heating energy compared to the 2008 Title 24 Standards.[26]

For the remaining sub-sources, staff intends to compile benchmark performance standards as part of its final threshold recommendation. ARB staff believes that existing progressive green building standards provide a starting point for performance standards for transportation, water use, waste, and construction-related emissions. Existing green building rating systems like LEED, GreenPoint Rated, the California Green Building Code, and others, contain examples of measures that are likely to result in substantial GHG emission reductions from residential and commercial projects. The key to this approach will be identifying effective GHG reduction measures within these systems. ARB staff would like input from the public and stakeholders on appropriate performance standards for these sub-sources. Performance standards that already exist and have been proven to be effective – at the local, State, national or international level – are preferable.

Under staff's proposed approach, lead agencies would be allowed to find that a project's mitigation is "equivalent" to identified performance standards, thereby allowing for cost-effective and innovative approaches to reducing GHG emissions.

Staff believes that under some circumstances, projects that meet performance standards or include equivalent mitigation measures will have impacts that may still be cumulatively considerable and therefore significant. For this reason, staff recommends that, in addition to meeting performance standards or including

[26] Guidelines for California's Solar Electric Incentive Program Pursuant to Senate Bill 1 - SECOND EDITION - Draft Guidelines can be found at: http://www.energy.ca.gov/2008publications/CEC-300-2008-007/CEC-300-2008-007-D.PDF

equivalent mitigation measures, a project must also emit no more than “X” $MTCO_2e/yr$. Criteria for determining this emissions level have yet to be defined. ARB requests public and stakeholder input on what types of projects might still have significant climate change-related impacts.

Box 4: Presumption of significant impacts.

If a project cannot meet the requirements in the previous boxes, it should be presumed to have significant impacts related to climate change. The lead agency must then prepare an EIR, or other appropriate document, and implement all feasible GHG mitigation measures.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

White Paper on
Potential Control Strategies to Address Cumulative Impacts
From Air Pollution

August 2003

Deputy Executive Officer
Planning, Rule Development, and Area Sources
Elaine Chang, DrPH

Assistant Deputy Executive Officer
Planning, Rule Development, and Area Sources
Laki Tisopulos, Ph.D., P.E.

Planning and Rules Manager
Jill Whynot

Authors:	Tracy A. Goss, P.E. – Air Quality Specialist Amy Kroeger – Assistant Air Quality Engineer
Technical Assistance:	Chris Nelson – Senior Staff Specialist
Reviewed by:	Barbara Baird – District Counsel Gary Quinn, P.E. – Program Supervisor Frances Keeler – Senior Deputy District Counsel

FOREWORD

Since its inception in 1997, AQMD's Environmental Justice (EJ) program has sought to identify and address local air quality issues, such as those brought to the agency's attention at Town Hall events and community meetings. Such issues have included concerns that the District's existing permitting, rules, and clean fleet control programs may need enhancements to better address multiple exposures, as experienced in or near urban industrial settings, including those operating in or near low-income communities of color.

The phrase "cumulative air quality impacts" is often used to describe possible health and nuisance impacts potentially related to a given neighborhood's cumulative emissions from sources that individually comply with AQMD, state, and federal rules. As such, cumulative impacts discussed in the White Paper go beyond those covered under CEQA. In neighborhoods near a relatively large number of industrial facilities, or located near heavy cross-town traffic, for example, there is concern about the accumulated effects of numerous emission sources operating within a limited area, particularly as related to air toxics, and when the group of sources is near residences, schools, or other sensitive receptors.

This White Paper is intended to present a forward-looking comprehensive strategy of how the AQMD intends to identify and further address cumulative impacts of air pollution, so that all communities in the South Coast receive equitable treatment and attention as to their local air quality concerns. The AQMD also intends to ensure fair and consistent treatment of local businesses as it carries out this facet of environmental justice.

This paper points out potential ways to achieve more substantial progress in public health protection. It describes a basic, reasoned approach and lays out a number of tools that staff believes can lay a valuable foundation for this emerging effort; the implementation tools will be developed in more detail upon Governing Board direction, and in conjunction with ongoing working group input. The strategies outlined will directly or indirectly contribute to addressing cumulative impacts. For example, some measures are designed to address localized impacts, which are likely to also address cumulative impacts, while other strategies are more for reducing cumulative impacts. The paper also outlines areas requiring more research, and makes suggestions on how to carry this out. Some elements (e.g., MATES II), are parts of other EJ initiatives or Board directives.

This White Paper is a starting point, developed with input from the Cumulative Impacts Working Group, whose members have spent much time and energy in contributing their expert knowledge, experience, and suggestions to this pathfinding effort. Input was also incorporated from five Community Forums held throughout the four-county region in June and July, and three community meetings in August. The report however, represents the AQMD staff's recommendations in this important area of air quality management.

This White Paper is intended as a policy document. With the Governing Board's direction, staff will proceed to work with stakeholders through working groups and a full public process to develop individual proposed rules and policies for the Board's consideration. Addressing cumulative air quality impacts should not be viewed as a means to prohibit growth or to interfere with local land use decisions. AQMD staff will work with local agencies in a partnership, by providing information and technical assistance relative to their critical role in land use and mitigation measures.

Acknowledgements

The following members of the Cumulative Impacts Working Group provided valuable input and their assistance is greatly appreciated.

Facilitator	
Mr. Greg Bourne	Center for Collaborative Policy
Environmental/Community Representatives	
Mr. Luis Cabrales	California League of Conservation Voters Education Fund
Mr. Todd Campbell	Coalition for Clean Air
Mr. Bahram Fazeli	Communities for a Better Environment
Ms. Angela Johnson-Meszaros	University of Southern California
Mr. Angelo Logan	East Yard Communities for Environmental Justice
Mr. Joseph K. Lyou	California Environmental Rights Alliance
Mr. Anastacio Medina	American Lung Association
Ms. Penny Newman	Center for Community Action and Environmental Justice*
Ms. Gail Ruderman-Feuer	Natural Resources Defense Council
Industry Representatives	
Mr. Mike Carroll	Latham & Watkins
Mr. Curt Coleman	California Manufacturers Association
Mr. Bill LaMarr	California Small Business Alliance
Mr. Bill Quinn	California Council for Environmental and Economic Balance
Mr. Gary Stafford	Wood Furniture Manufacturers Association
Mr. Lee Wallace	Sempra Energy
Mr. Mike Wang	Western States Petroleum Association
Local Government / Agency Representatives	
Mr. Greg Adams	Los Angeles County Sanitation Districts
Ms. Detrich B. Allen	City of Los Angeles Environmental Affairs Division
Ms. Linda Murchison	California Air Resources Board
Ms. Winona Victery	U.S. Environmental Protection Agency

* Invited, did not attend

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EXECUTIVE SUMMARY

This report is an outgrowth of the following South Coast Air Quality Management District (AQMD) Governing Board actions:

- October 1997 adoption of ten Environmental Justice (EJ) Initiatives;
- September 2002 approval of enhancements to the EJ program for the Fiscal Year 2002-2003, including a directive to staff to report back on the feasibility of rulemaking to address cumulative impacts of air toxics beyond current AQMD requirements; and
- January 10, 2003 direction to staff to report back to the Board with a White Paper on regulatory and policy options for addressing cumulative impacts from air pollution emissions, including recommendations and schedule. At the January 10th meeting, staff also recommended a work plan that entailed creation of a Cumulative Impacts Working Group and a planned update to the second Multiple Air Toxics Exposure Study (MATES II).

Addressing cumulative impacts is a very complex issue. The working group process, which included a facilitator, was very helpful to staff in the development of the recommended approaches. The Working Group met seven times to discuss a program to reduce cumulative impacts from air pollution. This White Paper presents staff's recommendations regarding options for assessing cumulative impacts from sources of air pollution. It includes consideration of input received from the California Air Resources Board (CARB), U.S. Environmental Protection Agency (EPA), local government representatives, industry, and environmental and community groups on the Working Group, as well as input received from five Community Forums. Key policy issues addressed during the working group process include, but were not limited to:

- scope of the program (i.e., stationary and/or mobile sources; cancer and/or non-cancer health effects; and including particulate emissions);
- defining areas of concern for specific actions to reduce cumulative exposures, and
- potential approaches to address cumulative impacts.

Definitions

For the purposes of developing a program to address cumulative impacts from air pollution emissions, the AQMD staff will rely upon the definition of Environmental Justice that was approved by the Governing Board in October 1997:

> *Environmental Justice means the equitable environmental policymaking and enforcement to protect the health of all persons who live or work in the AQMD, regardless of age, culture, ethnicity, gender, race, socioeconomic status, or geographic location, from the health effects of air pollution.*

Under the subject of Environmental Justice, definitions of cumulative impact were extensively discussed by the Working Group. A cumulative impact can be defined in many ways and it is therefore difficult to arrive at a single definition that fits all circumstances. Cumulative impacts can be regional, as well as localized or neighborhood level. Estimated risks from air toxic measurement at 10 monitoring stations for residents of the South Coast Air Basin (Basin) are ~1,400 in a million (based on a range from about 1,120 in a million to about 1,740 in a million), with some areas experiencing higher risks. Reducing emissions throughout the

Basin would decrease the overall risk on a regional basis and will lower neighborhood risks by varying degrees, depending on the localized circumstances.

The following definition of a cumulative air pollution impact, while not a consensus of the Working Group members, attempts to recognize their viewpoints and develop a working definition:

> *A cumulative air pollution impact is an adverse health effect, risk or nuisance from exposure to pollutants released into the air from multiple air pollution sources.*

Further refinement or variation of this definition may be needed in the future when a specific regulation or policy is formulated. Reference to "air pollution" under this working definition is intended to include not only air toxics, but criteria pollutants, such as particulates, and nuisances (e.g., odors).

Cumulative Impacts Reduction Strategy (CIRS)

At the start of the process, to stimulate discussions, staff introduced four design principles that were factored into the working group process: no redlining (e.g., defining an acceptable/unacceptable geographical area based on level of risk); not interfering with local land use decisions, but making more comprehensive air quality information available to decision makers; reasonable decision-making time frame for CEQA analysis and permits; and resource considerations and regulatory certainty.

Based on the design criteria and early discussions of the working group, staff developed a list of initial options for addressing cumulative impacts for working group comments. Industry and environmental/community representatives were asked to provide design criteria and options. Staff then evaluated the options in an attempt to examine feasibility and to identify where efforts should be prioritized. Several information sources, most notably, MATES II, year 2000 census data, and health care data were examined in an attempt to identify potentially high cumulative impact areas.

Section IV discusses MATES II, census data, and health care information, while Section V outlines the positions and interests of key stakeholder groups. Staff carefully considered the information, as well as the viewpoints expressed by stakeholders, and has the following recommendations:

Approach

The overall approach in addressing cumulative impacts will include several key features:

- Build on existing State Implementation Plan (SIP) programs that address criteria pollutants;
- Start with existing known information (i.e., MATES II) to address cumulative impacts of air toxics;
- Identify high cumulative impact areas and develop effective solutions accordingly; and
- Continue to develop/refine technical databases and tools.

Staff will rely on implementation of the most recently approved Air Quality Management Plan (AQMP) (i.e., 2003) to address criteria pollutants by expeditiously implementing the approved plan.

Scope

After consideration of information and comments from the Working Group members and from Community Forums, staff recommends that the scope of CIRS include the following areas:

- Cancer risk;
- Hazard Index from non-cancer risk sources;
- Odors; and
- Enforcement.

The proposed control strategies incorporate these elements.

High Impact Areas

After examining MATES II modeling data and incorporating input from stakeholders, staff is recommending that modeled cancer risks be ranked according to mobile and stationary source contribution separately. The ranking provides a priority list to characterize source contribution and identify solutions to address cumulative impacts. MATES II models cancer risk in grid cells of 1 km x 1 km. Staff recommends that the approach for investigating potential high impact areas start with the top 100 grid cells with the highest mobile source impacts and another top 100 grid cells with the highest stationary source impacts. As a result, there will be a total of 200 grid cells analyzed, which may have some overlapping areas, but will be examined separately. Total mobile and stationary source contributions need to be examined separately because the nature of the sources and possible solutions are different. Cumulative impacts can be addressed for localized areas, depending on the nature of the sources in that situation. These top 100 grid cells, each for total mobile or stationary sources, represent the approximate top 1 percent of risks from all grid cells in the MATES II study. The top 100 grid cells should not be viewed as a cut-off point for defining high cumulative impact areas. Rather it serves as guidance to prioritize staff resources. The intent is to work through the ranking (not necessarily limited to the top 100 cells) to evaluate individual circumstances, and to develop solutions accordingly. It is not staff's intent to prohibit growth in the high impact areas identified. This prioritization should be re-examined in future ATCP updates once staff gains more experience in addressing the cumulative impact issues and when additional technical information and tools become available.

Key Elements

Addressing the cumulative impacts associated with exposure to air toxics requires a multi-faceted approach comprised of short- and long-term strategies. AQMD staff's suggested approach consists of three major components:

- a set of early action control strategies for immediate development and implementation;
- revisions to Air Toxic Control Plan (ATCP)
    - addendum to the March 2000 ATCP; and
    - periodic updates; and
- a planned update to the Multiple Air Toxics Exposure Study, or conduct MATES III.

Figure EX-1 is a graphical representation of what is proposed under each component. Early-action strategies are those for which there is sufficient information for development and that can be implemented within 2 to 3 years. The ATCP Addendum will be completed by the end of 2003 and will contain additional strategies that can be developed and implemented in 3 to 5 years. The ATCP is expected to be updated periodically following a similar schedule as the Air Quality Management Plan (AQMP) to reflect the latest technical information and analytical methodology. The third component, MATES III, is already in the planning stages and is anticipated to be completed in approximately 1 ½ years, starting 2nd Quarter 2004. For a more detailed description of the suggested strategies that have been conceptualized, the reader is referred to Section IV of this White Paper.

Figure EX-1

Cumulative Impacts Reduction Strategy

Early-Action Control Strategies

Recommended for Immediate Development

- Control Strategies (Rules)
  - Back-up Diesel Generators (No. 1)
  - New Source Review, Rule 1401 (No. 2)
    - New and relocated facilities near existing schools and possibly other sensitive receptors
    - More stringent risk requirements
  - Yard Hostlers at Ports, Rail Yards, & Distribution Centers (No. 3)
  - Chromium Spray Coating Operations (No. 4)
  - Private Fleet Rule Development (No. 5)
- Control Strategies (Policy)
  - Increased Compliance Assurance for Repeat Emission Violators (No. 6)
  - Prioritize Resources for CEQA Document Review in High Cumulative Impact Areas (No. 7)
  - Voluntary AQMD/Local Government/Public Agency Partnership (No. 8)
  - Governing Board Resolution to CARB (No. 9)
- Nuisance Strategy
  - Pilot Odor Abatement Program (No. 10)

Air Toxic Control Plan Process

Addendum by End of 2003, Periodic Updates

- Improve Emissions Inventory, Data, & Tools
- Improve Modeling Tools
- Health Based Criteria
  - Cancer & Non-cancer
  - Asthma
- Evaluate High Cumulative Impact Areas
- Control Strategies (Rules)
  - Mobile
    - Truck Idling (No. 11)
    - Train Idling (No. 12)
    - Marine and Airport Operations (No. 13)
  - Stationary Source
    - More Stringent Requirements for Rule 1402 Sources Near Existing Schools and Possibly Other Sensitive Receptors (No. 14)
    - More Stringent Air Toxic Source-Specific Requirements for Existing Sources Located Near Existing Schools and Possibly Other Sensitive Receptors (No. 15)
    - Neighborhood Air Toxic Abatement Fund (No. 17)
    - Additional Controls for Arsenic (No. 18)
    - Additional Controls for Auto-Body Shops (No. 19)
  - ARB Component (No. 23)
  - U.S. EPA Component (No. 24)
- Control Strategies (Policy)
  - Diesel Traffic Flow Control (No. 20)
  - Analysis and Mitigation for Sources Contributing to High Health Risks (Cancer and Non-Cancer) (No. 21)
  - Develop and Launch Pollution Prevention (No. 16)
  - Increased/Targeted Funding for Disproportionately Impacted Areas (No. 25)
- Nuisance Strategy
  - Odor Abatement for Existing Facilities (No. 22)

MATES III

Start 2003-2004 Fiscal Year

- Utilize scientific review panel and public input
- Revise list of TACs to sample
- Select micro-scale sites
- Approximately 1 ½ years to complete, sampling to start 2nd quarter 2004

I. INTRODUCTION

In October 1997, the South Coast Air Quality Management District (AQMD) Governing Board adopted a series of ten Environmental Justice Initiatives, along with four Guiding Principles, to address the potential adverse health effects of air pollution, including air toxics, and set forth a strategy to help ensure that clean air benefits are accorded to all residents and communities of the South Coast Air Basin (Basin). These Initiatives have helped identify and address potential areas of the AQMD's jurisdiction where citizens may be disproportionately impacted by air pollutants. Potential adverse public health impacts from cumulative emissions exposure, particularly from air toxics, are an environmental justice (EJ) concern. In September 2002, the Governing Board approved enhancements to the EJ program for the Fiscal Years 2002-2003. Addressing concerns about cumulative emission impacts is a key objective of the EJ program enhancements. An outgrowth of these enhancements was a Governing Board directive to staff to report back on the feasibility of rulemaking to address cumulative impacts of air toxics beyond current AQMD requirements.

On January 10, 2003, staff reported to the Governing Board on the initial investigation into the development of a cumulative impacts program. Also presented at that meeting was a proposal to develop a White Paper on regulatory and policy options for addressing cumulative impacts from air pollution emissions, including a work plan that entailed creation of a working group, development of a White Paper, and a planned update to the second Multiple Air Toxics Exposure Study (MATES II). The Board directed staff to report back to the Board with a White Paper containing recommendations and schedule.

Addressing cumulative impacts is a very complex issue. There are many factors that contribute to areas of higher impact in the Basin. Land use decisions, some made decades ago, prevalence of freeways and other transportation corridors, density and types of businesses, and local meteorology are some of these factors. Mobile source emissions continue to be the predominant contributor to regional cancer risk in the Basin. Cumulative impacts are somewhat difficult to define and assess. Stakeholders in the working group had divergent viewpoints with respect to what indicators should be used to address cumulative impacts and what approaches are needed. There are data limitations, as well. AQMD has an extensive air monitoring program and has the benefit of MATES II, an extensive toxic monitoring and modeling effort. However, there are knowledge gaps where additional information on air pollution emissions and exposures would be beneficial.

The working group process, which included a facilitator, was very helpful to staff in the development of the recommended approaches. The Working Group met seven times to discuss a program to reduce cumulative impacts from air pollution. This White Paper presents staff's recommendations regarding options for assessing cumulative impacts from sources of air toxics. It includes consideration of input received from the California Air Resources Board (ARB), U.S. Environmental Protection Agency (EPA), local government representatives, industry, and environmental and community groups on the Working Group, as well as input from five Community Forums. Key policy issues addressed during the working group process include, but were not limited to, scope of the program (i.e., stationary and/or mobile sources; cancer and/or non-cancer health effects; and particulate emissions), defining high impact areas for specific actions to reduce cumulative exposures, and potential approaches to address cumulative impacts.

II. DEFINITIONS

For the purposes of developing a program to address cumulative impacts from air pollution emissions, the AQMD staff will rely upon the definition of Environmental Justice that was approved by the Governing Board in October 1997:

> *Environmental Justice means the equitable environmental policymaking and enforcement to protect the health of all persons who live or work in the AQMD, regardless of age, culture, ethnicity, gender, race, socioeconomic status, or geographic location, from the health effects of air pollution.*

Under the subject of Environmental Justice, the definition of cumulative impact was extensively discussed by the Working Group. A cumulative impact can be defined in many ways and it is therefore difficult to arrive at a single definition that fits all circumstances. Cumulative impacts can be regional, as well as localized or neighborhood. Estimated risks from air toxic measurement at 10 monitoring stations for residents of the Basin are ~1,400 in a million (based on a range from about 1,120 in a million to about 1,740 in a million), with some areas experiencing higher risks. Reducing emissions throughout the Basin would decrease the overall risk on a regional basis and will lower neighborhood risks by varying degrees, depending on the localized circumstances.

Definitions were discussed at several Working Group meetings. This was important to different stakeholders because the definitions would help frame the policy discussions and recommendations. The environmental and community groups were interested in ensuring that the definition of cumulative impacts would not be restrictive with respect to needing to prove harm before addressing an impact. These groups also stressed that cumulative impacts are not just related to air pollution, but include other media, such as water pollution, and ingestion.

It was important to industry representatives that the definition of cumulative impact not result in using resources where there was not a nexus demonstrated between pollution sources and health effects. For example, emissions may not result in an adverse impact if the compound is emitted in low amounts or has low toxicity. The following definition proposed by the AQMD staff, while not a consensus, attempts to recognize these view points and develop a working definition.

> *A cumulative air pollution impact is an adverse health effect, risk or nuisance from exposure to pollutants released into the air from multiple air pollution sources.*

Further refinement or variation of this definition may be needed in the future when a specific regulation or policy is formulated. Reference to "air pollution" under this working definition is intended to include not only air toxics, but criteria pollutants, such as particulates, and nuisances (e.g., odors).

III. BACKGROUND

Currently, cumulative impacts are indirectly reduced through the application of existing programs at the federal, state, and local level. The State Implementation Plan (SIP) addresses criteria pollutants and the California Health and Safety Code covers nuisances. Control of air toxics is addressed in a variety of programs as described below.

For air toxics, it is generally assumed by the scientific community that there is no safe level or threshold that can be set relative to cancer risk regardless of the source. The AQMD has very limited jurisdiction over mobile sources and therefore its rules and regulations are primarily geared toward stationary and area sources only. Historically, jurisdiction for reducing mobile source (e.g., motor vehicles, diesel trucks, trains, ships, and aircraft) emissions, and therefore risk contribution, primarily falls to both state and federal levels of government, whereas localized reduction of stationary sources falls to the local level. The regulatory structure for addressing new or modified stationary sources is to require best available control technology (BACT) for air toxics, or T-BACT. Relative to existing sources, risk reductions are sought via rules and regulations, considering technical feasibility and cost.

AQMD's current regulatory program has five principle programs for addressing air toxics.

- Rule 1401 – New Source Review of Toxic Air Contaminants is equipment-specific and limits incremental increases in public health risk from new projects and modifications to existing equipment/processes;
- Rule 1402 – Control of Toxic Air Contaminants from Existing Sources is facility-specific and requires reduction of risk and public notification under certain conditions;
- California Environment Quality Act (CEQA) is project-specific and requires public disclosure and mitigation measures, as necessary, to limit risk;
- Multiple Air Toxics Exposure Study (MATES) is regional and utilizes actual monitored and modeling data to estimate emissions and risk in the Basin; and
- Air Toxics Control Plan is regional and utilizes MATES data in developing recommendations for source-specific and air toxic rules, as well as non-regulatory programs.

The AQMD, together with the state and federal agencies, works to control air pollution emissions from several sources. As mentioned earlier the AQMD has jurisdiction over stationary and area source emissions, as well as mobile source fleets. Over the years several programs and tools have been developed to regulate these sources. These programs and tools and the roles of the state and federal agencies are described in Appendix A.

IV. CUMULATIVE IMPACTS REDUCTION STRATEGY (CIRS)

At the start of the process, to stimulate discussions, staff introduced four design principles that were factored into the working group process: no redlining (e.g., defining an acceptable/unacceptable geographical area based on level of risk); not interfering with local land use decisions, but making more comprehensive air quality information available to decision makers; reasonable decision-making time frame for CEQA analysis and permits; consider resource considerations and regulatory certainty.

Based on the design criteria and early discussions of the working group, staff developed a list of initial options for addressing cumulative impacts for working group comments. Industry and environmental/community representatives provided their own list of design criteria and options. Staff then evaluated the options in an attempt to examine feasibility and to identify where efforts should be prioritized. Staff examined several information sources, most notably, the MATES II, year 2000 census data, and health care data in an attempt to identify potentially high cumulative impact areas.

Cumulative Impacts

In addition to the sections on the control strategies, this report also provides information on MATES II, census data, and the interests of key stakeholder groups. Staff carefully considered the information, as well as viewpoints expressed by stakeholders, and has the following recommendations.

Approach

The overall approach in addressing cumulative impacts includes several key features:

- Build on existing State Implementation Plan (SIP) Programs that address criteria pollutants;
- Start with existing known information (i.e., MATES II) to address cumulative impacts of air toxics;
- Identify high cumulative impact areas and develop effective solutions accordingly; and
- Continue to develop/refine technical database and tools.

These concepts are incorporated in the individual strategies described below.

Scope

After consideration of information and comments from the Working Group members and from Community Forums, staff recommends that the scope of the CIRS include the following areas:

- Cancer risk;
- Hazard Index from non-cancer risk sources;
- Odors; and
- Enforcement.

The control strategies incorporate these components.

Key Elements

Addressing the cumulative impacts associated with exposure to air toxics requires a multi-faceted approach including short- and long-term strategies. AQMD staff's suggested approach consists of three major components:

- a set of early-action control strategies for immediate development and implementation;
- Air Toxic Control Plan process; and
- Planned update to the Multiple Air Toxics Exposure Study, or MATES III.

Analysis for Identification of High Impact Areas

A significant portion of the Working Group discussions focused on potential criteria for determining high impact areas. Basin-wide regional risk and census data maps were developed by staff as part of their analysis and in support of the Working Group discussions.

During 1998 and 1999, the AQMD conducted a second MATES program to further understand the current air toxics setting in the Basin. The results of MATES II were released in March 2000. MATES II examined the potential cancer risk from over 30 known toxic air contaminants including diesel particulates. MATES II data was key in this analysis, as it was an important part of the characterization of cumulative impacts throughout the Basin. It also was an indicator of risk contributions and aided in identifying control strategies and further steps needed, such as improved data, tools, and modeling.

MATES II Data

The results of MATES II indicate that the overall average Basin cancer risk is approximately 1,400-in-one million when diesel emissions are considered; the Basin risk is around 400- to 600-in-one million excluding diesel emissions. Figure 1 contains a map of the Basin showing the range of cancer risk contributed by all sources, including diesel emissions. As seen in Figure 1, the MATES II results also indicate that higher risk levels are seen in the more industrialized areas of the Basin (the south-central portion of Los Angeles County, not the neighborhood of south-central Los Angeles; at freeway interchanges; areas near airports; and industrial areas). However, as seen in Figure 2, mobile sources are the most significant contributors to risk levels in the Basin, with some individual grid cells as high as 5,700 in a million. The stationary source emissions of TACs contribution to the overall estimated risk levels are presented in Figure 3, with some individual grid cells as high as 660 in a million. Stationary source TACs tend to be around the same level year-round. However, mobile source TACs tend to be higher during the fall and winter months. Due to limitations in modeling techniques, stationary source risks tend to be underestimated at the localized level.

Figure 1
Range of Risk From All Sources In the South Coast Air Basin, Including All Mobile and Stationary Sources

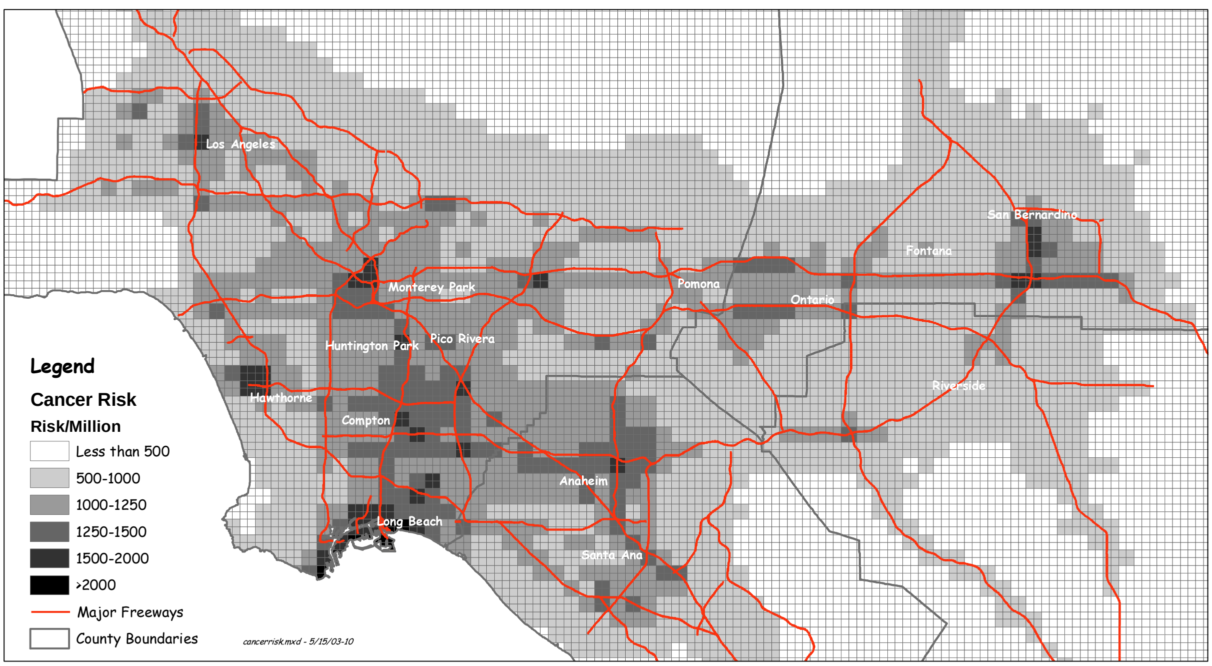


Figure 2
Range of Risk for Mobile Sources Only in the South Coast Air Basin, Including Diesel Particulate

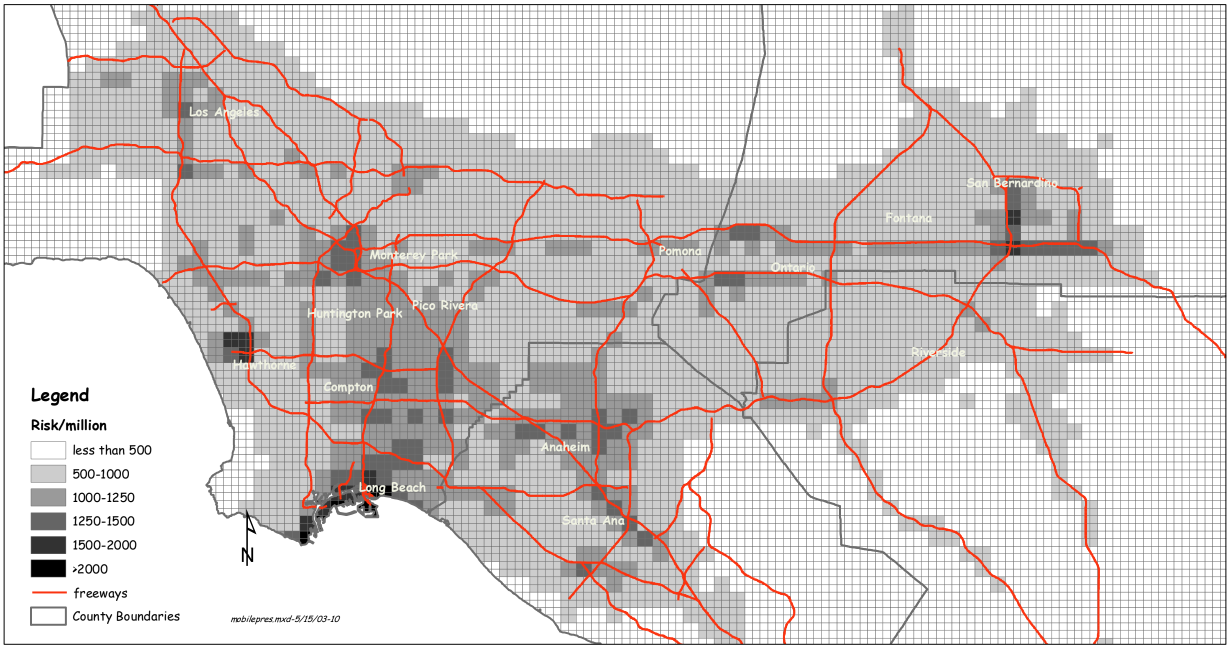
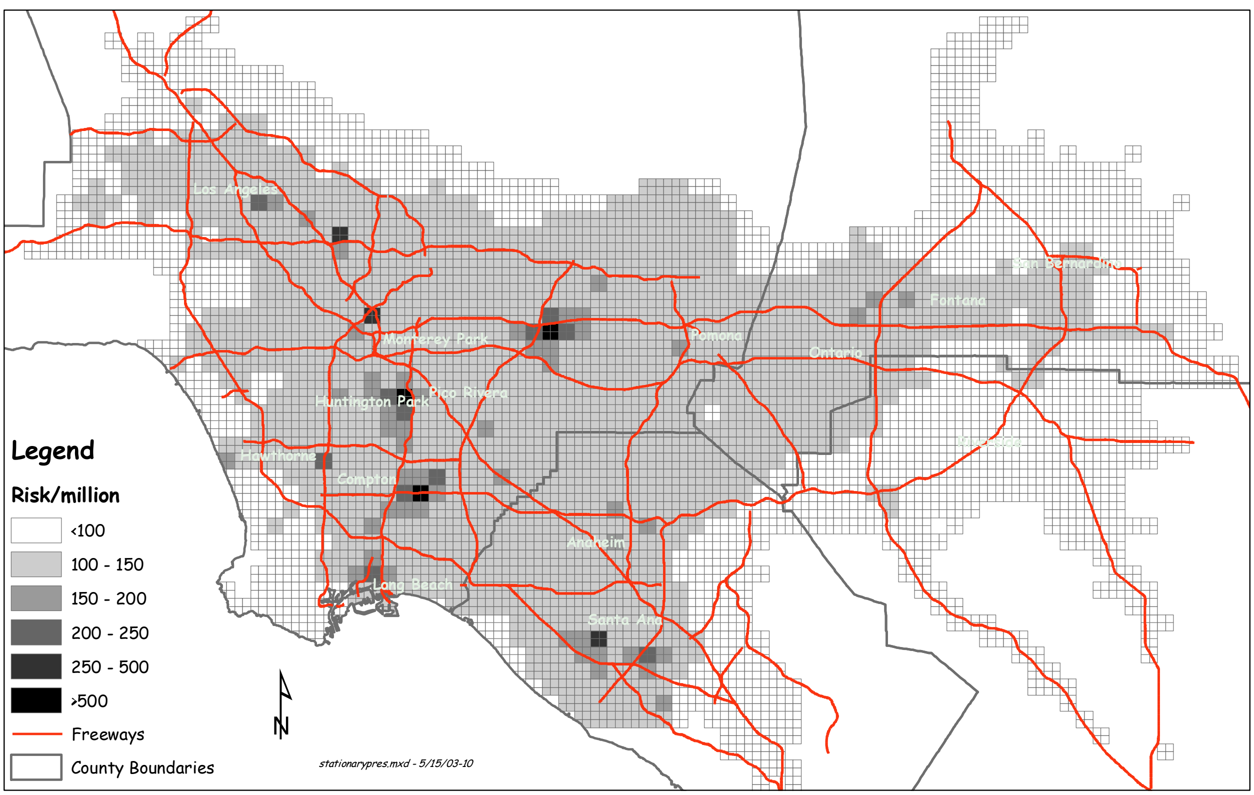


Figure 3
Range of Risk from Stationary Sources Only in the South Coast Air Basin



2000 Census Data

The Governing Board adopted definition of Environmental Justice states that the public health of all persons should be protected, regardless of race, socioeconomic status, etc. However, environmental and community members on the Working Group asked staff to evaluate poverty and ethnicity information that would potentially be used to define high cumulative impact areas.

Consistent with addressing Environmental Justice under the Carl Moyer program, staff examined those census tracts with greater than 10 percent poverty. Utilizing tract level data from the 2000 Census, Figure 4 shows the range of poverty for all demographics for the entire Basin. Staff also examined which areas, have greater than 50 percent non-white population, also utilizing 2000 Census data (see Figure 5). As can be seen from Figures 4 and 5, there is a correlation between areas of high poverty and those of large non-white populations. These areas also correlate strongly with modeled cancer risks. Therefore, prioritizing efforts in areas of high risk would also benefit those areas highlighted by the environmental and community members.

Figure 4
Range of Poverty Within the South Coast Air Basin by Census Tract

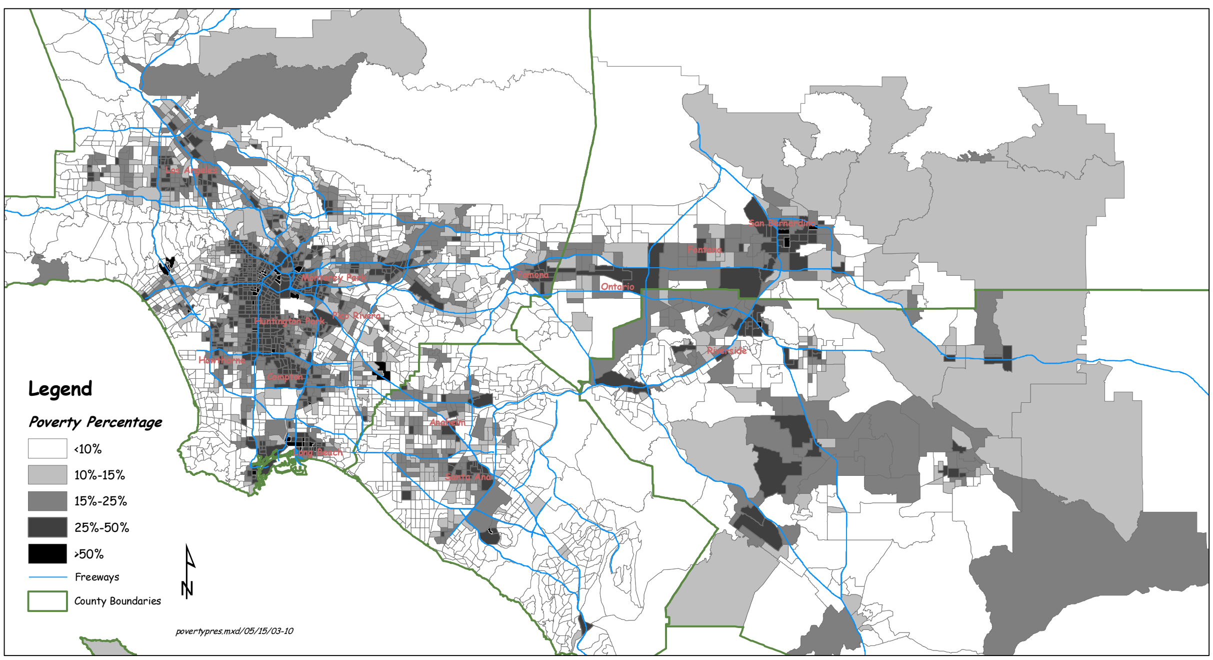
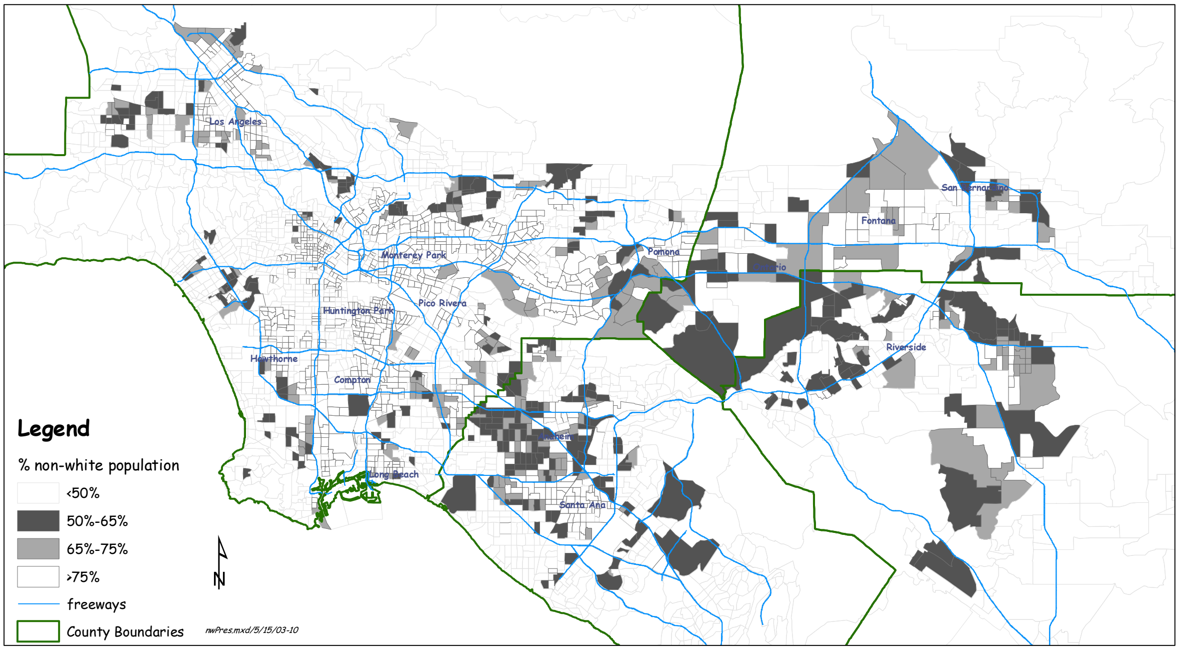


Figure 5
Range of Non-White Populations within the South Coast Air Basin by Census Tract



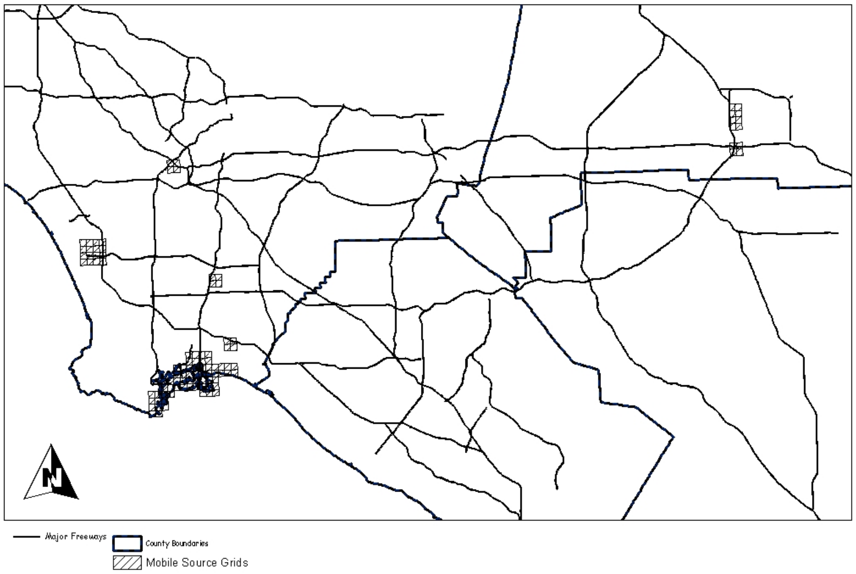
Health Care Data

A request was made at a working group meeting to use health care data to identify areas of high cumulative impacts by using information on rates of air pollution related illnesses, such as asthma. Lack of access to health care could exacerbate cumulative impacts of air pollution. There is not a conclusive source of information for local areas to derive these health-based criteria. Where data might be available, it would be resource intensive to obtain and analyze, as well as only being available for selected areas of the Basin. Therefore, this was determined not to be a practical source of information for prioritizing efforts.

Conclusion

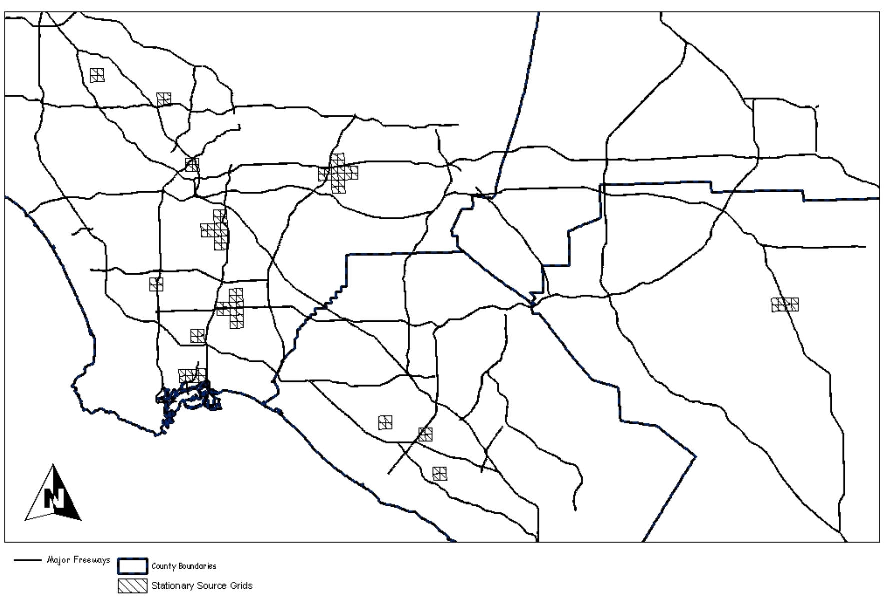
After consideration of the aforementioned data and information, staff recommends that the approach for investigating potential high impact areas start with the top 100 grid cells with the highest mobile source impacts and another top 100 grid cells with the highest stationary source impacts. As a result, there will be a total of 200 grid cells analyzed, which may have some overlapping areas, but will be examined separately. Staff was also asked to look at the top 100 grid cells due to all emission sources, which should be the same as the top cells for mobile sources because greater than 90 percent of the risks are from those sources. Figures 6, 7, and 8 contain preliminary maps using the MATES II data. The location of the top 100 mobile source grid cells are shown on the map in Figure 6, whereas the location of the top 100 stationary source grid cells are shown in Figure 7. Figure 8 shows which grid cells from Figures 7 and 8 overlap.

Figure 6
Top 100 Grid Cells for Mobile Sources Only



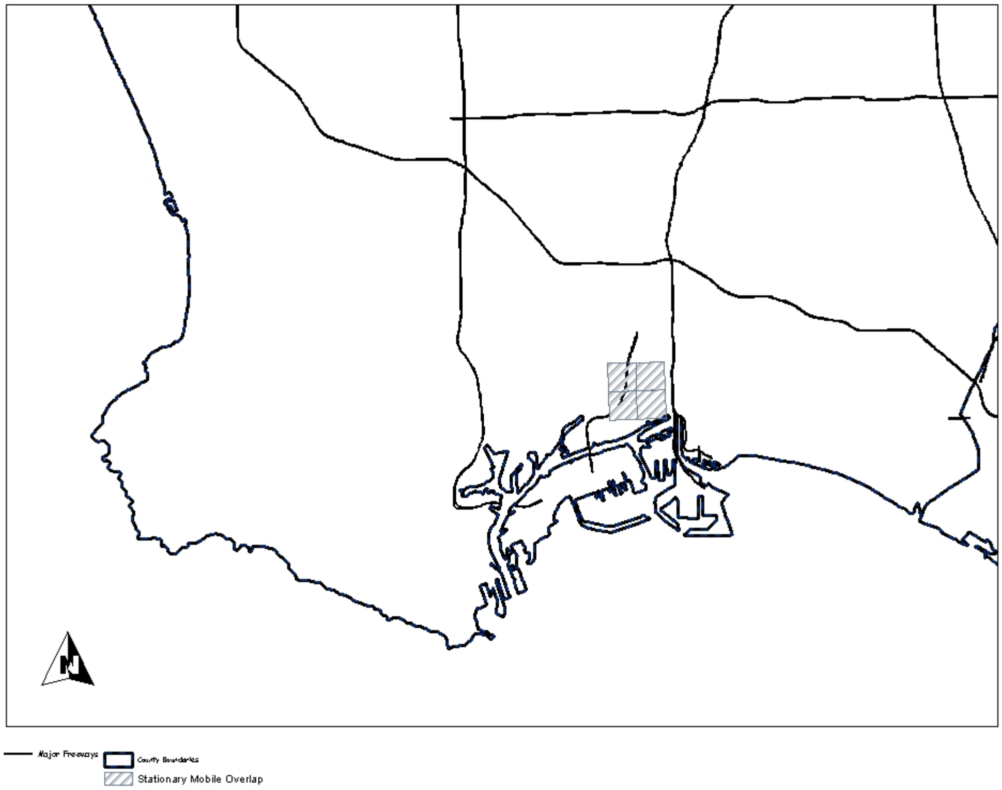
Note: The range of risks due to the mobile source contribution are 1,400 to 5,700 in a million.

Figure 7
Top 100 Grid Cells for Stationary Sources Only



Note: The range of risks due to the stationary source contribution are 160 to 660 in a million.

Figure 8
Overlap of the Top 100 Grid Cells for Both Mobile and Stationary Sources



Mobile and stationary source contributions need to be examined separately because the nature of the sources and possible solutions are different. Furthermore, the MATES II modeling technique (i.e., regional modeling rather than point source modeling) tends to underestimate the potential localized impacts. By evaluating the top mobile and stationary grid cells, cumulative impacts can be addressed for localized areas, depending on the nature of the sources in that situation. These top 100 grid cells represent the approximate top 1 percent of risks from all grid cells in the MATES II study. The top 100 grid cells should not be viewed as a cut-off point for defining high cumulative impact areas. Rather it serves as guidance to prioritize staff resources. Staff will not propose a prohibition of growth in these areas. The intent is to work through the ranking (not limited to the top 100 cells) to evaluate individual circumstances, and to develop solutions accordingly. This prioritization should be re-examined in the future ATCP updates once staff gains more experience in addressing the cumulative impact issues and when additional technical information and tools become available.

As seen in Table 1, when examining the top 100 grid cells, based on cancer risk, for mobile sources only, including diesel particulate, diesel emissions contribute the majority of risk in those cells (more than 90% in most grid cells). Relative to stationary sources, the risk within the top 100 grid cells is mostly contributed (e.g., more than 80%) by perchloroethylene, carbon tetrachloride, ethylene oxide, arsenic, chromium, cadmium, and nickel. Many of these pollutants have or will be controlled through implementation of rules or rule amendments over the last three years. Perchloroethylene and carbon tretrachloride are used as degreasers, ethylene oxide as a sterilizer, arsenic in metallurgical processes, and chromium, cadmium, and nickel in plating operations.

Table 1
Key Mobile and Stationary Source Risk Contributors
(MATES II Modeled Risk Levels)

Category	Key TACs	Range of Cancer Risk
Mobile Sources, Including Diesel Particulate Only	diesel particulate	1,400 – 5,700 in a million
Stationary Sources Only	perchloroethylene (Rules 1122, 1421, &1425) carbon tetrachloride (Rule 1122) ethylene oxide (Rule 1405) arsenic (Rule 1407) chromium (Rule 1469) cadmium (Rule 1426) nickel (Rule 1426)	160 – 660 in a million

CONTROL STRATEGIES FOR REDUCING CUMULATIVE IMPACTS FROM AIR POLLUTION

Early-Action Control Strategies

The following early action control strategies are those that staff recommends should be started immediately. Not all strategies are expected to result in a rulemaking as they may not be necessary after further evaluation or solutions may not be technically or economically feasible at this time. Any strategy that is developed into a rule will go through the full public review process, including CEQA and socioeconomic analysis and public comments, and will be developed for Governing Board consideration. Some of the strategies may already be initiated as part of AQMD's EJ program. Each of these strategies are anticipated to be developed and implemented within 2 to 3 years.

Control Strategies (Rules)

1. Approach: **Air Toxic Control for Back-Up Generators**

Description: A key finding of MATES II was the significant contribution of cancer risk throughout the Basin by diesel sources. The current AQMD permitting rules exempt emergency engines from Rule 1401 – New Source Review of Toxic Air Contaminants. A number of these sources, such as back-up generators, are located in and around schools, as well as other sensitive receptors. This strategy would seek to reduce air toxic emissions, including diesel particulates, from back-up generators.

Mechanism: Under this measure, staff would develop requirements to reduce emissions from back-up generators, taking into consideration state Air Toxics Control Measure (ATCM) requirements assessment for diesel particulates and Office of Environmental Health Hazard Assessment (OEHHA) updated risk procedures. Such requirements may include greater limitation on hours for maintenance operation, designation of when maintenance may be conducted when a generator is located near a sensitive receptor, or requiring the addition of diesel particulate filters. Such requirements may be applied to both existing back-up generators and new generators. Staff has been asked to evaluate whether special consideration is needed for engines to be used under emergency situations for essential public services, such as flood control or earthquakes.

2. Approach: **More Stringent Requirements for New Sources Located Near Existing Schools and Possibly Other Sensitive Receptors**

Description: This control strategy would seek to establish requirements for new and relocated facilities near schools and possibly other sensitive receptors.

Mechanism: Staff would seek to amend Rule 1401 to establish more stringent risk limits for new and relocated facilities emitting air toxics located near existing schools and possibly other sensitive receptors for their risk levels at these receptors. Sensitive receptors include schools (kindergarten through grade 12), licensed daycare centers, hospitals, and convalescent homes. The risk assessment procedures in Rule 1401 would be used to assess the maximum individual cancer risk at the school. These requirements may include more stringent risk limits for new and relocated facilities. If the increase in risk triggers Rule 1402 applicability, this strategy may also seek to expedite Rule 1402 risk reduction. For example, a new facility being located within a specified distance from a school (e.g., within 100 meters as specified in AQMD Rule 1469) may be required to meet a risk limitation of less than 1 in a million without using BACT or less than 10 in a million using BACT for toxics, or T-BACT. It is the staff's intent to use 100 meters as the distance threshold. However, the distance threshold needs to be further discussed through the rulemaking process. In addition, a new facility being located within a certain distance of a school may also be required to reduce a facility-wide cancer risk below the action level prior to the start of operation of the new equipment. The amendment to Rule 1401 associated with this strategy would be for existing schools or sensitive receptors only and would proceed through a two-step hearing process to first identify key policy issues and seek Governing Board direction prior to the rule adoption hearing.

Since this strategy has raised a number of general questions, a summary table (Table 2) has been provided to highlight key elements.

Table 2
Summary of Key Elements of Strategy No. 2

Element	Summary
Applies to:	new and relocated facilities
Variables	• distance • impacts at specified receptors
Sensitive Receptor	• schools (kindergarten through grade 12) • licensed daycare centers • hospitals • convalescent homes
Proposed Strategy	• more stringent risk levels • or expedited Rule 1402 risk reduction, if triggered.

3. Approach: **Yard Hostlers at Ports, Rail Yards, and Distribution Centers**

Description: One source of emissions contributing to a cumulative impact is ground support operations associated with cargo sorting and transport within ports, rail yards, and distribution centers. These sources, known as yard hostlers, can cumulatively create potential increased exposures to the surrounding area due to their emissions. This strategy would seek to reduce emissions from yard hostlers at ports, rail yards, and distribution centers used in conjunction with these operations.

Mechanism: Staff would develop new requirements to control emissions from yard hostlers used at ports, rail yards, and distribution centers (e.g., warehouses). Control strategies could include lower emitting equipment either by add-on control technologies or alternative fuels.

4. Approach: **Chromium Spray Coating Operations**

Description: Emissions of hexavalent chromium have historically been a contributor to the ambient risk contributed by stationary sources throughout much of the Basin. Since 1990, a number of measures have been taken to reduce emissions of chromium from various sources, including metal finishing and coating applications. In 2000, the results of MATES II identified chromium as one of the most significant stationary source toxic air contaminants. Rule 1469 has been strengthened to significantly reduce chromium emissions from metal finishing operations. However, other operations, such as chromium-based spray coating operations have also been identified as potentially contributing to cancer risk. This strategy would investigate and potentially seek to reduce emissions of chromium from these operations.

Mechanism: Staff would conduct an investigation into the remaining risk associated with spray operations using chromium-based coatings, including a technical analysis as to alternative coating materials, or the effectiveness of add-on control equipment. An issue was raised to have staff evaluate the potential toxic characterization of chrome from paint spray operations. In addition, compliance records for metal coating operations will also be examined to determine if non-compliant sources, if any, are contributing significantly to the risk. Consideration will be given to sources already in compliance with Rule 1402, for example. Staff has been asked to consider sources covered under other rules, such as the aerospace NESHAP and Rule 1124. The result of this effort may result in the adoption of a new or amended rule to control emissions of chromium from spray coating applications.

5. Approach: **Private Fleet Rule Development**

Description: Findings from the MATES II program showed that the largest portion of the ambient cancer risk is contributed by diesel sources throughout the Basin. As a result, the AQMD Governing Board adopted a series of fleet rules (e.g., 1190 series rules) to reduce emissions of diesel particulates from mobile sources within the agency's jurisdiction. This strategy would develop additional new rules for further emission reductions from private fleets.

Mechanism: This strategy would lead to the development of new rules for additional emission reductions from private fleets, such as fuel providers and cargo/shipment carriers. This strategy also leads to the development of the necessary infrastructure to maintain the fleets, which is an important element for sustainability.

Control Strategies (Policy)

6. Approach: **Increased Compliance Assurance for Repeat Emission Violations**

Description: At public outreach meetings, requests are often made for an increased field compliance presence, particularly in those areas consisting of a high concentration of facilities. This stems from the concerns that non-compliance or accidental release would contribute to cumulative impacts. This strategy is to develop and implement an enhanced compliance assurance program for stationary sources which receive multiple notices of violation. Such action will likely provide the greater benefit in high cumulative impact areas.

Mechanism: As an early action measure, this strategy involves the development of a program that would guarantee minimum inspections and minimum penalties for repeat emission violations to assure continuous and consistent compliance. AQMD staff would investigate data and compliance records so as to focus resources to address the more localized issues. In determining repeat emission violations, AQMD staff will take into consideration industry-specific operations and the amount of excess emissions. Thus, facilities with multiple emission-related violations would be inspected at a greater frequency. Rules will be enforced consistently, regardless of facility location. The enhancement would involve more strategic deployment of AQMD field inspections and increased deterrence for repeat emission violators. This strategy will be implemented after approval of the ATCP by the AQMD Governing Board.

7. Approach: **Prioritize Resources for CEQA Document Review in High Cumulative Impact Areas**

Description: Projects with potentially significant adverse environmental impacts require an evaluation under CEQA. AQMD regularly receives CEQA documents prepared by other lead agencies for comments. Air quality is one of the CEQA topics. Relative to air quality impacts, a thorough evaluation of project related emissions, including both mobile and stationary source emissions is needed, particularly for projects located in high cumulative impact areas. This strategy would ensure that CEQA documents prepared in conjunction with these projects are evaluated by AQMD for potentially significant impacts and that adequate measures are taken to mitigate the impacts when required.

Mechanism: AQMD staff will prioritize resources to ensure adequate intergovernmental review of CEQA documents to ensure the accuracy and the adequacy of air quality impact analyses and the associated mitigation measures, if deemed necessary.

8. Approach: **Voluntary AQMD/Local Government/Public Agency Partnership**

Description: One of the key resources to address potential cumulative impacts associated with emissions from new, modified, and relocated facilities is local government staff such as planners, as they have the ability to control where and how facilities are located in their community. This strategy is to work with local governments and planners through a partnership to provide the necessary information and tools to minimize cumulative impacts from future potentially air toxic emitting facilities and projects in their area.

Mechanism: This strategy would be implemented through an education and outreach program to advise local governments outside the current CEQA analysis process. AQMD would partner with local governments and other public agencies. This effort is different than AQMD's role in review and comment on CEQA projects because it is a more proactive, educational effort, not related to a specific project. In conjunction with the Model Air Quality Element (an EJ enhancement), AQMD staff will offer to make presentations and to consult with City Councils and Planning Commissions regarding land use decisions, and provide them with tools to identify incompatible land uses and to identify and address projects that may have a direct or indirect affect on the health of the surrounding community due to their operations. An air quality/environmental checklist may be developed for use by any local government to aid them in their decisions.

9. Approach: **Governing Board Resolution to CARB**

Description: Mobile sources, which are regulated under CARB, are significant contributors to risk levels in the Basin (see section on MATES II). Consequently, additional controls from this sector would greatly enhance the reduction of cumulative impacts.

Mechanism: This Early Action strategy would entail a Governing Board resolution to CARB urging their partnership and timely control of mobile source emissions. AQMD wants to work with CARB to be full partners in resolving cumulative impacts in this Basin, especially where mobile sources are the key contributors to cumulative impacts. Staff recommends that the resolution include a request that CARB Board members participate in a summit with a delegation of AQMD Board members to discuss this partnership and efforts to assist in reducing cumulative impacts.

Nuisance Strategy

10. Approach: **Pilot Odor Abatement Program**

Description: Nuisance complaints, including odors, have continuously been raised by the public at outreach meetings, such as the AQMD's Town Hall and Environmental Justice (EJ) meetings, as well as Community Forums for addressing cumulative impacts. Odor complaints are a localized issue and can trigger adverse health impacts due to the physical sensitivity of individuals located in and around the area of incidence. The presence (or absence) of odors does not always relate directly to toxics exposure. Currently, odor issues are addressed after occurrence of the incident through public nuisance complaints (i.e., AQMD Rule 402). This strategy would seek to develop proactive measures to prevent exposure to odors.

Mechanism: To address this issue staff would develop a pilot rule for one or two industries. The pilot rule would set the foundation for a process to determine and implement control requirements for odors from new sources. The selection of industries for this pilot program would be based on the historical nuisance compliant records, recent compliance actions, and input from a working group. The control technologies could include best management practices and would examine technologies used in the past resolution of Orders of Abatement or Notices of Violations (NOV).

Appendix C shows the records of the most frequent confirmed odor complaints from 1988 to 2003 along with the corresponding NOVs. These complaints and NOVs are summarized and organized by standard industrial classification (SIC) codes. The industrial classifications receiving the highest number of odor complaints include: Petroleum Refining, Refuse Systems, and Sewage Systems. The next steps needed to develop a control strategy for these sources of odors would be to analyze individual complaints received regarding facilities in these categories. Once a pattern of complaints is found (i.e., type of odor, area, time of day, weather conditions) it can then be determined if a control strategy can be used to mitigate odors in the ambient air. To accomplish this task, staff would rely on a scientific review group for developing standards, similar to that used for establishing BACT (the same group could be used) for sources of criteria air contaminants.

AIR TOXICS CONTROL PLAN (ATCP) PROCESS

Identifying and resolving cumulative impacts will be a continuous and iterative process since no single solution can adequately address the issues. Therefore, staff is proposing to integrate a cumulative impact component into the ATCP process, which will be updated periodically to incorporate the latest technical information as well as strategies to address air toxic issues (e.g., regional and localized) in the Basin. The ATCP was approved by the Governing Board in March 2000. It was designed to reduce air toxic exposure in the Basin and was envisioned to be updated following the SIP revision process.

Addendum to the Air Toxics Control Plan

An Addendum to the ATCP will be completed after the 2003 update to the Air Quality Management Plan (AQMP). It will include improved emission data and a partial inventory update using the AQMP, as well as data from the implementation of control strategies contained within the March 2000 ATCP to revise current and projected air toxic levels (see Appendix B for ATCP implementation progress). Staff anticipates that the air toxics plan update will be presented to the Governing Board for its approval by the end of 2003. Although MATES III emissions monitoring will not be completed by this time, the inventory and assessment of changes in toxic air pollution levels can proceed for the air toxics plan addendum. Future updates to the ATCP will include MATES III data.

The addendum will utilize information contained in the enhanced Toxic Emissions Inventory, described as follows. The procedure used will be similar to that used in MATES II and the March 2000 ATCP. The base calendar year used for the inventory will be 2000 with future years extending from 2010 to approximately 2020.

The inventory data used will be as follows: on-road sources will use EMFAC 2002 and CARB's most recent specification profiles; point sources not in the AB 2588 program will use calendar year 2000 Annual Emissions Report (AER) data; sources within the AB 2588 program will incorporate any changes reported up to the end of 2000; metal plating facilities, gas stations, and dry cleaners will use the most recent inventory information available; and off road sources will use the data in the 2003 AQMP for calendar years 2000, 2010, and 2020. Once the 2000 inventory is complete, appropriate emission reductions for each category will be determined and a future inventory will be created.

The ATCP Addendum will consider additional health based indicators in the development of control strategies. Consistent with MATES II, the March 2000 air toxics plan primarily focused on cancer-based risks. The air toxics plan Addendum will also consider non-cancer health risks. In addition, it will also examine asthma as a health-based indicator for potential control strategy development to the extent feasible.

The Addendum will have both mobile and stationary control strategies based on technically and economically feasible approaches. Relative to mobile strategies, the efforts will focus on the risks associated with diesel particulate emissions. Control strategies to be developed would include truck and train idling restrictions, and diesel traffic flow management. Staff will also be evaluating other control strategies. This effort will benefit mobile source risk reduction because it will use the CARB Diesel Reduction Plan (October 2000) as a baseline and seek additional reductions beyond what is called for in the state plan.

The ATCP update will include a systematic review of existing toxic rules to determine if additional reductions are technically and economically feasible for facilities located near schools and possibly other sensitive receptors. These efforts may include the addition of sensitive receptor requirements for existing sources through amendments to existing rules and consideration during future rule development.

Other potential control strategies include pollution prevention (such as technical assistance for all facilities and a focus on facilities in higher cumulative impact areas that are close to schools), and funding for localized risk reduction projects, through an abatement fund or other mechanisms.

Analysis of MATES II stationary source cancer risk indicates that perchloroethylene (a.k.a., "perc" or tetrachloroethylene), chromium, arsenic, and carbon tetrachloride were key contributors to cancer risk. Several of these TACs are or will be reduced from implementation of recently adopted and amended rules. Spray coatings containing chromium will be evaluated for further reduction. Arsenic will also be evaluated. Due to odor complaints and the large use of various TACs in paint formulations, staff proposes a two-step process for evaluating odors and potential control approaches for auto-body shops. Additional fleet rules will also be developed.

Conceptually, an outline of Addendum to the March 2000 Air Toxics Control Plan would include the following topics:

Progress in Implementing 2000 Toxics Plan
- AQMD
- State
- Federal
- Previous projections
- Revised projections

Additional Control Strategies
- Introduction, including design criteria used in first plan and any updates
- Early action measures
- Stationary source measures
- Mobile source measures

Implementation
- Time frame
- Partnerships with other agencies and stakeholders
- Environmental and socioeconomic implications
- Outreach
- Monitoring
- Future enhancement

It should be noted that MATES II and the March 2000 ATCP focused primarily on cancer risks. This update will include incremental efforts to reduce cancer risk, since most of these are on-going, long term efforts. The update will also identify high cumulative impact areas for focusing efforts relative to the control strategies.

The following control strategies, which are in addition to the Early Action Control Strategies, are staff's recommendation for further consideration and development. Development of some strategies will begin right away, others may take longer to develop. Not all strategies are expected to result in a rulemaking, as they may not be necessary or feasible upon further evaluation. For example, there were strategies identified in the March 2000 ATCP that did not result in rulemaking and were not pursued after further technical evaluation (i.e., hospital ethylene oxide sterilizers and rubber manufacturing). Any strategy that is developed into a rule will go through the full public review process, including CEQA and socioeconomic analysis, and public comments, and will be developed for Governing Board consideration. Some of the strategies may already be initiated in conjunction with the AQMD's EJ program. Each of these strategies are anticipated to be developed and fully implemented within 3 to 5 years.

Proposed Control Strategies for Addendum to the Air Toxics Control Plan

11. Approach: **Truck Idling**
    Description: During many public outreach meetings, staff has heard numerous concerns about the diesel truck traffic associated with the moving of cargo to and from ports, rail yards, and distribution centers. In addition to the traffic from moving cargo, the idling of trucks waiting for loading and unloading contributes to increased ground level emissions that move into nearby areas and contribute to health and nuisance complaints. This strategy will seek to develop requirements to reduce emissions

		from diesel truck idling. This control measure was identified in the March 2000 ATCP.
	Mechanism:	Under this strategy, staff would develop a new rule to control diesel truck idling to the extent feasible, taking into consideration operational needs for the movement of cargo and infrastructure for electrification as necessary.
12.	Approach:	**Train Idling**
	Description:	As with truck idling, staff has heard numerous complaints related to rail traffic. This traffic is associated with the moving of cargo to and from ports and rail yards. Particular focus has been on idling locomotives waiting to move cargo. This strategy would likewise seek to develop requirements to reduce emissions from train engine idling.
	Mechanism:	Under this strategy, staff would develop a new rule to control train idling to the extent feasible, taking into consideration operational needs for the movement of cargo and infrastructure needed to support locomotives.
13.	Approach:	**Marine and Airport Operations**
	Description:	Early-Action Strategy No. 3 addresses yard hostlers at ports, rail yards and distribution centers. This strategy would seek to address emissions from marine and airport related operations.
	Mechanism:	Staff would examine emission reduction options for marine and airport related operations. Staff would first conduct feasibility studies, including AQMD legal authority, control technologies, and cost effectiveness prior to developing specific regulatory programs.
14.	Approach:	**More Stringent Requirements for Rule 1402 Sources Near Existing Schools and Possibly Other Sensitive Receptors**
	Description:	As stated under early action measure No. 2, health risks associated with facilities located near existing schools and possibly other sensitive receptors are of concern. Whereas strategy No. 2 would address new and relocated equipment, and new facilities, this strategy would address existing facilities located near (e.g., within 100 meters) schools and possibly other sensitive receptors.
	Mechanism:	Staff would seek to amend Rule 1402 to add additional requirements for risk levels for facilities located near schools, and possibly other sensitive receptors. Sensitive receptors include schools (kindergarten through grade 12), licensed daycare centers, hospitals, and convalescent homes. The risk assessment procedures in Rule 1401 would be used to assess the maximum individual cancer risk at the school. Such requirement may include lowering the action risk level below the current 25 in a million or expediting the timeframe allowed to implement risk reduction. The amendment to Rule 1402 associated with this strategy would address schools or sensitive receptors only and would proceed through a two-step hearing process to first identify key policy issues and seek Governing Board direction prior to the rule adoption hearing. Staff will seek funding to assist facilities with cost of risk reduction or relocation. Staff's intent is that this would apply to existing facilities and existing sensitive receptors, not for a new sensitive receptor that moves near facilities. Strategy No. 8, the Voluntary AQMD/Local

Government/Public Agency Partnership, will be used to help better inform land use decisions.

Since this strategy has raised a number of general questions, a summary table (Table 3) has been provided to highlight key elements.

Table 3
Summary of Key Elements of Strategy No. 14

Element	Summary
Applies to:	• existing facilities subject to Rule 1402
Variables	• distance • impacts at specified receptors
Sensitive Receptor	• schools (kindergarten through grade 12) • licensed daycare centers • hospitals • convalescent homes
Proposed Strategy	• more stringent risk reduction action levels, or • expedited compliance schedule for risk reductions

15. Approach: **More Stringent Air Toxic Source-Specific Requirements for Sources Near Existing Schools and Possibly Other Sensitive Receptors**

Description: Early action strategy No. 2 addresses facilities located near schools and possibly other sensitive receptors through an amendment to Rule 1401. Strategy No. 14 would address existing facilities located near existing schools and possibly other sensitive receptors through an amendment to Rule 1402. This strategy would seek to amend existing toxic source-specific rules, or for consideration during development of future new toxic rules, to evaluate more stringent requirements and distance and receptor criteria.

Mechanism: Staff would investigate the feasibility of amending existing toxic source-specific rules that currently contain requirements for industries or pieces of equipment to include requirements based on distance and receptor impacts, similar to that contained in Rule 1469-Hexavalent Chromium Emissions From Chrome Plating and Chromic Acid Anodizing Operations. Consideration would also be given during future new rule development. Each source category would be evaluated individually to determine feasible and appropriate proposals.

16. Approach: **Develop and Launch Pollution Prevention Initiatives**

Description: Staff continues to identify and implement pollution prevention measures when developing regulatory and non-regulatory programs. Under this strategy, staff would seek to develop a pilot pollution prevention program that could be initiated in areas of high cumulative impact.

Mechanism: The pilot pollution prevention program would initially be focused on sources contributing to high cumulative risk and would start by concentrating on facilities located near schools. AQMD staff would provide a consultation and make recommendations to facilities as to how they may improve operations, provide information on low-cost alternatives to lower emissions, or outline steps that can be taken to prevent nuisance complaints. According to the success of this program, it may be expanded to other sensitive receptors. Staff also recognizes that there have been concerns raised by members of the Cal EPA Environmental Justice Advisory Committee with regards to pollution prevention techniques. Such concerns will be taken into account as part of the development of this strategy. Staff's analysis will consider technical feasibility, cost-effectiveness, product quality, and other potential impacts of pollution prevention options. District staff will also work with facilities and local government to seek potential funding for implementing pollution prevention strategies.

17. Approach: **Neighborhood Air Toxics Abatement Fund**

Description: This strategy would call for the creation of a fund that can be used for local programs to reduce public exposures to air pollution and support or match funds for projects that would reduce local exposures to air pollution.

Mechanism: Staff would recommend AQMD establish a Neighborhood Air Toxics Abatement Fund for facilities from penalties and other public funding. Staff would also seek U.S. EPA/state funding designated for EJ/toxic programs for matching funds for high priority mobile source emission reduction projects. The funding mechanism is not intended to be a pay to pollute program nor a means for compliance flexibility. The fund would not be used for strategies Nos. 2 and 14. Strong concerns were raised by environmental and community representatives regarding potential toxic trading and receptors benefiting from the toxic reduction projects not being the same receptors that are affected by the facility. However, they indicated that public funding or penalty monies directed toward reducing toxic emissions would be acceptable and if residual risks cannot be mitigated in a meaningful way, potential relocation of receptors should be considered.

18. Approach: **Additional Controls for Arsenic**

Description: MATES II data indicates that arsenic is one of several compounds that contributes to the ambient risk. This strategy would evaluate and establish additional control requirements for sources of arsenic emissions.

Mechanism: Using the MATES II data, staff will examine the sources of arsenic contributing to the risk levels within the Basin. Staff will then develop technically and economically feasible requirements for the control of arsenic emissions. Such requirements may be implemented through a new or existing rule, depending on the findings of staff's assessment.

19. Approach: **Additional Controls for Auto-body Shops**

Description: During public outreach meetings, auto-body refinishing has been identified as a source of nuisance complaints. This has been verified by examining nuisance complaint records. Due to odor complaints and the variety of TACs in auto-body coatings, this strategy will examine typical causes of odors, compliance status, and evaluate control options for auto-body shops.

Mechanism: This strategy would be implemented in two steps. First, staff would work jointly with stakeholders to conduct a technical assessment of the auto-body refinishing industry to determine what causes odor complaints. The second step would focus on developing technically and economically feasible options for the reduction of TAC emissions and odors. The options will consider compliance history and impacts on receptors. Such requirements may be implemented through amendments to Rule 1151.

20. Approach: **Diesel Traffic Flow Control**
Description: Companion to strategy No. 11, this strategy would work with local governments and planners to minimize impacts from diesel-based traffic on schools or other sensitive receptors.
Mechanism: Under this strategy, staff would work with local governments and planners to develop alternative traffic patterns for diesel traffic to minimize impacts to schools or other sensitive receptors. This strategy stems from staff's previous analysis for diesel fuel traffic from distribution centers in the Mira Loma area.

21. Approach: **Analysis and Mitigation for Sources Contributing to High Cumulative Air Pollution Impacts (Cancer and Non-Cancer)**
Description: Once the high cumulative impact areas and their key risk contributors are identified, this strategy seeks to develop mitigation measures to reduce air toxic emissions from sources contributing to the cumulative impacts.
Mechanism: Staff would identify those sources in the high ranking areas that contribute to the ambient risk and develop strategies to reduce that risk. Implementation of this strategy will be independent of other strategies contained herein, thereby eliminating duplication. Strategies for sources identified could include regulatory or policy approaches. Regulatory approaches may include, but are not limited to, more stringent new source review or risk reduction requirements for existing sources. Other enforceable legal instruments, such as memorandums of understanding (MOUs) and stipulated abatement orders, may also be used. Staff would recommend the most effective regulatory or policy tools available to reduce cumulative impacts.

Nuisance Strategy

22. Approach: **Odor Abatement Program for Existing Facilities**
Description: As mentioned in Early-Action Control Strategy No. 10, the issue of nuisance odors has continuously been raised at public meetings. This program would build on the Pilot Odor Abatement Program by extending control strategies to existing facilities.
Mechanism: This control strategy would focus on existing equipment that have been identified in the Pilot Odor Abatement Program or other efforts that require measures to prevent exposure to odors. This would include the identification and development of technically feasible and cost-effective retrofit control options.

23. Approach: **ARB Component**
Description: This strategy would consider CARB's air toxics control program to identify sources under their jurisdiction that contribute significantly to cumulative impacts.
Mechanism: Staff would work cooperatively with CARB to identify strategies under their authority for implementation that would be supported at the local level. Such strategies could include requirements for particulate traps for in-use diesel

engines. AQMD could also make recommendations to CARB based on findings from this effort.

24. Approach: **U.S. EPA Component**
Description: As with CARB, this strategy would develop strategies for sources under U.S. EPA jurisdiction that contribute significantly to cumulative impacts.
Mechanism: Staff would work cooperatively with U.S. EPA to identify strategies for mobile sources, such as diesel trucks, trains, and ships that are under U.S. EPA jurisdiction. AQMD could also make recommendations to U.S. EPA based on findings from this effort.

25. Approach: **Increased/Targeted Funding for Disproportionately Impacted Areas**
Description: Prioritize funding to disproportionately impacted areas.
Mechanism: AQMD would continue to prioritize funding for areas of higher risk, similar to the criteria set by AB 1390 (Firebaugh) applicable to the use of Moyer Funds in disproportionately impacted areas and the priority established in the AQMD's grant program for school bus funding and non-perc dry cleaners (50 percent of funding reserved for areas with greater than 1,000 in a million cancer risk or greater than 10 percent population below the poverty level). Funding could also include money from the federal government and other sources. AQMD will maintain an active role in securing continuous funding for Carl Moyer, school bus funding, and other programs where funding is essential for reducing cumulative impacts.

Periodic ATCP Revisions

Future updates to the air toxics plan will be conducted on a periodic basis, the first of which will utilize data from MATES III (discussed below). Future updates will include improved inventories, methodologies, and special studies to focus on achieving greater air toxic emission reductions from stationary and mobile source categories. Development of those plans will rely on an iterative process for prioritization. The updates will also take into consideration comments received at various Town Hall meetings, task forces, and other public meetings.

The ATCP will be subject to periodic revisions, including the following four enhancements:

1. Improve Emissions Inventories, Data and Analysis Tools

This enhancement would involve the development of better data and analytical methods with which to measure, report, and evaluate cumulative air pollution impacts, and programs to address those risks. Such improvements would be made to the AQMD's inventories, as well as the data needed to conduct analyses. This would be accomplished by using special studies (e.g., MATES III), information gained through various rule development efforts and existing efforts to update and improve emissions inventories, such as linking Annual Emission Reporting (AER) program and Air Toxics Hot Spots (AB 2588) databases. Updated inventory information from the state relative to mobiles sources (i.e., EMFAC 2002) will also be utilized for the first ATCP update. Such information will be continually updated on an ongoing basis. This will enable staff to focus and facilitate efforts relative to addressing cumulative impacts and implementing the control strategies in the most efficient manner possible.

2. Improve Modeling Tools

To assess cumulative impacts, staff would utilize improved modeling tools (e.g., 2003 AQMP modeling techniques) for evaluating air toxic impacts at the local level from all nearby sources, including mobile sources, for comparing local level exposures within the region. In the short-term, staff will conduct an assessment using the improved emission inventories associated with the 2003 AQMP to examine progress since the approval of the March 2000 ATCP. Staff would then continue to update these tools on an ongoing basis.

3. Identify and Address Non-Cancer Risks

MATES II focused on examining those TACs contributing to cancer risk throughout the Basin and did not specifically analyze non-cancer impacts associated with those chemicals. At many public outreach meetings, consistent comments were made that such studies should also address non-cancer impacts. This strategy would develop a program that not only seeks to reduce cancer risk, but also identifies ways to reduce chronic and acute non-cancer or other public health exposures. To address this issue in the short-term, staff will be examining the data collected in MATES II to estimate the non-cancer impacts throughout the Basin using the previous data. This information will be used in the ATCP Addendum and to assist in development of the strategies. MATES III will examine non-cancer and asthma impacts (to the extent possible) and staff will seek to use this information for future updates to the ATCP.

4. Evaluate High Cumulative Air Pollution Impact Areas

Using the data and information resulting from the previous three enhancements, staff will refine the approach to prioritize areas of concern based on unusually high levels of cumulative health risk and to identify sources contributing significantly to that risk. This information will be used to develop specific measures to reduce public exposures to air pollution and health risks. As previously described, the approach was developed as a tool to prioritize staff resources, not as a regulatory classification. Staff recommends using MATES II data to examine the top 100 1 km x 1 km grid cells for each mobile and stationary sources to identify sources and potential solutions. The process will then continue with the next 100 grid cells. This approach may be revised when staff gains more experience and new techniques become available. The analysis of potentially high cumulative impact areas will form the foundation to formulate control strategies.

MATES III

As directed by the Governing Board in January 2003, staff will be conducting the third MATES program. As before, AQMD will use a scientific review panel and will seek public input on the various aspects of the program, including monitoring locations and evaluation tools. The list of toxic air contaminants (TACs) will be revised from MATES II to address the risks associated with additional chemicals of concern. Some TACs may be eliminated from the analysis if they were not detected in the previous study.

A key element of MATES III will be the selection of micro-scale sites for localized monitoring. Staff has received numerous suggestions for such sites and will be further evaluating various locations. It is anticipated that monitoring, modeling, analysis, and reporting, will take approximately 1 ½ years. Monitoring is projected to start in April 2004.

V. PUBLIC PROCESS

The Working Group met seven times to discuss a program to reduce cumulative impacts from air pollution. These meetings, plus five Community Forums, helped identify issues and potential approaches.

Working Group and Public Input

Environmental/community, industry, and AQMD staff Working Group members generated separate lists of recommended cumulative impact control strategies. All three lists of suggested options were discussed, combined and narrowed down to a list of 19 options that were provided for public comment at five Community Forums. Staff conducted these forums at various locations throughout the Basin in the evenings or Saturdays (Mira Loma, Fontana, Sun Valley, Santa Ana, and Wilmington) in May and June 2003. A summary of the input received from the Community Forums is provided in Appendix F. Additional strategies were added as a direct result of comments heard at the Community Forums.

The discussion in the following sections highlights interests of the different groups represented on the working group. There were many areas of agreement among the members. First, all parties agreed that areas of high cumulative impacts need to be addressed; it is how that may be accomplished where there are differences. There was also consensus that in order to establish an effective program to reduce cumulative impacts, improvements in emission inventories, data, tools, and modeling are necessary. In addition, all parties agreed that non-cancer risks need to be identified and addressed. These areas of agreement correspond to the enhancements proposed for the periodic updates to the ATCP. There was also general agreement on other suggested control strategies to reduce air emissions from source-specific activities that are currently unregulated, such as truck and train idling (Nos. 11 and 12), yard/port activities (No. 3), chromium spray operations (No. 4), and arsenic controls (No. 18). There was support for the Voluntary AQMD/Local Government/Public Agency Partnerships.

However, there was not consensus on strategies that would result in source-specific requirements for sources, such as more stringent requirements for new or existing sources located close to schools or possibly other sensitive receptors.

Following is a summary of the key interests and recommendations by members of the working group representing industry, environmental/community, and local governments.

Industry

Industry representatives of the Cumulative Impacts Working Group felt that the most effective programs addressing air pollution have resulted from identifying the source(s) of the cumulative air pollution problem and developing strategies for reducing pollution from the sources that are creating the problem. They pointed out that California law provides clear direction in the area of Environmental Justice, defining it as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." (Government Code §65040. 12(c)), as well as highlighting AQMD's own definition. Industry also felt that the AQMD should use valid tools to identify areas that have unusually high levels of cumulative risk and exposure and develop programmatic solutions to address these areas.

Pursuant to Health and Safety Code Section 40440(c), industry representatives have pointed out AQMD's obligation to regulate in a manner that results in the most effective and least burdensome programs. They felt that this can only be done if the problem areas are clearly identified and prioritized and the sources of the problem identified. The industry representatives' key recommendations are summarized as follows:

1. Define the areas of concern based on areas which have unusually high levels of cumulative risk when compared to the region;
2. Identify the sources contributing significantly to the health risk in those areas; and
3. Develop programs targeting the sources contributing to the problem.

Environmental/Community

Environmental/community representatives agree that high risk areas should be addressed. In addition, they site the need for better tools and data for analyzing cumulative risks and they suggest a program that is broad and more encompassing. The environmental/community representatives are also interested in:

1. Further developing and implementing methods of pollution prevention;
2. Developing additional mitigation requirements for all facilities, including both existing and future proposed facilities that are located in heavily impacted areas;
3. Establishing emission reduction goals for industry-wide reductions for certain heavy polluting sectors (e.g., refineries, auto body/paint shops, printers, and nail salons);
4. Adoption of specific goals for Hazardous Air Pollutants (HAPs) emission reductions from both the stationary and mobile sources under AQMD's authority. Success would be measured by decreased TAC emissions and increased number of permits denied or not renewed; and
5. Developing and incorporating into source-specific rules health-based and distance-based siting criteria for residential and sensitive receptors, and requiring applicants for new, modified, or renewed permits in heavily impacted areas to verify the underlying assumptions and assertions about emissions and impacts of the proposed equipment and processes.

The environmental and community representatives feel strongly that Rules 1401 and 1402 should be strengthened and applied to all permitted sources, regardless of their contribution to cumulative impacts. They also do not want the Neighborhood Toxic Abatement Fund to be used by facilities to meet more stringent standards.

Local Government

Local government representatives commented that a program to mitigate cumulative risk should only proceed once the highest risk areas and the contributors to those highest risks are identified. In general, across-the-board programs that target risk reduction within the stationary source category while disregarding the large contribution from mobile sources are undesirable. Stationary source risk reduction is appropriate where it has been clearly shown that the stationary source contributes the major portion of the risk. In general local government representatives desire a cumulative impacts program that:

1. Identifies high risk areas from all contributors;
2. Analyzes the risk contributors for those high risk areas;
3. Identifies agencies with authority/jurisdiction;
4. Minimizes disproportionate risk through existing programs if possible, such as expanded fleet rules, AB 2588 etc.; and
5. Creates incentive programs secondly to target under-regulated/unregulated problem source.

VI. RECOMMENDATIONS

Staff recommends the approach outlined within this White Paper, which calls for immediate work to develop the Early-Action Control Strategies and an Addendum to the March 2000 Air Toxics Control Plan, a commitment for future periodic updates to the ATCP, and completion of MATES III.

VII. PROPOSED SCHEDULE

Staff proposes the following schedule:

1. White Paper presented to the Governing Board: September 2003.
2. Addendum to the March 2000 Air Toxics Control Plan: December 2003.
3. Report to the Stationary Source Committee every 6 months.
4. Report to Board once per year as part of the EJ Enhancements.
5. Early-Action Control Strategies developed and implemented within 3 years.
6. Remaining Control Strategies developed and implemented within 3 to 5 years.
7. Working Group meetings, as necessary, to receive input on proposals being developed.

Table 4A presents the proposed schedule for each of the control strategies, sorted by strategy number, addressed in this paper. Table 4B presents the strategies sorted by proposed adoption date.

Table 4A
Control Strategy Schedule
(Sorted by Strategy Number)

No.	Title	Date of Proposed Adoption
	Early-Action Control Strategies (Rules)	
1	Air Toxic Control for Back-up Generators	1st Quarter 2004
2	More Stringent Requirements for New Sources Located Near Existing Schools and Possibly Other Sensitive Receptors	2004
3	Yard Hostlers at Ports, Rail Yards, and Distribution Centers	2004-2005
4	Chromium Spray Coating Operations	4th Quarter 2004
5	Private Fleet Rule Development	2004-2005
	Early-Action Control Strategies (Policy)	
6	Increased Compliance Assurance for Repeat Emission Violations	2004-2005
7	Prioritize Resources for CEQA Document Review in High Cumulative Impact Areas	2004
8	Voluntary AQMD/Local Government/Public Agency Partnership	2004
9	Governing Board Resolution to CARB	2003
	Early-Action Nuisance Strategy	
10	Pilot Odor Abatement Program	2004-2006
	Additional Recommended Strategies for the ATCP	
11	Truck Idling	2005
12	Train Idling	2005
13	Marine and Airport Operations	2005-2008
14	More Stringent Requirements for Rule 1402 Sources Near Existing Schools and Possibly Other Sensitive Receptors	2004-2005
15	More Stringent Air Toxic Source-Specific Requirements for Sources Near Existing Schools and Possibly Other Sensitive Receptors	2005-2008
16	Develop and Launch Pollution Prevention Initiatives	Ongoing
17	Neighborhood Air Toxic Abatement Fund	2004 & Ongoing
18	Additional Controls for Arsenic	2005
19	Additional Control for Auto-body Shops	2005
20	Diesel Traffic Flow Control	Ongoing
21	Analysis and Mitigation for Sources Contributing to High Cumulative Air Pollution Impacts (Cancer and Non-Cancer)	2004 & Ongoing
22	Odor Abatement Program for Existing Facilities (Nuisance Strategy)	2005 & Ongoing
23	ARB Component	Ongoing
24	U.S. EPA Component	Ongoing
25	Increased/Targeted Funding for Disproportionate Impacted Areas	Ongoing

*Initial development will commence upon the ATCP Addendum approval by the AQMD Governing Board. Updates will be made in conjunction with future updates to the AQMP and ATCP, as well as using the results derived from the MATES III effort.

Table 4B
Control Strategy Schedule
(Sorted by Date)

No.	Title	Date of Proposed Adoption
9	Governing Board Resolution to CARB	2003
1	Air Toxic Control for Back-up Generators	1st Quarter 2004
2	More Stringent Requirements for New Sources Located Near Existing Schools and Possibly Other Sensitive Receptors	2004
7	Prioritize Resources for CEQA Document Review in High Cumulative Impact Areas	2004
8	Voluntary AQMD/Local Government/Public Agency Partnership	2004
4	Chromium Spray Coating Operations	4th Quarter 2004
3	Yard Hostlers at Ports, Rail Yards, and Distribution Centers	2004-2005
5	Private Fleet Rule Development	2004-2005
6	Increased Compliance Assurance for Repeat Emission Violations	2004-2005
14	More Stringent Requirements for Rule 1402 Sources Near Existing Schools and Possibly Other Sensitive Receptors	2004-2005
10	Pilot Odor Abatement Program	2004-2006
17	Neighborhood Air Toxic Abatement Fund	2004 & Ongoing
21	Analysis and Mitigation for Sources Contributing to High Cumulative Air Pollution Impacts (Cancer and Non-Cancer)	2004 & Ongoing
11	Truck Idling	2005
12	Train Idling	2005
18	Additional Controls for Arsenic	2005
19	Additional Control for Auto-body Shops	2005
13	Marine and Airport Operations	2005-2008
15	More Stringent Air Toxic Source-Specific Requirements for Sources Near Existing Schools and Possibly Other Sensitive Receptors	2005-2008
22	Odor Abatement Program for Existing Facilities (Nuisance Strategy)	2005 & Ongoing
16	Develop and Launch Pollution Prevention Initiatives	Ongoing
20	Diesel Traffic Flow Control	Ongoing
23	ARB Component	Ongoing
24	U.S. EPA Component	Ongoing
25	Increased/Targeted Funding for Disproportionate Impacted Areas	Ongoing

Guidance Document for Addressing Air Quality Issues in General Plans and Local Planning

A Reference for Local Governments Within the South Coast Air Quality Management District

This guidance document is prepared by the South Coast Air Quality Management District (AQMD) as a reference for cities and counties within AQMD's jurisdiction. It provides suggested policies that local governments can use to prevent or reduce potential air pollution impacts and protect public health in their General Plans or through local planning. The objective of the guidance document is to facilitate stronger collaboration between local governments and the AQMD to reduce community exposure to source-specific and cumulative air pollution impacts. It is recognized that local governments, to make the best decisions for the benefit of their residents, must weigh and balance multiple issues, demands and concerns, including, but not limited to, the need for housing, existing development and development patterns, environmental responsibilities and more when making land use decisions.

May 6, 2005

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CHAPTER 7

PREFACE

The South Coast Air Quality Management District (AQMD) environmental justice program is designed to protect the rights of the residents in the South Coast basin to live and work in an environment of clean air, free of airborne health threats. The guiding principle of the program is based on "equitable environmental policymaking and enforcement to protect the health of all residents, regardless of age, culture, ethnicity, gender, race, socioeconomic status, or geographic location, from the health effects of air pollution." In suggesting enhancements to the AQMD's 2002 environmental justice program, stakeholders proposed the development of a model air quality element for cities and counties within AQMD's jurisdiction that considers the health risks to community residents associated with local government land use planning and decision-making. To that end, the AQMD is making this guidance document available to local governments as a tool to assist them as they develop or update their General Plans and make other planning decisions. The primary users will likely be local government planners within the geographic boundaries of the South Coast air district; however, the ideas, technical issues, and references in the guidance document are also intended for use by private developers, residents, and community organizations. The use of this document by local governments is strictly voluntary. The AQMD recognizes that local governments, to make the best decisions for the benefit of their residents, must weigh and balance multiple issues, demands and concerns, including, but not limited to, the need for housing, existing development and development patterns, environmental responsibilities and more when making land use decisions.

Neither state or federal law mandates separate air quality elements in General Plans. Similarly, the AQMD does not require that cities or counties include a "stand alone" air quality element in their plans, but we encourage local governments to use the information presented in this guidance document to: (1) help develop a separate air quality element, (2) update their current air quality element or (3) integrate air quality policies in other elements of their General Plans such as Land Use and Circulation. We recognize that each community must address a unique combination of air quality and community development issues in their General Plans; therefore, the suggested goals, objectives and policies/strategies presented in this document will not apply uniformly in every jurisdiction. The format and scope of suggested air pollution policies and strategies for each local jurisdiction should be tailored to be consistent with the structure and content of the existing General Plan. Local jurisdictions have complete discretion to select the appropriate mix of pertinent air quality goals and objectives and determine the level of detail of policies and implementation measures that will effectively reduce air pollution and protect public health in their communities.

The combined implementation of the suggested strategies throughout the region will strengthen the local government partnership with the AQMD to achieve state and federal clean air standards and demonstrate the resolve of cities and counties in the district to provide environmental equity and protect public health. The AQMD will update this document periodically to make available the most current air quality information, the results of local health effects studies related to air pollution and the state of air pollution control technologies to help local governments update their General Plans and make other planning decisions.

CHAPTER 1
INTRODUCTION

- REGULATED AIR POLLUTANTS
- EFFECTS OF AIR POLLUTION ON HEALTH AND WELFARE
- THE ROLE OF FEDERAL, STATE, AND LOCAL AGENCIES TO REDUCE AIR POLLUTION
- THE REGIONAL COMPREHENSIVE PLAN
- THE REGIONAL AIR QUALITY MANAGEMENT PLAN
- ENVIRONMENTAL JUSTICE
- FORMAT OF THE DOCUMENT

INTRODUCTION

California state law requires each city and county to adopt a General Plan "for the physical development of the county or city, and any land outside its boundaries which bears relation to its planning". The General Plan must contain seven "elements:" land use, circulation, housing, open-space, conservation, noise and safety. The policies in the required General Plan elements are the basis for most land use decisions. General Plan policies and practices have the potential to exacerbate localized air pollution impacts and adversely affect public health. State law offers the flexibility to go beyond the mandatory elements, to adopt "any other elements or address any other subjects, which in the judgment of the legislative body, relate to the physical development of the county or city." Many cities and counties in the district have addressed air quality in other sections of their General Plan, such as land use, circulation, and conservation. While an air quality element is not mandatory, two counties (San Bernardino and Riverside) and 44 cities within AQMD's jurisdiction have adopted separate air quality elements in their General Plans (see Appendix A). The fact that Southern California continues to be faced with some of the most serious air pollution problems in the United States is a strong case for the topic of air quality to be included as a stand alone element in General Plans. It is recognized that local governments, to make the best decisions for the benefit of their residents, must weigh and balance multiple issues, demands and concerns, including, but not limited to, the need for housing, existing development and development patterns, environmental responsibilities and more when making land use decisions.

The South Coast basin exceeds federal standards for ozone and particulate matter (PM_{10} and $PM_{2.5}$). Although the AQMD is moving forward in implementing both near and long term control measures that aggressively seek to reduce air quality emissions, the basin is currently one of only two areas in the nation classified as "extreme" non-attainment for ozone. Clean air for all the residents in the basin cannot be accomplished by air quality agencies alone. Achieving the mutual goals of protecting public health and providing environmental equity to residents throughout the basin can only be accomplished through a strong partnership with local jurisdictions. The involvement of local governments to establish public policies that support AQMD strategies is essential for this region to meet state and federal air quality goals. The General Plan, as the foundation for all local planning and development, is an important tool to implement local government policies and programs that are vital to achieving clean air standards. Cities and counties have the flexibility and authority to address air quality issues through General Plans that guide the development of local circulation systems, transportation services, and land use. The AQMD and CARB have strong, comprehensive regulatory programs in place for new and existing sources of air pollution. However, local policies in conjunction with air agency efforts can greatly enhance the effectiveness of these programs by addressing cumulative impacts in local areas. Many land use decisions that involve siting, zoning and permitting actions provide opportunities to complement local and state air regulations and prevent or minimize adverse health impacts. The development of land use policy and the authority to site sensitive land uses are local government functions. In local planning and policy development, sensitive land uses should be given special consideration to best protect those individuals that are especially vulnerable to the effects of air pollution. The intent of this document is to provide information that will lead to general plan policies and local decision making that considers potential air quality impacts on public health. The suggested policies and strategies are intended to guide land use planners in developing approaches tailored to their community that reduce exposure to source-specific air pollution and lower the health risk associated with cumulative air pollution impacts.

Chapter 1 presents an overview of regulated air pollutants in the South Coast air district and summarizes the effects of air pollution on public health and welfare.

REGULATED AIR POLLUTANTS

Air pollutants regulated by the federal and California Clean Air Acts or other laws fall under three categories:

- criteria air pollutants,
- toxic air contaminants (TAC),
- global warming and ozone-depleting gases.

Pollutants in each of these categories are monitored and regulated differently. Criteria air pollutants are measured by sampling concentrations in the ambient air; toxic air contaminants are measured at the source and in the general atmosphere; and, global warming and ozone-depleting gases are not monitored but are subject to federal and regional policies that call for their reduction and eventual phase out. The U.S. Environmental Protection Agency (USEPA) has established ambient air quality standards for the following air pollutants:

- ozone (O_3)
- nitrogen dioxide (NO_2)
- carbon monoxide (CO)
- sulfur dioxide (SO_2)
- lead (Pb)
- particulate matter (PM_{10} and $PM_{2.5}$)

The California Air Resources Board (CARB) has also established ambient air quality standards for the six pollutants regulated by the USEPA. Some of the California ambient air quality standards are more stringent than the national ambient air quality standards (NAAQS). In addition, California has established ambient air quality standards for the following pollutants or air quality conditions:

- hydrogen sulfide
- sulfates

- vinyl chloride
- visibility

NAAQS and California ambient air quality standards for the criteria pollutants are listed in Appendix B.

Criteria Air Pollutants

Criteria air pollutants are defined as those pollutants for which the federal and state governments have established air quality standards for outdoor or ambient concentrations to protect public health. The national and state ambient air quality standards have been set at levels to protect human health with a determined margin of safety. For some pollutants, there are also secondary standards to protect the environment. The following is a description of the ambient air pollutants and the attainment status of each pollutant in the South Coast basin. A discussion of the health effects of the ambient air pollutants is found in Appendix C.

Carbon Monoxide. Carbon monoxide (CO) is a colorless, odorless gas formed by the incomplete combustion of fuels. Motor vehicles are the main source of this gas. CO competes with oxygen, often replacing it in the blood, thus reducing the blood's ability to transport oxygen to vital organs in the body. The ambient air quality standard for carbon monoxide is intended to protect persons whose medical condition already compromises their circulatory system's ability to deliver oxygen. These medical conditions include certain heart ailments, chronic lung diseases, and anemia. Persons with these conditions have reduced exercise capacity even when exposed to relatively low levels of CO. Fetuses are at risk because their blood has an even greater affinity to bind with CO. Smokers are also at risk from ambient CO levels because smoking increases the background level of CO in their blood. The South Coast basin is designated as a serious non-attainment area for carbon monoxide by both USEPA and CARB. However, there have been no violations of the CO standard in the past three years, and AQMD has submitted to EPA a request for redesignation to attainment status.

Nitrogen Dioxide. Nitrogen dioxide (NO_2) is a byproduct of fuel combustion. The principal form of nitrogen oxide produced by combustion is nitric oxide (NO), but NO reacts quickly to form NO_2, creating the mixture of NO and NO_2 commonly called NO_x. NO_2 acts as an acute irritant and, in equal concentrations, is more injurious than NO. At atmospheric concentrations, however, NO_2 is only potentially irritating. There is some indication of a relationship between NO_2 and chronic pulmonary fibrosis. Some increase in bronchitis in young children has also been observed at concentrations below 0.3 parts per million (ppm). NO_2 absorbs blue light which results in a brownish red cast to the atmosphere and reduced visibility. Although NO_2 concentrations have not exceeded national standards since 1991 and the state hourly standard since 1993, NO_x emissions remain of concern because of their contribution to the formation of O_3 and particulate matter.

Ozone. Ozone (O_3) is one of a number of substances called photochemical oxidants that are formed when volatile organic compounds (VOC) and NO_x react in the presence of ultraviolet sunlight. O_3 concentrations in the South Coast basin are typically among the highest in the nation, and the damaging effects of photochemical smog, which is a popular name for a number of oxidants in combination, are generally related to the concentrations of O_3. Individuals exercising outdoors, children, and people with pre-existing lung disease, such as asthma and chronic pulmonary lung disease, are considered to be the subgroups most susceptible to O_3 effects. Short-term exposures (lasting for a few hours) to O_3 at levels typically observed in southern California can result in breathing pattern changes, reduction of breathing capacity, increased susceptibility to infections, inflammation of the lung tissue, and some immunological changes. In recent years, a correlation between elevated ambient O_3 levels and increases in daily hospital admission rates, as well as mortality, has also been reported. The South Coast basin is designated by both the USEPA and the CARB as an extreme non-attainment area for ozone. Although O_3 concentrations declined between 1991 and 2004 to the lowest levels since monitoring began, the South Coast basin continues to have peak O_3 levels that exceed both state and federal standards. In 2004, the peak concentration (1-hr standard) exceeded the federal standard 131 percent and the state standard 163 percent.

In 1997, the USEPA issued a new ozone air quality standard based on an 8-hour average exposure (the current federal ozone air quality standard is based on a 1-hour average period). The new 8-hour average ozone air quality standard provides for greater health protection. Current regulatory controls which are directed toward attaining the 1-hour ozone standard will also have benefits toward attaining the 8-hour ozone standard.

Particulate Matter. Inhalable fine particulate matter (PM_{10}) consists of extremely small suspended particles or droplets 10 microns or smaller in diameter that can lodge in the lungs, contributing to respiratory problems. PM_{10} arises from such sources as re-entrained road dust, diesel soot, combustion products, tire and brake abrasion, construction operations, and fires. It is also formed in the atmosphere from NO_x and SO_2 reactions with ammonia. PM_{10} scatters light and significantly reduces visibility.

Inhalable particulates pose a serious health hazard, alone or in combination with other pollutants. More than half of the smallest particles inhaled will be deposited in the lungs and can cause permanent lung damage. Inhalable particulates can also have a damaging effect on health by interfering with the body's mechanism for clearing the respiratory tract or by acting as a carrier of an absorbed toxic substance. USEPA designates the South Coast basin as serious non-attainment for PM_{10}, while CARB designates the South Coast basin simply as non-attainment.

In 1997, the USEPA established a new particulate matter $PM_{2.5}$ standard, in addition to the PM_{10} standard. $PM_{2.5}$ is defined as particulate matter with a diameter less than 2.5 microns and is a subset of PM_{10}. $PM_{2.5}$ consists mostly of products from the reaction of NO_x and SO_2 with ammonia, secondary organics, finer dust particles, and the combustion of fuels including diesel soot. Deadlines for meeting this standard will be ten years after the region is designated as non-attainment by the USEPA.

Sulfur Dioxide. Sulfur dioxide (SO_2) is a colorless, pungent gas formed primarily by the combustion of sulfur-containing fossil fuels. Health effects include acute respiratory symptoms and difficulty in breathing for children. Individuals with asthma may experience constriction of airways with exposure to SO_2. Though SO_2 concentrations have been reduced to levels well below state and federal standards, further reductions in SO_2 emissions are needed because SO_2 is a precursor to sulfate and PM_{10}. The South Coast basin is considered a SO_2 attainment area by USEPA and CARB.

Lead. Lead (Pb) concentrations once exceeded the state and federal air quality standards by a wide margin, but have not exceeded state or federal air quality standards at any regular monitoring station since 1982. Though special monitoring sites immediately downwind of lead sources recorded very localized violations of the state standard in 1994, no violations were recorded at these stations in 1996. Consequently, the South Coast basin is designated as an attainment area for lead by both the USEPA and CARB.

Volatile Organic Compounds. It should be noted that there are no state or federal ambient air quality standards for VOCs because they are not classified as criteria pollutants. VOCs are regulated, however, because a reduction in VOC emissions reduces certain chemical reactions which contribute to the formation of ozone. VOCs are also transformed into organic aerosols in the atmosphere, contributing to higher PM_{10} and lower visibility levels.

Although health-based standards have not been established for VOCs, health effects can occur from exposures to high concentrations of VOC. Some hydrocarbon components classified as VOC emissions are hazardous air pollutants. Benzene, for example, is a hydrocarbon component of VOC emissions that is known to be a human carcinogen.

Criteria air pollutant concentrations are typically higher in the South Coast basin than in any other area of the country because of the region's climate, geographical setting, and high concentrations of industry and motor vehicles. Although still high, pollutant concentrations have declined sharply throughout the 1990s. Air quality in 2004, aided by favorable weather conditions, was the best recorded since air pollution agencies began monitoring air pollution in this region in the 1940s prior to the creation of the AQMD. Table 1-1 lists the primary emission sources of the criteria pollutants and some of the harmful effects of the pollutants.

Table 1-1

Primary Sources and Effects of Criteria Pollutants

Pollutants	Source	Primary Health and Welfare Effects
Lead (Pb)	Contaminated soil	Behavioral and hearing disabilities in children; Nervous system impairment
Sulfur Dioxide (SO_2)	Combustion of sulfur-containing fossil fuels; Smelting of sulfur-bearing metal ores; Industrial processes	Aggravation of respiratory diseases (asthma, emphysema); Reduced lung function
Carbon Monoxide (CO)	Incomplete combustion of fuels and other carbon-containing substances, such as motor vehicle exhaust; Natural events, such as decomposition of organic matter	Aggravation of some heart diseases (angina); Reduced tolerance for exercise; Impairment of mental function; Impairment of fetal development; Death at high levels of exposure
Nitrogen Dioxide (NO_2)	Motor vehicle exhaust; High-temperature stationary combustion; Atmospheric reactions	Aggravation of respiratory illness
Ozone (O_3)	Atmospheric reaction of organic gases with nitrogen oxides in sunlight	Aggravation of respiratory and cardiovascular diseases; Reduced lung function, Increased cough and chest discomfort
Fine Particulate Matter (PM_{10} and $PM_{2.5}$)	Stationary combustion of solid fuels; Construction activities; Industrial processes; Atmospheric chemical reactions	Reduced lung function; Aggravation of respiratory & cardio-respiratory diseases; Increases in mortality rate; Reduced lung function growth in children

The AQMD measures current air quality and provides forecasts on the AQMD website in several formats. Current information on air pollution levels may be viewed in text form on the "Current Air Quality Readings" page, or retrieved from a clickable map on the "Animated Air Quality Map" page. Air quality data, trends, and studies are available via the “Air Quality Data” page, and a forecast of pollution levels for the following day is available on the "Daily Air Quality Forecast" page. Also, meteorological data needed for the air dispersion model applications may be downloaded from this website at no charge.

Toxic Air Contaminants

Toxic Air Contaminants (TACs) are often referred to as “non-criteria” air contaminants because ambient air quality standards have not been established for them. There are hundreds of TACs, and exposure to these pollutants is associated with elevated risk of cancer and non-cancer health effects such as birth defects, genetic damage, and other adverse health effects. Effects may be chronic (i.e., of long duration) or acute (i.e., of short duration) on human health. Acute health effects are attributable to short term exposure to air toxics. These effects include nausea, skin irritation, respiratory illness, and, in extreme cases, death. Chronic health effects result from long-term exposure. The effect of major concern for this type of exposure is cancer, which may develop up to 30 years after exposure. The USEPA regulates TACs through technology-based requirements which are implemented by state & local agencies. California regulates TACs through the air toxics program (H&SC §§ 39660 et seq.) and the Air Toxics "Hot Spots" Information and Assessment Act (H&SC §§ 44300 et seq.).

The CARB, working in conjunction with the Office of Environmental Health Hazard Assessment (OEHHA), identifies TACs. Air Toxic Control Measures (ATCMs) must then be adopted by CARB to reduce the identified TACs. Where there are federal standards, CARB must, at minimum, adopt the standards established by the USEPA. If there is a threshold below which there would be no significant adverse health impacts, CARB must create an ATCM to reduce emissions so there are no adverse health effects. If there is not a threshold below which there would be no significant adverse health impacts CARB must create an ATCM that reduces TAC emissions using the best available control technologies. Local air quality control agencies must implement ATCMs, or adopt equal or more stringent control measures as rules, within six months of adoption by CARB.

The Air Toxics "Hot Spots" Information and Assessment Act, codified in the Health and Safety Code, requires operators of specified facilities in the South Coast air district to submit to the AQMD comprehensive emissions inventories and reports by specified dates. The AQMD reviews the reports and then places the facilities into high-, intermediate-, and low-priority categories, based on the potency, toxicity, quantity, and volume of emissions and on the proximity of receptors, including sensitive receptors, to the facility. Facilities designated as high priority must prepare a health risk assessment. If the risk is above specified levels, facilities are required to notify the surrounding population and may be required to develop and implement a risk reduction plan.

The AQMD has also developed "industry-wide" inventories and assessed risks of small business facilities with emissions that are easily characterized. Some of the facilities in the industry-wide program are gas stations, small auto body shops, small dry cleaners, plating shops, and fiberglass product manufacturers. This information can then be used as an initial screening tool to determine whether a particular site is advisable for siting a sensitive receptor, or vice versa. Additional information is available on control strategies to minimize cumulative impacts of toxic emissions at http://www.aqmd.gov/rules/CIWG/final_white_paper.pdf and the AQMD Air Toxics "Hot Spots" Program (AB2588) at http://www.aqmd.gov/prdas/AB2588/AB2588.html. Information is also available from the AQMD Office of Engineering and Compliance to determine if a facility is operating under AQMD permits and what types of pollutants are emitted.

AQMD also adopts other rules that are not part of the federal or state programs and works with other agencies to encourage TAC reductions in their purview. The emissions inventory data are to be updated every four years. In addition to implementing federal and state toxic requirements, AQMD has an Air Toxics Control Plan and a Cumulative Impacts Reduction Strategy to further reduce TACs and their impacts on the communities in the South Coast basin.

Global Warming and Ozone-Depleting Gases

"Stratospheric ozone depletion" refers to the slow destruction of naturally occurring ozone, which lies in the upper atmosphere (called the stratosphere) and which protects Earth from the damaging effects of solar ultraviolet radiation. Certain compounds, including chlorofluorocarbons (CFCs,) halons, carbon tetrachloride, methyl chloroform, and other halogenated compounds, accumulate in the lower atmosphere and then gradually migrate into the stratosphere. In the stratosphere, these compounds participate in complex chemical reactions to destroy the upper ozone layer. Destruction of the ozone layer increases the penetration of ultraviolet radiation to the Earth's surface, a known risk factor that can increase the incidence of skin cancers and cataracts, contribute to crop and fish damage, and further degrade air quality.

Some gases in the atmosphere affect the Earth's heat balance by absorbing infrared radiation. This layer of gases in the atmosphere functions much the same as glass in a greenhouse (i.e., both prevent the escape of heat). This is why global warming is also known as the "greenhouse effect." Gases responsible for global warming and their relative contribution to the overall warming effect are carbon dioxide (55 percent), CFCs (24 percent), methane (15 percent), and nitrous oxide (6 percent). It is widely accepted that continued increases in greenhouse gases will contribute to global warming although there is uncertainty concerning the magnitude and timing of the warming trend.

Global warming gases and ozone-depleting gases include, but are not limited to, the following:

- **Carbon dioxide**. Carbon dioxide results from fossil fuel combustion in stationary and mobile sources. It contributes to the greenhouse effect, but not to stratospheric ozone depletion. In the South Coast basin, approximately 48 percent of carbon dioxide emissions come from transportation, residential and utility sources contribute approximately 13 percent each, 20 percent come from industry, and the remainder come from a variety of other sources.

- **Chlorofluorocarbons**. Chlorofluorocarbons (CFCs) are emitted from blowing agents used in producing foam insulation. They are also used in air conditioners and refrigerators and as solvents to clean electronic microcircuits. CFCs are primary contributors to stratospheric ozone depletion and to global warming. Sixty-three percent of CFC emissions in the South Coast basin come from the industrial sector. Federal regulations require service practices that maximize recycling of ozone-depleting compounds (both CFCs, hydro-chlorofluorocarbons and their blends) during the servicing and disposal of air-conditioning and refrigeration equipment. AQMD Rule 1415 – Reduction of Refrigerant Emissions from Stationary Refrigeration and Air Conditioning Systems requires CFC refrigerants to be reclaimed or recycled from stationary refrigeration and air conditioning systems. AQMD Rule 1405 – Control of Ethylene Oxide and Chlorofluorocarbon Emissions From Sterilization or Fumigant Processes requires recovery of reclamation of CFCs at certain commercial facilities and eliminates the use of some CFCs in the sterilization processes. Some CFCs are classified as TACs and regulated by AQMD Rule 1401 – New Source Review of Toxic Air Contaminants and AQMD Rule 1402 Control of Toxic Air Contaminants from Existing Sources.

- **Halons.** These compounds are used in fire extinguishers and behave as both ozone-depleting and greenhouse gases. Halon production ended in the United States in 1993. AQMD Rule 1418 – Halon Emissions From Fire Extinguishing Equipment requires the recovery and recycling of halons used in fire extinguishing systems and prohibits the sale of halon in small fire extinguishers.

- **Hydro-chlorofluorocarbons.** HCFCs are solvents, similar in use and chemical composition to CFCs. The hydrogen component makes HCFCs more chemically reactive than CFCs, allowing them to break down more quickly in the atmosphere. These compounds deplete the stratospheric ozone layer, but to a much lesser extent than CFCs. HCFCs are regulated under the same AQMD rules as CFCs.

- **Methane.** Methane is emitted from biogenic sources, incomplete combustion in forest fires, landfills, and leaks in natural gas pipelines. It is a greenhouse gas and traps heat 40-70 times more effectively than carbon dioxide. In the South Coast basin, more than 50 percent of human-induced methane emissions come from natural gas pipelines, while landfills contribute 24 percent. Methane emissions from landfills are reduced by AQMD Rule 1150.1 - Control of Gaseous Emissions from Active Landfills. Methane emissions from petroleum sources are reduced by a number of rules in AQMD Regulation XI that control fugitive emissions from petroleum production, refining and distribution.

- **1,1,1,-trichloroethane (TCA).** TCA (methyl chloroform) is a solvent and cleaning agent commonly used by manufacturers. It is less destructive on the environment than CFCs or HCFCs, but its continued use will contribute to global warming and ozone depletion. 1,1,1-trichloroethane (TCA) is a synthetic chemical that does not occur naturally in the environment. No TCA is supposed to be manufactured for domestic use in the United States after January 1, 2002 because it affects the ozone layer. TCA had many industrial and household uses, including use as a solvent to dissolve other substances, such as glues and paints; to remove oil or grease from manufactured metal parts; and as an ingredient of household products such as spot cleaners, glues, and aerosol sprays. AQMD regulates this compound as a toxic air contaminant under Rules 1401 and 1402.

The Montreal Protocol on Substances That Deplete the Ozone Layer controls the phase-out of ozone depleting compounds (ODCs). Under this international agreement, several organizations report on the science of ozone depletion, implement projects to help move away from ODCs, and provide a forum for policy discussions. The AQMD supports state, federal and international policies to reduce levels of ozone depleting gases through its Global Warming Policy and rules. Further, AQMD has developed ODC Replacement Guidelines to facilitate transition from ODCs to substances that are the most environmentally benign.

EFFECTS OF AIR POLLUTION ON HEALTH AND WELFARE

The residents of Southern California bear the cost of air pollution by:

- reduced visibility
- increased episodes of respiratory infections and other illnesses
- increased number of days of discomfort
- absent days from work and school
- increased symptoms related to respiratory disease, including asthma
- slowed lung function growth and increased asthma risk in children
- heart disease
- shortened life spans

Polluted air also damages agriculture, the natural environment, and human-made materials. Improving air quality enhances public health and produces economic benefits that more than offset the costs of attaining clean air. The overall strategy for reducing air pollution for criteria pollutants in the South Coast air district is contained in the Air Quality Management Plan (AQMP). The AQMP provides control measures that reduce emissions to attain federal ambient air quality standards by their applicable deadlines. The cost benefit analysis for the plan is conducted as part of the AQMP development. However, not all the health benefits associated with implementing the AQMP can be quantified. Further, the Air Toxic Control Plan amended in 2003 outlines the strategies pursued by the AQMD, CARB, and USEPA to reduce air toxic emissions.

THE ROLE OF FEDERAL, STATE, AND LOCAL AGENCIES TO REDUCE AIR POLLUTION

U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (USEPA) is responsible for establishing the national ambient air quality standards and enforcing the federal Clean Air Act. This agency also regulates emission sources under the exclusive authority of the federal government, such as aircraft, certain types of ships and locomotives. The USEPA has jurisdiction over emission sources outside state waters (e.g., beyond the outer continental shelf) and establishes various emission standards, including those for vehicles sold in states other than California. Automobiles sold in California must also meet the often stricter emission standards established by the California Air Resources Board (CARB). For additional information about the USEPA, contact the USEPA's general internet address at www.epa.gov. Information on the programs and activities in USEPA Region IX, which includes California, can be found at www.epa.gov/region9, and additional information on mobile source emissions is available from the Office of Mobile Sources at www.epa.gov/otaq/index.htm.

California Air Resources Board

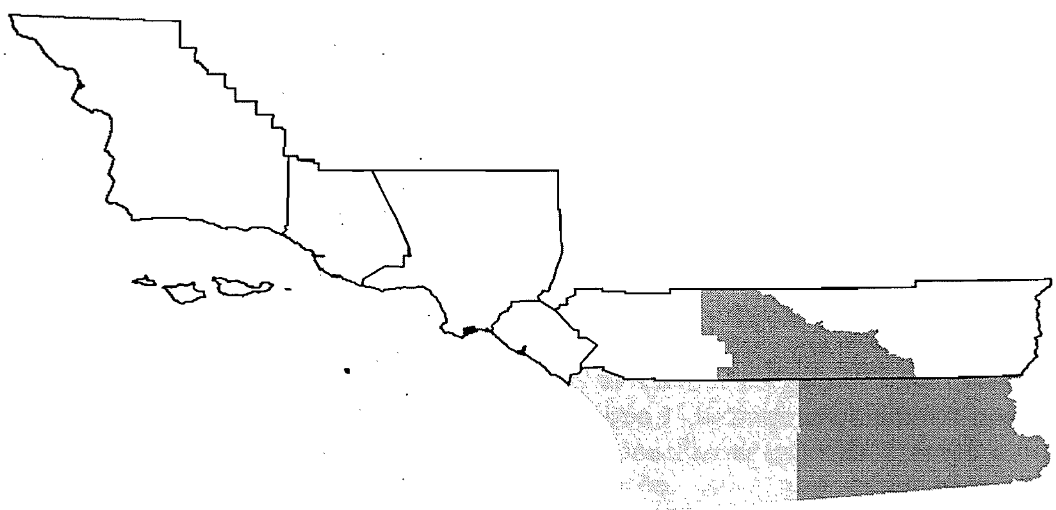
The CARB became part of the California Environmental Protection Agency (CalEPA) in 1991. The agency is responsible for ensuring implementation of the California Clean Air Act, meeting state requirements of the federal Clean Air Act, and establishing state ambient air quality standards. It is also responsible for setting vehicle emission standards and fuel specifications, and regulating emissions from other sources such as consumer products and certain types of mobile equipment (e.g., lawn & garden equipment, industrial forklifts). The internet address for CalEPA is www.calepa.ca.gov; the internet address for CARB is www.arb.ca.gov.

South Coast Air Quality Management District

Because Southern California has one of the worst air quality problems in the nation, the AQMD was created by the 1977 Lewis Air Quality Management Act. Four county air pollution control agencies were merged into one regional district to better address the issue of improving air quality in Southern California. Under the act, revised and renamed the Lewis-Presley Air Quality Management Act in 1988, the AQMD is the agency principally responsible for comprehensive air pollution control in the South Coast basin. Specifically, the AQMD is responsible for monitoring air quality and planning, implementing, and enforcing programs designed to attain and maintain state and federal ambient air quality standards in the district. Programs developed include air quality rules and regulations that regulate stationary source emissions, including area and point sources and certain mobile source emissions. The AQMD is also responsible for establishing permitting requirements and issuing permits for stationary sources and ensuring that new, modified, or relocated stationary sources do not create net emissions increases. The AQMD enforces air quality rules and regulations through a variety of means, including inspections, educational and training programs, and fines.

The AQMD has jurisdiction over an area of 10,743 square miles, referred to in this document as the South Coast air district. This area includes all of Orange county, all of Los Angeles county except for the Antelope Valley, the non-desert portion of western San Bernardino county, and the western and Coachella Valley portions of Riverside county. The South Coast basin is a sub-region of the district and covers an area of 6,745 square miles. The South Coast basin includes all of Orange county and the non-desert portions of Los Angeles, Riverside, and San Bernardino counties. Figure 1-1 shows the jurisdictional boundaries of the South Coast air district and the South Coast basin.

Both the district and the South Coast basin are surrounded by mountains, which tend to restrict air flow and concentrate pollutants in the valleys or “basins” below. The South Coast basin is almost entirely urban, and its pollution is typically related to dense population and associated area sources, heavy vehicular traffic, and industrial sources. In the Coachella Valley, pollution problems are associated primarily with ozone transport from the South Coast basin and with particulate emissions from heavy construction, travel on paved and unpaved roads, and agriculture.



public. This committee, therefore, offers local governmental agencies the opportunity to comment on the AQMD's rule-making and planning processes.

The second branch of the AQMD is the Hearing Board, which is a quasi-judicial panel authorized to provide relief to regulated facilities from AQMD regulations. Relief from regulations can only occur under specific circumstances, such as emergencies, etc. State law requires that the Hearing Board be appointed by the Governing Board, but the Hearing Board acts independently of the Governing Board. The third branch is management/staff, which is the bulk of the agency and reports to the AQMD Governing Board. This branch includes the divisions responsible for: developing rules and rule amendments; permitting of air pollution sources and rule compliance; planning programs such as the AQMP; air quality monitoring; public outreach and small business assistance; and prosecuting cases of rule violations. Additional information on the AQMD is available at AQMD's internet address - www.aqmd.gov.

Local Governments

Air quality issues in the South Coast air district are addressed through the efforts of federal, state, regional, and local government agencies. These agencies and the legislation that authorizes them to regulate air quality are shown in Figure 1-2. Local governments work in concert with their Councils of Governments and the AQMD to improve air quality through a variety of programs, including regulatory actions, policy making, and education programs. **Local governments have the flexibility to address air quality issues through ordinances, local circulation systems, transportation services, and land use. No other level of government has that authority, including the AQMD.** This document recognizes the vital role of local government policies and programs that are designed to complement and support both local and state air regulations. These policies, particularly in land use, transportation and energy, are essential to achieve state and federal air pollution standards and reduce localized air pollution impacts. For many local governments in the district, the General Plans consolidate air quality related goals, objectives and polices into an optional air quality element. A stand alone air quality element gives direction for sound decision making on air quality-related issues and provides a solid basis to inform the public, as well as developers, about air quality policies to protect public health.

Local governments, which include both city and county agencies, have the ability to control or mitigate air pollution through their police powers and land use decision-making authority. Local ordinances can also provide mechanisms for reducing air pollution. Many cities in the South Coast air district have adopted air quality elements into their General Plans, coordinating these elements with the Air Quality Management Plan (AQMP) and the congestion management program requirements required by state law. Local design standards such as requirements for bicycle racks and bicycle paths may result in reducing motor vehicle trips, and administrative actions can be taken that reduce air pollution, such as creating a telecommunication program that enables employees to work at home. Also, capital improvement programs can fund transportation infrastructure projects such as bus turnouts, energy-efficient street lights, and synchronized traffic signals that contribute to improved air quality.

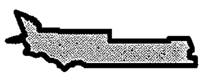
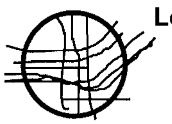
Government	Legislation	Implementing Agencies
Federal 	Clean Air Act	U.S. Environmental Protection Agency (USEPA)
State 	California Clean Air Act (H&S §§ 39660 et seq.)	California EPA (Cal-EPA) and California Air Resources Board (CARB)
	AB 1807, Air Toxics Contaminants Act	Office of Environmental and Health Hazard Assessments (OEHHA)
Regional 	Assembly Bill 2588, Air Toxics "Hot Spots" Information and Assessment Act of 1987	South Coast Air Quality Management District (AQMD)
	Lewis-Presley Air Quality Management Act	
Local 	Local Ordinances and Air Quality Elements in General Plans (Gov't. 65303) CEQA mitigation measures (PRC §21000, et seq.)	Public Agencies Including Local Governments and County Transportation Commissions

Figure 1-2

Authorizing Legislation with Air Quality Components

THE REGIONAL COMPREHENSIVE PLAN

The Regional Comprehensive Plan (RCP) is being developed by SCAG as a useful resource for local governments within the SCAG region to implement regional plans and policy objectives. The goals, policies and strategies of four regional plans are described in the RCP:

- 2004 Regional Transportation Plan
- 2004 Regional Transportation Plan Environmental Impact Report
- 2004 Transportation Improvement Plan
- Regional Growth Strategy ("Compass Growth Vision")

Similar to this Guidance Document for Addressing Air Quality in General Plans and Local Planning, the RCP is an advisory document that lays out steps that local governments and other stakeholders may take to support regional objectives.

THE REGIONAL AIR QUALITY MANAGEMENT PLAN

The AQMD has authority to reduce emissions from stationary sources, some area sources, and certain indirect sources. The AQMD is the lead agency in charge of, with input from the Southern California Association of Governments (SCAG) and CARB, developing the AQMP. The AQMP is a comprehensive plan that includes control strategies for stationary and area sources, as well as for on-road and off-road mobile sources. SCAG has the primary responsibility for providing future growth projections and the development and implementation of transportation control measures. CARB in coordination with federal agencies provides the control element for mobile sources.

ENVIRONMENTAL JUSTICE

California state law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies (California Government Code sec.65040.12). In 1997, AQMD implemented 10 environmental justice initiatives designed to protect district residents' right to live and work in an environment of clean air, free of airborne health threats. The AQMD defines environmental justice as "equitable environmental policymaking and enforcement to protect the health of all residents, regardless of age, culture, ethnicity, gender, race, socioeconomic status, or geographic location, from the health effects of air pollution."

AQMD's environmental justice program was expanded in 2002 to include 23 enhancements that serve as the basis for further outreach and problem-solving activities regarding environmental justice issues. The goal of developing a model air quality element for local government General Plans is one of the program enhancements established to reduce health risks associated with exposure to air pollution. The progress of AQMD's environmental justice program is reviewed each year and a new workplan is established for the coming year. Public input on the workplan is solicited through a series of public consultation meetings. Prior to being adopted by the AQMD Governing Board, environmental justice work plans are reviewed by the Ethnic Community Advisory Group, an ethnically-diverse committee of residents and businesspeople. For an update on AQMD's environmental justice initiatives, visit http://www.aqmd.gov/ej/index.htm.

Often, local governments broadly define "environmental justice" in general plans to balance air quality with other environmental, economic, and social objectives. Broad definitions supported by specific goals, objectives and polices prevent possible procedural inequities (e.g., public meeting times that limit attendance by certain groups) and geographical inequities (e.g., heavy industrial land uses adjacent to certain neighborhoods). California General Plan Guidelines recommend incorporating policies that support environmental justice in all mandatory and optional elements. Local jurisdictions may choose to define "environmental justice" and consolidate all environmental justice policies in an optional environmental justice element. As stated in the California General Plan Guidelines, the definition of environmental justice clearly leads to policies and planning principles that prevent incompatible land uses that pose threats to the health, safety, and welfare of the community. Furthermore, the definition of "environmental justice" and the policies to achieve environmental equity in an air quality element must not conflict with policies in other elements.

FORMAT OF THE DOCUMENT

This guidance document is formatted with six topics that are typically addressed in an air quality element of a general plan. Air quality issues are described as they are related to each topic, and a menu of strategies and suggested policies are listed that will integrate air quality issues into the general plan. Not all suggested policies are pertinent or applicable for all jurisdictions. The severity of local air pollution problems in various regions of the district (e.g., windblown dust or localized TAC concentrations) will influence the number and scope of air pollution-related strategies that jurisdictions consider for adoption in their General Plans.

The six topics discussed in this document are:

Chapter 2 - Land Use
Chapter 3 - Transportation
Chapter 4 - Stationary Sources of Pollution
Chapter 5 - Reduction of Fugitive Dust Emissions
Chapter 6 - Energy Conservation
Chapter 7 - Public Awareness and Education

The State Guidelines closely adhere to statute and case law and rely upon commonly accepted principles of contemporary planning practice. A four-tier format for general plan elements is suggested, using the terms "goal," "objective," "policy," and "implementation measure" as follows:

1. **Goal -** A goal statement expresses an end, not an action.

2. **Objective -** An objective describes a specified end, condition, or state that is an intermediate step toward attaining a goal. It should be achievable and, when possible, measurable and time-specific.

3. **Policy -** A policy statement guides decision-making and indicates a commitment of the local legislative body to a particular course of action. A policy is based on and

helps implement a general plan's objectives. A policy is carried out by implementation measures.

4. **Implementation Measure -** An implementation measure is an action, procedure, program, or technique that carries out general plan policy. Each policy has at least one corresponding implementation measure.

This guidance document includes a three-tier format (goals, objectives, and policies/strategies) which closely parallels the four-tier format outlined in state guidelines. A number of stakeholders suggested that the "policies/strategies" category is more helpful and less prescriptive, and allows more flexibility to interpret and craft policy statements that are specific to the needs of the local jurisdiction. During the implementation phase, staff will continue to solicit feedback from stakeholders. If necessary, AQMD staff will move toward a four-tier format in the future and consider an additional subcategory of "implementation measures".

CHAPTER 2
AIR QUALITY ISSUES REGARDING LAND USE

- LOCAL GOVERNMENT SITING CRITERIA FOR SENSITIVE RECEPTORS
- JOB-HOUSING BALANCE
- SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES RELATED TO LAND USE

AIR QUALITY ISSUES REGARDING LAND USE

Local government land use authority in planning, zoning, and permitting can be a very effective tool to minimize air pollutant emissions and associated health risks. However, it is important to recognize that traditional assumptions about planning and zoning compatibility to protect the public may not always eliminate adverse health impacts of air pollution. While it is recognized that local governments, to make the best decisions for the benefit of their residents, must weigh and balance multiple issues, demands and concerns, including, but not limited to, the need for housing, existing development and development patterns, environmental responsibilities and more when making land use decisions, some projects being considered by local land use decision-makers may comply with zoning and air pollution control requirements but still result in adverse health impacts on nearby sensitive receptors. These health impacts may result from emissions released at a single site, along a transportation corridor or a combination of co-located air pollution sources in a community. For example, the co-location of residential and commercial zones often minimize transportation-related emissions, but in some situations this mixed land use may also increase health risks if commercial facilities that emit toxic chemicals are over concentrated. While mixed-use zoning offers economic, social, and environmental benefits compared to single-use zoning, this chapter describes certain industrial, commercial and transportation uses that may pose health concerns with residences, schools, and other sensitive sites. This document introduces land use related policies that rely on design and distance parameters to minimize emissions and lower potential health risk.

LOCAL GOVERNMENT SITING CONSIDERATIONS FOR SENSITIVE RECEPTORS

There is a strong connection between health risk and the proximity of the source of air pollution. Local jurisdictions have the responsibility for determining land use compatibility for sensitive receptors. A sensitive receptor is a person in the population who is particularly susceptible to health effects due to exposure to an air contaminant. The following are land uses (sensitive sites) where sensitive receptors are typically located:

- schools, playgrounds and childcare centers
- long-term health care facilities
- rehabilitation centers
- convalescent centers
- hospitals
- retirement homes
- residences

Facilities and Operations That Emit Odors and Dust

Both the AQMD and local governments receive complaints about dust and offensive odors. Odors and dust are air pollutants that can have negative health impacts. While almost any source may emit objectionable odors, some land uses will be more likely to produce odors or dust because of their operation. The types of facilities or operations that are prone to generate odors, and dust, and other air pollutants can be identified from complaints received by the AQMD (Table 2-1). While AQMD records indicate these facilities have the potential to emit odor or dust that may impact sensitive receptors, individual equipment and operations within each source category do not necessarily generate dust or odor. Special care needs to be given to the initial siting and design of operations and facilities listed in Table 2-1. Assessing potential impacts depends on a number of variables such as wind speed and direction, design features of the proposed facility such as stack height, and the physical distance from the source and the sensitive receptors. Local governments should identify both new projects that have a probability of pollution-related complaints and new developments that may be affected by existing upwind sources. Ideally, potential odor and dust emissions from new projects should be identified and evaluated while the project is still in its initial design phase. This early effort could provide an opportunity to change the project design to minimize or eliminate emissions before the facility becomes operational. Potential odor and dust sources that can be identified and mitigated before construction of a project begins will minimize health impacts and enforcement problems. Local governments are advised to contact the AQMD's Office of Engineering and Compliance to determine if complaints have been filed by property owners or occupants in the general vicinity of a proposed project site to help evaluate the potential for dust or odor complaints.

Table 2-1

Sources of Odor and Dust Complaints Received by the AQMD

Sources of Odors	Sources of Dust
Agriculture (farming and livestock)	Agricultural (Land Tilling)
Chemical Plants	Asphalt and Cement Plants
Composting Operations	Auto Body Facilities
Dairies	Construction Activities
Fiberglass Molding	Diesel Engines/Vehicles
Landfills	Composting Operations
Refineries	Fertilizer Operations
Rendering Plants	Fiberglass Molding
Rail Yards	Furniture Manufacturing - Sawdust
Wastewater Treatment Plant	Landfills and Transfer Stations
	Refineries
	Roofing Operations
	Rubber Manufacturing
	Sand and Gravel Operations
	Sandblasting
	Silk Screening
	Wood dust

Toxic Air Contaminants

Sensitive receptors (and the facilities that house them) in proximity to sources of air pollutants that emit TACs are of particular concern. Exposure to TACs can increase the risk of contracting cancer or result in adverse non-cancer health effects. Non-cancer health risks associated with TAC exposure include birth defects and other reproductive damage, neurological disorders, and damage to the respiratory system. A comprehensive monitoring study of TACs was initiated as part of AQMD's environmental justice program. The Multiple Air Toxics Exposure Study (MATES-II) included fixed sites characterizing neighborhood-scale conditions and a complementary microscale study to sample potential localized influences of toxic-emitting sources near residential neighborhoods. Inventories of TACs were utilized in computer simulation models to depict toxic risks for the entire South Coast basin. The MATES-II project represents one of the most comprehensive air toxics monitoring programs ever conducted in a major urban area in the country, and it has been recognized as a model program. Findings from the study revealed the following:

- Average cancer risk from ambient measurements in the South Coast basin was found to be 1400 in a million;
- Diesel exhaust is responsible for about 70 percent of the total cancer risk from air pollution;
- Emissions from mobile sources -- including cars and trucks as well as ships, trains and planes -- account for about 90 percent of the cancer risk. Emissions from businesses and industry are responsible for the remaining 10 percent; and
- The highest cancer risk occurs in south Los Angeles county -- including the port area -- and along major freeways.

In 2005, the AQMD plans to release the results of another intensive one-year study that examined current levels of cancer-causing TACs and the risk they pose to district residents. This study will help gauge the effectiveness of current regulations and serve as a vital tool in helping shape future air quality and environmental justice policies. MATES-III will monitor 21 TACs and four other substances at 10 sites across the Los Angeles basin. The AQMD will use mobile monitoring stations to sample at neighborhood sites near toxic emission sources or in areas where community members are concerned about health risks from air pollution. Such neighborhood sites could be near airports, rail yards, warehouses, landfills, high-volume vehicle traffic, or multiple commercial or industrial facilities. Sampling at each neighborhood site lasts for up to two months. The goal of MATES-III is to update TAC levels and toxic emission inventories, determine the cancer and non-cancer health risk from air toxics across the district. Also, the study will investigate potential toxic "hot spots" in local communities.

The potential impacts of new facilities on sensitive sites will depend on a variety of factors including the amount and toxicity of pollutants emitted, the type of air pollution control equipment at the facility, design features of the facility, the distance from the source of emissions to the sensitive receptor, and local meteorology. All these factors should be carefully evaluated when siting a source of air pollution. Typically, the siting process followed by land use agencies to avoid the location of sensitive sites (e.g., residences, health clinics, etc.) near sources of air pollution does not involve the AQMD. The potential for public health impacts remains unchanged when siting sensitive receptors near a pollution source or a pollution source near a sensitive receptor. Therefore, local policies should allow for a thorough evaluation of the air quality impacts for both scenarios.

Where possible, CARB recommends a minimum separation between new sensitive land uses and the following eight categories of existing sources (Table 1-1 in CARB's Proposed Air Quality and Land Use Handbook: A Community Health Perspective. March 2005, or subsequent versions adopted by CARB):

- high-traffic freeways and roads
- distribution centers
- rail yards
- ports
- refineries
- chrome plating facilities
- perchloroethylene dry cleaners
- large gasoline stations

It is recommended that the AQMD be consulted to obtain facility-specific emissions information and accepted assessment methods for determining relative exposure and health risk for proposed projects.

Recent studies have found an increased incidence of adverse effects among those who live near busy roadways; these include increased respiratory disease and increased mortality (Wilhelm, M., et al 2003; Kim, J. et al 2004). These studies found that residential proximity to traffic was associated with increased risk of low birth weight, increased medical visits for asthma and increased respiratory symptoms in children. Studies conducted near freeways in Southern California show that traffic emissions, such as carbon monoxide, ultra-fine particulates, and black carbon (soot) are several times higher next to freeways than the background concentrations. These concentrations fell to lower levels with increasing distance from the roadway, decreasing about 60-80 percent within 100 meters (Zhu, Yifang, et al, 2002).

Recent results from the Children's Health Study have shown strong evidence of adverse effects in children exposed to ambient levels of traffic-related pollutants. This study followed children in 12 communities in Southern California from 4th grade through 12th grade (McConnell, K., et al, 2002). Children in communities with high levels of NOx, $PM_{2.5}$, acid vapors, and elemental carbon showed reduced lung function growth over the study period. Additionally, a higher level of asthma was found in the children that lived nearest to busy roadways. In a report prepared for CARB, researchers concluded that the current levels of ambient air pollution in Southern California are associated with clinically important chronic health effects that have substantial health and economic impacts (Peters, 2004).

The primary authority for siting public schools rests with local school districts which are the designated "lead agencies" for the CEQA environmental analyses. The California Education Code requires public school districts to notify the local planning agency when siting new public schools and the planning agency to determine if the proposed site conforms with the General Plan. If the proposed school is within 500 feet of the edge of a freeway or traffic corridor that has specified minimum average daily traffic counts, the school district is required to determine through specified risk assessment and air dispersion modeling that neither short-term nor long-term exposure poses significant heath risks to pupils. Both the California Education Code section 17213 and the California Public Resources Code section 21151.8 require school districts to consult with the AQMD when preparing the environmental assessment. The AQMD verifies all permitted and non-permitted sources of air pollution that might significantly affect health have been identified and evaluated.

Generally, cancer risk will drop off with distance from a ground level pollution source, such as a freeway. Freeways and busy traffic corridors are defined as traffic volume of over 100,000 vehicles per day in urban areas and 50,000 vehicles per day in rural areas (Education Code Section 17312). CARB studies show that air pollution levels can be significantly higher within 500 feet (150 meters) of freeways or busy traffic corridors and then diminish rapidly. Actual concentration of diesel particulate matter will vary at a particular location depending on traffic volume, vehicle mix, prevailing winds and other variables. The decline in the relative concentration of diesel particulate matter as one moves away from the edge of a freeway is illustrated Figure 2-1. These data have been normalized to a receptor located 20 meters from the edge of freeway (i.e., at a distance of 20 m, the receptor is exposed to 100 percent of the diesel particulate matter emissions from the freeway). A downwind distance of 328 feet (100 m) will reduce cancer risk by over 60 percent. If the physical downwind distance is increased to 984 feet (300 m), the relative concentration is reduced over 80 percent.

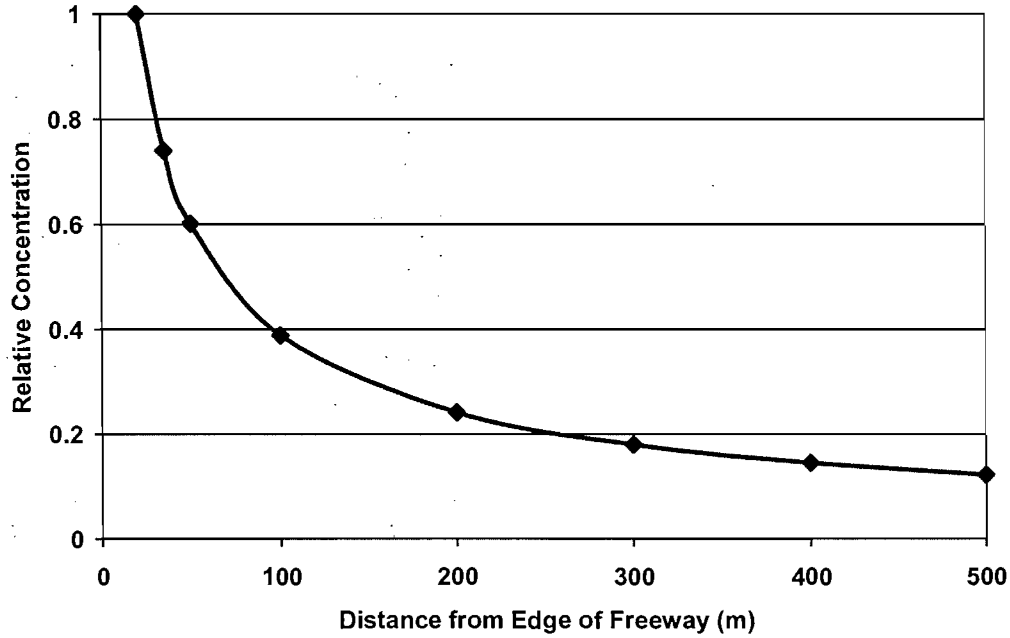


Figure 2-1

Relative Concentration of Diesel Particulate Matter in Relation to the Distance from The Edge of a Freeway

Source: South Coast Air Quality Management District. Adapted from the California Air Resources Board's Diesel Risk Reduction Plan.

A comparison of total cancer risk and cancer risk from diesel particulate matter emissions in rural and urban areas shows that cancer risk associated with elevated levels of diesel particulate both decrease rapidly within the first 100 – 150 meters from the edge of a roadway (Table 2-2). Estimated cancer risk from diesel particulate matter along rural and urban roadways is decreased approximately 68 percent at a distance 150 m (492 ft) from the edge of the roadway. Clearly, these data demonstrate that a minimum distance that separates sources of diesel emissions from nearby receptors is effective in reducing potential cancer risk. The AQMD recognizes that physical separation of the receptors from the pollution sources is not always reasonable or feasible particularly in mature communities. For example, in southern Los Angeles county a sequence of land use decisions in urban areas allowed freeway construction through existing neighborhoods.

Table 2-2

Cancer Risks from Diesel Particulate Matter at the Edge of Roadways in Rural and Urban Areas

Distance from Edge of Roadway (meters)	Diesel Particulate Matter Cancer Risk (in one million)		Total Cancer Risk (in one million)*	
	Rural	Urban	Rural*	Urban*
20 m	475	890	589	1104
150 m	151	277	187	343
500 m	86	159	107	197

Source: South Coast Air Quality Management District. Adapted from the California Air Resources Board's Diesel Risk Reduction Plan.

*To account for gasoline vehicle emissions, the diesel PM risk was multiplied by 1.24. This represents the relative risk contribution from benzene, 1, 3 butadiene, formaldehyde, and acetaldehyde on a basin-wide basis. It is assumed that the vast majority of benzene, 1, 3 butadiene, formaldehyde, and acetaldehyde emissions come from on-road gasoline vehicles.

The AQMD provides guidance for analyzing cancer risks from diesel particulate matter from mobile sources at facilities such as truck stops and warehouse distribution centers in the document titled Health Risk Assessment Guidance for Analyzing Cancer Risks from Mobile Source Diesel Idling Emissions for CEQA Air Quality Analysis. This document may be downloaded at http://www.aqmd.gov/ceqa/hdbk.html. This guidance describes analysis of potential cancer risks associated with diesel particulates from truck idling and movement (such as truck stops, warehouse and distribution centers, or transit centers), ship hotelling at ports, and train idling. It is suggested that projects with diesel-powered mobile sources use this health risk guidance document to quantify potential cancer risks from the diesel particulate emissions.

Projects that incorporate transit nodes may include a range of multiple services ranging from a bus or light rail stop to a combination of services that may include bus, shuttles, light and heavy rail systems. The concept of a "clean" transit node refers to transit services that predominately operate with zero emission vehicles (e.g., electric light rail), clean fuel vehicles (e.g., compressed natural gas or hydrogen), or vehicles powered with low-emission engines (e.g., California certified Super Ultra Low Emissions Vehicles). Projects that emphasize "clean" transit nodes not only minimize VMT, but also reduce the potential health impacts associated with transit-related emissions on individuals living near transit services.

Current USEPA regulations establish fuel registration and formulation requirements. All diesel fuels and all additives for on-road motor vehicles are required to be registered with the USEPA, and all new diesel-fueled on-road and off-road engines and vehicles sold in California are required to meet both federal and state emission certification requirements. In addition, the Carl Moyer Program, administered by CARB and local air districts, is a clean engine incentive program that incentivizes projects that substantially reduce emissions of oxides of nitrogen (NOx) and fine particulate matter (PM) from heavy-duty diesel engines. Funds are distributed to project proponents through the AQMD to incentivize cost-effective projects. Funds, in the form of grants for private companies, public agencies, or individuals operating heavy-duty diesel engines, cover an incremental portion of the cost of cleaner on-road, off-road, marine, locomotive, and agricultural irrigation pump engines. This framework is also used to award grants for other equipment and for retrofitting or repowering existing engines.

The CARB Diesel Risk Reduction Plan proposes a three-pronged approach that would require use of low-sulfur diesel fuel; retrofitting existing engines with PM filters; and nearly a 90 percent reduction of PM emissions from all new diesel engines and vehicles. A number of adopted and proposed state regulations that will reduce diesel emissions target the following source categories: Heavy-Duty Public Fleets and Private Utilities; Cargo Handling Equipment; Non-Urban Transit Buses; Harbor Craft; Truck Idling from Sleeper Cabs; Off Road and Private On-Road Fleets; Agriculture Equipment; and Ships.

Further, the AQMD has adopted fleet rules that will gradually shift public agencies to lower emissions and alternative fuel vehicles whenever a fleet operator with 15 or more vehicles replaces or purchases new vehicles.

Rule 1186.1	Less – polluting sweepers
Rule 1191	Clean On-Road Light and Medium-Duty Public Fleet Vehicle
Rule 1192	Clean On-Road Transit Buses
Rule 1193	Clean On-Road Residential and Commercial Refuse Collection Vehicles
Rule 1194	Commercial Airport Ground Access Vehicles
Rule 1195	Clean On-Road School Buses
Rule 1196	Clean On-Road Heavy-duty Public Fleet Vehicles

Air regulatory agencies have collaborated closely with regulated industries, refineries and diesel vehicle manufacturers to establish cleaner fuel specifications and engine technologies. Although AQMD's fleet rules have been challenged, CARB is moving forward with its rulemaking to facilitate the implementation of fleet rules in the South Coast Air Basin that will result in significant emission reductions. In addition, state and federal requirements are the cornerstone of the clean air strategy to clean up diesel pollution in the South Coast district. Combined, the current and planned regulatory efforts by USEPA, CARB and AQMD are expected to substantially lower the average level of diesel emissions per vehicle. CARB or AQMD staff can be contacted to obtain additional information on the current status of rule development.

The goals established by the CARB plan call for a statewide reduction in diesel particulate emissions of 75 percent by 2010 and 85 percent by 2020. AQMD' s 2004 addendum to the 2000 Air Toxics Control Plan indicates that full implementation of the 2003 AQMP, including CARB's measures to reduce diesel particulate matter, would reduce basin-wide toxic-weighted emissions by 50 percent. While there continues to be an overall reduction in air pollution for the region, the emission reductions expected from cleaner engine standards that employ new control technologies often require a lengthy "fleet turnover" time to be effective. Given projections for future growth and additional vehicles that will utilize the regions transportation corridors, there are no guarantees that localized cancer risk and non-cancer impacts will diminish rapidly in the short term or adequately in the long run. Cities are encouraged to join the AQMD in a proactive approach to address existing health concerns in their communities identified in the AQMD's Multiple Air Toxics Emissions Study (MATES II). Policies and strategies suggested in this guidance document can offer a near-term remedy to lower cancer risk from exposure to air pollution, and at the same time, provide preventive measures that protect health over the long-term planning horizon of the general plan.

TACs from stationary sources are of particular concern with regard to sensitive receptors. For example, state law requires school districts to consider the impact of siting a new school close to existing facilities that emit TACs. This same principle should be applied in siting other sensitive sites such as retirement homes and hospitals. AQMD serves as a clearinghouse for publicly available information on stationary sources that emit TACs and associated public health risks. This information is compiled from documentation required of facilities that emit TACs by AQMD Rules 1401 & 1402, and Assembly Bill (AB) 2588 Air Toxics Hot Spots Program (H&SC §§ 39660 et seq.). Toxic risk assessments are routinely included in CEQA evaluations performed by the local governments in its land use decisions

Jurisdictions may conduct a current inventory of all major sources of air pollution within a specified radius of the proposed sensitive site. Examples of facilities with the potential to emit TACs that could pose a health risk are shown in Table 2-3. Also, AQMD staff are available to assist local governments in identifying sources of TACs within their jurisdictions and evaluating potential health risk from TAC exposure. Local governments may contact the AQMD to obtain recommended analytical methods.

Existing land use conflicts are best addressed on an individual basis. AQMD is available to assist cities and counties in evaluating local government options and strategies for minimizing existing pollution exposure problems. Options may include relocation, recycling, redevelopment, rezoning, process changes, incentive programs, and other types of measures.

Table 2-3

Examples of Facilities That Emit Toxic Air Contaminants

Categories	Facility Type	Air Pollutants of Concern
Commercial		
	Perchloroethylene Dry Cleaners[1]	Perchloroethylene
	Chrome Platers/Chrome Spraying Operations	Hexavalent Chromium
	Gas Stations	Benzene
	Auto Body Shops	Metals, Solvents
	Furniture Repair	Solvents[2], Methylene Chloride
	Film Processing Services	Solvents, Perchloroethylene
	Cold Storage Distribution Centers, Warehouses	Diesel Particulate Matter
	Printing Shops	Solvents
	Diesel Engines	Diesel Particulate Matter
Industrial		
	Manufacturers	Solvents, Metals
	Metal Platers, Welders, Metal Spray (flame spray) Operations	Hexavalent Chromium, Nickel, Metals
	Chemical Producers	Solvents, Metals
	Gasoline Refineries	Benzene, Solvents, Metals, PAHs
	Furniture Manufacturers	Solvents
	Shipbuilding and Repair	Hexavalent Chromium and other metals, Solvents
	Hazardous Waste Incinerators	Dioxin, Solvents, Metals
	Power Plants	Benzene, Formaldehyde, Particulate Matter
	Research and Development Facilities	Solvents, Metals, etc.
	Freight Distribution Centers	Diesel Particulate Matter
Public		
	Landfills	Benzene, Vinyl Chloride, Diesel Particulate Matter
	Waste Water Treatment Plants	Hydrogen Sulfide
	Medical Waste Incinerators	Dioxin, Benzene, PAH, PCBs, 1,3-Butadiene
	Recycling, Garbage Transfer Stations	Diesel Particulate Matter
	Municipal Incinerators	Dioxin, Benzene, PAH, PCBs, 1,3-Butadiene
Transportation		
	Port Facilities	Diesel Particulate Matter, Methyl Bromide
	Airports	Benzene, Formaldehyde
	Rail Yards (diesel locomotives)	Diesel Particulate Matter
	Rail Corridors	Diesel Particulate Matter
	Intermodal Facilities	Diesel Particulate Matter
	Truck Stops	Diesel Particulate Matter
	Freeways and Roadways	Diesel Particulate Matter, Benzene, 1,3-Butadiene, Formaldehyde
Agricultural Operations		
	Farming Operations	Diesel Particulate Matter, VOCs, NOx, PM_{10}, CO, SOx, Pesticides
	Livestock and Dairy Operations	Ammonia, VOCs, PM_{10}

Source: Adapted from the Proposed Air Quality and Land Use Handbook: A Community Health Perspective. CARB, March 2005.

[1]Non-perc alternatives (e.g. wet cleaning and CO_2 cleaning) may eliminate TAC emissions.

[2]Many, but not all solvents contain TACs.

Mapping Sources of Toxic Air Contaminants. Land use/zoning maps should be utilized to identify the location of facilities and transit corridors that are potential sources of TACs and the locations of sensitive receptors. An internet-based mapping tool is available from CARB that allows local planners to view maps showing the locations of air pollution sources. The Community Health Air Pollution Information System (CHAPIS) was developed by ARB and the State's 35 local air districts. The AQMD provides the data for facilities in its jurisdiction. Facilities that emit 10 or more tons per year of nitrogen oxides, sulfur oxides, carbon monoxide, PM_{10}, or reactive organic gases are included in the database. AQMD facilities that emit TACs are being phased in by categories. The CHAPIS database includes chemical manufacturing, metal fabrication, and aerospace/electronics manufacturing facilities if they have conducted health risk assessments under California's Air Toxics "Hot Spots" program. The remaining "Hot Spot" facilities and other industries and smaller businesses, such as gas stations and dry cleaners will eventually be added. An example of a CHAPIS map for the Central Los Angeles - Port region is shown in Figure 2-2.

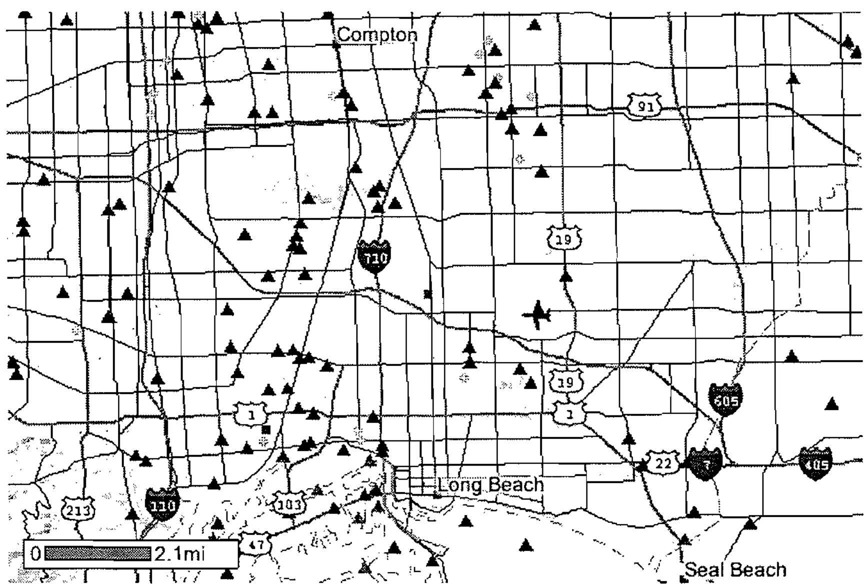


Figure 2-2
Example of a CHAPIS Map of Central Los Angeles Port Regions

CHAPIS maps may answer questions such as:

- What are the major sources of air pollution within several miles from a residence?
- What are the relative contributions of mobile and stationary source emissions?
- What are major sources of air pollution near schools?
- What air pollutants are emitted by a particular facility or from mobile sources?

While the CHAPIS information can serve as an indicator of local levels of air pollution, it is the exposure to emissions that influences health effects. Exposure is the amount of pollution that someone actually breathes or otherwise ingests. The degree of exposure varies with the distance from the source and the activities of the individual. Exposure is also dependent on how the emissions are released and dispersed into the atmosphere. Exposure to air pollutants can also occur from indoor sources such as cooking, cleaning, and smoking. Health risk, as it is related to exposure to air contaminants is influenced by the number of air pollutants an individual is exposed to and the relative toxicity of those pollutants. The air pollutant emission information contained in CHAPIS is provided for general informational purposes. This mapping tool does not address the contribution of indoor sources of air pollution, and it does not show exposure levels or the health risks associated with the pollutants and sources it tracks. Not all stationary source facilities that are required to be permitted by the AQMD can be identified by CHAPIS at this time. Also, there can be a lag time between when the emissions occurred and the reporting of the information to the AQMD or CARB emission inventory databases. The AQMD should be consulted for the most recent emissions data and for information on facilities that may not appear on CHAPIS maps.

Siting issues, with respect to sensitive receptors need to be identified early in the review process, preferably before projects are formally submitted to the public agencies' planning boards. The following three air quality questions related to land use compatibility should be considered for each project in close proximity to sensitive receptors:

- Will a sensitive receptor be located downwind from an existing source of dust or odors (Table 2-1)?

- Will a sensitive receptor be located in close proximity to a congested roadway or an existing facility that emits TACs (Table 2-3)?

- Is adequate separation provided, or are there established siting criteria to minimize exposure and health risk between sensitive receptors and sources of air pollution (see Table 1-1 in CARB's Draft Air Quality and Land Use Handbook: A Community Health Perspective. February 2005)?

Cities and counties could establish policies that provide for the location of sensitive sites and sources of air pollution in a manner that seeks to avoid the over-concentration of these facilities near sensitive sites. A number of strategies that may be employed to address over-concentration of emission sources and the cumulative impacts of the combined emissions include:

- physical separation between the source and the sensitive site
- design features at the source to minimize air pollution emissions
- siting, permitting and zoning policies
- capping cumulative impacts of various pollution sources

- changing the land use designations in areas where there are significant cumulative impacts

"Cumulative" air quality analyses describe health and nuisance impacts related to cumulative emissions from sources that individually comply with AQMD, state, and federal rules. For example, in local jurisdictions where there are neighborhoods near a relatively large number of industrial facilities or near heavy cross-town traffic, there is concern that there may be accumulated effects of numerous emission sources operating near residences, schools, or other sensitive sites. Cumulative impacts may be mitigated through siting and zoning policies that consider, where feasible, appropriate setbacks and buffer zones to disperse the air pollutants before they reach sensitive receptors. When physical separation of sensitive receptors from sources of air pollution is not a feasible option, particularly in older well-developed communities, the design features of a specific facility or project (e.g., barriers and walls, landscaping, stack height, and ventilation systems) should be evaluated as an alternative to physical land separation.

JOB-HOUSING BALANCE

Residents in urban areas in the South Coast basin have become increasingly concerned with increased traffic congestion and the failure of the region to achieve state and federal clean air standards. The concept of a "jobs/housing balance" is based on the premise that the number of vehicle trips and vehicle miles traveled (VMT) can be reduced when sufficient jobs are available locally to balance the employment demands of the community, and when commercial services are convenient to residential areas. Achieving a good balance requires planning the location and nature of jobs and housing in order to encourage a reduction in vehicle trips and VMT while increasing mass transit ridership and alternative modes of transportation, such as bicycles and walking. The AQMD and the SCAG both embrace jobs/housing balance as a viable tool available to local governments to reduce air pollution.

SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES RELATED TO LAND USE

Goal 1 **Land use policies that address the relationship between land use and air quality to protect public health and minimize impacts on existing land use patterns and future land use development**

Objective 1.1 **Through land use plans provide heightened consideration of policies and strategies to minimize exposure of sensitive receptors and sites (e.g., schools, hospitals, and residences) to health risks related to air pollution.**

Suggested Policies/Strategies to Protect Sensitive Receptors from Health Risks Related to Air Pollution:

AQ 1.1.1 Develop mapping and inventory resources to identify sensitive receptors and sources of air pollution.

AQ 1.1.2 Consider environmental justice issues as they are related to potential health impacts associated with air pollution and ensure that all land use decisions, including enforcement actions, are made in an equitable fashion to protect residents, regardless of age, culture, ethnicity, gender, race, socioeconomic status, or geographic location from the health effects of air pollution.

AQ 1.1.3 Encourage site plan designs to provide the appropriate set-backs and/or design features that reduce TAC at the source.

AQ 1.1.4 Encourage the applicants for sensitive land uses (e.g., residences, schools, daycare centers, playgrounds and medical facilities) to incorporate design features (e.g., pollution prevention, pollution reduction, barriers, landscaping, ventilation systems, or other measures) in the planning process to minimize the potential impacts of air pollution on sensitive receptors.

AQ 1.1.5 Promote and support mixed-use land patterns that allow the integration of retail, office, institutional and residential uses. Consult with the AQMD when siting new facilities with dust, odors or TAC emissions to avoid siting those facilities near sensitive receptors and avoid siting sensitive receptors near sources of air pollution.

AQ 1.1.6 Consider cumulative air quality impacts from both existing and new projects when making siting decisions.

AQ 1.1.7 Facilitate communication among residents, businesses and the AQMD to quickly resolve air pollution nuisance complaints. Distribute information to advise residents on how to register a complaint with AQMD (AQMD's "Cut Smog" program).

AQ 1.1.8 The owners of new developments that have the potential to emit air pollutants that would impact sensitive receptors are required, during the early stages of the business license, development or conditional use permit processes, to notify residents and businesses adjacent to the proposed site prior to starting construction. However, potential business and resident occupants newly locating near sites that may impact sensitive receptors should be encouraged to inquire through their local government or the AQMD about the air quality emissions from such sites.

AQ 1.1.9 Consider all feasible alternatives to minimize emissions from diesel equipment (e.g., trucks, construction equipment, and generators).*

AQ 1.1.10 Actively participate in decisions on the siting or expansion of facilities or land uses (e.g. freeway expansions), to ensure the inclusion of air quality mitigation measures.

AQ 1.1.11 Where decisions on land use may result in emissions of air contaminants that pose significant health risks, consider options, including possible relocation, recycling, redevelopment, rezoning, process changes, incentive programs, and other types of measures.

Objective 1.2 Reduce mobile source emissions by reducing vehicle trips and vehicle miles traveled associated with land use patterns.

Suggested Policies/Strategies to reduce vehicle miles traveled:

AQ 1.2.1 For planned high density and mixed use developments, project proponents should consult with the local transit agency and incorporate all appropriate and feasible transit amenities into the plans.

AQ 1.2.2 Establish a Mixed-Use Zoning District that offers incentives to mixed use developments.

AQ 1.2.3 Encourage through the land use entitlement process or business regulation, design of commercial and residential areas to foster pedestrian circulation.

AQ 1.2.4 Adopt and implement zoning codes that encourage community centers, telecommuting programs, and home-based businesses.*

AQ 1.2.5 Create opportunities to receive State transportation funds by adopting incentives (e.g., an expedited review process) for planning and implementing infill development projects within urbanized areas that include job centers and clean transportation nodes (e.g., preparation of "transit village" plans).

AQ 1.2.6 Collaborate with local, regional, state and federal agencies to create incentives for "job/housing opportunity zones," to promote housing in job-rich areas and jobs in housing-rich areas.

AQ 1.2.7 Design safe and efficient vehicle access to commercial land uses from arterial streets to ensure efficient vehicular ingress and egress.

AQ 1.2.8 Locate public facilities and services so that they further enhance job creation opportunities.

AQ 1.2.9 Ensure that development projects and zoning codes create the maximum opportunity for the use of bicycles as an alternative work transportation mode.*

AQ 1.2.10 Encourage "walkable neighborhoods" by siting parks and community centers near residential areas.*

Objective 1.3 Reduce mobile source emissions by increasing population densities within one-half mile of clean transit nodes.

Suggested Policies/Strategies to Increase Densities:

AQ 1.3.1 Increase residential and commercial densities around clean rail and bus transit stations and corridors. Clean rail and bus transit nodes and corridors are those that are served by rail and buses that are powered by electricity, alternative fuels (i.e., CNG and LNG), or that meet or exceed SULEV emission standards.

AQ 1.3.2 Sponsor paratransit transportation systems, such as neighborhood electric vehicle "station cars" or jitneys for short trips to and from transit nodes.*

*Potential funding for these policies has been identified in Appendix E.

CHAPTER 3
TRANSPORTATION

- CATEGORIES OF MOBILE SOURCE EMISSIONS
- TRANSPORTATION AND INDIRECT SOURCE CONTROL PROGRAMS
- CONGESTION AND TRANSPORTATION SYSTEM MANAGEMENT
- SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES

TRANSPORTATION

CATEGORIES OF MOBILE SOURCE EMISSIONS

Mobile sources are motorized vehicles, which are classified as either on-road or off-road. On-road mobile sources typically include automobiles and trucks that operate on public roadways. Off-road mobile sources include aircraft, ships, trains, and self-propelled construction equipment that operate off public roadways. Mobile source emissions are accounted for as both direct source emissions (those directly emitted by the individual source) and indirect source emissions that by themselves do not emit air contaminants but indirectly cause the generation of air pollutants by attracting vehicles. Examples of indirect sources include office complexes, commercial and government centers, warehouses/distribution centers, sports and recreational complexes, rail yards, port terminals, and residential developments that attract mobile source emissions.

TRANSPORTATION AND INDIRECT SOURCE CONTROL PROGRAMS

Indirect sources are generally considered to be sources which generate or attract motor vehicle activity. State law is clear that the creation of the AQMD does not constitute an infringement on the existing authority of cities and counties to plan or control land use, and does not provide or transfer new land use authority to the AQMD, SCAG or CARB (H&SC § 40414). Historically, cities and counties in the South Coast basin have determined appropriate land uses through the planning process, while the AQMD imposes air quality requirements on sources of air pollution operating within the local jurisdictions. The relationship between the AQMD and the cities and counties is one of concurrent jurisdictional authority over sources of air pollution. Therefore, the regulation of indirect sources by the AQMD falls within the existing shared authority with the local jurisdictions and would not infringe on city and county land use decisions. This is supported by state law which specifies the authority of the AQMD to reduce or mitigate emissions from indirect and area wide sources of air pollution but does not constitute an infringement on the existing authority of counties and cities to plan or control land use (H&SC § 40716(a)).

The California Clean Air Act (CCAA) authorizes the AQMD to consider Indirect Source Control (ISC) programs in the development of the AQMP, and CARB has provided guidance for air districts and local governments that advocates the development of ISC programs as an effective tool to attain and maintain state ambient air quality standards. Generally the AQMD relies on the CEQA process to mitigate indirect source emissions. SCAG has the responsibility to coordinate the efforts of the counties and cities in the process of developing and reviewing plan elements which meet the requirements of state and federal law, and local needs relating to transportation, land use, demographic projections, employment, housing, and other matters of local concern (H&SC § 40464).

The CCAA defines the term "transportation control measure" (TCM) as "any strategy to reduce vehicle trips, vehicle use, vehicle miles traveled, vehicle idling, or traffic congestion for the purpose of reducing motor vehicle emissions" (H&SC § 40717(g)). The TCMs must be at a stringency level commensurate with the air quality designation (H&SC § 40918-40920). Indirect source control measures in the 2003 AQMP are broadly described in the TCMs developed by SCAG. There is inherent overlap between ISC strategies and TCMs, and the distinction between the two is subtle. Generally, TCMs are designed to implement a local or regional strategy to change travel behavior. In contrast, an indirect source control measure may rely on TCMs or stand alone to affect a change in travel behavior that occurs to and from a specific indirect source.

According to the CARB document, *Guidance for the Development of Indirect Source Control Programs*, land use design strategies that are sensitive to air quality issues, such as incorporating mixed uses into a land use project, can reduce vehicle trips by as much as 50 percent. Design strategies for site plans that are sensitive to air quality are also effective in reducing mobile source emissions. For example, a site plan design that incorporates amenities such as bicycle racks and pedestrian paths may reduce vehicle trips up to 10 percent.

CONGESTION AND TRANSPORTATION SYSTEM MANAGEMENT

Land use development may affect local transportation/circulation systems by increasing traffic to congested roadways and reducing vehicle speeds. The resulting increase in mobile source emissions adversely affects regional air quality, especially ozone levels and localized carbon monoxide concentrations. Under the regional Congestion Management Plan (CMP), local governments are required to adopt and implement a program to analyze the impacts of land use decisions on their portion of the CMP transportation system. If the project would cause traffic service at an intersection to deteriorate below level of service E (considerable congestion) or the level established in the CMP, the resulting congestion should be addressed by improvements, programs, or actions that either mitigate the deficiency or measurably improve the level of service of the system. In fact, the CMP requires that the impact be mitigated through the development of a deficiency plan. AQMD staff are available to assist local agencies identify areas where a project or series of projects may bring increased congestion to a segment of roadway.

The following questions should be asked regarding the potential of a development project to adversely affect air quality:

- Does the site design for public right-of-way and pedestrian walkways encourage pedestrian traffic? If not, can the site be modified to encourage pedestrian traffic?
- Is onsite traffic circulation designed to reduce vehicle queuing? If not, can the project layout be modified to minimize vehicle idling emissions?

- Are links between the project and bike/pedestrian pathways adequate to facilitate walking and bicycling rather than driving? If not, can the site be modified to accommodate bike/pedestrian pathways?
- Do residential-specific plans incorporate mixed uses such as banks, post offices, etc., to minimize vehicle miles traveled (VMT) but avoid incompatible land use between sensitive receptors and air pollution sources? If not, can mixed uses be incorporated?
- Is the project accessible to transit facilities? If not, can the project design be modified to access public transit facilities?
- Do developments in transit corridors provide sustainable densities to support transit ridership? If not, how could those developments be modified to achieve minimum densities?
- Could the project affect the levels of service on the Congestion Management Plan (CMP) transportation system? If so, what would be the impact on the transportation system?

Transportation System Management

Transportation System Management (TSM) is a means of improving the efficiency of the existing transportation system through more effective utilization of facilities. TSM programs that discourage single-occupant vehicle trips and promote flexible work hours may improve levels of service on city streets. Overall, effective TSM programs that reduce the existing traffic congestion and VMT while increasing the carrying capacity of the transportation system will reduce air pollution. The California Department of Transportation (CALTRANS) lists the following TSM measures that could be appropriately included in the air quality element:

- programs to improve traffic flow
- preferential treatments for transit and other HOV strategies
- provisions for pedestrians and bicyclists
- management/control of parking
- changes in work schedules, fares and tolls
- actions to reduce motor vehicle use in congested areas
- improved public transit

CALTRANS and local transit agencies recommend uniform design features that should be considered in the planning stages of some TSM measures. For example, the Riverside Transit Agency provides guidelines for local planners, developers and decision makers that outline uniform standards for the design and placement of bus-related facilities. The document, titled *Design Guidelines for Bus Transit*, defines criteria, dimensions, and space requirements for the following transit facilities and amenities:

- pedestrian and bicycle access-ways connecting with transit

- bus stops, signs, and hardware (e.g., benches, shelters, lighting)
- park and ride facilities
- transit centers

Cities are encouraged to consider all CALTRANS TSM measures in their air quality elements and to collaborate with CALTRANS and local transit agencies to reduce air pollution through efficient design and management of transportation facilities and fleets.

Cities may utilize a portion of the state motor vehicle registration fees to fund TSM measures. Assembly Bill 2766 authorizes a $4 motor vehicle fee surcharge at the time motor vehicles are registered to be used solely to fund projects and programs that reduce air pollution from motor vehicles, as well as to fund mobile-source related planning, monitoring, enforcement, and technical studies necessary to implement the California Clean Air Act. The AQMD subvenes 40 percent of the total AB 2766 revenue Subvention Funds to cities and counties within the air district based on the prorated share of the jurisdiction's population. For many cities, the AB 2766 revenue provides a vital funding source to implement TSM measures and AQMP mobile source control measures. The AQMD provides an AB 2766 Resource Guide as a framework for use of the funds to help local governments evaluate and select cost-effective projects that are eligible for funding. The Resource Guide describes typical projects that reduce vehicle emissions from the following categories:

- purchase of alternative-fueled vehicles
- abatement of vehicle emissions
- implement land use strategies to reduce vehicle emissions
- public transportation programs
- traffic management projects
- transportation demand programs
- market-based strategies
- promote bicycle use
- PM_{10} reduction strategies
- public education

A California statewide regulation now limits diesel-fueled commercial motor vehicle idling. Effective February 1, 2005, operators of diesel-fueled commercial motor vehicles over 10,000 pounds are prohibited from idling more then five minutes when not engaged in work activity. California state law prohibits the idling of a vehicle's primary diesel engine for greater than five minutes at any location with some exceptions. The use of diesel auxiliary power systems and main engines are limited to five minutes when within 100 feet of homes or schools while a driver is resting. The idling rules are among a series of rules adopted by the CARB as part of its Diesel Risk Reduction Plan. Efforts by local jurisdictions to encourage residents to turn their engines off when they park, saves fuel and emissions. Cities may adopt ordinances to impose more stringent engine idling requirements than those imposed by the state or the local air district.

Cities are encouraged to work collaboratively with non-government organizations and consult with the broader community about the mix of anti-idling initiatives (e.g., workplace-based, school-based, municipal by-law, and/or community outreach) that will work best in their area. Further, cities could determine if vehicle idling is a concern at municipally-owned or controlled facilities (e.g., city hall, community centers) and implement measures to discourage idling. Local jurisdiction environmental advisory or air quality committees are good forums to start to discuss the health effects of emissions from idling vehicles and the options available to reduce or eliminate those emissions. Local jurisdictions may consider partnering with other community organizations (e.g., environmental groups, school boards) to implement a community anti-idling campaign or project and consider participating in a "fleet challenge" with other municipalities or fleet owners in the community.

SUGGESTED GOAL, OBJECTIVES AND POLICIES/STATEGIES

Goal 2 **A reduction in air pollution from mobile sources**

Objective 2.1 **Reduce motor vehicle trips and vehicle miles traveled.**

Suggested Policies/Strategies to Reduce Motor Vehicle Trips and VMT:

AQ 2.1.1 Seek new cooperative relationships between employers and employees to reduce vehicle miles traveled (VMT).*

AQ 2.1.2 Work with large employers and commercial/industrial complexes to create Transportation Management Associations and to implement trip/VMT reduction strategies. (For additional information please refer to AQMD's Rule 2202 Employee Commute Reduction Program Guidelines.)*

AQ 2.1.3 Cooperate with surrounding jurisdictions to provide incentives, adopt regulations and develop transportation demand management programs that reduce and eliminate vehicle trips and VMT.*

AQ 2.1.4 Collaborate with local transit agencies to:*

- develop programs and educate employers about employee rideshare and transit
- establish mass transit mechanisms for the reduction of work-related and non-work related vehicle trips
- promote mass transit ridership through careful planning of routes, headways, origins and destinations, and types of vehicles

AQ 2.1.5 Identify and develop non-motorized transportation corridors (e.g., bicycling & walking trails).*

AQ 2.1.6 Provide merchants with fliers/posters that publicize public mass transit schedules to encourage their customers to use mass transit.*

AQ 2.1.7 Outline a plan of mobile source enforcement methods such as periodic mobile source (e.g., trucks and buses) checkpoints throughout the City to enforce opacity regulations. Technical assistance can be sought from ~~by~~ CARB and the California Highway Patrol (CHP) on enforcement issues.

AQ 2.1.8 Provide incentives such as preferential parking for alternative-fuel vehicles (e.g., CNG or hydrogen).

Objective 2.2 **Establish necessary policies and requirements to reduce indirect source emissions.**

Suggested Policies/Strategies Related to the Reduction of Mobile Source Emissions at Special Event Centers:

AQ 2.2.1 Establish requirements for special event centers to provide off-site parking and park-n-ride facilities at remote locations. Remote parking should be as close as practicable to the event site and the operator should operate or provide alternative-fuel vehicles for shuttles.*

AQ 2.2.2 Promote peripheral parking by increasing on-site parking rates and reduced peripheral parking rates.*

AQ 2.2.3 Encourage special event center operators to provide discounted transit passes with event tickets or offer discounted on-site parking for carpooling patrons (four or more persons per vehicle).*

Objective 2.3 **Reduce mobile source emissions through efficient management of transportation facilities and system infrastructure using cost-effective management and innovative demand-management techniques.**

Suggested Policies/Strategies Related to TSM efficiency:

AQ 2.3.1 Synchronize traffic signals throughout the City and with adjoining cities and counties while allowing free flow of mass transit systems.*

AQ 2.3.2 Construct and improve traffic signals with Automated Traffic Surveillance and Control systems at appropriate intersections.*

AQ 2.3.3 Reduce traffic delays through highway maintenance, rapid emergency response, debris removal, and elimination of at-grade railroad crossings.*

AQ 2.3.4 Encourage businesses to schedule deliveries at off-peak traffic periods through the land use entitlement or business regulation process.

AQ 2.3.5 Encourage the construction of HOV lanes whenever necessary to relieve congestion and reduce air pollution. Emphasize the use of HOV lanes, as well as light rail and bus routes, and pedestrian and bicycle facilities to improve mobility and air quality.

AQ 2.3.6 Monitor traffic and congestion to determine when and where the City needs new transportation facilities to achieve increased mobility efficiency.*

AQ 2.3.7 Work with local transit providers to incorporate best design practices for transit into new development projects.*

AQ 2.3.8 Adopt a Trip Reduction Ordinance that is equivalent to or more stringent than the requirements of AQMD Rule 2202 (refer to Rule 2202 (l)).*

AQ 2.3.9 Implement the required components of the Congestion Management Plan (CMP), and continue to work with *(applicable body/organization)* on annual updates to the CMP.

AQ 2.3.10 Support SCAG's Regional Growth Management Plan by developing intergovernmental agreements with appropriate governmental entities such as the *(Council of Government)*, sanitation districts, water districts, and those sub-regional entities identified in the Regional Growth Management Plan.

AQ 2.3.11 Replace existing vehicles in the city fleet with the cleanest vehicles commercially available.*

Objective 2.4 Secure all available funding from local, state and federal sources to improve TSM cost effectiveness

Suggested Policies/Strategies Related to Funding Resources:

AQ 2.4.1 Develop and coordinate a plan with local agencies for cost-effective use of AB 2766 funds so that revenue is used for projects and programs identified in the AQMP.

AQ 2.4.2 Develop and adopt a policy to utilize federal Congestion Mitigation and Air Quality Improvement (CMAQ) funds in coordination with regional agencies in a manner consistent with projects approved in the AQMP.

AQ 2.4.3 Apply annually to the AQMD Mobile Source Reduction Committee (MSRC) for AB 2766 "Local Government Match Program" grants for projects that reduce mobile source emissions (e.g., purchases of alternative-fueled vehicles).

AQ 2.4.4 Seek opportunities to pool AB 2766 revenue with neighboring cities to fund programs that will reduce mobile source emissions (e.g., traffic synchronization, fueling station infrastructure, teleconferencing facilities).

Objective 2.5 Advocate for stricter regulations on mobile source emissions.

Suggested Policies/Strategies Related to Advocacy:

AQ 2.5.1 Cooperate with federal and state agencies and the AQMD in their efforts to reduce exposure from railroad, truck, and ship emissions.

AQ 2.5.2 Collaborate with the USEPA, CARB, AQMD, and warehouse owners to create programs and ordinances to minimize the amount of diesel emissions related to warehousing operations.

Objective 2.6 Purchase and operate alternative fuel vehicles and encourage the greater use of alternative fuel vehicles

Suggested Policies/Strategies Related to the Increased Use of Alternative Fuels:*

AQ 2.6.1 Support full compliance with the AQMD's and CARB's Fleet Rules.

AQ 2.6.2 Manage the City's transportation fleet fueling standards to achieve the greatest number of alternative fuel vehicles in the City fleet.

AQ 2.6.3 Encourage City contractors who operate vehicles within the City boundaries to operate alternative fuel vehicles.

AQ 2.6.4 Support the development of alternative fuel infrastructure that is publicly accessible.

AQ 2.6.5 Establish programs for priority or free parking on City streets or in City parking lots for alternative fuel vehicles.

AQ 2.6.6 Join or continue current membership with a Clean Cities Coalition.

Objective 2.7 Reduce emissions from idling vehicles.

Suggested Policies/Strategies to Reduce Emissions From Idling Vehicles:*

AQ 2.7.1 Enforce a statewide regulation that requires school buses and other heavy-duty vehicle operators to turn off their engines if they are idling within 100 feet of a school.

AQ 2.7.2 Adopt an ordinance that restricts vehicle engine idling for the purpose of controlling or mitigating vehicle emissions or abating a nuisance.

AQ 2.7.3 Design traffic plans, including the development of suggested routes, to minimize diesel truck idling.

*Potential funding for these policies has been identified in Appendix E.

CHAPTER 4
STATIONARY SOURCES OF AIR POLLUTION

- CATEGORIES OF STATIONARY EMISSION SOURCES
- SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES

STATIONARY SOURCES OF AIR POLLUTION

CATEGORIES OF STATIONARY EMISSION SOURCES

Air pollutant emissions sources are typically grouped into two categories: stationary and mobile sources. Stationary sources are further divided into two major subcategories: point and area sources. Point sources consist of a single emission source with an identified location point at a facility. Facilities could have multiple point sources located onsite. Point sources are usually associated with manufacturing and industrial processes, such as boilers, spray booths or degreasers. Area sources are small emission sources that are widely distributed, but may have substantial cumulative emissions; examples include residential water heaters, small engines, and consumer products, such as barbecue lighter fluid and hair spray.

Stationary source facilities that propose new or modified equipment, or want to relocate operations need to obtain or modify permits issued by the AQMD. For modifications at an existing facility, such as expansion of existing operations, it may be helpful for local governments to coordinate with the AQMD and the facility to obtain information about the facility's current operations. Further, AQMD will provide information on the type and quantity of pollutants that are currently emitted from the facility and the pollutants that are proposed after the modification. Information on permitted facilities can be obtained from the AQMD's Office of Engineering and Compliance.

The AQMP is a blueprint for achieving clean air that contains regulations and commitments to adopt regulations and programs to reduce pollution from stationary, mobile and area sources. Cities and counties are encouraged to act prospectively to support these strategies to improve air quality by including in their decision-making full consideration of the air quality impacts that will result in new receptors near existing sources of air pollution. For example, cities could consider incentives for existing businesses and new developments which complement AQMD strategies to reduce emissions. The air quality element could include a clear policy statement(s) that commits local agencies to work with the AQMD and other stakeholders to find cost-effective emission reductions and pollution prevention strategies that could be implemented at sources within their jurisdictions. SCAG and the AQMD provide forums for local jurisdictions to participate in control measure development when the AQMD is updated every three years. Control measures in the 2003 AQMP are classified in nine categories:

- coatings and solvents
- petroleum operations and fugitive VOC emissions
- combustion sources
- fugitive dust sources
- miscellaneous sources
- compliance flexibility programs

- mobile sources
- long term measures
- transportation conformity budget backstop

SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES

Goal 3 A reduction of air pollution emissions from stationary sources

Objective 3.1 Coordinate with the AQMD and operators of stationary source equipment or processes to minimize air pollution emissions

Suggested Policies/Strategies Related to Reduction of Emissions from Stationary Sources:

AQ 3.1.1 Assist small businesses by developing training programs related to clean, innovative technologies to reduce air pollution (e.g., wet cleaning or CO_2 cleaning in lieu of perchloroethylene), and provide incentives to those businesses that use clean air technologies.*

AQ 3.1.2 Encourage the use of building materials and methods that minimize air pollution.

AQ 3.1.3 Support, through the use of development standards, the use of fuel-efficient heating equipment, and other appliances, such as water heaters, swimming pool heaters, cooking equipment, refrigerators, furnaces, boiler units, and low or zero-emitting architectural coatings. Provide incentives to encourage the use of clean air technology beyond what is required by AQMD. For example, encourage the use of fuel and material substitution, cleaner fuel alternatives, product reformulation, change in work practices, and air pollution control measures identified in the latest AQMP.*

AQ 3.1.4 Encourage pollution prevention and source emission reduction strategies through:

- process change
- best management practices
- preventative inspection and maintenance programs
- emergency response planning

AQ 3.1.5 Provide incentives to promote siting or use of clean air technologies (e.g., fuel cell technologies, renewable energy sources, UV coatings, hydrogen fuel).

AQ 3.1.6 Consider support of legislation which promotes clean industrial technologies, and more efficient stationary source combustion equipment and energy generation.*

*Potential funding for these policies has been identified in Appendix E.

CHAPTER 5

REDUCTION OF FUGITIVE DUST

- **SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES**

REDUCTION OF FUGITIVE DUST

Fugitive dust is a generic term used to describe any solid particulate matter that becomes airborne, other than that emitted from an exhaust stack, directly or indirectly as a result of the activities of any person. Fugitive dust can vary in size and composition, depending on the location, wind direction, time of the day, and the time of season for its source. The AQMD includes two air basins that exceed State and federal ambient air quality standards for PM_{10} (fine particulate matter less than 10 microns in diameter). Studies indicate that approximately one-third of the South Coast basin's ambient PM_{10} concentrations and over ninety percent of Coachella Valley's ambient PM_{10} levels are a result of fugitive dust.

AQMD regulates fugitive dust via several district rules. For example, Rule 403 (Fugitive Dust) requirements are applicable to the South Coast Air District and to the Coachella Valley portion of the Salton Sea Air Basin. The purpose of Rule 403 is to reduce the amount of particulate matter entrained in the ambient air as a result of anthropogenic (man-made) fugitive dust sources. Rule 403 requires implementation of control measures to prevent, reduce, or mitigate fugitive dust emissions and includes a performance standard that prohibits visible emissions from crossing any property line. Under Rule 403, large operations (projects greater than 50 acres and/or more than 5,000 cubic yards of daily earth-movement) are required to notify the AQMD of the project location and implement Table 2, and, if necessary Table 3, control measures and maintain recordkeeping. Rule 403 can be viewed or downloaded at: http://www.aqmd.gov/rules/reg/reg04/r403.pdf Forms for large operation submittals can be viewed or downloaded at: http://www.aqmd.gov/comply/Forms/403N_8_2004.doc.

Rule 403 requires all projects and activities in the South Coast Air Basin to control dust generation, with specified control measures for large operations of 50 acres or more. In spite of these basin-wide requirements, ground disturbances, geological conditions, or meteorological conditions may result in dust generation that constitutes a chronic public nuisance, or would prevent attainment of federal PM_{10} standards. These limited areas may warrant additional dust control efforts on the part of local governments. A local dust control policy that requires preparation and approval of a dust control plan for all projects seeking a grading permit in such limited areas may be needed to supplement current Rule 403 requirements. Local governments may also choose to apply specific control measures crafted to address their chronic public nuisance dust problems or PM_{10} exceedances.

Coachella Valley (Palm Springs area) local governments have adopted dust control ordinances that require approval of a dust control plan prior to local government issuance of grading permits. The Coachella Valley's response to its elevated levels of PM_{10} illustrates how local dust control plans can work to address areas with elevated particulate levels. AQMD and Coachella Valley local government staff have developed a guidance handbook to assist persons preparing and reviewing dust control plans. A copy of the model dust control ordinance for Coachella Valley is provided in Appendix D. AQMD Rule 403.1 (Supplemental Fugitive Dust Control Requirements for Coachella Valley Sources) is a companion regulation to Rule 403 that is only applicable to fugitive dust sources in the Coachella Valley. Rule 403.1 establishes special requirements for Coachella Valley fugitive dust sources under high-wind conditions and requires AQMD approval of dust control plans for sources not subject to local government ordinances (e.g., school districts). AQMD compliance staff ensures compliance with Rules 403 and 403.1 to complement the fugitive dust control programs developed by local Coachella Valley governments. Rule 403.1 can be viewed or downloaded at: http://www.aqmd.gov/rules/reg/reg04/r403-1.pdf.

SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES

Goal 4 **Achieve ambient levels of particulate matter that meet state and federal clean air standards**

Objective 4.1 **Reduce the amount of fugitive dust that is re-entrained into the atmosphere from unpaved areas, parking lots and construction sites**

Suggested Policies/Strategies Related to Controlling Fugitive Dust Emissions:*

AQ 4.1.1 Where fugitive dust is causing a chronic public nuisance or the air quality is in exceedance of the PM_{10} standards consider adopting a dust control policy that requires preparation and approval of a dust control plan. Please contact AQMD for the most recent local PM_{10} air quality information.

AQ 4.1.2 Adopt by ordinance, a regulation, after considering small business impacts that controls the use of leaf blowers in areas with sensitive receptors.

AQ 4.1.3 Encourage vegetative thinning or mowing for weed abatement activities to minimize wind-blown dust.

AQ 4.1.4 Identify and create a control plan for areas within the jurisdiction that are prone to wind erosion of soil and take measures to prevent illegal off-highway vehicle (OHV) use.

AQ 4.1.5 Require conditions in a zoning or conditional use permit to require fugitive dust controls and compliance mechanisms for stationary sources (landfills, composting facilities, aggregate facilities, etc.).

AQ 4.1.6 Ensure compliance with California Vehicle Code section 23113 provisions intended to prevent deposition and rapid removal of material from any highway or street.

AQ 4.1.7 Adopt incentives, regulations, and/or procedures to reduce paved road dust emissions through targeted street sweeping of roads subject to high traffic levels and silt loadings.

AQ 4.1.8 Pave currently unpaved roads and parking lots or establish and enforce 15 mile per hour speed limits on low-use unpaved roads as permitted under California Vehicle Code section 22365.

AQ 4.1.9 Adopt incentives or procedures to limit dust from agricultural lands and operations.

AQ 4.1.10 Consider the suspension of all grading operations, not including dust control actions, at construction projects when the source represents a public nuisance or potential safety hazard due to reduced visibility on streets surrounding the project.

AQ 4.1.11 Cooperate with local, regional, state and federal jurisdictions to better control fugitive dust from stationary, mobile and area sources.

AQ 4.1.12 Collaborate with the transportation agencies, utilities, railroads, etc., to minimize fugitive dust during construction and maintenance activities.

AQ 4.1.13 Encourage, and support stricter state and federal legislation for vehicles that spill debris on roadways.

AQ 4.1.14 Ensure that vehicles do not transport aggregate or similar material upon a highway unless the material is stabilized or covered, in accordance with state law and AQMD regulations.

AQ 4.1.15 Encourage vegetation or chemical stabilization for disturbed land for phased construction projects.

*Potential funding for these policies has been identified in Appendix E.

CHAPTER 6
ENERGY

- ENERGY CONSERVATION
- GREEN BUILDING OPPORTUNITIES
- PUBLIC FACILITIES AND FLEETS
- SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES

ENERGY

ENERGY CONSERVATION

All new residential and non-residential buildings within California must meet minimum energy efficiency standards contained in Title 24, Part 6 of the California Code of Regulations. New 2005 standards were recently adopted by the California Energy Commission and the Building Standards Commission. These new standards become effective October 1, 2005, and will reduce energy demand from all new development, translating into emission reduction benefits. The Energy Commission estimates the standards will save $57 billion by 2011. The previous 2001 standards have already saved more than $20 billion in electricity and natural gas costs.

New development consumes energy in several ways. Gas-fired combustion equipment such as water heaters, pool heaters, space heaters, furnaces, boilers, steam generators, internal combustion engines, etc. are used throughout the South Coast basin in the residential, commercial, and industrial sectors. Residential uses of natural gas include space heating, water heating, laundry, cooking, dishwashers, and pool/hot tub heaters. The largest demand for natural gas from this sector is from space and water heating. Natural gas in the commercial sector is used for space heating, water heating, process heating, cooling, and food preparation. The industrial sector includes a wide range of manufacturing and industrial processes that use natural gas in a variety of processes such as steam generation, curing and drying processes, metal melting, and heat treatment.

Implementation policies in this chapter promote full implementation of Title 24 and, where possible, voluntary energy conservation beyond Title 24 to reduce emissions. Local governments may provide incentives to developers and proponents of facilities to incorporate energy efficiency measures to improve air quality.

GREEN BUILDING OPPORTUNITIES

Projects may be voluntarily designed to exceed energy efficiency standards established by Title 24 of the California Code of Regulations. Local governments have the voluntary option to provide incentives to implement energy-saving measures for projects, and energy performance targets beyond those required by Title 24 as appropriate. A comprehensive approach to energy conservation in building construction is known as "green building". Green building techniques integrate energy efficiency and sustainable building practices into the design and construction phases. Municipal buildings that follow green building design principles not only help create healthy workplaces, but also reduce the city's energy demand. This results in cost savings and a reduction in air pollution associated with energy production. There are several private and government rating systems for green buildings. One system for example, is the voluntary LEED

(Leadership in Energy and Environmental Design) standard developed by the U.S. Green Building Council, which has been extensively used to date for commercial projects. LEED standards have been adopted nationwide by federal agencies, state and local governments, and interested private companies as the guideline for sustainable building. Another example of a "green building" program is a voluntary program developed by the Building Industry Institute for residential development called the California Green Builder Program. Developers of Green Builder projects select measures that reduce energy consumption to levels that are 15 percent below Title 24 requirements.

Where opportunities exist to go beyond Title 24 energy efficiency requirements, those techniques and features that best fit the nature and economics of the development may be selected. Examples of energy conservation features incorporated into LEEDS and California Green Builder projects include the following:

- more energy efficient lighting, heating and cooling systems and appliances
- landscape treatments that reduce energy consumption use (e.g., planting of deciduous trees)
- use of passive daylight and heating (i.e., sun light)
- use of photovoltaic systems (solar energy)
- use of lighter colored building and roofing materials and coatings
- installation of recharging outlets for electric and hybrid vehicles
- remote sensors that adjust heating, cooling and lighting when rooms are occupied
- bicycle lockers and paths, preferred parking spaces and bus turnouts to encourage alternative modes of transportation

AQMD staff plan to establish a website that will provide examples of green building practices and policies.

PUBLIC FACILITIES AND FLEETS

Energy conservation efficiency and generation operations should be considered when building, acquiring, or retrofitting public facilities. Also, alternative-fuel vehicles are in operation in many local jurisdictions in the air district which help reduce mobile source emissions (see Chapter 3 -Transportation).

SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES

Goal 5 **Reduction in air pollution resulting from greater energy efficiency and conservation, and the use of renewable resources**

Objective 5.1 Increase energy efficiency of city facilities and private developments

Suggested Policies/Strategies Related to Energy Conservation:

AQ 5.1.1 Utilize source reduction, recycling and other appropriate measures, to reduce the amount of solid waste disposed in landfills.

AQ 5.1.2 Develop incentives that encourage the use of energy conservation strategies by private and public developments.

AQ 5.1.3 Promote energy-efficient design features, including appropriate site orientation, use of lighter color roofing and building materials, and use of deciduous shade trees and windbreak trees to reduce fuel consumption for heating and cooling.

AQ 5.1.4 Promote or provide incentives for "Green Building" programs that go beyond the requirements of Title 24 of the California Administrative Code and encourage energy efficient design elements as appropriate to achieve "green building" status.

AQ 5.1.5 Promote the use of automated time clocks or occupant sensors to control central heating and air conditioning.

AQ 5.1.6 Utilize all available renewable energy sources to reduce fuel consumption and demand on the power grid.

AQ 5.1.7 Replace vehicles in the local government fleet with the most fuel-efficient vehicles that are commercially available.*

*Potential funding for these policies has been identified in Appendix E.

CHAPTER 7
PUBLIC AWARENESS AND EDUCATION

- **SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES**

PUBLIC AWARENESS AND EDUCATION

In Town Hall meetings held by the AQMD, residents throughout the South Coast basin have asked how the public can become more involved in reducing local air pollution impacts in their communities. Local governments are encouraged to invest in public outreach activities and programs to build strong public awareness of regional and local air quality issues and health studies. To foster greater community involvement and support in developing public policy, local jurisdictions should consider the following activities to improve awareness of air quality and environmental justice issues.

- identify an individual as a contact person for environmental justice issues.
- participate with the AQMD in Town Hall meetings to hear citizen concerns regarding air quality and environmental justice.
- schedule community meetings to update residents of proposed large development projects, the results of AQMD air monitoring programs (e.g., MATES-II), cumulative air quality impacts and evaluate various options to reduce health impacts from exposure to air pollution. To encourage greater participation, hold public meetings in centrally-located community meeting rooms, libraries, and schools. Schedule meetings at times that encourage public participation (e.g., evenings and weekends) and provide translation services, and childcare services, if needed.
- collaborate with local school districts and private schools to increase student awareness of air pollution and health effects issues.
- distribute air quality information, AQMD brochures and fact sheets on the health effects of air pollution, public service announcements, and web page links. Provide this information in languages of the major ethnic groups in the community.
- collaborate with AQMD and other public entities as appropriate on distribution of public notices for air emission related actions and events involving environmental justice, including, but not limited to, mailing lists, noticing venues, and content of notices to improve the effectiveness and efficiency of this outreach effort.
- dedicate a page of the local government website to address local land use policies as they relate to environmental justice programs and cumulative air quality impacts.

- allow, encourage, and promote community access to activities related to land use activities such as General Plan or Community Plan updates, zoning changes, special studies, CEQA reviews, variances, etc.

- create and distribute simple, easy-to-read, understandable material on public participation that describes how to contact the local jurisdiction or AQMD to obtain information and assistance regarding air quality, health effects and environmental justice programs. A model handbook is available from CARB titled "Public Participation Guidebook."

USEPA's Environmental Education Center provides curricula and creative activities on a variety of air quality topics. Kids' sites from the USEPA include educational material on air pollution and its effects on global warming. USEPA's Office of Air Quality Planning and Standards' Environmental Education Web site describes air quality training opportunities for teachers K-12, resource materials and available grants.

The AQMD provides a number of air quality curricula and materials to assist teachers at no charge. For example, a project titled: "Air Pollution - What's the Solution" has been developed for students, grades 6 – 12. This curriculum utilizes online, real-time data to guide student discovery of the science behind the causes and effects of ground level ozone in the context of an authentic real-world problem. The AQMD Student's Health Web Site is a resource for high school students and adults to learn about the health effects of air pollution in Southern California. Also, the website includes a "Kids' Page" that shows three colorful chameleons to teach children how to moderate their activity to safely play outside when air pollution levels are elevated.

SUGGESTED GOAL, OBJECTIVES AND POLICIES/STRATEGIES

Goal 6 **Greater public awareness of the changes in personal behavior that can be chosen to minimize air pollution**

Objective 6.1 **Make air quality education a priority for the City's effort to protect public health and achieve state and federal clean air standards.**

Suggested Policies/Strategies Related to Public Awareness:*

AQ 6.1.1 Provide regional and local air quality information on City's website, including links to the AQMD, CARB, USEPA and other environmental-based internet sites.

AQ 6.1.2 Organize city-sponsored events on topics that educate businesses and the public about compliance with air quality regulations (e.g., alternative fuels and low polluting clean household products).

AQ 6.1.3 Work with school districts to develop air quality curricula for students.

AQ 6.1.4 Encourage, publicly recognize, and reward innovative approaches that improve air quality.

AQ 6.1.5 Encourage the participation of environmental groups, the business community, civic groups, special interest groups, and the general public in the formulation and implementation of programs that effectively reduce air pollution.

AQ 6.1.6 Encourage the purchase and use of low- or zero-emission vehicles, coordinate with AQMD and with local car dealerships and their associations to encourage and support the dealerships' participation in AQMD's "Clean Air Choice" vehicle information program.

AQ 6.1.7 Provide public education to encourage local consumers to choose the cleanest paints, consumer products, etc.

AQ 6.1.8 Publicize the AQMD's 1-800-CUT-SMOG number for the public to report air pollution complaints to the AQMD.

*Potential funding for these policies has been identified in Appendix E.

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GLOSSARY

AB 2766 Funds (AB 2766 (Sher) Motor Vehicle Fee Program): A program that permits air districts and local governments to allocate vehicle registration surcharge fees to projects that reduce motor vehicle emissions such as zero emission vehicles, alternative-fueled street sweepers and trip reduction programs.

Air Pollutants: Amounts of foreign and/or natural substances occurring in the atmosphere that may result in adverse effects on humans, animals, vegetation, and/or materials.

Area Sources: Stationary sources of pollution (e.g., water heaters, gas furnaces, fireplaces, and wood stoves) that are typically associated with homes and non-industrial sources. The CCAA requires districts to include area sources in the development and implementation of AQMPs.

Air Toxics: A generic term referring to a harmful chemical or group of chemicals in the air that has the potential to produce adverse health effects. Typically, substances that are especially harmful to health, such as those considered under USEPA's hazardous air pollutant program or California's AB 1807 toxic air contaminant program, are considered to be air toxics.

Alternative Fuels: Fuels such as methanol, ethanol, natural gas, and liquid propane gases that are cleaner burning and help to meet CARB's mobile and stationary emission standards.

Ambient Air: The air found at a particular time and place outside of structures. Often used interchangeably with "outdoor air."

Air Quality Management Plan (AQMP): A plan prepared by an air pollution control district or air quality management district, for a county or region designated as a non-attainment area, for the purpose of bringing the area into compliance with the requirements of the national and/or California Ambient Air Quality Standards. AQMPs are incorporated into the State Implementation Plan (SIP).

Best Available Control Technology (BACT): The most up-to-date methods, systems, techniques, and production processes available to achieve the greatest feasible emission reductions for given regulated air pollutants and processes. BACT is a requirement of NSR (New Source Review) and PSD (Prevention of Significant Deterioration) under the federal Clean Air Act. BACT, as used in federal law under PSD, is defined as an emission limitation based on the maximum degree of emission reductions allowable taking into account energy, environmental and economic impacts and other costs [CAA Section 169(3)]. The term BACT as used in state law means an emission limitation that will achieve the lowest achievable emission rates, which means the most stringent of either the most stringent emission limits contained in the SIP for the class or category of source, (unless it is demonstrated that the limitation is not achievable) or the most stringent emission limit achieved in practice by that class in category of source. "BACT" under state law is more stringent than federal BACT and is equivalent to federal LAER (lowest achievable emission rate) which applies to NSR permit actions.

Best Available Retrofit Control Technology (BARCT): An air emission limitation that applies to existing sources and is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source.

Best Available Control Technology for Toxics (T-BACT): The most stringent emissions limitation or control technique which:

- has been achieved in practice for such permit unit category or class of source; or
- is any other emissions limitation or control technique, including process and equipment changes of basic and control equipment, found by the Executive Officer to be technologically feasible for such class or category of sources, or for a specific source.

Best Design Practice for Transit: An approach to transit planning that requires adherence to nationally recognized industry standards for physical facilities and services.

Buffer Zone: An area of land separating two distinct land uses that acts to soften or mitigate the effects of one land use on the other.

California Air Resources Board (CARB): The State's lead air quality agency, led by an eleven-member Governor-appointed board. It is responsible for attainment and maintenance of the State and federal air quality standards, and is chiefly responsible for motor vehicle pollution control. It oversees county and regional air pollution management programs.

California Ambient Air Quality Standards (CAAQS): Standards set by the State of California for the maximum levels of air pollutants which can exist in the outdoor air without unacceptable effects on human health or the public welfare. These are more stringent than NAAQS.

California Clean Air Act (CCAA): A California law passed in 1988 which provides the basis for air quality planning and regulation independent of federal regulations. A major element of the Act is the requirement that local air pollution control districts and air quality management districts in violation of state ambient air quality standards must prepare attainment plans which identify air quality problems, causes, trends, and actions to be taken to attain and maintain California's air quality standards by the earliest practicable date utilizing all feasible measures and an expeditious adoption schedule.

Carbon Monoxide (CO): A colorless, odorless gas resulting from the incomplete combustion of hydrocarbon fuels. CO interferes with the blood's ability to carry oxygen to the body's tissues and results in numerous adverse health effects. Over 80% of the CO emitted in urban areas is contributed by motor vehicles. CO is a criteria air pollutant.

Congestion Management Plan (CMP): A state mandated program (Government Code Section 65089a), that requires each county to prepare a plan to relieve congestion and reduce air pollution.

Criteria Pollutant: An air pollutant for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. Examples include: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM_{10} and $PM_{2.5}$. The term "criteria air pollutants" derives from the requirement that the U.S. EPA must describe the characteristics and potential health and welfare effects of these pollutants. The U.S. EPA and CARB periodically review new scientific data and may propose revisions to the standards as a result.

Environmental Justice: California state law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies (California Government Code section 65040.12). The AQMD defines environmental justice as equitable environmental policymaking and enforcement to protect the health of all residents, regardless of age, culture, ethnicity, gender, race, socioeconomic status, or geographic location, from the health effects of air pollution.

Environmental Protection Agency (USEPA): The United States agency charged with setting policy and guidelines, and carrying out legal mandates for the protection of national interests in environmental resources.

Federal Clean Air Act (CAA): A federal law passed in 1970 and amended in 1977 and 1990 which forms the basis for the national air pollution control effort. Basic elements of the act include national ambient air quality standards for major air pollutants, air toxics standards, acid rain control measures, and enforcement provisions.

Fugitive Dust: Dust particles which are introduced into the air through certain activities such as soil cultivation, off-road vehicles, or any vehicles operating on open fields or dirt roadways.

Fugitive Dust Control Plan: A document that describes fugitive dust sources at a site and the corresponding control measures.

Growth Management Plan: A plan for a given geographical region containing demographic projections (i.e., housing units, employment, and population) through some specified point in time, and which provides recommendations for local governments to better manage growth and reduce projected environmental impacts.

Hybrid Vehicles: Hybrid electric motor vehicles may operate using both electric and gasoline-powered motors. Emissions from hybrid electric motor vehicles can be substantially lower than conventionally powered motor vehicles.

Indirect Source: Any facility, building, structure, or installation, or combination thereof, which generates or attracts mobile source activity that results in emissions of any pollutant (or precursor) for which there is a state ambient air quality standard. Examples include employment sites, shopping centers, sports facilities, housing developments, airports, commercial and industrial development, and parking lots and garages.

Jobs/Housing Balance (Jobs/Housing Ratio): The availability of housing for employees. The jobs/housing ratio divides the number of jobs in an area by the total number of dwelling units. Jobs/housing balance is an indicator of the number of residents in an area that must travel outside their commute-shed for work. No jobs/housing ratio is recognized in state, regional or local plans and policies. However, SCAG considers South Coast Air Basin communities to be jobs –rich if they have more than 1.29 jobs per dwelling unit, and housing-rich if they have less than 1.0 jobs per household.

Land Use Recycling: Changing historic land uses to meet the changing needs and priorities of a community. For example, commercial or industrial land areas that are "recycled" to housing, mixed use or institutional use in order to facilitate and be consistent with the current and future needs of a community.

Lead: A gray-white metal that is soft, malleable, ductile, and resistant to corrosion. Sources of lead resulting in concentrations in the air include industrial sources and crystal weathering of soils followed by fugitive dust emissions. Health effects from exposure to lead include brain and kidney damage and learning disabilities. Lead is the only substance which is currently listed as both a criteria air pollutant and a toxic air contaminant.

Maximum Achievable Control Technology (MACT): Federal emissions limitations based on the best demonstrated control technology or practices in similar sources to be applied to major sources emitting one or more federal hazardous air pollutants.

Mixed Use: Properties on which various uses such as office, commercial, institutional, and residential are combined in a single building or on a single site in an integrated development project with significant functional interrelationships and a coherent physical design. A "single site" may include contiguous properties.

Mobile Sources: Sources of air pollution such as automobiles, motorcycles, trucks, off-road vehicles, boats and airplanes (contrast with stationary sources).

National Ambient Air Quality Standards (NAAQS): Standards established by the USEPA that apply for outdoor air throughout the country. There are two types of NAAQS. Primary standards set limits to protect public health and secondary standards set limits to protect the environment and public welfare.

New Source Review (NSR): A program used in development of permits for new or modified industrial facilities which are in a non-attainment area, and which emit non-attainment criteria air pollutants. The two major requirements of NSR are Best Available Control Technology and Emissions Offset.

Nitrogen Oxides: Oxides of Nitrogen, NO_x. A general term pertaining to compounds of nitric acid (NO), nitrogen dioxide (NO_2), and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes, and are major contributors to smog formation and acid deposition. NO_2 is a criteria air pollutant, and may result in numerous adverse health effects. It absorbs blue light, resulting in a brownish-red cast to the atmosphere and reduced visibility.

Non-Attainment Area: A geographic area identified by the USEPA and/or CARB as not meeting either NAAQS or CAAQS standards for a given pollutant.

Opacity Regulations: Rules, laws, and regulations that require the measurement of the amount of light obscured by particle pollution in the atmosphere and limit the amount of allowable emissions from pollution sources. Opacity is used as an indicator of changes in performance of particulate control systems.

Ozone: A strong smelling, pale blue, reactive toxic chemical gas consisting of three oxygen atoms. It is a product of the photochemical process involving the sun's energy. Ozone exists in the upper atmosphere ozone layer as well as at the earth's surface. Ozone at the earth's surface causes numerous adverse health effects and is a criteria air pollutant. It is a major component of urban smog.

Paratransit: Transportation systems such as jitneys, car pooling, van pooling, taxi services and dial-a-ride services..

Particulate matter (PM): Solid or liquid particles of soot, dust, smoke, fumes, and aerosols.

- **Particulate Matter less than 10 microns (PM_{10}) in size:** A major air pollutant consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and aerosols. The size of the particles (10 microns or smaller, about 0.0004 inches or less) allows them to easily enter the air sacs in the lungs where they may be deposited, resulting in adverse health effects. PM_{10} also causes visibility reduction and is a criteria air pollutant.

- **Particulate Matter less than 2.5 microns ($PM_{2.5}$) in size:** A major pollutant consisting of tiny solid or liquid particles, generally soot and aerosols. The size of the particles (2.5 microns or smaller, about 0.0001 inches or less) allows them to easily enter the air sacs deep in the lungs where they may cause adverse health effects, as noted in several recent studies. $PM_{2.5}$ also causes visibility reduction.

Permit: Written authorization from a government agency (e.g., air quality management district) that allows for the construction and/or operation of an emissions generating facility or its equipment within certain specified limits.

Redevelop: To demolish existing buildings; or to increase the overall floor area existing on a property; or both; irrespective of whether a change occurs in land use.

Rezoning: An amendment to the map and/or text of a zoning ordinance to effect a change in the nature, density, or intensity of uses allowed in a zoning district and/or on a designated parcel or land area.

Sensitive Receptor (Sensitive Individual): Those segments of a population such as children, athletes, elderly, and sick that are more susceptible to the effects of air pollution than the population at large.

Sensitive Sites: Land uses where sensitive receptors are most likely to spend time, including schools and schoolyards, parks and playgrounds, day care centers, nursing homes, hospitals, and residential communities.

Setback: In zoning parlance, a setback is the minimum amount of space required between a lot line and a building line.

State Implementation Plan (SIP): A document prepared by each state describing existing air quality conditions and measures which will be taken to attain and maintain national ambient air quality standards (see AQMP).

Smog Check Program: A motor vehicle inspection program implemented by the California Bureau of Automotive Repair. It is designed to identify vehicles in need of maintenance and to assure the effectiveness of their emission control systems on a biennial basis. Enacted in 1979 and strengthened in 1990.

Station Car: A vehicle that operates at transit stations for the use of patrons of these transit services. The availability of station cars facilitates and encourages the use of mass transit systems.

Stationary Sources: Non-mobile sources such as power plants, refineries, and manufacturing facilities which emit air pollutants.

South Coast basin: Includes all of Orange county and the non-desert portions of Los Angeles, Riverside and San Bernardino counties.

Sulfur Dioxide (SO_2): A strong smelling, colorless gas that is formed by the combustion of fossil fuels. Power plants, which may use coal or oil high in sulfur content, can be major sources of SO_2. SO_2 and other sulfur oxides contribute to the problem of acid deposition. SO_2 is a criteria pollutant.

Toxic Air Contaminant (TAC): An air pollutant, identified in regulation by the CARB, which may cause or contribute to an increase in deaths or in serious illness, or which may pose a present or potential hazard to human health. TACs are considered under a different regulatory process (California Health and Safety Code section 39650 et seq.) than pollutants subject to CAAQS. Health effects due to TACs may occur at extremely low levels, and it is typically difficult to identify levels of exposure which do not produce adverse health effects.

Transportation System Management (TSM): A comprehensive strategy developed to address the problems caused by additional development, increased vehicle trips, and a shortfall in transportation capacity. Transportation Systems Management focuses on more efficiently utilizing existing highway and transit systems rather than expanding them. TSM measures are characterized by their low cost and quick implementation time frame, such as computerized traffic signals, metered freeway ramps, and one-way streets.

Visibility: A measurement of the ability to see and identify objects at different distances. Visibility reduction from air pollution is often due to the presence of sulfur and nitrogen oxides, as well as particulate matter.

Zero Emission Vehicles (ZEV): Vehicles which produce no emissions from the on-board source of power (e.g. an electric or fuel cell vehicle).

APPENDIX A

CITIES AND COUNTIES WITHIN THE SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT THAT HAVE ADOPTED AIR QUALITY ELEMENTS IN GENERAL PLANS

&

EXAMPLE AIR QUALITY ELEMENTS*

*FOR ADDITIONAL EXAMPLES OF AIR QUALITY ELEMENTS LISTED IN ATTACHMENT A, PLEASE CONTACT LOCAL GOVERNMENTS DIRECTLY.

Cities and Counties within the South Coast Air Quality Management District that have Adopted Air Quality Elements in General Plans

City/County	Date	City/County	Date
Agoura Hills	1994	Laguna Hills	2002
Baldwin Park	2002	Lakewood	1996
Buena Park	1994	Lawndale	1992
Calabasas	1995	Long Beach	1998
Carson	1994	Los Angeles	1992
Cathedral City	2002	Montclair	1999
Cerritos	2002	Palm Desert	1980
Chino	1991	Palm Springs	1993
Colton	1992	Rancho Cucamonga	2001
Commerce	1991	Rancho Mirage	1997
Cudahy	1992	Rancho Palo Verdes	1975
Cypress	2001	Redlands	1995
El Segundo	1992	Riverside County	1995
Fontana	1990	San Bernardino County	1989
Garden Grove	1995	Santa Clarita	1991
Glendale	1994	South Gate	1993
Grand Terrace	1999	Temecula	1993
Hemet	1992	Upland	1991
Huntington Beach	1996	Walnut	1974
Indian Wells	1996	West Hollywood	1988
La Cañada-Flintridge	1995	Whittier	1993
La Habra	1992	Yorba Linda	1993
La Quinta	2002	Yucaipa	1992

Source – The California Planners' Book of Lists 2004: Governor's Office of Planning and Research

AIR QUALITY ELEMENT

EXAMPLE #1

CITY OF CHINO

CITY OF CHINO

AIR QUALITY ELEMENT

City Council

Fred Aguiar, Mayor
Diane J. Erwin, Mayor Pro Tem [1]
Richard Sawhill, Council Member
Eunice Ulloa, Council Member
Al Yankey, Council Member

City Manager

Richard D. Rowe

Planning Commission

Emil Torkar, Chairman
Pete Garcia, Vice Chairman
Reva Salter
Fred Nerio
Cal Morey
Earl C. Elrod
Kristi Smith

Prepared By

Community Development Department
Earl P. Nelson, A.I.C.P., Director of Community Development
Brent Arnold, Associate Planner

November 1991

[1] City of Chino's Policy Committee Representative to the San Bernardino County, Regional Air Quality Plan.

RESOLUTION NO. 91-100

A RESOLUTION OF THE CHINO CITY COUNCIL AMENDING THE GENERAL PLAN TO INCLUDE AN AIR QUALITY ELEMENT AND REVISIONS TO THE CIRCULATION AND CONSERVATION/OPEN SPACE ELEMENTS TO ENSURE CONSISTENCY WITH THE AIR QUALITY ELEMENT. GENERAL PLAN AMENDMENT NO. 128.

WHEREAS, a draft Air Quality Element has been prepared in accordance with state law governing the content and intent of the General Plan Element, which includes the attached addendum of requested modifications for City Council action; and

WHEREAS, community workshops were held on October 21 and November 4, 1991 to receive citizen input and encourage citizen participation in the formulation of the Air Quality Element and its proposed goals, policies, and action programs; and

WHEREAS, the Development Review Committee reviewed the Element and recommended a Negative Declaration for the project; and

WHEREAS, the City Council discussed the Draft Air Quality Element at a regular hearing date on November 19, 1991, for the purpose of receiving public input; and

WHEREAS, the City Council recognizes the vital role that local governments must play in the attainment of state and federal air quality standards; and

WHEREAS, the City of Chino is committed to achieving healthful air standards in the City and other parts of the South Coast Air Basin at the earliest possible date; and

WHEREAS, the proposed Air Quality Element is the result of an extensive, cooperative effort between the County and 15 cities in San Bernardino County.

WHEREAS, the 1991 Air Quality Management Plan directs local governments to assume responsibility for implementation of 24 of the 126 control measures contained in the Plan, three of which expressly call for the adoption of an air quality element or its equivalent by local governments; and

WHEREAS, the Air Quality Management Plan calls for local government to take actions that will achieve an 8% region-wide reduction of reactive organic gases and oxides of nitrogen; and

WHEREAS, the General Plan is subject to amendment whenever conditions, study, public interest, and/or practices indicate such amendments to be in the interest of the public health, safety and welfare; and

Resolution No. 91-100
Page 2

WHEREAS, state law authorizes cities and counties to include an air quality element or its equivalent as part of their General Plan; and

WHEREAS, the Air Quality Element is designed to promote the health, safety and welfare of the public by seeking attainment of state and federal ambient air standards; and

WHEREAS, environmental documentation has been completed in accordance with the California Environmental Quality Act and local environmental guidelines; and

WHEREAS, the City Council has determined that the following conditions for self-certification have been met:

1. Consistency with the Regional Air Quality Management Plan

2. Consistency with the Regional Mobility Plan

3. Consistency with the Regional Growth Management Plan

4. Consistency with the Regional Housing Needs Assessment

WHEREAS, on November 4, 1991, the Planning Commission duly held a public hearing to consider the recommended Air Quality Element and public testimony with the following amendments to the Circulation and Conservation/Open Space Elements of the General Plan.

CIRCULATION ELEMENT

1. Page I-4, Policy 4: "The parking supply should be, to the maximum extent possible, managed in a fashion to encourage a reduction in single occupant vehicles utilizing parking facilities."

2. Page II-24, Parking 2B: "Off-street parking shall be provided in a manner to encourage multiple occupant vehicle use."

CONSERVATION/OPEN SPACE

1. The following actions located in the Implementation Table on page V-74 of the Conservation/Open Space Element shall delete all reference to the responsible

Resolution No. 91-100
Page 3

Agency/Department required to implement said action and all reference to time for action implementation. In place of these activities the timing column of the table shall read:

Conservation/Open Space Actions	Corresponding CAQE Actions
A5-2.1.1	A8-2.1.5*
A5-2.2.1	A8-5.1.2 and A8-5.1.4*
A5-2.3.1	A-5.1.2 and A8-5.1.4*

*Include in Time Information Column of Conservation/Open Space Element Implementation Table

In addition, action A5-7.3.1 shall be amended as requested by the Public Works Department.

2. Require High Pressure Sodium Vapor Lamps (HPSV). The City shall pursue the feasibility of requiring high sodium vapor lamps for all street lights and public parking lots.

WHEREAS, the proposed changes to the General Plan are reasonable and beneficial at this time because they will make the Chino General Plan Elements consistent with each other.

NOW, THEREFORE, BE IT RESOLVED, the Chino City Council approves the Air Quality Element of the Chino General Plan.

APPROVED and ADOPTED this 19th day of November, 1991.

Fred Aguiar
Mayor, City of Chino

ATTEST:

K A Blewm
City Clerk, City of Chino

Resolution No. 91-542
Page 4

State of California)
County of San Bernardino) §
City of Chino)

I, Kathleen A. Blomo, Chino City Clerk, hereby certify the foregoing Resolution of the City of Chino was duly adopted by said City Council at a regular meeting held on the 19th day of November, 1991, by the following vote:

AYES:	COUNCIL MEMBERS	AGUIAR, ERWIN, SAWHILL, YANKEY
NOES:	COUNCIL MEMBERS	NONE
ABSENT:	COUNCIL MEMBERS	ULLOA

K A Blomo
City Clerk, City of Chino

Chapter VIII Air Quality

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Chapter VIII Air Quality

Introduction

Why Prepare an Air Quality Element?

Southern California has the worst air pollution in the nation. Almost every day, smog stretches from the beach cities in Orange and Los Angeles Counties to the inland valleys of Riverside and San Bernardino Counties. The brown haze affects the health and scenic views of the approximate 12 million people who live within the 13,350 square mile region. This region is known as the South Coast Air Quality Management District (SCAQMD) (see Figure 1, page VIII-4).

With the aim of complying with all federal standards by 2007, the South Coast Air Quality Management District (SCAQMD) and Southern California Association of Governments (SCAG) jointly prepared the 1989 Air Quality Management Plan (AQMP). The AQMP calls upon local governments to achieve an 8% reduction region-wide in emissions from reactive organic gases and oxides of nitrogen. Specifically, local governments are asked to implement appropriate control measures contained in the AQMP to achieve this reduction. Each Control measure that is required for local jurisdiction implementation is noted in parentheses, i.e., (AQMP Control Measure No. 2.a.) at the end of the action which addresses that particular measure. Local governments are required to address air quality strategies comprehensively in the General Plan. The adoption of an Air Quality Element is recognized as a decisive method for satisfying this requirement.

Air Quality and Southern California

The primary influence on air quality in Southern California is our climate and topography. Our climate features warm sunshine and soft easterly sea breezes. Our topography consists of a desert-like terrain bounded by the Pacific Ocean on the west and mountains on the north and east. These characteristics help create an inversion layer trapping pollutants within the basin region. Air quality in the South Coast Air Basin, as a whole, is characterized by high levels of ozone (O_3), carbon monoxide (Co), nitrogen dioxide (No2) and particulate matter (PM10) (see Figures 2, 3, 4, 5 on pages VIII-5,-6,-7,-8).

The source of our air pollution problem is directly related to how we perform many daily activities, predominantly related to driving in an automobile. The motor vehicle, frequently with a single occupant, parked on a gridlock freeway, is responsible for about half of our air pollution. The other half is caused by stationary sources.

San Bernardino County regularly exceeds state and federal air quality standards for ozone, carbon monoxide, nitrogen dioxide, and particulate matter (see Table 1, page VIII-9). Violations of state and federal standards are acute during summer months when on-shore wind patterns transport pollutants from the western portion of the South Coast Air Basin--notably Los Angeles and Orange Counties--and combine with local emission sources in San Bernardino County to create some of the nation's worst air quality (see Figure 6, page VIII-10).

Chapter VIII — Air Quality

The last complete basin inventory was developed by the Air Quality Management District as part of the 1989 Air Quality Management Plan development process. The relative contribution of sources within San Bernardino County varies somewhat for each pollutant, but is well under 10% of the basin for each of the four criteria pollutants shown in Table 2, page VIII-11. The ability of the County, as a whole, to significantly influence air quality is limited by the fact that the County and the City of Chino currently contribute so little air pollution within the basin.

Southern California, as well as San Bernardino County, stands at a turning point in history. The growth of this region has made it the eleventh largest economic center in the world. In the next 20 years, the region's current population will grow by one third. Yet, with prosperity and growth also comes undesirable side effects. The freeways are extremely congested, housing prices continue to rise, and most of the region suffers from the effects of air pollution.

A new age of planning and cooperation will be needed to manage the projected growth in the region. Land use planning must emphasize air quality issues by understanding and coordinating the linkages between growth, housing, jobs, traffic, and air quality.

Difficult choices will be required by local governments if the region is to stay on a course which will guide us to cleaner air. This course is far different from before. The new approach will require a stronger commitment to regional goals, which often contrast individual goals, by local government, business, and citizens. It will also require cooperation among local governments when issues cross jurisdictional boundaries.

Cooperative Approach

Beginning in early 1990, Chino participated with the County of San Bernardino and 15 other cities within the County to meet its responsibilities of preparing an Air Quality Element as outlined in the Air Quality Management Plan (AQMP). By doing so, the City made its first formal contribution to air quality planning since the district's creation of the AQMP.

San Bernardino County/cities, in recognition of the inter-jurisdictional nature of air quality, as individual entities, united to prepare a Regional Air Quality Plan. The plan set up a framework which provides participating jurisdictions with the necessary information to develop their own local air quality elements. The document layed out certain goals, policies, and action programs which were arrived at by appointed technical and policy committee members of the participating jurisdictions. Each jurisdiction agreed to adopt the basic goals and policies into their City's General Plan. The goals, policies, and actions in this document are derived from the Regional Air Quality Element and input by members of the Planning Commission and City Council, and various City staff.

Legal Mandate

State and Federal air quality legislation establishes roles and responsibilities for several agencies. Table 3 (page VIII-12) identifies the various air quality planning agencies and their primary responsibilities. Most of local governments' responsibilities relate to their land use planning authority.

The extent of legal obligation on the part of local government to meet air quality standards mandated at the state and federal levels has not been clearly resolved. The federal government has clearly stated its intent to withhold certain funds to the region, or a local agency, if significant steps to meet federal air quality standards are not taken. This is one reason why establishment of local commitments are most appropriately accomplished in an expeditious and cooperative manner.

The SCAQMD and SCAG highly recommend adoption of an air quality element and/or amending the general plan to include air quality considerations. Conversely, adoption of a general plan element or amendment will not, in and of itself, meet local government responsibilities. The key is to translate air quality policy statements into actions--that is the challenge that must be met by Chino and other communities within the air basin.

Relationship to Other General Plan Elements

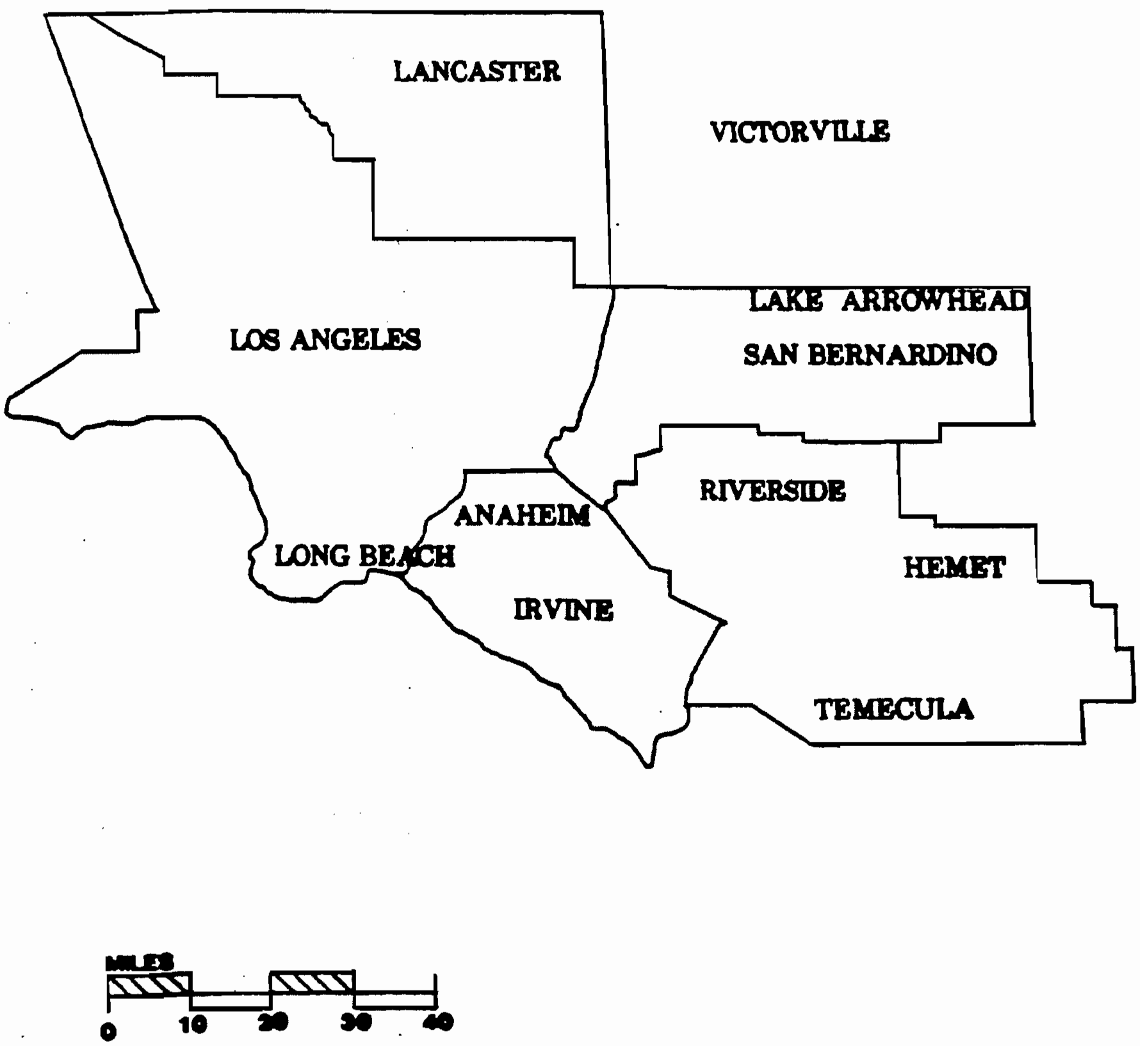
In determining the relationship of the air quality element to other general plan elements, it is appropriate to remind the reader of the relationship between growth, housing, jobs, circulation, and air quality noted before. Implementation of the Housing, Land Use, and Circulation Elements have a profound impact on the type and amount of air quality impacts which may occur. These elements provide goals and policies which influence housing supply, housing density, jobs, and the necessary backbone infrastructure to support growth in jobs and housing. Likewise, the Open Space/Conservation Element provides goals and policies about energy conservation and air quality.

Citizen Participation

The City of Chino encourages citizen input on development of general plan goals, policies, and actions programs. Public workshops were held in October and November of 1991 before the Planning Commission and City Council. The purpose of the workshops were to discuss the air quality element, and ask for public input from community residents and other interested parties.

FIGURE 1

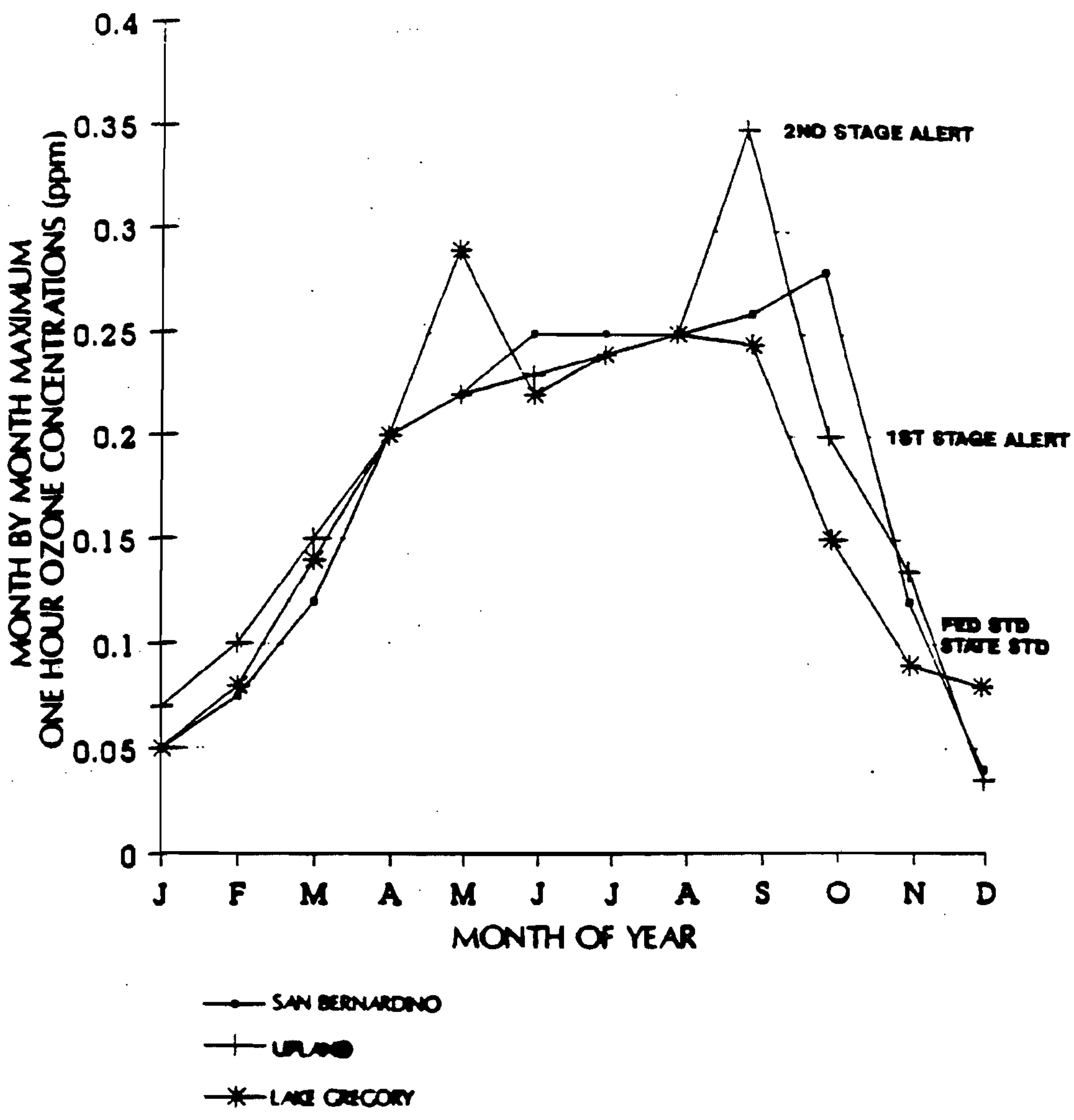
South Coast Air Quality Management District



Source: Regional Air Quality Plan EIR - San Bernardino County/Cities

FIGURE 2

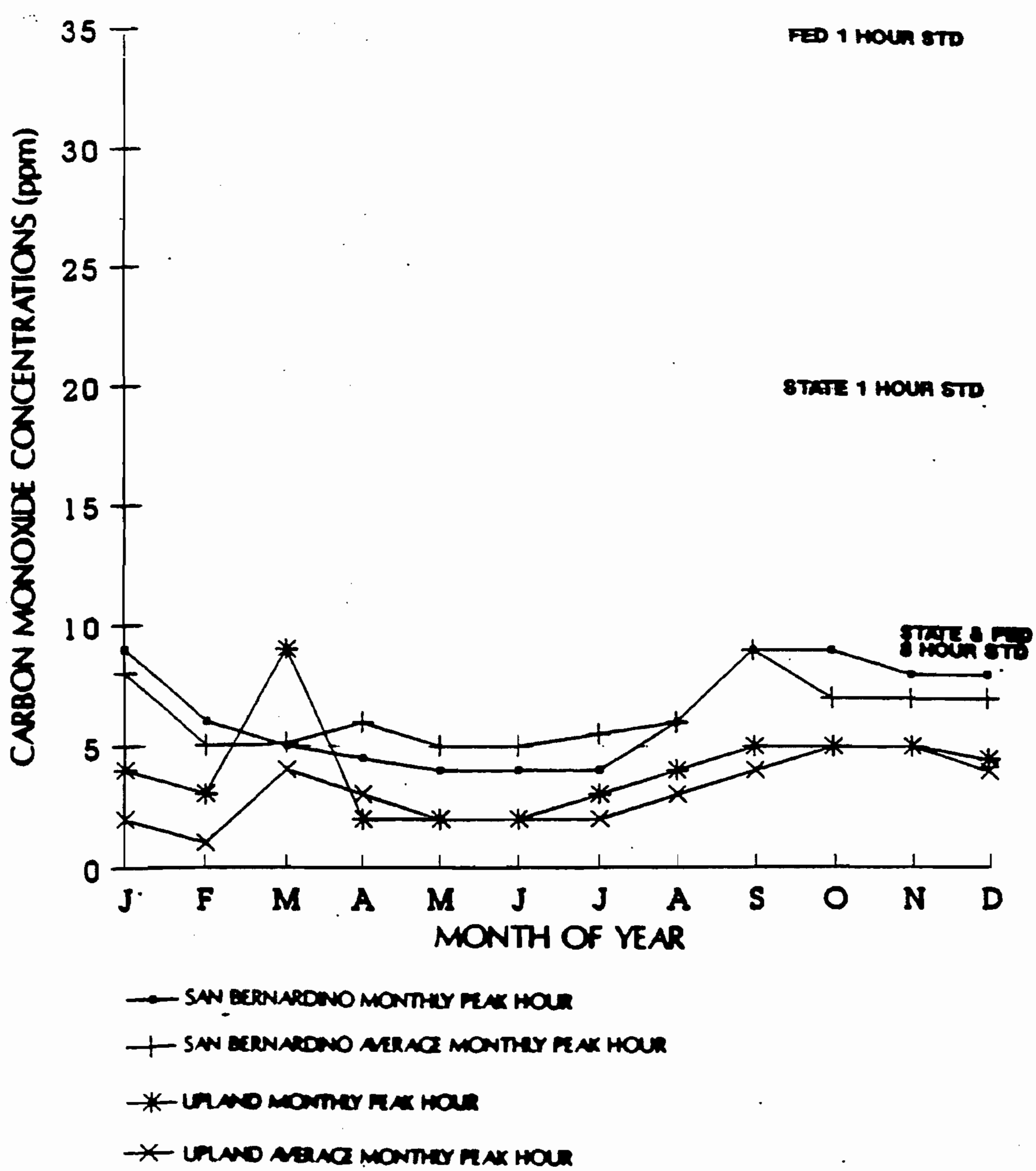
Annual Variation in San Bernardino County Ozone Exposure (1988)



Source: Regional Air Quality Plan EIR - San Bernardino County/Cities

FIGURE 3

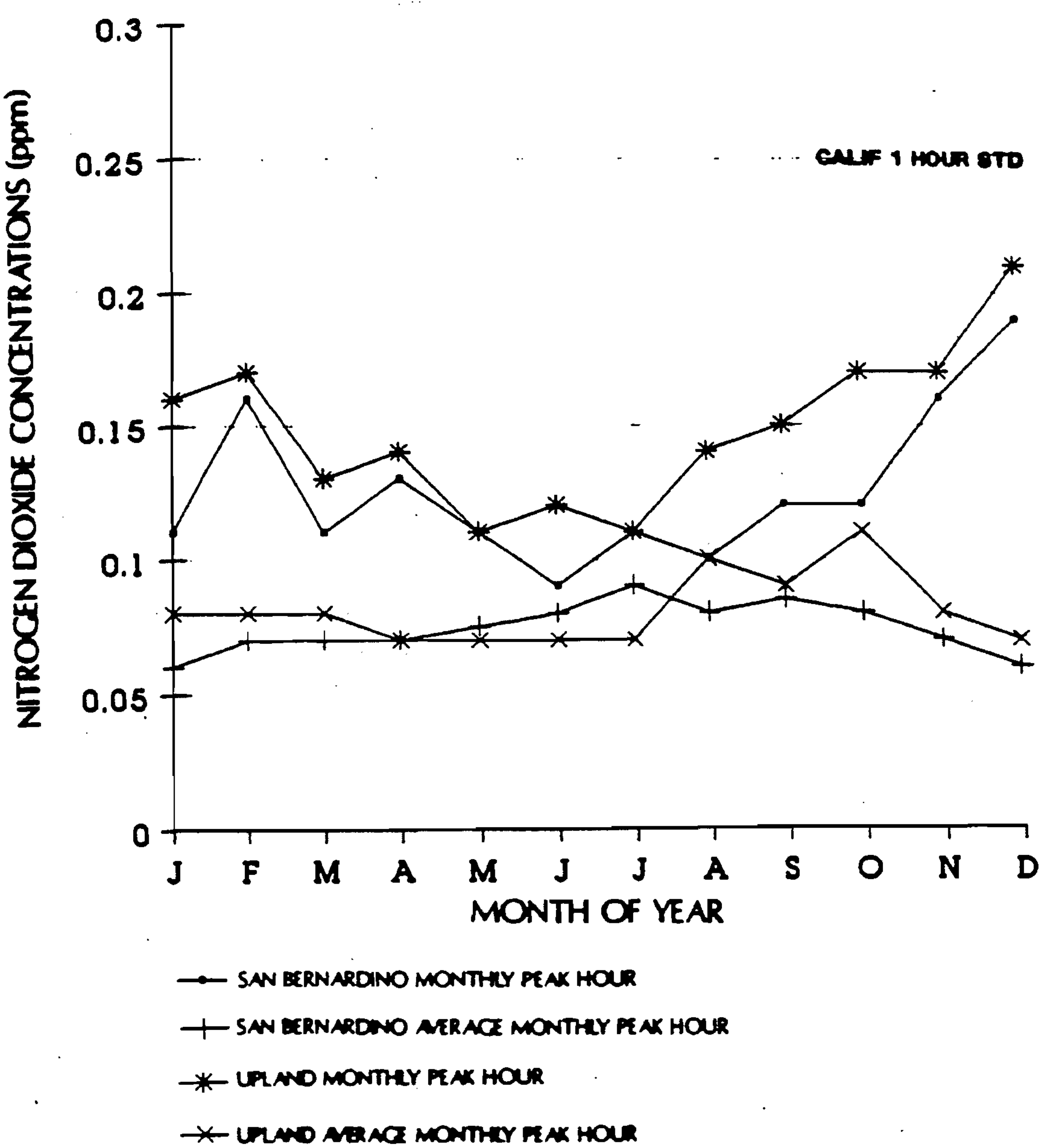
San Bernardino County Carbon Monoxide Levels



Source: Regional Air Quality Plan - San Bernardino County/Cities

FIGURE 4

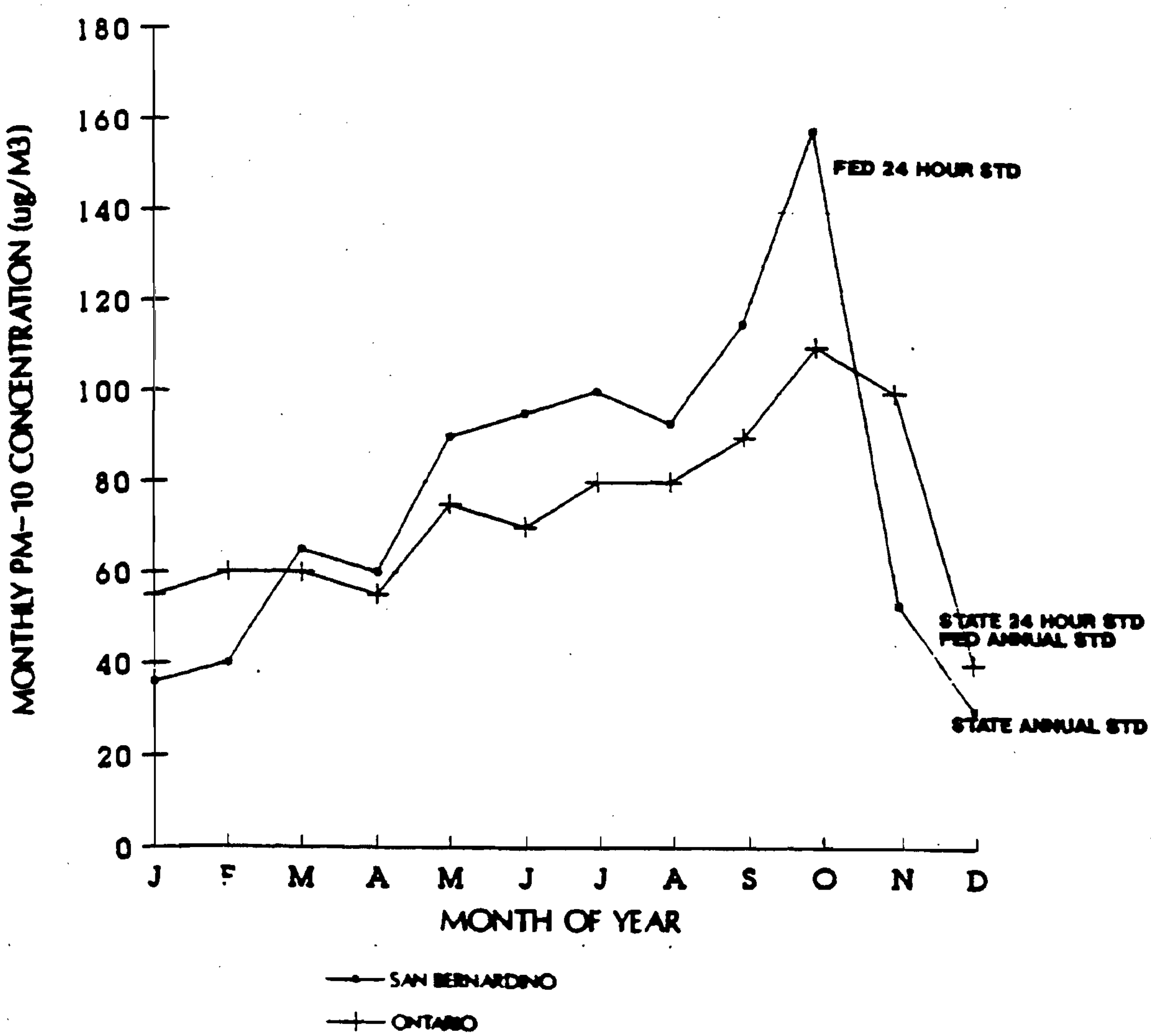
San Bernardino County Nitrogen Dioxide Levels



Source: Regional Air Quality Plan EIR - San Bernardino County/Cities

FIGURE 5

Particulate (PM-10) Levels



Source: Regional Air Quality Plan EIR - San Bernardino County/Cities

TABLE 1

Percent of Days Exceeding Federal Standards and Maximum Concentrations

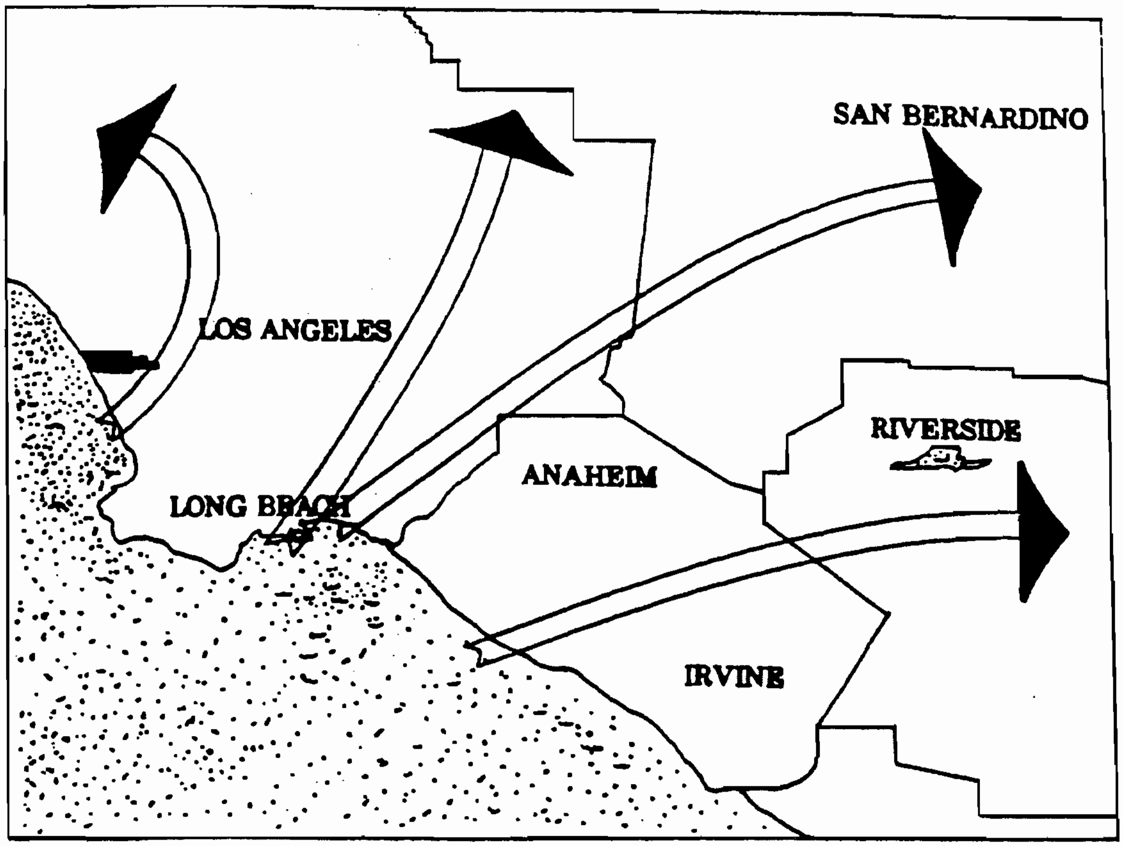
Pollutant	Standard	Upland	San Bernardino	Crestline
Ozone	1 Hour > 0.12 ppm	27%	32%	35%
	Max 1 Hour Conc. (ppm)	0.32	0.30	0.27
Carbon Monoxide	1 Hour > 35. ppm	0%	0%	ND
	8-Hour > 9. ppm	0%	0%	ND
Nitrogen Dioxide	Annual Avg. > 0.05 ppm	No	No	ND
	Annual Avg. (ppm)	0.045	0.041	ND
Respirable Particulates	24-Hour > 150 ug/m3	7%	5%	0%
	Max. 24-Hour Conc. (ug/m3)	254.*	271	87.

* = Data from Ontario Airport area, no measurement at Upland.
ND = No Date, no measurements at this site.

Source: Air Quality Management District 1989.

FIGURE 6

Airflow Patterns in the South Coast Air Basin
Influencing Pollutant Emission Migration



Source: Regional Air Quality Plan EIR - San Bernardino County/Cities

TABLE 2

County Share of Basinwide Pollutant Emission Burden (%)

Pollutant	1985	1990	2000	2010
ROG	8.7	9.6	10.3	10.6
NOx	8.2	9.2	10.6	11.0
CO	7.5	9.0	10.9	11.4
PM-10	8.6	8.7	8.9	9.0

ROG = Reactive Organic Gas
NOx = Nitrogen Dioxide
CO = Carbon Monoxide
PM-10 = Suspended Particulates

Source: Regional Air Quality Plan, San Bernardino County/Cities. Technical Background Report.

TABLE 3

Agencies' Responsibilities in Air Quality Planning

Agency	Level of Government	Enabling Legislation	Responsibilities
EPA	Federal	Clean Air Act [2]	Establishes NAAQS. Approves SIP. Levies sanctions against nonattainment areas.
ARB	State	Federal Clean Air Act California Clean Air Act [3]	Prepares and submits SIP to EPA. Reviews regional plans to ensure every reasonable TCM action is taken to achieve standards at earliest practicable date. [4] Emission standards for mobile sources.
SCAG	Local	Federal Clean Air Act California Clean Air Act	Submits annual progress report to EPA and ARB. Responsible for transportation and land use measures. [5]
SCAQMD	Local		Adopt, implement, and enforce transportation control measures. [6]
CITY/COUNTY	Local		Implement land use and transportation control measures.

Source: Regional Air Quality Plan, San Bernardino County/Cities.

2 Amended in November, 1990.

3 AB 2595 Sher Act, 1988.

4 Health and Safety Code, Section 41503.5.

5 Health and Safety Code, Section 40717 (b-(b-f).

6 Health and Safety Code, Section 40716-17.

Government Organization, Roles and Responsibilities

Introduction

Air pollution in the South Coast Air Basin follows no precise boundaries. Its physical location is constantly shifting with seasonal meteorological conditions. This characteristic makes regulating air pollution most appropriately influenced by local government at a regional level.

Technical Information

San Bernardino County is a source area for air pollutants primarily during the winter months when emissions of nitrogen oxide and carbon monoxide travel westward, helping to create unhealthful levels of pollutants in Los Angeles and Orange Counties. During summer months, on-shore winds transport pollutants from the western portion of the basin (notably Los Angeles and Orange Counties) into San Bernardino County. These pollutants combine with local emission sources to create some of the nation's worst air quality. However, San Bernardino County is responsible for less than 10% of the South Coast Air Basin's pollutant emissions (see Table 2, page VIII-11).

Air quality in the South Coast Air Basin as a whole is characterized by high levels of ozone (O_3), carbon monoxide (Co), nitrogen dioxide (No2) and particulate matter (PM10). San Bernardino County is in attainment with federal standards for carbon monoxide and nitrogen dioxide (No2). However, the primary source areas for ozone and particulate emissions are Los Angeles and Orange Counties. This makes it very difficult to directly effect improvements in these pollutants, especially when combined with the wind flow influences discussed in the introduction.

Issues

Although San Bernardino County generates only 10% of the total emissions basin-wide, its residents are exposed to significantly greater health risks than other residents within the basin. San Bernardino County pays a high price for poor air quality. The ill effects of air pollution include: poor health, damage to property, landscaping, agriculture, and livestock; impaired visibility; all of which result in a reduction in the quality of life.

The following goals, policies and actions will aid the City of Chino in improving regional air quality by developing a coordinated approach with other agencies in San Bernardino County and the south coast air basin.

GOALS, POLICIES, AND ACTIONS

GOAL G8-1

Air Quality Improvement.

To achieve coordination of air quality improvement within the portion of the South Coast Air Basin in San Bernardino County and improved air quality through reductions in pollutants from Orange, Riverside and Los Angeles Counties.

POLICY P8-1.1

Establish a Coordinated Approach.
Coordinate with other jurisdictions in San Bernardino County to establish parallel air quality plans and implementation programs.

ACTION A8-1.1.1

Coordinated Review.
Work with the Planning Director's Committee of San Bernardino County to provide coordinated review and response to project proposals, etc., effecting air quality within the San Bernardino County portion of the South Coast Air Quality Management District.

ACTION A8-1.1.2

AQMP Regional Financing.
Work on regional financing of AQMP control measures by influencing San Bernardino Associated Governments, the South Coast Air Quality Management District, and other agencies to provide economic assistance for implementation of the measures.

ACTION A8-1.1.3

Local Input.
Participate in establishing an ongoing air quality implementation and development project referral process within the San Bernardino County portion of the South Coast Air Basin, adapting it as necessary to local circumstances, resources, and procedures.

POLICY P8-1.2

Integrate with Related Programs.
Cooperate in establishing a process to integrate air quality programs, implementation, monitoring, and reporting which will affect air quality improvements in San Bernardino County.

ACTION A8-1.2.1

Implement Congestion Management Plan.
Participate with San Bernardino Associated Governments (SANBAG) to create and implement the Congestion Management Plan (CMP).

ACTION A8-1.2.2

Establish Regional Transportation Management Agencies.
Participate with other agencies/organizations to establish regional and sub-regional Transportation Management Agencies (TMA's) which may include Chino Hills, Ontario, Montclair, and San Bernardino County (AQMP Control Measure No. 2.a.).

ACTION A8-1.2.3

OmniTrans/RTD - Transit Improvements.
Work with OmniTrans/RTD/OCTD to improve transit within Chino and San Bernardino County. (AQMP Control Measure No. 2.g.)

POLICY P8-1.3

Affect Source Jurisdictions.
Cooperate actively with Los Angeles, Orange, and Riverside counties to comprehensively improve air quality at the emission source.

ACTION A8-1.3.1

Communication Network.

Participate in a joint communications network for the purpose of improving regional air quality through interagency program development and implementation, such as vanpools between neighboring cities and sharing costs of the capital outlay for such activities.

ACTION A8-1.3.2

Lobby Other Entities to Implement AQMP.

Directly lobby local agencies and private entities to comply with the AQMP.

POLICY P8-1.4

Encourage Community Participation.

Involve environmental groups, the business community, special interests, and the general public in the formulation and implementation of programs which effectively reduce air borne pollutants.

ACTION A8-1.4.1

Public Participation Programs.

Prepare public participation programs which target City residents, businesses, and industries for the purpose of educating them about how they can reduce air pollution.

ACTION A8-1.4.2

Educate Local Businesses.

Work with the Chamber of Commerce to educate and incorporate AQMP programs and Chino Air Quality Element actions into local business activities.

ACTION A8-1.4.3

Obtaining Public Input.

Gain public input during implementation of the City's Air Quality Element and SCAQMD's Air Quality Management Plan.

ACTION A8-1.4.4

Homeowner's Association/Neighborhood Groups.

Work with Homeowner's Associations and neighborhood groups to encourage implementation of the AQMP and Chino Air Quality Element.

POLICY P8-1.5

Support Innovative Approaches.

Advocate and support innovative strategies to improve air quality.

ACTION A8-1.5.1

Tier III Implementation.

Support Tier III implementation of the AQMP by supporting new technology which is not available today but will improve air quality in the future.

ACTION A8-1.5.2

Encourage Business/Research.

Support new approaches to improving air quality through encouraging business/research companies to utilize financing mechanisms provided by federal, state, and local sources.

ACTION A8-1.5.3

Support Creative Solutions.

Support agencies/organizations who provide creative solutions to improve air quality, such as auto buy-back programs and consumer product emissions fees.

ACTION A8-1.5.4
Regional Cooperation.
Cooperate with local and regional agencies by preparing a memorandum of understanding for obtaining the minimum pollutant emissions while maintaining the City's economic viability.

Ground Transportation

Introduction

San Bernardino County's residents commute by the tens of thousands to employment sites throughout Los Angeles and Orange Counties. Likewise, a large group of Chino residents commute out of the City to their work sites. They make this workday commute from a housing-rich to a job-rich area. This commuting pattern impacts transportation systems, which leads to traffic congestion.

Ground transportation related sources produce the largest amount of pollutant emissions in the South Coast Air Basin. These emissions are generated from about eight (8) million on-road vehicles. The vehicles are characterized by passenger cars, light duty trucks, medium duty vehicles, heavy duty vehicles, and motorcycles. In 1989, they travelled approximately 240 million miles within the basin.

One of the most important steps local governments can do to reduce pollutant emissions from mobile sources is to utilize programs which attract businesses that provide employment opportunities for their residents. Jobs/housing balance will be discussed in more detail in the land use section of this document. However, recognition of the linkage between land use, transportation, and air quality is crucial in bringing about a solution to the basin's air quality problem. Recognition of this linkage means understanding that residents of Chino, as well as the region, must make lifestyle changes to reduce demand on existing transportation systems.

Technical Information

Transportation related sources are responsible for most emissions of Co (96%) and NOx (72%) and for a significant amount of ROG (52%) and SOx (54%). Vehicular emissions of reactive organic gases (ROG) and carbon monoxide (Co) are higher at low speeds or idling, while nitrogen oxide (NOX) emissions increase with higher speeds and acceleration. Therefore, actions which reduce vehicle miles travelled must be combined with stringent tailpipe standards, better inspection, and vehicle maintenance programs to address pollutant emission reductions both locally and regionally.

The effects of travel distance and congestion have a profound effect on the amount of air pollutant emissions generated from ground transportation sources. The net effect is that vehicles (trips) which are driven longer distances for longer hours, result in increased amounts of pollutants. However, combining vehicle trips rather than a series of single destination trips create less pollutants, because vehicles emit more pollutants when they are cold.

Ridesharing, business induced transportation incentives/disincentives, modifying work schedules, tele-communication, and establishing transportation management agencies are some ways of reducing vehicular miles travelled (VMT). These actions mean riding together instead of riding alone; getting paid not to drive; and talking on the phone instead of driving; each inherently require changes in our day-to-day lifestyles.

These actions emphasize reducing pollutant emissions from ground transportation sources through reducing vehicle use (i.e., vehicle miles travelled (VMT) and number of trips). Reducing vehicle use means choosing another transportation mode, commute time of day, or whether to travel altogether.

The City prepared an analysis which assessed the feasibility of creating a Transportation Management Association (TMA) within a 430 acre business park and/or an adjacent 370 acre specific plan area. This analysis clearly showed that a TMA could be successful at some point in the future if both project areas were included.

Issues

Statistics compiled in the California Department of Transportation Travel Forecast Summary indicated that over 75% of those who travel from home to work in the Los Angeles region chose to drive alone. About 11% travelled from home to work with one other person; less than 7% utilized public transit.

Residents of the air basin must reduce their dependency on the single occupant vehicle to obtain cleaner air. Changing this commuting pattern is a monumental task and the primary issue with regard to ground transportation emission sources. Local government must take a leading role in this task.

The City has plans to assess the feasibility of establishing a Transportation Terminal in the downtown area. If established, it would provide a central location for transit services, commute activities, and shuttle services to commuter trains within the region.

The following goals, policies and actions will aid the City in obtaining a reduction in air pollutants from ground transportation sources and help to encourage the desired lifestyle changes.

GOALS, POLICIES, AND ACTIONS

GOAL G8-2

Ground Transportation.

To achieve a diverse and efficient ground transportation system which generates the minimum feasible pollutants.

POLICY P8-2.1

Eliminate Unnecessary Trips.

Use market incentives, regulations, and Transportation Demand Management in cooperation with other jurisdictions in the South Coast Air Basin to eliminate unnecessary vehicle trips which would otherwise be made.

ACTION A8-2.1.1

Neighborhood Services.

Examine the feasibility of adopting a zone ordinance amendment to permit essential services (postal, retail, convenience items, etc.) to be located in residential neighborhoods where these services are not within walking or bicycling distance.

ACTION A8-2.1.2

On-Site Services.

Examine the feasibility of providing services for civic center employees (i.e., cafeteria, banking, postal services, etc.) within walking distance.

ACTION A8-2.1.3

Trip Reduction Ordinance.

Adopt an ordinance requiring all employers within the City to reduce work trips by 12% by 1999, 20% by 2004 and 30% by 2010. This may be achieved through programs such as compressed work weeks, flex schedules, carpooling, and tele-communication, etc. (AQMP Control Measure No. 1.a. and 1.b.)

ACTION A8-2.1.4

Compliance with SCAQMD AVR.

Adopt an ordinance by 1994 requiring trip reduction plans to meet SCAQMD Average Vehicle Ridership (AVR) requirements (1.5) for facilities with tenants employing more than 100 employees and 25+ employees by 1995. (AQMP Control Measure No. 2.a.)

ACTION A8-2.1.5

Reduced Service During Stage 3 Smog Alerts.

Require City public facilities to operate at reduced staffing levels during Stage 3 smog alerts.

ACTION A8-2.1.6

Trip Reduction Program.

Implement a program which requires the City, as an employer, to reduce work trips by 12% by 1999, 20% by 2004 and 30% by 2010. This can be accomplished by requiring flex schedules, compressed work weeks, non-motorized transportation, carpooling, tele-communication, market incentives, etc. (AQMP Control Measure No. 1.a. and 1.b.)

POLICY P8-2.2

Reduce Vehicle Miles Travelled.

Use incentives, regulations and Transportation Demand Management in cooperation with other jurisdictions in the South Coast Air Basin to reduce the vehicle miles travelled for auto trips which still need to me made.

ACTION A8-2.2.1

Travel Demand Management.

Adopt an ordinance to require Travel Demand Management (TDM) programs for all new and existing developments. (AQMP Control Measure No. 2.b.)

POLICY P8-2.3

Improve Traffic Flow.

Improve traffic flow by implementing the state mandated Congestion Management Program (CMP), the AQMP, and other means to lessen roadway congestion.

ACTION A8-2.3.1

Congestion Management Plan (CMP).

Provide on-going participation in the CMP process within San Bernardino County.

ACTION A8-2.3.2

Adopt CMP Ordinance.

Adopt CMP ordinance by 1992 reflecting air quality goals, policies, and actions.

ACTION A8-2.3.3

Truck Routing/Deliveries.

Continue to require Truck Travel Demand Management Plans for commercial and industrial developments which include scheduling and routing of deliveries in conformance with this element. Companies with deliveries of a time-sensitive nature shall be required to submit plans which comply with the truck delivery restrictions where possible. (AQMP Control Measure No. 3.a.)

ACTION A8-2.3.4

Restrict Trucks from Major Arterials.

Adopt an ordinance restricting operating times for heavy duty vehicles on congested portions of major arterials during peak hours for deliveries which are not of a time sensitive nature. (AQMP Control Measure No. 3.a.)

ACTION A8-2.3.5

Traffic Signal Improvements.

Require interconnected signal control systems on all primary arterials including those which cross interjurisdictional boundaries. (AQMP Control Measure No. 4.)

ACTION A8-2.3.6

On-Street Parking During Peak Hours.

Eliminate peak hour on-street parking on arterials within the City. (AQMP Control Measure No. 2.b. and 4.)

ACTION A8-2.3.7

Surcharge for Truck Operations During Peak Periods.

Adopt an ordinance which establishes a surcharge and permit issuance procedures to permit the operation of commercial vehicles during periods of peak traffic congestion on congested portions of major arterials and establish a fine for those operating without a permit or not in compliance with their approved Truck Travel Demand Management Plans. (AQMP Control Measure No. 3.a.)

POLICY P8-2.4

Establish Fees.

Encourage market based incentives and disincentives to relieve peak hour/peak congestion within highly congested travel corridors in and adjacent to the City of Chino.

[Note: Future actions may be included under this policy if fees are determined to be needed for implementation of other Air Quality actions.]

POLICY P8-2.5

Expand Transit.

Cooperate in efforts to expand bus, rail, and other forms of transit in the portion of the South Coast Air Basin within San Bernardino County and the inter-county links to Los Angeles, Orange and Riverside counties.

ACTION A8-2.5.1

Sub-Regional Transportation System.
Lobby regional transportation agencies to expand regional transit systems between residential areas and employment centers in San Bernardino County.

ACTION A8-2.5.2

Auto Use Restrictions.
Require special event centers which have the ability to attract over 10,000 persons to operate park-n-ride facilities and enhance transit performance to venues within Chino. (AQMP Control Measure No. 2.e.)

ACTION A8-2.5.3

City Shuttle.
Develop a City shuttle between regional land uses, park-n-ride facilities, and neighborhoods.

POLICY P8-2.6

Promote Non-Motorized Transportation.
Provide bicycle and pedestrian pathways and facilities to encourage non-motorized trips.

ACTION A8-2.6.1

Bike Trails.
Continue to implement the Circulation Element goals and policies which provide bike and pedestrian trails between residential neighborhoods and employment and commercial areas. (AQMP Control Measure No. 1.b.)

ACTION A8-2.6.2

Merchant Transportation Incentives.
Examine the feasibility to adopt a non-work trip reduction ordinances which require large retail and business establishments to offer customer travel incentives and facilities for non-motorized transportation needs. (AQMP Control Measure No. 2.d.)

ACTION A8-2.6.3

Bicycle Parking and Showers.
Adopt an ordinance requiring commercial and industrial facilities to provide bicycle parking and shower facilities for riders. (AQMP Control Measure No. 1.b.)

POLICY P8-2.7

Manage Parking Supply.
Manage the parking supply for public and private development to discourage auto use, while ensuring that economic development goals are not impacted.

ACTION A8-2.7.1

Rideshare Incentives in Public Parking Lots.
Provide incentives for ridesharing and non-single occupancy vehicles for those vehicles who use public parking lots. (AQMP Control Measure No. 2.b.)

ACTION A8-2.7.2

Limit Parking Supply by Zone.
Adopt an ordinance establishing a cap on the number of parking spaces permitted per square foot for particular uses. (AQMP Control Measure No. 2.b.)

ACTION A8-2.7.3

Preferential Parking for Rideshares.

Adopt an ordinance which requires employers/developers to provide preferential parking for rideshares. (AQMP Control Measure No. 2.b.)

POLICY P8-2.8

Encourage Market Incentives/Disincentives.

Promote a regional approach to increasing parking costs in order to discourage low vehicle occupancy.

ACTION A8-2.8.1

Parking Cost Standards.

Work with other cities to establish standard parking costs to ensure that the City is not placed at an economic disadvantage with other communities. (AQMP Control Measure No. 2.b.)

POLICY P8-2.9

Support Legislation.

Lobby for state and federal legislation which would improve vehicle/transportation technology and establish differential pricing mechanisms to assess the true cost of emissions.

ACTION A8-2.9.1

Emission Fee.

Support State and Federal legislation which establishes emission fees on gasoline products.

ACTION A8-2.9.2

Emission Surcharge.

Adopt an ordinance increasing the bail for vehicles ticketed for air pollutant emissions violations.

ACTION A8-2.9.3

Support Tax Credit/Tax Benefit.

Support legislation which provides favorable tax credits or benefits for employers who purchase or lease vans for employee use, employers who sponsor work day use of clean fuel vehicles, and employees who use employer sponsored vanpools. (AQMP Control Measure No. 2.a.)

POLICY P8-2.10

Institute Clean Fuel Systems.

Invest in clean fuel systems on all non-electric fleet vehicles.

ACTION A8-2.10.1

Clean Fuel Electric Vehicles.

Purchase vehicles which use clean fuels (such as electricity) for use as part of the City fleet. Attempt to achieve 10% of City fleet vehicles to be electric (or electric clean fuel) by the year 2000, and 20% by the year 2010.

ACTION A8-2.10.2

MPG Purchase Limitation.

Require all non-emergency and maintenance vehicles to obtain at least 25 MPG (highway) as a criteria for new fleet vehicle acquisition.

Chapter VIII Air Quality

Air Transportation

Introduction

There are two airport facilities which directly impact the air quality within Chino: Ontario International Airport located within the City of Ontario and Chino Airport located in the southeastern portion of Chino. The emissions generated as a result of Ontario International Airport will be controlled by the City of Ontario (in terms of ground access and vehicle trip reductions), by the airport operator, Los Angeles Department of Airports, the various airlines (in terms of fleet replacement and on-site operational changes), and SCAQMD (in terms of various role changes, monitoring, etc.).

Chino Airport, a 950-acre facility, is owned by the County of San Bernardino and located near the southeast corner of Merrill and Euclid Avenues. It is classified as a "Basic Transportation Airport" functioning as a home base for business jets, corporate jets, and recreational aircraft. It is also the designated reliever facility for John Wayne Airport in Orange County.

Chino Airport serves the general aviation needs of southwestern San Bernardino County and parts of the surrounding three counties because of its convenient location. Many of the basic transportation airports within this region are already either, or close to, capacity. The demand for airport services will force some users to search elsewhere for accommodations and services. This activity will make the potential expansion capabilities of Chino Airport significant.

Technical Information

The Southern California Association of Governments projected that 43% of Los Angeles County airports and 100% of Orange County airports would be at capacity by 1985. These projections have held true and spatial demand, regionally, for based aircraft is greater than the area available.

The volume of based aircraft at Chino Airport is forecasted to increase from 1,100 in 1990 to 1,900 in 2005. While pollutant emissions at Chino Airport are currently not a significant problem, air and ground transportation related emissions associated with anticipated expansion are expected to increase.

The Chino Airport Master Plan envisions additional space for terminal/administrative facilities in order to accommodate the increased air transportation activities expected. Likewise, it is anticipated that airport support uses, such as, restaurants and hotels, will develop within or adjacent to the immediate airport facility.

Issues

A large portion of the airport facility and adjacent property is undeveloped. The City has agreed to support the implementation of the Chino Airport Master Plan which was prepared by the County. Implementation of the Master Plan may have significant impacts to air quality unless future development is required to adhere to air quality guidelines.

The following goals, policies, and actions will provide the framework to assure that implementation of the Chino Airport Master Plan produces the minimum amount of pollutant emissions.

GOALS, POLICIES, AND ACTIONS

GOAL G8-3

General Aviation Emissions.
To encourage the minimum feasible emissions from Chino Airport.

POLICY P8-3.1

Promote Improved Technology.
Support the South Coast Air Quality Management District in promoting the best available technology to reduce emissions in aircraft fleet and ground service vehicles.

ACTION A8-3.1.1

Cleaner Fuels.
Encourage airport service vehicles to use alternate (cleaner) fuels, i.e., electrification.

POLICY P8-3.2

Coordinate Airport Development.
Coordinate airport development to minimize pollutant emission from ground and air transportation systems.

ACTION P8-3.2.1

Airport Transportation Demand Management.
Coordinate airport development to minimize pollutant emission from ground and air transportation systems (i.e., indirect sources) by utilizing Transportation Demand Management (TDM) measures.

Land Use

Introduction

An efficient land use pattern served by a diverse transportation system can minimize air pollutants by minimizing congestion. This means balancing growth. Balanced growth is obtained by equalizing jobs and housing, (i.e., jobs/housing balance).

The purpose of jobs/housing balance is to allow workers to live closer to their jobs, thereby reducing traffic congestion and air pollution problems. However, cities and subregions develop on the fortunes of their constituent industries and supply of affordable housing. To achieve a jobs/ housing balance and reduce vehicle miles travelled, growth must be managed. Ensuring the timely provision of infrastructure to serve new development, implementing an economic development strategy, and providing adequate housing for the employment population are essential elements of managing growth and balancing the jobs and housing within the community.

Technical Information

The West San Bernardino Valley subregion is expected to grow by 46.2% in population between 1990 and 2010. This same region will capture 4.7% of the projected regional and 22.9% of the county population growth over the same period.

The City of Chino, which is part of this subregion, is projected to increase in population by 7.5%, from 15,665 to 21,379 dwelling units.

There are approximately 1,088 acres of undeveloped industrial and 738 acres of undeveloped residential property within the City. Based on the growth projected in the West Valley area, residential build out may be accomplished by the year 2010. Industrial development is expected to lag slightly behind.

Employment in San Bernardino County is characterized by 10 main industrial groupings. Retail trade establishments are the largest employers which capture 26.5% of the total employment. Service establishments are the second largest employers and capture 26.5% of total business employment. Overall most businesses are small firms with fewer than 50 employees.

Issues

The socioeconomic background information contained in the San Bernardino County Regional Air Quality Plan projects the City's jobs/housing ratio to be 1.76 jobs per household by the year 2010. It is estimated that the City's existing jobs/housing ratio is 1.42 jobs per household. The existing and projected ratios reflect a community which has an appropriate balance between jobs and housing. Such a balance will certainly contribute to a reduction in air pollutants generated locally if vehicle miles travelled can be reduced.

It will be most difficult to achieve this balance without an exhaustive planning effort. Several factors will inhibit the City's ability to achieve the projected jobs/housing balance and desired reduction in vehicie miles travelled. First, Measure "M", effective in 1988, fixes the housing supply making affordable housing programs difficult to implement. Second, the City does not currently have an economic development strategy to attract business and industry which fit the existing labor pool. Third, the City does not have a Capital Improvement Plan (CIP) consistent with state requirements which works to balance jobs/housing, or consider the timely provision of infrastructure to housing and employment sectors.

The following goals, policies, and actions will aid the City in improving air quality by promoting jobs/housing balance for the purpose of reducing vehicle miles travelled.

GOALS, POLICIES, AND ACTIONS

GOAL G8-4

Efficient Land Use Pattern.

To achieve a pattern of land uses which can be efficiently served by a diversified transportation system and development projects which directly and indirectly generate the minimum feasible air pollutants.

POLICY P8-4.1

Manage Growth.

Continue to ensure that the fundamental City documents, including the General Plan, achieves a community which is efficiently balanced in terms of jobs/housing and which adequately prepares for management of growth.

ACTION A8-4.1.1

Capital Improvement Plan.

Prepare and annually update a Capital Improvement Plan (CIP) to include state mandated air quality requirements.

ACTION A8-4.1.2

Economic Development Strategy.

Complete the preparation of an economic development strategy which examines the available labor pool and targets/markets the City to those industries/ businesses who best fit the labor pool characteristics.

ACTION A8-4.1.3

Coordinate Regional Job/Housing Balance.

Participate in the preparation of a Memorandum of Understanding (MOU) between participating jurisdictions in the Regional Air Quality Element (RAQE) as to mutually acceptable approaches to improve and maintain the jobs/housing balance in the West Valley area. (AQMP Control Measure No. 17.)

POLICY P8-4.2

Jobs/Housing Balance.

Create and execute programs which control and manage the balance between jobs and housing.

ACTION A8-4.2.1

Project Impacts.

Adopt an ordinance to establish criteria to assess the impacts of development projects upon air quality in terms of such factors as jobs created, traffic generated (by type), and direct/indirect pollutant emissions for certain size development.

ACTION A8-4.2.2

Draw From City Labor Pool.

Assess the feasibility of requiring businesses to employ a portion of its labor force from within the City or close proximity to the City.

ACTION A8-4.2.3

Growth Management Plan Performance.

Amend the Land Use Element to attain jobs/housing balance performance goals including jobs/housing targets by year, at a sub-regional level consistent with the Growth Management Plan (GMP). Prepare bi-annual assessment of the City's status in attaining its jobs/housing balance goals. (AQMP Control Measure No. 17.)

ACTION A8-4.2.4

New Jobs/Backbone Infrastructure.

Include in the City's C.I.P. a provision to provide backbone infrastructure to areas within the City where new jobs could be created which best fit the City's labor pools characteristics.

ACTION A8-4.2.5

Mixed Use Development.

Examine the feasibility of preparing a zoning ordinance amendment requiring mixed use development within the parameters established by Measure "M" in certain commercial zones.

POLICY P8-4.3

Protect Sensitive Receptors.

Protect sensitive receptors (schools, parks, hospitals) by supporting a regional approach to regulating the location and design of land uses which are especially sensitive to air pollution.

ACTION A8-4.3.1

Locational Requirements for Sensitive Receptors.

Prepare a zoning ordinance amendment which formulates standards for regulating the location and protection of sensitive receptors (such as schools, parks, hospitals, churches, etc.) from air pollutant emissions.

Particulate Emissions

Introduction

Particulate matter, or suspended particulates are solid and liquid particles of dust, soot, aerosol and other matter which are small enough to remain suspended in the air for a long period of time. A portion of the total particulate matter is caused by natural sources such as wind-blown dust and pollen. Man made sources include auto combustion, agriculture, factories, construction activity and roads (especially unpaved roads).

The City is transitioning from a primarily agricultural to urbanized community. While some agricultural activities currently operate within the City, the community make-up is predominately urban. Urban activities are the primary sources of particulate matter within Chino.

Technical Information

The primary source of particulate matter within Chino is from construction activity. The projected growth in this region and the amount of undeveloped land make construction activity the number one generator.

The adjacent San Bernardino County Dairy Preserve and agricultural activities located within the southern portion of the City, also generate particulate matter. It is expected that dust particles from agricultural uses within the City will diminish over time. However, impacts from the San Bernardino County Dairy Preserve and California Institution for Men will continue.

In the urbanized portion of the City, dust is generated from curbs and gutters, unpaved road shoulders, and parking lots. Presently, street sweepers clean each street 26 times annually. This totals approximately 4,160 miles of roadway per year. Statistics collected during the development of the San Bernardino County Regional Air Quality Plan show Chino's street sweeping program to be one of the most ambitious.

Issues

As the City continues to develop, construction activity will continue to produce particulates which will impact air quality. The current street sweeping program is adequate to mitigate impacts from streets, roads, natural sources, parking lots and agricultural uses. The primary issue will be to control particulate matter during new construction and on unpaved roads and lots.

The following goals, policies, and actions will aid the City in reducing air born particulates from activity within the City, including construction activity.

GOALS, POLICIES, AND ACTIONS

GOAL G8-5

Reduce Particulate Emissions.

Reduce to a minimum particulate emissions from such uses as construction, operation of roads, and buildings.

POLICY P8-5.1

Control Dust.

Reduce particulate emissions from roads, parking lots, construction sites and agricultural lands.

ACTION A8-5.1.1

Street Sweeping.

Continue to sweep City streets approximately twice per month. (AQMP Control Measure No. 12.a.)

ACTION A8-5.1.2

Control Particulate Emissions from Unpaved Roads.

Adopt an ordinance amendment to control particulate emissions created from unpaved roads, drives, vehicle maneuvering areas, parking lots, and vacant lots in conformance with the criteria established by the Air Resources Board. (AQMP Control Measure No. 12.b.)

ACTION A8-5.1.3

Limit Dust.

Adopt an ordinance amendment to control dust from vacant lands and operations and erosions from storm water washing into streets. (AQMP Control Measure No. 12.a.)

ACTION A8-5.1.4

Storage of Particulate Matter.

Eliminate the outdoor storage of sand, gravel and other particulate matter which is left uncovered or not confined at City facilities. (AQMP Control Measure No. 12.a.)

POLICY P8-5.2

Reduce Emissions from Building Materials and Methods of Construction.

Reduce emissions from building materials and methods of construction which generate excessive pollutants.

ACTION A8-5.2.1

Control Emissions, Construction, and Demolition.

Adopt an ordinance requiring the control of particulate emissions from construction and demolition activities and on-site construction traffic flow by requiring such things as truck wheel washers and paving of access roads. (AQMP Control Measure No. 12.a.)

ACTION A8-5.2.2

Particulate Emissions from Truck Hauling.

Require the installation of liners on truck beds, truck loads to be covered, and maintain freeboard levels for trucks use in construction activities. Establish penalties for commercial vehicles which are not in compliance. (AQMP Control Measure No. 12.a.)

POLICY P8-5.3

Reduce Emissions from Building Interiors.

To reduce interior air pollutants which produce poor air quality within building interiors.

Note: No Actions approved at this time. Actions might be added at a later date.

Energy Conservation

Introduction

Energy use contributes significantly to pollutant emissions, as well as gases that effect global warming. In 1987, approximately 80% of all emissions were related to energy use.

As population growth continues, it is imperative to advocate the efficient use of energy. It is also important to reduce the use of energy and encourage alternative energy sources.

Technical Information

The South Coast Air Quality Management District's 1991 Air Quality Management Plan requires local government to reduce its energy demand by 8% by January 1, 1994, 15% by 2000, and 30% by 2010. A recent League of California Cities' survey revealed that nearly 40% of responding cities have no organized energy management programs. The City of Chino is no exception.

Conservation measures involving building operation improvements, such as lighting, building area and boiler efficiency improvements, can lead to a significant reduction in energy consumption. Other areas where energy conservation can be achieved are: heating, ventilation and air conditioning (HVAC) system modifications, electrical use from space heating and cooling, food preparation, and energy efficient lighting in a variety of commercial and industrial facilities and residential homes. Additionally, industrial facilities use electricity in the manufacturing process for activities such as hydraulic pumping, air movement systems, electroplating, metal melting, drying and curing processes, and electric motor operation.

The use of cleaner types of energy is also an important aspect of reducing pollutant emissions. Electricity, ethanol, geothermal, LPG, methanol, natural gas, solar, and wind are considered clean fuels. The AQMP assumes that fuels which are cleaner and/or more efficient will be used, where appropriate, as an alternative to the high polluting fuels currently being used.

Issue

The primary issue with carrying out energy conservation actions is generating the initial capital for their creation and taking the necessary actions to implement them.

The following goals policies and actions will aid the City in conserving energy and reducing pollutant emissions which contribute to global warming.

GOALS, POLICIES, AND ACTIONS

GOAL C8-6

Reduce Energy Consumption.

To reduce emissions through reduced energy consumption.

POLICY P8-6.1

Energy Conservation.

Reduce energy consumption through energy conservation improvements and requirements.

ACTION A8-6.1.1

Energy Conservation Plan.

Develop a 5-year energy conservation plan which describes improvements to City buildings which will conserve energy or convert to cleaner fuels and include implementation of this plan in the City's annual budget.

ACTION A8-6.1.2

Energy Conservation Requirements.

Adopt an ordinance creating a program of local administrative practices to reduce local government energy demand 8% by January 1, 1994; 15% by the year 2000, and; 30% by the year 2010. (AQMP Control Measure No. 18.a.)

POLICY P8-6.2

Limit Water Heater Emissions.

To reduce emissions resulting from swimming pool water heaters and residential and commercial water heaters.

ACTION A8-6.2.1

Emission Reduction from Pool Heaters.

Adopt a regulation requiring an emission reduction from swimming pool water heaters. (AQMP Control Measure No. 18.a.)

ACTION A8-6.2.2

Emission Reduction From Water Heaters.

Adopt a regulation to require an emission reduction from residential and commercial water heaters. (AQMP Control Measure No. 18.a.)

POLICY P8-6.3

Recycle Wastes.

Promote local recycling of wastes and use of recycled materials.

ACTION A8-6.3.1

Waste Recycling.

Adopt a Source Reduction and Recycling Element to divert 25% of local solid waste requiring disposal by the year 1995 and 50% by the year 2000.

Implementation Strategy

Everyone wants cleaner air, a better place to live and work, and a healthy environment. The problem, however, as it relates to air quality, is that it will require a significant commitment by local government, business, and area residents to obtain cleaner air. The commitment comes in the form of modification to one's lifestyle. This type of change has the potential to be overwhelming.

The South Coast Air Quality Management District - Air Quality Management Plan, (and the control measures it contains) may appear overwhelming to area residents, business, and municipal government. The control measures noted in Appendix "A" of this document, in effect, ask local governments to use their land use regulatory powers to encourage the lifestyle change to obtain Federal air standards.

To successfully achieve the prescribed federal air quality standards, the City, local businesses, employees, and residents will all need to play a role in implementing these actions. The role of each party is separate and distinct but critical to our region being successful in this endeavor. The following are examples of the roles each of these parties may be asked to participate in.

City

Prepare an Air Quality Element; educate local businesses and residents about air quality issues; become a partner with local businesses and area residents to improve air quality within the air basin; require its employees to rideshare; buy fuel efficient fleet vehicles; save energy in City buildings; lobby other jurisdictions to do their fair share in improving air quality in the basin, etc.

Local Business

Work with the City in a partnership role to implement the various actions within this element; educate employees about how they can affect air quality; try to hire local residents; create flexible work hours for employees; encourage employees to rideshare; where feasible, permit telecommuting; schedule truck deliveries in off-peak hours; assist in establishing and/or participate in a Transportation Management Association; and provide showers and lockers for employees who bike or walk to work, etc.

Local Residents

Educate themselves about how they can affect air quality; become ridesharers, walk or bike to local activities within the City; plan their non-work trips so they are efficient; become familiar with and use local transit; when considering a job change, look for employment close to home; support the City and local business efforts to improve air quality, etc.

Recognizing the commitment and resources needed to accomplish such a change, and the inevitable impacts facing the people who will make that first commitment. The following guidelines are included to assist City Departments in implementing the Air Quality Element actions.

Guidelines for the City's Implementation of the Air Quality Element actions:

1. In all applicable cases, actions shall be implemented by utilizing market incentives available to the City or business community to encourage compliance with specific activities. If a market incentive approach fails to yield the desired air quality benefit, a direct regulatory approach shall be pursued, as a last resort.

2. The City shall form a partnership with businesses and area residents to achieve the goal of cleaner air through cooperation, sharing of available resources, and creative solutions to action implementation.

3. The City shall function, to the maximum extent possible, as a liaison between the business community, South Coast Air Quality Management District, other air quality planning agencies, and agencies with funding sources in order to facilitate action implementation. This role may include examining funding sources, establishing incentives, providing information, and consulting area residents.

The City is committed to achieving the air quality improvements set forth in the South Coast Air Quality Management District's Air Quality Management Plan. However, the City realizes that achieving such a goal may have a burden on businesses and residents. The aforementioned implementation guidelines will assist the City in achieving district requirements while sharing the responsibility with area residents and local business/industry.

Implementation

- Government Organization, Roles and Repsonsibilities
- Ground Transportation
- Air Transportation
- Land Use
- Particulate Emissions
- Energy Conservation

AIR QUALITY ELEMENT IMPLEMENTATION

GOVERNMENT ORGANIZATION, ROLES AND RESPONSIBILITIES

ACTIONS	GOALS AND POLICIES				RESPONSIBLE AGENCY / DEPARTMENT *									TIMING
	Goal G8-1 Air Quality Improvement				CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	
	P8-1.1	P8-1.2	P8-1.3											
Coordinated Review. Action A8-1.1.1	X				X									On-going
AQMP Regional Financing. Action A8-1.1.2	X				X						X			On-going
Local Input. Action A8-1.1.3	X				X									1991
Implement Congestion Management Plan. Action A8-1.2.1		X				X								1992
Establish Regional Transportation Management Agencies. Action A8-1.2.2		X				X					X			On-going
OmniTrans/RTD - Transit Improvements. Action A8-1.2.3 (AQMP Cntl Measure No. 2.g.)		X				X					X			On-going
Communication Network. Action A8-1.3.1			X								X			On-going
Lobby Other Entities to Implement AQMP. Action A8-1.3.2			X								X			On-going

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AIR QUALITY ELEMENT IMPLEMENTATION

GOVERNMENT ORGANIZATION, ROLES AND RESPONSIBILITIES

ACTIONS	GOALS AND POLICIES				RESPONSIBLE AGENCY / DEPARTMENT *									TIMING
	Goal G8-1 Air Quality Improvement				CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	
	P8-1.4	P8-1.5												
Public Participation Programs. Action A8-1.4.1	X				X						X			On-going
Educate Local Businesses. Action A8-1.4.2	X				X						X			1992
Obtaining Public Input. Action A8-1.4.3	X				X									On-going
Homeowner's Association/Neighborhood Groups. Action A8-1.4.4	X				X						X			1992
Tier III Implementation. Action A8-1.5.1		X			X						X			On-going
Encourage Business/Research. Action A8-1.5.2		X			X						X			On-going
Support Creative Solutions. Action A8-1.5.3		X			X						X			On-going
Regional Cooperation. Action A8-1.5.4		X									X			On-going

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AIR QUALITY ELEMENT IMPLEMENTATION

GROUND TRANSPORTATION

ACTIONS	GOALS AND POLICIES: Goal G8-2 Ground Transportation				RESPONSIBLE AGENCY / DEPARTMENT *									TIMING
	P8-2.1	P8-2.2			CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	
Neighborhood Services. Action A8-2.1.1	X				X									1993
On-Site Services. Action A8-2.1.2	X										X			1994 *
Trip Reduction Ordinance. Action A8-2.1.3 (AQMP Cntl Measure No. 1.a. & 1.b.)	X					X								1994 *
Compliance with SCAQMD AVR. Action A8-2.1.4 (AQMP Cntl Measure No. 2.a.)	X				X						X			1994/1995
Reduced Service During Stage 3 Smog Alerts. Action A8-2.1.5	X										X			1991 *
Trip Reduction Program. Action A8-2.1.6 (AQMP Cntl Measure No. 1.a. & 1.b.)	X										X			1994 *
Travel Demand Management Action A8-2.2.1 (AQMP Cntl Measure No. 2.b.)		X			X									1994 *

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AIR QUALITY ELEMENT IMPLEMENTATION

GROUND TRANSPORTATION

ACTIONS	GOALS AND POLICIES: Goal G8-2 Ground Transportation				RESPONSIBLE AGENCY / DEPARTMENT *									TIMING
	P8-2.3	P8-2.4	P8-2.5		CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	
Congestion Management Plan. Action A8-2.3.1	X					X								1992
Adopt CMP Ordinance. Action A8-2.3.2	X					X								1992
Truck Routing/Deliveries. Action A8-2.3.3 (AQMP Cntl Measure No. 3.a.)	X					X								1994
Restrict Trucks from Major Arterials. Action A8-2.3.4 (AQMP Cntl Measure No. 3.a.)	X					X								1994
Traffic Signal Improvements. Action A8-2.3.5 (AQMP Cntl Measure No. 4.)	X					X								1995
On-Street Parking During Peak Hours. Action A8-2.3.6 (AQMP Cntl Measure No. 2.b. & 4.)	X					X								1994
Surcharge for Truck Operations During Peak Periods. Action A8-2.3.7 (AQMP Cntl Measure No. 3.a.)	X					X					X			1994
(Note: Future actions may be included under this policy if fees are determined to be needed for implementation of other Air Quality actions.)		X												
Sub-Regional Transportation System. Action A8-2.5.1			X								X			1992
Auto Use Restrictions. Action A8-2.5.2 (AQMP Cntl Measure No. 2.e.)			X			X								1992
City Shuttle. Action A8-2.5.3			X								X			1994

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AIR QUALITY ELEMENT IMPLEMENTATION

GROUND TRANSPORTATION

ACTIONS	GOALS AND POLICIES: Goal G8-2 Ground Transportation					RESPONSIBLE AGENCY / DEPARTMENT *									TIMING
	P8-2.6	P8-2.7	P8-2.8	P8-2.9	P8-2.10	CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	
Bike Trails. Action A8-2.6.1 (AQMP Cntl Measure No. 1.b.)	X					X		X							On-going
Merchant Transportation Incentives. Action A8-2.6.2 (AQMP Cntl Measure No. 2.d.)	X					X	X					X			1994
Bicycle Parking and Showers. Action A8-2.6.3 (AQMP Cntl Measure No. 1.b.)	X					X						X			1999
Rideshare Incentives in Public Parking Lots. Action A8-2.7.1 (AQMP Cntl Measure No. 2.b.)		X				X						X			1994
Limit Parking Supply by Zone. Action A8-2.7.2 (AQMP Cntl Measure No. 2.b.)		X				X	X								1994
Preferential Parking for Ridesharers. Action A8-2.7.3 (AQMP Cntl Measure No. 2.b.)		X				X	X								1992
Parking Cost Standards. Action A8-2.8.1 (AQMP Cntl Measure No. 2.b.)			X			X						X			1992
Emission Fee. Action A8-2.9.1				X		X						X			1994
Emission Surcharge. Action A8-2.9.2				X		X						X			1995
Support Tax Credit/Tax Benefit. Action A8-2.9.3				X								X			1995
Clean Fuel Electric Vehicles. Action A8-2.10.1					X		X					X			On-going 2000, 2010
MPG Purchase Limitation. Action A8-2.10.2					X	X				X		X			1992

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AIR QUALITY ELEMENT IMPLEMENTATION

AIR TRANSPORTATION

ACTIONS	GOALS AND POLICIES: Goal G8-3 General Aviation Emissions				RESPONSIBLE AGENCY / DEPARTMENT *									TIMING
	P8-3.1	P8-3.2			CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	
Cleaner Fuels. Action A8-3.1.1	X					X						X		1992
Airport Transportation Demand Management. Action A8-3.2.1		X			X	X						X		1992

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AIR QUALITY ELEMENT IMPLEMENTATION

LAND USE

ACTIONS	GOALS AND POLICIES: Goal G8-4 Efficient Land Use Pattern				RESPONSIBLE AGENCY / DEPARTMENT *									TIMING
	P8-4.1	P8-4.2	P8-4.3		CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	
Capital Improvement Plan. Action A8-4.1.1	X				X	X								1992
Economic Development Strategy. Action A8-4.1.2	X				X									1992
Coordinate Regional Jobs/Housing Balance. Action A8-4.1.3 (AQMP Cntl Measure No. 17.)	X				X									On-going/ 1992
Project Impacts. Action A8-4.2.1		X			X									1992
Draw From City Labor Pool. Action A8-4.2.2		X			X									1993
Growth Management Plan Performance. Action A8-4.2.3 (AQMP Cntl Measure No. 17.)		X			X			X			X			On-going/ 1994
New Jobs/Backbone Infrastructure. Action A8-4.2.4		X			X									1992
Mixed Use Development. Action A8-4.2.5 (AQMP Cntl Measure No. 1.b.)		X			X	X								1994
Locational Requirements for Sensitive Receptors. Action A8-4.3.1			X		X									1994

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AIR QUALITY ELEMENT IMPLEMENTATION

PARTICULATE EMISSIONS

ACTIONS	GOALS AND POLICIES: Goal G8-5 Reduce Particulate Emissions.				RESPONSIBLE AGENCY / DEPARTMENT *									TIMING
	P8-5.1	P8-5.2	P8-5.3		CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	
Street Sweeping. Action A8-5.1.1 (AQMP Cntl Measure No. 12.a.)	X					X								On-going
Control Particulate Emissions from Unpaved Roads. Action A8-5.1.2 (AQMP Cntl Measure No. 12.b.)	X					X								1994
Limit Dust. Action A8-5.1.3 (AQMP Cntl Measure No. 12.a.)	X				X	X								1994
Storage of Particulate Matter. Action A8-5.1.4 (AQMP Cntl Measure No. 12.a.)	X					X	X							1994
Control Emissions, Construction, and Demolition. Action A8-5.2.1 (AQMP Cntl Measure No. 12.a.)		X			X									1994
Particulate Emissions from Truck Hauling. Action A8-5.2.2 (AQMP Cntl Measure No. 12.a.)		X			X	X								1994
Note: No Actions approved at this time. Actions might be added at a later date.			X											

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AIR QUALITY ELEMENT IMPLEMENTATION

ENERGY CONSERVATION

ACTIONS	GOALS AND POLICIES: Goal G8-6 Energy Consumption. P8-6.1	P8-6.2	P8-6.3		RESPONSIBLE AGENCY / DEPARTMENT *: CD	PW	CS	MS	PD	FD	A	SBC	Other (specify)	TIMING
Energy Conservation Plan. Action A8-6.1.1	X						X							1994
Energy Conservation Requirements. Action A8-6.1.2 (AQMP Cntl Measure No. 18.a.)	X						X				X			1994
Emission Reduction from Pool Heaters. Action A8-6.2.1 (AQMP Cntl Measure No. 18.a.)		X			X									1999
Emission Reduction from Water Heaters. Action A8-6.2.2 (AQMP Cntl Measure No. 18.a.)		X			X									2006
Waste Recycling. Action A8-6.3.1			X								X			1993

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Glossary

Air Quality Management Plan (AQMP)
A comprehensive policy document that delineates goals, policies, pollution reduction strategies, and implementation responsibilities for improving air quality in the South Coast Air Basin.

Air Resources Board (ARB)
The State Agency which prepares and submits the State Implementation Plan (SIP) to the Environmental Protection Agency (EPA). The ARB is also the agency that reviews regional plans to ensure that Transportation Control Measures are taken to achieve air quality standards at the earliest practicable date. This Agency establishes emissions standards for mobile sources.

Average Vehicle Ridership (AVR)
The average amount of occupants for a vehicle over a period of time.

Basic Transportation Airport
An airport which primarily services aircraft for commercial and recreational use. Generally, commuter, local and itinerant aircraft visit such airports. Air carrier aircraft usually do not have access to Basic Transportation Airports.

California Clean Air Act (CCAA)
The State Legislation which requires all non-attainment air basins to develop new attainment plans to meet Federal and State air quality standards.

California Environmental Quality Act (CEQA)
State legislation which requires all governmental agencies at all levels to document and consider the environmental considerations of their actions.

CalTrans
State of California Department of Transportation (CalTrans) is the State Agency which oversees the State network of roadways and highways.

Carbon Monoxide (C_O)
A colorless, odorless gas formed by the incomplete combustion of fuels. Carbon monoxide replaces oxygen in the blood and reduces its ability to transport oxygen to vital organs in the body.

Conformity Review
The process which ensures that local government actions and projects (i.e., planning, actions, permit activity, project approval, programming, or funding) do not prevent attainment of the National Ambient Air Quality Standards (NAAQS).

Congestion Management Plan (CMP)
A county-wide program which addresses congestion problems in a coordinated manner with other agencies in the county.

Control Measure
The nuts and bolts of the South Coast Air Quality Management Plan. Control measures are commitments to adopt rules and regulations to reduce pollutant emissions. There are 126 control measures in the Air Quality Management Plan, 17 of which are designated for local agency action.

District
A commonly-used abbreviation for the South Coast Air Quality Management District (SCAQMD).

Environmental Impact Report (EIR)
An informational document which provides public agencies and the public in general with detailed information about the effects which a proposed project is likely to have on the environment.

High Occupancy Vehicle (HOV) Lane
HOV lane on a highway or freeway which is restricted for use by vehicles carrying two or more passengers.

Memorandum of Understanding (MOU)

Mobile Sources
Emissions from on-road motor vehicles.

Oxides of Nitrogen (NOx)
Oxides of nitrogen are brownish gas that is formed in the atmosphere through a rapid reaction of the colorless gas nitric oxide (NO) with atmospheric oxygen. Oxides of nitrogen play an important role in visibility degradation within the basin. They are formed in the atmosphere from reactions involving NOx emissions from man-made combustion sources.

Oxides of Sulfur (SOx)
A colorless gas with a pungent irritating odor. It is created by the combustion of sulfur--containing fuel.

Ozone (O_3)
A secondary pollutant which is formed in the atmosphere through a reaction of reactive organic gases (ROG), nitrogen oxides (NOx), oxygen, and other hydrocarbon materials with sunlight.

Particulate Matter (PM)
Suspended particulates which included a complex mixture of man-made and natural substances including sulfates, nitrates, metals, elemental carbon, sea salt, soil organics and other materials.

Reactive Organic Gases (ROG)
Reactive organic gases are hydrocarbons. ROG emissions react with other pollutants in the presence of sunlight to form photo-chemical oxidants or ozone.

Regional Mobility Plan (RMP)

A comprehensive regional planning document for the Southern California Association of Governments (SCAG) region which provides specific means for recapturing and retaining the transportation mobility levels of 1984.

South Coast Air Quality Management District (SCAQMD)

The air pollution control district for the area which includes the County of Orange and the urbanized portions of Los Angeles, Riverside and San Bernardino Counties. (The agency's responsibilities as they pertain to conformity are detailed in Appendix C of this document.)

Southern California Association of Governments (SCAG)

The metropolitan planning organization for the six-county region which includes Imperial, Los Angeles, Orange, Riverside, San Bernardino and Ventura Counties. (The agency's responsibilities for conformity are detailed in Appendix C of this document.)

Transportation Control Measure (TCM)

Any demand management, systems management, facilities improvement, or technology-based measure (or mixture thereof) intended to influence choices of mode, time of day, or decisions whether to travel at all.

Transportation Demand Management (TDM)

Demand based techniques for reducing traffic congestion, such as ridesharing programs and flexible work schedules enabling employees to commute to and from work outside of peak hours.

Transportation Management Association (TMA)

An organization with its main purpose is to coordinate, among association members, Transportation Demand Management techniques to reduce traffic congestion.

Vehicle Miles Travelled (VMT)

The total miles traveled by all vehicles in a particular geographic area measured over a 24-hour period.

Bibliography

Guidelines for the Development of Local Air Quality Elements. Southern California Association of Governments, March 1990. A report that outlines an approach to preparing an air quality element which is consistent with other regional plans.

Draft Final 1991 Air Quality Management Plan for the South Coast Air Basin, Southern California Association Of Governments/South Coast air Quality Management District. A comprehensive plan which includes measures for bringing the air basin into compliance with State and Federal air quality standards.

Draft Air Quality Management Plan 1991 Revisions: Appendix IV-E - Southern California Association of Governments, December 1990. A report describing the air quality control measures pertaining to transportation, land use, and energy conservation.

San Bernardino County Regional Air Quality Plan, San Bernardino County/cities, March 1991. A regional plan prepared by San Bernardino County and certain cities within the county which includes goals, policies, and a menu of action programs that assist these agencies in complying with the Air Quality Management Plan in terms of bringing the Air district in compliance with Federal and State air quality standards.

San Bernardino County Regional Air Quality Plan, Technical Background Report, San Bernardino County/cities, March 1991. A report which describes the air quality condition in San Bernardino County.

San Bernardino County Regional Air Quality Plan, Socioeconomics Analysis of Selected Air Quality Measures, San Bernardino County/cities, March 1991. A socioeconomic analysis of the implementation of selected AQMP control measures.

Chino Airport Master Plan, County of San Bernardino, January 1987. A Master Plan by the County of San Bernardino outlining development strategy for the approximate 950 acre project area.

References

City of Chino

Community Development Department .... Earl P. Nelson, Director

Community Services Department .... Tina Sray, Manager of Parks and Facilities

Public Works Services .... Tom Mace, Street Superintendent

Larry Mayfield, Fleet Superintendent

County of San Bernardino

Regional Air Quality Element,
Technical Advisory Committee .... Sharon Hightower, Chairman

Julie Hemphill, Project Manager

San Bernardino Association of Governments .... Wes McDaniel

City of Big Bear Lake .... Ed Johnson

City of Colton .... Jaime R. Aquilar

City of Fontana .... Kurt Anderson

City of Grand Terrace .... David Sawyer

City of Highland .... Steve Walker

City of Loma Linda .... Dan Smith

City of Montclair .... Hall Fiederickson

City of Ontario .... Joyce Babicz

City of Rancho Cucamonga .... Brad Buller

City of Redlands .... Jeff Shaw

City of Rialto .... Rod Taylor

City of San Bernardino .... Valerie Ross

City of Upland .... Jeff Bloom

City of Yucaipa .... John McMains

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Actions

Chapter VIII Air Quality

Policies

Appendix

A. SCAQMD - AQMP, Control Measure/Chino Air Quality Element Action Matrix

B. Regional Air Quality Plan, San Bernardino County/Cities, Technical Background Report (under separate cover)

C. Regional Air Quality Plan, San Bernardino County/Cities, Socioeconomics Analysis - Selected Air Quality Measures (under separate cover)

AIR QUALITY ELEMENT
APPENDIX A

SCAQMD-AQMP Control Measures/Chino Air Quality Element Action Matrix

Chino General Plan

November 1991

Air Quality Management Plan (AQMP) Control Measure/ Chino Air Quality Element (CAQE) Action Matrix

AQMP CONTROL MEASURE	CAQE ACTION
1.a. Person Work Trip Reduction.	A8-2.1.3 Trip Reduction Ordinance. A8-2.1.6 Trip Reduction Program.
1.b. Non-Motorized Transportation.	A8-2.1.3 Trip Reduction Ordinance. A8-2.1.6 Trip Reduction Program. A8-2.6.1 Bike Trails. A8-2.6.3 Bicycle Parking and Showers.
2.a. Employer Ridesharing and Transit Incentives.	A8-1.2.2 Establish Regional Transportation Management Agencies. A8-2.1.4 Compliance with SCAQMD AVR. A8-2.9.3 Support Tax Credit/Tax Benefit.
2.b. Parking Management.	A8-2.2.1 Travel Demand Management. A8-2.3.6 On-Street Parking During Peak Hours. A8-2.7.1 Rideshare Incentives in Public Parking Lots. A8-2.7.2 Limit Parking Supply by Zone. A8-2.7.3 Preferential Parking for Ridesharers. A8-2.8.1 Parking Cost Standards.
2.d. Merchant Transportation Incentives.	A8-2.6.2 Merchant Transportation Incentives.
2.e. Auto Use Restrictions.	A8-2.5.2 Auto Use Restrictions.
2.f. HOV Facilities.	Not Applicable.
2.g. Transit Improvements.	A8-1.2.3 OmniTrans/RTD - Transit Improvements.
3.a. Truck Dispatching, Rescheduling and Rerouting.	A8-2.3.3 Truck Routing/Deliveries. A8-2.3.4 Restrict Trucks from Major Arterials. A8-2.3.7 Surcharge for Truck Operations During Peak Periods.
3.b. Diverting Port-Related Truck Traffic to Rail.	Not Applicable.
4. Traffic Flow Improvements.	A8-2.3.5 Traffic Signal Improvements. A8-2.3.6 On-Street Parking During Peak Hours.
5. Non-Recurrent Congestion.	Not Applicable.

APPENDIX "A"

Air Quality Management Plan (AQMP) Control Measure/ Chino Air Quality Element (CAQE) Action Matrix

AQMP CONTROL MEASURE		CAQE ACTION	
6.	Aircraft and Ground Service Vehicles.		Not Applicable.
7.	Centralized Ground Power Systems.		Not Applicable.
8.	Airport Ground Access.		Not Applicable.
9.	Replacement of High Emitting Aircraft.		Not Applicable.
10.	General Aviation Vapor Recovery.		Not Applicable.
11.	Rail Consolidation to Reduce Grade Crossings.		Not Applicable.
12.a.	Paved Roads.	A8-5.1.1 A8-5.1.3 A8-5.1.4 A8-5.2.1 A8-5.2.2	Street Sweeping. Limit Dust. Storage of Particulate Matter. Control Emissions, Construction and Demolition. Particulate Emissions from Truck Hauling.
12.b.	Unpaved Roads and Parking Lots.	A8-5.1.2	Control Particulate Emissions from Unpaved Roads.
13.	Freeway and Highway Capacity Enhancements.		Not Applicable.
14.	Railroad Electrification.		Not Applicable.
16.	High Speed Rail.		Not Applicable.
17.	Growth Management.	A8-4.1.3 A8-4.2.3	Coordinate Regional Job/Housing Balance. Growth Management Plan Performance.
18.a.	Local Government Energy Conservation.	A8-6.1.2 A8-6.2.1 A8-6.2.2	Energy Conservation Requirements. Emission Reduction from Pool Heaters. Emission Reduction from Water Heaters.

APPENDIX "A" (cont'd.)

BACKGROUND STATEMENT

The air quality in San Bernardino County results from a unique combination of factors; air flow patterns and emission sources, both local and those located through the region, results in some of the worst air quality in the nation. San Bernardino County regularly exceeds state and federal air quality standards for Ozone (O_3), Carbon Monoxide (CO), Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}). Exceedances are acute during summer months when onshore wind patterns transport pollutants from the western portion of the South Coast Air Basin, notably Los Angeles and Orange Counties and combine with local sources. San Bernardino County records the most severe violations of air quality standards for Ozone and PM_{10} in the summer months relative to the rest of the air basin.

REGULATORY FRAMEWORK

The Clean Air Act, promulgated in 1970 and amended twice thereafter (including the recent 1990 amendment), establishes the framework for modern air pollution control. The Act directs the Environmental Protection Agency (EPA) to establish ambient air standards for six pollutants: Ozone, Carbon Monoxide, Lead, Nitrogen Dioxide, Particulate Matter and Sulphur Dioxide. The standards (NAAQS) are divided into primary and secondary standards; the former are set to protect human health within an adequate margin of safety and the latter to protect environmental values such as plant and animal life.

According to the Act, states are required to submit a State Implementation Plans (SIP) for areas that exceed the NAAQS, or nonattainment areas. The SIP, which is reviewed and approved by the EPA, must demonstrate how the federal standards will be achieved. Failure to submit a plan or secure approval could lead to denial of federal funding and permits for such improvements as highway construction and sewage treatment plants. In cases where the SIP is submitted but fails to demonstrate achievement of the standards, the EPA is directed to prepare a Federal Implementation Plan.

In addition to the six pollutants regulated by federal legislation, the California Clean Air Act establishes standards for Hydrogen Sulphide, Sulphates and Vinyl Chloride. Responsibility for achieving these standards (which are more stringent that federal standards) is placed on the California Air Resources Board and local air pollution control districts. District plans for nonattainment areas must be designed to achieve a 5% annual reduction in emissions. The Air Quality Management Plan (AQMP) is, in turn, incorporated into the SIP.

With the aim of complying with all federal standards by 2007, the South Coast Air Quality Management District (SCAQMD) and Southern California Association of Governments (SCAG) jointly prepared the 1989 Air Quality Management Plan (AQMP). The Plan calls for implementation of rules and regulations by the Air Resources Board, the South Coast Air Quality Management District, the Environmental Protection Agency and Local Jurisdictions.

The AQMP calls upon local governments to achieve an 8% reduction regionwide in emissions from reactive organic gases and oxides of nitrogen. Specifically, local governments are asked to implement appropriate control measures contained in the AQMP to achieve this reduction. Several measures direct local government to adopt an Air Quality Element or its equivalent into its General Plan. If all of the applicable control measures are not implemented, the air quality standards cannot be achieved. In this event, the existing moratorium on location of stationary sources in the basin will be continue and federal funding and other permits may be denied until the standards are met.

In an effort to comply with federal and state regulations, and to improve air quality in the county and region, this Air Quality Element has been adopted.

Subtopic 2.6 CLEANER FUELS

Policy 2.6.1 **Support Legislation**

Promote state and federal legislation which would improve vehicle/transportation technology and which would establish differential pricing mechanisms to assess the true cost of emissions.

Programs:

2.6.1.1 Support legislation to stimulate the development of practical electric vehicles (15).

2.6.1.2 Support state legislation which would establish: - Emission Fees on gasoline products and Differential Registration Fees on motor vehicles according to the emission levels that they are designed to produce. - Include exploration of an option that imposes pollution fees on individual vehicles at time of mandated smog inspections, based on actual vehicle performance.

2.6.1.3 Support legislation which tightens the existing vehicle inspection program, both in terms of standards to be met and requirements for compliance.

Policy 2.6.2 **Institute Clean Fuel Systems**

Invest in clean fuel systems on new local government fleet vehicles.

Programs:

2.6.2.1 Institute clean fuel systems on new local government fleet vehicles (G-4).

TOPIC 3: AIR TRANSPORTATION

GOAL 3 Minimum feasible emissions from air carrier airports.

Policy 3.1 **Promote Improved Technology**

Promote requiring the best available technology to reduce emissions in aircraft fleet.

Programs:

3.1.1 Adopt/urge establishment of the best available technology and operational measures for aircraft and ground service vehicles (6).

3.1.2 Support phasing out of Stage II aircraft and the earliest possible transition to Stage III aircraft for operation within the Air Basin (9).

Policy 3.2 **Promote Centralized Ground Power**

Promote installation of centralized ground power systems at existing air carrier airports.

[1] Programs which further more than one air quality policy.

Policy 2.3.2 **Expand Transit in the Air Basin**

Promote expansion of all forms of transit in the urbanized portions of San Bernardino, Orange, Los Angeles and Riverside Counties.

Programs:

2.3.2.1 Influence the expansion of intraregional commuter and main line rail services, particularly those linking with destinations in San Bernardino County.

2.3.2.2 Support public transit providers in efforts to increase funding for transit improvements to supplement other means of travel (2.g).[1]

2.3.2.3 Jointly support efforts to establish a regionwide bus pass.

Subtopic 2.4 NON-MOTORIZED MEANS OF TRANSPORTATION

Policy 2.4.1 **Promote Non-Motorized Transportation**

Provide bicycle and pedestrian pathways to encourage non-motorized trips.

Programs:

2.4.1.1 Develop standards and guidelines for support facilities to incorporate into development plans for increased bicycle and pedestrian routes to link appropriate activity centers to nearby residential development.

Subtopic 2.5 PARKING MANAGEMENT

Policy 2.5.1 **Manage Parking Supply**

Manage parking supply to discourage auto use, while ensuring that economic development goals will not be sacrificed.

Programs:

2.5.1.1 Establish short and long-term parking management strategies at governmental and private facilities in ways that discourage single occupancy vehicle usage and reward high vehicle occupancy rates without placing the County at a competitive disadvantage.[1]

Policy 2.5.2 **Encourage Market Incentives/Disincentives**

Promote a regional approach to increasing parking costs in order to discourage low vehicle occupancy.

Programs:

2.5.2.1 Establish parking management strategies for governmental and private facilities in ways that discourage single occupancy vehicle usage and reward high vehicle occupancy rates without placing the County at an economic disadvantage in enticing jobs.[1]

[1] Programs which further more than one air quality policy.

Programs:

2.2.1.1 Jointly, through the County, SANBAG, and SCAG, participate with adjacent counties in expanding HOV lanes on the freeway system within those counties.

Policy 2.2.3 **Integrate Congestion Management Program**

Coordinate overlapping components of the State mandated Congestion Management Program and the Regional Air Quality Plan.

Programs:

2.2.3.1 Participate with SANBAG in defining and implementing a Congestion Management Program for San Bernardino County to insure appropriate coordination with air quality planning.

Policy 2.2.4 **Establish Congestion Fees**

Promote market based incentives and disincentives to relieve peak hour/peak direction congestion within highly congested travel corridors.

Programs:

2.2.4.1 Cooperatively initiate a pilot program to explore, jointly with Los Angeles, Orange and Riverside counties, methods and workability of Congestion Fees for peak hour/peak direction use to be levied within highly congested travel corridors, particularly those which generate emissions transported to San Bernardino County.

Subtopic 2.3 EXPANDED TRANSIT SYSTEMS AND SERVICES

Policy 2.3.1 **Expand Transit in the County**

Cooperate in efforts to expand bus, rail and other forms of transit in the portion of the South Coast Air Basin within San Bernardino.

Programs:

2.3.1.1 Participate with public transit providers serving San Bernardino County in a cooperative program to increase transit services with existing equipment and expand services through transit facility improvements.

2.3.1.2 Coordinate with public transit providers to increase funding for transit improvements to supplement other means of travel (2.g).[1]

2.3.1.3 Plan for intraregional commuter and main line rail service development including convenience facilities at rail stops.

2.3.1.4 Develop design standards that promote access to transit facilities.

[1] Programs which further more than one air quality policy.

Subtopic 2.1 AUTO USE

Policy 2.1.1 **Eliminate Vehicle Trips**

Use incentives, regulations and Transportation Demand Management in cooperation with other jurisdictions in the South Coast Air Basin to eliminate vehicle trips which would otherwise be made.

Programs:

2.1.1.1 Establish and implement a Transportation Demand Management Program.[1]
2.1.1.2 Define and implement auto limitation procedures in selected areas and at selected times, provided that alternative transportation modes are available.[1]

2.1.1.3 Establish incentives and regulations to eliminate work trips.[1]

Policy 2.1.2 **Reduce Vehicle Miles Traveled**

Use incentives, regulations and Transportation Demand Management in cooperation with other jurisdictions in the South Coast Air Basin to reduce the vehicle miles traveled for auto trips which still need to be made.

Programs:

2.1.2.1 Establish and implement a Transportation Demand Management Program.[1]

2.1.2.2 Establish and maintain telecommunications strategies to reduce the length of auto trips.

2.1.2.3 Define and implement auto limitation procedures in selected areas and at selected times, provided that alternative transportation modes are available.[1]

Subtopic 2.2 CONGESTION MANAGEMENT

Policy 2.2.1 **Modify Work Schedules**

Promote and establish modified work schedules which reduce peak period auto travel.

Programs:

2.2.1.1 Establish incentives and regulations to spread work trips over a longer period to reduce peak period congestion.[1]

Policy 2.2.2 **Establish HOV Lanes**

Participate in efforts to achieve increased designation, construction, and operation of HOV lanes on freeways in Los Angeles, Orange, Riverside and San Bernardino counties.

[1] Programs which further more than one air quality policy.

1.2.3 Establish and maintain an implementation/monitoring system devised as part of the Air Quality Plan preparation. Integrate with monitoring and reporting systems required for purposes which overlap with the Air Quality Plan.

Policy 1.3 **Affect Source Jurisdictions**

Cooperate actively with Los Angeles, Orange and Riverside counties to comprehensively improve air quality at the emission source.

Programs:

1.3.1 Jointly establish a communication network with key elected officials and staff involved in air quality planning in Los Angeles, Orange and Riverside counties as the basis for identifying and implementing parallel measures of mutual benefit.

Policy 1.4 **Encourage Community Participation**

Involve environmental groups, the business community, special interests and the general public in the formulation and implementation of programs which effectively reduce air borne pollutants.

Programs:

1.4.1 Design and conduct efforts to involve the public and affected/interested parties in the adoption of local air quality plans and implementation of air quality improvement programs.

- Conduct Public Forums
- Establish Communication and Education Programs
- Make written briefs available locally
- Conduct Planning Commission/City Council public workshops
- Utilize a variety of media forms to maximize citizen involvement

Policy 1.5 **Support Innovative Approaches**

Advocate and support innovative strategies to improve air quality.

Programs:

1.5.1 Support new approaches to improving air quality through:

- Supporting legislation;
- Cooperating with regional bodies;
- Establishing pilot programs; and
- Funding and/or participating in private/public partnerships.

TOPIC 2: GROUND TRANSPORTATION

GOAL 2 A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.

[1] Programs which further more than one air quality policy.

Principles

1. **Air Quality and Economic Growth**

   Achieve air quality improvements in such a way that continued economic growth can be sustained.

2. **Market Incentives and Regulations**

   Achieve necessary air quality related life style and economic changes through market incentives where feasible and through regulatory measures where necessary.

GOALS, POLICIES AND PROGRAMS

Because the air quality problem is larger than any one jurisdiction, this Air Quality Element includes goals, policies and programs which have been accepted by the fifteen cities in the San Bernardino County portion of the South Coast Air Basin. These consensus goals, policies and programs provide a common foundation for coordinated action.

TOPIC 1: GOVERNMENT ORGANIZATION, ROLES & RESPONSIBILITIES

GOAL 1 Effective coordination of air quality improvement within the portion of the South Coast Air Basin in San Bernardino County and improved air quality through reductions in pollutants from Orange and Los Angeles counties.

Policy 1.1 **Establish Coordinated Approach**

Coordinate with other jurisdictions in San Bernardino County to establish parallel air quality plans and implementation programs.

Programs:

1.1.1 Adopt local air quality plans based on the San Bernardino County/Cities Regional Air Quality Plan.

1.1.2 Establish an ongoing air quality implementation and project referral process within the San Bernardino portion of the South Coast Air Basin, adapting it as necessary to local circumstances, resources and procedures.

Policy 1.2 **Integrate With Related Programs**

Coordinate a process to integrate related functional programs' implementation, monitoring and reporting.

Programs:

1.2.1 Establish a coordination process for relating parallel actions undertaken as part of other regional or countywide plans.

1.2.2 Participate with SANBAG in defining and implementing a Congestion Management Program for San Bernardino County.[1]

REGIONAL AIR QUALITY IMPLEMENTATION PLAN
SAN BERNARDINO COUNTY/CITIES

TOPIC 2: GROUND TRANSPORTATION		
GOAL	**POLICIES**	**PROGRAMS AND ACTION OPTIONS**
SUBTOPIC 5: PARKING MANAGEMENT		
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Manage Parking Supply 1. Manage parking supply to discourage auto use, while ensuring that economic development goals will not be sacrificed.	1. Establish short and long term parking management strategies for governmental and private facilities that discourage single occupancy vehicle usage and reward high vehicle occupancy rates without placing the County at an economic disadvantage in enticing jobs by means such as[1]: • Reducing or redirecting parking supply. • Creating Parking "Banks" of landscaping and other less intensive land uses which could be used for parking in the future or could be developed with a more intensive land use provided the tenant/owner effectively reduces the demand for parking (through Transportation Demand Management, Regulation XV programs, increased parking cost, etc.).
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Encourage Market Incentives/ Disincentives 2. Promote a regional approach to increasing parking costs in order to discourage low vehicle occupancy.	1. Establish parking management strategies for governmental and private facilities that discourage single occupancy vehicle usage and reward high vehicle occupancy rates without placing the County at an economic disadvantage in enticing jobs by means such as[1]: • Recapturing parking costs through: establish fees; single occupant surcharges; reduced employee subsidized parking; and increased parking enforcement.
SUBTOPIC 6: CLEANER FUELS		
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Support Legislation 1. Promote state and federal legislation which would improve vehicle/transportation technology and which would establish differential pricing mechanisms to assess the true cost of emissions.	1. Support legislation to stimulate the development of practical electric vehicles (15). 2. Support state legislation which would establish: 1) Emission Fees on gasoline products and Differential Registration Fees on motor vehicles according to the emission levels that they are designed to produce. Include exploration of an option that imposes pollution fees on individual vehicles at the time of mandated smog inspection, based on actual vehicle performance. 3. Support legislation which tightens the existing vehicle inspection program, both in terms of standards to be met and requirements for compliance.
	Institute Clean Fuel Systems 2. Invest in clean fuel systems on new local government fleet vehicles.	1. Institute clean fuel systems on new local government fleet vehicles (G 4).

[1] Programs which further more than one air quality policy

TOPIC 2: GROUND TRANSPORTATION

GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
SUBTOPIC 2: CONGESTION MANAGEMENT (Continued)		
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Integrate Congestion Management Program 3. Coordinate overlapping components of the State mandated Congestion Management Program and the Regional Air Quality Plan.	1. Participate with SANBAG in defining and implementing a Congestion Management Program for San Bernardino County to insure appropriate coordination with air quality planning.
	Establish Congestion Fees 4. Promote market based incentives and disincentives to relieve peak hour/peak direction congestion within highly congested travel corridors.	1. Cooperatively initiate a pilot program to explore, jointly with Los Angeles, Orange and Riverside counties, methods and workability of Congestion Fees for peak hour/peak direction use to be levied within highly congested travel corridors, particularly those which generate emissions transported to San Bernardino County.
SUBTOPIC 3: EXPANDED TRANSIT SYSTEMS AND SERVICES		
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Expand Transit in the County 1. Cooperate in efforts to expand bus, rail and other forms of transit in the portion of the South Coast Air Basin within San Bernardino.	1. Participate with public transit providers serving San Bernardino County in a cooperative program to increase transit services with existing equipment and expand services through transit facility improvements. 2. Coordinate with public transit providers to increase funding for transit improvements to supplement other means of travel (2g).[1] 3. Plan for intraregional commuter and main line rail service development including convenience facilities at rail stops through such means as: • Intensifying planned land uses in the vicinity of transit stops. • Consolidating parking facilities to support transit as well as adjacent uses. 4. Develop design standards that promote access to transit facilities.
	Expand Transit in the Air Basin 2. Promote expansion of all forms of transit in the urbanized portions of San Bernardino, Orange, Los Angeles and Riverside Counties.	1. Influence the expansion of intraregional commuter and main line rail services, particularly those linking with destinations in San Bernardino County. 2. Support public transit providers in efforts to increase funding for transit improvements to supplement other means of travel (2g).[1] 3. Jointly support efforts to establish a regionwide bus pass.
SUBTOPIC 4: NON-MOTORIZED MEANS OF TRANSPORTATION		
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Promote Non-Motorized Transportation 1. Provide for bicycle and pedestrian pathways to encourage non-motorized trips.	1. Develop standards and guidelines to incorporate into development plans for increased bicycle and pedestrian routes and support facilities to link appropriate activity centers to nearby residential development.

[1] Programs which further more than one air quality policy

TOPIC 2: GROUND TRANSPORTATION

GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
SUBTOPIC 1: AUTO USE		
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Reduce vehicle miles traveled (Continued)	2. Establish and maintain telecommunications strategies to reduce the length of auto trips through such actions as:[1] • Implementing teleconferencing and telecommuting programs in public agencies (1.b.) • Requiring teleconferencing and telecommuting for private employers with more than 25 employees at a single location. Apply to existing businesses at license renewal times; to new businesses at project approval or permit stage (1.b.). 3. Define and implement auto limitation procedures in selected areas and at selected times, provided that alternative transportation modes are available, by (2.e.):[1] • Establishing regulations and procedures to limit direct auto access: - To special event centers; and - In auto-free zones during peak periods.
SUBTOPIC 2: CONGESTION MANAGEMENT		
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Modify Work Schedules 1. Promote and establish modified work schedules which reduce peak period auto travel	1. Establish incentives and regulations to spread work trips over a longer period to reduce peak period congestion, including such actions as (1.a):[1] • Implementing staggered, flexible and compressed work schedules in public agencies. • Requiring work schedule flexibility programs for employers with more than 25 employees at a single location. Apply to existing businesses at license renewal time; to new businesses at project approval or permit stage.
	Establish HOV lanes 2. Participate in efforts to achieve increased designation, construction, and operation of HOV lanes on freeways in Los Angeles, Orange, Riverside and San Bernardino Counties.	1. Jointly, through the County, SANBAG, and SCAG participate with adjacent counties in expanding HOV lanes on the freeway system within those counties by: • Initiating an HOV task force to work with CALTRANS in implementing HOV lanes within the urbanized and urbanizing portions of San Bernardino, Orange, Los Angeles and Riverside counties.

[1] Programs which further more than one air quality policy

TOPIC 2: GROUND TRANSPORTATION

GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
SUBTOPIC 1: AUTO USE		
A diverse and efficiently operated ground transportation system which generates the minimum feasible pollutants.	Eliminate Vehicle Trips 1. Use incentives, regulations and Transportation Demand Management in cooperation with other jurisdictions in the South Coast Air Basin to eliminate vehicle trips which would otherwise be made.	1. Establish and implement a Transportation Demand Management Program through actions such as[1]: • Requiring TMA/TMO establishment for large employers and commercial/industrial complexes. Apply to new businesses at project approval or permit stage (2.a.). • Implementing employee rideshare and transit incentives in public agencies (2.a.). • Requiring employee rideshare and transit incentives for employers with more than 25 employees at a single location. Apply to existing businesses at license renewal time; to new businesses at project approval or permit stage (2.a.). • Participating in cooperative efforts to establish legislation affording incentives for purchase of Vanpools (2.c.). • Participating in the design and establishment of incentives which would eliminate vehicle trips. • Implementing teleconferencing and telecommuting programs in public agencies (1.b.). • Requiring teleconferencing and telecommuting for private employers with more than 25 employees at a single location. Apply to existing businesses at license renewal time; to new businesses at project approval or permit stage (1.b.). • Participating with SANBAG to develop a private/public telecommunication center in San Bernardino County. 2. Define and implement auto limitation procedures in selected areas and at selected times, provided that alternative transportation modes are available, by: • Establishing regulations and procedures to limit direct auto access(2.e.):[1] - To special event centers; and - In auto-free zones during peak periods. 3. Establish incentives and regulations to eliminate work trips including such actions as: • Implementing staggered, flexible and compressed work schedules in public agencies (1.a)[1]. • Requiring work schedule flexibility programs for employers with more than 25 employees at a single location. Apply to existing businesses at license renewal time; to new businesses at project approval or permit stage (1.a)[1].
	Reduce vehicle miles traveled 2. Use incentives, regulations and Transportation Demand Management in cooperation with other jurisdictions in the South Coast Air Basin to reduce the vehicle miles traveled for auto trips which still need to be made.	1. Establish and implement a Transportation Demand Management Program through actions such as[1]: • Requiring TMA/TMO establishment for large employers and commercial complexes. Apply to new businesses at project approval or permit stage (2.a.). • Implementing employee rideshare and transit incentives in public agencies (2.a.). • Requiring employee rideshare and transit incentives for employers with more than 25 employees at a single location. Apply to existing businesses at license renewal time; to new businesses at project approval or permit stage (2.a.). • Participating in cooperative efforts to establish legislation providing incentives for purchase of Vanpools (2.c.). • Participating in the design and establishment of incentives which would reduce vehicle miles traveled.

[1] Programs which further more than one air quality policy

REGIONAL AIR QUALITY IMPLEMENTATION PLAN
SAN BERNARDINO COUNTY/CITIES

TOPIC 1: GOVERNMENT ORGANIZATION, ROLES & RESPONSIBILITIES		
GOAL	**POLICIES**	**PROGRAMS AND ACTION OPTIONS**
Effective coordination of air quality improvement within the portion of the South Coast Air Basin in San Bernardino County and improved air quality through reductions in pollutants from Orange and Los Angeles counties.	Support Innovative Approaches 5. Advocate and support innovative strategies to improve air quality.	1. Support new approaches to improving air quality through: • Supporting legislation; • Cooperating with regional bodies; • Establishing pilot programs; and • Funding and/or participating in private/public partnerships Potential actions could include: • Supporting legislation which would authorize imposition of consumer product Emission Fees, either at retail outlets or manufacturing points; • Instituting Time of Day, Seasonal and Place Control Measures; • Implementing an Auto Buy-Back Program; • Creating an Emissions Reduction Trust to administer emission offsets; • Investigating the feasibility of Highway Electrification and Automation; and • Supporting state enabling legislation to reassess the equitable distribution of property and sales tax revenues.

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GOALS, POLICIES, PROGRAMS AND ACTION OPTIONS

TOPIC 1: GOVERNMENT ORGANIZATION, ROLES & RESPONSIBILITIES

GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
Effective coordination of air quality improvement within the portion of the South Coast Air Basin in San Bernardino County and improved air quality through reductions in pollutants from Orange and Los Angeles counties.	Establish Coordinated Approach 1. Coordinate with other jurisdictions in San Bernardino County to establish parallel air quality plans and implementation programs.	1. Adopt local air quality plans based on the San Bernardino County/Cities Regional Air Quality Plan. 2. Establish an ongoing air quality implementation and project referral process within the San Bernardino portion of the South Coast Air Basin, adapting it as necessary to local circumstances, resources and procedures.
	Integrate With Related Programs 2. Coordinate a process to integrate related functional programs' implementation, monitoring and reporting.	1. Establish a coordination process for relating parallel and implementive actions undertaken as part of other regional or countywide plans. 2. Participate with SANBAG in defining and implementing a Congestion Management Program for San Bernardino County.[1] 3. Establish and maintain an implementation/monitoring system devised as part of the Air Quality Plan preparation. Integrate with monitoring and reporting systems required for purposes which overlap with the Air Quality Plan.
	Affect Source Jurisdictions 3. Cooperate actively with Los Angeles, Orange and Riverside counties to comprehensively improve air quality at the emission source.	1. Jointly establish a communication network with key elected officials and staff involved in air quality planning in Los Angeles, Orange and Riverside counties as the basis for identifying and implementing parallel measures of mutual benefit.
	Encourage Community Participation 4. Involve environmental groups, the business community, special interests and the general public in the formulation and implementation of programs which effectively reduce air borne pollutants.	1. Design and conduct efforts to involve the public and affected/interested parties in the adoption of local air quality plans and implementation of air quality improvement programs, including: • Conduct Public Forums • Establish Communication and Education Programs • Make written briefs available locally • Conduct Planning Commission/City Council public workshops • Utilize a variety of media forms to maximize citizen involvement

[1] Programs which further more than one air quality policy

GOALS, POLICIES, PROGRAMS AND ACTION OPTIONS

Revised November 29, 1990

REGIONAL AIR QUALITY PLAN	
PURPOSE	**PRINCIPLES**
Achievement of state and federal air quality standards within established schedules in the South Coast Air Quality Management Plan and maintenance of air quality standards at prescribed levels once they are achieved.	Air Quality and Economic Growth 1. Achieve air quality improvements in such a way that continued economic growth can be sustained. Market Incentives and Regulations 2. Achieve necessary air quality related life style and economic changes through market incentives where feasible and through regulatory measures where necessary.

Policy 5.2 **Reduce Emissions from Building Materials/Methods**

Reduce emissions from building materials and methods which generate excessive pollutants.

Programs:

5.2.1 Adopt incentives, regulations and procedures to prohibit the use of building materials and methods which generate excessive pollutants (F-9).

TOPIC 6: ENERGY CONSERVATION

GOAL 6 Reduced emissions through reduced energy consumption.

Policy 6.1 **Energy Conservation**

Reduce energy consumption through conservation improvements and requirements.

Programs:

6.1.1 Implement plans and programs to phase in energy conservation improvements through the annual budget process (18.a).

6.1.2 Adopt incentives and regulations to enact energy conservation requirements for private development.

Policy 6.2 **Limit Water Heater Emissions**

Reduce water heating emissions resulting from swimming pool heaters and residential and commercial water heaters.

Programs:

6.2.1 Adopt incentives and regulations to reduce emissions from swimming pool heaters (d-4).

6.2.2 Adopt incentives and regulations to reduce emissions from residential and commercial water heating (d-5).

Policy 6.3 **Recycle Wastes**

Promote local recycling of wastes and use of recycled materials.

Programs:

6.3.1 Implement provisions of AB 939 and adopt incentives, regulations and procedures to specify local recycling requirements (18.b).

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[1] Programs which further more than one air quality policy.

4.2.4 Develop and adopt an agreement among the participating jurisdictions as to mutually acceptable approaches to improve and maintain jobs/housing balance.

Policy 4.3 **Protect Sensitive Receptors**

Support a regional approach to regulating the location and design of land uses which are especially sensitive to air pollution.

Programs:

4.3.1 Participate with the SCAQMD in jointly formulating appropriate standards for regulating the location and protection of sensitive receptors (schools, day care facilities, hospitals and the like) from excessive and hazardous emissions.

Policy 4.4 **Integrate Planning Process**

Integrate air quality planning with the land use and transportation process.

Programs:

4.4.1 Locate and design new development in a manner that will minimize direct and indirect emission of air contaminants.

TOPIC 5: PARTICULATE EMISSIONS

GOAL 5 The minimum practicable particulate emissions from the construction and operation of roads and buildings.

Policy 5.1 **Control Dust**

Reduce particulate emissions from roads, parking lots, construction sites and agricultural lands.

Programs:

5.1.1 Adopt incentives, regulations and procedures to manage paved roads so they produce the minimum practicable level of particulates (12.a).

5.1.2 Adopt incentives, regulations and procedures to minimize particulate emissions during road, parking lot and building construction (f-4).

5.1.3 Adopt incentives, regulations and procedures to control particulate emissions from unpaved roads, drives, vehicle maneuvering areas and parking lots (12.b).

5.1.4 Adopt incentives, regulations and procedures to limit dust from agricultural lands and operations (where applicable) (E-3).

[1] Programs which further more than one air quality policy.

Programs:

3.2.1 Adopt/urge establishment of requirements for centralized ground power systems to be installed and used as soon as practicable at existing air carner airports (7).

Policy 3.3 **Promote Improved Ground Access**

Promote conditioning of air carrier airports upon inclusion of plans for improved ground access.

Programs:

3.3.1 Adopt/urge establishment of an ordinance requiring air carrier airport operators to obtain permits based on approved plans for trip reduction, facility design and access improvements (8).

TOPIC 4: LAND USE

Goal 4 A pattern of land uses which can be efficiently served by a diversified transportation system and land development projects which directly and indirectly generate the minimum feasible air pollutants (17).

Policy 4.1 **Manage Growth**

Manage growth by insuring the timely provision of infrastructure to serve new development.

Programs:

4.1.1 Incorporate phasing policies and requirements in general plans and development plans to achieve timely provision of infrastructure (particularly transportation facilities) to serve development.

Policy 4.2 **Balance Growth**

Improve the balance between jobs and housing in order to create a more efficient urban form.

Programs:

4.2.1 Improve jobs/housing balance through new development and redevelopment project reviews and actions.

4.2.2 Improve jobs/housing balance at a subregional level in relation to major activity centers as new development occurs.

4.2.3 Continue support for and consider expansion of the CLOUT demonstration project to incorporate: incentive oriented tax credits; loan programs; small business development programs; and complementary land use policies, all aimed at improving the jobs/housing balance in the western San Bernardino/eastern Los Angeles Counties area.

' Programs which further more than one air quality policy.

Fugitive Dust - *Dust particles that are introduced into the air through certain activities such as soil cultivation, off-road vehicles, or any vehicles operating on open fields or dirt roadways.*

Lead

Lead is a gray-white metal that is soft, malleable, and resistant to corrosion. Sources of lead resulting in concentrations in the air include industrial sources and weathering of soils, followed by fugitive dust emissions. Health effects from exposure to lead include brain and kidney damage, learning disabilities, seizures and death. Fetuses, infants and children are more sensitive than others to the adverse effects of lead exposure. Exposure to low levels of lead can adversely affect the development and function of the central nervous system, leading to learning disorders, distractibility, inability to follow simple commands and a lower intelligence quotient.

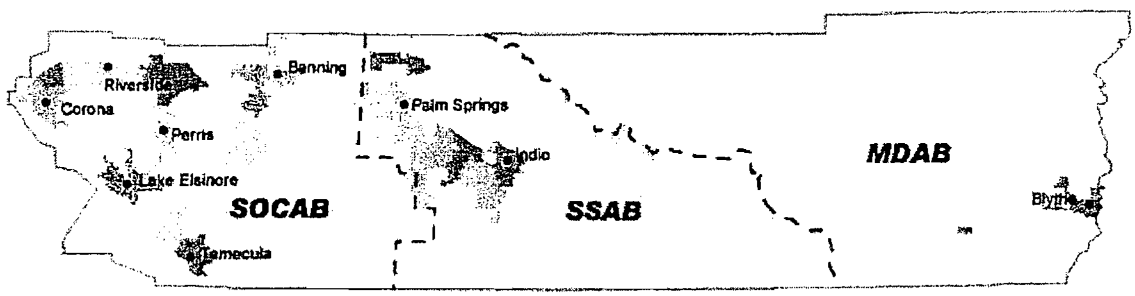
The SOCAB, SSAB and MDAB are all designated as attainment areas for both federal and state lead standards.

Particulate Matter

Particulate matter is the term used for a mixture of solid particles and liquid droplets found in the air. Coarse particles (larger than 2.5 but smaller than 10 micrometers, or PM_{10}) come from a variety of sources, including windblown dust and grinding operations. Fine particles (less than 2.5 micrometers, or $PM_{2.5}$) often come from fuel combustion, power plants and diesel buses and trucks. Fine particles can also be formed in the atmosphere through chemical reactions. PM_{10} and its health affects are discussed in greater detail later in the Particulate Matter section of this Element.

The SOCAB and SSAB are designated as non-attainment areas for both state and federal PM_{10}. The MDAB is designated as a non-attainment area for state PM_{10} standards, but as an attainment unclassified area for Federal standards (after meeting attainment standards, the MDAQMD discontinued monitoring efforts; consequently it cannot be given full attainment status).

The following table summarizes the attainment status for these six pollutants within each of the three air quality basins covering Riverside County.



Source Information: SCAQMD.
The oldest data shown on this map is 1990

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Air Basin Boundary

SOCAB - South Coast Air Basin
SSAB - Salton Sea Air Basin
MDAB - Mojave Desert Air Basin

Figure AQ-1

0 20 Miles

RIVERSIDE COUNTY AIR QUALITY BASINS

Riverside County has made great strides in achieving state and federal air quality standards. The following provides a description of the six criteria air pollutants and their attainment status in each of the three Riverside County air basins.

Ozone

Ozone is a pungent, colorless gas typical of southern California smog. Elevated ozone concentrations result in reduced lung function, particularly during vigorous physical activity. Ozone levels peak during the summer and early fall months.

The SOCAB is designated as a non-attainment area for both federal and state ozone standards, meaning that air quality standards are being exceeded. The Environmental Protection Agency (EPA) has classified the entire Southern California Association of Governments region as an "extreme" non-attainment area, and has mandated that the South Coast Air Quality Basin achieve attainment by 2010. The SSAB and MDAB are both designated as non-attainment areas for federal and state ozone standards.

Carbon Monoxide

Carbon monoxide (CO) is formed by the incomplete combustion of fossil fuels, almost entirely from automobiles. It is a colorless, odorless gas that can cause dizziness, fatigue and impairments to central nervous system functions.

The SOCAB is designated as a non-attainment area for federal CO standards. However, the Riverside County area of SOCAB has not exceeded either federal or state CO standards in the past five years. The SSAB and MDAB have both been designated as attainment areas for federal and state Carbon Monoxide standards.

Nitrogen Oxides

Nitrogen dioxide (NO_2), a reddish brown gas, and nitric oxide (NO), a colorless odorless gas, are jointly referred to as nitrogen oxides or NO_x. NO_x is a primary component of smog and also contributes to other pollution problems such as high concentration of fine particulate matter, poor visibility, and acid deposition. NO_2 decreases lung function and may reduce resistance to infection.

The SOCAB has not exceeded either federal or state standards for nitrogen dioxides in the past five years. It is designated as a maintenance area (an area that was once classified as non-attainment but has recently shown achievement of air quality standards) under federal standards and as an attainment area under state standards. The SSAB and MDAB are designated as attainment areas for both federal and state NO_2 standards.

Sulfur Dioxide

Sulfur dioxide (SO_2) is a colorless irritating gas created mainly by industrial facilities. SO_2 irritates the respiratory tract, injures lung tissue when combined with fine particulate matter and reduces visibility and the level of sunlight.

The SOCAB, SSAB and MDAB are all designated as attainment areas for both federal and state sulfur dioxide standards.

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The SOCAB, SSAB and MDAB are all designated as attainment areas for both federal and state sulfur dioxide standards.

Issues and Policies

AIR QUALITY

> *Air quality is viewed as such an important factor in the quality of life that its measurements are used as a major factor in evaluating the Plan's performance.*
>
> *– RCIP Vision*

Six criteria air pollutants have been established for every air basin within the State of California. These are pollutants for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. As shown in Table AQ-1, Ambient Air Quality Standards, federal and state standards have been developed for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide and PM_{10}. Federal primary standards for air pollutants have been established to protect the public health, while secondary standards protect the public welfare by preventing impairment of visibility and damage to vegetation and property.

Table AQ-1
Ambient Air Quality Standards

Pollutant	Averaging Time	State	Federal Primary	Federal Secondary
Ozone	1 Hour	0.09 ppm	0.12 ppm	Same as Primary Standard
	8 Hour	0.08 ppm	0.08 ppm	
Nitrogen Dioxide	Annual Average	0.053 ppm	0.053 ppm	Same as Primary Standard
	1 Hour	0.25 ppm	–	
Carbon Monoxide	8 Hour	9.0 ppm	9.0 ppm	–
	1 Hour	20.0 ppm	35.0 ppm	–
Suspended Particulate Matter (PM_{10} & $PM_{2.5}$)	Annual Geometric Mean	30 µg/m³	65 µg/m³ ($PM_{2.5}$)	–
	24 Hour	50 µg/m³	150 µg/m³ (PM_{10}) 15 µg/m³ ($PM_{2.5}$)	Same as Primary Standard
	Annual Arithmetic Mean	--	50 µg/m³	
Sulfur Dioxide	Annual Average	--	0.03 ppm	Same as Primary Standard
	24 Hour	0.04 ppm	0.14 ppm	
	3 Hour	--	--	0.5 ppm
	1 Hour	0.25 ppm	–	–
Lead	30 Day Average	1.5 µg/m³	--	--
	Calendar Quarter	--	1.5 µg/m³	Same as Primary Standard

Notes: ppm = parts per million; µg/m³ = micrograms per cubic meter of air
Source: California Air Resources Board Fact Sheet 39, 1998.

Indirect Source – *A facility, building, structure, installation, property, road, or highway which attracts, or may attract, mobile sources of pollution such as cars and trucks.*

To achieve the goals and objectives of the air quality plans at the local level, all cities and counties must adopt air quality elements or other elements/plans that fully address air quality as well as implement these plans to achieve compliance with state and federal standards. Local responsibilities for achieving compliance primarily focus on measures that control "Indirect Sources" such as facilities, buildings, structures, installations, real property, roads or highways that attract mobile sources of pollution.

Regulatory Restrictions

The combination of geographical features and high levels of pollutants produced in the region have resulted in the Environmental Protection Agency (EPA) designating the air basins in Riverside County as non-attainment areas (Table AQ-2). This means that due to the high level of pollutants in the region, the area is not expected to meet National Ambient Air Quality Standards in the near future.

The Federal Clean Air Act (1977 Amendments) requires that designated agencies in any region of the nation not meeting national clean air standards must prepare a plan demonstrating the steps that would bring the area into compliance with all national standards by December 31, 1987. In response, the Governor of California designated agencies to develop these plans.

For the South Coast Air Basin and the Salton Sea Air Basin, the agencies designated to develop regional air quality plans are the South Coast Air Quality Management District (SCAQMD) and the Southern California Association of Governments (SCAG). The two agencies first adopted an Air Quality Management Plan (AQMP) in 1979 and have revised it several times subsequently, as earlier attainment forecasts were shown to be overly optimistic. Equivalent regional air quality plans were created for the Mojave Desert Air Basin by the Mojave Desert Air Quality Management Basin (MDAQMD) in conjunction with SCAG.

In 1998, the California Legislature enacted the California Clean Air Act (CCAA). The CCAA requires regional emissions to be reduced by 5% per year, averaged over a 3-year period, until attainment can be demonstrated. Each region that did not meet a national or state air quality standard was required to prepare a plan which demonstrated how the 5% reductions were to be achieved. In response, the SCAQMD and MDAQMD revised their air quality plans to meet CCAA requirements.

The latest AQMP, approved in 1997, was designed to meet both federal and state air quality planning guidelines. Strategies for controlling air pollutant emissions in the AQMP are grouped into three "tiers," based on their anticipated timing for implementation. Tier I consists of the implementation of best available current technology and management practices that can be adopted within five years. Tier II is based on anticipated advancement in current technology and vigorous regulatory action, while Tier III controls consist of implementation measures which first require the development of new technologies.

The MDAQMD adopted its Air Quality Attainment Plan in 1995 to meet state ozone standards and the Attainment Demonstration Plan in 1996 to meet federal ozone standards. While the Mojave Desert Air Basin is classified by the state as a non-attainment area for PM_{10} (coarse particles larger than 2.5 but smaller than 10 micrometers), state law does not require an air quality plan to meet this standard, and as such, no plan has been adopted.

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MOJAVE DESERT AIR BASIN

The Mojave Desert Air Basin (MDAB), comprised of 21,000 square miles, encompasses the eastern portion of Riverside County consisting of the Palo Verde Valley along with portions of Los Angeles, Kern and San Bernardino Counties. Air quality conditions in the Riverside County MDAB are partly under the jurisdiction of the SCAQMD and partly under the jurisdiction of the Mojave Desert Air Quality Management District (MDAQMD).

The MDAB consists of an assemblage of mountain ranges interspersed with long broad valleys that often contain dry lakes. Many of the lower mountains that dot the vast terrain rise from 1,000 to 4,000 feet above the valley floor. Prevailing winds in the MDAB are out of the west and southwest. These prevailing winds are due to the proximity of the MDAB to coastal and central regions and the presence of the Sierra Nevada mountains, which pose as a natural barrier to the north; air masses pushed onshore in southern California by differential heating are channeled through the MDAB. The MDAB is separated from the southern California coastal and central California valley regions by mountains whose passes form the main channels for these air masses.

During the summer months, the MDAB is generally influenced by a Pacific Subtropical High Cell that sits off the coast, inhibiting cloud formation and encouraging daytime solar heating. The MDAB is rarely influenced by cold air masses moving south from Canada and Alaska, with desert moisture arriving from infrequent warm, moist and unstable air masses from the south. The MDAB averages between three and seven inches of precipitation per year.

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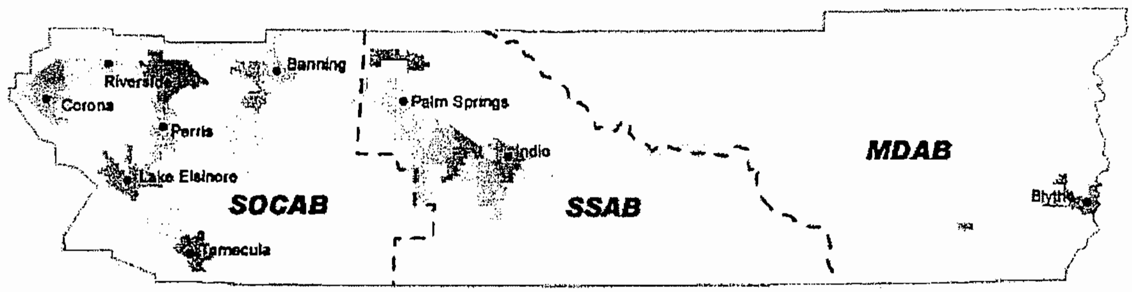

Air Basin Boundary

SOCAB - South Coast Air Basin
SSAB - Salton Sea Air Basin
MDAB - Mojave Desert Air Basin

0 20 Miles

Source Information: SCAQMD.
The oldest data shown on this map is 1990.

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Figure AQ-1

RIVERSIDE COUNTY
AIR QUALITY BASINS

This phenomenon is frequently observed in the middle of late afternoon on hot summer days when the smog appears to clear up suddenly. Winter inversions frequently break by mid-morning, thereby preventing contaminant build-up.

The combination of low wind speeds and low level inversions produces the greatest concentration of pollutants. On high wind days other air pollutants including particulate matter such as dust and soil are swept and carried in the air. On days of no inversion or on days of winds averaging over 15 miles per hour, there will be no important smog effects, during either summer or winter.

Smog - A combination of smoke, ozone, hydrocarbons, nitrogen oxides, and other chemically reactive compounds which, under certain conditions of weather and sunlight, may result in a murky brown haze that causes adverse health effects. The primary source of smog in California is motor vehicles.

In the winter, the greatest pollution problems are carbon monoxide and oxides of nitrogen because of extremely low level inversions and air stagnation during the night and early morning hours. Smog levels are much lower during this season due to the lack of strong inversion during the daylight hours and the lack of intense sunlight which is needed to produce photochemical reactions.

In the summer, the longer daylight hours and the brighter sunshine combine to cause a reaction between hydrocarbons and oxides of nitrogen to form more smog. Carbon monoxide is not as great a problem in summer because inversions are not as low and intense in the surface boundary layer (within 100 feet of the ground) as in winter and because horizontal ventilation is better in summer.

The basin-wide average occurrence of inversion at the ground surface is 11 days per month; the averages vary from two days in June to 22 days in December and January. The potential for high concentration varies seasonally for many contaminants. During late spring, summer and early fall, light winds, low mixing heights and brilliant sunshine combine to produce conditions favorable for the maximum production of photochemical oxidants, mainly ozone. During the spring and summer, when fairly deep marine layers are frequently found in the Basin, sulfate concentrations are at their peak.

SALTON SEA AIR BASIN

Subtropical High Cell - An area of atmospheric high pressure located at approximately 30 degrees north and south latitude. Air tends to sink near high-pressure centers, which inhibits precipitation and cloud formation. This is why high-pressure systems tend to bring bright, sunny days with calm weather.

The middle part of Riverside County (between San Gorgonio Pass and Joshua Tree National Monument), belongs in the Salton Sea Air Basin (SSAB), along with Imperial County. Air quality conditions in this portion of the County, although in the SSAB, are also administered by the SCAQMD. The SCAQMD is responsible for the development of the regional Air Quality Management Plan and efforts to regulate pollutant emissions from a variety of sources.

The SSAB portion of Riverside County is separated from the SOCAB region by the San Jacinto Mountains and from the Mojave Desert Air Basin to the east by the Little San Bernardino Mountains. During the summer, the SSAB is generally influenced by a Pacific Subtropical High Cell that sits off the coast, inhibiting cloud formation and encouraging daytime solar heating. The SSAB is rarely influenced by cold air masses moving south from Canada and Alaska, as these systems are weak and diffuse by the time they reach the desert. Most desert moisture arrives from infrequent warm, moist and unstable air masses from the south. The SSAB averages between three and seven inches of precipitation per year.

The Setting

Riverside County is located within three air basins, as can be seen on Figure AQ-1, Riverside County Air Quality Basins They are the South Coast Air Basin (SOCAB), Salton Sea Air Basin (SSAB) and the Mojave Desert Air Basin (MDAB). Air quality within each basin is not only affected by various emissions sources (mobile, industry, etc.), but also by atmospheric conditions such as wind speed, wind direction, temperature and rainfall. The following provides a description of each air basin and its relevant climate and meteorological conditions affecting air pollution.

SOUTH COAST AIR BASIN

Western Riverside County (west of the San Gorgonio Pass) is located within the South Coast Air Basin (SOCAB), which includes all of Orange County and the non-desert portions of Los Angeles, Riverside and San Bernardino Counties. Air quality conditions in the SOCAB are under the jurisdiction of the South Coast Air Quality Management District (SCAQMD).

According to the Air Quality Management Plan (AQMP), the worst air quality problem in the nation occurs in the South Coast Air Basin. With very light average wind speeds, the basin atmosphere has a limited capability to disperse air contaminants horizontally. The dominant daily wind pattern is a daytime sea breeze (onshore breeze) and a nighttime land breeze (offshore breeze), broken only occasionally by winter storms and infrequent strong Santa Ana winds from the Great Basin, Mojave, and deserts to the north.

> ***Santa Ana Winds** - Santa Ana winds are generally defined as warm, dry winds that blow from the east or northeast (offshore) occurring predominantly between the months of December and February. The winds develop when a region of high pressure builds over the Great Basin (the high plateau east of the Sierra Mountains and west of the Rocky Mountains including most of Nevada and Utah) and move locally across the Mojave Desert and then over and through passes in the San Gabriel, San Bernardino and San Jacinto Mountains.*

On virtually all spring and early summer days, most of the pollution produced during an individual day is moved out of the basin through mountain passes, or is lifted by the warm, vertical currents produced by the heating of mountain slopes. In those seasons, the basin can be "flushed" of pollutants by a transport of ocean air during the afternoon. From late summer through the winter months, the flushing is less pronounced because of lower wind speeds and the earlier appearance of offshore winds. With extremely stagnant wind flows, the drainage winds may begin near the mountains by late afternoon. Remaining pollutants are trapped and begin to accumulate during the night and the following morning. A low average morning wind speed in pollution source areas is an important indicator of air stagnation potential.

The vertical dispersion of air pollutants in the South Coast Air Basin is hampered by the presence of a temperature inversion in the layers of the atmosphere near the surface of the Earth. In a normal situation, as temperatures decrease with altitude, air continues to rise as it remains warmer than the surrounding air. With an inversion layer, air cannot continue to expand upwards, as it is trapped by the warmer air above.

> ***Inversion layer** - A layer of warm air that traps the cooler air and any pollutants it carries below.*

However, as the day progresses and the sun warms the ground, the surface layer of air approaches a temperature equal to that of the inversion layer. When these temperatures become equal, the inversion layer begins to erode at its lower edge. If enough warming takes place, the inversion layer becomes weaker and weaker and finally "breaks." The surface air layers can then mix upward without limit.

Ambient Air - Outside air, any portion of the atmosphere not contained by walls and a roof.

It is an intent of this Air Quality Element to provide background information on the physical and regulatory environment affecting air quality in the County. This element also identifies goals, policies and programs that are meant to balance the County's actions regarding land use, circulation and other issues with their potential effects on air quality. This element in conjunction with local and regional air quality planning efforts addresses ambient air quality standards set forth by the Federal Environmental Protection Agency and the California Air Resources Board (CARB).

Chapter 9: Air Quality Element

Introduction

> Air quality attainment goals established by the South Coast Air Quality Management District have been more than met despite the substantial growth in the region in the last 20 years. Most of this is a result of significantly improved engine technology and the replacement of more polluting vehicles. However, local initiatives that expanded transit options, concentrated development more efficiently, and increased local employment opportunities have also contributed to air quality improvement.
>
> – RCIP Vision

WHY IS AIR QUALITY IMPORTANT?

The quality of the air we breathe directly affects our health, environment, economy and our quality of life. Because the inside of our bodies are in constant contact with the outside world through the oxygen we inhale, air pollutants make their way to our lungs and into our blood stream. An overabundance of pollutants in the air can cause mild to severe health effects, including increased hospitalization and emergency room visits, respiratory illnesses, increased risk of developing cancer, decreased breathing capacity, lung inflammation, difficulty in exercising and even a reduction in life-span.

Just as we are affected by air pollution, so too are plants and animals. Animals must breathe the same air and are subject to the same types of negative health effects. Certain plants and trees may absorb air pollutants which can stunt their development or cause premature death. There are also numerous impacts to our economy including lost work days due to illness, a desire on the part of business to locate in areas with a healthy environment, and increased expenses from medical costs. Pollutants may also lower visibility and cause damage to property Certain air pollutants are responsible for discoloring painted surfaces, eating away at stones used in buildings, dissolving the mortar that holds bricks together, and cracking tires and other items made from rubber.

WHAT CAN WE DO ABOUT AIR QUALITY?

Air quality is a regional issue, effecting and affected by every city and county. Although Riverside County generates the lowest emissions of any county in the South Coast Air Basin, air quality in the County is among the Basin's worst due to onshore winds transporting vast amounts of pollutants from Los Angeles and Orange Counties into the Inland Empire.

While the County and the region have made great strides in reducing air pollution, it is committed to meeting state and federal air quality guidelines. Policies and programs addressed in this element will focus on the two main sources of air pollutant emissions: mobile sources and stationary sources. Mobile sources include automobiles, motorcycles, trucks and airplanes. Motor vehicles constitute the largest generator of air pollutant emissions in Riverside County. Stationary sources produce significant amounts of pollutants and include electrical power-generating facilities, manufacturing, fabrication, miscellaneous industrial processes and combustion of natural gas.

9. Air Quality Element

AIR QUALITY ELEMENT

EXAMPLE #2

COUNTY OF RIVERSIDE

TOPIC 5: PARTICULATE EMISSIONS

GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
The minimum practicable particulate emissions from the construction and operation of roads and buildings.	Control Dust 1. Reduce particulate emissions from roads, parking lots, construction sites and agricultural lands.	1. Adopt incentives, regulations and procedures to manage paved roads so that they produce the minimum practicable level of particulates (12a). 2. Adopt incentives, regulations and procedures to minimize particulate emissions during road, parking lot and building construction (I-4). 3. Adopt incentives, regulations and procedures to control particulate emissions from unpaved roads, drives, vehicle maneuvering areas and parking lots (12b). 4. Adopt incentives, regulations and procedures to limit dust from agricultural lands and operations (where applicable) (E-3).
	Reduce Emissions from Building Materials/Methods 2. Reduce emissions from building materials and methods which generate excessive pollutants.	1. Adopt incentives, regulations and procedures to prohibit the use of building materials and methods which generate excessive pollutants (F-9).

TOPIC 6: ENERGY CONSERVATION

GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
Reduced emissions through reduced energy consumption.	Energy Conservation 1. Reduce energy consumption through conservation improvements and requirements.	1. Implement plans and programs to phase in energy conservation improvements through the annual budget process (18a). 2. Adopt incentives and regulations to enact energy conservation requirements for private development.
	Limit Water Heater Emissions 2. Reduce water heating emissions resulting from swimming pool heaters and residential and commercial water heaters.	1. Adopt incentives and regulations to reduce emissions from swimming pool heaters (d-4). 2. Adopt incentives and regulations to reduce emissions from residential and commercial water heating (d-5).
	Recycle Wastes 3. Promote local recycling of wastes and use of recycled materials.	1. Implement provisions of AB 939 and adopt incentives, regulations and procedures to specify local recycling requirements (18b).

TOPIC 4: LAND USE		
GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
	Protect Sensitive Receptors 3. Support a regional approach to regulating the location and design of land uses which are especially sensitive to air pollution.	1. Participate with the SCAQMD in jointly formulating appropriate standards for regulating the location and protection of sensitive receptors (schools, day care facilities, hospitals and the like) from excessive and hazardous emissions.
	Integrated Planning Process 4. Integrate air quality planning with the land use and transportation planning processes.	1. Locate and design new development in a manner that will minimize direct and indirect emission of air contaminants through such means as: • Promoting mixed use development to reduce the length and frequency of vehicle trips. • Providing for increased intensity of development along existing and proposed transit corridors. • Providing for the location of ancillary employee services (including, but not limited to child care, restaurants, banking facilities, convenience markets) at major employment centers for the purpose of reducing midday vehicle trips.

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TOPIC 4: LAND USE

GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
A pattern of land uses which can be efficiently served by a diversified transportation system and land development projects which directly and indirectly generate the minimum feasible air pollutants (17).	<u>Manage Growth</u> 1. Manage growth by insuring the timely provision of infrastructure to serve new development.	1. Incorporate phasing policies and requirements in general plans and development plans to achieve timely provision of infrastructure (particularly transportation facilities) to serve development through: • Tying growth to Level of Service (LOS) standards; and • Using Urban Limit Lines or phasing areas to manage growth.
	<u>Balance Growth</u> 2. Improve the balance between housing and jobs in order to create a more efficient urban form.	1. Improve jobs/housing relationships through new development and redevelopment project reviews and actions through: • Project review procedures, ensuring that individual projects have a positive or neutral impact on housing/jobs balance; • Revising the General Plan Land Use designations; • Revising the Zoning Code; • Imposing exactions or linkage fees on projects which negatively impact housing/jobs balance; • "Fast-Tracking" projects which improve jobs/housing balance; • Project review procedures, ensuring that site design allows for alternative modes of transportation (bus stops, bus turnouts, bikeways, pedestrian routes, etc.); • Phasing growth to ensure that job expansion and housing production occur at a targeted pace; • Indexing residential development in housing-rich areas to commercial/industrial construction or availability; • Encouraging/allowing mixed use development; • Providing density/intensity bonuses to projects which improve housing/jobs balance; • Encouraging/allowing Planned Unit Development; • Giving incentives for employer-provided housing; • Providing subsidies to attract new businesses; • Utilizing tax exempt bond financing to encourage job-creating businesses; and • Providing infrastructure improvements and/or land for industrial and commercial development. 2. Improve jobs/housing relationships at a subregional level in relation to major activity centers as new development occurs by: • Allowing/encouraging intensified development around transit nodes and along transit corridors; and • Using an urban limit lines or phasing areas to manage growth; 3. Continue support for and consider expansion of the CLOUT demonstration project to incorporate: incentive oriented tax credits; loan programs; small business development programs; and complementary land use policies, all aimed at improving the housing/jobs balance in the western San Bernardino/eastern Los Angeles Counties area. 4. Develop and adopt an agreement among the participating jurisdictions as to mutually acceptable approaches to improve and maintain housing/jobs balance.

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TOPIC 3: AIR TRANSPORTATION

GOAL	POLICIES	PROGRAMS AND ACTION OPTIONS
Minimum feasible emissions from air carrier airports.	Promote Improved Technology 1. Promote requiring the best available technology to reduce emissions in aircraft fleet.	1. Adopt/urge establishment of the best available technology and operational measures for aircraft and ground service vehicles (6). 2. Support phasing out of Stage II aircraft and the earliest possible transition to Stage III aircraft for operation within the Air Basin (9).
	Promote Centralized Ground Power 2. Promote installation of centralized ground power systems at existing air carrier airports.	1. Adopt/urge establishment of requirements for centralized ground power systems to be installed and used as soon as practicable at existing air carrier airports (7).
	Promote Improved Ground Access 3. Promote conditioning of air carrier airports upon inclusion of plans for improved ground access.	1. Adopt/urge establishment of an ordinance requiring air carrier airport operators to obtain permits based on approved plans for trip reduction, facility design and access improvements (8).

Health Effects of Ambient Air Pollutants

Ozone

Ozone is a strong irritant that can constrict the airways, forcing the respiratory system to work hard to deliver oxygen. Individuals exercising outdoors, children and people with pre-existing lung disease such as asthma and chronic pulmonary lung disease are considered to be the most susceptible to the health effects of ozone. Short term exposure (lasting for a few hours) to ozone at levels typically observed in Southern California can result in aggravated respiratory diseases such as emphysema, bronchitis and asthma, shortness of breath, increased susceptibility to infections, inflammation of the lung tissue, increased fatigue as well as chest pain, dry throat, headache and nausea.

Elevated ozone levels are associated with increased school absences. In recent years, a correlation between elevated ambient ozone levels and increases in daily hospital admission rates, as well as mortality, has also been reported. An increased risk for asthma has been found in children who participate in multiple sports and live in high ozone communities.

Ozone exposure under exercising conditions is known to increase the severity of the above mentioned observed responses. Animal studies suggest that exposures to a combination of pollutants which include ozone may be more toxic than exposure to ozone alone. Although lung volume and resistance changes observed after a single exposure diminish, with repeated exposures biochemical and cellular changes appear to persist, which can lead to subsequent lung structural changes.

Particulate Matter

A series of scientific studies has linked particulate matter, especially fine particles, with a variety of significant health problems. A consistent correlation between elevated ambient fine particulate matter (PM_{10} and $PM_{2.5}$) levels and an increase in mortality rates, respiratory infections number and severity of asthma attacks, and the number of hospital admissions has been observed in different parts of the United States and various areas around the world. In recent years, some studies have reported an association between long-term exposure to air pollution dominated by fine particles and increased mortality, reduction in life-span, and an increased mortality from lung cancer.

Daily fluctuations in fine particulate matter concentration levels have also been related to hospital admissions for acute respiratory conditions in children, to school and kindergarten absences, to a decrease in respiratory lung volumes in normal children and to increased medication use in children and adults with asthma. Recent studies show lung function growth in children is reduced with long-term exposure to particulate

APPENDIX C

HEALTH EFFECTS

OF

AMBIENT AIR POLLUTANTS

Ambient Air Quality Standards

AIR POLLUTANT	STATE STANDARD CONCENTRATION/ AVERAGING TIME	FEDERAL PRIMARY STANDARD CONCENTRATION/ AVERAGING TIME	MOST RELEVANT EFFECTS
Ozone	0.09 ppm, 1-hr. avg. >	0.12 ppm, 1-hr avg.> 0.08 ppm, 8-hr avg.>	(a) Short-term exposures: (1) Pulmonary function decrements and breathing difficulty. (2) Risk to public health implied by alterations in pulmonary morphology and host defense in animals; (b) Long-term exposures: Risk to public health implied by altered connective tissue metabolism and altered pulmonary morphology in animals after long-term exposures and pulmonary function decrements in chronically exposed humans; (c) Vegetation damage; (d) Property damage
Carbon Monoxide	9.0 ppm, 8-hr avg. > 20 ppm, 1-hr avg. >	9 ppm, 8-hr avg.> 35 ppm, 1-hr avg.>	(a) Aggravation of angina pectoris and other aspects of coronary heart disease; (b) Decreased exercise tolerance in persons with peripheral vascular disease and lung disease; (c) Impairment of central nervous system functions; (d) Possible increased risk to fetuses
Nitrogen Dioxide	0.25 ppm, 1-hr avg. >	0.053 ppm, ann. avg.>	(a) Potential to aggravate chronic respiratory disease and respiratory symptoms in sensitive groups; (b) Risk to public health implied by pulmonary and extra-pulmonary biochemical and cellular changes and pulmonary structural changes; (c) Contribution to atmospheric discoloration
Sulfur Dioxide	0.04 ppm, 24-hr avg.> 0.25 ppm, 1-hr. avg. >	0.03 ppm, ann. avg.> 0.14 ppm, 24-hr avg.>	(a) Broncho constriction accompanied by symptoms which may include wheezing, shortness of breath and chest tightness, during exercise or physical activity in persons with asthma
Suspended Particulate Matter (PM_{10})	20 µg/m3, ann. geometric mean > 50 µg/m3, 24-hr average>	50 µg/m3, ann. arithmetic mean > 150µg/m3, 24-hr avg.>	(a) Excess deaths from short-term exposures and exacerbation of symptoms in sensitive patients with respiratory disease; (b) Declines in pulmonary function, especially in children; (c) Increased risk of premature death from heart or lung diseases in elderly
Suspended Particulate Matter ($PM_{2.5}$)	12 µg/m3, ann. arithmetic mean	15 µg/m3, ann. arithmetic mean > 65 µg/m3, 24-hr avg.>	
Sulfates	25 µg/m3, 24-hr avg. ≥		(a) Decrease in ventilatory function; (b) Aggravation of asthmatic symptoms; (c) Aggravation of cardio-pulmonary disease; (d) Vegetation damage; (e) Degradation of visibility; (f) Property damage
Lead	1.5 µg/m3, 30-day avg. ≥	1.5 µg/m3, calendar quarter>	(a) Learning disabilities in children; (b) Impairment of blood formation and nerve conduction
Visibility-Reducing Particles	In sufficient amount such that the extinction coefficient is greater than 0.23 inverse kilometers (to reduce the visual range to less than 10 miles) at relative humidity less than 70 percent, 8-hour average (10am - 6pm)		Visibility impairment on days when relative humidity is less than 70 percent
Hydrogen Sulfide (H_2S)	0.03 ppm, 1-hr. avg. ≥		Odor (rotten egg smell) Headache

Source: South Coast Air Quality Management District

APPENDIX B

AMBIENT AIR QUALITY STANDARDS

AQ 17.6 Reduce emissions from building materials and methods that generate excessive pollutants, through incentives and/or regulations.

AQ 17.7 Separate trucks from other vehicles in industrial areas of the County with the creation of truck-only access lanes to promote the free flow of traffic. (AI 43)

AQ 17.8 Adopt regulations and programs necessary to meet state and federal guidelines for diesel emissions. (AI 121)

AQ 17.9 Encourage the installation and use of electric service units at truck stops and distribution centers for heating and cooling truck cabs, and particularly for powering refrigeration trucks in lieu of idling of engines for power. (AI 120)

AQ 17.10 Promote and encourage the use of natural gas and electric vehicles in distribution centers.

AQ 17.11 Create and implement street-sweeping plans, as appropriate, in areas of the County disproportionately affected by particulate matter pollution.

Multi-jurisdictional Cooperation

Particulate matter concentrations are a regional issue. In addition to those created in Riverside County, particulates originating in surrounding cities and counties are transported into Riverside County by prevailing winds. Therefore, any meaningful attempt to decrease particulate concentrations in the County will involve cooperation with local and regional governments and a tightening of state and federal standards.

Policies:

AQ 16.1 Cooperate with local, regional, state and federal jurisdictions to better control particulate matter.

AQ 16.2 Encourage stricter state and federal legislation on bias belted tires, smoking vehicles, and vehicles that spill debris on streets and highways, to better control particulate matter. (AI 113)

AQ 16.3 Collaborate with the SCAQMD and MDAQMD to require and/or encourage the adoption of regulations or incentives to limit the amount of time trucks may idle. (AI 120)

AQ 16.4 Collaborate with the EPA, SCAQMD, MDAQMD, and warehouse owners and operators to create regulations and programs to reduce the amount of diesel fumes released due to warehousing operations. (AI 121)

Control Measures

Riverside County can implement simple control measures to reduce the amount of particulates produced within its borders. Strict enforcement of these and current regulations can then lead to a substantial decrease in particulate concentrations in the County and neighboring areas.

Policies:

AQ 17.1 Reduce particulate matter from agriculture, construction, demolition, debris hauling, street cleaning, utility maintenance, railroad rights-of-way, and off-road vehicles to the extent possible. (AI 123)

AQ 17.2 Enforce regulations against illegal fires.

AQ 17.3 Identify and create a control plan for areas within the County prone to wind erosion of soil.

AQ 17.4 Adopt incentives, regulations and/or procedures to manage paved and unpaved roads and parking lots so they produce the minimum practicable level of particulates (AI 111)

AQ 17.5 Adopt incentives and/or procedures to limit dust from agricultural lands and operations, where applicable. (AI 123)

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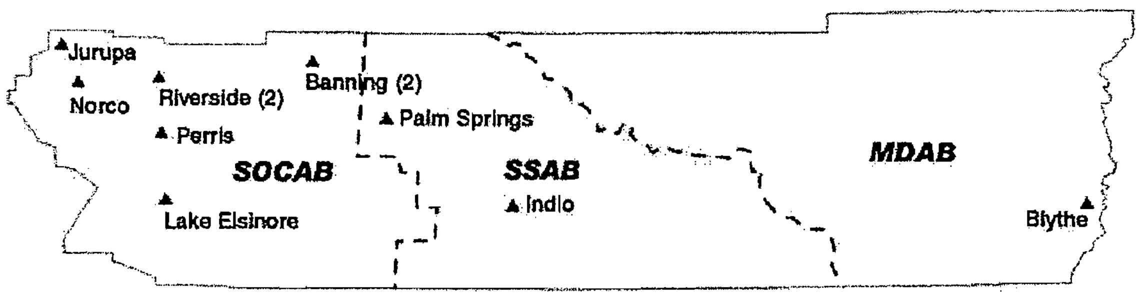


▲ Monitoring Sites

Air Basin Boundary

SOCAB - South Coast Air Basin
SSAB - Salton Sea Air Basin
MDAB - Mojave Desert Air Basin

0 20 Miles

Source Information: SCAQMD.
The oldest data shown on this map is 1990.

The County of Riverside or the RCIP consultants have no reason or indication to believe that this map contains any inaccuracies, defects or misinformation. The County of Riverside and the RCIP consultants assume no warranties or legal responsibility, however, as to the absolute accuracy of any data or information contained within this map, regardless the location, subject and size. Data and information represented on this map is subject to update and modification without prior notification. The geographic information system and other sources should be queried for the most current information. This map or any information represented on it, shall not be reproduced or transmitted in any form or by any means, electronic or mechanical, including photo copying and recording, except as expressly permitted in writing by the County of Riverside.

RIVERSIDE COUNTY
AIR MONITORING NETWORK

Figure AQ-2

precipitates rather than dust, smoke or soot. Riverside County is also responsible for generating large amounts of particulate matter from sources such as agriculture, warehousing operations, and truck traffic.

While Riverside County is dedicated to implementing policies to control particulate matter produced within its own boundaries, it has no control over particulate imported from beyond its boundaries. The solution to the problem of imported particulate matter in western Riverside County is the adoption of adequate control measures by those responsible jurisdictions in Los Angeles and Orange Counties. By adhering to the control measures contained in the AQMP, these jurisdictions can have a positive impact on particulate matter pollution in the SOCAB portion of Riverside County.

The air quality concerns in the Salton Sea Air Basin (SSAB) portions of the County differ somewhat from those in western Riverside County. Unlike the SOCAB region, particulates in SSAB are primarily dust, smoke and soot. While in 1993 and 1994, PM_{10} concentrations were under the federal standard, concentrations in 1995 were slightly above federal limits. The maximum annual average PM_{10} concentration in 1995 was recorded at 4% above the federal standard; however, the measurement included one day with high winds without which the SSAB would have been under the federal standard. The far more stringent state standards were exceeded on 44% of the days in 1995.

The Mojave Desert Air Basin (MDAB), like the SOCAB and SSAB, is designated as a non-attainment area for PM_{10}. Particulates in the MDAB are primarily fugitive caused by high winds or vehicle travel on unpaved roads. Particulates in the area are generally not caused by exhaust stacks or primary emission points.

While sources and severity of particulate pollution differ in subareas of the County, it is the County's objective to control particulate matter throughout all of Riverside County. However, where necessary, the County shall tailor its control measures and implementation procedures to best address the unique situations found in each area. One example of such an area is the Mira Loma community, where particulate pollutant levels are among the worst in the nation. In such an area, strong measures must be taken immediately to protect the health and welfare of residents, especially children, the elderly and those with respiratory illnesses.

Monitoring

Air quality monitoring stations are locating throughout Riverside County (Figure AQ-2). However, at times it may be necessary to locate additional monitors in those areas of the County suspected of producing excessively high levels of particulates. This more localized data may then assist control and law enforcement efforts in reducing and minimizing particulate matter levels.

Policies:

AQ 15.1 Identify and monitor sources, enforce existing regulations, and promote stronger controls to reduce particulate matter.

pedestrian overpasses, and bus turnouts. These projects improve mobility and air quality by encouraging efficient transportation use.

Policies:

AQ 14.1 Emphasize the use of high occupancy vehicle lanes, light rail and bus routes, and pedestrian and bicycle facilities when using transportation facility development to improve mobility and air quality.

AQ 14.2 When developing new capital facility improvement plans, also consider measures such as Transportation Demand Management, Transportation Systems Management, or job/housing balance strategies.

AQ 14.3 Monitor traffic and congestion to determine when and where the County needs new transportation facilities to achieve increased mobility efficiency.

AQ 14.4 Preserve transportation corridors with the potential of high demand or of regional significance for future expansion to meet project demand. (AI 53)

PARTICULATE MATTER

The Environmental Protection Agency (EPA) defines particulate matter (PM) as either airborne photochemical precipitates or windborne dust. Consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and aerosols, common sources of PM are manufacturing and power plants, agriculture, diesel trucks and other vehicles, construction sites, fire and windblown dust. Generally PM settles from atmospheric suspension as either particulate or acid rain and fog that has the potential to damage health, crops, and property. Particulate of 2.5 microns or smaller (2.5 microns is approximately equal to .000098 inches) may stay suspended in the air for longer periods of time and when inhaled can penetrate deep into the lungs. Among the health effects related to $PM_{2.5}$ are premature death, decreased lung function and exacerbation of asthma and other respiratory tract illnesses.

Particulate sized between 2.5 and 10 microns (10 microns is approximately equal to .0004 inches), known as PM_{10} also pose a great risk to human health. PM_{10} can easily enter the air sacs in the lungs where they may be deposited, resulting in an increased risk of developing cancer, potentially changing lung function and structure, and possibly exacerbating preexisting respiratory and cardiovascular diseases. It can also irritate the eyes, damage sensitive tissues, sometimes carry disease, and may even cause premature death. $PM_{2.5}$ and PM_{10} are especially hazardous to the old, young and infirm.

Although it produces less than 10% of the South Coast Air Basin's particulate matter, western Riverside County, which is part of the SOCAB, exceeds federal standards more than any other urban area in the nation, and has the highest particulate concentration in the SOCAB. These high levels of particulate matter are largely imported from the urbanized portions of Los Angeles and Orange Counties. This imported particulate is generally composed of photochemical

AQ 13.3 Encourage the construction of high-occupancy-vehicle (HOV) lanes whenever possible to relieve congestion, safety hazards and air pollution as described in the AQMP.

TRANSPORTATION FACILITY DEVELOPMENT

Please see the General Plan Circulation Element, Planned Circulation Systems section for additional information and policies.

Regionally, transportation facility development means increasing capacity through the expansion of highway and transit systems to meet population and land use demand. Though major construction projects often require massive capital investment, mobility and capacity are increased. These projects include: major highways in high growth regions, construction of high occupancy vehicle (HOV) lanes where severe traffic problems occur, and the construction of rapid transit corridors and facilities. Unfortunately, this strategy responds slowly to changing demands on the transportation system and may burden the region with debt.

Estimates for the development of additional facilities and systems over the next twenty years call for billions of dollars in investment. While federal government spending will account for a large portion of the funding required, additional revenues will have to be raised through a variety of means, including the gas tax, sales tax, user fees, tolls and bonds.

The costs of regional transportation projects also include growth in population, housing and services, and their impact on the transportation system. This raises traffic volume to or above the system's designed capacity while decaying air quality. When major transit corridors become congested, for example, daily commuters take alternate routes to avoid traffic delays. Once a new route becomes operational, commuters abandon these alternative routes for the new or improved systems until they too become congested. However, trying to build out of this situation does not solve the problem because it fuels an unbridled cycle of more growth, traffic, transportation facility development and smog. Continued transportation facility development results in increased growth, higher taxes, and minimal net gains in mobility for each dollar spent. All of this only lessens the chances for good air quality.

Just as there is a need regionally, capital improvements are also required locally to keep traffic moving and reduce emissions. It is the intent of the County to continue such improvements. However, the County recognizes that large construction projects are not always the best option for meeting transportation demands and that other, less expensive alternatives, are sometimes available. These alternatives include demand management, transportation systems management, and strategies to improve the job/housing ratio. While the County cannot meet all of its mobility and air pollution challenges using these alternatives, they may supplement needed capital improvements to help meet the County's transportation demands.

The transportation facility development required must improve mobility by encouraging multiple-occupancy vehicle use and alternative travel modes for both short and long trips. Therefore, the County must emphasize construction projects such as single purpose, high occupancy vehicle lanes, park-n-ride lots, light rail and bus routes. It should also give priority to bicycle paths and trails, travel and idling time for cars, buses and trucks. Congestion increases transportation costs and vehicle emissions, and frays nerves. Moreover, a lack of fleets using alternative fuels adds to poor air quality.

Because transportation systems management provides an important weapon for relieving congestion, improving mobility, and enhancing air quality, the County should use it extensively in its fight for cleaner air.

Traffic Flow

It is a goal of the County to manage its transportation systems in a manner in which mobility and efficiency are enhanced. Improving the flow of traffic promotes mobility on our streets, resulting in decreased impacts on air quality.

Policies:

AQ 12.1 Manage traffic flow through signal synchronization, while coordinating with and permitting the free flow of mass transit vehicles, when possible. (AI 117)

AQ 12.2 Synchronize signals throughout the County with those of its cities, adjoining counties and the California Department of Transportation. (AI 117)

AQ 12.3 Construct and improve traffic signals with channelization and Automated Traffic Surveillance and Control systems at appropriate intersections (AI 117)

AQ 12.4 Eliminate traffic hazards and delays through highway maintenance, rapid emergency response, debris removal, and elimination of at-grade railroad crossings, when possible. (AI 119)

AQ 12.5 Encourage business owners to schedule deliveries at off-peak traffic periods.

***Channelization** - Involves the separation or regulation of conflicting traffic movements into definite paths of travel by traffic islands or pavement markings, to facilitate the safe and orderly movement of vehicles and pedestrians.*

Transportation System Management Improvements

Proper management and oversight of the County-owned fleet can provide a highly effective tool for reducing direct and indirect impacts on air quality. It is therefore a goal of the County to continually improve its own transportation system and cooperate with officials in all levels of government to enhance regional efforts to improve transportation systems management.

Policies:

AQ 13.1 Manage the County of Riverside transportation fleet fueling standards to achieve an appropriate alternate fuel fleet mix. (AI 118)

AQ 13.2 Cooperate with local, regional, state, and federal jurisdictions to better manage transportation facilities and fleets.

***High Occupancy Vehicles (HOV) Lanes** -Carpools, vanpools, buses and motorcycles are the only vehicles allowed to use HOV lanes. Generally, HOV lanes require two-person carpools, though there are some roadways that require a minimum of three (with the exception of super-ultra-low-emission vehicles, which may use HOV lanes with only a single occupant).*

AQ 10.2 Use incentives, regulations and Transportation Demand Management in cooperation with surrounding jurisdictions when possible to eliminate vehicle trips which would otherwise be made. (AI 47)

AQ 10.3 Assist merchants in encouraging their customers to shift from single occupancy vehicles to transit, carpools, bicycles, or foot. (AI 48)

AQ 10.4 Continue to enforce the County's Transportation Demand Management Ordinance and update as necessary.

Special Events

Temporary special events provide recreational and retail opportunities for residents. However, these events may also result in traffic congestion on roadways adjacent to the event. The following policies are designed to alleviate traffic congestion and the accompanying pollution caused by excess vehicle travel times.

Policies:

AQ 11.1 Establish requirements for special event centers to provide off-site parking and park-n-ride facilities at remote locations. Remote parking should be as close to practicable to the event site and the operator should supply shuttle services. (AI 116)

AQ 11.2 Promote the use of peripheral parking by increasing on-site parking rates and offering reduced rates to peripheral parking with tickets sold for non-ridesharing patrons. (AI 116)

AQ 11.3 Encourage special event center operators to advertise and offer discounted transit passes with event tickets (AI 116)

AQ 11.4 Encourage special event center operators to advertise and offer discount parking incentives to carpooling patrons, with two or more persons per vehicle, for on-site parking facilities. (AI 116)

TRANSPORTATION SYSTEMS MANAGEMENT

Transportation systems management improves traffic flow through modification in the operation of existing transit facilities and fleets. This increases mobility and thereby improves air quality. Commerce, industry and public welfare require adequate mobility. Poor transportation systems management, on the other hand, creates congested highways, perpetuates poorly maintained and polluting fleets, weakens the County's economy and diminishes its citizens' health and well-being.

An at-grade railroad crossing is one where the street and the rail line form an intersection, and physically cross one-another.

The County's rapidly growing population combined with unsynchronized traffic signals, delays at grade-level rail crossings, non-uniform street widths, inadequate roadway maintenance and poor emergency response, has resulted in increased congestion. Increased congestion means stop-and-go traffic and longer vanpools, and to take the bus or light rail. Alternatively, workers may work longer hours and so eliminate a trip to the office once or twice a week. Two other TDM strategies that eliminate work trips are telecommuting and work-at-home programs. When individuals must drive, TDM calls for changes in their work schedules to avoid peak traffic periods. A similar TDM strategy encourages large trucks to operate at night. Because traffic at night is lighter, accidents are less likely, and when they do occur, they may not tie up the freeway for hours as they would during the day.

TDM strategies for reducing trips that are not work related are also important. Among these are merchant transportation incentives, such as discounts to customers who use public transit and free bus passes. Some measures reduce both work and non-work related trips. For example, by pricing parking spaces and providing convenient parking for people who rideshare, parking management encourages the use of carpools, vanpools and public transit. It also eliminates on-street parking which adds to congestion.

TDM alone, however, is not the answer. Transit improvements and facility development must accompany these changes. Efforts to encouraging a shift to transit will fail unless transit operators make convenient, safe and reliable transit service available. Similarly, a lack of work centers now blocks the development of telecommuting. The County can take steps to foster the development of such work centers. Changing transportation demand will also require facility development, such as park-n-ride lots, bus turnouts, off-site parking, and facilities for bicycles and pedestrians.

The County's Transportation Demand Management Ordinance for new developments, designed to meet the requirements of the Riverside County Congestion Management Program and the Air Quality Management Plan, promotes the development of TDM strategies early in the development review process. The ordinance sets goals for reducing vehicle trips generated by new developments, a minimum road level-of-service for all new development projects and a reduction in overall vehicle trips emanating from the County. This ordinance also establishes potential TDM measures to be used where appropriate including off-site telecommunications facilities, carpooling, alternative work schedules, transit ridership incentives, and an enhanced pedestrian and bikeway circulation system.

Trip Reduction

As the automobile is the major source of air pollution in the region, the County recognizes the importance of reducing the number of vehicle trips and miles traveled. Policies in this section are not intended to create additional regulation, but to create incentives to reduce vehicle trips, encourage alternative schedules and conform to policies created by regional governments.

Policies:

AQ 10.1 Encourage trip reduction plans to promote alternative work schedules, ridesharing, telecommuting and work-at-home programs, employee education and preferential parking. (AI 47)

Table AQ-4
Commute Distance by Home County

Home County	1992	1993	1994	1996	1998	1999
Los Angeles	15.8 miles	13.3 miles	15.3 miles	14.6 miles	15.3 miles	14.9 miles
Orange	14.9	14	15.8	15.7	14.2	16.1
Riverside	**20.9**	**22.8**	**22.2**	**24.1**	**21**	**21.6**
San Bernardino	20.4	20	21.3	25	22.4	21.3
Ventura	17.7	15.4	16.2	17.8	15.9	16.3
Imperial*	NA	NA	NA	11.8	12.1	14.5

* Imperial County was included for the first time in the 1996 study.
Source: 1999 SCAG State of the Commute Report

Table AQ-5
Commuting Time for Trip to Work by Home County

Home County	1992	1993	1994	1996	1998	1999
Los Angeles	37 minutes	33 minutes	30 minutes	33 minutes	31 minutes	34 minutes
Orange	32	29	30	30	31	33
Riverside	**38**	**37**	**36**	**38**	**36**	**37**
San Bernardino	35	36	36	38	37	35
Ventura	28	26	28	28	26	27
Imperial	NA	NA	NA	20	23	24

* Imperial County was included for the first time in the 1996 study.
Source: 1999 SCAG State of the Commute Report

Table AQ-6
Commuting Time for Return Trip Home by Home County

Home County	1992	1993	1994	1996	1998	1999
Los Angeles	42 minutes	36 minutes	34 minutes	36 minutes	38 minutes	41 minutes
Orange	35	34	38	37	34	41
Riverside	**41**	**43**	**43**	**46**	**40**	**38**
San Bernardino	42	39	42	47	39	41
Ventura	32	30	31	32	30	33
Imperial	NA	NA	NA	21	24	23

* Imperial County was included for the first time in the 1996 study.
Source: 1999 SCAG State of the Commute Report

Transportation Demand Management (TDM) - Low-cost ways to reduce demand by automobiles on transportation systems, such as programs to promote telecommuting, flextime and ridesharing.

Transportation Demand Management (TDM) can help unclog freeways and reduce commute times, thereby improving air quality. However, it means planning driving patterns to reduce the number of cars and trucks using the roads at any one time. This in the essence of TDM.

As stated in the Circulation Element, TDM strategies help reduce work-related trips by encouraging individuals who now drive alone to form carpools and

> *Please see the General Plan **Land Use Element** Land Use Designation Policies section and Appendix J, Community Center Guidelines for additional information.*

> *Please see the General Plan **Circulation Element** Planned Circulation Systems section for further policies regarding alternative modes of travel.*

AQ 8.5 Develop community centers in conformance with policies contained in the Land Use Element. (AI 14)

AQ 8.6 Encourage employment centers in close proximity to residential uses. (AI 14)

AQ 8.7 Implement zoning code provisions which encourage community centers, telecommuting and home-based businesses. (AI 1)

AQ 8.8 Promote land use patterns which reduce the number and length of motor vehicle trips. (AI 26)

AQ 8.9 Promote land use patterns that promote alternative modes of travel. (AI 26)

Multi-jurisdictional Coordination

The County of Riverside recognizes the regional context of the policies it creates. Because air pollutants do not recognize political boundaries, often the policies of one community may adversely impact residents of another. This is particularly true with respect to pollutants emitted by motor vehicles, which underscores the importance of regional and subregional cooperation.

Policies:

AQ 9.1 Cooperate with local, regional, state and federal jurisdictions to reduce vehicle miles traveled and motor vehicle emissions through job creation. (AI 18)

AQ 9.2 Attain performance goals and/or VMT reductions which are consistent with SCAG's Growth Management Plan. (AI 26)

Transportation Demand Management

> *Please see the General Plan **Circulation Element** Transportation Demand Management section for additional information.*

Vehicles are an essential part of life in California. People use them to go to work, run errands and transport goods all across the state and nation. However, while they serve a valuable function, many streets and freeways are increasingly overburdened with traffic. Everyday, cars and trucks jam onto the freeway at the beginning and end of each workday. Inching along the average twenty-two mile commute for Riverside County residents, automobiles spew pollutants into the air, while long sunny days change these pollutants into other noxious compounds. Most cars carry a single occupant, adding to the congestion and smog. When traffic does move, accidents often involving large trucks bring traffic to a grinding halt.

The good news is that our commute times and distance traveled to and from work have been stable over the last decade. The bad news is that Riverside County residents drive the furthest distance and have some of the longest commute times in all of southern California (Tables AQ-4, AQ-5 and AQ-6).

Policies:

AQ 7.1 Provide incentives to encourage new firms to locate within the County and existing firms to expand operations. (AI 18)

AQ 7.2 Work with SCAQMD and MDAQMD to develop a means to encourage the location of new commercial and industrial development in those localities where jobs are most needed. (AI 18)

AQ 7.3 Create a loan program to encourage small businesses to locate within the County. (AI 18)

AQ 7.4 Offer incentives to businesses to control emissions and implement the AQMP. (AI 18)

AQ 7.5 Reduce regulations on small businesses wherever possible and thereby encourage small business development and job creation. The County shall set performance standards as well as design standards, thus giving small business owners as many options as possible to comply with County regulations. (AI 18)

AQ 7.6 Adopt policies freeing small businesses from unnecessary and duplicative paperwork. (AI 18)

AQ 7.7 Assemble information collected from County agencies and departments concerning the business community to develop programs that better serve their needs. (AI 18)

Jobs-to-Housing Ratio

One of the challenges facing the County is to provide the appropriate quantity of residential and employment-generating uses within close proximity to each other in order to reduce the amount of vehicle miles traveled and minimize impacts on air quality. In addition to providing incentives for businesses to locate within Riverside County, it is important to consider the jobs-to-housing ratio when approving the construction of new developments, including the use of mixed-use land patterns and the placement of new public facilities.

Policies:

AQ 8.1 Locate new public facilities in job-poor areas of the County. (AI 18)

AQ 8.2 Emphasize job creation and reductions in vehicle miles traveled in job-poor areas to improve air quality over other less efficient methods. (AI 18)

AQ 8.3 Time and locate public facilities and services so that they further enhance job creation opportunities. (AI 18)

AQ 8.4 Support new mixed-use land use patterns and community centers which encourage community self-sufficiency and containment, and discourage automobile dependency. (AI 14)

Table AQ-3
Home County by Work County

Work County	Home County: Los Angeles	Orange	Riverside	San Bernardino	Ventura	Imperial
Los Angeles	90%	17%	8%	16%	18%	0%
Orange	6	79	10	7	0	0
Riverside	**0**	**0**	**68**	**9**	**0**	**1**
San Bernardino	2	2	8	68	0	0
Ventura	2	0	1	0	80	1
San Diego	0	1	4	0	1	1
Imperial	0	0	1	0	0	97

Source: 1999 SCAG State of the Commute Report

Education and Job Training

To stay competitive, the business community requires an educated and trained work force. While County residents are among the most talented and skilled in southern California, job training and education programs should be provided as an incentive for businesses to locate within the County. This will help ensure residents are trained and qualified to meet the specific needs of the business community.

Policies:

AQ 6.1 Assist small businesses by developing education and job training programs, especially in job-poor areas. (AI 124)

AQ 6.2 Collaborate with local colleges and universities to develop appropriate educational programs to assist residents in obtaining job skills to meet market demands.

Business Development

To the extent possible, the Air Quality Element will be an economic development program designed to enhance employment opportunities in Riverside County. Attempts to improve air quality should not prevent business development, especially within job-poor areas. In fact, business development should be identified as a critical factor in increasing air quality. Increasing employment opportunities within the County will allow residents to obtain jobs locally and decrease commute times. Decreased commute times mean less time spent in air polluting vehicles.

AQ 5.3 Update, when necessary, the County's Policy Manual for Energy Conservation to reflect revisions to the County Energy Conservation Program.

AQ 5.4 Encourage the incorporation of energy-efficient design elements, including appropriate site orientation and the use of shade and windbreak trees to reduce fuel consumption for heating and cooling.

JOBS AND HOUSING

Imagine commuting in the morning and driving only a few short miles to work. There would be no commutes over an hour, no crowded freeways that resemble parking lots and no fighting traffic. This is the life of people who live near work. And as more residents are able to live and work within the County, this will be the commuting pattern of most residents. This will save fuel, ease congestion, speed traffic, cut emissions and improve air quality. However, if nothing is done, the risks are great. SCAG predicts that by the year 2010 commutes between Riverside County and Los Angeles County may increase by 600% over 2000 levels.

Part of the solution to the region's air quality problems is a better jobs-to-housing ratio. The objective of the jobs to housing ratio concept is to reduce Vehicle Miles Traveled (VMT) by locating jobs and housing closer together. In the ideal situation, the appropriate number of housing units in various income categories are provided to house the County's workforce. While this does not ensure that residents will live and work within Riverside County, the likelihood of it occurring does increase.

As stated in the General Plan Housing Element, traffic patterns on the major east-west transportation routes indicate that Riverside County serves as a bedroom community that supplies approximately 18% of the labor pool for the Los Angeles-Orange County metropolitan area (Table AQ-3, Home County by Work County). Statistics for 1990 to 2000 show that Riverside County's jobs-household ratio is slowly improving, however, from 0.80 jobs per household in 1990 to 0.90 in 1997 and 0.94 in 2000. The unincorporated area shows a severe shortage of jobs, however, with only 0.48 jobs per household in the western County and 0.26 jobs per household in the eastern County in 1997. This is the reverse of the jobs to housing ratio experienced in Los Angeles and Orange Counties where there were approximately 1.46 and 1.52 jobs per household respectively in the year 2000.

A "household" consists of all the people occupying a dwelling unit, whether or not they are related.

Whenever possible, the County should offer incentives to businesses and individuals to control emissions and implement the AQMP. In job-poor areas, the County should stress job creation and reductions in vehicle miles traveled to improve air quality over other less efficient methods. Among the positive approaches available to the County to encourage job creation in job-poor areas are: education; job training and placement services; technical assistance to incoming businesses; reducing regulation and paperwork on businesses; fast-tracking and fee waivers; and low interest loans.

AQ 4.3 Encourage centrally heated facilities to utilize automated time clocks or occupant sensors to control heating.

AQ 4.4 Require residential building construction to comply with energy use guidelines detailed in Title 24 of the California Administrative Code.

AQ 4.5 Require stationary pollution sources to minimize the release of toxic pollutants through:
- Design features;
- Operating procedures;
- Preventive maintenance;
- Operator training; and
- Emergency response planning

AQ 4.6 Require stationary air pollution sources to comply with applicable air district rules and control measures.

AQ 4.7 To the greatest extent possible, require every project to mitigate any of its anticipated emissions which exceed allowable emissions as established by the SCAQMD, MDAQMD, SOCAB, the Environmental Protection Agency and the California Air Resources Board.

AQ 4.8 Expand, as appropriate, measures contained in the County's Fugitive Dust Reduction Program for the Coachella Valley to the entire County.

AQ 4.9 Require compliance with SCAQMD Rules 403 and 403.1, and support appropriate future measures to reduce fugitive dust emanating from construction sites.

AQ 4.10 Coordinate with the SCAQMD and MDAQMD to create a communications plan to alert those conducting grading operations in the County of first, second, and third stage smog alerts, and when wind speeds exceed 25 miles per hour. During these instances all grading operations should be suspended. (AI 111)

Energy Efficiency and Conservation

Recycling and conservation efforts established and encouraged by the County can reduce the amount of pollutants emitted within the County. Efforts to recycle wastes can reduce the amount of pollutants emitted from the production of new materials while preserving raw materials. Conservation measures minimize the impacts of not only the consumption of, but also the production of energy sources.

Policies

AQ 5.1 Utilize source reduction, recycling and other appropriate measures to reduce the amount of solid waste disposed of in landfills.

AQ 5.2 Adopt incentives and/or regulations to enact energy conservation requirements for private and public developments. (AI 62)

AQ 2.3 Encourage the use of pollution control measures such as landscaping, vegetation and other materials, which trap particulate matter or control pollution. (AI 114)

AQ 2.4 Consider creating a program to plant urban trees on an Area Plan basis that removes pollutants from the air, provides shade and decreases the negative impacts of heat on the air. (AI 114)

Mobile Pollution Sources

Mobile sources are subdivided into two categories: on-road (generally motorized vehicles like automobiles, motorcylces and trucks) and non-road sources (trains, boats, jet skis and all-terrain vehicles). The County's land use distribution, proximity to Orange and Los Angeles Counties, and subsequent auto-generated traffic have had a tremendously detrimental impact on air quality. Vehicle miles traveled (VMT) have doubled over the past 20 years, with mobile pollution sources constituting approximately 60% of air pollution in the region.

Transportation Management Associations *- Non Profit organizations formed so that employers, developers, building owners, local government representatives, and others can work together and collectively establish policies, programs, and services to address local transportation problems.*

Policies:

AQ 3.1 Allow the market place, as much as possible, to determine the most economical approach to relieve congestion and cut emissions.

AQ 3.2 Seek new cooperative relationships between employers and employees to reduce vehicle miles traveled.

AQ 3.3 Encourage large employers and commercial/industrial complexes to create Transportation Management Associations. (AI 115)

AQ 3.4 Encourage employee rideshare and transit incentives for employers with more than 25 employees at a single location.

Stationary Pollution Sources

Stationary pollution sources are generally divided into two subcategories for analysis: point sources (such as power plants and refinery boilers) and area sources (including small emission sources such as residential water heaters and architectural coatings). Agricultural and industrial land uses are generally the main stationary pollution sources in Riverside County, though most urbanized land areas and their associated activities also contribute to poor air quality in the region. While industrial sources are addressed here, agricultural source impacts, due to their primary emissions of PM_{10}, are addressed in the Particulate Matter section of this element.

Policies:

AQ 4.1 Encourage the use of building materials/methods which reduce emissions.

AQ 4.2 Encourage the use of efficient heating equipment and other appliances, such as water heaters, swimming pool heaters, cooking equipment, refrigerators, furnaces and boiler units.

AQ 1.4 Coordinate with the SCAQMD and MDAQMD to ensure that all elements of air quality plans regarding reduction of air pollutant emissions are being enforced. (AI 111)

AQ 1.5 Establish and implement air quality, land use and circulation measures that improve not only the County's environment but the entire region's. (AI 111)

AQ 1.6 Establish a level playing field by working with local jurisdictions to simultaneously adopt policies similar to those in this Air Quality Element

AQ 1.7 Support legislation which promotes cleaner industry, clean fuel vehicles and more efficient burning engines and fuels. (AI 113)

AQ 1.8 Support the introduction of federal, state or regional enabling legislation to permit the County to promote inventive air quality programs, which otherwise could not be implemented. (AI 113)

AQ 1.9 Encourage, publicly recognize and reward innovative approaches that improve air quality. (AI 113)

AQ 1.10 Work with regional and local agencies to evaluate the feasibility of implementing a system of charges (e.g., pollution charges, user fees, congestion pricing and toll roads) that requires individuals who undertake polluting activities to bear the economic cost of their actions where possible. (AI 111)

AQ 1.11 Involve environmental groups, the business community, special interests, and the general public in the formulation and implementation of programs that effectively reduce airborne pollutants.

Sensitive Receptors

Children may suffer from asthma or other chronic diseases as a result of exposure to polluted air.

Sensitive receptors refer to those segments of the population most susceptible to poor air quality (i.e. children, elderly and the sick) and to certain at-risk sensitive land uses such as schools, hospitals, parks, or residential communities. The intent of the following policies is to reduce the negative impacts of poor air quality on the County's sensitive receptors.

Policies:

AQ 2.1 The County land use planning efforts shall assure that sensitive receptors are separated and protected from polluting point sources to the greatest extent possible. (AI 114)

AQ 2.2 Require site plan designs to protect people and land uses sensitive to air pollution through the use of barriers and/or distance from emissions sources when possible. (AI 114) matter. Seniors, people with pre-existing respiratory and/or cardiovascular disease and children appear to be more susceptible to the effects of PM_{10} and $PM_{2.5}$.

Carbon Monoxide (CO)

Carbon monoxide replaces oxygen in the body's red blood cells. Individuals with a deficient blood supply to the heart, patients with diseases involving heart and blood vessels, fetuses (unborn babies), and patients with chronic hypoxemia (oxygen deficiency) as seen in high altitudes are the most susceptible to the adverse effects of CO exposure. People with heart disease are also more susceptible to developing chest pains when exposed to low levels of carbon monoxide. Exposure to high levels of carbon monoxide can slow reflexes and cause drowsiness, and result in death in confined spaces at very high concentrations.

Reduction in birth weight and impaired neurobehavioral development has been observed in animals chronically exposed to CO resulting in carboxyhemoglobin levels similar to those observed in smokers. Recent studies have found increased risks for adverse birth outcomes with exposure to elevated CO levels. These include pre-term births and heart abnormalities. Additional research is needed to confirm these results.

Nitrogen Dioxide (NO_2)

Population-based studies suggest that an increase in acute respiratory illness, including infections and respiratory symptoms in children (not infants), is associated with long-term exposures to NO_2 at levels found in homes with gas stoves, which are higher than ambient levels found in Southern California. Increase in resistance to air flow and airway contraction is observed after short-term exposure to NO_2 in healthy individuals. Larger decreases in lung functions are observed in individuals with asthma and/or chronic obstructive pulmonary disease (e.g. chronic bronchitis, emphysema) than in healthy individuals, indicating a greater susceptibility of these sub-groups.

In animals, exposure to levels of NO_2 considerably higher than ambient concentrations results in increased susceptibility to infections, possibly due to the observed changes in cells involved in maintaining immune functions. The severity of lung tissue damage associated with high levels of ozone exposure increases when animals are exposed to a combination of ozone and NO_2.

Sulfur Dioxide (SO_2)

Exposure of a few minutes to low levels of SO_2 can result in airway constriction in some asthmatics. All asthmatics are sensitive to the effects of SO_2. In asthmatics, increase in resistance to air flow, as well as reduction in breathing capacity leading to severe breathing difficulties, are observed after acute exposure to SO_2. In contrast, healthy individuals do not exhibit similar acute responses even after exposure to higher concentrations of SO_2. Animal studies suggest that despite being a respiratory irritant, it does not cause substantial lung injury at ambient concentrations. However, very high levels of exposure can cause lung edema (fluid accumulation), lung tissue damage, and sloughing off of cells lining the respiratory tract.

Some population-based studies indicate that the mortality and morbidity effects associated with fine particles show a similar association with ambient SO_2 levels. In these studies, efforts to separate the effects of SO_2 from those of fine particles have not been successful. It is not clear whether the two pollutants act synergistically or one pollutant alone is the predominant factor.

Sulfates

Most of the health effects associated with fine particles and sulfur dioxide at ambient levels are also associated with sulfates. Thus, both mortality and morbidity effects have been observed with an increase in ambient sulfate concentrations. However, efforts to separate the effects of sulfates from the effects of other pollutants have generally not been successful. Clinical studies of asthmatics exposed to sulfuric acid suggest that adolescent asthmatics are possibly a subgroup susceptible to acid aerosol exposure. Animal studies suggest that acidic particles such as sulfuric acid aerosol and ammonium bisulfate are more toxic than non-acidic particles like ammonium sulfate. Whether the effects are attributable to acidity or to particles remains unresolved.

Lead

Fetuses, infants, and children are more sensitive than others to the adverse effects of lead exposure. Exposure to low levels of lead can adversely affect the development and function of the central nervous system, leading to learning disorders, distractibility, inability to follow simple commands, and lower intelligence quotient. In adults, increased lead levels are associated with increased blood pressure. Lead poisoning can cause anemia, lethargy, seizures and death. It appears that there are no direct effects of lead on the respiratory system. Lead can be stored in the bone from early-age environmental exposure, and elevated blood lead levels can occur due to breakdown of bone tissue during pregnancy, hyperthyroidism (increased secretion of hormones from the thyroid gland) and osteoporosis (breakdown of bony tissue). Fetuses and breast-fed babies can be exposed to higher levels of lead because of previous environmental lead exposure of their mothers.

APPENDIX D

COACHELLA VALLEY

MODEL DUST CONTROL ORDINANCE

Section 100 Purpose

The purpose of this ordinance is to establish minimum requirements for construction and demolition activities and other specified sources in order to reduce man-made fugitive dust and the corresponding PM10 emissions.

Section 200 Definitions

For the purpose of this ordinance, the following definitions are applicable:

1 AGRICULTURAL OPERATIONS are any operation directly related to the growing of crops, or raising of fowls or animals for the primary purpose of making a livelihood.

2 AQMD is the South Coast Air Quality Management District and the representatives thereof.

3 AVERAGE DAILY TRAFFIC (ADT) is the number of motor vehicles that traverse a given unpaved or paved surface during a specified 24-hour period. ADT levels are calculated as the average daily volume over a specified 48-hour period as determined by the City (County) in consultation with the AQMD.

4 BULK MATERIAL is all sand, gravel, soil, aggregate and other organic and inorganic particulate matter.

5 CHEMICAL DUST SUPPRESSANTS are non-toxic chemical soil binders that are not prohibited for use by the City (County), the California Regional Water Quality Control Board, the California Air Resources Board, the U.S. Environmental Protection Agency (U.S. EPA), or any other law, rule or regulation, used to reduce dust on disturbed surfaces.

6 COACHELLA VALLEY BEST AVAILABLE CONTROL MEASURES (CV BACM) are methods to prevent or mitigate the emission and/or airborne transport of fugitive dust, as identified in the Coachella Valley Fugitive Dust Control Handbook.

7 COACHELLA VALLEY FUGITIVE DUST CONTROL HANDBOOK is the most recently approved reference document by the AQMD that includes a description of fugitive dust control measures, guidance for preparation of Fugitive Dust Control Plans, notification forms, signage provisions, and test methods.

8 CONSTRUCTION ACTIVITIES are any on-site activities preparatory to or related to the building, alteration, rehabilitation, or improvement of property, including, but not limited to the following activities; grading, excavation, trenching, loading, vehicular travel, crushing, blasting, cutting, planning, shaping, breaking, equipment staging/storage areas, weed abatement activities or adding or removing bulk materials from storage piles.

9 DEMOLITION ACTIVITIES are the wrecking or taking out of any load-supporting structural member of a structure or building and related handling operations or the intentional burning of any structure or building.

10 DISTURBED SURFACE AREA is any portion of the earth's surface (or material placed thereupon) that has been physically moved, uncovered, destabilized, or otherwise modified from its undisturbed native condition (including vehicular disturbances) thereby increasing the potential for the emission of fugitive dust. This definition does not include land that has been restored to a native condition, such that the vegetative ground cover and soil characteristics are equal to surrounding native conditions.

11 EARTH-MOVING OPERATIONS are the use of any equipment for an activity where soil is being moved or uncovered.

12 FINISH GRADE is the final grade of the site that conforms to the approved grading plan.

13 FUGITIVE DUST is any solid particulate matter that becomes airborne, other than that emitted from an exhaust stack, directly or indirectly as a result of human activities. PM10 is a subset of fugitive dust and is defined as particulate matter with an aerodynamic diameter of 10 microns or less.

14 FUGITIVE DUST CONTROL PLAN is a document that describes fugitive dust sources at a site and the corresponding control measures and is prepared in accordance with the guidance contained in the Coachella Valley Fugitive Dust Control Handbook.

15 HIGH-WIND EPISODE is when wind speeds exceed 25 miles per hour as measured by:

A. the closest AQMD monitoring station, or
B. a certified meteorological monitoring station, or
C. an on-site wind monitor calibrated and operated on-site in accordance with the manufacturer's specifications with a data logger or strip chart.

16 OPERATOR is any person who owns, leases, operates, controls, or supervises any potential fugitive dust generating operation subject to the requirements of this ordinance. This definition includes any person who has been officially designated by a property owner as the person responsible for fugitive dust control at a site, as indicated in an approved Fugitive Dust Control Plan.

17 PAVED ROAD is an improved street, highway, alley, public way, or easement that is covered by roadway materials (e.g., cement, asphalt or asphaltic concrete).

18 PHYSICAL ACCESS RESTRICTION is any barrier, including but not limited to; curbs, fences, gates, posts with fencing, shrubs, trees, or other measures that are effective in preventing vehicular and Off-Highway Vehicle (OHV) use of a specified site.

19 SILT is any bulk material with a particle size less than 75 micrometers in diameter that passes through a Number 200 sieve as determined by American Society of Testing and Materials (ASTM) Test Method C 136 or any other test method approved by the U.S. EPA and AQMD.

20 SITE is the real property on which construction, demolition, or other activities subject to this ordinance may occur.

21 STABILIZED SURFACE is any portion of land that meets the minimum standards as established by the applicable test method contained in the Coachella Valley Fugitive Dust Control Handbook.

22 STORAGE PILE is any accumulation of bulk material with a height of three feet or more and a total surface area of 300 or more square feet.

23 UNPAVED PARKING LOT is an area utilized for parking vehicles and associated vehicle maneuvering that is not covered with roadway materials (e.g., cement, asphalt or asphaltic concrete).

24 UNPAVED ROAD is any service roads, internal access roads, heavy and light duty equipment paths and other roadways which are not covered by typical roadway materials (e.g., cement, asphalt, asphaltic concrete).

25 TEMPORARY UNPAVED PARKING LOTS are those used less than 24 days per year.

Section 300 Performance Standards and Test Methods

All performance standards and test methods referenced in this ordinance shall be based on the methodologies included in the Coachella Valley Dust Control Handbook.

Section 400 Control Requirements

410. Work Practices – All Fugitive Dust Sources

1 No operator shall conduct any potential dust-generating activity on a site unless the operator utilizes one or more Coachella Valley Best Available Control Measures, as identified in the Coachella Valley Fugitive Dust Control Handbook for each fugitive dust source such that the applicable performance standards are met.

2 Any operator involved in any potential dust-generating activity on a site with a disturbed surface area greater than one acre shall, at a minimum, operate a water application system as identified in the Coachella Valley Fugitive Dust Control Handbook, if watering is the selected control measure.

Performance Standards and Test Methods

3 No person subject to the requirements contained in Section 410.1 shall cause or allow visible fugitive dust emissions to exceed 20 percent opacity, or extend more than 100 feet either horizontally or vertically from the origin of a source, or cross any property line.

420. Construction and Demolition Activities

1 Any operator applying for a grading permit, or a building permit for an activity with a disturbed surface area of more than 5,000 square feet, shall not initiate any earth-moving operations unless a Fugitive Dust Control Plan has been

prepared pursuant to the provisions of the Coachella Valley Fugitive Dust Control Handbook and approved by the City (County).

2 A complete copy of the approved Fugitive Dust Control Plan must be kept on site in a conspicuous place at all times and provided to the City (County) and AQMD upon request.

3 Any operator involved in demolition activities shall comply with AQMD Rule 1403 (Asbestos Emissions from Demolition/Renovation Activities) requirements, and the requirements of Title 40, Part 61 of the code of Federal Regulations.

4 Any operator involved in earth-moving operations shall implement at least one of the following short-term stabilization methods during non-working hours:
   A. maintaining soils in a damp condition as determined by sight or touch; or
   B. establishment of a stabilized surface through watering; or
   C. application of a chemical dust suppressant in sufficient quantities and concentrations to maintain a stabilized surface.

5 Within 10 days of ceasing activity, an operator shall implement at least one of the following long-term stabilization techniques for any disturbed surface area where construction activities are not scheduled to occur for at least 30 days:
   A. revegetation that results in 75 percent ground coverage provided that an active watering system is in place at all times; or
   B. establishment of a stabilized surface through watering with physical access restriction surrounding the area; or
   C. use of chemical stabilizers to establish a stabilized surface with physical access restriction surrounding the area.

6 Any operator shall remove all bulk material track-out from any site access point onto any paved road open to through traffic:
   A. within one hour if such material extends for a cumulative distance of greater than 25 feet from any site access point; and
   B. at the conclusion of each workday.

7 Any operator of a project with a disturbed surface area of five or more acres or of any project that involves the import or export of at least 100 cubic yards of bulk material per day shall install and maintain at least one of the following control measures at the intersection of each site entrance and any paved road open to through traffic with all vehicles exiting the site routed over the selected device(s):
   A. pad consisting of minimum one inch washed gravel maintained in a clean condition to a depth of at least six inches and extending at least 30 feet wide and at least 50 feet long; or
   B. paved surface extending at least 100 feet and at least 20 feet wide; or
   C. wheel shaker / wheel spreading device consisting of raised dividers (rails, pipe, or grates) at least three inches tall and at least six inches apart and 20 feet long; or

D. a wheel washing system.

8 Any operator required to submit a Fugitive Dust Control Plan under Section 420.1 shall install and maintain project contact signage that meets the minimum standards of the Coachella Valley Fugitive Dust Control Handbook, including a 24-hour manned toll-free or local phone number, prior to initiating any type of earth-moving operations.

9 Any operator of a project with a disturbed surface area of 50 or more acres shall have an Environmental Observer on the site or available on-site within 30 minutes of initial contact that:

A. is hired by the property owner or developer; and
B. has dust control as the sole or primary responsibility; and
C. has successfully completed the AQMD Coachella Valley Fugitive Dust Control Class and has been issued a Certificate of Completion for the class; and
D. is identified in the approved Fugitive Dust Control Plan as having the authority to immediately employ sufficient dust mitigation 24-hours per day, seven days a week and to ensure compliance with this ordinance, the approved Fugitive Dust Control Plan, and AQMD regulations.

Performance Standards and Test Methods

10 No operator required to submit a Fugitive Dust Control Plan under Section 420.1 shall cause or allow visible fugitive dust emissions to exceed 20 percent opacity, or extend more than 100 feet either horizontally or vertically from the origin of a source, or cross any property line.

11 Exceedance of the visible emissions prohibition in Section 420.10 occurring due to a high-wind episode shall constitute a violation of Section 420.10, unless the operator demonstrates to City (County) all the following conditions:

A. all Fugitive Dust Control Plan measures or applicable Coachella Valley Best Available Control Measures were implemented and maintained on site; and
B. the exceedance could not have been prevented by better application, implementation, operation, or maintenance of control measures; and
C. appropriate recordkeeping was complied and retained in accordance with the requirements in Section 420.12 through 420.15; and
D. documentation of the high-wind episode on the day(s) in question is provided by appropriate records.

Reporting / Recordkeeping

Before Construction

12 The operator of a project with ten acres or more of earth-moving operations shall:

A. forward two copies of a Site-Specific, Stand Alone [8½ by 11 inch] Fugitive Dust Control Plan to the AQMD within ten days after approval by the City (County). [Note: A separate AQMD approval will not be issued]; and
B. notify the City (County) and the AQMD at least 24-hours prior to initiating earth-moving operations.

During Construction

13 Any operator involved in earth-moving operations shall compile, and maintain for a period of not less than three years, daily self-inspection recordkeeping forms in accordance with the guidelines contained in the Coachella Valley Fugitive Dust Control Handbook.
14 Any operator involved in earth-moving operations that utilizes chemical dust suppressants for dust control on a site shall compile records indicating the type of product applied, vendor name, and the method, frequency, concentration, quantity and date(s) of application and shall retain such records for a period of not less than three years.

After Construction

15 Any operator subject to the provisions of Section 420.12 shall notify the City (County) and the AQMD within ten days of the establishment of the finish grade or at the conclusion of the finished grading inspection.

430. Disturbed Vacant Lands / Weed Abatement Activities

1 Owners of property with a disturbed surface area greater than 5,000 square feet shall within 30 days of receiving official notice by the City (County) prevent trespass through physical access restriction as permitted by the City (County).
2 In the event that implementation of Section 430.1 is not effective in establishing a stabilized surface within 45 days of restricting access, the owner shall implement at least one of the following long term stabilization techniques within an additional 15 days, unless the City (County) has determined that the land has been restabilized:
A. uniformly apply and maintain surface gravel or chemical dust suppressants such that a stabilized surface is formed; or
B. begin restoring disturbed surfaces such that the vegetative cover and soil characteristics are similar to adjacent or nearby undisturbed native conditions. Such restoration control measure(s) must be maintained and reapplied, if necessary, such that a stabilized surface is formed within 8 months of the initial application.
3 Any operator conducting weed abatement activities on a site that results in a disturbed surface area of 5,000 or more square feet shall:
A. apply sufficient water before and during weed abatement activities such that the applicable performance standards are met; and

B. ensure that the affected area is a stabilized surface once weed abatement activities have ceased.

Performance Standards and Test Methods

4 No person subject to the provisions of Sections 430.1 through 430.3 shall cause or allow visible fugitive dust emissions to exceed 20 percent opacity, or extend more than 100 feet either horizontally or vertically from a source, or cross any property line, and shall either:

A. maintain a stabilized surface; or

B. maintain a threshold friction velocity for disturbed surface areas corrected for non-erodible elements of 100 centimeters per second or higher.

Reporting / Recordkeeping

5 Within 90 days of ordinance adoption, operators of property with disturbed surface area of 5,000 or more square feet shall notify the City (County) of the location of such lands and provide owner contact information.

6 Any person subject to the provisions of Sections 430.1 through 403.3 shall compile, and retain for a period of not less than three years, records indicating the name and contact person of all firms contracted with for dust mitigation, listing of dust control implements used on-site, and invoices from dust suppressant contractors/vendors.

440. Unpaved Roads

1 Owners of private unpaved roads with average daily traffic levels between 20 and 150 vehicles must take measures (signage or speed control devices) to reduce vehicular speeds to no more than 15 miles per hour.

2 Owners of a cumulative distance of six or less miles of private unpaved roads shall pave each segment having 150 or more average daily trips or, alternatively apply and maintain chemical dust suppressants in accordance with the manufacturer's specifications for a travel surface and the performance standards included in Section 440.4 in accordance with the following treatment schedule:

A. one-third of qualifying unpaved road segments within one year of ordinance adoption; and

B. remainder of qualifying unpaved road segments within three years of ordinance adoption. (Note: treatments in excess of annual requirements can apply to future years.)

3 Owners of a cumulative distance of more than six miles of private unpaved roads shall stabilize each segment having 150 or more average daily trips in accordance with the following treatment schedule:

A. at least two miles paved or four miles stabilized with chemical dust suppressants in accordance with the manufacturer's specifications for a travel surface and the performance standards established in Section 440.4 within one year of the ordinance adoption; and

B. at least two miles paved or four miles stabilized with chemical dust suppressants in accordance with the manufacturer's specifications for a travel surface and the performance standards included in Section 440.4 in accordance with the following treatment schedule annually thereafter until all qualifying unpaved roads have been stabilized. (Note: treatments in excess of annual requirements can apply to future years).

Performance Standards and Test Methods

4 Owners of any private unpaved road shall not allow visible fugitive dust emissions to exceed 20 percent opacity, or extend more than 100 feet either horizontally or vertically from the origin of a source, and shall either:

A. not allow silt loading to be equal to or greater than 0.33 ounces per square foot; or

B. not allow the silt content to exceed six percent.

Reporting / Recordkeeping

5 Within 90 days of ordinance adoption, owners of unpaved roads shall provide to the City (County) and the AQMD the location and ADT estimates for all unpaved roads.

6 Owners of unpaved roads that utilize chemical dust suppressants shall compile, and retain for a period of not less than three years, records indicating the type of product applied, vendor name, and the method, frequency, concentration, quantity and date(s) of application.

450. Unpaved Parking Lots

1 Owners of parking lots established subsequent to ordinance adoption are required to pave such areas, or alternatively apply and maintain chemical dust suppressants in accordance with the manufacturer's specifications for traffic areas and the performance standards included in Section 450.4.

2 Owners of existing private unpaved parking lots shall implement one of the following control strategies within 180 days of ordinance adoption:

A. pave; or

B. apply and maintain dust suppressants in accordance with the manufacturer's specifications for traffic areas and the performance standards included in Section 450.4;

C. apply and maintain washed gravel in accordance with the performance standards included in Section 450.4.

3 Owners of private temporary unpaved parking lots (those that are used 24 days or less per year) shall apply and maintain chemical dust suppressants in accordance with the manufacturer's specifications for traffic areas and the

performance standards included in Section 450.4 prior to any 24-hour period when more than 40 vehicles are expected to enter and park. The owner of any temporary unpaved parking lot greater than 5,000 square feet shall implement the disturbed vacant land requirements contained in Section 430 during non-parking periods.

Performance Standards and Test Methods

4 The operator of any private unpaved parking lot shall not allow visible fugitive dust emissions to exceed 20 percent opacity, or extend more than 100 feet either horizontally or vertically from the origin of a source, and shall either:
A. not allow silt loading to be equal to or greater than 0.33 ounces per square foot; or
B. not allow the silt content to exceed eight percent.

Reporting / Recordkeeping

5 Within 90 days of ordinance adoption, owners of unpaved parking lots shall provide to the City (County) and the AQMD the location and ADT estimates and the size (in square feet) of unpaved parking lots.

6 Owners of unpaved parking lots that utilize chemical dust suppressants or apply gravel shall compile, and retain for a period of not less than three years, records indicating the type of product applied, vendor name, and the method, frequency, concentration, quantity and date(s) of application.

460. Public or Private Paved Roads

1 Any owner of paved roads shall construct, or require to be constructed all new or widened paved roads in accordance with the following standards:
A. curbing in accordance with the American Association of State Highway and Transportation Officials guidelines or as an alternative, road shoulders paved or treated with chemical dust suppressants or washed gravel in accordance with the performance standards included in Section 440.4 with the following minimum widths:

Average Daily Trips	Minimum Shoulder Width
500 - 3,000	4 feet
3,000 or greater	8 feet

B. paved medians or as an alternative, medians surrounded by curbing and treated with landscaping, chemical dust suppressants, or washed gravel applied and maintained in accordance with the performance standards included in Section 440.4.

2 Any owner of public or private paved roads shall remove or cause to be removed any erosion-caused deposits of greater than 2,500 square feet within

24-hours after receiving notice by the City (County) or the AQMD or prior to resumption of traffic where the paved area has been closed to vehicular traffic.

Section 500 Administrative Requirements

1 Any operator preparing a Fugitive Dust Control Plan shall complete the AQMD Coachella Valley Fugitive Dust Control Class and maintain a current valid Certificate of Completion.

2 At least one representative of each construction or demolition general contractor and subcontractor responsible for earth-movement operations shall complete the AQMD Coachella Valley Fugitive Dust Control Class and maintain a current valid Certificate of Completion.

3 All reporting / recordkeeping required by Section 420 shall be provided to the City (County) and AQMD representatives immediately upon request.

4 All reporting / recordkeeping required by Section 430 through Section 460 shall be provided to the City (County) and AQMD representatives within 24-hours of a written request.

Section 600 Exemptions

1 The provisions of this ordinance shall not apply to:

A. agricultural operations including on-field sources and unpaved roads used solely for agricultural operations.

B. any dust-generating activity where necessary fugitive dust preventive or mitigative actions are in conflict with either federal or State Endangered Species Act provisions as determined in writing by the appropriate federal or state agency.

C. any action required or authorized to implement emergency operations that are officially declared by the City (County) to ensure the public health and safety.

2 The provisions of Section 420.1 shall not apply to any construction or demolition activity meeting any of the following activity levels or requirements:

A. the activity is occurring entirely within an enclosed structure from which no visible airborne particulate matter escapes; or

B. activities that do not require issuance of a grading permit or those that require a building permit provided that the project results in 5,000 or less square feet of soil disturbance.

3 The provisions of Section 420.8 shall not apply to:

A. projects that takes two weeks or less to complete provided that a long-term stabilization technique(s) identified in Section 430 are implemented; and

B. line projects (i.e., pipelines, cable access lines, etc.).

Compliance

1 A person violating any section of this ordinance or with any portion of an approved Dust Control Plan is guilty of an infraction punishable by a fine of not more than one hundred dollars ($100.00) for a first violation and a fine not exceeding four hundred dollars ($400.00) for a second violation within one year. A third violation, or more, within one year shall each be prosecuted at a level consistent with a misdemeanor violation.

2 In addition to any other remedy provided by law, failure to correct any condition indicated in a notice of violation within one hour of issuance will allow the City (County) to initiate one or more of the following actions where appropriate:

A Criminal proceedings.

B Civil proceedings to obtain an injunction; or any other relief against the owner or operator to stop operations at the site.

C Refusal to issue future permits and/or release of securities held until owner or operator has adequately demonstrated compliance with the notice of violation.

D Correction of the condition by the City (County) through the use of any securities held under this ordinance.

APPENDIX E

FUNDING RESOURCES AVAILABLE

TO LOCAL JURISDICTIONS

TO SUPPORT

THE IMPLEMENTATION OF SUGGESTED POLICIES/STRATEGIES

FUNDING RESOURCES AVAILABLE TO LOCAL JURISDICTIONS TO SUPPORT THE IMPLEMENTATION OF SUGGESTED POLICIES/STRATEGIES

AB2766 Subvention Fund. Cities within the jurisdiction of the South Coast Air Quality Management District (AQMD) receive a portion of the fees charged to register motor vehicles. AQMD disburses this fund to the cities on a quarterly basis. The revenue must be used to fund projects and programs that *reduce emissions from mobile sources*. Additional revenue is available to match AB2766 subvention funding for certain types of expenditures from the Mobile Source Air Pollution Reduction Review Committee's (MSRC) AB2766 Local Government Match Program. A separate application is required for the MSRC matching fund.

Contact: South Coast AQMD
Transportation Programs
(909) 396-3271
Website: www.aqmd.gov/Business/Transportation/AB2766SubventionFunding

AQMD Financial Assistance for Small Business. Small businesses that are planning to purchase air pollution control equipment may apply for a loan guarantee under the California Capital Access Program (CalCAP). The program guarantees the repayment of your loan and motivates banks and other lenders to offer loans to small businesses for pollution control equipment. Guarantees are available for loans from $15,000 to $250,000 and may be up to 90 percent of the loan amount. To be eligible for assistance, a business must be subject to AQMD rules and regulations and must meet the definition of small business set by the U.S. Small Business Administration (typically less than 500 employees and $5 million annual gross revenue).

Contact: South Coast AQMD
Public Affairs
1-800-CUT-SMOG
Website: www.aqmd.gov/Business/Financial Assistance

AQMD Lower Emission School Bus Program. AQMD requires public schools and private operators with more than 15 or more school buses to purchase or lease cleaner buses to protect children from exposure to toxic diesel emissions. AQMD grants are available to public school districts for the *purchase of clean school buses* (e.g. compressed natural gas or low-emitting diesel), and for the retrofit of diesel buses with particulate traps. To qualify for grants to purchase new buses, school districts agree to retire an equivalent number of the oldest, most polluting buses in the district's fleet. Funds are first distributed in proportion to the number of residents within each county. School Districts in LA county receive about 61 percent, Orange county - 18 percent, San Bernardino county - 11 percent, and Riverside receives - 10 percent. LA Unified School District is restricted to a maximum of 50 percent of the total funds distributed to LA County. Additional funding criteria apply.

Contact: South Coast AQMD
Technology Advancement Office
(909) 396-3331
Website: www.aqmd.gov/Education/CleanAirTechnologies/Implementation/SchoolBusProgram

Carl Moyer Memorial Air Quality Standards Attainment Program. The state legislature created this funding program to develop state air quality measures. The Carl Moyer program is designed to facilitate the introduction and use of low-emission, heavy-duty engines. Funds may be used to help purchase or repower new vehicles. New vehicles and equipment must achieve a 30 percent reduction of NO_x emissions compared to current emission standards. Alternative fuel engines, (e.g. compressed natural gas, liquefied natural gas, propane and electricity) will be given preference for funding. However, cleaner diesel engines may be considered in the off-road category if a CARB-certified alternative fuel engine is not available for a specific application. Vehicles and equipment must remain in operation for at least five years, and 75 percent of their use must be within the South Coast basin.

Contacts: South Coast AQMD
Technology Advancement Office
On-Road, Off-Road, Locomotive, Construction
(909) 396-3331
Website: www.aqmd.gov/Education/CleanAirTechnologies/Implementation/CarlMoyerProgram

Congestion Mitigation and Air Quality Improvement (CMAQ) Program. This program is implemented by the local transportation commissions or metropolitan planning organization. Funding is available for transit improvement projects and alternative fuels.

Website: www.fhwa.dot.gov/environment/cmaq.htm

Mobile Source Air Pollution Reduction Review Committee (MSRC) – Competitive Grants. The discretionary funds are to be used for clean air projects that results in direct and tangible reductions in air pollution from vehicles within the South Coast Air District. Project categories include clean fuel vehicles, alternative fuel infrastructure, transportation control measures; such as ridesharing telecommuting, videoconferencing, parking management, traffic synchronization and research and development of new clean air technologies, as well as educational projects.

Contacts: South Coast AQMD
info@msrc-cleanair.org
Website: www.msrc-cleanair.org

MSRC – Local Government Match Program. This program provides matching funding against local funds for investments such as alternative fuel infrastructure and vehicles. Local governments such as cities and counties are eligible to apply for funding. Historically, project categories include clean fuel vehicles, alternative fuel infrastructure, and transportation.

Contacts: South Coast AQMD
info@msrc-cleanair.org
Website: www.msrc-cleanair.org

Rule 2202 Air Quality Investment Program (AQIP). AQMD requires employers with over 250 employees to reduce emissions from employee commute trips. One option available to employers under Rule 2202 is to invest in the AQMD's Air Quality Investment Program (AQIP) in lieu of implementing other rule requirements. AQIP revenue is placed in a restricted fund to be used to reduce emissions to mitigate the impacts of not participating in an employee commute reduction program. The objective of the program is to use the AQIP fund to reduce emissions to levels that are equivalent to levels that would have been achieved if the employer had implemented other strategies in the rule. The AQMD accepts emission reduction proposals and awards contracts on a bi-annual basis. Qualified AQIP proposals may include the purchase of clean on-road and off-road vehicles, and projects that enhance mobility (e.g. shuttle services).

Contacts: South Coast AQMD
Technology Advancement Office (909) 396-3331
Website: www.aqmd.gov/Education/CleanAirTechnologies/
Implementation/Rule2202AirQualityInvestmentProgram

Sempra Energy. Rebates, grants and loans are available until funding is depleted. *Flex Your Power's* website is a great resource for energy efficiency and conservation information. Incentives/rebates, technical assistance, retailers, product guides, case studies and more are found on this website.

Website: www.fypower.org

U.S. Department of Energy (U.S.DOE)-Clean Cities Program. The United States Department of Energy (DOE) established the Clean Cities Program as a locally based public/private alliance to expand the use of alternative fuels to gasoline and diesel fuel. By combining local decision-making with voluntary action by partners, the grassroots approach of Clean Cities departs from traditional top-down federal programs. It creates an effective plan carried out at the local level for creating a sustainable nationwide alternative fuels market.

Contacts:	US DOE Roxanne.deppsy@ee.doe.gov (206) 553-2155 California Energy Commission (CEC) pward@energy.state.ca.us (916) 654-4639
Website:	www.eere.energy.gov/cleancities

Appendix G

Emissions Inventory Methodology and Results

TABLE OF CONTENTS

List of Acronyms

ARB	Air Resources Board
BACT	Best Available Control Technology
BOE	Board of Equalization
BTS	Bureau of Transportation Statistics
CHP	California Highway Patrol
CRC	Coordinating Research Council
CY	Calendar Year
DMV	Department of Motor Vehicles
DOF	Department of Finance
DPF	Diesel Particulate Filter
DR	Deterioration Rate
ECE	Electronically Controlled Engines
EGR	Exhaust Gas Recirculation
FE	Fuel Economy
GDP	Gross Domestic Product
GVWR	Gross Vehicle Weight Rating
HH	Heavy Heavy (Duty Diesel Trucks)
HHDDT	Heavy Heavy Duty Diesel Trucks
IFTA	International Fuel Tax Agreement
IRP	International Registration Plan
LESBP	Lower Emissions School Bus Program
LA/LB	Los Angeles/Long Beach
MCPP	Motor Carrier Permit Program
MH	Medium Heavy (Duty Diesel Trucks)
MHDDT	Medium Heavy Duty Diesel Trucks
MY	Model Year
NOOS	Neighboring out-of-state
NNOOS	Non-neighboring out-of-state
PM	Particulate Matter
POAK	Port of Oakland
POLA/LB	Ports of Los Angeles and Long Beach
PTO	Power Take Off
SCR	Selective catalytic reduction
TIAX	TIAX LLC Consultants
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VIN	Vehicle Identification Number
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle Miles Traveled
ZMR	Zero-mile rate

A. Introduction

Commercial heavy-duty diesel trucks and buses (defined as commercial diesel buses and trucks exceeding 14,000 lbs gross vehicle weight rating (GVWR)) are currently the single largest source of nitrogen oxide (NO_x) emissions in California, accounting for 30% of statewide NO_x emissions (ARB, 2008). These same trucks buses are also the largest source of diesel particulate matter (diesel PM) in California, representing about 40% of statewide diesel PM emissions.

On-road mobile source emissions in California are currently calculated using the ARB's EMFAC2007 model that was released in December of 2006 (ARB, 2006). Since the last EMFAC release, Staff members have conducted a comprehensive re-evaluation of the heavy duty diesel truck emissions inventory. In developing this new analysis, we have integrated new data and assumptions into an expanded methodology that builds upon current modeling in EMFAC2007. With this methodology, we incorporate detail for different types of trucking operations and truck configurations that are referred to as "inventory categories". Emission factors differ from those in EMFAC2007 and reflect our enhanced knowledge of trucking operations in California that has been developed through this effort. With this document we describe our approach and the results from its application. With this document we also provide emissions estimates for each category of vehicles that would be regulated under the proposed Statewide Truck and Bus Regulation.

B. Methodology

Fundamentally the EMFAC model uses a simple, vehicle population-based technique for estimating emissions for any type of on-road vehicle. We calculate emissions as the product of a population of vehicles, the number of miles traveled per vehicle, and emission rates for each vehicle per mile. Beneath this simple equation lies a series of data and assumptions about the population, miles traveled, and emission rates per vehicle model year in a given calendar year, growth and attrition estimates, deterioration rates, and other factors that affect emissions estimates.

Our revised approach for estimating commercial heavy-duty diesel truck emissions builds upon this concept by applying it separately for each category of trucks. These categories were selected by evaluating different groups of trucks that have similar travel, service, size, age or other characteristics within the category but differing between categories.

The methodology used to develop the proposed rule inventory is based on the following equation:

$$EMS_{CY} = \sum_{MY,\,C} \left(POP_{MY,\,C} \times AC_{MY,\,C} \times ER_{MY,\,C} \right)$$

where: EMS_{CY} is the emissions calculated in tons per day for a given calendar year CY.

$POP_{MY,\,C}$ is the population of trucks for model year MY within each inventory category C for a given calendar year;

$AC_{MY,\,C}$ is the accrual rate (miles traveled per year) per truck by model year MY and inventory category C in a given calendar year;

$ER_{MY,\,C}$ is the calculated emission rate, in grams pollutant per mile driven, assuming statewide speed travel distributions in EMFAC2007 and category-specific cumulative mileage accrual over the life of the truck, by model year MY and inventory category C;

With this new analysis, we developed a population and model year distribution for each vehicle category. We also estimated accrual by model year for the category and cumulative mileage accrual (odometer) by model year. Because trucks can move between categories as they age, we assessed the movement of used trucks between categories in order to develop cumulative mileage accrual estimates that reflect this movement. As a result, cumulative odometer readings by model year will not necessarily be consistent with accrual schedules for each inventory category. We developed emission rates using EMFAC2007 and statewide speed distributions, and we adjusted emission rates for modeled odometer readings by category. A more complete discussion of the data sources used is provided in the following section.

C. Data Sources

We have used many different data sources to develop input data to the methodology described above. In this section we provide a general description of each data source as well as links for further information.

1. Motor Vehicle Registration Data

The California Department of Motor Vehicles (DMV) is responsible for the process of vehicle registration in California (DMV, 2001). As part of this program, commercial trucks and buses are required to pay registration annually; however, vehicle owners have the option of registering their vehicles on a seasonal basis. Staff have an agreement with the DMV to get registration data downloads in April and October of each year. Staff process the data in order to compile a list of vehicles by vehicle class, body type, rated weight, and other parameters.

Using each vehicle’s license plate configuration, which separates International Registration Plan (IRP) vehicles from non-IRP vehicles, each vehicle’s rated weight, and each vehicle’s body type data, we separated vehicles into different inventory categories. As such DMV registration was the primary source for vehicle population and model year by category. We also used the DMV registration data to group trucks by fleet and thus fleet size. With these data we could assess the fraction of owner-operators in each category. We did this by sorting data by owner/operator name and address before grouping trucks into trucking categories. Overall, owner-operator trucks tend to be older than other trucks within the same inventory category. These results will be discussed in detail in subsequent sections of this report describing each inventory category.

2. International Registration Plan (IRP)

The International Registration Plan is a program administered by the American Association of Motor Vehicle Administrators to transfer registration fees assessed to commercial and other vehicles that cross state boundaries, in accordance with the number of miles affected vehicles travel in each participating U.S. State or Canadian Province (IRP Inc., 2008). IRP-registered vehicles most often include commercial heavy-duty trucks and buses but can also include government vehicles and smaller vehicles. Under this program a fleet of vehicles has the option of registering their vehicles in any state where a portion of their fleet is domiciled.

IRP recordkeeping varies by state with some states maintaining electronic databases and others paper files. To facilitate data analysis, Staff obtained IRP data from states in electronic format whenever possible. Staff received in electronic format comprehensive reports representing mileage driven by California-registered IRP trucks in calendar years 2000-2006, and obtained hardcopy samples of IRP data from a number of other jurisdictions for miles driven by their IRP trucks in California.

IRP data representing California trucks were used to directly assess the population and model year distribution of these trucks, as well as the fraction of IRP-registered vehicles' mileage accrual that occurs within California. To evaluate out-of-state IRP data, we copied and analyzed one month's worth of IRP updates by fleet. This represents about 9% of all fleets operating in a given state because a similar number of fleets are required to report each month. Data were collected from four neighboring states (Arizona, Idaho, Nevada, Oregon) as well as eight non-neighboring states (Alabama, Indiana, Nebraska, New Jersey, Oklahoma, Tennessee, Texas, and Wisconsin). Of these states, Alabama, Nebraska, New Jersey, and Oklahoma each provided a model year or Vehicle Identification Number (VIN) for each truck in each fleet, allowing detailed age distributions for each of these states to be developed. Staff relied on roadside survey data to develop age distributions for other states.

All IRP data are provided at the level of a fleet rather than the level of an individual vehicle. Each fleet registered with the IRP reports the total number of power units or trucks in the fleet, the total miles traveled by that fleet, and the total miles traveled in California by that fleet. Reporting is completed annually. Many fleets reporting to IRP are large; as a result, the population of trucks reflected in that fleet's report will reflect a large number of trucks that do not enter California even though they may be authorized to do so. In addition, each state's data format is different; some states provide information such as VIN or model year for each truck in the fleet, while other states don't. Where model year data were available, staff used the information directly. Where model year data were not available but VIN data were, staff decoded the VIN to derive model year. Staff also received a summary report from DMV that provided the total population of trucks in the IRP program from each state. This report provided an estimate of the number of trucks in fleets cleared to come into California from other states.

3. Motor Carrier Permit Program (MCPP)

The California Department of Motor Vehicles and California Highway Patrol (CHP) jointly administer the Motor Carrier Permit Program (MCPP), which applies to any operator of a commercial vehicle in California exceeding 10,000 lbs GVWR or truck and trailer combinations exceeding 40 feet in length. The program generally applies to all commercial vehicle operators with an office in California. MCPP data provide information on the number of vehicles per fleet and the number of fleets operating in California; the data are separated between for-hire and private carriers. The database does not provide license plate, VIN or GVWR of trucks in each fleet.

We obtained the DMV/CHP 2005 database and used it to estimate the fraction of truck owner-operators in California. These data were compared to similar estimates derived from DMV registration data. Because the MCPP database does not provide information on individual truck size, activity, or model year, we ultimately chose to use DMV registration data to assess the fraction of total owners that are owner-operators.

4. International Fuel Tax Agreement (IFTA)

The International Fuel Tax Agreement (IFTA) is an agreement among U.S. states and Canadian provinces to simplify the reporting of fuel use taxes by interstate motor carriers. In California, IFTA is administered by the Motor Carrier Section of the Board of Equalization (BOE) (BOE, 2008). The program operates similarly to IRP in that motor carriers may choose a state for filing fuel tax returns and then each state distributes fuel taxes among other states depending on the fraction of fuel burned and miles traveled by each fleet in each jurisdiction.

Staff obtained 2005 aggregated IFTA data as well as 2006 and 2007 IFTA data summarized for each state by the California BOE. For each state, BOE provided information on the number of miles traveled and the amount of fuel burned within California by trucks from each reported state. However, data for 2006 and 2007 were incomplete with about 10% of the data in each of those years not summarized. For states with incomplete data, we extrapolated estimates using overall population data from IRP. Staff used the 2005 IFTA aggregated out-of-state records to estimate the miles traveled in California by out-of-state heavy-heavy duty trucks; Staff used the 2006 and 2007 data to develop the ratio between trucks from neighboring and non-neighboring states.

5. Vehicle Inventory and Use Survey (VIUS)

The main intent of the Vehicle Inventory and Use Survey (VIUS) is to provide data on the physical and operational characteristics of the nation's private and commercial truck population (US Census Bureau, 2002), including national and state-level estimates of the total number of trucks. Up until 2002, this survey was conducted every 5 years by the U.S. Census Bureau as part of the national census but VIUS is no longer being updated due to lack of funding. Nevertheless, VIUS provides a wealth of information on truck body types, mileage accrual, odometer, and many other factors.

We used VIUS data reported by trucks operating in California to develop mileage accrual rates and cumulative odometer by model year for interstate trucks and by model year and body type for California-based trucks.

6. ARB Vehicle Surveys

As part of this rule development, staff developed an on-line survey for truck and bus fleets in general (ARB, 2008), as well as industry-specific surveys of individual truck categories including agricultural trucks, dump trucks, and others. These surveys provided information such as truck age, miles traveled, body type, and other factors useful for inventory development.

7. Estimated Emission Rates

The EMFAC2007 model (ARB, 2006a and 2006b) was used as the starting point for developing emission rates used in this inventory. EMFAC2007 emission rates are based on analysis of chassis dynamometer testing conducted by the Coordinating Research Council (CRC) under the E55/59 testing program (CRC, 2007). Although both heavy-heavy and medium-heavy duty trucks were tested in the E55/59 study, only heavy-heavy duty truck emission rates were updated for EMFAC2007.

As part of this rule development, staff made three revisions to EMFAC emission rates. Medium-heavy duty truck emission rates were updated with new data made available through the CRC E55/59 program. Staff re-evaluated assumed penetration rates of new technologies into truck sales between 2006 and 2011, and assessed the emissions impact of these revised assumptions. Carbon dioxide emission rates were updated based upon new analysis of several different data sources. Each of these revisions is discussed further in this document. We anticipate incorporating these revised emission rates into the next EMFAC update scheduled for 2010.

8. UC Davis Out-of-State Truck Travel Surveys

In 2006 the ARB contracted with researchers at the University of California at Davis (UC-Davis) to develop and administer truck surveys at major border crossings into California from Oregon, Nevada, Arizona, and Mexico (Lutsey, 2008). For these surveys, interstate trucks were assumed to be those trucks that were registered, domiciled, and/or refueled outside California. Researchers administered 433 surveys of truck drivers at seven weigh stations near state borders with high commercial truck traffic (Lutsey, 2008). These surveys provided estimates of annual travel activity in California for each of the respondents, allowing staff to estimate the number of out-of-state trucks, their mileage, fuel usage, and fueling locations. Based on results of this study, staff examined whether estimates of interstate truck age, mileage, and fuel usage assumed in EMFAC2007 were reasonable.

Staff also used raw data from this analysis to validate estimates of model year distribution for out-of-state trucks that were developed using IRP data. In an accompanying report, UC Davis estimated the fraction of total VMT in California represented by out-of-state trucks relative to EMFAC2007. ARB did not use these estimates because, subsequent to the Lutsey (2008) report being finalized, staff received IFTA data from the BOE that provided direct mileage reports by state of registration. These issues will be described in greater detail later in this document.

D. Base Year Population and Activity by Age

In Table 1 below, we provide a list of the data sources underlying each of the truck inventory categories to be discussed in the next section including how each data source was used to help develop truck population and activity estimates.

Table 1. Data Sources Used to Develop Population and Activity Estimates

Type / Category	Population	Activity
Heavy-Heavy / Out-of-State	CA Dept. of Motor Vehicles (DMV) International Registration Plan (IRP) reports; adjusted to account only for trucks that enter California. Model-year distribution from IRP data and surveys. Category split between neighboring states (WA, OR, NV, AZ, ID) vs non-neighboring states.	Vehicle Inventory and Use Survey (2002) - Fraction of mileage accrued in California estimated using IRP data samples and International Fuel Tax Agreement Data (IFTA)
Heavy-Heavy / California-Interstate	DMV CA-IRP reports provide population by model year	VIUS for nationally registered trucks in IRP as above. CA-IRP reports fraction of mileage accrued in CA, and IFTA reports for total mileage.
Heavy-Heavy / In-State Tractor	DMV Registration data, adjusted to subtract vehicles from specific categories such as Utility, Drayage, and others.	VIUS 2002 data
Heavy-Heavy / In-State Single	DMV Registration data, adjusted to subtract specific vehicles from specific categories such as Utility, Drayage, and others.	VIUS 2002 data
Heavy-Heavy / Drayage Tractors	License plate and gate count surveys conducted at the Ports of Los Angeles, Long Beach, and Oakland.	Trip-based model developed for ARB Drayage Truck Regulation; mileage accrual assumed flat at total mileage divided by total number of trucks.
Heavy-Heavy / Agricultural Trucks	Age distribution from survey; population extrapolated from survey results; specialty trucks estimated from survey and registration data.	Accrual from survey
Heavy-Heavy / Utility Trucks	Population and age of trucks registered to public utilities in DMV database.	Surveys conducted for ARB Public Fleet Rule.

Type / Category	Population	Activity
Medium-Heavy / In-State Trucks	DMV registration data	VIUS 2002 data
Medium-Heavy / Interstate Trucks	IRP reports	VIUS 2002 data
Medium-Heavy / Agricultural Trucks	Age distribution from survey; population extrapolated from survey results; specialty trucks estimated from survey and registration data.	Accrual from survey
Medium-Heavy / Utility Trucks	DMV registration data.	Surveys conducted for ARB Public Fleet Rule.
Buses / School	California Highway Patrol Data	ARB Surveys
Buses / Other	EMFAC2007	EMFAC2007
Other / Power Take-Off	No population estimated. Total fuel usage provided by California State Board of Equalization; age distribution assumed same as in-state single-unit trucks	Fuel usage converted to equivalent mileage assuming EMFAC speed distributions and fuel economy.

One of the key assumptions in the development of this inventory is that trucks and buses that are grouped by vocation or body type have a common age distribution and accrual schedule. This assumption has been verified through analysis of the data sources described above.

Another assumption that applies to many truck inventory categories is that trucks typically move between categories as they age and accrue mileage. Staff recognized this through analysis of DMV data. For example, heavy-heavy duty diesel trucks (HHDDTs) that are used for interstate travel (e.g. by CA IRPs) are often retired from interstate travel after a few years due to increasing maintenance costs and bought for intrastate travel where reliability is less of a concern. Vehicles are driven many more miles during interstate travel than during intrastate travel. As a result, a ten year old truck that was used during its first five years for interstate travel and its last five for intrastate travel would, on average, have a higher odometer reading than a vehicle used strictly for intrastate travel during those ten years. Staff used estimated as to when vehicles would most typically be transferred between inventory categories and adjusted the odometer readings from those assumed in EMFAC2007 appropriately.

This section describes each vehicle category including the key assumptions and data analysis results that underlie the development of the inventory. For each category we show the age distribution in calendar year 2008 as well as the anticipated mileage accrual of vehicles of different age. We developed age distributions for trucks ranging between ages -1 and 44. Trucks of age -1 represent vehicles sold and operated in the calendar year prior to the model year (e.g. MY2009 trucks sold in CY2008). Model years beyond age 44 were included in the 44 age bin since the EMFAC model handles only 45 model years. We also show the distribution of trucks in each category between different fleet sizes where appropriate and the difference in the average age of vehicles between different-size fleets.

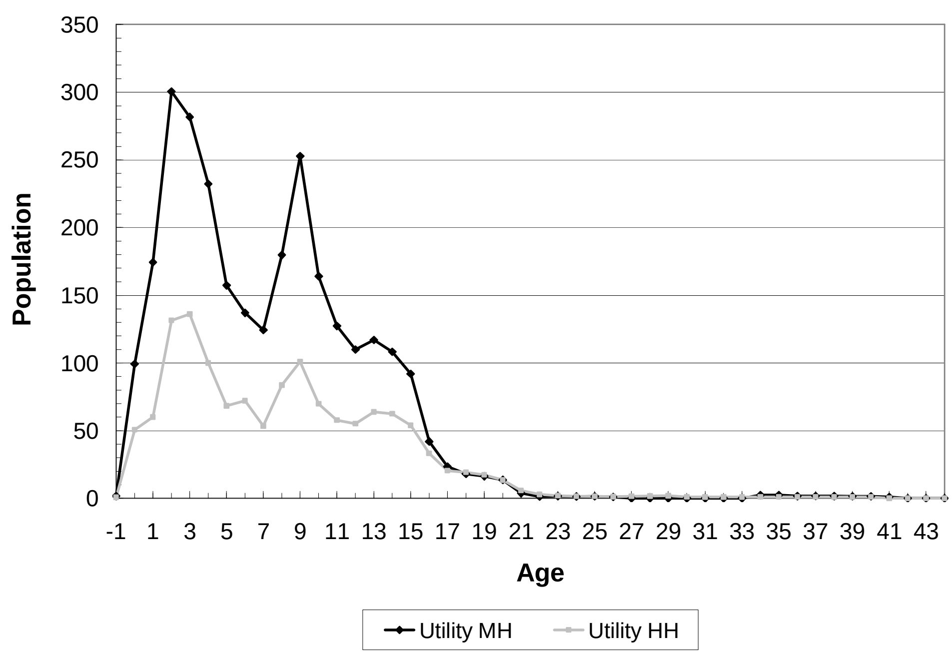
1. Utility Fleets

In October 2006, the ARB adopted a regulation designed to reduce emissions from diesel trucks that are owned or operated by private utilities that operate in California (ARB, 2006). The utility truck category as defined by the regulation includes both medium-heavy (14,000 – 33,000 lbs gross vehicle weight rating or GVWR - MHDDT) and heavy-heavy (>33,000 lbs GVWR - HHDDT) trucks but does not include refuse haulers or fire trucks and other emergency vehicles operated by public agencies. The regulation required fleet operators to reduce diesel PM emissions on a defined schedule by purchasing newer regulation-compliant engines or installing diesel particulate filters. The following methodology was used to develop a Utility Fleet emissions inventory.

a) Base Year Population and Age Distribution by Fleet Size

Staff used an identical methodology for assessing the utility truck population and model year distribution as was used in development of the utility fleet regulation (ARB, 2005). Staff developed a list of utility names and used those names to extract vehicles from DMV registration data. Those vehicles were then separated by model year and weight category (MHDDT vs HHDDT). The population-weighted average age of a vehicle in the utility fleet category was estimated at 8.2 years for HHDDT, 7.2 years for MHDDT. Figure 1 provides the distribution of the California utility truck population by age for calendar year 2008.

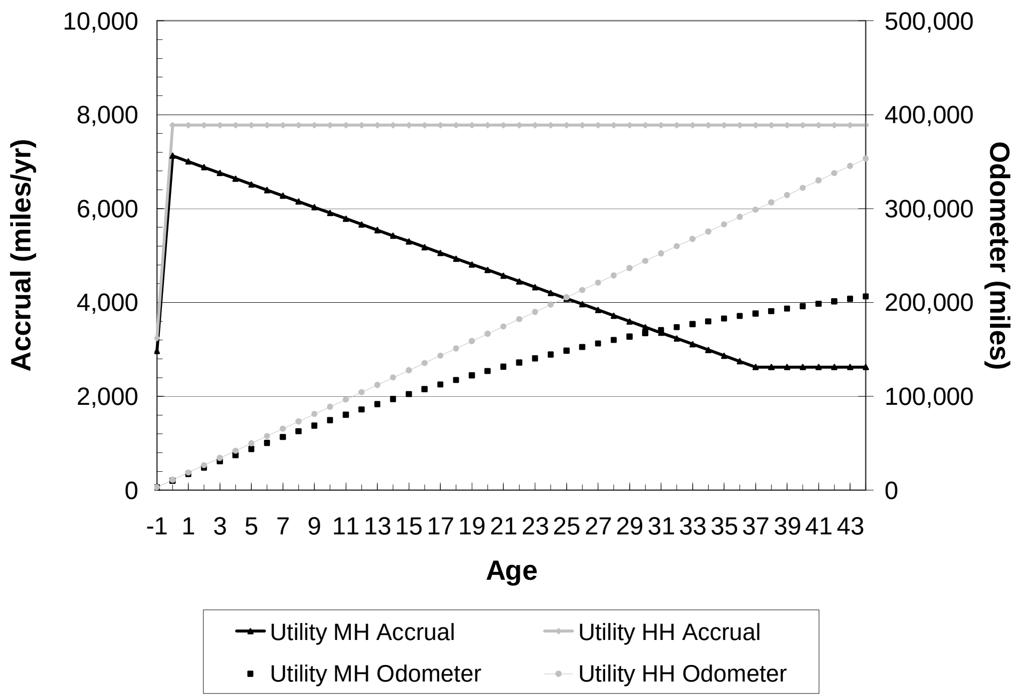
Figure 1: Utility Truck Population and Model Year Distribution (2008)



b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

Staff used accrual rates and cumulative odometer readings that were published in the utility fleet rule staff report (ARB, 2005). These were developed by TIAX (2003); results showed that utility trucks accrue between 6,000 and 8,000 miles per year, with slightly more miles accrued per year by HHDDT. The estimated annual average mileage accrual was 7,800 miles per year for HHDDT and 6,200 miles per year for MHDDT, all of which is assumed to occur in California. The estimated average odometer reading was 122,000 miles for HHDDT and 78,000 miles for MHDDT. In Figure 2 we plot annual accrual and cumulative modeled odometer readings for utility category trucks.

Figure 2: Utility Truck Category Accrual and Modeled Odometer Readings (2008)



c) Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds

Utility fleet vehicles were not separated into different categories by fleet size or mileage threshold. This vehicle and emissions inventory evaluates only the fleets of privately owned utilities. The utility fleets of larger municipal agencies are not included in this assessment.

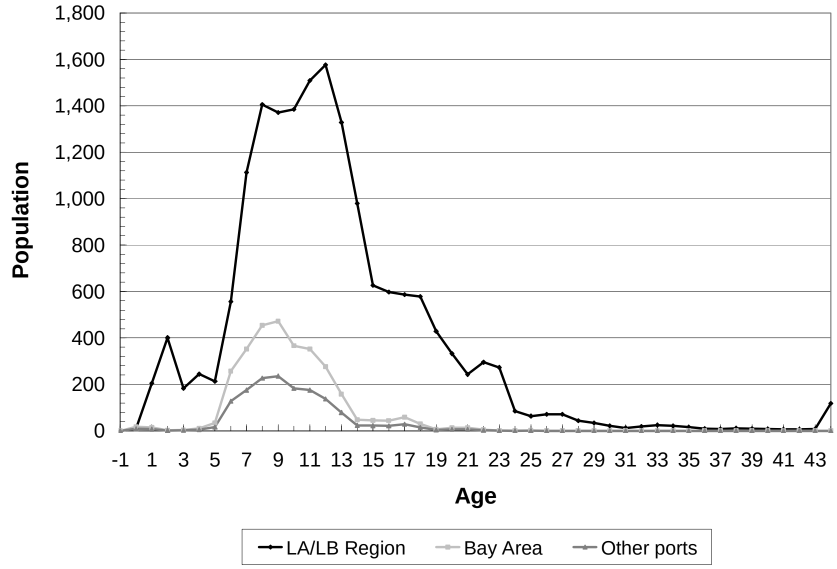
2. Drayage Trucks Serving California's Ports and Railyards

In 2007 the ARB passed a regulation requiring NO_x and diesel PM emissions reductions from drayage trucks serving California's ports and railyards (ARB, 2007a). Drayage trucks are typically older than other trucks in California and primarily serve the Ports of Los Angeles, Long Beach and Oakland along with railyards near those ports. Drayage truck travel is predominantly regional; in general, these trucks make multiple trips to and from the facilities each week. Drayage trucks are all heavy-heavy duty vehicles, exceeding 33,000 lbs GVWR. According to the regulation, by calendar year 2010 all drayage trucks must meet at a minimum model year 1994 or later emissions standards with a diesel particulate filter and by 2014 all trucks must meet 2007 truck emission standards. The following methodology was used to develop the drayage truck emissions inventory:

a) Base Year Population and Age Distribution by Fleet Size

Drayage trucks are defined by their operation rather than body type. Since DMV registration records provide information on body type but not vehicle operator, DMV registration cannot be used alone to estimate the statewide drayage truck population. The population of trucks serving the Ports of Los Angeles and Long Beach and associated railyards was derived from an analysis of one year of gate count and license plate information from approximately half of the terminals at the two Ports; these data were provided by officials from the ports. Staff compared observed license plates to DMV data to assess model year distribution; we then extrapolated results to all terminals at both Ports. A similar approach was used for the Port of Oakland and associated railyards. Regulatory documentation (ARB, 2007b) describes in more detail the methodology used to assess the population of drayage trucks. We estimated the age of drayage trucks serving other ports and railyards in California by assuming that these trucks were similar to those in the HHDDT (instate) tractor category (ARB, 2007b). The population-weighted average age of a vehicle in the drayage category was estimated at 12.4 years for trucks serving the Ports of Los Angeles and Long Beach and regional intermodal railyards and 9.7 years for drayage trucks serving Oakland and associated railyards and for trucks serving the remainder of California ports. In Figure 3 we provide drayage truck population by model year for calendar year 2008. As shown, trucks serving the Ports of Los Angeles and Long Beach are typically several years older than drayage trucks serving other California ports.

Figure 3. Drayage Truck Population and Model Year Distribution (2008)

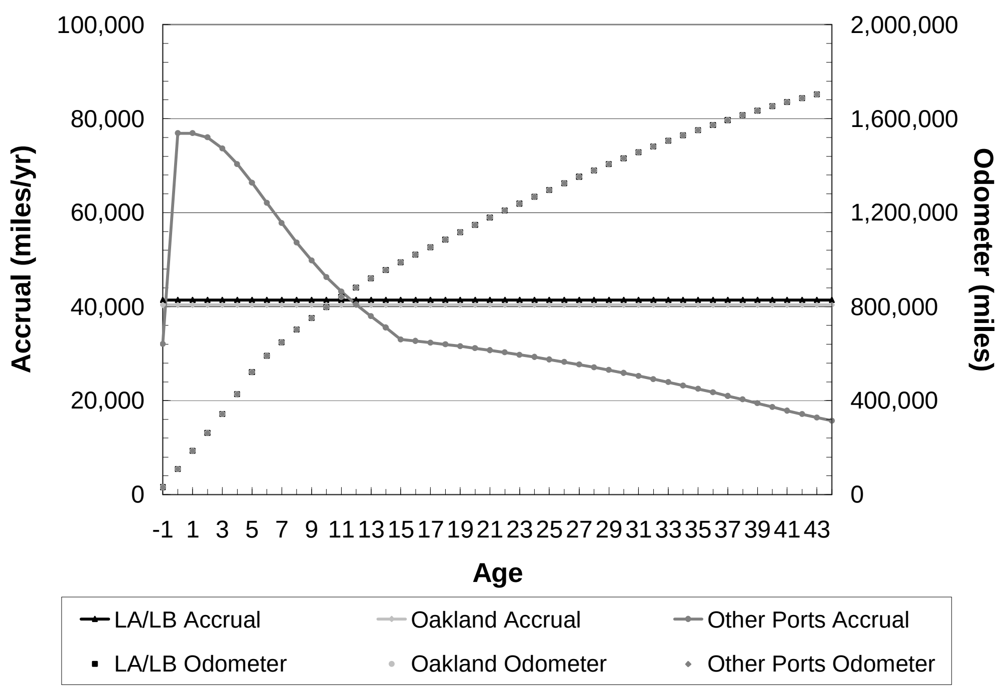


b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

Staff used accrual rates and cumulative odometer readings published in the drayage truck rule staff report (ARB, 2007b) to estimate the vehicle miles traveled (VMT) associated with drayage trucks in each region. Staff then assumed that accrual rates were independent of age for drayage trucks and that the vehicle population increased in proportion to the overall VMT for the inventory category.

Drayage trucks serving the Ports of Los Angeles and Long Beach were estimated to drive around 41,000 miles per year. Drayage trucks serving the Port of Oakland drive, on average, around 40,000 miles per year. Drayage trucks serving other ports in California are assumed to have travel characteristics similar to in-state HHDDT tractors and therefore drive, on average, 49,000 miles per year. All drayage-related VMT are assumed to accrue in California. Odometer readings are modeled assuming that drayage trucks were purchased used from larger national fleets that drive hundreds of thousands of miles in their first several years of operation. This assumption is described in detail in the in-state tractor category. The resulting average odometer reading as estimated was 860,000 miles for LA/LB trucks and 770,000 miles for trucks serving Oakland and other ports/railyards; the apparent difference from the mileage if projected from the accrual rate and the age results from the trucks likely having been used for other purposes before being converted to drayage trucks. In Figure 4 we plot annual accrual and cumulative modeled odometer readings for drayage trucks.

Figure 4. Drayage Truck Category Accrual and Modeled Odometer Readings (2008)



c) *Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds*

Drayage trucks were categorized by fleet size as single truck fleets, two truck fleets, three truck fleets, and fleets of more than three trucks. No differentiation was made for drayage trucks with regard to mileage threshold, on the assumption that nearly all drayage fleets are operated in a similar manner. In Table 2, Table 3, and Table 4 we show the distribution of VMT among drayage fleets of various fleet sizes and VMT-weighted ages for trucks near the Ports of Los Angeles/Long Beach, Oakland, and all other California ports/railyards, respectively. The age distribution of drayage trucks was also assumed not to differ with regard to fleet size. With regard to the VMT-weighted average age within each category, drayage trucks near LA/LB were estimated to be older, on average, than drayage trucks near other facilities. In Table 5 we provide a summary of the VMT driven by different size drayage trucks fleets serving all California facilities.

Table 2. Distribution of VMT among POLA/LB Drayage Trucks by Fleet Size (2008)

Fleet Size	Daily VMT	Share	VMT-weighted Average Age
1 truck	1,219,969	53.7%	12.4
2 trucks	135,552	6.0%	12.4
3 trucks	152,496	6.7%	12.4
> 3 trucks	762,481	33.6%	12.4
Total	2,270,498	100.0%	

Table 3. Distribution of VMT among Port of Oakland Drayage Trucks by Fleet Size (2008)

Fleet Size	Daily VMT	Share	VMT-weighted Average Age
1 truck	210,556	53.7%	9.7
2 trucks	23,395	6.0%	9.7
3 trucks	26,319	6.7%	9.7
> 3 trucks	131,597	33.6%	9.7
Total	391,868	100.0%	

Table 4. Distribution of VMT among Drayage Trucks at Other Ports/Railyards by Fleet Size (2008)

Fleet Size	Daily VMT	Share	VMT-weighted Average Age
1 truck	127,097	53.7%	9.1
2 trucks	14,122	6.0%	9.1
3 trucks	15,887	6.7%	9.1
> 3 trucks	79,436	33.6%	9.1
Total	236,542	100.0%	

Table 5. Distribution of VMT among Drayage Trucks at all California Ports/Railyards by Fleet Size (2008)

Fleet Size	Daily VMT	Share	VMT-weighted Average Age
1 truck	1,557,622	53.7%	11.8
2 trucks	173,069	6.0%	11.8
3 trucks	194,703	6.7%	11.8
> 3 trucks	973,513	33.6%	11.8
Total	2,898,907	100.0%	

3. *Trucks Serving the Agricultural Economic Sector*

Agricultural trade associations, in conjunction with staff, administered a survey to farmers, ranchers, and other agricultural businesses designed to identify and characterize trucks associated with agricultural businesses. The stakeholder survey was designed primarily to capture trucks owned and operated by farms, ranches, and first processing facilities, and was similar in format to the on-line survey used to collect information on the broader truck fleet as part of this rule development (ARB, 2008). Results from the survey were used to assess the population of MHDDT and HHDDT that operate in California for agricultural purposes, either seasonally or annually. The survey was also used to assess the model year distribution and mileage accrual of these trucks, as well as the fraction that would be captured by proposed rule exemptions.

a) Base Year Population and Age Distribution by Fleet Size

To assess the model year distribution of agricultural trucks, we compiled survey results for MHDDT and HHDDT separately, and modeled the data in order to smooth trends in model year variability. Based on analysis of the survey data, the population-weighted average ages of HHDD and MHHD agricultural trucks were found to be very similar (17.3 years for HHDDTs and 17.2 years for MHDDTs).

To assess population, we compiled the survey results and extrapolated the survey sample to a statewide population using the numbers of acres farmed and other metrics collected in the survey as scaling factors. Using this methodology, Staff estimated a statewide agricultural truck population of between 40,000 and 60,000 vehicles. However, when staff compared the model year specific truck populations estimated using the extrapolated data to model year specific DMV registration data, they found that the extrapolated agricultural truck populations for certain model years exceeded the total number of trucks of that model year in the DMV database. This suggested that the directly extrapolated survey results were overestimating the agricultural truck population, at least for those model years.

In reviewing the surveys, staff found that very few were administered to farms or organizations that do not own agricultural trucks. In effect, these businesses were excluded from the survey; thus, extrapolating the population using the metrics described above would overestimate the agricultural truck population.

To correct for this overestimation, we used the DMV registration data as an upper bound of the possible number of agricultural trucks of a given model year.

Using the statewide truck population, we back-calculated an agricultural truck population assuming that the agricultural truck population, in any model year, could not exceed 80% of the total trucks registered in that model year. With this technique, we assessed a likely population of 22,150 agricultural trucks in California, of which 45% are MHDDT and 55% are HHDDT. In Figure 5 we show the California agricultural truck population and model year distribution estimated for the 2008 calendar year.

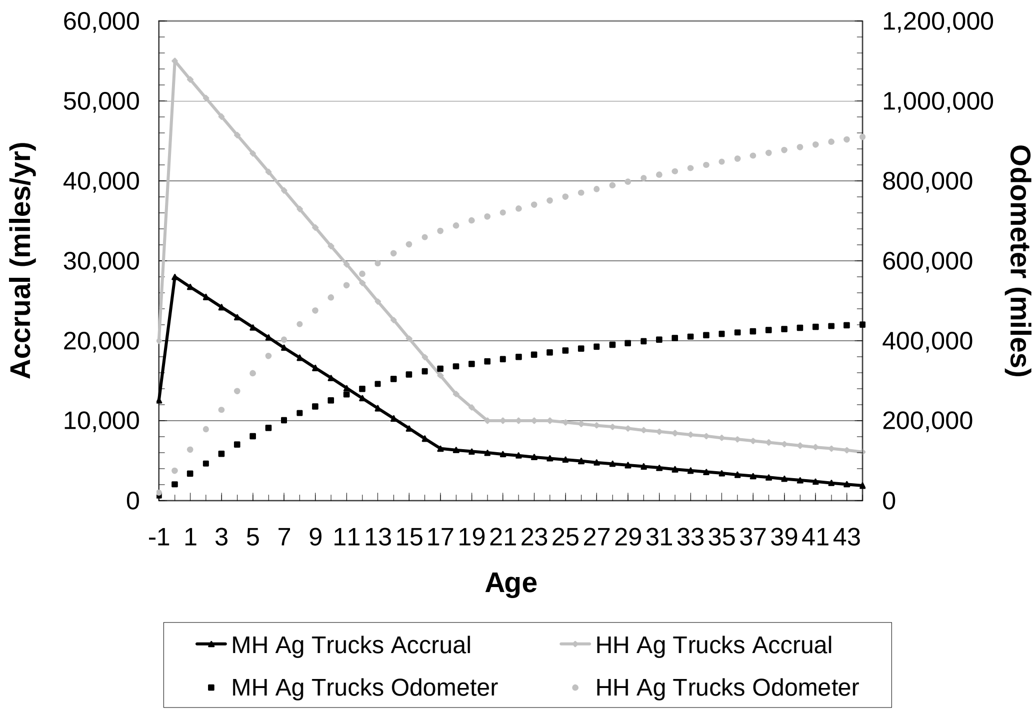
Figure 5. Agricultural Truck Population and Model Year Distribution (2008)

b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

We analyzed survey results in order to estimate mileage accrual for agricultural trucks. Because agricultural HHDDT are assumed to be purchased used, their modeled odometer follows a composite that accounts for the mix of single-unit and combination trucks entering the category as well as the likelihood that most tractors currently in the agricultural category were previously in other categories. Because in-state tractors and single-unit trucks are driven more, on average, than agricultural trucks, the composite odometer reading is projected to be higher than the odometer reading of a truck that had been used exclusively for agriculture. These trucks then follow the agricultural truck accrual rate upon transition. Agricultural MHDDT also followed a composite rate, since in-state MHDDT were also assumed to migrate toward the agricultural category. The average odometer reading for agricultural was estimated to be approximately

601,000 miles for HHDDT and 293,000 miles for MHDDT. The average annual mileage accrual was estimated to be 23,000 miles for HHDDT agricultural trucks and 11,000 miles for MHDDT agricultural trucks. All miles are assumed to accrue in California. We present the results in Figure 6.

Figure 6. Agricultural Truck Category Mileage Accrual and Modeled Odometer (2008)



c) Base Year Vehicle Miles Traveled by Size and Mileage Thresholds

Staff did not categorize agricultural trucks by fleet size. With regard to application, both medium-heavy and heavy-heavy trucks were categorized into specialty and non-specialty vehicles. Specialty vehicles are specifically defined under the proposed regulation as water trucks used on the farm, nurse rigs, cotton module movers, or feed or mixer feed trucks owned by a cattle or calf feedlot. Using this definition, by analyzing the DMV registration data, we found that 10% of agricultural trucks or approximately 2200 agricultural trucks statewide were specialty vehicles.

Non-specialty agricultural trucks were categorized according to mileage thresholds, since the regulation is to be applied differently to vehicles driven different mileage thresholds each year. The regulation sets the low use mileage threshold for trucks in general at 10,000 miles per year. Vehicles that exceed 10,000 miles per year but do not exceed an upper mileage threshold need to turnover or retrofit their trucks prior to 2017. Agricultural trucks are below the upper mileage threshold if they fall into one of the following three categories:

- MY 1995 or earlier, and driven less than 15,000 miles/year
- MY 1996-2005, and driven less than 20,000 miles/year, or
- MY 2006 or newer, and driven less than 25,000 miles/year

These categories of agricultural truck are subject to regulatory requirements at the beginning of calendar year 2017 and are categorized as “between mileage thresholds”. The third category consists of trucks that exceed the upper VMT threshold; these trucks are subject to the ARB regulation according to the standard turnover and retrofit timeline.

In Table 6 we show the distribution of daily VMT among medium-heavy agricultural trucks in California in calendar year 2008. In Table 7 we show the distribution of daily VMT among heavy-heavy agricultural trucks in California in 2008. In each table we also show the average VMT-weighted age by mileage threshold. For both heavy-heavy and medium-heavy agriculture truck weight classes, the trucks driven the fewest miles tended to be older than other vehicles.

Table 6. Distribution of VMT among Medium-Heavy Agricultural Trucks by Fleet Size (2008)

Vehicle Type	Daily VMT	Share	VMT-weighted Average Age
Non specialty, below lower threshold	46,021	13.4%	16.0
Non specialty, between thresholds	78,768	23.0%	10.3
Non specialty, above upper threshold	183,598	53.6%	9.2
Ag specialty vehicle	34,265	10.0%	10.5
Total	342,652	100.0%	

Table 7. Distribution of VMT among Heavy-Heavy Agricultural Trucks by Fleet Size (2008)

Vehicle Type	Daily VMT	Share	VMT-weighted Average Age
Non specialty, below lower threshold	82,489	9.4%	17.1
Non specialty, between thresholds	62,773	7.1%	12.5
Non specialty, above upper threshold	645,375	73.5%	10.5
Ag specialty vehicle	87,849	10.0%	11.4
Total	878,486	100.0%	

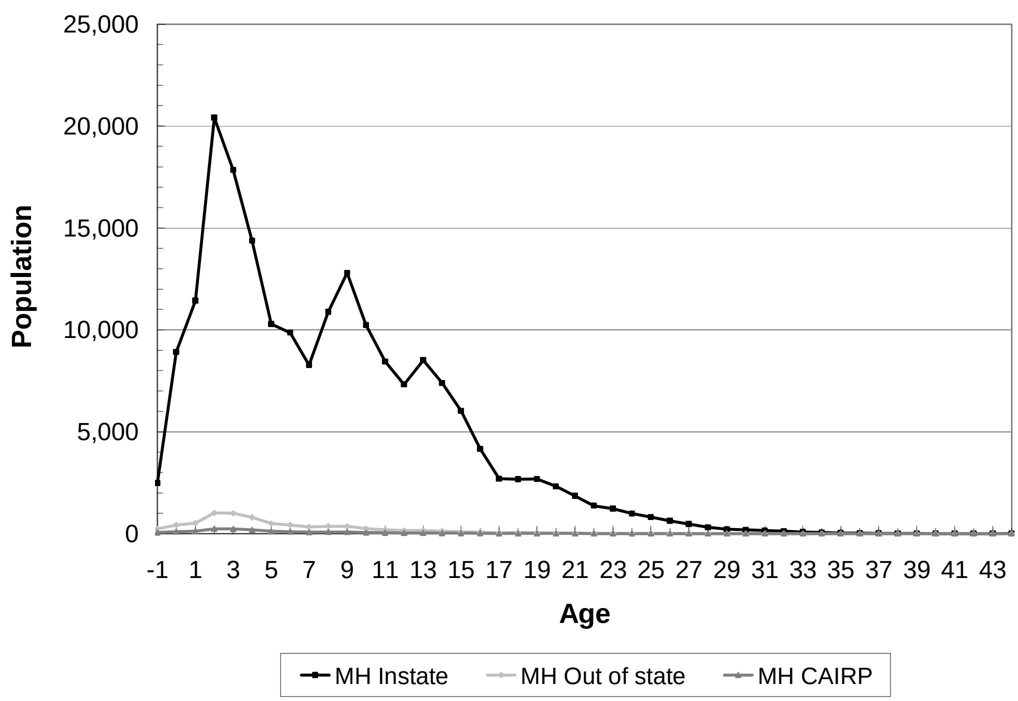
4. *Medium Heavy Duty Diesel Trucks*

Staff estimate that more than 200,000 MHDDT are registered in and operate in California. These trucks are primarily lighter weight delivery trucks with a GVWR between 14,000 and 33,000 lbs that travel during the work day within the area where they are registered. Most of these trucks are registered in and never leave California, although a few are California-registered and in the IRP program, and a few enter California from other states. Most MHDDTs are found in fleets of two or more although some are single-truck-fleet.

a) Base Year Population and Age Distribution by Fleet Size

Staff identified MHDDT in the DMV registration database by selecting all diesel powered vehicles with a GVWR between 14,000 and 33,000 lbs. The data were then analyzed in two ways. First, staff sorted the registration data by owner name and address to identify the number of vehicle records associated with a unique owner. This list was then used to develop the fleet size distribution, including the number of owner-operators and small fleets. Staff then used a combination of license plate and IRP registration data to estimate how many of the MHDDT are registered in California compared to other states, as well as what fraction of their travel is solely within California. Staff found that the vast majority of MHDDT that are registered in California never leave California. Also, using IRP data, staff estimated that very few out-of-state trucks fall into the MHDDT category. Since both the public and agricultural truck categories include MHDDT, we subtracted these by model year from the in-state MHDDT category to avoid double counting. We estimated the population-weighted average age of an out-of-state or IRP MHDDT at 5.4 years as compared to 8.0 years for an instate MHDDT. In Figure 9 we show the population and age distribution estimated for MHDDTs operating in California.

Figure 7. MHDDT Population and Model Year Distribution (2008)



b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

Staff used the most recent VIUS database (calendar year 2002) to estimate annual mileage accrual and modeled odometer readings for MHDDT. We did not differentiate between in-state and interstate MHDDT with modeled odometer readings. Staff used CA IRP data to calculate the fraction of total mileage accrual that occurs in California on average. Staff estimated that CA IRP MHDDT drive 63% and out-of-state registered

MHDDT 8% of their total annual miles in California. We estimated the average odometer reading as 161,000 miles for out-of-state MHDDT and CA IRP MHDDT and 207,000 miles for instate MHDDT. We estimated the average annual mileage accrual to be 22,000 miles for out-of-state and CA IRP MHDDT and 20,000 miles for instate MHDDT. Of the 22,000 miles driven annually by out-of-state and CA IRP MHDDTs, it was assumed that out-of-state vehicles drive only 8% (1,800 miles) of their annual miles in California as compared to 64% (14,000 miles) for CA IRP vehicles. The difference in average annual accrual resulted from the different age distribution representing the population within each category. In Figure 8 we plot the annual accrual in California and cumulative modeled odometer readings for MHDDT by age and category.

Figure 8. MHDDT Accrual and Modeled Odometer (2008)

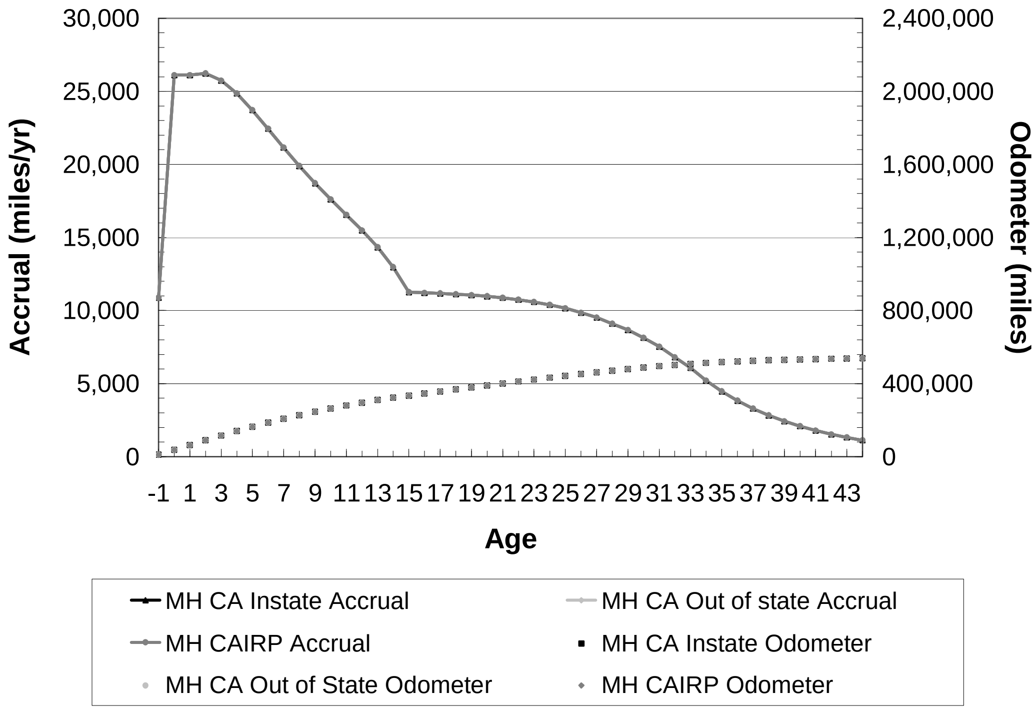
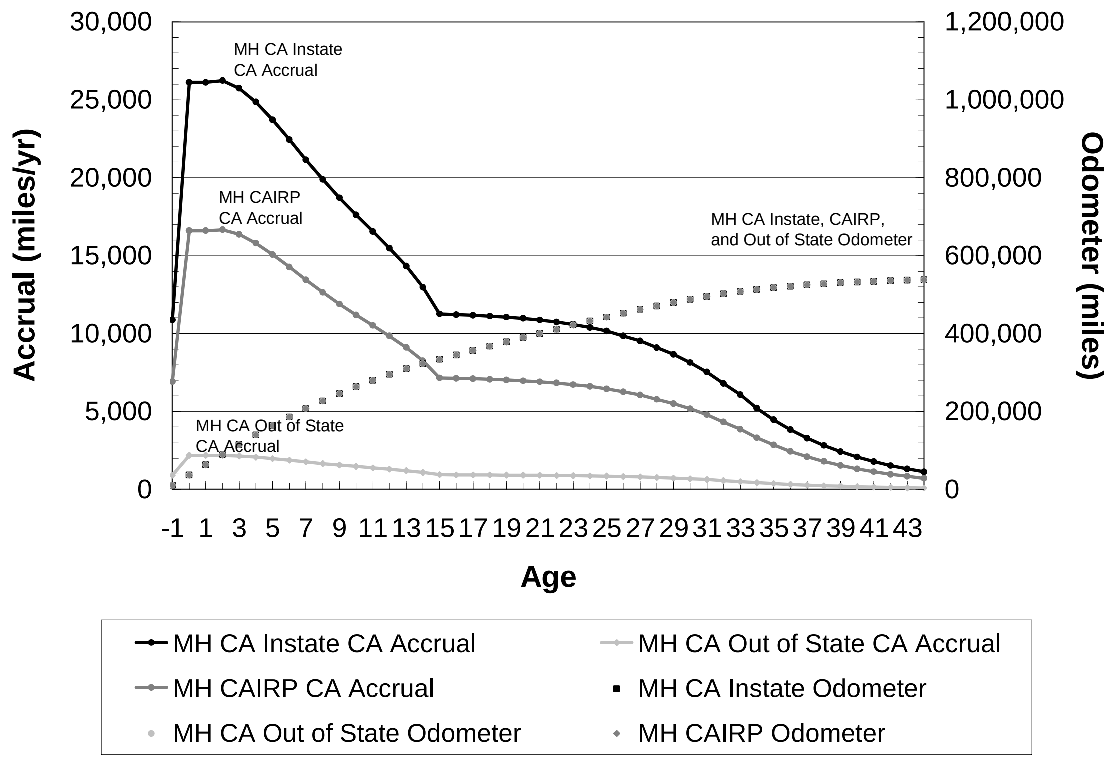


Figure 8 shows the annual mileage accrual rates to be similar for medium-heavy duty diesel CA Instate, CA Out-of-State, and CA IRP-registered trucks. However, these accrual rates are simply the total accrual rates for the vehicles in each inventory category; they do not represent the accrual rate for vehicles in each category within California. Because the share of annual travel within California varies between categories (8% for Out-of-State; 63% for CA-IRP; 100% for MHDDT Instate), the accrual rate for vehicles within California also varies for each category. We show these accrual rates in Figure 9; because California-registered MHDDT are assumed to spend 100% of their time in California, they have the highest CA accrual rate.

Figure 9. MHDDT Accrual in California and Modeled Odometer (2008)



c) *Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds*

We categorized medium-heavy duty diesel trucks by fleet size as single-truck fleets, two-truck fleets, three-truck fleets, and fleets of more than three trucks. We also categorized MHDDT based on their annual miles driven since the regulation is to be applied differently to vehicles used at differing mileage levels. The mileage threshold of significance for MHDDT from a regulatory perspective is 5,000 miles per year. In Table 8, Table 9, and Table 10 we show the distribution of daily VMT driven in California in calendar year 2008 by different size fleets of instate, CA-IRP, and out-of-state MHDDTs, respectively. Each table also shows the VMT-weighted average age of the trucks as a function of fleet size. For all categories of MHDDT, regardless of miles driven or state of registration, the smaller the fleet, the older the truck. Also, very little (less than 2%) of the total statewide MHDDT VMT is driven by vehicles in fleets driving less than 5,000 miles a year. In addition, MHDDTs driving less than 5,000 miles a year are significantly older (4 to 6 years older) than those in comparable size fleets that drive more than 5,000 miles a year.

Table 8. Distribution of VMT among Medium-Heavy Instate Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 5000 miles	1 truck	80,942	0.6%	13.4
	2 trucks	25,478	0.2%	13.1
	3 trucks	15,111	0.1%	13.0
	> 3 trucks	107,142	0.8%	11.6
Above 5000 miles	1 truck	3,786,410	29.7%	7.0
	2 trucks	1,244,223	9.8%	6.8
	3 trucks	740,914	5.8%	6.9
	> 3 trucks	6,731,027	52.9%	5.7
	Total	12,731,247	100.0%	

Table 9. Distribution of VMT among Medium-Heavy CAIRP Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 5000 miles	1 truck	95	0.1%	8.2
	2 trucks	61	0.1%	8.4
	3 trucks	68	0.1%	9.2
	> 3 trucks	616	0.8%	9.4
Above 5000 miles	1 truck	9,684	13.0%	4.3
	2 trucks	6,018	8.0%	4.3
	3 trucks	5,943	7.9%	4.5
	> 3 trucks	52,292	69.9%	4.7
	Total	74,777	100.0%	

Table 10. Distribution of VMT among Medium-Heavy Out-of-state Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 5000 miles	1 truck	54	0.1%	8.2
	2 trucks	35	0.1%	8.4
	3 trucks	39	0.1%	9.2
	> 3 trucks	353	0.8%	9.4
Above 5000 miles	1 truck	5,552	13.0%	4.3
	2 trucks	3,450	8.0%	4.3
	3 trucks	3,407	7.9%	4.5
	> 3 trucks	29,980	69.9%	4.7
	Total	42,871	100.0%	

5. California Registered Heavy Heavy Duty Diesel Trucks

California is somewhat unique in the United States in that it has a comparatively large population of older heavy-heavy duty diesel trucks. These trucks, with an average age of 10 to 12 years, generally do not travel outside California, operating practically as a captive fleet. These California registered trucks drive fewer miles per truck than IRP trucks registered in California, both because they are older and less mechanically reliable and because they are engaged in more localized trucking services than their out-of-state registered counterparts. Consequently, California registered HHDDT are much more likely to drive in the air basin in which they are primarily based.

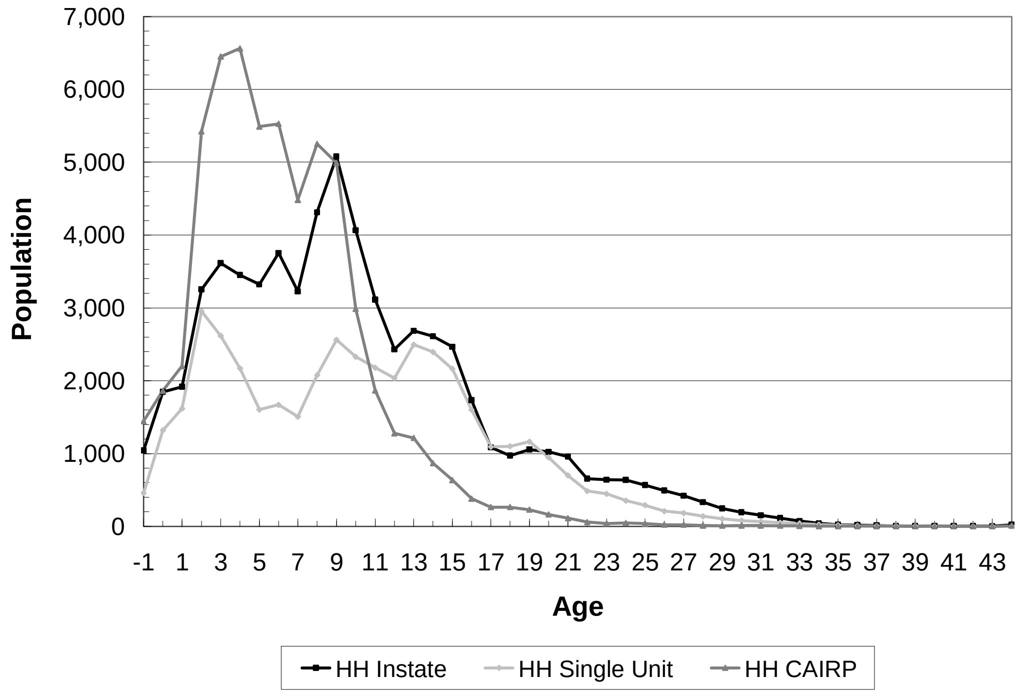
When evaluating VIUS data we realized there is a significant difference in the mileage a truck travels depending upon whether it is a single-unit truck or a combination tractor. On average, combination tractors drive more miles per year than single-unit trucks. We also found that while single-unit trucks tend to be purchased new in California and then operate in California for the life of the truck, in-state tractors tend to begin their life as interstate trucks and then transition into in-state usage as they age and accrue miles. Analysis of the VIUS data indicates interstate trucks are generally sold into the in-state fleets between 2 and 6 years of age, having accrued approximately 500,000 miles in interstate service.

a) Base Year Population and Age Distribution by Fleet Size

To develop population estimates for in-state HHDDT, staff used DMV registration data (license plate number and GVWR) to identify those HHDDT that operate solely within California (in-state). Staff then analyzed DMV and IRP data to identify only California registered IRP trucks. Next, staff used the DMV data to assess the body type of each in-state truck. We then used the DMV data to estimate the population and model year distribution of in-state single-unit trucks, in-state tractors, and California IRP trucks. We subtracted the populations of utility trucks, drayage trucks, and agricultural trucks estimated elsewhere from the in-state HHDDT category, by body type and registration, to estimate the number of in-state tractors and avoid double counting.

In Figure 10 we provide the estimated population and age distribution for in-state HHDDT categories in California in calendar year 2008. In general, vehicles traveling only in California are older than those traveling out-of-state and single unit trucks are slightly older than comparable model year tractors. As shown in Figure 10, CA IRP trucks have a population-weighted average age of 6.2 years, while in-state tractors average age 9.9 years, and single-unit trucks average 10.2 years old.

Figure 10. California-Registered In-State HHDDT Population and Model Year Distribution (2008)



b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

Staff used VIUS to assess annual mileage accrual rates by body type for in-state HHDDT and CA-IRP trucks. This analysis indicated that California IRP trucks drive about 55% of their total miles in California. Because used trucks are sold into the in-state tractor category from interstate categories, and interstate category tractors drive more miles than in-state tractors during their early years, we developed a composite modeled odometer to represent in-state tractors. The composite odometer estimate assumes a high annual mileage in early model years when a tractor is in long-haul service and lower annual mileage once a tractor begins shorter haul service in the in-state category. For comparative purposes, a vehicle of a given model year that had been used exclusively for interstate purposes would have a higher odometer reading than a vehicle of the same age that had been used exclusively for instate purposes; a vehicle that had been used earlier in its life for interstate purposes and later for instate purposes would likely have an odometer reading between the two. The average odometer reading estimated using this approach was 723,000 miles for instate HHDDT, 338,000 miles for single-unit HHDDT, and 668,000 miles for CAIRP HHDDT. The average annual mileage accrual was estimated to be 51,000 miles for instate HHDDT, 25,000 miles for single-unit HHDDT, and 75,000 miles for CAIRP HHDDT (of which 43,000 miles are driven in California). Figure 11 provides in-state HHDDT mileage accrual and modeled odometer by model year; these data reflect the assumption of composite use. For comparative purposes, in Figure 12 we provide the composite odometer reading for instate trucks of various model years in calendar year 2008 compared with the modeled odometer reading for similar trucks used purely for in-state or interstate long-haul traffic.

Figure 11. HHDDT In-state and Interstate Fleet Accrual and Modeled Odometer (2008)

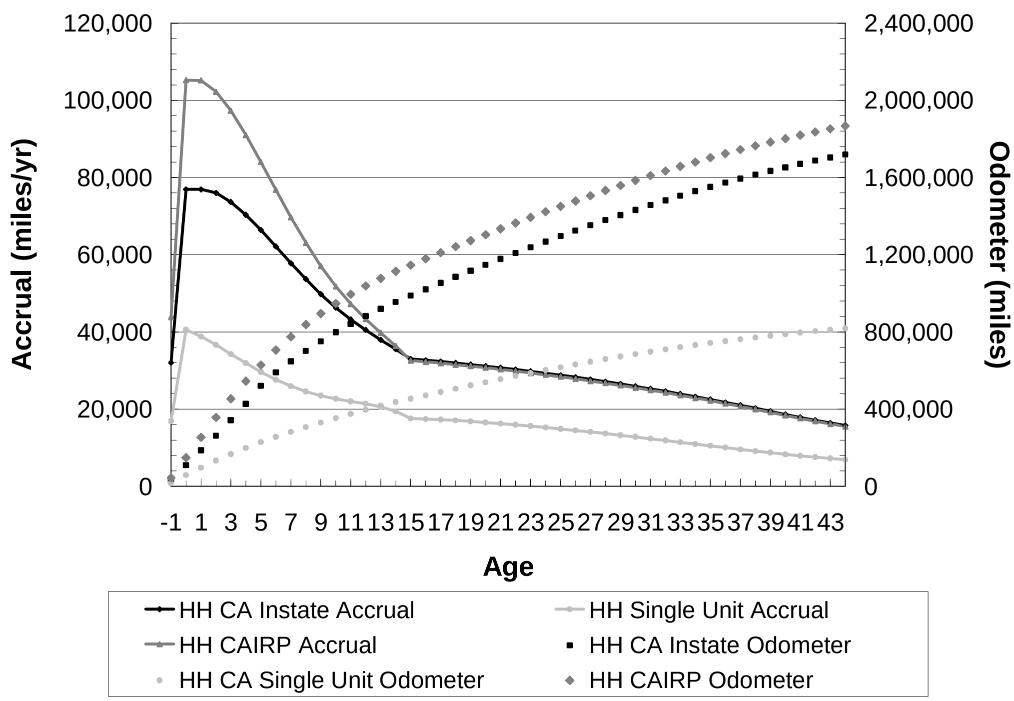
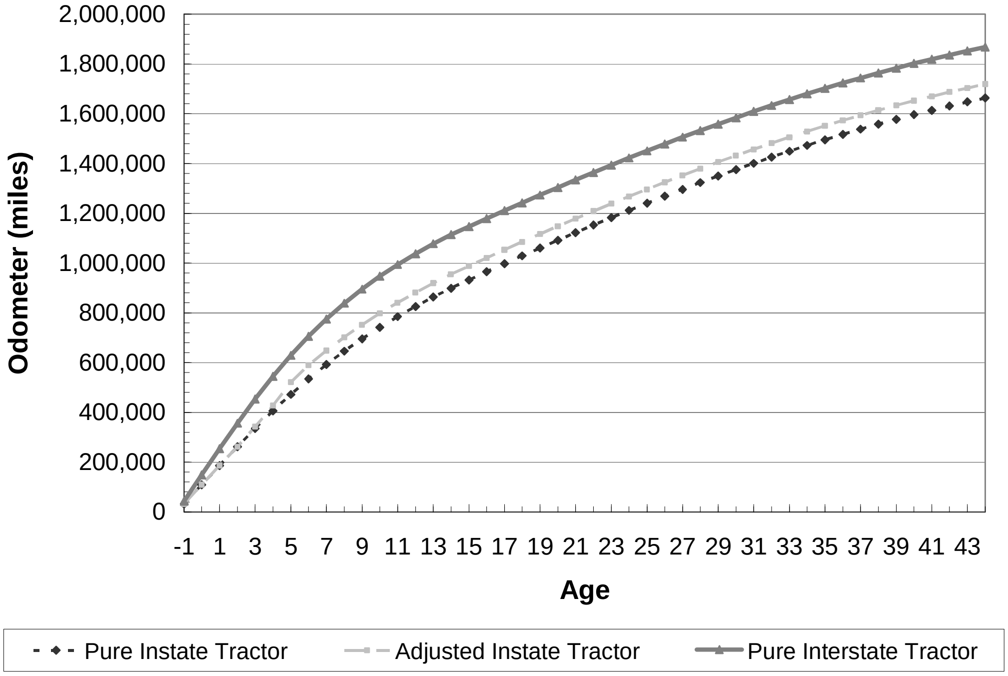


Figure 12. HHDDT In-State Tractor Modeled Odometer (2008)



c) *Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds*

We categorized heavy-heavy duty diesel trucks by fleet size as single-truck fleets, two-truck fleets, three-truck fleets, and fleets of more than three trucks. We also categorized the fleets by their annual VMT since the regulation is to be applied differently to trucks driven at different mileages each year. The mileage threshold of significance for HHHDT from a regulatory perspective is 7,500 miles per year. In Table 11 we show the distribution of daily VMT and the VMT-weighted average age as a function of fleet size and annual miles driven for heavy-heavy instate trucks in California in 2008. Heavy-heavy duty diesel instate trucks driving less than 7,500 miles a year are significantly older (5 years) than their counterparts driving more than 7,500 miles a year and contribute less than 2% of the total VMT driven each year by in-state HHDDTs. Regardless of miles driven, HHDDT in smaller fleets are on average older than those in larger fleets.

Table 11. Distribution of Daily VMT among California Instate Tractors Heavy-Heavy Duty Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	44,925	0.4%	15.2
	2 trucks	12,992	0.1%	15.4
	3 trucks	7,370	0.1%	15.3
	> 3 trucks	48,792	0.5%	13.6
Above 7500 miles	1 truck	3,031,868	29.1%	10.1
	2 trucks	902,069	8.7%	9.7
	3 trucks	529,836	5.1%	9.5
	> 3 trucks	5,835,899	56.0%	6.4
	Total	10,413,751	100.0%	

In Table 12 we show the distribution of daily VMT as a function of fleet size and mileage driven for heavy-heavy single-unit trucks operating in California in calendar year 2008. In Table 13 we show the distribution of daily VMT as a function of fleet size and mileage driven in California for heavy-heavy trucks licensed in California under the International Registration Program in California in 2008. Each table also shows the average VMT-weighted age of vehicles within the fleets of different sizes; in each case, the trucks driven fewer miles tended to be older than trucks driven more miles, and the average age of vehicles within a fleet was also estimated to decrease with the size of the fleet.

Table 12. Distribution of Daily VMT among Single-Unit Heavy-Heavy Duty Vehicles by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	37,585	1.1%	15.6
	2 trucks	13,153	0.4%	15.5
	3 trucks	7,951	0.2%	14.8
	> 3 trucks	63,491	1.9%	13.5
Above 7500 miles	1 truck	766,081	22.5%	10.3
	2 trucks	279,769	8.2%	9.9
	3 trucks	185,491	5.4%	9.2
	> 3 trucks	2,057,340	60.3%	7.1
	Total	3,410,860	100.0%	

Table 13. Distribution of Daily VMT among California International Registration Program Vehicles in California by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	5,804	0.1%	10.8
	2 trucks	2,096	0.0%	10.9
	3 trucks	1,223	0.0%	11.4
	> 3 trucks	9,801	0.1%	11.3
Above 7500 miles	1 truck	2,198,998	26.5%	6.0
	2 trucks	812,823	9.8%	5.8
	3 trucks	460,037	5.6%	5.7
	> 3 trucks	4,791,942	57.9%	4.6
	Total	8,282,725	100.0%	

6. Out-of-State Heavy Heavy Duty Diesel Trucks

According to the California Department of Finance, California's economy is the eighth largest in the world (DOF, 2008). Foreign trade, construction, and transportation are all major contributors to California's economy, and these economic sectors attract the services of national trucking fleets including large numbers of out-of-state heavy-heavy duty diesel trucks.

a) Base Year Population and Age Distribution by Fleet Size

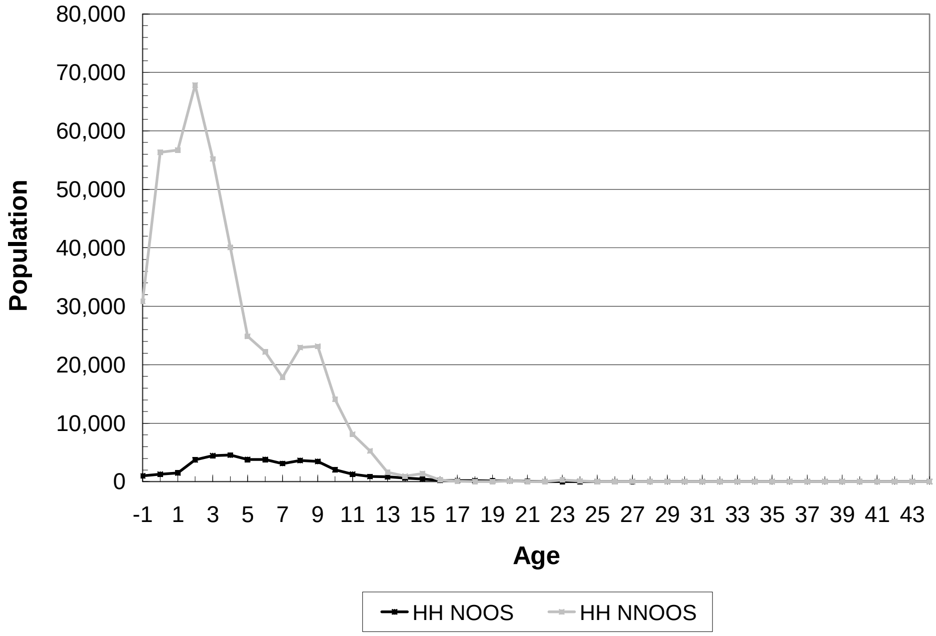
No single source of information describes out-of-state truck activity in California. To develop an inventory, staff conducted detailed research into the IRP and IFTA programs. The California DMV provided staff with a report providing the total number of out-of-state trucks, by state, that are enrolled in the IRP program and in fleets that reported any travel in California. These data suggested that more than one million trucks are in fleets that report mileage in California. However, this is likely to be an upper estimate as not all of the trucks in these fleets actually enter California. To better constrain the number of out-of-state trucks entering California, staff analyzed IRP data in greater detail, as described below.

In analyzing the age distribution of out-of-state trucks, staff divided heavy-heavy duty trucks into two groups based on their proximity to California under the assumption that trucks traveling longer distances are younger. Neighboring states were considered to include British Columbia, Washington, Oregon, Idaho, Nevada, and Arizona while non-neighboring states included all other states and Canadian provinces. Staff sampled IRP data from 12 states to obtain a statistically representative sample of data. IRP data suggested neighboring state trucks are on average 6.1 years old and have a model year distribution similar to that of California interstate trucks while non-neighboring state trucks are on average around 3.3 years old, much younger than other interstate trucks. Recent field studies supported by the ARB have confirmed this trend (Lutsey, 2008).

To better understand the population of out-of-state trucks that actually operate in California, staff developed a methodology to assess the number of trucks in a fleet likely to enter California. We evaluated all of the collected non-California registered IRP data by fleet. For each fleet we calculated the number of miles traveled in California per truck as reported in the IRP data. We then assumed an average trip length depending on the registered location of each fleet and where those trucks would most likely travel in California. In many cases the assumed trip length was longer than the calculated number of miles traveled per truck in the IRP data. In those cases, we calculated the population operating in California as the total miles traveled in California divided by the assumed trip length. For all other fleets we assumed all of the reported trucks in that fleet actually enter California. Staff then recompiled the population for trucks from neighboring states and non-neighboring states. The results suggested for fleets in states neighboring California, approximately 60% of trucks in those fleets authorized to enter California actually do so. Of fleets in states not neighboring California, approximately 40% of the trucks authorized to enter California are estimated to actually do so.

The fraction of owner-operators in the out-of-state category was based on the IRP samples collected. The population-weighted average age of HHDDT from neighboring states was estimated to be 6.2 years while HHDDT from non-neighboring states were estimated to be on average 3.6 years old. These estimates were each close to the IRP estimates. In Figure 13 we provide estimates of the out-of-state population and model year distribution of heavy-heavy duty diesel trucks operating in California in calendar year 2008.

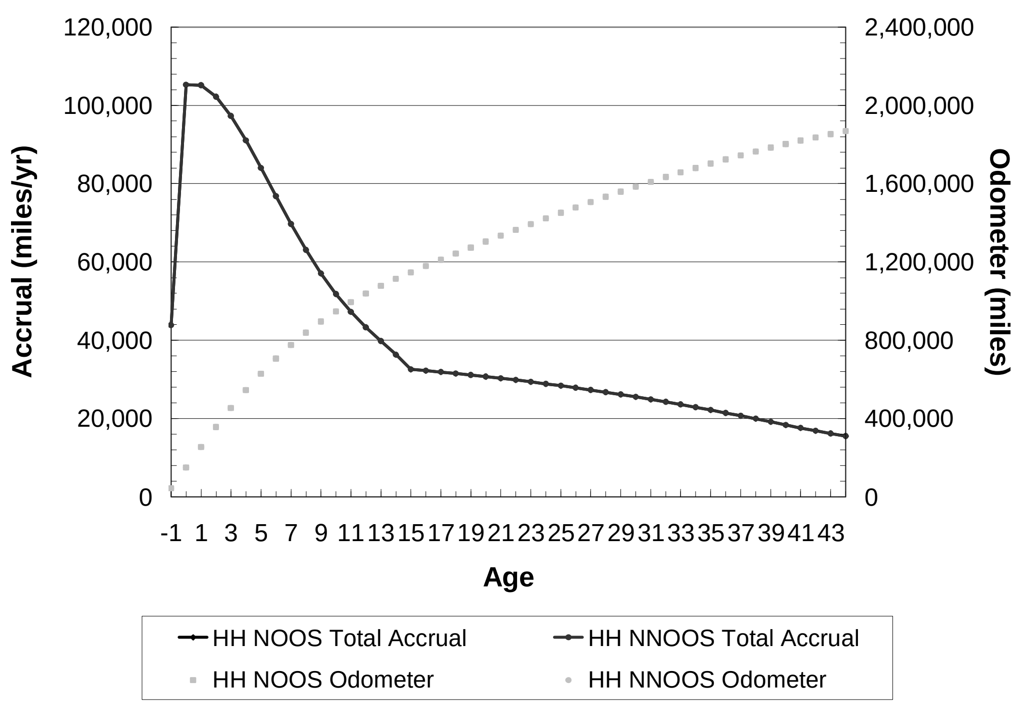
Figure 13. Out-of-State HHDDT Population and Model Year Distribution (2008)



b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

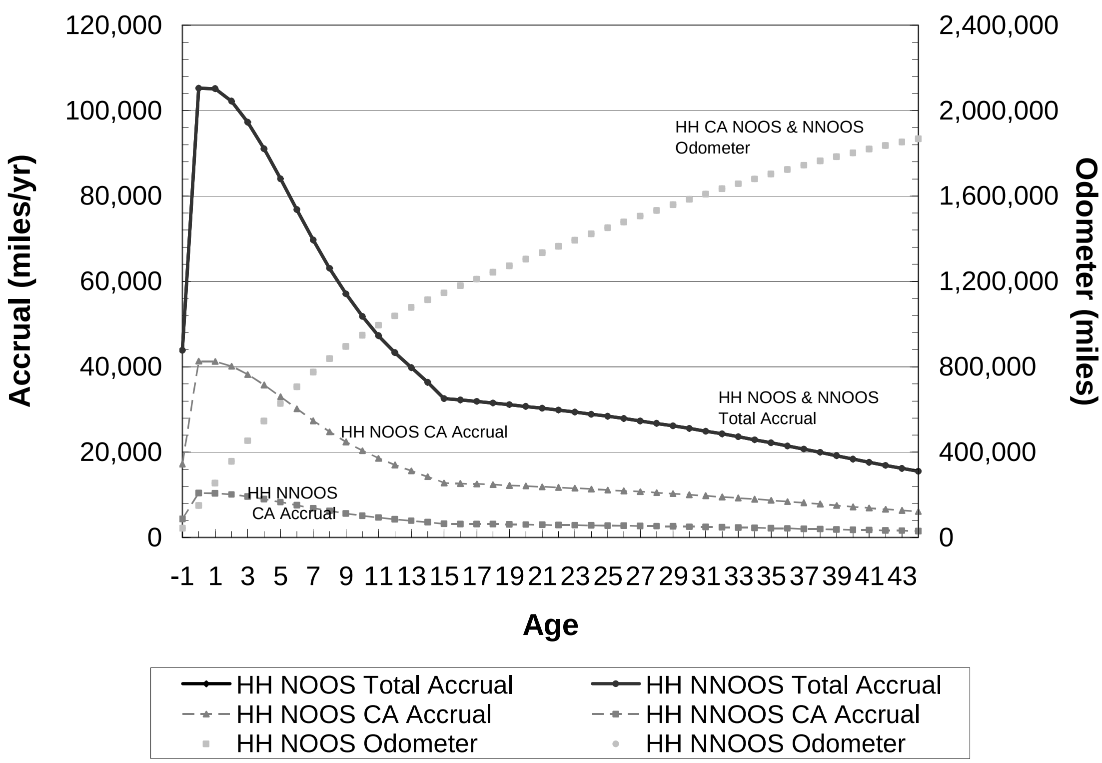
Staff used VIUS to assess accrual rates for the nationwide IRP truck category traveling in California. Staff then evaluated IRP sample data to estimate the fraction of miles accrued in California and 2005 IFTA records to quantify the total miles traveled in California by out-of-state HHDDT. Results suggested that trucks from neighboring states travel on average 40% of their total mileage in California, while trucks from non-neighboring states travel around 10% of their total mileage in California. The average odometer reading was estimated to be 668,000 miles for neighboring out-of-state HHDDT and 473,000 miles for non-neighboring out-of-state HHDDT. The average annual mileage accrual was estimated as 75,000 miles per year (30,000 miles per year in CA) for neighboring out-of-state HHDDT and 85,000 miles per year (8,400 miles per year in CA) for non-neighboring out-of-state HHDDT. In Figure 14 we provide estimates of the average annual mileage accrual and modeled odometer by model year for out-of-state heavy-heavy duty diesel trucks operating in California in calendar year 2008.

Figure 14. Out-of-State Truck Accrual and Modeled Odometer (2008)



In Figure 14, the accrual rates for HHDDT NOOS and NNOOS trucks are shown to be equal, but these rates represent the overall accrual for the trucks. Because trucks from states neighboring California drive a larger fraction of their annual miles in California than trucks from non-neighboring states, the model used for this analysis reflects different accrual rates for vehicles in each category in California. We show these in Figure 15.

Figure 15. Out-of-State Truck Accrual within California and Modeled Odometer (2008)



c) Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds

Staff also categorized heavy-heavy duty diesel trucks from outside California by fleet size as single truck fleets, two truck fleets, three truck fleets, and fleets of more than three trucks. We also categorized fleets based on the annual VMT of trucks, since the regulation is to be applied differently to fleets used at differing mileage levels. The mileage threshold of significance for HHDDT from a regulatory perspective is 7,500 miles per year. In Table 14 we show the distribution of daily VMT driven in California in calendar year 2008 by heavy-heavy diesel trucks of different fleet sizes registered in states neighboring California. In Table 15 we show the distribution of daily VMT driven in California in calendar year 2008 by heavy-heavy diesel trucks registered in non-neighboring states in 2008. Each table also shows the average VMT-weighted age of vehicles within each fleet size; we estimated the average age to be higher for vehicles driven fewer miles. We estimated the average age to be independent of the fleet size for vehicles registered outside California.

Table 14. Distribution of Daily California VMT among Heavy-Heavy Duty Diesel Trucks Registered in Neighboring States by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	1,149	0.0%	11.1
	2 trucks	357	0.0%	11.1
	3 trucks	261	0.0%	11.1
	> 3 trucks	7,253	0.2%	11.1
Above 7500 miles	1 truck	501,599	12.7%	5.1
	2 trucks	155,808	3.9%	5.1
	3 trucks	113,815	2.9%	5.1
	> 3 trucks	3,167,429	80.2%	5.1
	Total	3,947,672	100.0%	

Table 15. Distribution of Daily VMT among Heavy-Heavy Duty Diesel Trucks Registered in States not Neighboring California by Fleet Size (2008)

	Fleet Size	Daily VMT	Share	VMT-weighted Average Age
Below 7500 miles	1 truck	188	0.0%	8.3
	2 trucks	58	0.0%	8.3
	3 trucks	41	0.0%	8.3
	> 3 trucks	11,610	0.1%	8.3
Above 7500 miles	1 truck	192,875	1.6%	3.1
	2 trucks	58,926	0.5%	3.1
	3 trucks	41,740	0.3%	3.1
	> 3 trucks	11,889,217	97.5%	3.1
	Total	12,194,654	100.0%	

7. Buses

The proposed regulation achieves emissions reductions for two classes of buses: school buses and other buses. School buses may be either privately- or publicly-owned, but must be used exclusively for transporting students in accordance with the definition of school buses in the California Vehicle Code. Other buses are defined as all buses identified in the DMV database that cannot be categorized as school buses and are not owned by public transit agencies. This category includes intercity buses, charter buses, and church buses. This section describes the assumptions used to develop a baseline emissions inventory for school buses and other buses.

a) Base Year Population and Age Distribution by Fleet Size

Staff used a calendar year 2005 database of school buses compiled by the CHP to estimate the population and age distribution of school buses in California in 2005 (California Highway Patrol, 2006). The age distribution of school buses in 2005 was assumed to be consistent with the age distribution of school buses between 2000 and 2004.

Staff used the survival rate of school buses in EMFAC2007 and the existing Lower Emissions School Bus Program (LESBP) to estimate the age distribution of school buses in future years. Specifically, the impact of the LESBP was modeled as though: i) all pre-1985 model year school buses will be replaced by buses that meet 2007 emission standards as of December 31, 2009, and ii) 50% of 1985 and 1986 model year school buses will be replaced with school buses that meet 2007 emission standards by December 31, 2010. In addition, the maximum age for a school bus was set at thirty years; any school bus older than thirty years was assumed to be replaced with a new bus. Any school bus that was retired due to age or attrition was assumed to be replaced in the population with a new school bus. The aggregate population of diesel school buses was assumed to remain unchanged; any increases to the total school bus population were assumed to represent new vehicles using natural gas or some other alternative fuel entering the fleet.

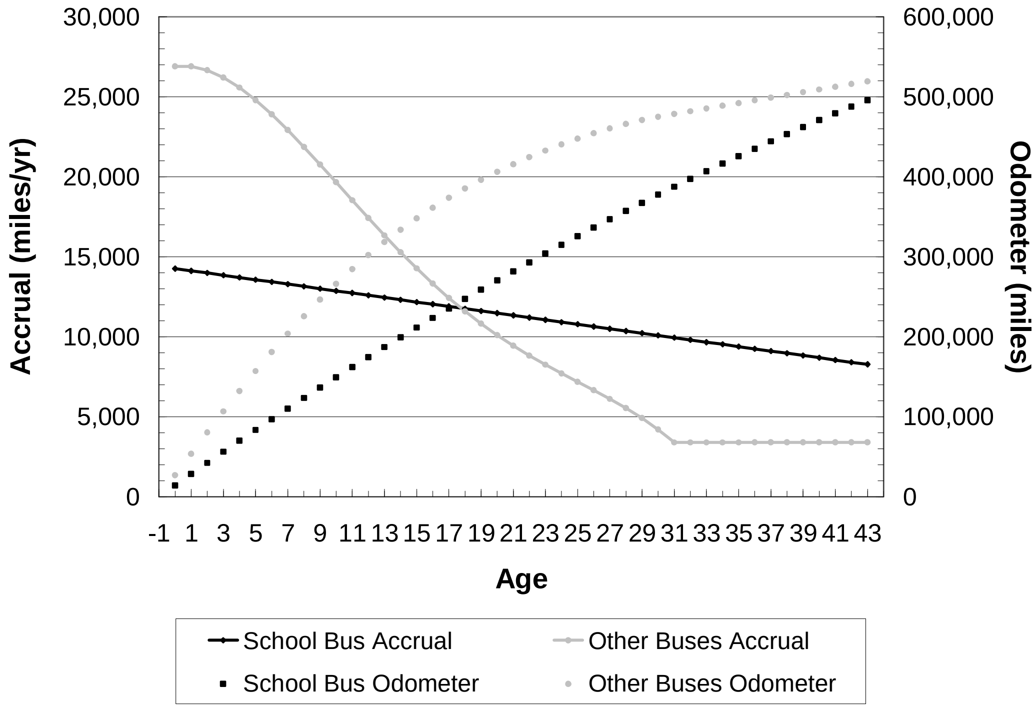
Other buses were assumed to follow the age distribution of such vehicles as modeled in EMFAC2007. The population-weighted average age was estimated to be 12.2 years for school buses and 9.6 years for other buses. We compare the age distribution of school buses and other buses operating in California as modeled for calendar year 2008 in Figure 16.

Figure 16. Bus Population and Model Year Distribution (2008)

b) Base Year Accrual, Lifetime Accrual, and Mileage Thresholds

In the absence of new information, staff used the average annual mileage accrual and odometer estimates assumed for buses in EMFAC2007 to estimate the benefits of the proposed rule. The average odometer reading was estimated to be 173,000 miles for school buses and 222,000 miles for other buses. The average annual mileage accrual was estimated to be approximately 13,000 miles for school buses and 22,000 miles for other buses. All such miles are assumed accrue in California. We show in Figure 17 the average annual mileage accrual and odometer estimates for school buses and other buses in California in calendar year 2008..

Figure 17. Bus Accrual and Modeled Odometer (2008)



c) Base Year Vehicle Miles Traveled by Fleet Size and Mileage Thresholds

Buses were not differentiated by fleet size or mileage threshold in this inventory as buses are not treated differently in the proposed regulation based on these criteria.

8. Power Take Off Operations in California

Power Take Off (PTO) operations are those that result in emissions related to activities other than travel, such as a crane lifting objects or a cement mixer processing raw materials. Emissions associated with these operations are more accurately quantified using fuel consumption than vehicle miles traveled, the usual activity metric for on-road vehicles.

a) Estimating Fuel Usage

Staff did not estimate the actual population or distribution of PTO activity. Instead we used fuel consumption data for PTO operations in California in calendar year 2005 as reported by the California Board of Equalization.

b) Converting Fuel Usage to Activity by Age

The age distribution PTO equipment was assumed to follow the same age distribution as HHDDT single-unit trucks. This distribution was given earlier in Figure 10.

Mileage accrual was not directly estimated for PTO operations since, as mentioned previously, emissions generally occur while the equipment is stationary. Staff used the fuel consumption rate in EMFAC2007 for HHDDT single-unit trucks at twenty miles-per-hour with the fuel consumption estimated by the CA Board of Equalization to back-calculate the VMT-equivalent for PTO activity in California, assuming the speed profile embedded in EMFAC2007.

E. Emission Rates

For most categories, staff have used EMFAC2007 and modeled cumulative mileage to develop category-specific emission rates. We have also updated several estimates of emission rates based upon recent data analysis. In this section we describe the methods used to estimate emission rates. In each case, a reference is provided for more detailed information as to the basis for the emission rates. The specific emission rates assumed for vehicles of each fleet will be provided in a database scheduled to be released in conjunction with the staff report..

1. Updated MHDDT Emissions

In EMFAC2007, staff did not update the emission factors for medium heavy heavy-duty trucks (MHDDT). Subsequent to the release of EMFAC2007, the CRC made emissions test data available for MHDDT available to staff through its E55/59 project final report. This proposed regulation incorporates updated MHDDT emission factors developed by staff using the latest E55/59 study results.

To revise the MHDDT emission factors for this analysis, staff merged the E55/59 data into the data set that was used to develop MHDDT emission factors for EMFAC2002. From this combined data set, staff then recalculated revised zero-mile rates (ZMR) and deterioration rates (DR) for MHDDT.

The method for deriving MHDDT ZMR and DR is the same as that used for calculating emission factors for heavy heavy-duty trucks (HHDDT); the methodology has been described in detail in an EMFAC2007 technical memo (ARB, 2006f).

In Table 16 we provide the zero-mile emission and deterioration rates for medium-heavy duty diesel trucks assumed in EMFAC2007. The deterioration rates are used to model the increase in emissions relative to the zero-mile (or new-vehicle) emission rate due to a vehicle aging and accruing miles. In Table 17 we give the updated emission rates reflecting incorporation of the latest E55/59 data, as discussed previously.

Table 16. EMFAC2007 MHDDT Zero-Mile Emission Rate (ZMR, g/mi) and Deterioration Rate (DR, g/mi/10,000 mi)

MY GROUP	HC		CO		NO_X		PM_{10}	
	ZMR	DR	ZMR	DR	ZMR	DR	ZMR	DR
Pre 1975	0.34	0.011	3.17	0.100	18.50	0.032	1.07	0.016
1975-76	0.34	0.011	3.17	0.100	18.50	0.032	1.07	0.016
1977-79	0.34	0.011	3.17	0.100	18.50	0.032	1.07	0.016
1980-83	0.34	0.011	3.17	0.100	18.50	0.032	1.07	0.016
1984-86	0.33	0.014	2.99	0.131	17.91	0.043	1.00	0.021
1987-90	0.21	0.016	1.80	0.140	15.74	0.034	0.73	0.017
1991-93	0.18	0.018	1.43	0.139	13.11	0.078	0.45	0.022
1994-97	0.11	0.017	0.78	0.121	11.55	0.048	0.27	0.018
1998	0.09	0.014	0.64	0.097	10.52	0.032	0.24	0.012
1999-02	0.09	0.014	0.64	0.097	10.52	0.032	0.24	0.012
2003	0.09	0.007	1.04	0.074	5.79	0.018	0.29	0.009
2004-06	0.09	0.006	1.04	0.074	5.48	0.017	0.29	0.009
2007-09	0.058	0.006	0.666	0.074	3.01	0.017	0.029	0.009
2010+	0.025	0.006	0.291	0.074	0.548	0.017	0.029	0.009

Table 17. Revised MHDDT Zero-Mile Emission Rate (ZMR, g/mi) and Deterioration Rate (DR, g/mi/10,000 mi)

MY GROUP	HC		CO		NO_X		PM_{10}	
	ZMR	DR	ZMR	DR	ZMR	DR	ZMR	DR
Pre 1986	0.83	0.047	2.79	0.159	15.61	0.033	0.97	0.038
1987-90	0.65	0.056	2.19	0.189	15.39	0.044	1.05	0.034
1991-93	0.29	0.025	1.12	0.095	11.51	0.053	0.57	0.026
1994-97	0.21	0.028	0.83	0.109	11.30	0.068	0.31	0.017
1998-02	0.22	0.028	0.84	0.108	11.11	0.078	0.35	0.015
2003-06	0.14	0.013	0.37	0.033	7.35	0.077	0.22	0.008
2007	0.12	0.008	0.31	0.020	4.78	0.065	0.022	0.001
2008	0.12	0.008	0.31	0.020	4.39	0.064	0.022	0.001
2009	0.12	0.008	0.31	0.020	3.78	0.062	0.022	0.001
2010	0.10	0.002	0.26	0.005	1.01	0.054	0.022	0.001
2011	0.10	0.002	0.26	0.005	0.86	0.054	0.022	0.001
2012	0.10	0.002	0.26	0.005	0.67	0.053	0.022	0.001
2013+	0.10	0.002	0.26	0.005	0.67	0.041	0.022	0.001

2. *Revised engine market information*

Staff also updated the emission factors for heavy heavy-duty diesel trucks (HHDDT) and medium heavy-duty diesel trucks (MHDDT) to reflect manufacturers' compliance with the 2007 engine standard and the anticipated compliance with the 2010 engine standard between 2006 and 2011. Staff estimated that the adjustment to 2006-2011 model year emission factors would result in lower NO_x emission rates for 2006 and 2009 model years but higher NO_x emission rates for 2007, 2008, 2010, and 2011 model years than the rates currently assumed in EMFAC2007.

The latest information available to staff indicates that at least one engine manufacturer does not plan to use selective catalyst reduction technology in their 2010-2011 model year heavy-duty diesel engines. In addition, review of the certification data shows that some engine manufacturers introduced 1.2 g/bhp-hr NO_x heavy duty engines one year earlier than required. As a result, staff decided to update the emission factors in EMFAC2007 to reflect the latest information from manufacturers and certification data.

For the earlier introduction of engines meeting 1.2 g/bhp-hr NO_x and 0.01 g/bhp-hr PM standards, the current zero-mile rates (ZMR) and deterioration rates (DR) for 2003-06 and 2007-09 model year groups were weighted by the sales fractions of 2007 standard compliant engines in 2006 model year.

For the introduction of 0.5 g/bhp-hr NOx engines in 2009 model year, staff estimated the ZMR by adjusting the current ZMR for 2006-2009 model year group (1.2 g/bhp-hr NO_x engines) but assumed that the deterioration rate for 2006-09 model year would still apply to the 0.5 g/bhp-hr NO_x engines. The assumption of unchanged DR is largely based on the fact that the engine manufacturers will achieve a 0.5 g/bhp-hr NO_x level with an integrated technology solution based on their 2006-09 model year technologies (advanced fuel system, air management, combustion and electronic controls, and enhanced cooled exhaust gas recirculation).

Staff estimated the 2005-2008 model year sales fractions of heavy and medium heavy-duty diesel engines based on the sales fraction data reported by the manufacturers and projected the 2009-2012 model year sales fractions from the information currently available. We show the ARB-estimated penetration rates for 2005 to 2012 model years in Table 18.

Table 18. ARB Estimated Penetration Rates of 2005-2012 Model Year Engines

Model Year	Certified NO_x (g/bhp-hr)				Certified PM_{10} (g/bhp-hr)	
	2.2	1.2	0.5	0.25/0.2*	0.1	0.01
Heavy Heavy-Duty Diesel						
2005	100%					
2006	99%	1%			98%	2%
2007	14%	86%			1%	99%
2008	7%	93%				100%
2009		90%	10%			100%
2010			10%	90%		100%
2011			10%	95%		100%
2012				100%		100%
Medium Heavy-Duty Diesel						
2005	100%					
2006	100%				98%	2%
2007	23%	77%				100%
2008	12%	88%				100%
2009		90%	10%			100%
2010			10%	90%		100%
2011			10%	90%		100%
2012				100%		100%

* 0.25 g/bhp-hour applies to 2010 model year only.

Using the sales fractions in Table 18, staff calculated the NO_x ZMRs and DRs of both HHDDT and MHDDT for 2006-2011 model years by weighting the ZMRs and DRs of the corresponding model year groups. Staff did not revise the PM emission factors for HHDDT and MHDDT. As can be seen in Table 18, the sales of PM filter-equipped engines in 2006 account for only about 2% for both HHDDT and MHDDT categories; thus the impact of DPF engines on the PM emission rates for the 2006 model year is negligible.

In Table 19 we show the current and revised NO_x ZMR and DR of both HHDDT and MHDDT for 2006 to 2011 model years.

Table 19. NO_x Emission Factors for 2006-2011 MY Heavy-Duty Diesel Trucks (ZMR in g/mi, DR in g/mi/10,000 mi)

<table>
<tr><th rowspan="3">Model Year</th><th colspan="4">HHDDT</th><th colspan="4">MHDDT</th></tr>
<tr><th colspan="2">Current</th><th colspan="2">Revised</th><th colspan="2">Current</th><th colspan="2">Revised</th></tr>
<tr><th>ZMR</th><th>DR</th><th>ZMR</th><th>DR</th><th>ZMR</th><th>DR</th><th>ZMR</th><th>DR</th></tr>
<tr><td>2006</td><td>12.54</td><td>0.0522</td><td>12.48</td><td>0.0521</td><td>7.35</td><td>0.0765</td><td>7.35</td><td>0.0765</td></tr>
<tr><td>2007</td><td rowspan="3">6.84</td><td rowspan="3">0.0465</td><td>7.66</td><td>0.0573</td><td rowspan="3">4.01</td><td rowspan="3">0.0621</td><td>4.78</td><td>0.0654</td></tr>
<tr><td>2008</td><td>7.25</td><td>0.0468</td><td>4.39</td><td>0.0638</td></tr>
<tr><td>2009</td><td>6.44</td><td>0.0464</td><td>3.78</td><td>0.0621</td></tr>
<tr><td>2010</td><td rowspan="2">1.14</td><td rowspan="2">0.0407</td><td>1.72</td><td>0.0413</td><td rowspan="2">0.669</td><td rowspan="2">0.0531</td><td>1.01</td><td>0.0540</td></tr>
<tr><td>2011</td><td>1.46</td><td>0.0413</td><td>0.859</td><td>0.0540</td></tr>
</table>

3. Carbon Dioxide (CO_2) Emission Rates

Reducing carbon dioxide (CO_2) emissions is a primary goal of the State of California. CO_2 emissions are generated through the combustion of fuels and in particular by combustion of fuels in trucks and buses that operate in California. CO_2 emissions are a function of engine size, load, speed, miles traveled, and many other factors. This section describes how the staff derived CO_2 emission rates to develop emissions inventories in support of the proposed regulation.

Although EMFAC2007 provides CO_2 emission rates for heavy duty diesel trucks, it assumes them to be constant regardless of model year, technology group, activity and other factors. To develop more finely resolved CO_2 emission rates for trucks, staff used fuel economy data as a surrogate for CO_2 since there is a larger database of fuel economy data available for trucks than CO_2 data. Fuel economy estimates were converted to CO_2 emission rates based on the carbon content of diesel fuel, as discussed in more detail later in this section.

In this analysis we have evaluated available data to determine how improvements in engine technology and increasingly stringent criteria pollutant emission control requirements have affected the fuel economy of HHDDT and, consequently, CO_2 emission rates. Staff has recently reviewed the following data sources to develop model year-specific fuel economy values for HHDDTs operating in California:

- Department of Energy: Calendar Year Fleet Average from 1970-2006 (United States Department of Transportation, 2007)
- CRC E55/59 study by West Virginia University: Model Year 1988-2003
- International Fuel Tax Agreement (IFTA) for trucks operating in California
- Consent Decree, in-use study by West Virginia University: Model Year 1994-2003

We chose to not use the Department of Energy (DOE) fuel economy data directly since those are national data and therefore not representative of the truck fleet or driving conditions found in California. Also, the DOE data do not provide information on how fuel economy and CO_2 emission rates vary as a result of technology. DOE data were used instead as an independent check on our technical analysis.

Our technical analysis shows differences in fuel economy between different technology groups (represented as model year groups), as shown in Table 20. This table provides the estimated HHDDT fuel economy by model year group, as well as the assumptions that are embedded in those estimates.

Table 20. Proposed Fuel Economy Values for HHDDT Operating in California

MY	MPG	Note
Pre-1988	5.20	100% Mechanically controlled engines (100% @ 5.2 mpg)
1988-1990	5.39	25% Phase-in of electronic control (75% @ 5.2 mpg and 25% @ 5.95 mpg)
1991-1993	5.58	50% Phase-in of electronic control (50% @ 5.2 mpg and 50% @ 5.95 mpg)
1994-1995	5.76	75% Phase-in of electronic control (25% @ 5.2 mpg and 75% @ 5.95 mpg)
1996	5.95	100% Phase-in of electronic control (100% @ 5.95 mpg)
1997-1998	5.95	Same Fuel Economy as MY 1996 engines
1999-2002	5.48	Post consent Decree Engines with 8% loss is Fuel Economy (Timing Retarding)
2003-2006	5.75	5% gain in Fuel Economy (Better Combustion Strategies)
2007	5.61	3% loss in Fuel Economy due to EGR + DPF (86% @5.58 mpg; 14% @5.75 mpg)
2008	5.59	3% loss in Fuel Economy due to EGR + DPF (93% @ 5.58 mpg; 7% @ 5.75 mpg)
2009	5.58	3% loss in Fuel Economy due to EGR + DPF (100% @ 5.58 mpg)
2010	5.78	4% gain in Fuel Economy due to SCR (90% @ 5.80 mpg and 10% @ 5.58 mpg)
2011	5.78	4% gain in Fuel Economy due to SCR (90% @ 5.80 mpg and 10% @ 5.58 mpg)
2012	5.80	4% gain in Fuel Economy due to SCR (100% @ 5.80 mpg)

The assumptions described in Table 20 are estimated based on the following assumptions that were derived from analysis of available data:

- Mechanical vs. Electronically Controlled Engines (ECE)
    - 5.95 mpg fuel economy for electronic engines from CRC E55/59 data
    - 0.75 mpg difference in fuel economy between mechanical control and electronic control from CRC E55/59 data
    - Assume all model year mechanical control engines have same fuel economy (5.20 mpg)
    - Phase-in of Electronic Controlled Engines
        - MY 1988 to 1990: 25%
        - MY 1991 to 1993: 50%
        - MY 1994 to 1995: 75%
        - MY 1996: 100%

- Off-Cycle operation in Electronic Controlled Engines
  - MY 1993-1998
  - Higher fuel economy and higher NO_x than mechanical control engines.
  - Model year fuel economy of 5.95 mpg does not reflect chip reflash
  - Adjusted for chip reflash beginning calendar year 2002
- MY 1999-2002:
  - 8% fuel penalty
  - Post-Consent Decree engines with injection timing retarding for NO_x control
- MY 2003-2006:
  - 5% gain in fuel economy
  - Introduction of advanced combustion technologies including exhaust gas recirculation (EGR)
- MY 2007-2009:
  - Introduction of diesel particulate filter (DPF) used for PM control
  - 3% fuel penalty for meeting 2007 emissions standards
  - 86% of engines would meet 2007 emissions standards in CY 2007 (ARB, 2008a)
  - 93% of engines would meet 2007 emissions standards in CY 2008
  - 100% of engines would meet 2007 emissions standards in CY 2009
- MY 2010-2012:
  - Introduction of selective catalytic reduction (SCR) for NO_x control
  - 4% gain in fuel economy for engines equipped with (SCR)
  - 90% of engines would meet 0.2 g/bhp-hr NO_x standards in 2010 and 2011
  - 10% of engines would meet 0.5 g/bhp-hr NO_x standards with fuel economy of 5.58 mpg in 2010 and 2011
  - 100% of engines would meet 0.2 g/bhp-hr NO_x standards in 2012 (ARB, 2008c)

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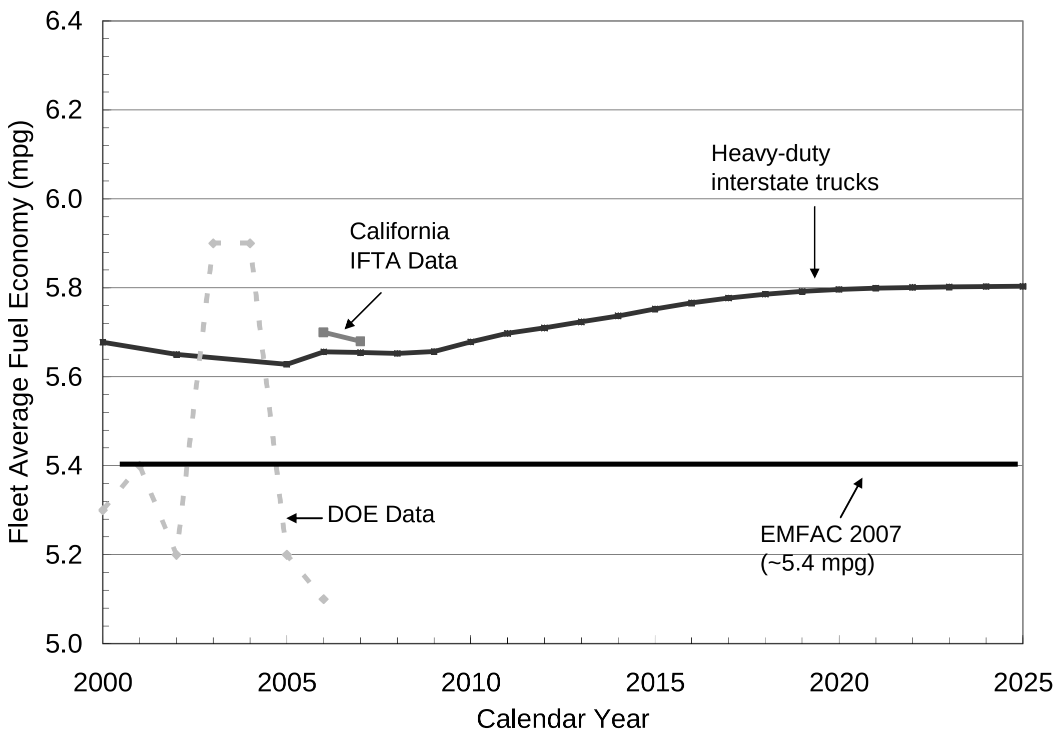
We applied the fuel economy estimates for each model year across each inventory category to develop a composite fuel economy by calendar year. Figure 18 compares fuel economy estimates by calendar year against values derived from DOE, IFTA, and EMFAC2007. This figure shows that HHDDT fuel economy is estimated to improve over time due initially to the introduction of electronically controlled engines and later due to the introduction of SCR-equipped engines. These results compare remarkably well with EMFAC, DOE, and IFTA data. For example, the composite fuel economy reported by all trucks operating in California in the IFTA program is 5.7 miles per gallon, which is equivalent to our estimates for interstate trucks. DOE data appear more variable across calendar years, probably due to varying sample size and representativeness in each year of reported data. Even so, DOE data are within 10% of ARB estimates, and EMFAC2007 is lower than current estimates by only 4 to 7%. In Figure 18 we show HHDDT fuel economy for interstate trucks only. In-state trucks, which are older on average than their interstate counterparts, are estimated to have slightly lower fuel economy (3% to 5%) than interstate trucks.

Figure 18. Fleet Average Fuel Economy for Trucks Operating in California



To convert fuel economy data to CO_2 emission rates, staff used the following methodology:

- estimate the fuel consumption, in gallons, for each truck category based upon the model year fuel economies and model year distribution
- multiply the estimated fuel consumption by the carbon content of diesel fuel (2,778 g carbon/gallon diesel (USEPA (2008)) to estimate the carbon emitted by each truck category
- multiply the estimate of carbon emitted by each category by the ratio between the molecular weight of CO_2 and the molecular weight of carbon (44/12) to estimate the CO_2 emissions from each category if 100% efficient
- assume 99% efficiency, multiplying the CO_2 emitted at 100% efficiency by 0.99, to estimate the final CO_2 emissions estimate for each category.

The application of this process is equivalent to applying an estimate of 22.2 lbs CO_2/gallon diesel fuel (10.08 kg CO_2/gallon diesel fuel) to the estimate of fuel consumed by vehicles in each category.

Fuel economy in MHDDT was assumed to be 33% higher than for HHDDT in the same model year, based on analysis of data described above. CO_2 emission rates for buses were taken directly from EMFAC2007.

4. Final emissions rates

Staff estimated the emission rates for each truck inventory category for two types of activity – vehicles in motion and vehicles idling. We estimated emission rates for vehicles in motion in terms of tons/day for the average vehicle; these are shown in the database provided in conjunction with this appendix. We estimated the emission rates for vehicles while idling in terms of tons/hour; these, too, are shown in the database provided with this appendix.

F. Forecasting the Baseline Inventory

In this section we describe the methods used to estimate the growth of future truck populations and truck VMT in the emissions inventory.

1. Growth

In modeling the emissions for future years, staff needed to estimate the amount of vehicular travel in future years. The emissions are in general proportional to the vehicle miles traveled. The growth rate for VMT is likely to vary between inventory categories; thus we estimated the VMT growth on a category-specific basis.

For utility trucks in this inventory, staff assumed the same growth rate (2.0%) as was assumed in the regulation adopted by the ARB for public and utility fleets (ARB, 2005).

Staff projected the population of drayage trucks to increase at 2.5% per year near the Ports of Los Angeles, Long Beach, and Oakland. We estimated the VMT associated with the drayage trucks at each of these ports/railyards to grow at a slightly faster rate. We estimated the population of drayage trucks at other California ports/railyards to increase at a rate between 1.5% and 1.6% per year, with the VMT also increasing at a slightly faster rate. We estimated future VMT using factors such as projected container traffic and projected vessel traffic that resulted from past data and survey data.

For agricultural trucks, staff assumed a negative growth rate of 0.31% statewide to reflect anticipated ongoing loss of farmland. This growth rate, which actually varies regionally, was developed in 2005 based on analysis of historical farmland acreage trends and with the assistance of agricultural stakeholders. The average annual mileage accrual of each agricultural truck was assumed to remain constant; thus the total annual VMT for agricultural trucks is assumed to decrease proportional to the truck population.

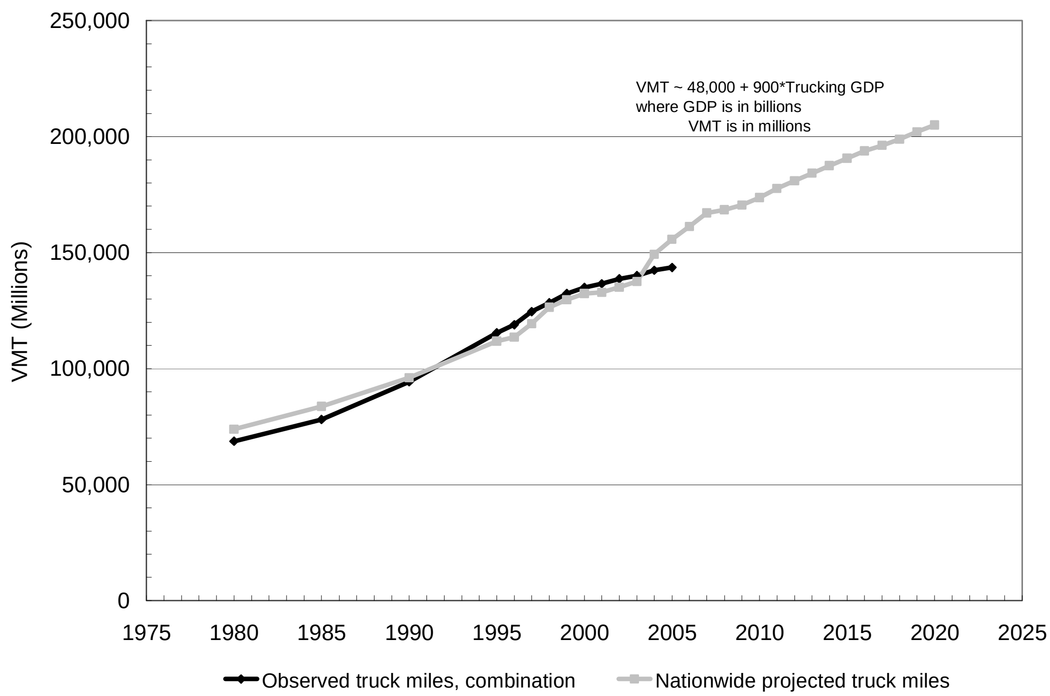
For all other truck types, we projected the VMT to grow at a rate equivalent to the overall VMT growth rate for trucks reported in EMFAC2007 which is 2.66% for heavy-heavy duty trucks and 1.62% for medium-heavy duty trucks. The annual VMT accrual of vehicles in these categories was assumed to remain constant; thus the population of the vehicles, in each category, was assumed to grow in proportion to the VMT. In Table 21 we summarize the annual growth rate estimated for VMT within each truck category.

Table 21. Annual VMT Growth Rates Projected by Category, 2008-2023

Inventory Category	VMT Growth Rate
MH Utility	2.00%
HH Utility	2.00%
HH Drayage near Oakland	5.38%
HH Drayage near LA/LB	4.93%
HH Drayage elsewhere	1.58%
MH Agriculture	-0.31%
HH Agriculture	-0.31%
MH Instate	1.62%
MH CAIRP	1.62%
MH Out of State	1.62%
HH Instate	2.66%
HH Single-unit	2.66%
HH CAIRP	2.66%
HH Non-neighboring Out-of-State	2.66%
HH Neighboring Out-of-State	2.66%
School Bus	-0.50%
Other Bus	3.65%
Power Take Off	2.64%
VMT-weighted Average	2.48%

Staff revisited VMT growth to examine the extent to which more current economic data could result in a revised VMT growth rate, different from that currently assumed in EMFAC2007. Staff regressed national VMT data from the Bureau of Transportation Statistics (BTS) against the US Gross Domestic Product (GDP) for the trucking industry nationwide, which was also released by the BTS. This relationship was then projected with a prediction of the future trucking GDP to estimate the future VMT, again on a federal level. The future nationwide trucking GDP was predicted by extending the relationship regressed earlier between the nationwide trucking GDP and the employment in the transportation sector predicted in the State of California Economic Forecast for the Sacramento Forecast Project. We show the results of this model in Figure 19.

Figure 19. The Historic and Projected Relationship between VMT and GDP on a Nationwide Level



The scale factor between nationwide VMT projected for future years and the nationwide VMT in 2007 was used with the VMT in California in 2007 to project future growth in California VMT. The resulting projections did not differ significantly from those that were estimated in the EMFAC2007 model; thus, staff decided to maintain the growth rates in EMFAC2007 as those for the overall California heavy duty truck fleet.

2. Attrition

For each vehicle category, staff assumed that, outside of regulatory impacts, the age distribution of vehicles within each inventory category would remain constant. Thus, the fraction of a vehicle class represented by vehicles of a certain age would remain constant; for example, the fraction of MY 2000 vehicles in the category in calendar year 2008 was assumed to be equivalent to the fraction of MY 2001 vehicles in the category in calendar year 2009.

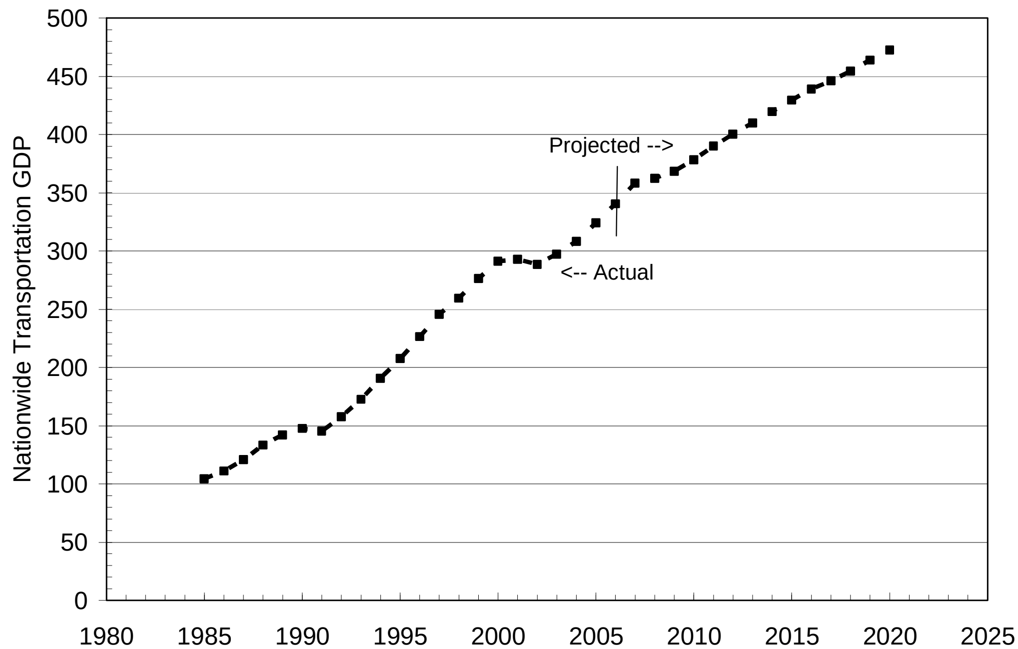
3. Pre-buy

When regulations are approved, past experience has indicated that the impact of these regulations can shift the purchase pattern of truck operators. A technology that is required in one year but not in another year may cause trucks from one year to be more expensive than, and thus preferred to, trucks of another year. A trucking firm might wish to not buy a truck with unproven technology; thus, they may delay their purchase for several years until the technology is more proven or purchase trucks with known technology in the year(s) preceding the regulation. Although our analysis has indicated that the shift in purchasing behavior related to "pre-buy" is less than that from general economic trends, we have attempted to incorporate this behavioral pattern in our assessment of model year distribution for each inventory category.

To approximate the sales of trucks in future years, and thus the impact to the age distribution of trucks, staff first estimated the historic annual nationwide truck sales as a function of the historic nationwide GDP associated with transportation activities. Staff used data regarding nationwide truck sales, as estimated by the website WardsAuto.com for 1985-2007, and GDP, as estimated for transportation services nationwide by the US Department of Commerce's Bureau of Economic Analysis to establish the historical model of truck sales as a function of time and the nationwide transportation GDP. The approximation of this model indicated that GDP had a stronger positive correlation with truck sales than did time itself; while truck sales had a positive correlation with time itself, the correlation that also existed between GDP and time lessened the positive impact of time when truck sales were regressed against both. The strongest relationship was also found to exist between truck sales in Year *y* and the GDP from Year *y+1*, the time lag indicating that the trucking industry could foresee the decline in economic activity and deferred the purchase of new trucks before the decline was experienced.

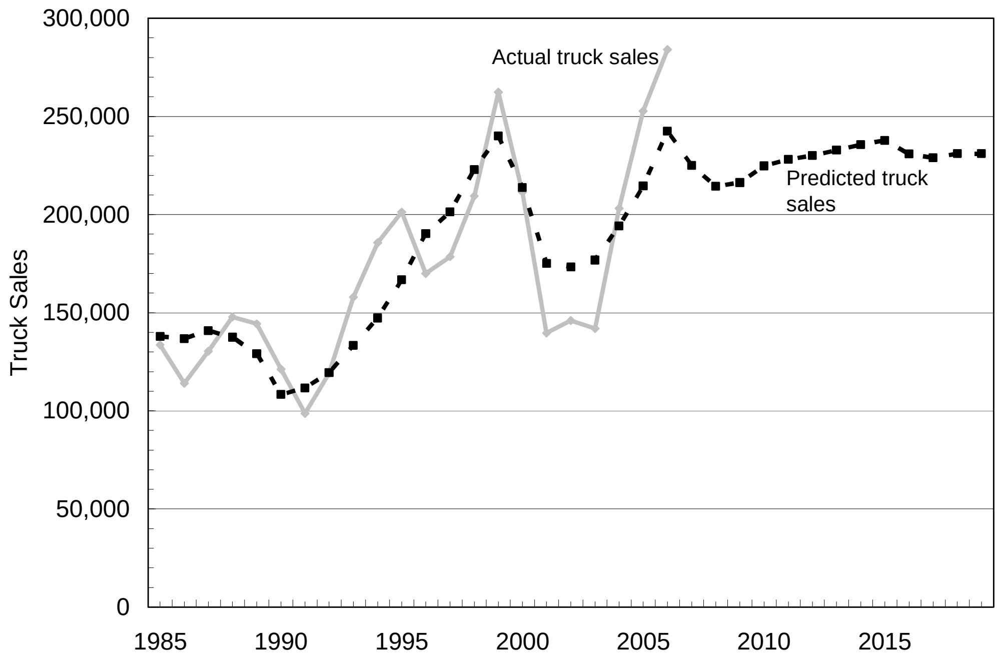
Staff then approximated the historic relationship between the historic nationwide transportation GDP and the historic California transportation employment, as estimated by a UCLA business forecast released in July 2007 (UCLA, 2007). We assumed that the growth rate for transportation employment in California was approximated by the growth rate for nationwide transportation GDP. We used this relationship with the projections to 2020 for California transportation employment from the UCLA forecast to project the nationwide transportation GDP until 2020 as shown in Figure 20.

Figure 20. Nationwide Transportation GDP Trends: Historic and as Projected from Forecast Transportation Employment



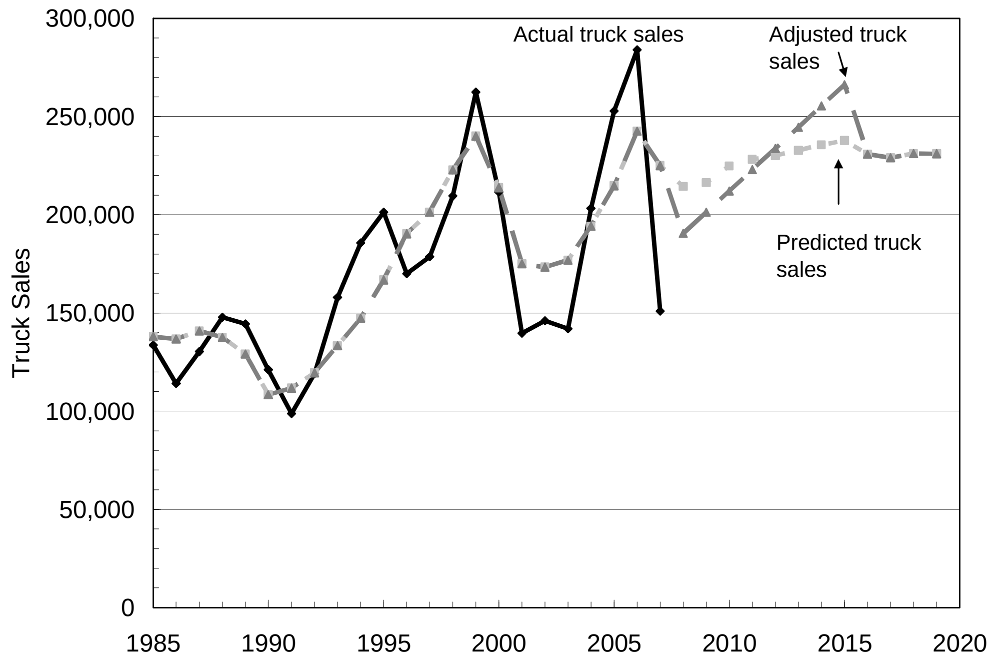
As a first step toward projecting truck sales, staff developed a regression model between nationwide transportation-related GDP and historic truck sales. We then used the estimates of the future transportation–related GDP to estimate future truck sales. In Figure 21 we compare the actual truck sales between 1985 and 2006 with the sales that would have been predicted by the model as well as the truck sales initially predicted from this model beyond 2006.

Figure 21. The Modeled Relationship between Nationwide Transportation GDP and Nationwide Truck Sales



The modeled relationship did not account for what appeared to be extremes. During periods of slow sales, the model underpredicted the decrease in sales; during periods of higher sales, the model underpredicted the increase in sales. To account for this, staff estimated a correction factor by which the 2008 truck sales were lowered. This correction factor, the adjustment made to the estimate resulting from the model, was equivalent in proportion to the difference between earlier estimates and corresponding actual results. Staff then adjusted truck sales between 2008 and 2015 by an amount appropriate to ensure that the aggregate number of trucks sold within this period remained constant. We show the resulting estimate of truck sales, the “adjusted truck sales”, in Figure 22.

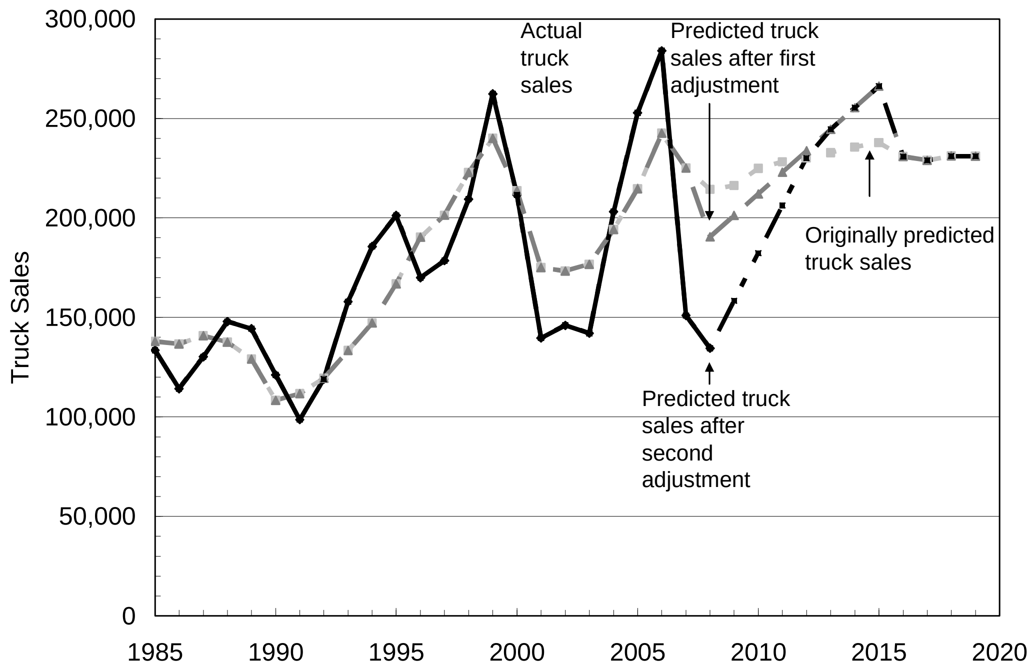
Figure 22. The Modeled Relationship between Nationwide Transportation GDP and Nationwide Truck Sales, Adjusted



Transportation employment within California was already projected to grow at a slightly slower rate after 2015; hence sales for this time period were projected to grow at a slower rate.

Finally, staff received additional data regarding truck sales to date in 2008. These sales were even lower than those projected by the adjusted model. To account for this difference, staff adjusted the model even further, decreasing the sales projected for 2008 and adjusting those in future years to account for the difference – sales in between 2008 and 2011 were adjusted downward, sales after 2011 were unchanged. We show the results of these adjustments in Figure 23.

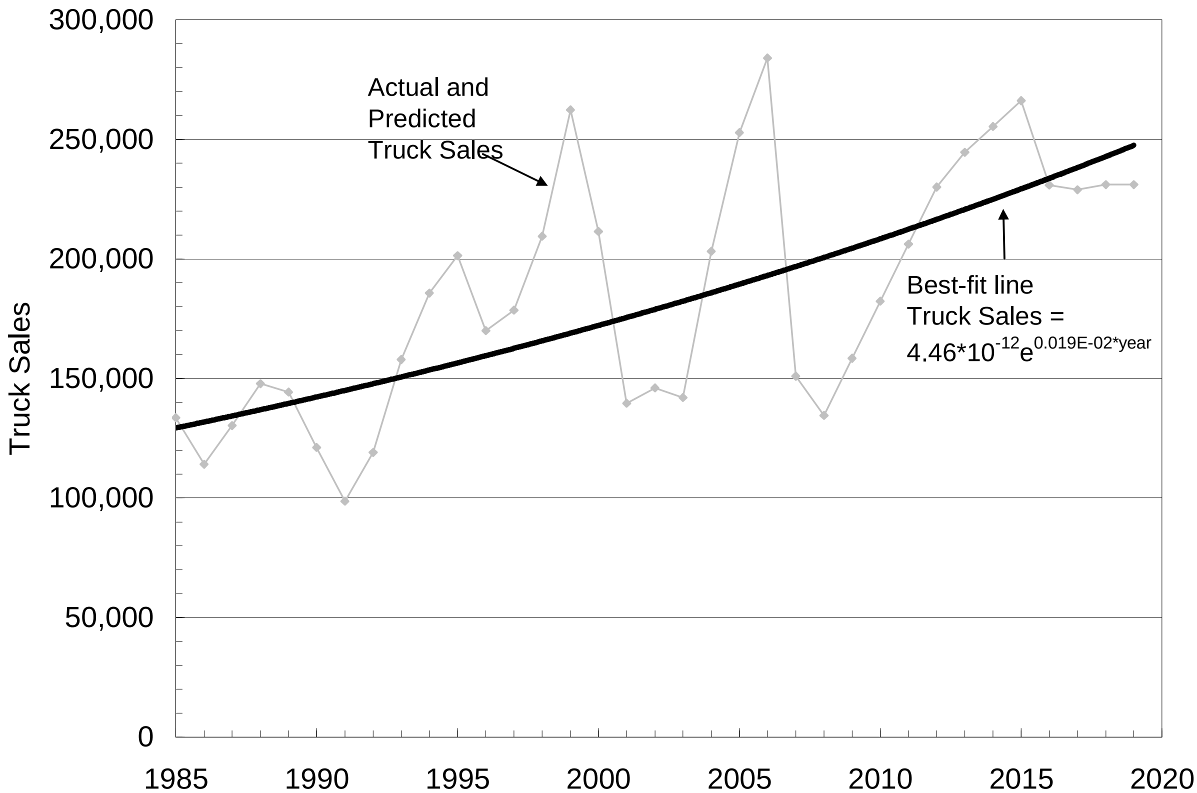
Figure 23. (Estimated) Truck Sales for Future Years



Because no data were available at the time for prediction of GDP past 2020 with the model used in this analysis, we assumed that trucks were sold in the years beyond 2020 at the same ratio as has happened historically.

Finally, to incorporate these estimates in the populations, staff calculated the ratio between sales of trucks in one model year and the expected number of sales if no factor (e.g. GDP) had caused variation. We show the actual sales and the sales predicted from the pre-buy model in Figure 24.

Figure 24. Actual and Predicted Truck Sales



The ratio between the actual/predicted truck sales and the best-fit value (the ratio assumed to be 1.0 for future years beyond 2019) was used to adjust the representation of each model year within future calendar years. (Adjusting the sales upward/downward for new trucks in a calendar year would have the same impact on the representation of trucks of that model year in later calendar years.) The representation of each model year was then scaled as appropriate to allow the cumulative representation of model years to be 100%. This adjustment was not made for the age distribution of drayage trucks, since the age distribution from the ARB drayage regulation was used.

G. Statewide Baseline Activity and Emissions

We discussed the population of each vehicle type earlier in the Base Year Population and Activity section, but we provide a summary table (Table 22) here to describe the emission sources included in this inventory.

Table 22. Population and VMT by Inventory Category

CY	Category	Population	Share of CA Population	CA Share of VMT	Share of VMT in CA
2008	HH Out-of-State	492,340	52.3%	12.1%	28.5%
2008	HH CA-IRP	60,263	6.4%	57.0%	14.6%
2008	HH Tractor	63,684	6.8%	100.0%	18.4%
2008	HH Single Unit	43,275	4.6%	100.0%	6.0%
2008	HH Drayage	21,650	2.3%	100.0%	5.1%
2008	HH Agriculture	11,998	1.3%	100.0%	1.6%
2008	HH Utility	1,357	0.1%	100.0%	0.1%
2008	MH In-State	198,525	21.1%	100.0%	22.5%
2008	MH Interstate	8,896	0.9%	18.7%	0.2%
2008	MH Agriculture	9,438	1.0%	100.0%	0.6%
2008	MH Utility	2,798	0.3%	100.0%	0.1%
2008	Buses	26,443	2.8%	100.0%	2.3%
2008	PTO				

For this table and later analyses, some categories have been combined to allow for simpler evaluation. Specifically, HH Out-of-State trucks include those trucks from neighboring states as well as non-neighboring states. HH Drayage trucks includes all drayage trucks in service in California, including those serving areas around the Ports of Los Angeles, Long Beach, Oakland, and other California ports. MH Interstate trucks include the medium-heavy trucks registered in other states as well as those registered in the CA-IRP program. Buses include those in the “school bus” and “other bus” inventory categories.

The population shown in Table 22 represents the estimated number of trucks and buses operating in California that fall under this proposed rule in calendar year 2008, including vehicles registered in-state and out-of-state. The share of California population represents the percentage of the total truck and bus population represented by each category. The California share of VMT represents the percentage of total annual VMT driven by vehicles in each category that occurs in California; this is assumed to be 100% for the majority of inventory categories but can be small for interstate categories. The share of VMT in California represents the contribution made by each inventory category to the total truck and bus VMT estimated for California.

As shown in Table 22, heavy-heavy duty diesel trucks registered outside California account for the majority of trucks traveling in California. Because these trucks do not travel exclusively in California, however, their portion of VMT in California, at 28.5%, is not as large as their representation among the population (52.3%). In addition, because trucks in this inventory category tend to be newer than trucks in other categories, their emission rates are lower and their contribution relatively less than from their in-state counterparts.

1. Base Year Age Distributions across Inventory Category

In an earlier section, we provided the age distribution of trucks within each inventory category. In Figure 25 we compare the age distributions for the different categories. (Note that trucks from non-neighboring states, because they outnumber trucks from other categories by such a large share, are plotted against the secondary axis.) From this figure one can see from the relative peaks of each age distribution that trucks from non-neighboring states tend to be newer than CA-IRP registered trucks and trucks from neighboring states, which in turn are newer than tractors registered instate. This is logical, in that the trucks traveling the farthest distances to California need to be the most reliable and therefore on average younger. In addition, the trucks representing the CA instate tractor category are frequently those transferred from the out-of-state and IRP categories in their later years. The oldest trucks represent the agriculture category and the drayage category; these trucks tend to travel, on average, the shortest distances. Staff used this age distribution when estimating emissions.

Figure 25. Comparison of Vehicle Age Distributions between Combination Tractors (2008)

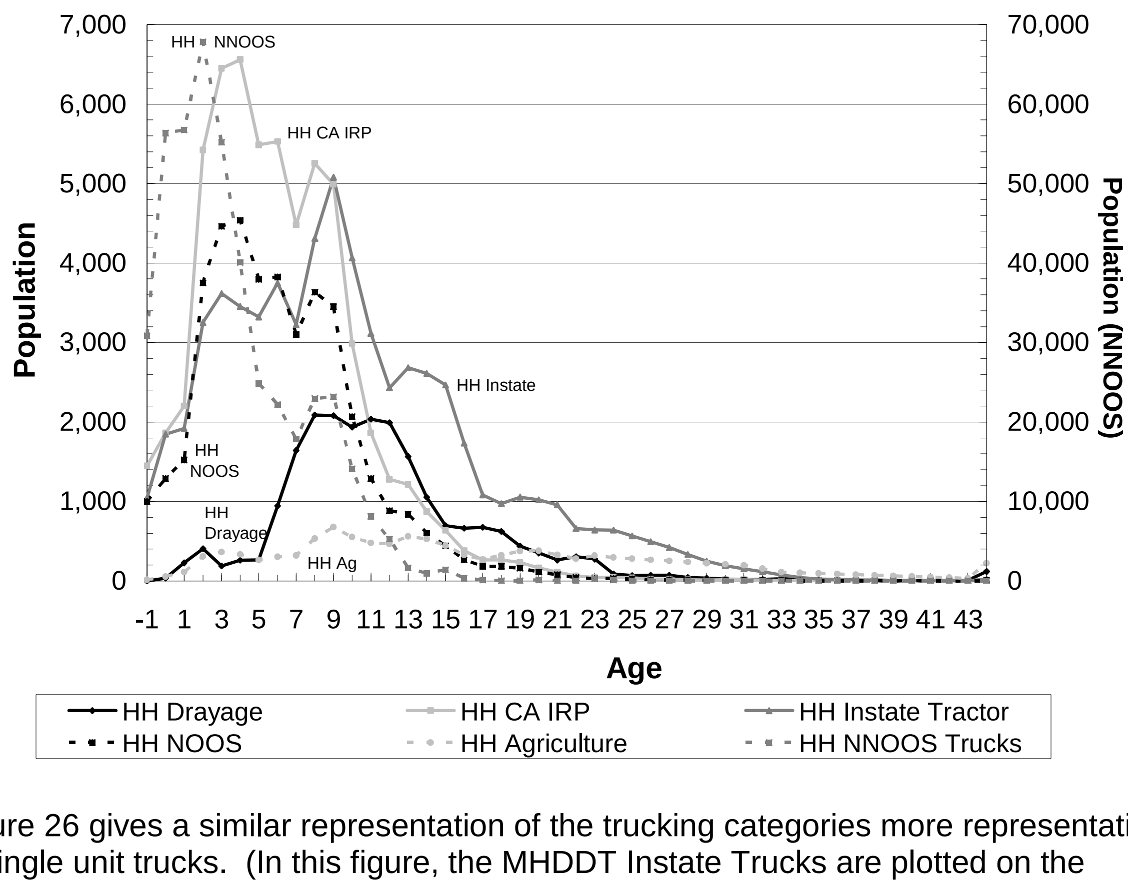
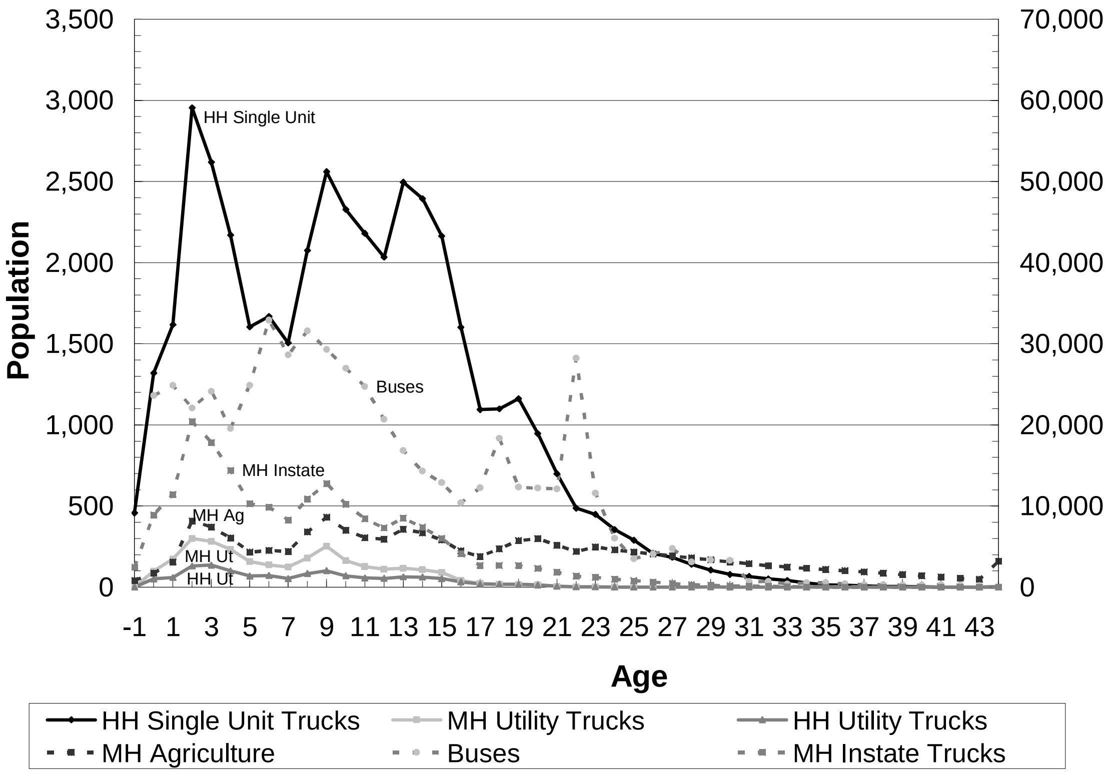


Figure 26 gives a similar representation of the trucking categories more representative of single unit trucks. (In this figure, the MHDDT Instate Trucks are plotted on the secondary axis to allow for better comparison.) As this figure shows, the age distribution for single-unit trucks does not vary so much between categories as the age distribution does for combination trucks. With regard to single-unit categories in particular, medium-heavy instate trucks are relatively newer and medium-heavy agriculture trucks relatively older.

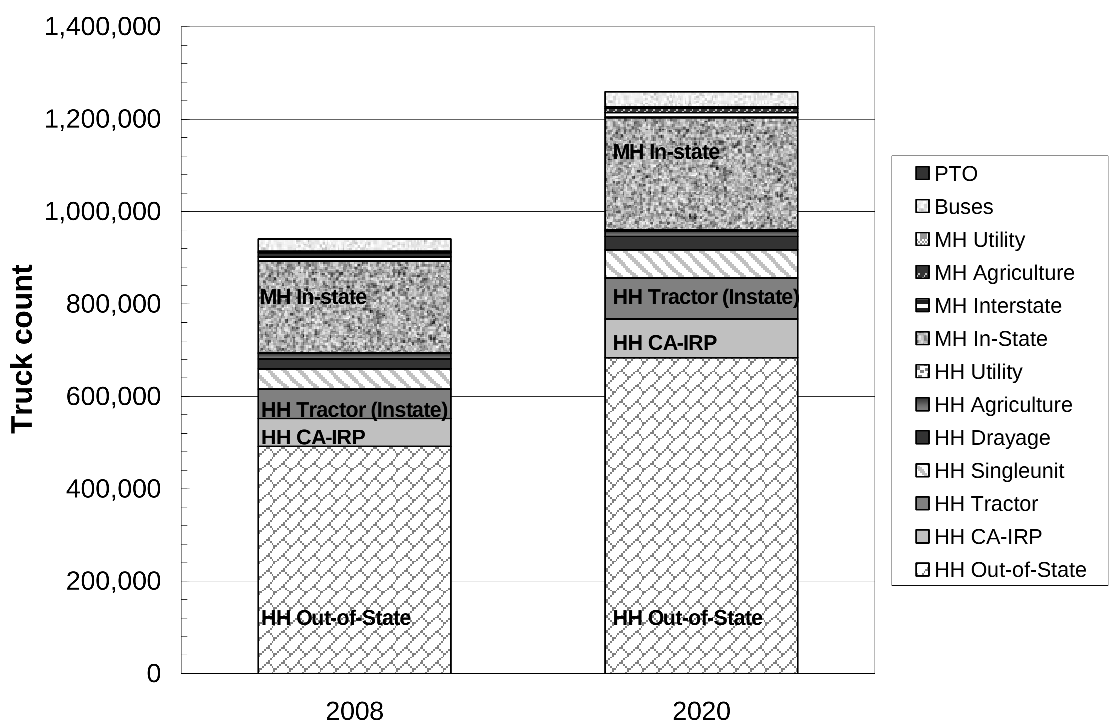
Figure 26. Comparison of Vehicle Age Distributions between Single-Unit Trucks and Buses (2008)



2. Base Year and Forecasted Population by Inventory Category

In Figure 27 we show the distribution of trucks assumed to visit California in 2008 and 2020. In both years the majority of individual trucks represent one of four categories: heavy-heavy trucks registered outside California, California-registered heavy-heavy trucks in the International Registration Program, heavy-heavy tractors registered in California, and medium-heavy trucks registered in California. In a later section we show the distribution of California VMT between the categories; for two primary reasons, the distribution of VMT differs slightly from the distribution of the unique trucks themselves. First, trucks registered outside California do not travel entirely within California. Second, trucks within differing categories typically do not exhibit the same travel patterns with regard to distance.

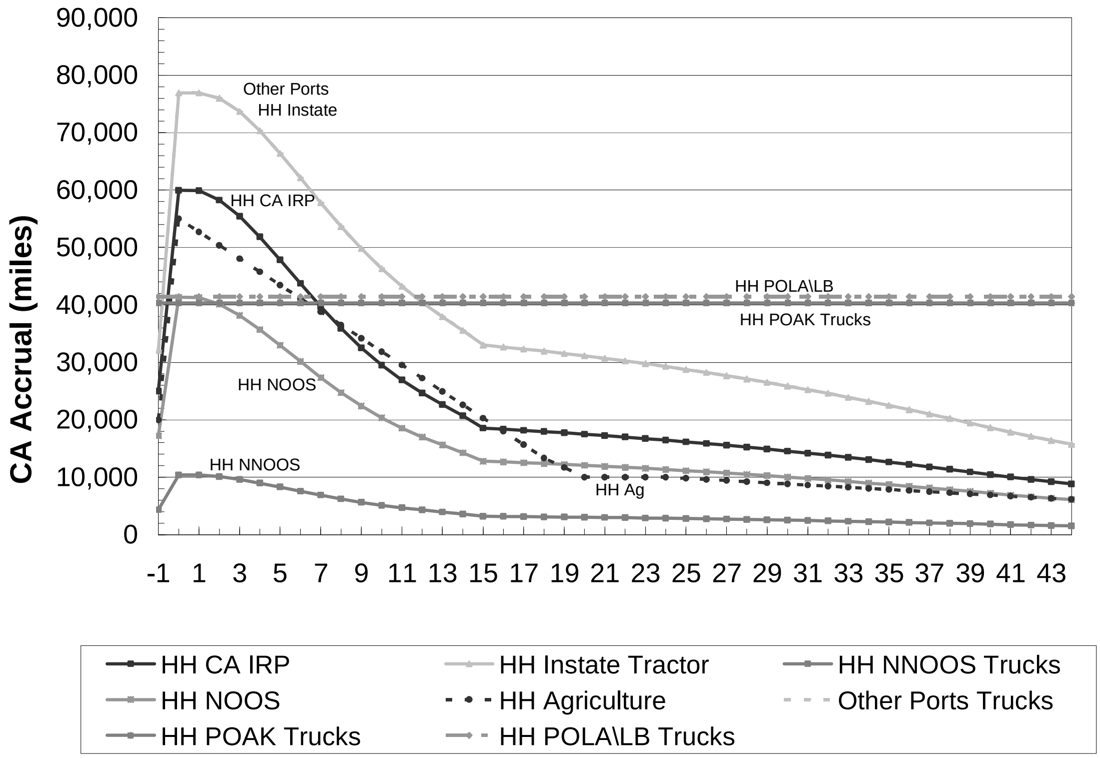
Figure 27. A Comparison of Truck Population by Category (2008 and 2020)



3. *Comparing Accrual Rates by Inventory Category*

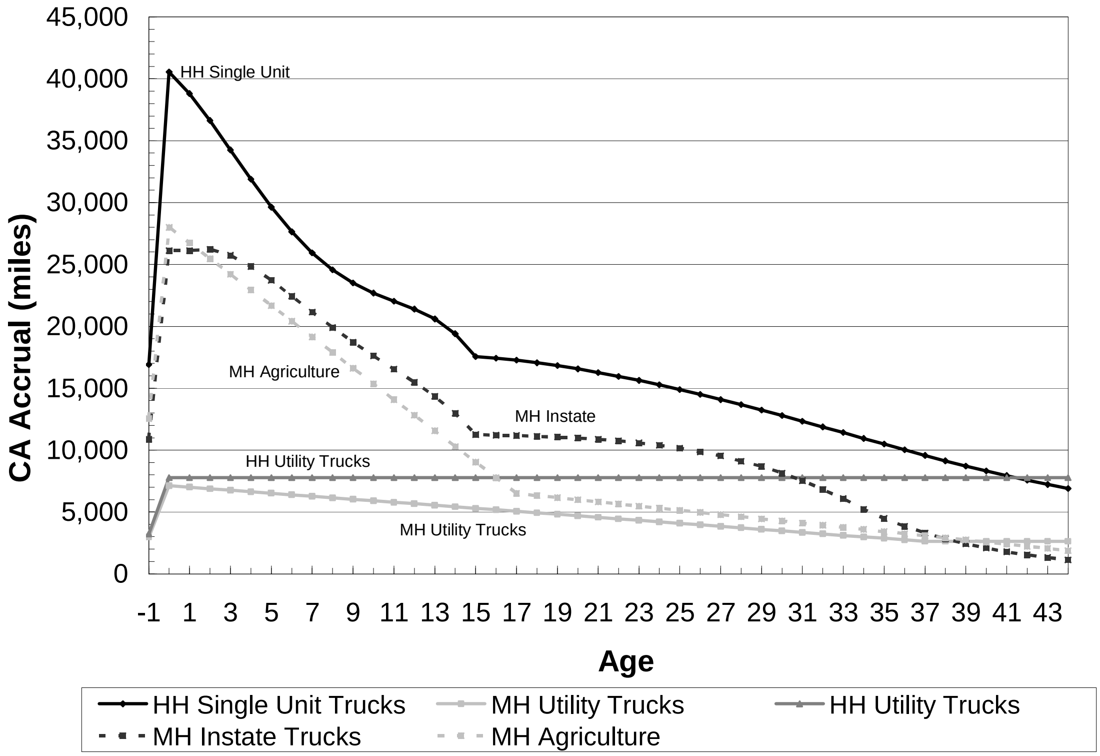
In Figure 28 we show the variation in VMT accrual rates between inventory categories in California. Note that this figure shows only the VMT estimated to be accrued within California's borders and does not include the VMT estimated to be accrued elsewhere. This is particularly relevant in the context of trucks registered in states that do not border California, of which more than 90% of the annual VMT are assumed to be accrued outside California. In the context of virtually all heavy vehicles except drayage trucks, the annual VMT for a vehicle is estimated to decrease with the age of the vehicle; drayage trucks are assumed to maintain a steady amount of usage throughout their lives.

Figure 28. Accrual Rates for Combination Trucks in California (2008)



In Figure 29 we show a similar distribution in accrual rates for single unit trucks. As shown, the average accrual rate is estimated to be highest for single unit trucks. The accrual rate is estimated to decrease with age for single unit trucks as well as medium-heavy instate trucks, buses, and medium-heavy trucks used for agriculture. The accrual rates estimated for heavy-heavy trucks from the utility category, however, start at a lower level and remain more stable throughout their lifetimes.

Figure 29. Accrual Rates for Single Unit Trucks in California (2008)



4. Base Year and Forecasted Vehicle Miles Traveled by Inventory Category

In Figure 30 and Table 23 we show the distribution of VMT driven by trucks in different categories in California between calendar years 2005 and 2025. Figure 30 shows the aggregate VMT for each year; the table lists the daily VMT for each truck category in select years. The five most significant contributors to VMT driven in California in calendar year 2008 are:

- MHDDT CA-registered instate trucks (22.5%)
- HHDDT Non-neighboring out-of-state trucks (21.5%)
- HHDDT CA-registered instate tractor (18.4%)
- HHDDT International Registration Plan, CA-IRP (14.6%)
- HHDDT Neighboring out-of-state trucks (7.0%)

Staff estimated these five categories together represent over 81% of all VMT associated with bus and truck travel in California in 2008. Though not necessarily in the same order, we project these five categories to remain the largest heavy duty truck VMT contributors in 2025, collectively accounting for over 83% of all heavy duty truck VMT driven within California's borders. (The HHDDT from states not neighboring California are projected to represent the single largest share in 2025 at 22.1%.)

Figure 30. California Vehicle Miles Traveled by Truck Category

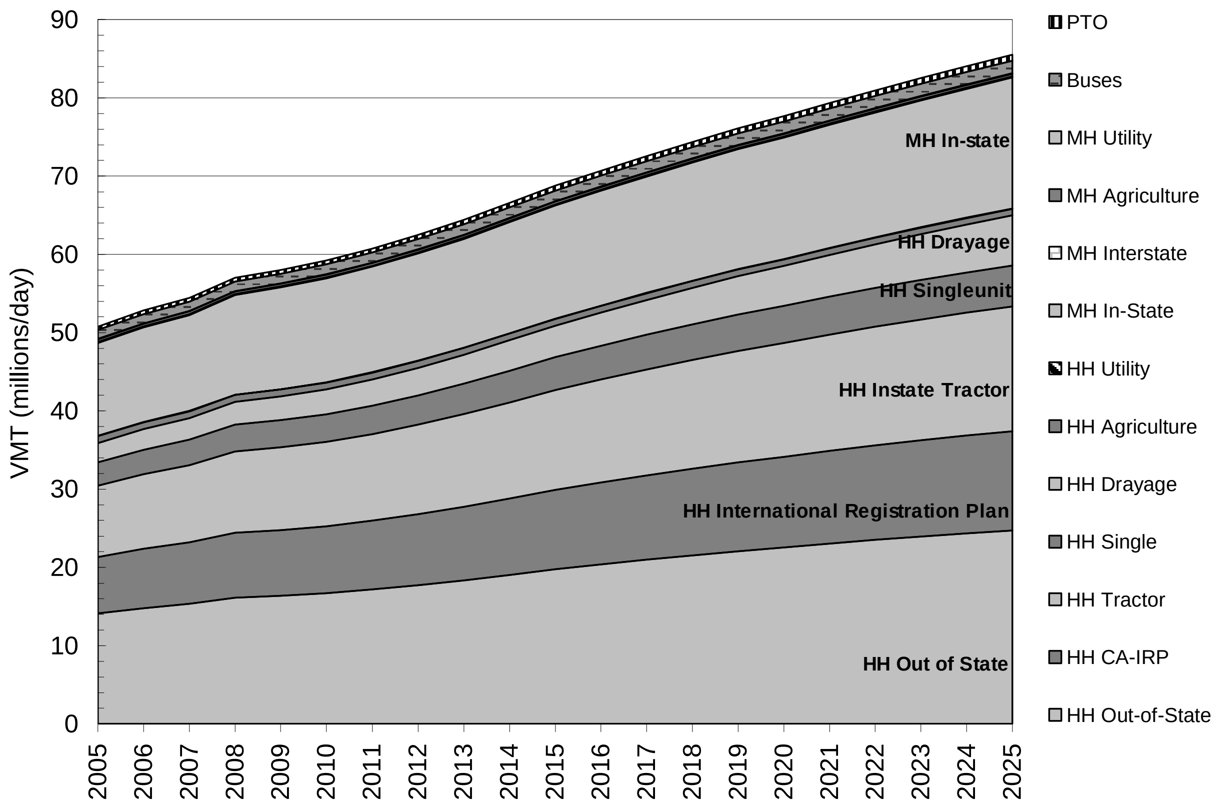


Table 23. Distribution of Estimated Daily VMT in Select Calendar Years

Inventory Category	2000	2005	2010	2015	2020	2025
HH Out-of-State	11,763,164	14,094,931	16,694,413	19,776,058	22,554,003	24,722,681
HH CA-IRP	6,035,750	7,232,194	8,566,004	10,147,215	11,572,595	12,685,357
HH Tractor	7,588,662	9,092,933	10,769,913	12,757,947	14,550,057	15,949,116
HH Single	2,485,547	2,978,247	3,527,515	4,178,664	4,765,642	5,223,882
HH Drayage	1,992,437	2,501,164	3,177,789	4,017,716	5,063,470	6,407,181
HH Agriculture	900,850	886,807	872,982	859,373	845,976	832,788
HH Utility	28,849	31,852	35,167	38,827	42,868	47,330
MH In-State	10,188,740	11,871,644	13,287,487	14,478,516	15,531,621	16,717,215
MH Interstate	94,153	109,705	122,789	133,795	143,526	154,482
MH Agriculture	351,375	345,897	340,505	335,197	329,972	324,828
MH Utility	47,746	52,716	58,203	64,260	70,949	78,333
Buses	890,204	1,125,836	1,259,711	1,371,993	1,500,120	1,617,738
PTO	358,622	429,614	509,088	601,588	685,075	751,094
Total	42,726,100	50,753,540	59,221,565	68,761,149	77,655,874	85,512,024

In Figure 31 we show the percentage of VMT associated with each category between 2005 and 2025. As the figure shows, the share of VMT represented by drayage traffic is expected to grow at the expense of other categories (e.g. MHDDT instate) due to the relatively higher growth in goods movement related truck categories.

Figure 31. Share of California Vehicle Miles Traveled by Truck Category

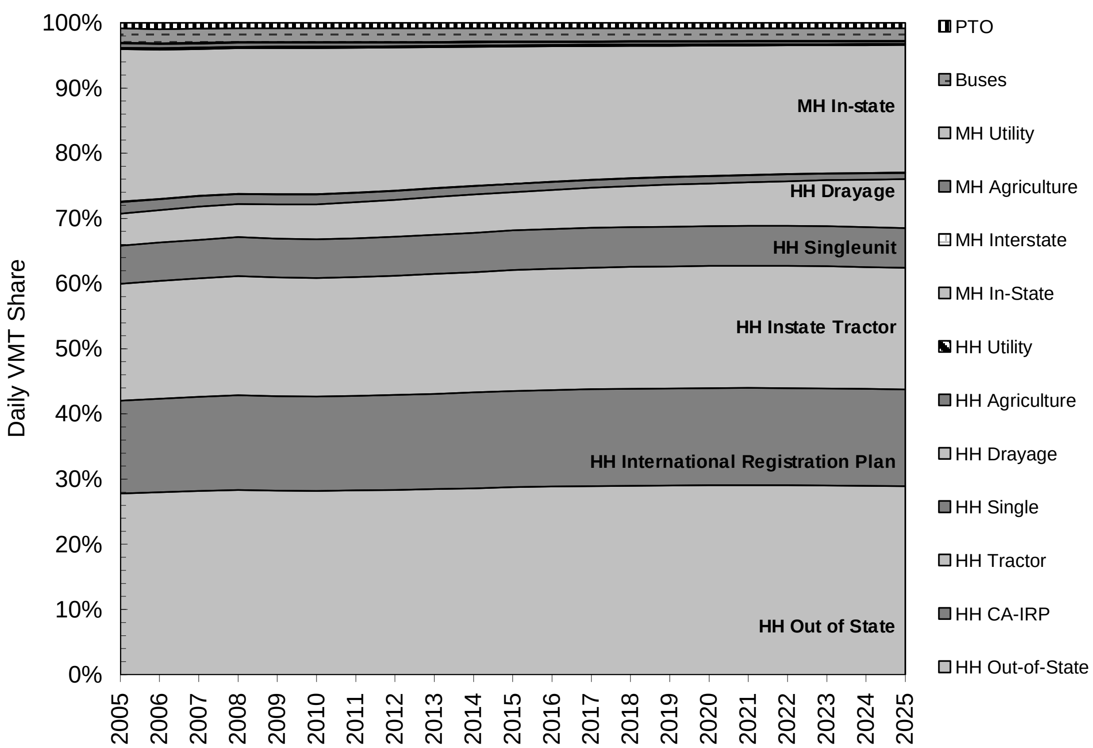


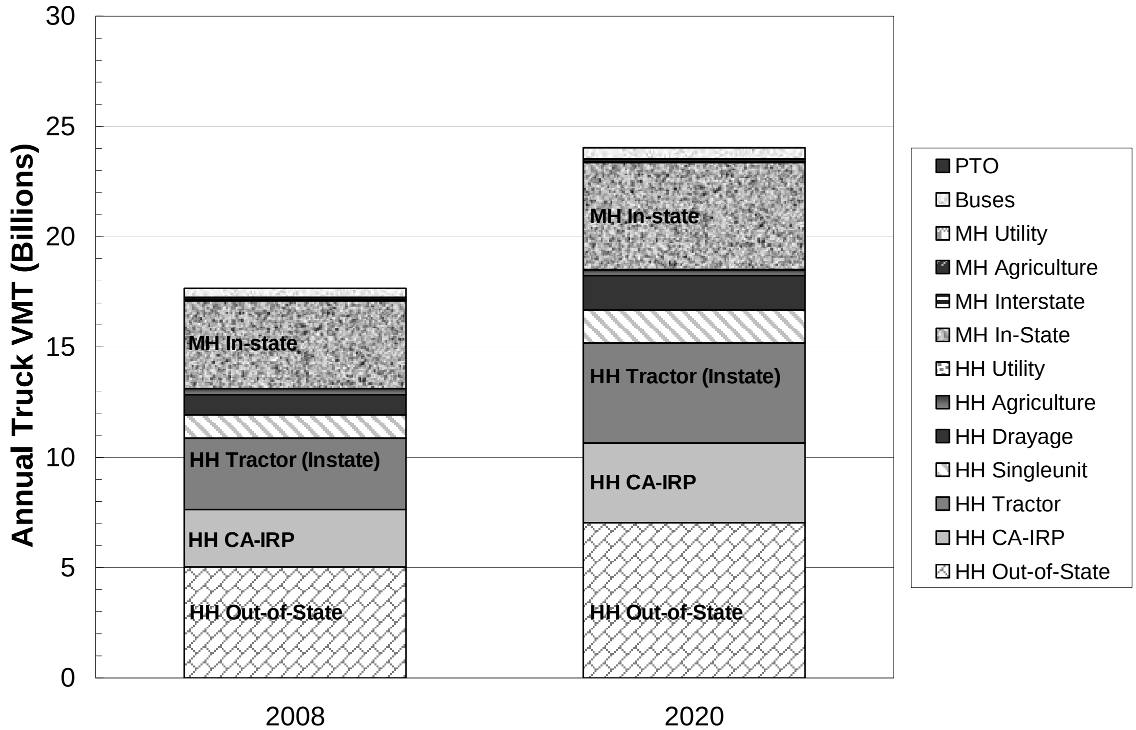
Table 24 provides the estimated population, average age, average odometer reading, and total VMT for each category of heavy duty truck in calendar year 2008.

Table 24. Assumptions made regarding truck categories in calculations.

CY	Inventory Category	Population	Average Age	Average Odometer	Total Accrual
2008	HH Out-of-State	492,340	3.8	489,526	41,666,633,775
2008	HH CA-IRP	60,263	6.2	668,314	4,535,889,834
2008	HH Tractor	63,684	9.9	722,999	3,249,093,053
2008	HH Single unit	43,275	10.3	338,253	1,064,186,055
2008	HH Drayage	21,650	11.8	839,789	904,462,366
2008	HH Agriculture	11,998	17.0	601,454	273,775,114
2008	HH Utility	1,357	8.2	74,611	10,545,996
2008	MH In-State	198,525	8.0	206,852	3,972,137,620
2008	MH Interstate	8,896	5.4	161,306	196,581,895
2008	MH Agriculture	9,438	17.3	293,027	106,907,874
2008	MH Utility	2,798	7.2	56,377	17,455,166
2008	Buses	26,443	11.2	191,829	406,667,394
2008	PTO				

In Figure 32 we show the distribution of annual truck VMT graphically. Four categories again represent the majority of truck VMT: heavy-heavy tractors registered outside California, heavy-heavy tractors registered in the International Registration Program, heavy-heavy tractors registered in California, and medium-heavy trucks registered in California.

Figure 32. A Comparison of Annual Truck VMT by Category (2008 and 2020)



5. Statewide Baseline Emissions Estimates

a) Baseline Emissions

Prior to implementation of the proposed regulation, approximately 941,000 trucks and buses were operating in California in calendar year 2008 and are estimated to contribute 859.3 tons per day NO_x, 33.1 tons per day $PM_{2.5}$, and 108,429 tons per day CO_2. We show these data in Table 25.

Table 25. Statewide Emissions (2008)

CY	Category	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
2008	All	940,667	57,009,437	859.3	33.1	108,429

b) Baseline Emissions by Inventory Category

We provide in Table 26 the baseline heavy duty truck and bus emissions inventory for the entire state of California in 2008, broken down by inventory category.

Table 26. Statewide Emissions by Inventory Category (2008)

CY	Inventory Category	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
2008	HH Out-of-State	492,340	16,142,326	221.9	8.0	32,766
2008	HH CA-IRP	60,263	8,282,725	139.6	5.2	16,783
2008	HH Tractor	63,684	10,413,751	194.1	7.9	20,897
2008	HH Single-unit	43,275	3,410,860	57.8	1.9	6,876
2008	HH Drayage	21,650	2,898,907	70.0	3.2	6,006
2008	HH Agriculture	11,998	878,486	17.3	0.7	1,788
2008	HH Utility	1,357	33,801	1	0	79
2008	MH In-State	198,525	12,731,247	125.0	4.6	19,067
2008	MH Interstate	8,896	117,648	1.0	0.0	176
2008	MH Agriculture	9,438	342,652	4.0	0.2	521
2008	MH Utility	2,798	55,942	1	0	85
2008	Buses	26,443	1,208,769	15.0	0.4	2,036
2008	PTO	0	492,322	12.2	0.8	1,349
2008	All	940,667	57,009,437	859.3	33.1	108,429

c) Baseline Emissions by Fleet Size

The baseline heavy duty truck emissions inventory for the entire state of California, broken down by inventory category, fleet size, and mileage threshold, is shown in Table 27.

Table 27. Baseline Emissions by Inventory Category and Fleet Size (2008)

Inventory Category	Fleet Size	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
HH Out of State	1 truck/above 7500 miles	12,011	694,474	10.92	0.40	1,411.3
	1 truck/below 7500 miles	432	1,337	0.04	0.00	4.2
	2 truck/above 7500 miles	3,695	214,735	3.38	0.12	436.4
	2 truck/below 7500 miles	133	414	0.01	0.00	1.3
	3 truck/above 7500 miles	2,652	155,555	2.45	0.09	316.1
	3 truck/below 7500 miles	96	301	0.01	0.00	1.0
	4+ truck/above 7500 miles	460,630	15,056,647	204.54	7.36	30,535.2
	4+ truck/below 7500 miles	12,690	18,863	0.56	0.02	60.5
HH CAIRP	1 truck/above 7500 miles	15,980	2,198,998	41.85	1.49	4,470.2
	1 truck/below 7500 miles	883	5,804	0.17	0.01	17.0
	2 truck/above 7500 miles	5,850	812,823	15.01	0.54	1,649.9
	2 truck/below 7500 miles	318	2,096	0.06	0.00	6.1
	3 truck/above 7500 miles	3,297	460,037	8.28	0.31	933.0
	3 truck/below 7500 miles	183	1,223	0.04	0.00	3.6
	4+ truck/above 7500 miles	32,273	4,791,942	73.95	2.83	9,674.7
	4+ truck/below 7500 miles	1,479	9,801	0.28	0.01	28.7
HH Tractor	1 truck/above 7500 miles	16,792	3,031,868	65.83	2.71	6,110.9
	1 truck/below 7500 miles	4,089	44,925	1.16	0.07	99.4
	2 truck/above 7500 miles	4,928	902,069	18.70	0.80	1,815.4
	2 truck/below 7500 miles	1,189	12,992	0.33	0.02	28.8

Inventory Category	Fleet Size	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
	3 truck/above 7500 miles	2,876	529,836	10.87	0.46	1,066.2
	3 truck/below 7500 miles	673	7,370	0.19	0.01	16.3
	4+ truck/above 7500 miles	28,859	5,835,899	95.82	3.82	11,652.5
	4+ truck/below 7500 miles	4,278	48,792	1.20	0.07	107.2
HH Single Unit	1 truck/above 7500 miles	7,819	766,081	14.15	0.49	1,545.2
	1 truck/below 7500 miles	3,358	37,585	0.88	0.04	82.8
	2 truck/above 7500 miles	2,826	279,769	5.01	0.18	563.7
	2 truck/below 7500 miles	1,171	13,153	0.31	0.01	29.0
	3 truck/above 7500 miles	1,857	185,491	3.26	0.11	373.0
	3 truck/below 7500 miles	703	7,951	0.18	0.01	17.4
	4+ truck/above 7500 miles	20,001	2,057,340	32.54	1.03	4,125.9
	4+ truck/below 7500 miles	5,540	63,491	1.44	0.06	138.9
HH Drayage	1 truck	11,633	1,557,622	37.64	1.69	3,227.1
	2 truck	1,293	173,069	4.18	0.19	358.6
	3 truck	1,454	194,703	4.70	0.21	403.4
	4+ truck	7,270	973,513	23.52	1.06	2,017.0
HH Agriculture	Ag non specialty higher VMT	4,098	645,375	12.41	0.49	1,301.8
	Ag non specialty lower VMT	5,258	82,489	1.89	0.10	178.5
	Ag non specialty midrange VMT	1,442	62,773	1.27	0.06	128.9
	Ag specialty vehicle	1,200	87,849	1.73	0.07	178.8
HH Utility		1,357	33,801	0.74	0.01	79.3
MH instate	1 truck/above 5000 miles	51,066	3,786,410	39.01	1.48	5,672.2
	1 truck/below 5000 miles	11,592	80,942	1.20	0.06	127.6
	2 truck/above 5000 miles	16,710	1,244,223	12.65	0.47	1,862.8
	2 truck/below 5000 miles	3,621	25,478	0.37	0.02	40.1
	3 truck/above 5000 miles	9,964	740,914	7.59	0.28	1,109.6
	3 truck/below 5000 miles	2,143	15,111	0.22	0.01	23.8
	4+ truck/above 5000 miles	88,520	6,731,027	62.45	2.24	10,063.3
	4+ truck/below 5000 miles	14,908	107,142	1.50	0.07	167.8
MH Interstate	1 truck/above 5000 miles	1,014	15,237	0.13	0.00	22.7
	1 truck/below 5000 miles	107	149	0.00	0.00	0.2
	2 truck/above 5000 miles	638	9,468	0.08	0.00	14.1
	2 truck/below 5000 miles	70	97	0.00	0.00	0.2
	3 truck/above 5000 miles	638	9,351	0.08	0.00	14.0
	3 truck/below 5000 miles	77	106	0.00	0.00	0.2
	4+ truck/above 5000 miles	5,648	82,272	0.70	0.02	122.7
	4+ truck/below 5000 miles	703	969	0.01	0.00	1.5
MH Agriculture	Ag non specialty higher VMT	1,750	183,598	2.04	0.09	277.0
	Ag non specialty lower VMT	4,799	46,021	0.66	0.04	72.6
	Ag non specialty midrange VMT	1,946	78,768	0.89	0.04	119.5
	Ag specialty vehicle	944	34,265	0.40	0.02	52.1
MH Utility		2,798	55,942	0.54	0.01	85.4
Buses		26,443	1,208,769	15.04	0.44	2,035.8
PTO			492,322	12.19	0.83	1,348.7
All		940,667	57,009,437	859.28	33.07	108,429.2

We show in Table 28 the baseline emissions inventory for the entire state of California, broken down only by fleet size and annual mileage thresholds.

Table 28. Baseline Emissions by Fleet Size and Mileage Threshold (2008)

CY	Fleet Size	Truck Population	Truck CA VMT/day	NO_x (tons/day)	$PM_{2.5}$ (tons/day)	CO_2 (tons/day)
2008	1 truck/above threshold	116,314	12,050,689	209.5	8.26	22,460
2008	1 truck/below threshold	20,462	170,742	3.4	0.17	331
2008	2 truck/above threshold	35,941	3,636,157	59.0	2.30	6,701
2008	2 truck/below threshold	6,502	54,229	1.1	0.05	105
2008	3 truck/above threshold	22,739	2,275,887	37.2	1.46	4,215
2008	3 truck/below threshold	3,876	32,062	0.6	0.03	62
2008	4+ truck/above threshold	643,202	35,528,640	493.5	18.36	68,191
2008	4+ truck/below threshold	39,598	249,058	5.0	0.22	505
2008	Ag non specialty higher VMT	5,848	828,973	14.5	0.58	1,579
2008	Ag non specialty lower VMT	10,057	128,510	2.6	0.14	251
2008	Ag non specialty midrange VMT	3,388	141,541	2.2	0.10	248
2008	Ag specialty vehicle	2,144	122,114	2.1	0.09	231
2008	Unspecified	30,597	1,790,835	28.5	1.29	3,549
2008	All	940,667	57,009,437	859.3	33.07	108,429

We show the emissions as estimated with the baseline scenario for each category of pollutant in the following figures: NO_x in Figure 33, $PM_{2.5}$ in Figure 34, and CO_2 in Figure 35. As shown, the statewide emissions for NO_x and $PM_{2.5}$ are expected to decrease in the absence of regulation, due to the natural replacement of older trucks with newer, cleaner trucks. Baseline CO_2 emissions, however, are projected to increase since improvements in fuel economy are not expected to keep pace with increased heavy duty truck VMT. ARB is proposing to improve fuel economy and reduce CO_2 emissions from heavy duty trucks in future years through other programs and technologies, including increased usage of aerodynamic fairings and tires of lower rolling resistance.

Figure 33. California Statewide NO_x emissions from Trucks, Baseline 2008 - 2023

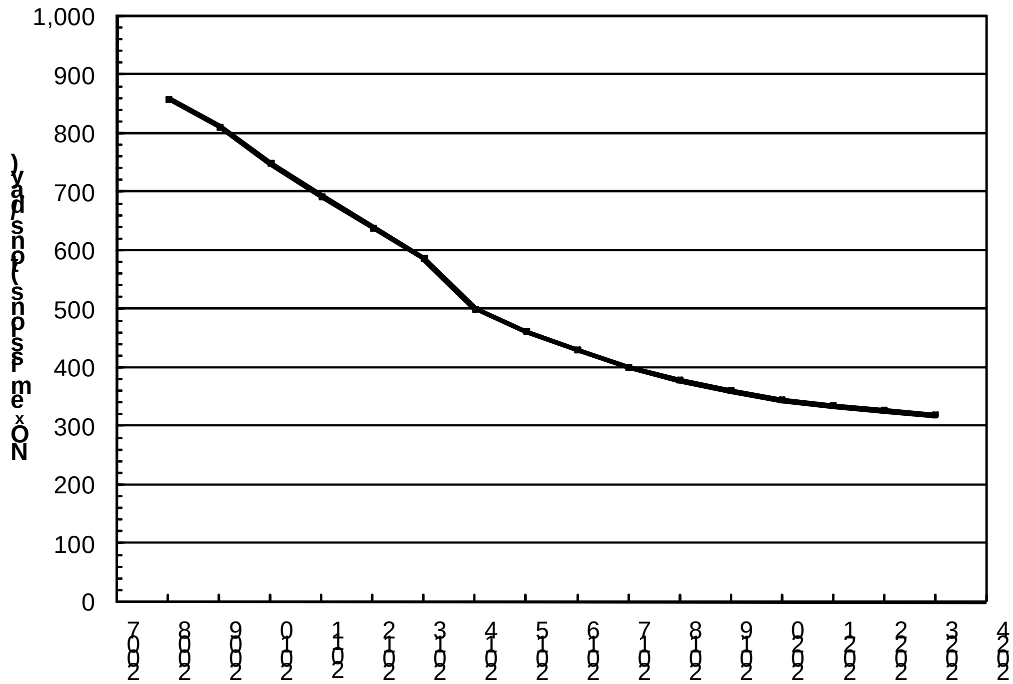


Figure 34. California Statewide $PM_{2.5}$ Emissions from Trucks, 2008-2023

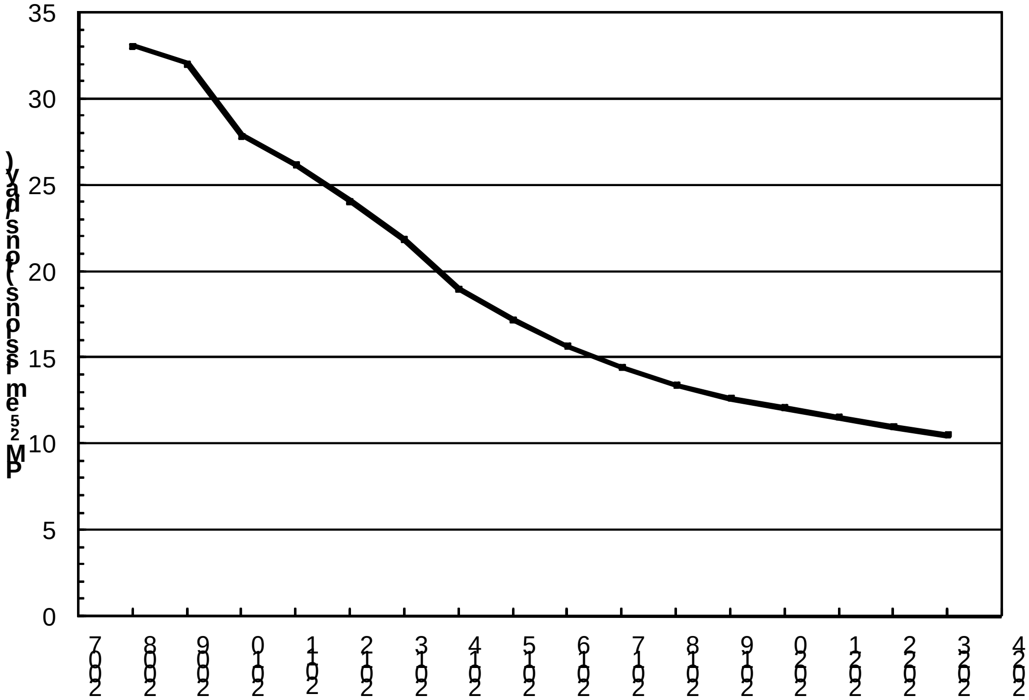
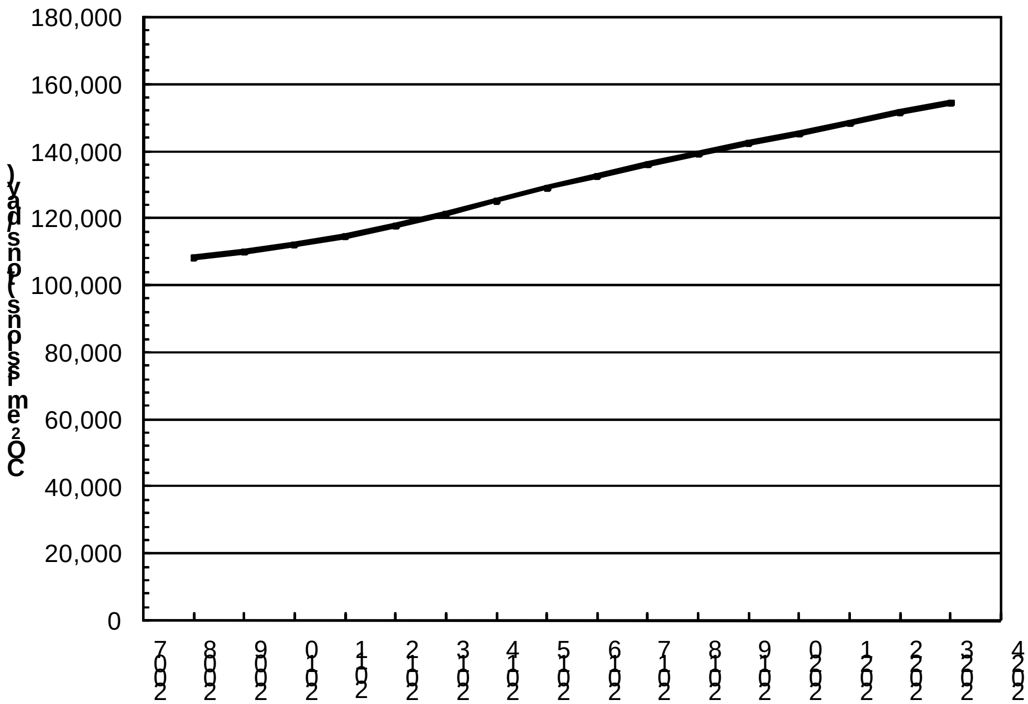


Figure 35. California Statewide CO_2 Emissions from Trucks, Baseline 2008-2023



H. Statewide Truck and Bus Regulation Benefits

The proposed Statewide Truck and Bus Regulation would initially require older vehicles to install diesel particulate filters. Several years later, the regulation would require operators to either purchase a newer compliant vehicle to replace an older non-compliant vehicle or retrofit the older non-compliant vehicle with emissions controls that would enable each vehicle to comply with regulatory emission standards. Under the proposed regulation, a fleet operator may choose among multiple compliance options on a per-pollutant and per-calendar year basis. Options include: (1) best available control technology (BACT) schedule; (2) fleet average requirements; (3) percent limit requirements; (4) low mileage thresholds with alternative compliance schedules; (5) small fleet compliance options; (6) regional compliance options; and (7) other special provisions.

To estimate the emissions benefits generated by the proposed regulation, one must understand how individual fleet operators may choose to comply with the regulation. Each operator's response may ultimately depend on the age, body type, and other characteristics of vehicles in each fleet and the relationship between vehicles in each fleet to the inventory categories. One of the ways we assess potential compliance patterns is by evaluating previous vehicle buying patterns by fleets based on survey data collected by staff. We input this information to the cost-model developed to assess capital costs under the baseline scenario and the scenario with regulation. We based the cost and economic model, described in greater detail in the *Appendix on Cost and Economic Analysis Methodology* upon survey data representing 6,700 vehicles from 688 individual company fleets.

Another way we can assess potential compliance patterns is by evaluating the base year age distribution in the inventory by category. As discussed above, the age distribution of non-neighboring out-of-state trucks suggests that trucks engaged in the longest hauls tend to be purchased new. After several years in long-haul operation, trucks tend to be sold to regional fleets, and a few years after that to local fleets. This type of purchase behavior may not be entirely true of all fleets or trucks within an inventory category, but it likely is representative of the majority. In addition to evaluating the age distribution for each inventory category, we also evaluated age distributions for each fleet size and mileage threshold group within each inventory category.

Our benefit calculations are also fundamentally based on the idea that newer vehicles drive more than older vehicles, but that the regulation will not affect the number of vehicle miles traveled within California. As a result, as new vehicles are purchased due to regulatory requirements, we redistribute VMT across age distributions by inventory category to ensure VMT is conserved, and to ensure that newer vehicles continue to be driven more than older vehicles.

1. Methodology to Assess Statewide Benefits

To calculate emission benefits, we used a methodology that separated vehicles into five groups: (a) high mileage large fleets, (b) high mileage small fleets, (c) low mileage vehicles in large or small fleets, (d) agricultural trucks, and (e) buses. For each group we developed a compliance schedule based upon our best estimate of anticipated purchase decisions. Our compliance schedules developed for each inventory category and compliance group assumed that larger, newer fleets will comply with the regulation by purchasing new or near-new vehicles and that where possible fleets will choose to avoid installing retrofits (especially on mechanically controlled engines that are more costly to control) – instead opting to purchase 2007 standard compliant trucks.

a) High Mileage Trucks in Fleets of Four or Greater

Large, high-mileage truck fleets are well-represented in the cost model. The cost model uses previous purchase behavior to predict future purchases for regulatory compliance by fleet, based on the compliance schedules available to these fleets. We assigned an inventory category to each truck in each fleet so that model results could be summarized into four general categories: in-state heavy-heavy tractors, in-state heavy-heavy single-unit trucks, medium heavy duty trucks, and heavy-heavy interstate trucks. We then compiled and analyzed model results to develop a compliance schedule for the four categories.

We show those compliance schedules in Table 29. As shown in the table, we assume large fleets will choose to replace, rather than retrofit, pre-2003 model year vehicles to meet PM BACT requirements. We do assume fleets will choose to retrofit 2003-2006 model year trucks in order to gain maximum use out of recently purchased vehicles. We also assume that, as in-state fleets purchase compliant replacement vehicles, they will purchase a vehicle that is four or five year old. This assumption is a schematic representation that some fleets will choose to purchase older compliant vehicles relatively cheaply, while other fleets will choose to purchase new or near-new vehicles. Table 29 shows that interstate fleets will replace trucks with newer trucks more frequently than in-state fleets.

Table 29. Compliance Assumptions for High-Mileage Trucks in Fleets of Four or Greater

Heavy-Heavy Duty Diesel In-state Tractors

		Turnover						
As of January 1,	**Model Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent with DPF (85% Control)**
2011	pre-1994	95.5%	2008	4.5%	2010	0.0%	2012	
2012	pre-1994	95.5%	2008	4.5%	2010	0.0%	2012	
2012	2003-2004							100%
2013	pre-2000	59.5%	2008	35.8%	2010	4.7%	2012	
2013	2005-2006							100%
2014	pre-2003	45.2%	2008	30.1%	2010	24.7%	2012	
2015	pre-2003	45.2%	2008	30.1%	2010	24.7%	2012	
2016	pre-2005	41.2%	2008	26.6%	2010	32.2%	2012	
2017	pre-2007	37.1%	2008	24.0%	2010	38.8%	2012	
2018	pre-2007	37.1%	2008	0.0%	2010	62.9%	2013	
2019	pre-2007	37.1%	2008	0.0%	2010	62.9%	2014	
2020	pre-2007	37.1%	2008	0.0%	2010	62.9%	2015	
2021	pre-2008	21.7%	2008	0.0%	2010	78.3%	2016	
2022	pre-2009	0.0%	2008	0.0%	2010	100.0%	2016	
2023	pre-2010	0.0%	2008	0.0%	2010	100.0%	2017	
2024	pre-2010	0.0%	2008	0.0%	2010	100.0%	2018	
2025	pre-2010	0.0%	2008	0.0%	2010	100.0%	2019	

Heavy-Heavy Duty Diesel In-State Single-Units and Power-Take Off

		Turnover						
As of January 1,	**Model Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent with DPF (85% Control)**
2011	pre-1994	100.0%	2008	0.0%	2010	0.0%	2012	
2012	pre-1994	100.0%	2008	0.0%	2010	0.0%	2012	
2012	2003-2004							100%
2013	pre-2000	61.1%	2008	37.0%	2010	1.9%	2012	
2013	2005-2006							100%
2014	pre-2003	47.9%	2008	37.4%	2010	14.7%	2012	
2015	pre-2003	47.9%	2008	37.4%	2010	14.7%	2012	
2016	pre-2005	44.8%	2008	33.9%	2010	21.3%	2012	
2017	pre-2007	38.5%	2008	30.5%	2010	31.0%	2012	
2018	pre-2007	38.5%	2008	0.0%	2010	61.5%	2013	
2019	pre-2007	38.5%	2008	0.0%	2010	61.5%	2014	
2020	pre-2007	38.5%	2008	0.0%	2010	61.5%	2015	
2021	pre-2008	22.6%	2008	0.0%	2010	77.4%	2016	
2022	pre-2009	0.0%	2008	0.0%	2010	100.0%	2016	
2023	pre-2010	0.0%	2008	0.0%	2010	100.0%	2017	
2024	pre-2010	0.0%	2008	0.0%	2010	100.0%	2018	
2025	pre-2010	0.0%	2008	0.0%	2010	100.0%	2019	

Medium-Heavy-Duty In-State and Interstate

		Turnover						
As of January 1,	**Model Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent with DPF (85% Control)**
2011	pre-1994	93.3%	2008	6.7%	2010	0.0%	2012	
2012	pre-1994	93.3%	2008	6.7%	2010	0.0%	2012	
2012	2003-2004							100%
2013	pre-2000	72.5%	2008	27.0%	2010	0.5%	2012	
2013	2005-2006							100%
2014	pre-2003	56.4%	2008	25.5%	2010	18.2%	2012	
2015	pre-2003	56.4%	2008	25.5%	2010	18.2%	2012	
2016	pre-2005	49.8%	2008	21.5%	2010	28.6%	2012	
2017	pre-2007	47.9%	2008	20.7%	2010	31.4%	2012	
2018	pre-2007	47.9%	2008	0.0%	2010	52.1%	2013	
2019	pre-2007	47.9%	2008	0.0%	2010	52.1%	2014	
2020	pre-2007	47.9%	2008	0.0%	2010	52.1%	2015	
2021	pre-2008	28.8%	2008	0.0%	2010	71.2%	2016	
2022	pre-2009	0.0%	2008	0.0%	2010	100.0%	2016	
2023	pre-2010	0.0%	2008	0.0%	2010	100.0%	2017	
2024	pre-2010	0.0%	2008	0.0%	2010	100.0%	2018	
2025	pre-2010	0.0%	2008	0.0%	2010	100.0%	2019	

Heavy-Heavy Duty Interstate Trucks

		Turnover						
As of January 1,	**Model Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent**	**Calendar Year**	**Percent with DPF (85% Control)**
2011	pre-1994	85.4%	2008	14.6%	2010	0.0%	2012	
2012	pre-1994	85.4%	2008	14.6%	2010	0.0%	2012	
2012	2003-2004							100%
2013	pre-2000	48.8%	2008	42.9%	2010	8.3%	2012	
2013	2005-2006							100%
2014	pre-2003	23.0%	2008	26.8%	2010	50.2%	2012	
2015	pre-2003	23.0%	2008	26.8%	2010	50.2%	2012	
2016	pre-2005	20.4%	2008	23.8%	2010	55.8%	2012	
2017	pre-2007	19.2%	2008	22.4%	2010	58.4%	2012	
2018	pre-2007	19.2%	2008	0.0%	2010	80.8%	2013	
2019	pre-2007	19.2%	2008	0.0%	2010	80.8%	2014	
2020	pre-2007	19.2%	2008	0.0%	2010	80.8%	2015	
2021	pre-2008	10.3%	2008	0.0%	2010	89.7%	2016	
2022	pre-2009	0.0%	2008	0.0%	2010	100.0%	2016	
2023	pre-2010	0.0%	2008	0.0%	2010	100.0%	2017	
2024	pre-2010	0.0%	2008	0.0%	2010	100.0%	2018	
2025	pre-2010	0.0%	2008	0.0%	2010	100.0%	2019	

b) High Mileage Trucks in Fleets of Three or Fewer

Under the proposed regulation, small fleets are exempt from performance requirements through 2011. In 2012 a small fleet must upgrade its first truck to a maximum emission rate equivalent to a 2004 engine with a retrofit DPF. Other vehicles in small fleets must be upgraded between 2013 and 2022. Using this information, we developed the compliance schedule identified in Table 30.

Table 30. Compliance Assumptions for High Mileage Trucks in Fleets of Three or Fewer

First truck in one-, two-, or three-truck fleet

As of January 1,	**Model Year**	**Turnover to**	**Percent with DPF (85% Control)**
2013	pre-2003	2007	
2013	2003-2006		100%
2018	2003-2006	2011	
2021	2007	2013	
2022	2008	2014	
2023	2009	2015	

Second truck in two-truck fleet

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2014	pre-2003	2009	
2014	2003-2006		100%
2016	2003-2004	2010	
2017	2005-2006	2010	
2021	2007	2013	
2022	2008	2014	
2023	2009	2015	

Second truck in three-truck fleet

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2014	pre-2003	80% to 2009	
2014	pre-2003	20% to 2010	
2014	2003-2006		100%
2016	2003-2004	2010	
2017	2005-2006	2010	
2021	2007	2014	
2022	2008	2015	
2023	2009	2017	

Third truck in three-truck fleet

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2014	pre-2003	80% to 2009	
2014	pre-2003	20% no turnover until 2015	
2014	2003-2006		100%
2016	2003-2004	2010	
2016	pre-2003	80% to 2009	
2016	pre-2003	20% to 2010	
2017	2005-2006	2010	
2021	2007	2015	
2022	2008	2016	
2023	2009	2017	

c) Low Mileage Trucks in Any Fleet Size

Under the proposed regulation, low mileage trucks (defined as heavy-heavy duty diesel trucks driving less than 7,500 miles/yr and medium-heavy duty diesel trucks driving less than 5,000 miles/yr) are allowed to delay compliance with turnover requirements until 2020. Using this information we applied the compliance schedule shown in Table 31.

Table 31. Compliance Assumptions for Low Mileage Trucks in Fleets of Any Size

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2012	pre-2007		20%
2013	pre-2007		60%
2014	pre-2007		100%
2021	pre-2008	2010	
2022	2008	2010	
2023	2009	2010	

d) Agricultural Trucks

Under the proposed regulation, agricultural fleets are allowed the choice of opting into an alternative compliance scenario. In this scenario, high mileage non-specialty trucks in agricultural fleets, defined as pre-1996 model year trucks driven more than 15,000 miles per year, 1996-2005 model year trucks driven more than 20,000 miles per year, and 2006 and newer model year trucks driven more than 25,000 miles per year, must comply with regulatory provisions. Non-specialty trucks driving fewer miles are not required to install retrofit DPFs and are not required to meet turnover requirements until 2016 or 2022 depending on the number of miles traveled per year. In 2016, the mileage threshold is reduced to 10,000 miles per year. Trucks above that threshold which had not previously been complying with regulatory provisions are required to upgrade to a 2010 model year truck. Trucks below that threshold, and all specialty agricultural vehicles, are required to upgrade to meet 2010 model year equivalent emissions standards by the beginning of 2023. In Table 32 we provide our compliance assumptions for agricultural trucks.

Table 32. Compliance Assumptions for Agricultural Trucks

Below 10,000 miles/yr and specialty agricultural trucks

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2023	pre-2010	2012	

Above 10,000 miles/yr but below first mileage threshold

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2017	pre-2007	2010	
2021	2007	2012	
2022	2008	2012	
2023	2009	2012	

Above first mileage threshold (15,000-25,000 miles/yr depending on model year)

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2011	pre-1994		100%
2012	2003-2004		100%
2013	2005-2006		100%
2013	1994-1999	2008	
2014	2000-2002	2009	
2015	pre-1994	2011	
2016	2003-2004	2011	
2017	2005-2006	2011	
2021	2007	2015	
2022	1994-1999	2016	
2022	2008	2016	
2023	2000-2002	2017	
2023	2009	2017	

e) Buses

Under the proposed regulation, non-school buses that are privately owned are assumed to follow BACT provisions in the proposed regulation. Due to the cost of replacing these vehicles we assume bus operators will achieve compliance with the least-cost option; this typically involves the oldest compliant vehicle available. Under the proposed regulation, school buses are required to install DPFs but are not required to meet NO_x emission standards. These requirements apply in addition to previous regulatory requirements developed under the Lower Emissions School Bus program. We provide bus compliance schedules in Table 33.

Table 33. Compliance Assumptions for Buses

School Buses

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2011	2000 and after		100%
2012	1994-1999		100%
2013	1987-1993		100%
2014	pre-1987	2007	

Other Buses

As of January 1,	Model Year	Turnover to	Percent with DPF (85% Control)
2011	pre-1994		100%
2012	2003-2004		100%
2013	2005-2006		100%
2013	1994-1999	2010	
2014	2000-2002	2010	
2015	pre-1994	2010	
2016	2003-2004	2010	
2017	2005-2006	2010	
2021	2007	2010	
2022	2008	2010	
2023	2009	2010	

2. Statewide Benefits

In this section we present the statewide emissions reductions anticipated from the proposed regulation.

a) Statewide Emissions Benefits

In Figure 36 we show the NO_x emissions reduction estimated to result from the proposed regulation. We estimate the greatest absolute NOx emissions benefit to be achieved in calendar year 2014, with a reduction of 123.7 tons NO_x/day relative to baseline emissions. In Figure 37 we show the emissions reduction estimated to result from the regulation, in terms of $PM_{2.5}$. We anticipate the greatest emissions reduction to be achieved for $PM_{2.5}$ in 2013, with a reduction of 13.6 tons $PM_{2.5}$/day relative to baseline emissions. We estimate the CO_2 emissions benefit resulting from the regulation to be negligible, with the greatest reduction of 570.8 tons CO_2/day occurring in 2023. In some years the CO_2 emissions are estimated to slightly increase due to the decreased fuel efficiency resulting from the technologies used to reduce NO_x and $PM_{2.5}$. We show the emissions reduction estimate for CO_2 in Figure 38.

Figure 36. Statewide NO_x Emissions Estimates with Regulation

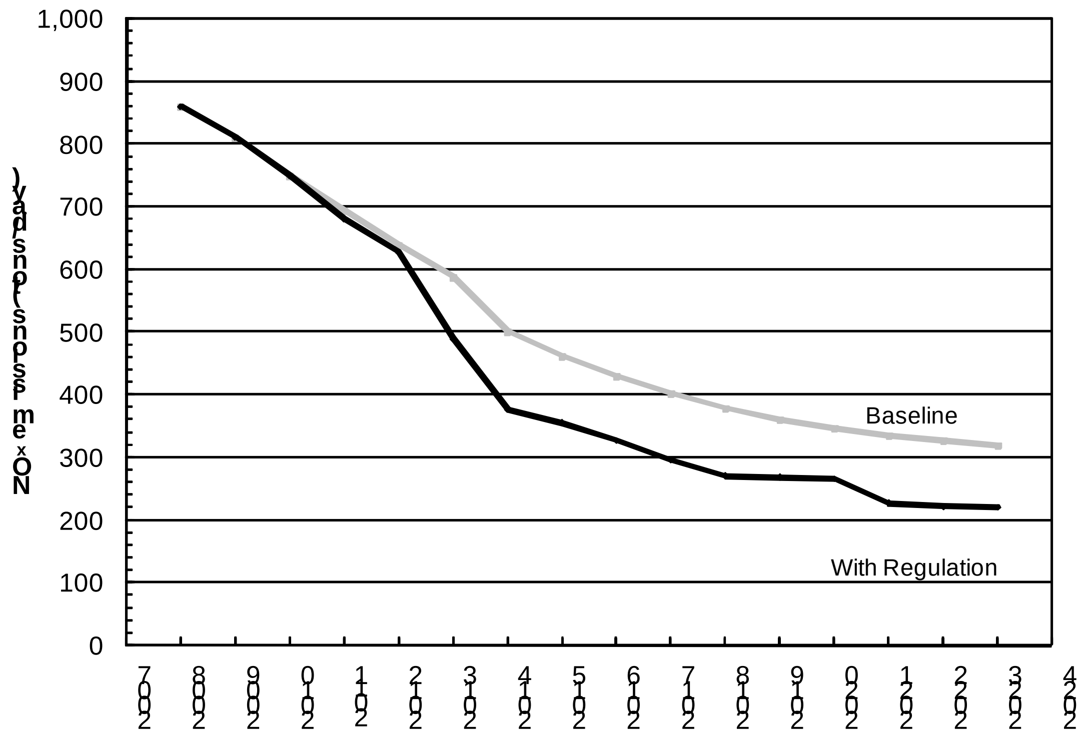


Figure 37. Statewide $PM_{2.5}$ Emissions Estimates with Regulation

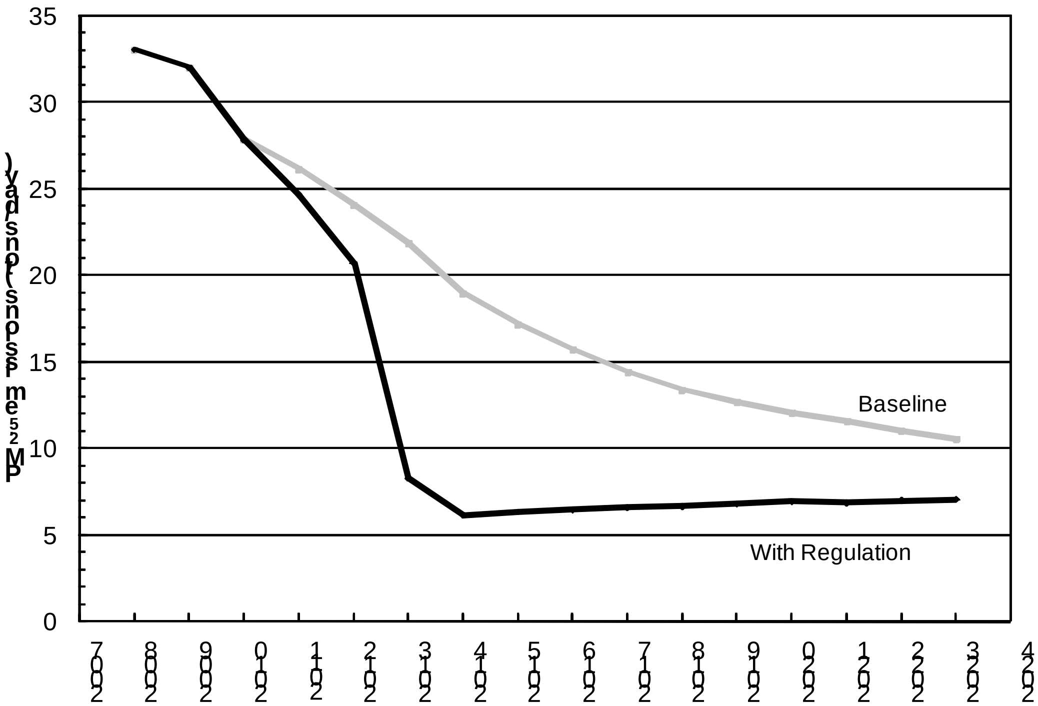
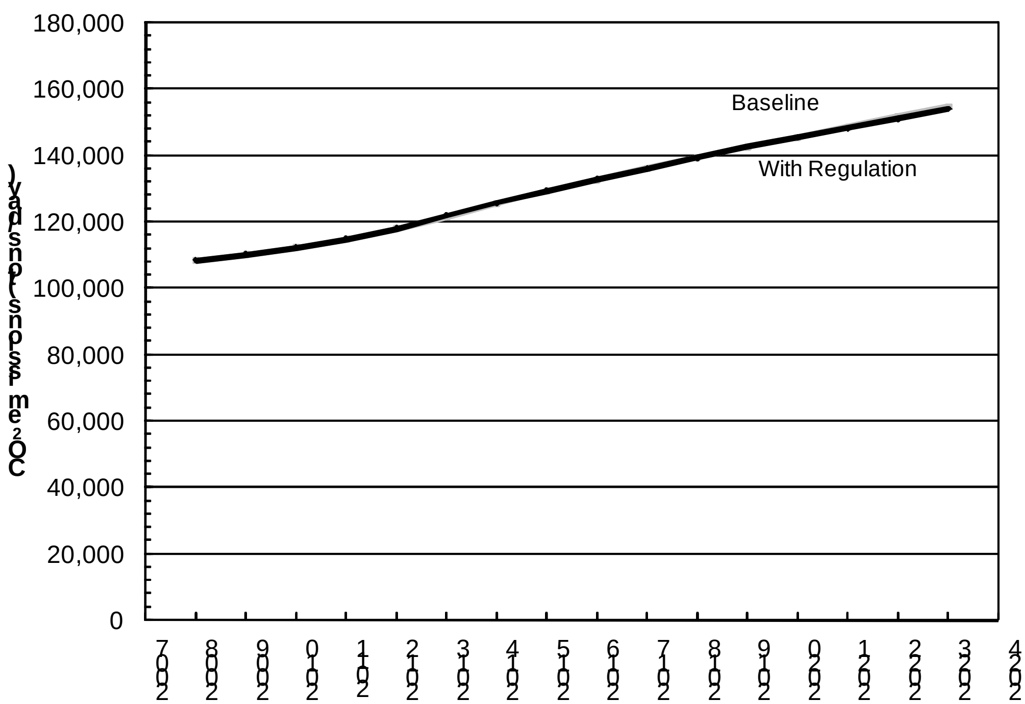


Figure 38. Statewide CO_2 Emissions Estimates with Regulation



b) Statewide Emissions Benefits by Inventory Category

In Table 34 we provide statewide NO_x reductions achieved by the proposed regulation in calendar years 2014 and 2020 for each inventory category. As the table shows, we estimate that single-unit trucks will provide the greatest percent NO_x reduction relative to their baseline, achieving 45% reductions in 2014 and 2020. (The reduction achieved by the proposed regulation with regard to drayage trucks is negligible for NO_x and other pollutants in 2014 and 2020 as a result of the ARB drayage truck regulation adopted in 2007, which will already require significant emissions reductions prior to 2014 (ARB, 2007a; ARB, 2007b); the regulation proposed herein requires further reductions after 2020). When considering all truck categories in aggregate, the largest share of the overall NO_x reduction to be achieved by the proposed rule will be provided by in-state heavy-heavy duty tractors (42% of total reductions in 2014, 45% in 2020) and medium-heavy duty diesel trucks (20%; 17%).

Table 34. California Statewide NO_x Future Emissions Reductions by Inventory Category, 2014 and 2020 (tons/day)

	2014				2020			
Inventory Category	Base[1]	Reg[2]	Reduction[3]	Share[4]	Base	Reg	Reduction	Share
HH Out-of-State	96.3	88.2	-8.4%	6.5%	62.6	59.9	-4.3%	3.4%
HH CA-IRP	74.0	64.1	-13.3%	8.0%	40.8	36.8	-9.9%	5.1%
HH Tractor	140.0	88.3	-36.9%	41.7%	92.3	56.3	-39.0%	45.2%
HH Single unit	44.9	24.5	-45.4%	16.4%	30.6	16.8	-45.2%	17.4%
HH Drayage	33.4	33.4	0.0%	0.0%	51.4	51.4	0.0%	0.0%
HH Agriculture	12.4	10.2	-17.6%	1.8%	7.5	4.6	-38.2%	3.6%
HH Utility	0.6	0.6	-1.6%	0.0%	0.5	0.5	-1.3%	0.0%
MH In-State	72.6	47.7	-34.2%	20.1%	40.2	26.3	-34.5%	17.4%
MH Interstate	0.4	0.3	-22.2%	0.1%	0.2	0.2	-19.3%	0.1%
MH Agriculture	2.7	2.5	-9.3%	0.2%	1.7	1.1	-38.7%	0.8%
MH Utility	0.3	0.3	-0.8%	0.0%	0.2	0.2	-1.4%	0.0%
Buses	11.3	9.2	-18.8%	1.7%	8.4	6.8	-19.7%	2.1%
PTO	11.4	7.1	-37.5%	3.4%	9.2	5.4	-41.8%	4.8%
All	500.2	376.5	-24.7%	100.0%	345.6	266.1	-23.0%	100.0%

[1] The emissions estimated from each category, under the baseline scenario in the absence of regulation
[2] The emissions estimated from each category, under the scenario with the proposed regulation
[3] The percent reduction estimated from each category with the proposed regulation
[4] The share of total emissions reductions (e.g. 123.7 tons/day, for all, in 2014) represented by the category

In Table 35 we provide statewide $PM_{2.5}$ reductions achieved by the proposed regulation in calendar years 2014 and 2020 for each inventory category. We predict that trucks in many categories will achieve large $PM_{2.5}$ reductions but we predict the largest reductions to come from the single-unit category as well as the in-state medium- and heavy-heavy duty tractors, in terms of reductions relative to individual category baseline emissions. When considering all truck categories in aggregate, the largest share of the overall $PM_{2.5}$ reduction to be achieved by proposed rule should be provided by in-state heavy-heavy duty tractors (38% of total reductions in 2014; 47% of total reductions in 2020) and medium-heavy duty diesel trucks (16%; 17%).

Table 35. California Statewide $PM_{2.5}$ Future Emissions Reductions by Inventory Category, 2014 and 2020 (tons/day)

	2014				2020			
Inventory Category	Base[1]	Reg[2]	Reduction[3]	Share[4]	Base	Reg	Reduction	Share
HH Out-of-State	3.7	1.7	-53.3%	15.5%	2.2	2.0	-9.0%	3.9%
HH CA-IRP	2.9	1.1	-63.8%	14.4%	1.5	1.2	-19.8%	5.8%
HH Tractor	6.1	1.3	-79.4%	37.7%	3.9	1.5	-61.2%	46.7%
HH Single Unit	1.4	0.3	-79.1%	8.5%	1.0	0.3	-66.9%	13.5%
HH Drayage	0.5	0.5	0.0%	0.0%	0.8	0.8	0.0%	0.0%
HH Agriculture	0.5	0.3	-52.6%	2.2%	0.3	0.2	-52.4%	3.3%
HH Utility	0.0	0.0	-4.7%	0.0%	0.0	0.0	-2.7%	0.0%
MH In-State	2.7	0.6	-77.1%	16.3%	1.5	0.6	-60.9%	17.3%
MH Interstate	0.0	0.0	-65.7%	0.1%	0.0	0.0	-37.2%	0.1%
MH Agriculture	0.1	0.1	-33.4%	0.3%	0.1	0.0	-52.1%	0.8%
MH Utility	0.0	0.0	-0.8%	0.0%	0.0	0.0	-0.8%	0.0%
Buses	0.4	0.1	-65.2%	1.9%	0.3	0.2	-53.2%	3.4%
PTO	0.6	0.2	-63.9%	3.1%	0.4	0.1	-74.3%	5.4%
All	19.0	6.1	-67.7%	100.0%	12.1	6.9	-42.7%	100.0%

[1] The emissions estimated from each category, under the baseline scenario in the absence of regulation
[2] The emissions estimated from each category, under the scenario with the proposed regulation
[3] The percent reduction estimated from each category with the proposed regulation
[4] The share of total emissions reductions (e.g. 12.9 tons/day, for all, in 2014) represented by the category

In Table 36 we provide statewide CO_2 reductions achieved by the proposed regulation in calendar years 2014 and 2020 for each inventory category. The overall CO_2 reduction for each category is negligible, with none exceeding 1% and some actually increasing CO_2 emissions. When considering all the categories in aggregate, the largest share of the overall CO_2 reduction in 2014 is again represented by the tractors, the heavy-heavy tractors from out-of-state as well as California, and the medium-heavy trucks from in-state. In aggregate, we anticipate a slight increase in emissions for 2014 and a slight reduction for 2020.

Table 36. California Statewide CO_2 Future Emissions Reductions by Inventory Category, 2014 and 2020 (tons/day)

	2014				2020			
Inventory Category	Base[1]	Reg[2]	Reduction[3]	Share[4]	Base	Reg	Reduction	Share
HH Out-of-State	37,997	38,058	0.2%	23.9%	44,681	44,678	0.0%	7.1%
HH CA-IRP	19,564	19,618	0.3%	20.8%	22,881	22,876	0.0%	12.4%
HH Tractor	24,309	24,363	0.2%	21.2%	28,441	28,424	-0.1%	42.2%
HH Single Unit	8,006	8,022	0.2%	6.2%	9,401	9,394	-0.1%	16.0%
HH Drayage	8,000	8,000	0.0%	0.0%	10,393	10,393	0.0%	0.0%
HH Agriculture	1,735	1,747	0.7%	4.5%	1,680	1,674	-0.4%	15.2%
HH Utility	88	88	-0.2%	-0.1%	98	98	-0.1%	0.2%
MH In-State	20,993	21,051	0.3%	22.6%	22,752	22,751	0.0%	1.9%
MH Interstate	193	194	0.2%	0.1%	210	210	0.0%	0.0%
MH Agriculture	505	507	0.4%	0.8%	489	487	-0.4%	5.1%
MH Utility	95	95	0.0%	0.0%	105	105	0.0%	0.1%
Buses	2,280	2,280	0.0%	0.0%	2,529	2,529	0.0%	-0.1%
PTO	1,589	1,589	0.0%	0.0%	1,878	1,878	0.0%	0.0%
All	125,354	125,612	0.2%	100.0%	145,537	145,496	0.0%	100.0%

[1] The emissions estimated from each category, under the baseline scenario in the absence of regulation
[2] The emissions estimated from each category, under the scenario with the proposed regulation
[3] The percent reduction estimated from each category with the proposed regulation
[4] The share of total emissions reductions (e.g. -258 tons/day, for all, in 2014) represented by the category

In Table 37 we show the distribution of all emissions reductions anticipated to result from the proposed regulation. We expect the largest reductions in NO_x and $PM_{2.5}$ will come from trucks registered in California, with heavy-heavy instate trucks providing the greatest reductions followed by medium-heavy in-state trucks and single-unit trucks. These three categories alone represent over 74% of the overall NO_x and 67% of the overall $PM_{2.5}$ emissions reductions anticipated between 2008 and 2023.

Table 37. Distribution of Total Future Emissions Reductions across Inventory Category , 2008-2023

Inventory Category	NO_x Share	$PM_{2.5}$ Share
HH Out-of-State	4.4%	10.8%
HH CA-IRP	5.8%	10.3%
HH Tractor	41.1%	40.7%
HH Single Unit	16.0%	10.4%
HH Drayage	6.0%	1.1%
HH Agriculture	2.9%	3.0%
HH Utility	0.0%	0.0%
MH In-State	17.4%	16.4%
MH Interstate	0.1%	0.1%
MH Agriculture	0.6%	0.6%
MH Utility	0.0%	0.0%
Buses	1.7%	2.7%
PTO	4.1%	4.1%
Total	100.0%	100.0%

c) Statewide Emissions Benefits by Fleet Size

In Table 38 we subdivide the statewide benefits for NO_x reductions for 2014 and 2020 by truck fleet size. As shown in the table, we expect the reductions in both 2014 and 2020 to come primarily from trucks that are driven above the respective mileage thresholds that are included for application of the regulation. When pooling the fleets together, we expect that the largest share of the overall emission reduction will come from fleets operating more than three trucks, with the second largest share coming from single-truck fleets. We expect the reduction rates, however, to be largest for fleets of 3 or fewer vehicles. In addition, we expect that nearly 45% of the NO_x emissions reductions anticipated in 2014, and more than 47% of the reductions anticipated in 2020, will come from fleets with three or fewer vehicles. These projections result largely from the fact that smaller fleets tend to have on average older trucks than do larger fleets. In Table 39 we show the future NO_x baseline emissions and reductions as a function of inventory category and fleet size.

Table 38. California Statewide NO_x Future Emissions Reductions by Fleet Size, 2014 and 2020 (tons/day)

	2014				2020			
Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
1 truck/above threshold	134.8	98.2	-27.2%	29.6%	98.3	73.3	-25.5%	31.5%
1 truck/below threshold	3.8	3.8	0.0%	0.0%	3.1	3.1	0.0%	0.0%
2 truck/above threshold	38.7	26.5	-31.4%	9.8%	25.5	17.6	-31.1%	10.0%
2 truck/below threshold	1.2	1.2	0.0%	0.0%	1.0	1.0	0.0%	0.0%
3 truck/above threshold	23.7	17.0	-28.6%	5.5%	16.6	11.9	-28.1%	5.9%
3 truck/below threshold	0.7	0.7	0.0%	0.0%	0.6	0.6	0.0%	0.0%
4+ truck/above threshold	253.6	194.2	-23.4%	48.0%	169.3	136.4	-19.4%	41.3%
4+ truck/below threshold	5.1	5.1	0.0%	0.0%	4.0	4.0	0.0%	0.0%
Ag non specialty higher VMT	8.9	6.4	-27.5%	2.0%	4.9	2.3	-52.1%	3.2%
Ag non specialty lower VMT	2.5	2.5	0.0%	0.0%	1.8	1.8	0.0%	0.0%
Ag non specialty midrange VMT	2.2	2.2	0.0%	0.0%	1.6	0.6	-61.0%	1.3%
Ag specialty vehicle	1.5	1.5	0.0%	0.0%	0.9	0.9	0.0%	0.0%
Unspecified	23.5	17.2	-27.1%	5.2%	18.2	12.7	-30.2%	6.9%
All	500.2	376.5	-24.7%	100.0%	345.6	266.1	-23.0%	100.0%

Table 39. California Statewide NO_x Future Emissions Reductions by Inventory Category and Fleet Size, 2014 and 2020 (tons/day)

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Out of State	1 truck/above 7500 miles	5.45	4.93	-9.5%	0.4%	3.16	2.93	-7.3%	0.3%
	1 truck/below 7500 miles	0.04	0.04	0.0%	0.0%	0.03	0.03	0.0%	0.0%
	2 truck/above 7500 miles	1.69	1.52	-10.0%	0.1%	0.98	0.91	-7.2%	0.1%
	2 truck/below 7500 miles	0.01	0.01	0.0%	0.0%	0.01	0.01	0.0%	0.0%
	3 truck/above 7500 miles	1.23	1.11	-9.7%	0.1%	0.71	0.66	-7.3%	0.1%
	3 truck/below 7500 miles	0.01	0.01	0.0%	0.0%	0.01	0.01	0.0%	0.0%
	4+ truck/above 7500 miles	87.40	80.10	-8.3%	5.9%	57.36	55.01	-4.1%	3.0%
	4+ truck/below 7500 miles	0.47	0.47	0.0%	0.0%	0.37	0.37	0.0%	0.0%

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH CAIRP	1 truck/above 7500 miles	23.01	20.90	-9.2%	1.7%	11.77	10.84	-7.9%	1.2%
	1 truck/below 7500 miles	0.16	0.16	0.0%	0.0%	0.12	0.12	0.0%	0.0%
	2 truck/above 7500 miles	8.17	7.32	-10.4%	0.7%	4.29	3.94	-8.4%	0.5%
	2 truck/below 7500 miles	0.06	0.06	0.0%	0.0%	0.04	0.04	0.0%	0.0%
	3 truck/above 7500 miles	4.53	4.03	-11.1%	0.4%	2.42	2.18	-9.9%	0.3%
	3 truck/below 7500 miles	0.04	0.04	0.0%	0.0%	0.03	0.03	0.0%	0.0%
	4+ truck/above 7500 miles	37.72	31.32	-16.9%	5.2%	21.91	19.40	-11.4%	3.2%
	4+ truck/below 7500 miles	0.30	0.30	0.0%	0.0%	0.22	0.22	0.0%	0.0%
HH Tractor	1 truck/above 7500 miles	52.13	32.96	-36.8%	15.5%	33.68	19.74	-41.4%	17.5%
	1 truck/below 7500 miles	1.31	1.31	0.0%	0.0%	1.14	1.14	0.0%	0.0%
	2 truck/above 7500 miles	14.90	8.86	-40.5%	4.9%	9.90	5.67	-42.7%	5.3%
	2 truck/below 7500 miles	0.39	0.39	0.0%	0.0%	0.34	0.34	0.0%	0.0%
	3 truck/above 7500 miles	8.51	5.24	-38.4%	2.6%	5.65	3.22	-43.0%	3.1%
	3 truck/below 7500 miles	0.22	0.22	0.0%	0.0%	0.19	0.19	0.0%	0.0%
	4+ truck/above 7500 miles	61.24	38.05	-37.9%	18.7%	40.27	24.90	-38.2%	19.3%
	4+ truck/below 7500 miles	1.31	1.31	0.0%	0.0%	1.11	1.11	0.0%	0.0%
HH Single Unit	1 truck/above 7500 miles	12.31	6.24	-49.3%	4.9%	8.54	4.06	-52.5%	5.6%
	1 truck/below 7500 miles	1.04	1.04	0.0%	0.0%	0.90	0.90	0.0%	0.0%
	2 truck/above 7500 miles	4.28	2.08	-51.4%	1.8%	3.01	1.42	-53.0%	2.0%
	2 truck/below 7500 miles	0.36	0.36	0.0%	0.0%	0.32	0.32	0.0%	0.0%
	3 truck/above 7500 miles	2.68	1.41	-47.4%	1.0%	1.80	0.87	-51.7%	1.2%
	3 truck/below 7500 miles	0.22	0.22	0.0%	0.0%	0.18	0.18	0.0%	0.0%
	4+ truck/above 7500 miles	22.37	11.56	-48.3%	8.7%	14.54	7.72	-46.9%	8.6%
	4+ truck/below 7500 miles	1.60	1.60	0.0%	0.0%	1.31	1.31	0.0%	0.0%
HH Drayage	1 truck	17.94	17.94	0.0%	0.0%	27.62	27.62	0.0%	0.0%
	2 truck	1.99	1.99	0.0%	0.0%	3.07	3.07	0.0%	0.0%
	3 truck	2.24	2.24	0.0%	0.0%	3.45	3.45	0.0%	0.0%
	4+ truck	11.21	11.21	0.0%	0.0%	17.26	17.26	0.0%	0.0%
HH Agriculture	Ag non specialty higher VMT	7.79	5.60	-28.1%	1.8%	4.27	2.06	-51.7%	2.8%
	Ag non specialty lower VMT	1.92	1.92	0.0%	0.0%	1.38	1.38	0.0%	0.0%
	Ag non specialty midrange VMT	1.48	1.48	0.0%	0.0%	1.11	0.45	-59.3%	0.8%
	Ag specialty vehicle	1.24	1.24	0.0%	0.0%	0.75	0.75	0.0%	0.0%
HH Utility		0.60	0.59	-1.6%	0.0%	0.46	0.45	-1.3%	0.0%
MH instate	1 truck/above 5000 miles	23.96	15.18	-36.6%	7.1%	13.48	8.05	-40.3%	6.8%
	1 truck/below 5000 miles	1.20	1.20	0.0%	0.0%	0.87	0.87	0.0%	0.0%
	2 truck/above 5000 miles	7.59	4.71	-37.9%	2.3%	4.22	2.55	-39.7%	2.1%
	2 truck/below 5000 miles	0.37	0.37	0.0%	0.0%	0.26	0.26	0.0%	0.0%
	3 truck/above 5000 miles	4.52	2.90	-35.9%	1.3%	2.50	1.50	-40.0%	1.3%
	3 truck/below 5000 miles	0.22	0.22	0.0%	0.0%	0.16	0.16	0.0%	0.0%
	4+ truck/above 5000 miles	33.36	21.77	-34.7%	9.4%	17.76	12.01	-32.4%	7.2%
	4+ truck/below 5000 miles	1.39	1.39	0.0%	0.0%	0.95	0.95	0.0%	0.0%
MH Interstate	1 truck/above 5000 miles	0.05	0.05	-11.2%	0.0%	0.03	0.02	-14.4%	0.0%
	1 truck/below 5000 miles	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
	2 truck/above 5000 miles	0.03	0.03	-17.6%	0.0%	0.02	0.01	-21.2%	0.0%
	2 truck/below 5000 miles	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
	3 truck/above 5000 miles	0.03	0.03	-21.8%	0.0%	0.02	0.01	-23.0%	0.0%
	3 truck/below 5000 miles	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
	4+ truck/above 5000 miles	0.31	0.23	-25.5%	0.1%	0.16	0.13	-20.6%	0.0%
	4+ truck/below 5000 miles	0.01	0.01	0.0%	0.0%	0.01	0.01	0.0%	0.0%
MH Agriculture	Ag non specialty higher VMT	1.08	0.83	-23.3%	0.2%	0.59	0.26	-55.5%	0.4%
	Ag non specialty lower VMT	0.60	0.60	0.0%	0.0%	0.44	0.44	0.0%	0.0%
	Ag non specialty midrange VMT	0.76	0.76	0.0%	0.0%	0.54	0.19	-64.4%	0.4%
	Ag specialty vehicle	0.27	0.27	0.0%	0.0%	0.17	0.17	0.0%	0.0%
MH Utility		0.32	0.32	-0.8%	0.0%	0.16	0.15	-1.4%	0.0%
Buses		11.27	9.15	-18.8%	1.7%	8.41	6.75	-19.7%	2.1%
PTO		11.35	7.10	-37.5%	3.4%	9.22	5.37	-41.8%	4.8%
All		500.23	376.48	-24.7%	100.0%	345.63	266.13	-23.0%	100.0%

In Table 40 we provide statewide $PM_{2.5}$ reductions in 2014 and 2020 by truck fleet size and mileage threshold. We expect the reductions in both 2014 and 2020 to come from trucks of all different fleet sizes, regardless of whether the trucks are driven above the respective thresholds included for application of the regulation. The only trucks not affected are agricultural trucks that are less-utilized. When considering all fleets in aggregate, the largest share of the overall reduction is again represented first by fleets operating more than three trucks, with the second largest share represented by single-truck fleets. The reduction rates, again, are greatest for fleets of 3 or fewer vehicles. We again expect that nearly 45% of the $PM_{2.5}$ emissions reductions anticipated in 2014, and more than 47% of the reductions anticipated in 2020, will come from fleets with three or fewer vehicles. These projections again result largely from the fact that smaller fleets tend to have older vehicles than do larger fleets. In Table 41 we break down the future $PM_{2.5}$ baseline emissions and reductions further as a function of inventory category and fleet size.

Table 40. California Statewide $PM_{2.5}$ Future Emissions Reductions by Fleet Size, 2014 and 2020

	2014				2020			
Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
1 truck/above threshold	5.0	1.3	-74.4%	29.2%	3.2	1.6	-48.7%	30.3%
1 truck/below threshold	0.1	0.0	-84.0%	1.0%	0.1	0.0	-79.1%	1.7%
2 truck/above threshold	1.5	0.4	-76.0%	8.9%	0.9	0.4	-52.6%	9.5%
2 truck/below threshold	0.0	0.0	-83.9%	0.3%	0.0	0.0	-79.2%	0.5%
3 truck/above threshold	0.9	0.3	-71.9%	5.0%	0.6	0.3	-49.9%	5.5%
3 truck/below threshold	0.0	0.0	-83.9%	0.2%	0.0	0.0	-78.9%	0.3%
4+ truck/above threshold	9.4	3.5	-63.5%	46.7%	6.0	4.0	-32.2%	37.2%
4+ truck/below threshold	0.2	0.0	-82.8%	1.2%	0.1	0.0	-75.6%	2.0%
Ag non specialty higher VMT	0.4	0.1	-81.2%	2.5%	0.2	0.1	-72.7%	3.0%
Ag non specialty lower VMT	0.1	0.1	0.0%	0.0%	0.1	0.1	0.0%	0.0%
Ag non specialty midrange VMT	0.1	0.1	0.0%	0.0%	0.1	0.0	-79.8%	1.0%
Ag specialty vehicle	0.1	0.1	0.0%	0.0%	0.0	0.0	0.0%	0.0%
Unspecified	1.0	0.4	-64.1%	5.0%	0.7	0.3	-64.0%	8.8%
All	19.0	6.1	-67.7%	100.0%	12.1	6.9	-42.7%	100.0%

Table 41. California Statewide $PM_{2.5}$ Future Emissions Reductions by Inventory Category and Fleet Size, 2014 and 2020 (tons/day)

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Out of State	1 truck/above 7500 miles	0.21	0.08	-60.4%	1.0%	0.11	0.10	-15.7%	0.3%
	1 truck/below 7500 miles	0.00	0.00	-81.5%	0.0%	0.00	0.00	-65.3%	0.0%
	2 truck/above 7500 miles	0.07	0.03	-60.6%	0.3%	0.04	0.03	-15.8%	0.1%
	2 truck/below 7500 miles	0.00	0.00	-81.5%	0.0%	0.00	0.00	-65.4%	0.0%
	3 truck/above 7500 miles	0.05	0.02	-60.0%	0.2%	0.03	0.02	-15.8%	0.1%
	3 truck/below 7500 miles	0.00	0.00	-81.5%	0.0%	0.00	0.00	-65.4%	0.0%
	4+ truck/above 7500 miles	3.39	1.61	-52.4%	13.8%	2.04	1.87	-8.2%	3.2%
	4+ truck/below 7500 miles	0.02	0.00	-80.1%	0.1%	0.01	0.00	-55.4%	0.1%
HH CAIRP	1 truck/above 7500 miles	0.93	0.30	-67.8%	4.9%	0.42	0.35	-16.5%	1.4%
	1 truck/below 7500 miles	0.01	0.00	-81.9%	0.0%	0.00	0.00	-63.4%	0.0%
	2 truck/above 7500 miles	0.32	0.11	-66.4%	1.7%	0.16	0.13	-17.5%	0.5%
	2 truck/below 7500 miles	0.00	0.00	-81.8%	0.0%	0.00	0.00	-65.0%	0.0%
	3 truck/above 7500 miles	0.18	0.06	-66.0%	0.9%	0.09	0.07	-20.5%	0.4%
	3 truck/below 7500 miles	0.00	0.00	-82.3%	0.0%	0.00	0.00	-68.1%	0.0%
	4+ truck/above 7500 miles	1.44	0.58	-60.1%	6.8%	0.82	0.65	-21.0%	3.3%
	4+ truck/below 7500 miles	0.01	0.00	-82.0%	0.1%	0.01	0.00	-70.0%	0.1%

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Tractor	1 truck/above 7500 miles	2.36	0.40	-82.8%	15.2%	1.45	0.51	-65.1%	18.3%
	1 truck/below 7500 miles	0.06	0.01	-84.3%	0.4%	0.05	0.01	-79.5%	0.7%
	2 truck/above 7500 miles	0.67	0.11	-82.9%	4.3%	0.43	0.15	-65.9%	5.5%
	2 truck/below 7500 miles	0.02	0.00	-84.3%	0.1%	0.01	0.00	-80.0%	0.2%
	3 truck/above 7500 miles	0.38	0.08	-79.2%	2.3%	0.25	0.09	-65.3%	3.1%
	3 truck/below 7500 miles	0.01	0.00	-84.3%	0.1%	0.01	0.00	-80.0%	0.1%
	4+ truck/above 7500 miles	2.54	0.63	-75.1%	14.9%	1.70	0.76	-55.0%	18.1%
	4+ truck/below 7500 miles	0.06	0.01	-83.5%	0.4%	0.04	0.01	-78.0%	0.7%
HH Single Unit	1 truck/above 7500 miles	0.38	0.07	-82.5%	2.5%	0.29	0.08	-71.5%	4.1%
	1 truck/below 7500 miles	0.03	0.00	-84.5%	0.2%	0.03	0.01	-81.0%	0.4%
	2 truck/above 7500 miles	0.13	0.02	-82.3%	0.9%	0.10	0.03	-71.2%	1.4%
	2 truck/below 7500 miles	0.01	0.00	-84.5%	0.1%	0.01	0.00	-81.0%	0.2%
	3 truck/above 7500 miles	0.08	0.02	-77.2%	0.5%	0.06	0.02	-68.8%	0.8%
	3 truck/below 7500 miles	0.01	0.00	-84.3%	0.0%	0.01	0.00	-80.4%	0.1%
	4+ truck/above 7500 miles	0.68	0.16	-76.0%	4.0%	0.50	0.20	-60.9%	5.9%
	4+ truck/below 7500 miles	0.05	0.01	-83.6%	0.3%	0.04	0.01	-78.7%	0.6%
HH Drayage	1 truck	0.24	0.24	0.0%	0.0%	0.43	0.43	0.0%	0.0%
	2 truck	0.03	0.03	0.0%	0.0%	0.05	0.05	0.0%	0.0%
	3 truck	0.03	0.03	0.0%	0.0%	0.05	0.05	0.0%	0.0%
	4+ truck	0.15	0.15	0.0%	0.0%	0.27	0.27	0.0%	0.0%
HH Agriculture	Ag non specialty higher VMT	0.35	0.06	-81.2%	2.2%	0.19	0.05	-71.8%	2.6%
	Ag non specialty lower VMT	0.08	0.08	0.0%	0.0%	0.06	0.06	0.0%	0.0%
	Ag non specialty midrange VMT	0.05	0.05	0.0%	0.0%	0.04	0.01	-78.2%	0.7%
	Ag specialty vehicle	0.05	0.05	0.0%	0.0%	0.03	0.03	0.0%	0.0%
HH Utility		0.00	0.00	-4.7%	0.0%	0.00	0.00	-2.7%	0.0%
MH instate	1 truck/above 5000 miles	0.91	0.19	-79.2%	5.6%	0.50	0.17	-65.3%	6.3%
	1 truck/below 5000 miles	0.05	0.01	-83.6%	0.3%	0.03	0.01	-79.3%	0.5%
	2 truck/above 5000 miles	0.29	0.06	-78.5%	1.7%	0.15	0.06	-63.7%	1.9%
	2 truck/below 5000 miles	0.01	0.00	-83.5%	0.1%	0.01	0.00	-78.7%	0.2%
	3 truck/above 5000 miles	0.17	0.04	-75.6%	1.0%	0.09	0.03	-63.1%	1.1%
	3 truck/below 5000 miles	0.01	0.00	-83.5%	0.1%	0.01	0.00	-78.5%	0.1%
	4+ truck/above 5000 miles	1.23	0.31	-74.9%	7.2%	0.63	0.29	-54.1%	6.7%
	4+ truck/below 5000 miles	0.05	0.01	-82.6%	0.3%	0.03	0.01	-76.4%	0.5%
MH Interstate	1 truck/above 5000 miles	0.00	0.00	-59.3%	0.0%	0.00	0.00	-25.5%	0.0%
	1 truck/below 5000 miles	0.00	0.00	-77.3%	0.0%	0.00	0.00	-64.4%	0.0%
	2 truck/above 5000 miles	0.00	0.00	-62.2%	0.0%	0.00	0.00	-35.7%	0.0%
	2 truck/below 5000 miles	0.00	0.00	-78.6%	0.0%	0.00	0.00	-70.3%	0.0%
	3 truck/above 5000 miles	0.00	0.00	-63.3%	0.0%	0.00	0.00	-38.8%	0.0%
	3 truck/below 5000 miles	0.00	0.00	-80.1%	0.0%	0.00	0.00	-71.0%	0.0%
	4+ truck/above 5000 miles	0.01	0.00	-66.6%	0.1%	0.01	0.00	-37.3%	0.0%
	4+ truck/below 5000 miles	0.00	0.00	-80.2%	0.0%	0.00	0.00	-69.9%	0.0%
MH Agriculture	Ag non specialty higher VMT	0.05	0.01	-80.9%	0.3%	0.03	0.01	-79.0%	0.4%
	Ag non specialty lower VMT	0.03	0.03	0.0%	0.0%	0.02	0.02	0.0%	0.0%
	Ag non specialty midrange VMT	0.03	0.03	0.0%	0.0%	0.02	0.00	-82.9%	0.4%
	Ag specialty vehicle	0.01	0.01	0.0%	0.0%	0.01	0.01	0.0%	0.0%
MH Utility		0.00	0.00	-0.8%	0.0%	0.00	0.00	-0.8%	0.0%
Buses		0.38	0.13	-65.2%	1.9%	0.33	0.15	-53.2%	3.4%
PTO		0.62	0.22	-63.9%	3.1%	0.38	0.10	-74.3%	5.4%
All		18.96	6.12	-67.7%	100.0%	12.08	6.93	-42.7%	100.0%

In Table 42 we subdivide the statewide benefits for CO_2 reductions for 2014 and 2020 by truck fleet size. We anticipate a slight increase for CO_2 emissions in 2014 and a slight decrease for emissions in 2020. As noted earlier, these proposed regulations are not directed toward the reduction of CO_2 emissions. When pooling the fleets together, the largest share of the overall reduction is represented by larger fleets and single-truck fleets in both 2014 and 2020.

Table 42. California Statewide CO_2 Future Emissions Reductions by Fleet Size, 2014 and 2020

	2014				2020			
Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
1 truck/above threshold	26,009	26,102	0.4%	36.4%	30,703	30,689	0.0%	33.0%
1 truck/below threshold	394	400	1.6%	2.5%	433	438	1.1%	-12.0%
2 truck/above threshold	7,650	7,681	0.4%	12.1%	8,923	8,921	0.0%	5.3%
2 truck/below threshold	125	127	1.6%	0.8%	138	140	1.1%	-3.8%
3 truck/above threshold	4,854	4,872	0.4%	6.8%	5,674	5,670	-0.1%	8.0%
3 truck/below threshold	74	75	1.6%	0.5%	82	82	1.1%	-2.2%
4+ truck/above threshold	79,365	79,449	0.1%	32.6%	92,151	92,124	0.0%	65.6%
4+ truck/below threshold	591	600	1.4%	3.2%	655	661	0.9%	-14.3%
Ag non specialty higher VMT	1,446	1,459	1.0%	5.3%	1,361	1,356	-0.4%	12.9%
Ag non specialty lower VMT	256	256	0.0%	0.0%	245	245	0.0%	0.0%
Ag non specialty midrange VMT	315	315	0.0%	0.0%	346	343	-0.9%	7.5%
Ag specialty vehicle	224	224	0.0%	0.0%	217	217	0.0%	0.0%
Unspecified	4,052	4,052	0.0%	-0.1%	4,610	4,610	0.0%	0.2%
All	125,354	125,612	0.2%	100.0%	145,537	145,496	0.0%	100.0%

Table 43. California Statewide CO_2 Future Emissions Reductions by Inventory Category and Fleet Size, 2014 and 2020 (tons/day)

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Out of State	1 truck/above 7500 miles	1,642	1,647	0.3%	1.9%	1,925	1,924	0.0%	0.6%
	1 truck/below 7500 miles	5	5	1.0%	0.0%	5	5	0.4%	-0.1%
	2 truck/above 7500 miles	508	509	0.3%	0.6%	595	595	0.0%	0.2%
	2 truck/below 7500 miles	2	2	1.0%	0.0%	2	2	0.4%	0.0%
	3 truck/above 7500 miles	368	369	0.3%	0.4%	431	431	0.0%	0.1%
	3 truck/below 7500 miles	1	1	1.0%	0.0%	1	1	0.4%	0.0%
	4+ truck/above 7500 miles	35,407	35,460	0.2%	20.7%	41,647	41,645	0.0%	6.7%
	4+ truck/below 7500 miles	65	65	0.9%	0.2%	74	74	0.3%	-0.5%
HH CAIRP	1 truck/above 7500 miles	5,084	5,110	0.5%	9.9%	6,183	6,183	0.0%	2.3%
	1 truck/below 7500 miles	20	20	1.1%	0.1%	22	22	0.4%	-0.2%
	2 truck/above 7500 miles	1,879	1,888	0.5%	3.4%	2,283	2,282	0.0%	1.1%
	2 truck/below 7500 miles	7	7	1.1%	0.0%	8	8	0.4%	-0.1%
	3 truck/above 7500 miles	1,065	1,070	0.5%	1.9%	1,270	1,269	0.0%	0.6%
	3 truck/below 7500 miles	4	4	1.1%	0.0%	5	5	0.5%	-0.1%
	4+ truck/above 7500 miles	11,469	11,483	0.1%	5.3%	13,073	13,069	0.0%	9.2%
	4+ truck/below 7500 miles	35	35	1.1%	0.1%	37	38	0.5%	-0.5%

		2014				2020			
Inventory Category	Fleet Size	Base	Reg	Red	Share	Base	Reg	Red	Share
HH Tractor	1 truck/above 7500 miles	6,995	7,030	0.5%	13.6%	8,158	8,152	-0.1%	15.2%
	1 truck/below 7500 miles	121	123	1.7%	0.8%	136	137	1.2%	-3.9%
	2 truck/above 7500 miles	2,093	2,103	0.5%	4.0%	2,443	2,443	0.0%	0.6%
	2 truck/below 7500 miles	35	36	1.7%	0.2%	40	40	1.2%	-1.2%
	3 truck/above 7500 miles	1,232	1,238	0.4%	2.1%	1,439	1,437	-0.1%	3.3%
	3 truck/below 7500 miles	20	20	1.7%	0.1%	22	23	1.2%	-0.7%
	4+ truck/above 7500 miles	13,682	13,681	0.0%	-0.5%	16,056	16,042	-0.1%	32.5%
	4+ truck/below 7500 miles	129	131	1.5%	0.8%	148	149	1.0%	-3.7%
HH Single Unit	1 truck/above 7500 miles	1,799	1,806	0.4%	2.6%	2,103	2,100	-0.1%	7.1%
	1 truck/below 7500 miles	101	102	1.7%	0.7%	116	117	1.3%	-3.7%
	2 truck/above 7500 miles	653	656	0.4%	1.1%	762	761	-0.1%	1.6%
	2 truck/below 7500 miles	35	36	1.7%	0.2%	41	41	1.3%	-1.3%
	3 truck/above 7500 miles	435	437	0.4%	0.7%	510	509	-0.2%	2.0%
	3 truck/below 7500 miles	21	22	1.7%	0.1%	24	25	1.3%	-0.8%
	4+ truck/above 7500 miles	4,793	4,792	0.0%	-0.3%	5,652	5,646	-0.1%	16.3%
	4+ truck/below 7500 miles	169	172	1.6%	1.0%	193	195	1.1%	-5.3%
HH Drayage	1 truck	4,299	4,299	0.0%	0.0%	5,584	5,584	0.0%	0.0%
	2 truck	478	478	0.0%	0.0%	620	620	0.0%	0.0%
	3 truck	537	537	0.0%	0.0%	698	698	0.0%	0.0%
	4+ truck	2,687	2,687	0.0%	0.0%	3,490	3,490	0.0%	0.0%
HH Agriculture	Ag non specialty high VMT	1,205	1,217	1.0%	4.5%	1,141	1,136	-0.4%	10.8%
	Ag non specialty lower VMT	183	183	0.0%	0.0%	175	175	0.0%	0.0%
	Ag non specialty mid VMT	173	173	0.0%	0.0%	197	195	-0.9%	4.4%
	Ag specialty vehicle	174	174	0.0%	0.0%	168	168	0.0%	0.0%
HH Utility		88	88	-0.2%	-0.1%	98	98	-0.1%	0.2%
MH instate	1 truck/above 5000 miles	6,164	6,186	0.3%	8.3%	6,721	6,718	0.0%	7.8%
	1 truck/below 5000 miles	146	149	1.6%	0.9%	154	156	1.1%	-4.1%
	2 truck/above 5000 miles	2,024	2,032	0.4%	3.0%	2,203	2,202	0.0%	1.9%
	2 truck/below 5000 miles	46	46	1.6%	0.3%	48	49	1.1%	-1.2%
	3 truck/above 5000 miles	1,201	1,206	0.4%	1.6%	1,310	1,309	-0.1%	1.9%
	3 truck/below 5000 miles	27	27	1.6%	0.2%	29	29	1.0%	-0.7%
	4+ truck/above 5000 miles	11,193	11,211	0.2%	7.2%	12,087	12,086	0.0%	0.8%
	4+ truck/below 5000 miles	192	194	1.5%	1.1%	201	202	0.9%	-4.3%
MH Interstate	1 truck/above 5000 miles	25	25	0.3%	0.0%	28	28	0.0%	0.0%
	1 truck/below 5000 miles	0	0	0.9%	0.0%	0	0	0.4%	0.0%
	2 truck/above 5000 miles	16	16	0.3%	0.0%	17	17	0.0%	0.0%
	2 truck/below 5000 miles	0	0	1.1%	0.0%	0	0	0.6%	0.0%
	3 truck/above 5000 miles	15	15	0.3%	0.0%	17	17	0.0%	0.0%
	3 truck/below 5000 miles	0	0	1.2%	0.0%	0	0	0.6%	0.0%
	4+ truck/above 5000 miles	135	135	0.2%	0.1%	145	145	0.0%	0.0%
	4+ truck/below 5000 miles	2	2	1.2%	0.0%	2	2	0.6%	0.0%
MH Agriculture	Ag non specialty high VMT	240	242	0.9%	0.8%	221	220	-0.4%	2.1%
	Ag non specialty lower VMT	73	73	0.0%	0.0%	70	70	0.0%	0.0%
	Ag non specialty mid VMT	142	142	0.0%	0.0%	149	148	-0.8%	3.0%
	Ag specialty vehicle	50	50	0.0%	0.0%	49	49	0.0%	0.0%
MH Utility		95	95	0.0%	0.0%	105	105	0.0%	0.1%
Buses		2,280	2,280	0.0%	0.0%	2,529	2,529	0.0%	-0.1%
PTO		1,589	1,589	0.0%	0.0%	1,878	1,878	0.0%	0.0%
All		125,354	125,612	0.2%	100.0%	145,537	145,496	0.0%	100.0%

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Final –Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds

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Executive Officer
Barry R. Wallerstein, D. Env.

Deputy Executive Officer
Planning, Rule Development and Area Sources
Elaine Chang, DrPH

Assistant Deputy Executive Officer
Planning, Rule Development and Area Sources
Laki Tisopulos, Ph.D., P.E.

Planning and Rules Manager
Planning, Rule Development and Area Sources
Susan Nakamura

Authors:	Mike Krause	Air Quality Specialist
	Steve Smith, Ph.D.	Program Supervisor
Technical Assistance:	James Koizumi	Air Quality Specialist
	Tom Chico	Program Supervisor
	Robert Wu	Air Quality Specialist
	Xinqiu Zhang	Air Quality Specialist
	Joe Cassmassi	Planning Manager
	Julia Lester, Ph.D.	

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Introduction

In the last few years, both California and the federal governments have established ambient air quality standards for fine particulate matter (PM) less than or equal to 2.5 microns in diameter (PM2.5). As a result, there is a need to establish a methodology for calculating PM2.5 and appropriate PM2.5 significance thresholds for the purpose of analyzing local and regional PM2.5 air quality impacts in California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) air quality analyses. This document provides a methodology for calculating PM2.5 and recommendations for localized and regional PM2.5 significance thresholds.

Background

PM larger than 2.5 microns and less than 10 microns, often referred to as the coarse PM fraction (or PM10), is mostly produced by mechanical processes. These include automobile tire wear, industrial processes such as cutting and grinding, and re-suspension of particles from the ground or road surfaces by wind and human activities such as construction or agriculture. In contrast, PM less than or equal to PM2.5 is mostly derived from combustion sources, such as automobiles, trucks, and other vehicle exhaust, as well as from stationary combustion sources. The particles are either directly emitted or are formed in the atmosphere from the combustion of gases, such as NOx and SOx combining with ammonia. PM2.5 components from material in the earth's crust, such as dust, are also present, with the amount varying in different locations. Staff's recommendation for calculating PM2.5 focuses only on directly emitted PM2.5.

In 1997, U.S. EPA established an annual and a 24-hour standard for the finest fraction of particulates, PM2.5, to complement the existing PM10 standards. However, U.S. EPA recently modified the 24-hr PM2.5 standard and revoked the annual PM10 standard. (Table 1). The annual component of the standard was established to provide protection against typical day-to-day exposures as well as longer-term exposures, while the daily component protects against more extreme short-term events.

TABLE 1

Federal Standards for Particulate Matter

Federal Standards	PM 10	PM 2.5
Annual	Revoked[a]	15 $\mu g/m^3$
24-Hour	150 $\mu g/m^3$	35 $\mu g/m^3$ [b]

In June 2002, the California Air Resources Board (CARB) adopted new, stricter standards for particulate matter that would affect both the coarse as well as fine particulate fraction (Table 2). CARB delayed action on the proposed 24-hour PM2.5 standard in light of the

[a] U.S. EPA final rulemaking for CFR 40 Part 50.7 National Primary and Secondary Ambient Air Quality Standards at http://epa.gov/pm/pdfs/20060921_rule.pdf
[b] U.S. EPA final rulemaking for CFR 40 Part 50.13 National Primary and Secondary Ambient Air Quality Standards at http://epa.gov/pm/pdfs/20060921_rule.pdf

findings related to statistical issues in several key short-term exposure health effects studies.

TABLE 2

California Standards for Particulate Matter

California Standards	PM 10	PM 2.5
Annual	20 μg/m³	12 μg/m³
24-Hour	50 μg/m³	n/a

Methodology to Calculate PM 2.5

Because there are currently few or no PM2.5 emission factors for mechanical or combustion processes, staff is recommending an indirect approach to calculating PM2.5 emissions until such time as PM2.5 factors are developed. Since PM2.5 is a subset of PM10, the current methodology for calculating PM10 from fugitive dust sources (grading, demolition, unpaved roads, open storage piles, etc.) and combustion sources (stationary combustion sources, vehicle exhaust) will continue to be used to calculate PM10 and can also be used to calculate PM2.5. Total suspended PM (TSP) emissions typically contain specific fractions of PM10 and PM2.5 that can be measured. In general, PM from fugitive dust generating sources is primarily composed of PM10 with a relatively small fraction of the fugitive PM consisting of PM2.5. Alternatively, PM from combustion sources is primarily composed of PM2.5 with a small fraction consisting of PM10.

To calculate both PM10 and PM2.5, existing PM10 calculation methodologies for both fugitive dust PM10 and combustion PM10 can be used. To determine the PM2.5 fractions of the PM10 emission results, staff is recommending that the PM10 emissions be calculated using standard PM10 calculation methodologies. The PM10 emission results for each emission source or operation would then be multiplied by the applicable PM2.5 fraction, derived by emissions source, using PM profiles in the California Emission Inventory Data and Reporting System (CEIDARS) developed by the California Air Resources Board (CARB). The CEIDARS PM profiles are used to develop emission inventories for a variety of sources and operations in the Air Quality Management Plan (AQMP). The CEIDARS PM profiles have been streamlined to be used for most types of processes that would be encountered in a CEQA or NEPA document In addition, AQMD staff has identified the PM2.5 fraction of PM10. The streamlined CEIDARS PM profiles can be found in Appendix A. The CEIDARS PM profiles may be updated as necessary to reflect updates prepared by CARB.

If the project being evaluated is not listed among the categories in Appendix A, then the closest related type of operation/process should be used. For example in analyzing construction activities, e.g., grading, earth moving, etc., if the specific activity is not located in the tables the CEQA practitioner can use the following default factors derived from the 2003 AQMP annual inventories (see Tables 3 and 4 below under the "Localized Significance Thresholds for PM2.5 Emissions" discussion). For mechanical dust generating sources, e.g., construction, the PM2.5 fraction of PM10 is 21 percent and for combustion sources the PM2.5 fraction of PM10 is 99 percent. For off-road combustions sources, the PM2.5 fraction default would be 89 percent (Table 5). Other publicly available and peer reviewed sources of PM10 and PM2.5 emission factors can also be used if they more closely match the type of emission source than the sources identified in Appendix A. In addition, site-specific or project-specific information can be used.

Once the PM10 fractions from all emissions sources are calculated, these are summed and compared to the appropriate PM10 significance thresholds to determine whether or not a project is significant. Similarly, once the PM2.5 fractions from all emissions sources have been calculated, these are also summed (separate from the PM10 fractions) and compared to the appropriate PM2.5 significance threshold (see following discussion) to determine project significance.

The PM2.5 fraction of PM10 can be easily calculated as follows.

Step 1: Calculate PM10 emissions for each emissions source category.

Step 2: Look up the PM2.5 fraction of PM10 for the applicable source category by year that construction will occur or operation of the project will begin (Appendix A, column 6 of the appropriate table).

Step 3: Multiply the PM2.5 fraction by the PM10 emissions for each source category (PM2.5 emissions = PM10 emissions x [PM2.5 fraction])

Step 4: Sum the PM2.5 emissions from each emissions source.

Step 5: Compare PM2.5 emissions to the appropriate significance threshold.

Example:

A project is estimated to generate 8 pounds per day of PM10 from one piece of construction equipment. The PM2.5 emissions are as follows:
PM2.5 emissions = 8 pounds of PM10 per day x 0.89 = 7.12 pounds of PM2.5 per day.

In conjunction with establishing a methodology for calculating PM2.5, staff has developed the following recommended PM2.5 significance thresholds for both localized and regional significance for both construction and operation.

Localized Significance Thresholds for PM 2.5 Emissions

Localized significance thresholds (LSTs) were developed in response to the SCAQMD Governing Board's environmental justice (EJ) initiatives (EJ initiative I-4) in recognition of the fact that criteria pollutants, carbon monoxide (CO), oxides of nitrogen (NOx), and PM10 in particular, can have local impacts as well as regional impacts. The LST proposal went through extensive public outreach and was adopted by the Governing Board in October 2003. At the time the LST was adopted by the Governing Board, staff had not yet developed proposed LSTs for PM2.5.

Determining localized air quality impacts requires dispersion modeling. Because local lead agencies may not have the expertise or resources to perform dispersion modeling, SCAQMD created a series of look-up tables for CO, NOx, and PM10 in which staff back-calculated the mass emissions necessary to equal or exceed the construction or operation LST. The look-up tables were created for projects one to five acres in size and take into consideration location (source receptor area) and distance to the sensitive receptor. To use the look-up tables, the lead agency calculates daily emission as it normally would and then compares the results to the emissions in the applicable look-up table.

In general, the LSTs will apply primarily to construction because emissions from construction equipment occur at a fixed location compared to operation, which, for most land use projects, consists of emissions from vehicles traveling over the roadways, which, therefore, do not create impacts to a single location. To further assist lead agencies with calculating construction emissions, the SCAQMD conducted construction site surveys for each phase of construction to develop standard construction scenarios relative to construction equipment and hours of operation. Spreadsheets were developed to calculate emissions for the construction scenarios in an effort to create scenarios that would not exceed any applicable LSTs. When preparing a CEQA analysis, lead agencies could use the sample construction projects for their construction analyses, use the spreadsheets to tailor the analysis to their individual projects, or use a combination of the two.

The following subsections describe the proposed PM2.5 LSTs for both operation and construction.

Establishing LSTs

To determine the effects of PM2.5 on local (nearby) receptors, such as residents, hospitals, schools, etc., a PM2.5 localized significance threshold (LST) needs to be established. Since the Basin exceeds one or more of the state or federal ambient air quality standards for PM2.5, the process used to determine significance for attainment pollutants, i.e., NO2 and CO, developed for the LST program cannot be used[c]. Under the LST program, since PM10 is a nonattainment pollutant, the LST methodology uses a different process for determining whether localized PM10 air quality impacts are significant. To determine localized PM10 air quality impacts during operation, the LST methodology uses as a significance threshold the allowable change in concentration threshold for PM10 listed in Rule 1303, Table A-2, which is 2.5 micrograms per cubic meter ($\mu g/m^3$). The allowable change in concentration threshold is a modeled concentration that cannot be exceeded at the sensitive receptor, and determines whether or not a permit applicant will receive a permit from the SCAQMD. For the LST program staff used a dispersion model (ISCST3) to convert the 2.5 $\mu g/m^3$ concentration into mass daily PM10 emissions numbers based on the size of the project, location of the project, and distance to the sensitive receptor. The

[c] Under the LST program, to determine significance for attainment pollutants, the emissions contribution from the project expressed as a concentration is added to the highest local ambient concentration from the last three years where data are available. If the sum is equal to or greater than any applicable state or federal ambient air quality standard, the project is considered to have significant localized air quality impacts for that pollutant. More information on the LST program can be found at the following URL: http://www.aqmd.gov/ceqa/handbook/LST/LST.html.

results were then incorporated into an LST look-up table. If the mass emissions from a project exceed the applicable LST look-up tables' mass emission numbers (which are based on the 2.5 μg/m^3 concentration), then localized PM10 air quality impacts are considered to be significant.

Operational Localized Significance Thresholds

To establish operational PM2.5 localized significance thresholds, staff first reviewed the PM inventories in Appendix III of the 2003 AQMP. In particular, staff evaluated the composition of PM10 and PM2.5 from combustion processes in the 2003 AQMP to establish a general ratio of PM2.5 to PM10. Combustion processes were evaluated because, for most land use projects, mobile source combustion emissions comprise the majority of emissions. Table 3 shows the total PM10 and PM2.5 inventories for total fuel combustion process for the years 2005 through 2010. As can be seen in Table 3, over the five-year timeframe considered, the fraction of combustion PM10 that consists of PM2.5 is consistently 99 percent. Since combustion PM10 and PM2.5 fractions are essentially equivalent, staff is recommending that the operational localized significance threshold for PM2.5 be the same as the current operational localized significance threshold for PM10, i.e., 2.5 μg/m^3.

TABLE 3

Total Stationary Source Fuel Combustion Inventory (Tons/Day)

Year	PM 10	PM 2.5	Percent of PM 10 which is PM 2.5
2005	8.13	8.01	99
2006	8.21	8.10	99
2007	8.30	8.18	99
2008	8.38	8.26	99
2010	8.54	8.42	99

Source: Appendix III, 2003 AQMP, Annual Average Emission Inventory

Construction Localized Significance Thresholds

Similarly, to develop a PM2.5 construction significance threshold for localized impacts, staff considered the PM2.5 contribution from fugitive sources and the PM2.5 contribution from combustion sources (construction equipment). As discussed in more detail in the following paragraphs, combustion emissions from the construction equipment contribute a larger portion of the total PM2.5 emissions from construction operations than fugitive sources.

Staff then reviewed the 2003 AQMP, Appendix III fugitive PM inventory for construction and demolition to obtain the PM10 and PM2.5 compositions. Table 4 shows the total PM10 and PM2.5 inventories for construction activities for the years 2005 through 2010. As can be seen in Table 4, over the five-year timeframe, the fraction of PM10 that consists of PM2.5 is consistently 21 percent. Multiplying the fugitive PM2.5 percent fraction of

PM10 by the existing construction PM10 LST, 10.4 μg/m^3, produces a result of approximately 2.2 μg/m^3.

TABLE 4

Total Fugitive PM Inventory (Tons/Day)

Year	PM 10	PM 2.5	Percent of PM 10 which is PM 2.5
2005	42.7	8.91	21
2006	43.66	9.11	21
2007	44.6	9.3	21
2008	45.54	9.5	21
2010	47.44	9.9	21

Source: Appendix III, 2003 AQMP, Annual Average Emission Inventory

Off-road construction equipment, however, also contributes combustion PM as well as fugitive PM. To determine the contribution of PM2.5 from construction equipment combustion emissions, staff performed dispersion modeling using the ISCST3 dispersion model for one-, two-, and five-acre construction scenarios. The construction scenarios were developed from construction site surveys conducted in connection with staff's original LST proposal. Combustion sources were modeled as adjacent five-meter volume sources and fugitive sources were modeled as adjacent one-meter area sources. Worst-case meteorological data from the West Los Angeles source receptor area were used and receptors were placed at 25, 50, 100, 200, and 500 meter distances from the construction site. Using CARB speciation data, it was assumed that 21 percent of fugitive dust PM10 is comprised of PM2.5 and 89 percent of off-road equipment combustion PM10 emissions are comprised of PM2.5 (based 2003 AQMP inventories, see Table 5).

TABLE 5

Combustion PM Inventory from Off-Road Equipment (Tons/Day)

Year	PM 10	PM 2.5	Percent of PM 10 which is PM 2.5
2005	11.95	10.64	89
2006	11.61	10.33	89
2007	11.2	9.97	89
2008	10.93	9.71	89
2010	10.26	9.09	89

Source: Appendix III, 2003 AQMP, Annual Average Emission Inventory

The modeling results showed that combustion PM2.5 from off-road equipment comprise approximately 75 to 100 percent of the total PM2.5 emissions from construction activities. Further, the PM2.5 contribution from fugitive sources is dependant on the construction phase. For example, the modeling showed that the demolition and site preparation phases have the highest fugitive PM2.5 contribution to the overall results, whereas, the building and asphalt paving phases contribute the most combustion PM2.5 to the overall results.

The modeling results indicate that the contribution of off-road combustion PM2.5 emissions can be three to four times higher than the contribution of PM2.5 from fugitive sources. Based on this result, staff recommends that the PM2.5 fugitive dust component be adjusted upward by approximately four times to account for the PM2.5 emissions from the construction equipment. As a result, staff is recommending a PM2.5 construction LST of 10.4 $\mu g/m^3$, the same as the construction LST for PM10. Finally, an exceedance of either the PM10 construction LST or the PM2.5 construction LST is a significant adverse localized air quality impact.

Regional Emission Threshold of Significance for PM 2.5

Emissions that exceed the regional significance thresholds are mass daily emissions that may have significant adverse regional effects and are the air quality significance thresholds with which most CEQA practitioners are familiar.

Table 6
Regional Air Quality Significance Thresholds

Mass Daily Thresholds[a]		
Pollutant	**Construction** [b]	Operation [c]
NOx	100 lbs/day	55 lbs/day
VOC	75 lbs/day	55 lbs/day
PM10	150 lbs/day	150 lbs/day
SOx	150 lbs/day	150 lbs/day
CO	550 lbs/day	550 lbs/day
Lead	3 lbs/day	3 lbs/day

The following subsection describes the proposed PM2.5 regional significance thresholds for both operation and construction.

Establishing Regional Significance Thresholds

PM emissions also affect air quality on a regional basis. When fugitive dust enters the atmosphere, the larger particles of dust typically fall quickly to the ground, but smaller particles less than 10 microns in diameter may remain suspended for longer periods, giving the particles time to travel across a regional area and affecting receptors at some distance from the original emissions source. Fine PM2.5 particles have even longer atmospheric residency times. Staff is recommending a PM2.5 regional significance threshold based on a recent EPA proposal, as explained in the following paragraphs.

On September 8, 2005, EPA published in the Federal Register "Proposed Rule to Implement the Fine Particle National Ambient Air Quality Standards," which proposed a significant emission rate for PM2.5 of 10 tons per year. Staff is proposing to use EPA's significant emission rate for PM2.5 to develop the daily mass emission regional significance threshold for PM2.5. Converting the annual rate, 10 tons, into a daily rate produces a daily rate of approximately 55 pounds per day. A similar approach was used to derive the operational regional significance thresholds for NO2 and VOC. NO2 and VOC operational regional significance thresholds were derived by using the NOx/VOC emission rate that defined a major source in the South Coast Air Basin, 10 tons per year. Converting the annual emissions rate into a daily rate resulted in a regional operational significance threshold of 55 pounds per day for each pollutant. Similar to the regional significance threshold for PM10 of 150 pounds per day, the proposed PM2.5 regional significance threshold of 55 pounds per day would apply to both construction and operation.

Conclusion

In this document staff identified a methodology to indirectly calculate PM2.5 emissions for a CEQA or NEPA air quality analysis, to be used until such time as PM2.5 emission factors are available, which will allow the CEQA practitioner to calculate PM2.5 emissions directly. In addition, PM2.5 construction and operation LSTs have been identified to address localized impacts. The PM2.5 LSTs will be used to develop look-up tables for projects five acres in size or smaller, similar to those prepared for PM10, nitrogen dioxide (NO2), and carbon monoxide (CO). As with the other pollutants, the PM2.5 look-up tables can be used as a screening procedure to determine whether or not small projects (less than or equal to five acres) will generate significant adverse localized air quality impacts. Screening procedures are by design conservative, that is, the predicted impacts tend to overestimate the actual impacts. If the predicted impacts are acceptable using the LST look-up tables, then a more detailed evaluation is not necessary. However, if the predicted impacts are significant, then the project proponent may wish to perform a more detailed emission and/or modeling analysis before concluding that the impacts are significant. Project proponents are not required to use this LST procedure; and may complete site specific modeling instead. Site-specific modeling is required for projects larger than five acres.

CAPCOA

CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION

CEQA & Climate Change

Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act

January 2008

Disclaimer

The California Air Pollution Control Officers Association (CAPCOA) has prepared this white paper consideration of evaluating and addressing greenhouse gas emissions under the California Environmental Quality Act (CEQA) to provide a common platform of information and tools to support local governments.

This paper is intended as a resource, not a guidance document. It is not intended, and should not be interpreted, to dictate the manner in which an air district or lead agency chooses to address greenhouse gas emissions in the context of its review of projects under CEQA.

This paper has been prepared at a time when California law has been recently amended by the Global Warming Solutions Act of 2006 (AB 32), and the full programmatic implications of this new law are not yet fully understood. There is also pending litigation in various state and federal courts pertaining to the issue of greenhouse gas emissions. Further, there is active federal legislation on the subject of climate change, and international agreements are being negotiated. Many legal and policy questions remain unsettled, including the requirements of CEQA in the context of greenhouse gas emissions. This paper is provided as a resource for local policy and decision makers to enable them to make the best decisions they can in the face of incomplete information during a period of change.

Finally, this white paper reviews requirements and discusses policy options, but it is not intended to provide legal advice and should not be construed as such. Questions of legal interpretation, particularly in the context of CEQA and other laws, or requests for advice should be directed to the agency's legal counsel.

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Principal Authors

Greg Tholen, BAAQMD
Dave Vintze, BAAQMD
Jean Getchell, MBUAPCD
Matt Jones, YSAQMD
Larry Robinson, SMAQMD
Ron Tan, SBCAPCD

Editor

Barbara Lee, NSAPCD

Reviewers

CAPCOA Climate Protection Committee

Barbara Lee (NSCAPCD), Chair

Larry Allen, SLOCPCD
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Karen Brooks, SLOCAPCD
Chris Brown, MCAQMD
Tom Christofk, PCAPCD
Jorge DeGuzman, SMAQMD
Mat Ehrhardt, YSAQMD
Jean Getchell, MBUAPCD
Larry Greene, SMAQMD
Henry Hilken, BAAQMD
Alan Hobbs, PCAPCD
Jim Jester, SMAQMD
Dave Jones, KCAPCD
Tom Jordan, SJVUAPCD
Tom Murphy, SBAPCD
Don Price, VCAPCD
Jean Roggenkamp, BAAQMD
Ana Sandoval, BAAQMD
Amy Taketomo, MBUAPCD
Tim Taylor, SMAQMD
Mike Villegas, VCAPCD
David Vintze, BAAQMD
Dave Warner, SJVUAPCD
Jill Whynot, SCAQMD
John Yu, CAPCOA
Mel Zeldin, CAPCOA

CAPCOA Planning Managers:
CEQA & Climate Change Subcommittee

Dave Vintze (BAAQMD), Chair
Greg Tholen (BAAQMD), Project Manager

Charles Anderson, SMAQMD
Aeron Arlin Genet, SLOCAPCD
Jean Getchell, MBUAPCD
Melissa Guise, SLOCAPCD
Matt Jones, YSAQMD
Barbara Lee, NSCAPCD
Ryan Murano, NSAQMD
Tom Murphy, SBCAPCD
Susan Nakamura, SCAQMD
Larry Robinson, SMAQMD
Jean Roggenkamp, BAAQMD
Ana Sandoval, BAAQMD
Ron Tan, SBCAPCD
Brigette Tollstrup, SMAQMD
Jill Whynot, SCAQMD

External Reviewers

James Goldstene, CARB
Annmarie Mora, CARB
Terri Roberts, OPR

Proofing & Layout

Jake Toolson, CAPCOA
John Yu, CAPCOA

Contract Support

Jones & Stokes, Sacramento, CA *(analysis of non-zero threshold approaches)*
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List of Acronyms and Abbreviations

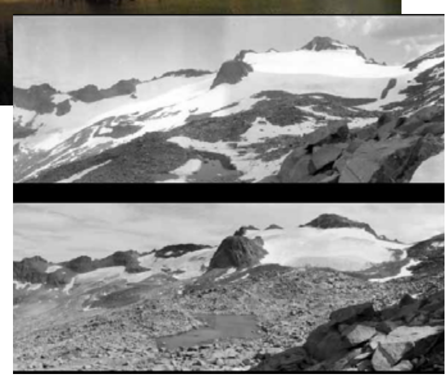
Acronym/ Abbreviation	Meaning
AB 32	Assembly Bill 32 Global Warming Solutions Act of 2006
AG	Attorney General
ARB	Air Resources Board
ASTM	American Society of Testing and Material
BAAQMD	Bay Area Air Quality Management District
BAU	Business as Usual
BEES	Building for Environmental and Economic Sustainability
Calfire	California Fire
Caltrans	California Department of Transportation
CAP	Criteria Air Pollutants
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resource Board
CAT	Climate Action Team
CCAP	Center for Clean Air Policy
CCAR	California Climate Action Registry
CDFA	California Department of Food and Agriculture
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CF	Connectivity Factor
CH_4	Methane
CIWMB	California Integrated Waste Management Board
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CNG	Compressed Natural Gas
CPUC	California Public Utilities Commission
CUFR	California Urban Forestry
DGS	Department of General Services
DOE	U.S. Department of Energy
DOF	Department of Finance
DPF	Diesel Particulate Filter
DWR	Department of Water Resources
E85	85% Ethanol
EEA	Massachusetts Executive Office of Energy and Environmental Affairs
EERE	Energy Efficiency and Renewable Energy
EIR	Environmental Impact Report
EOE	Encyclopedia of Earth
EPA	U.S. Environmental Protection Agency
ETC	Edmonton Trolley Coalition
EV	Electric Vehicles
FAR	Floor Area Ratio

GHG	Greenhouse Gas
GGEP	Greenhouse Gas Emissions Policy
GGRP	Greenhouse Gas Reduction Plan
GP	General Plan
GWP	Global Warming Potential
IGCC	Integrated Gasification Combined Cycle
IOU	Investor Owned Utility
IPCC	International Panel on Climate Change
IT	Information Technology
ITE	Institute of Transportation Engineers
J&S	Jones & Stokes
km	Kilometer
LandGem	Landfill Gas Emissions Model
LEED	Leadership in Energy and Environmental Design
LNG	Liquefied Natural Gas
MBUAPCD	Monterey Bay Unified Air Pollution Control District
MEPA	Massachusetts Environmental Policy Act
MND	Mitigated Negative Declaration
MMT CO_2e	Million Metric Tons Carbon Dioxide Equivalent
MW	Megawatts
N_2O	Nitrous Oxide
NACAA	National Association Clean Air Agencies
ND	Negative Declaration
NEV	Neighborhood Electric Vehicle
NIST	National Institute of Standards and Technology
NO_X	Oxides of Nitrogen
NREL	National Renewable Energy Laboratory
NSCAPCD	Northern Sonoma County Air Pollution Control District
NSR	New Source Review
OPR	State Office of Planning and Research
PFC	Perfluorocarbon
PG&E	Pacific Gas & Electric
POU	Publicly Owned Utility
PM	Particulate Mater
RoadMod	Road Construction Emissions Model
ROG	Reactive Organic Gas
RPS	Renewable Portfolio Standards
RTP	Regional Transportation Plan
S-3-05	Executive Order S-3-05
SB	Senate Bill
SBCAPCD	Santa Barbara County Air Pollution Control District
SCAQMD	South Coast Air Quality Management District
SCM	Sustainable Communities Model
SIP	State Implementation Plan
SJVAPCD	San Joaquin Valley Unified Air Pollution Control District
SLOCAPCD	San Luis Obispo County Air Pollution Control District

SMAQMD	Sacramento Metropolitan Air Quality Management District
SMUD	Sacramento Municipal Utilities District
SO_X	Sulfur Oxides
SP	Service Population
SRI	Solar Reflectance Index
SWP	State Water Project
TAC	Toxic Air Contaminants
TBD	To Be Determined
TDM	Transportation Demand Management
TMA	Transportation Management Association
THC	Total Hydrocarbon
UC	University of California
ULEV	Ultra Low Emission Vehicle
UNFCCC	United Nations Framework Convention on Climate Change
URBEMIS	Urban Emissions Model
USGBC	U.S. Green Building Council
VMT	Vehicle Miles Traveled
VTPI	Victoria Transit Policy
YSAQMD	Yolo-Solano Air Quality Management District

Introduction

The California Environmental Quality Act (CEQA) requires that public agencies refrain from approving projects with significant adverse environmental impacts if there are feasible alternatives or mitigation measures that can substantially reduce or avoid those impacts. There is growing concern about greenhouse gas emissions[1] (GHG) and recognition of their significant adverse impacts on the world's climate and on our environment. In its most recent reports, the International Panel on Climate Change (IPCC) has called the evidence for this "unequivocal." In California, the passage of the Global Warming Solutions Act of 2006 (AB 32) recognizes the serious threat to the "economic well-being, public health, natural resources, and the environment of California" resulting from global warming. In light of our current understanding of these impacts, public agencies approving projects subject to the CEQA are facing increasing pressure to identify and address potential significant impacts due to GHG emissions. Entities acting as lead agencies in the CEQA process are looking for guidance on how to adequately address the potential climate change impacts in meeting their CEQA obligations.



Air districts have traditionally provided guidance to local lead agencies on evaluating and addressing air pollution impacts from projects subject to CEQA. Recognizing the need for a common platform of information and tools to support decision makers as they establish policies and programs for GHG and CEQA, the California Air Pollution Control Officers Association has prepared a white paper reviewing policy choices, analytical tools, and mitigation strategies.

This paper is intended to serve as a resource for public agencies as they establish agency procedures for reviewing GHG emissions from projects under CEQA. It considers the application of thresholds and offers three alternative programmatic approaches toward

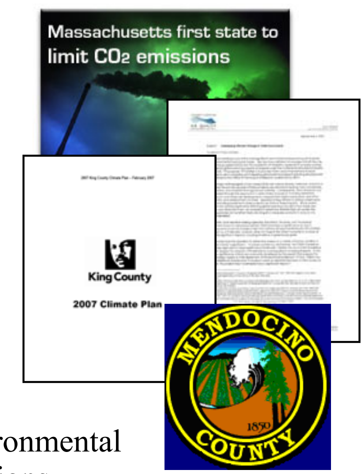
[1] Throughout this paper GHG, CO_2, CO_2e, are used interchangeably and refer generally to greenhouse gases but do not necessarily include all greenhouse gases unless otherwise specified.

determining whether GHG emissions are significant. The paper also evaluates tools and methodologies for estimating impacts, and summarizes mitigation measures. It has been prepared with the understanding that the programs, regulations, policies, and procedures established by the California Air Resources Board (CARB) and other agencies to reduce GHG emissions may ultimately result in a different approach under CEQA than the strategies considered here. The paper is intended to provide a common platform for public agencies to ensure that GHG emissions are appropriately considered and addressed under CEQA while those programs are being developed.

Examples of Other Approaches

Many states, counties, and cities have developed policies and regulations concerning greenhouse gas emissions that seek to require or promote reductions in GHG emissions through standards for vehicle emissions, fuels, electricity production/renewables, building efficiency, and other means. A few have developed guidance and are currently considering formally requiring or recommending the analysis of greenhouse gas emissions for development projects during their associated environmental processes. Key work in this area includes:

- Massachusetts Office of Energy and Environmental Affairs Greenhouse Gas Emissions Policy;
- King County, Washington, Executive Order on the Evaluation of Climate Change Impacts through the State Environmental Policy Act;
- Sacramento AQMD interim policy on addressing climate change in CEQA documents; and
- Mendocino AQMD updated guidelines for use during preparation of air quality impacts in Environmental Impact Reports (EIRs) or mitigated negative declarations.



The following paper evaluates options for lead agencies to ensure that GHG emissions are appropriately addressed as part of analyses under CEQA. It considers the use of significance thresholds, tools and methodologies for analyzing GHG emissions, and measures and strategies to avoid, reduce, or mitigate impacts.

Greenhouse Gas Significance Criteria

This white paper discusses three basic options air districts and lead agencies can pursue when contemplating the issues of CEQA thresholds for greenhouse gas emissions. This paper explores each path and discusses the benefits and disbenefits of each. The three basic paths are:

- No significance threshold for GHG emissions;

- GHG emissions threshold set at zero; or

- GHG threshold set at a non-zero level.

Each has inherent advantages and disadvantages. Air districts and lead agencies may believe the state or national government should take the lead in identifying significance thresholds to address this global impact. Alternatively, the agency may believe it is premature or speculative to determine a clear level at which a threshold should be set. On the other hand, air districts or lead agencies may believe that every GHG emission should be scrutinized and mitigated or offset due to the cumulative nature of this impact. Setting the threshold at zero will place all discretionary projects under the CEQA microscope. Finally, an air district or lead agency may believe that some projects will not benefit from a full environmental impact report (EIR), and may believe a threshold at some level above zero is needed.

This paper explores the basis and implications of setting no threshold, setting a threshold at zero and two primary approaches for those who may choose to consider a non-zero threshold. The first approach is grounded in statute (AB 32) and executive order (EO S-3-05) and explores four possible options under this scenario. The options under this approach are variations of ways to achieve the 2020 goals of AB 32 from new development, which is estimated to be about a 30 percent reduction from business as usual.

The second approach explores a tiered threshold option. Within this option, seven variations are discussed. The concepts explored here offer both quantitative and qualitative approaches to setting a threshold as well as different metrics by which tier cut-points can be set. Variations range from setting the first tier cut-point at zero to second-tier cut-points set at defined emission levels or based on the size of a project. It should be noted that some applications of the tiered threshold approach may require inclusion in a General Plan or adoption of enabling regulations or ordinances to render them fully effective and enforceable.

Greenhouse Gas Analytical Methodologies

The white paper evaluates various analytical methods and modeling tools that can be applied to estimate the greenhouse gas emissions from different project types subject to CEQA. In addition, the suitability of the methods and tools to characterize accurately a project's emissions is discussed and the paper provides recommendations for the most appropriate methodologies and tools currently available.

The suggested methodologies are applied to residential, commercial, specific plan and general plan scenarios where GHG emissions are estimated for each example. This chapter also discusses estimating emissions from solid waste facilities, a wastewater treatment plant, construction, and air district rules and plans.

Another methodology, a service population metric, that would measure a project's overall GHG efficiency to determine if a project is more efficient than the existing statewide average for per capita GHG emissions is explored. This methodology may be more directly correlated to a project's ability to help achieve objectives outlined in AB 32, although it relies on establishment of an efficiency-based significance threshold. The subcommittee believes this methodology may eventually be appropriate to evaluate the long-term GHG emissions from a project in the context of meeting AB 32 goals. However, this methodology will need further work and is not considered viable for the interim guidance presented in this white paper.

Greenhouse Gas Mitigation Measures

Common practice in environmental protection is first to avoid, then to minimize, and finally to compensate for impacts. When an impact cannot be mitigated on-site, off-site mitigation can be effectively implemented in several resource areas, either in the form of offsetting the same impact or preserving the resource elsewhere in the region.

This white paper describes and evaluates currently available mitigation measures based on their economic, technological and logistical feasibility, and emission reduction effectiveness. The potential for secondary impacts to air quality are also identified for each measure. A summary of current rules and regulations affecting greenhouse gas emissions and climate change is also provided.

Reductions from transportation related measures (e.g., bicycle, pedestrian, transit, and parking) are explored as a single comprehensive approach to land use. Design measures that focus on enhancing alternative transportation are discussed. Mitigation measures are identified for transportation, land use/building design, mixed-use development, energy efficiency, education/social awareness and construction.

Purpose

CEQA requires the avoidance or mitigation of significant adverse environmental impacts where there are feasible alternatives available. The contribution of GHG to climate change has been documented in the scientific community. The California Global Warming Solutions Act of 2006 (AB 32) mandates significant reductions in greenhouse gases (GHG); passage of that law has highlighted the need to consider the impacts of GHG emissions from projects that fall under the jurisdiction of the California Environmental Quality Act (CEQA). Because we have only recently come to fully recognize the potential for significant environmental impacts from GHG, most public agencies have not yet established policies and procedures to consider them under CEQA. As a result, there is great need for information and other resources to assist public agencies as they develop their programs.

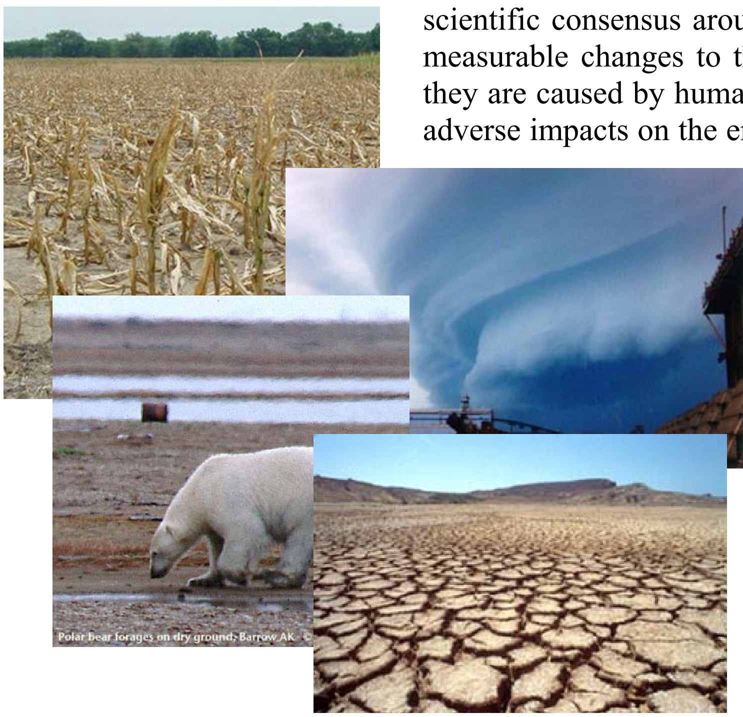
Air districts have historically provided guidance to local governments on the evaluation of air pollutants under CEQA. As local concern about climate change and GHG has increased, local governments have requested guidance on incorporating analysis of these impacts into local CEQA review. The California Air Pollution Control Officers Association (CAPCOA), in coordination with the CARB, the Governor's Office of Planning and Research (OPR) and two environmental consulting firms, has harnessed the collective expertise to evaluate approaches to analyzing GHG in CEQA. The purpose of this white paper is to provide a common platform of information and tools to address climate change in CEQA analyses, including the evaluation and mitigation of GHG emissions from proposed projects and identifying significance threshold options.

CEQA requires public agencies to ensure that potentially significant adverse environmental effects of discretionary projects are fully characterized, and avoided or mitigated where there are feasible alternatives to do so. Lead agencies have struggled with how best to identify and characterize the magnitude of the adverse effects that individual projects have on the global-scale phenomenon of climate change, even more so since Governor Schwarzenegger signed Executive Order S-3-05 and the state Legislature enacted The Global Warming Solutions Act of 2006 (AB 32). There is now a resounding call to establish procedures to analyze and mitigate greenhouse gas (GHG) emissions. The lack of established thresholds does not relieve lead agencies of their responsibility to analyze and mitigate significant impacts, so many of these agencies are seeking guidance from state and local air quality agencies. This white paper addresses issues inherent in establishing CEQA thresholds, evaluates tools, catalogues mitigation measures and provides air districts and lead agencies with options for incorporating climate change into their programs.

Background

National and International Efforts

International and Federal legislation have been enacted to deal with climate change issues. The Montreal Protocol was originally signed in 1987 and substantially amended in 1990 and 1992. In 1988, the United Nations and the World Meteorological Organization established the IPCC to assess the scientific, technical and socioeconomic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation. The most recent reports of the IPCC have emphasized the scientific consensus around the evidence that real and measurable changes to the climate are occurring, that they are caused by human activity, and that significant adverse impacts on the environment, the economy, and human health and welfare are unavoidable.



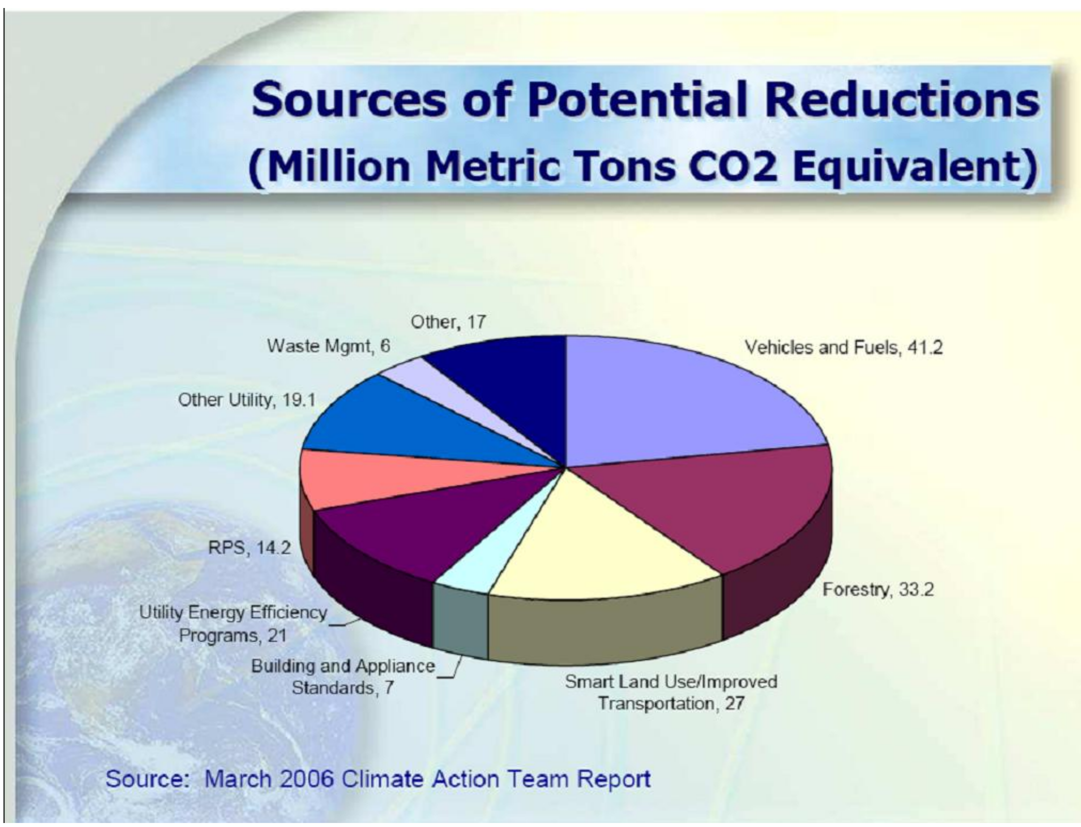
In October 1993, President Clinton announced his Climate Change Action Plan, which had a goal to return greenhouse gas emissions to 1990 levels by the year 2000. This was to be accomplished through 50 initiatives that relied on innovative voluntary partnerships between the private sector and government aimed at producing cost-effective reductions in greenhouse gas emissions. On March 21, 1994, the United States joined a number of countries around the world in signing the United Nations Framework Convention on Climate Change (UNFCCC). Under the Convention, governments agreed to gather and share information on greenhouse gas emissions, national policies, and best practices; launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and cooperate in preparing for adaptation to the impacts of climate change.

These efforts have been largely policy oriented. In addition to the national and international efforts described above, many local jurisdictions have adopted climate change policies and programs. However, thus far little has been done to assess the significance of the affects new development projects may have on climate change.

Executive Order S-3-05

On June 1, 2005, Governor Schwarzenegger issued Executive Order S-3-05 (S-3-05). It included the following GHG emission reduction targets: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; by 2050, reduce GHG emissions to 80 percent below 1990 levels. To meet the targets, the Governor directed the Secretary of the California Environmental Protection Agency to coordinate with the Secretary of the Business, Transportation and Housing Agency, Secretary of the Department of Food and Agriculture, Secretary of the Resources Agency, Chairperson of the CARB, Chairperson of the Energy Commission and President of the Public Utilities Commission on development of a Climate Action Plan.

The Secretary of CalEPA leads a Climate Action Team (CAT) made up of representatives from the agencies listed above to implement global warming emission reduction programs identified in the Climate Action Plan and report on the progress made toward meeting the statewide greenhouse gas targets that were established in the Executive Order.



SOURCE: ARB 2007

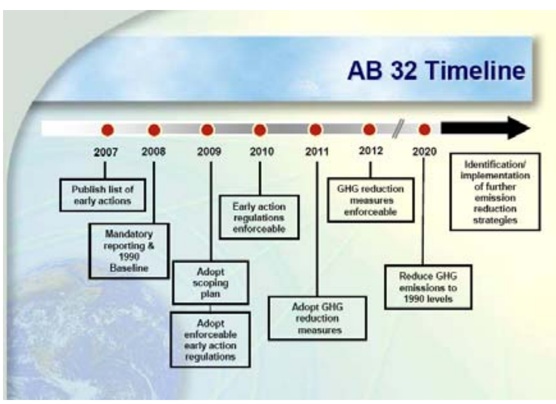
In accord with the requirements of the Executive Order, the first report to the Governor and the Legislature was released in March 2006 and will be issued bi-annually thereafter. The CAT Report to the Governor contains recommendations and strategies to help ensure the targets in Executive Order S-3-05 are met.

California Global Warming Solutions Act of 2006 (AB 32)

In 2006, the California State Legislature adopted the California Global Warming Solutions Act of 2006. AB 32 establishes a cap on statewide greenhouse gas emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emissions levels. AB 32 charges the California Air Resources Board (CARB), the state agency charged with regulating statewide air quality, with implementation of the act. Under AB 32, greenhouse gases are defined as: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

The regulatory steps laid out in AB 32 require CARB to: adopt early action measures to reduce GHGs; to establish a statewide greenhouse gas emissions cap for 2020 based on 1990 emissions; to adopt mandatory reporting rules for significant source of greenhouse gases; and to adopt a scoping plan indicating how emission reductions will be achieved via regulations, market mechanisms and other actions; and to adopt the regulations needed to achieve the maximum technologically feasible and cost-effective reductions in greenhouse gases.

AB 32 requires that by January 1, 2008, the State Board shall determine what the statewide greenhouse gas emissions inventory was in 1990, and approve a statewide greenhouse gas emissions limit that is equivalent to that level, to be achieved by 2020. While the level of 1990 GHG emissions has not yet been approved, CARB's most recent emission inventory indicates that California had annual emissions of 436 million metric tons of carbon dioxide equivalent (MMT CO_2e) in 1990 and 497 MMT CO_2e in 2004.



SOURCE: ARB 2007

The regulatory timeline laid out in AB 32 requires that by July 1, 2007, CARB adopt a list of discrete early action measures, or regulations, to be adopted and implemented by January 1, 2010. These actions will form part of the State's comprehensive plan for achieving greenhouse gas emission reductions. In June 2007, CARB adopted three discrete early action measures. These three new proposed regulations meet the definition of "discrete early action greenhouse gas reduction measures," which include the following: a low carbon fuel standard; reduction of HFC-134a emissions from non-professional servicing of motor vehicle air conditioning systems; and improved landfill methane capture. CARB estimates that by 2020, the reductions from those three discrete early action measures would be approximately 13-26 MMT CO_2e.

CARB evaluated over 100 possible measures identified by the CAT for inclusion in the list of discrete early action measures. On October 25, 2007 CARB gave final approval to the list of Early Action Measures, which includes nine discrete measures and 35 additional measures, all of which are to be enforceable by January 1, 2010. AB 32 requires that by January 1, 2009, CARB adopt a scoping plan indicating how emission reductions will be achieved via regulations, market mechanisms and other actions.

<u>Senate Bill 97</u>

Senate Bill (SB) 97, signed in August 2007, acknowledges that climate change is an important environmental issue that requires analysis under CEQA. This bill directs the OPR to prepare, develop, and transmit to the Resources Agency guidelines for the feasible mitigation of GHG emissions or the effects of GHG emissions, by July 1, 2009. The Resources Agency is required to certify or adopt those guidelines by January 1, 2010. This bill also protects projects funded by the Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act of 2006, or the Disaster Preparedness and Flood Protection Bond Act of 2006 (Proposition 1B or 1E) from claims of inadequate analysis of GHG as a legitimate cause of action. This latter provision will be repealed on January 1, 2010. Thus, this "protection" is highly limited to a handful of projects and for a short time period.

The Role of Air Districts in the CEQA Process

Air districts assume one of three roles in the CEQA process. They may be lead agencies when they are adopting regulations and air quality plans. In some instances, they can also be a lead agency when approving permits to construct or operate for applicants subject to district rules. However, in many cases where an air district permit is involved, another agency has broader permitting authority over the project and assumes the role of lead agency. In these situations, the air district becomes what is referred to as a responsible agency under CEQA. When CEQA documents are prepared for projects that do not involve discretionary approval of a district regulation, plan or permit, the air district may assume the role of a concerned or commenting agency. In this role, it is typical for air districts to comment on CEQA documents where there may be air quality-related adverse impacts, such as projects that may create significant contributions to existing violations of ambient standards, cause a violation of an ambient standard or create an exposure to toxic air contaminants or odors. In some cases, the air district may also act in an "advisory" capacity to a lead agency early on in its review of an application for a proposed development project.

A few air districts in California began developing significance thresholds for use in CEQA analyses in the late 1980's and early 1990's. By the mid-1990's most air districts had developed CEQA thresholds for air quality analyses. Many of the districts have included in their guidance the analysis of rule development and permits that may be subject to CEQA.

What is Not Addressed in this Paper

Impacts of Climate Change to a Project

The focus of this paper is addressing adverse impacts to climate change and the ability to meet statewide GHG reduction goals caused by proposed new land development projects. CEQA also requires an assessment of significant adverse impacts a project might cause by bringing development and people into an area affected by climate change (CEQA Guidelines §15126.2). For example, an area that experiences higher average temperatures due to climate change may expose new development to more frequent exceedances and higher levels of ozone concentrations. Alternatively, a rise in sea level brought on by climate change may inundate new development locating in a low-lying area. The methodologies, mitigation and threshold approaches discussed in this paper do not specifically address the potential adverse impacts resulting from climate change that may affect a project.

Impacts from Construction Activity

Although construction activity has been addressed in the analytical methodologies and mitigation chapters, this paper does not discuss whether any of the threshold approaches adequately addresses impacts from construction activity. More study is needed to make this assessment or to develop separate thresholds for construction activity. The focus of this paper is the long-term adverse operational impacts of land use development.

Introduction

Any analysis of environmental impacts under CEQA includes an assessment of the nature and extent of each impact expected to result from the project to determine whether the impact will be treated as significant or less than significant. CEQA gives lead agencies discretion whether to classify a particular environmental impact as significant. "The determination of whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved," ref: CEQA Guidelines §15064(b) ("Guidelines"). Ultimately, formulation of a standard of significance requires the lead agency to make a policy judgment about where the line should be drawn distinguishing adverse impacts it considers significant from those that are not deemed significant. This judgment must, however, be based on scientific information and other factual data to the extent possible (Guidelines §15064(b)).

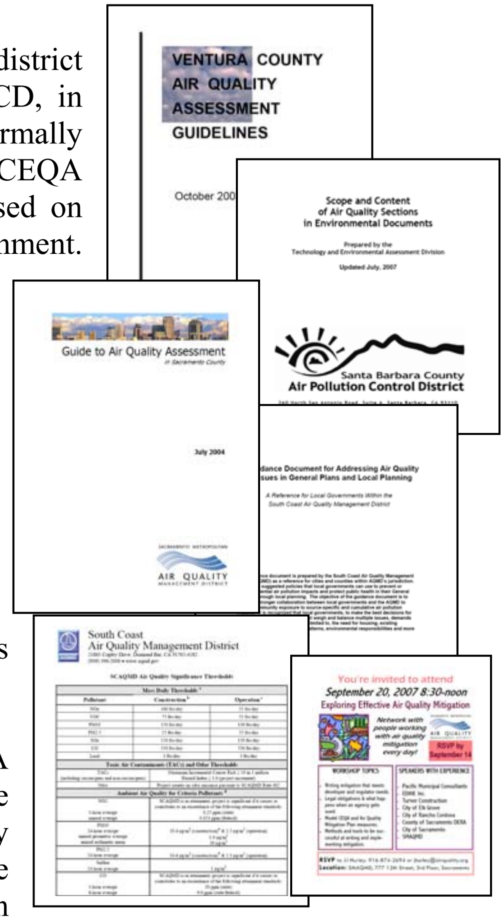
CEQA does not require that agencies establish thresholds of significance. Guidelines §15064.7(a) encourages each public agency "…to develop and publish thresholds of significance that the agency uses in the determination of the significance of environmental effects. A threshold of significance is an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which normally means the effect will be determined to be less than significant."

Once such thresholds are established, an impact that complies with the applicable threshold will "normally" be found insignificant and an impact that does not comply with the applicable threshold will "normally" be found significant.

Additionally, Guidelines §15064.7(b) requires that if thresholds of significance are adopted for general use as part of the lead agency's environmental review process they must be adopted by ordinance, resolution, rule or regulation, and developed through a public review process and be supported by substantial evidence.

While many public agencies adopt regulatory standards as thresholds, the standards do not substitute for a public agency's use of careful judgment in determining significance. They also do not replace the legal standard for significance (i.e., if there is a fair argument, based on substantial evidence in light of the whole record that the project may have a significant effect, the effect should be considered significant) (Guidelines §15064(f)(1). Also see *Communities for a Better Environment v. California Resource Agency* 103 Cal. App. 4th 98 (2002)). In other words, the adoption of a regulatory standard does not create an irrebuttable presumption that impacts below the regulatory standard are less than significant.

Summary of CEQA Thresholds at Air Districts



This section briefly summarizes the evolution of air district CEQA significance thresholds. Ventura County APCD, in 1980, was the first air district in California that formally adopted CEQA significance thresholds. Their first CEQA assessment document contained impact thresholds based on project type: residential, nonresidential, and government. Then, as now, the District's primary CEQA thresholds applied only to ROG and NO_x. The 1980 Guidelines did not address other air pollutants.

Santa Barbara County APCD and the Bay Area AQMD adopted thresholds in 1985. The South Coast AQMD recommended regional air quality thresholds in 1987 for CO, SO_2, NO_2, particulates, ROG, and lead. Most of the other California air districts adopted CEQA guidance and thresholds during the 1990's. Air districts have updated their thresholds and guidelines several times since they were first published.

Originally, most districts that established CEQA thresholds focused on criteria pollutants for which the district was nonattainment and the thresholds only addressed project level impacts. Updates during the 1990's began to add additional air quality impacts such as odors, toxic air contaminants and construction. Several air districts also developed thresholds for General Plans that relied on an assessment of the plan consistency with the district's air quality plans. A consistency analysis involves comparing the project's land use to that of the general plan and the population and employment increase to the forecasts underlying the assumptions used to develop the air quality plan.

Most air district thresholds for CEQA are based on the threshold for review under the New Source Review (NSR). The NSR threshold level is set by district rule and is different depending on the nonattainment classification of the air district. Areas with a less severe classification have a higher NSR trigger level while the most polluted areas have the lowest NSR trigger level. Some districts, such as Ventura County APCD, have significantly lower CEQA thresholds that are not tied to the NSR requirements. In Ventura, one set of CEQA thresholds is 25 pounds per day for all regions of Ventura County, except the Ojai Valley. The second set of CEQA thresholds was set at 5 pounds per day for the Ojai Valley.

The Sacramento Metropolitan AQMD bases its thresholds for ozone precursors on the projected land use share of emission reductions needed for attainment. The emission reductions needed to reach attainment are based on commitments made in the state implementation plan (SIP) prepared for the federal clean air act.

CEQA Considerations in Setting Thresholds

Public agencies use significance thresholds to disclose to their constituents how they plan on evaluating and characterizing the severity of various environmental impacts that could be associated with discretionary projects that they review. Significance thresholds are also used to help identify the level of mitigation needed to reduce a potentially significant impact to a less than significant level and to determine what type of an environmental document should be prepared for a project; primarily a negative declaration, mitigated negative declaration or an environmental impact report.

While public agencies are not required to develop significance thresholds, if they decide to develop them, they are required to adopt them by ordinance, resolution, rule or regulation through a public process. A lead agency is not restrained from adopting any significance threshold it sees as appropriate, as long as it is based on substantial evidence. CEQA Guidelines §15064.7 encourages public agencies to develop and publish significance thresholds that are identifiable, quantitative, qualitative or performance level that the agency uses in the determination of the significance of environmental effects. The courts have ruled that a "threshold of significance" for a given environmental effect is simply that level at which the lead agency finds the effects of the project to be significant.

Before an agency determines its course with regard to climate change and CEQA, it must be made clear that a threshold, or the absence of one, will not relieve a lead agency from having to prepare an EIR or legal challenges to the adequacy of an analysis leading to a conclusion, or lack of a conclusion, of significance under CEQA. CEQA has generally favored the preparation of an EIR where there is any substantial evidence to support a fair argument that a significant adverse environmental impact may occur due to a proposed project. This paper explores three alternative approaches to thresholds, including a no threshold option, a zero threshold option and a non-zero threshold option.

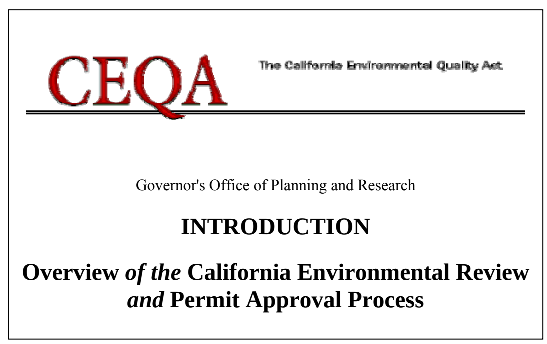
Fair Argument Considerations

Under the CEQA fair argument standard, an EIR must be prepared whenever it can be fairly argued, based on substantial evidence in the administrative record, that a project may have a significant adverse effect on the environment. "Substantial evidence" comprises "enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached." (Guidelines §15384) This means that if factual information is presented to the public agency that there is a reasonable possibility the project could have a significant effect on the environment, an EIR is required even if the public agency has information to the contrary (Guidelines §15064 (f)).

The courts have held that the fair argument standard "establishes a low threshold for initial preparation of an EIR, which reflects a preference for resolving doubts in favor of environmental review." (*Santa Teresa Citizen Action Group v. City of San Jose* [2003] 114 Cal.App.4th 689) Although the determination of whether a fair argument exists is made by the public agency, that determination is subject to judicial scrutiny when challenged in litigation. When the question is whether an EIR should have been prepared, the court will review the administrative record for factual evidence supporting a fair argument.

The fair argument standard essentially empowers project opponents to force preparation of an EIR by introducing factual evidence into the record that asserts that the project may have a significant effect on the environment. This evidence does not need to be conclusive regarding the potential significant effect.

In 1998, the Resources Agency amended the State CEQA Guidelines to encourage the use of thresholds of significance. Guidelines §15064 (h) provided that when a project's impacts did not exceed adopted standards, the impacts were to be considered less than significant. The section went on to describe the types of adopted standards that were to be considered thresholds. Guidelines § 15064.7 provided that agencies may adopt thresholds of significance to guide their determinations of significance. Both of these sections were challenged when environmental groups sued the Resources Agency in 2000 over the amendments. The trial court concluded that §15064.7 was proper, if it was applied in the context of the fair argument standard.


CEQA The California Environmental Quality Act

Governor's Office of Planning and Research

INTRODUCTION

Overview *of the* California Environmental Review *and* Permit Approval Process

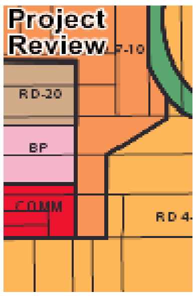
At the appellate court level, §15064(h) was invalidated.[2] Establishing a presumption that meeting an adopted standard would avoid significant impacts was "inconsistent with controlling CEQA law governing the fair argument approach." The Court of Appeal explained that requiring agencies to comply with a regulatory standard "relieves the agency of a duty it would have under the fair argument approach to look at evidence beyond the regulatory standard, or in contravention of the standard, in deciding whether an EIR must be prepared. Under the fair argument approach, any substantial evidence supporting a fair argument that a project may have a significant environmental effect would trigger the preparation of an EIR." (*Communities for a Better Environment v. California Resources Agency* [2002] 103 Cal.App.4th 98)

[2] Prior §15064(h) has been removed from the State CEQA Guidelines. Current §15064(h) discusses cumulative impacts.

In summary, CEQA law does not require a lead agency to establish significance thresholds for GHG. CEQA guidelines encourage the development of thresholds, but the absence of an adopted threshold does not relieve the agency from the obligation to determine significance.

Defensibility of CEQA Analyses

The basic purposes of CEQA, as set out in the State CEQA Guidelines, include: (1) informing decision makers and the public about the significant environmental effects of proposed projects; (2) identifying ways to reduce or avoid those impacts; (3) requiring the implementation of feasible mitigation measures or alternatives that would reduce or avoid those impacts; and (4) requiring public agencies to disclose their reasons for approving any project that would have significant and unavoidable impacts (Guidelines §15002). CEQA is enforced through civil litigation over procedure (i.e., did the public agency follow the correct CEQA procedures?) and adequacy (i.e., has the potential for impacts been disclosed, analyzed, and mitigated to the extent feasible?).



The California Supreme Court has held that CEQA is "to be interpreted in such manner as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language." (*Friends of Mammoth v. Board of Supervisors* [1972] 8 Cal.3d 247, 259) Within that context, the role of the courts is to weigh the facts in each case and apply their judgment. Although the court may rule on the adequacy of the CEQA work, the court is not empowered to act in the place of the public agency to approve or deny the project for which the CEQA document was prepared. Further, the court's review is limited to the evidence contained in the administrative record that was before the public agency when it acted on the project.

Putting aside the issue of CEQA procedure, the defensibility of a CEQA analysis rests on the following concerns:

- whether the public agency has sufficiently analyzed the environmental consequences to enable decision makers to make an intelligent decision;
- whether the conclusions of the public agency are supported by substantial evidence in the administrative record; and
- whether the agency has made a good faith effort at the full disclosure of significant effects.

CEQA analyses need not be perfect or exhaustive -- the depth and breadth of the analysis is limited to what is "reasonably feasible." (Guidelines §15151) At the same time, the analysis "must include detail sufficient to enable those who did not participate in its preparation to understand and to consider meaningfully the issues raised by the proposed project." (Laurel Heights Improvement Assn. v. Regents of University of California (1988) 47 Cal.3d 376)

By itself, establishment of a GHG threshold will not insulate individual CEQA analyses from challenge. Defensibility depends upon the adequacy of the analysis prepared by the lead agency and the process followed. However, the threshold can help to define the boundaries of what is a reasonable analysis by establishing when an analysis will be required and the basic scope of that analysis. The threshold would attempt to define the point at which an analysis will be required and when a level of impact becomes significant, requiring preparation of an EIR. If the threshold includes recommendations for the method or methods of analysis, it can establish the minimum level of analysis to address this issue.

Considerations in Setting Thresholds for Stationary Source Projects

In many respects, the analysis of GHG emissions from stationary sources is much more straightforward than the analysis of land use patterns, forecasted energy consumption, and emissions from mobile sources. The reason is that, for the most part, the latter analyses depend largely on predictive models with myriad inputs and have a wider range of error. Emissions from stationary sources involve a greater reliance on mass and energy balance calculations and direct measurements of emissions from the same or similar sources. Energy demand is more directly tied to production, and even associated mobile source emissions will likely fall within narrower predictive windows.

Implementing CEQA Without a Threshold

A lead agency is not required to establish significance thresholds for GHG emissions from stationary sources. The lead agency may find that it needs more information or experience evaluating GHG from these types of projects to determine an appropriate significance threshold. As with other project types, the lead agency could conduct a project specific analysis to determine whether an environmental impact report is needed and to determine the level of mitigation that is appropriate. The agency might also rely on thresholds established for criteria pollutants as a screening method, and analyze GHG emissions (and require mitigation) from projects with emissions above the criteria pollutant thresholds. Over time, the agency could amass information and experience with specific project categories that would support establishing explicit thresholds. The lead agency may also choose to base local CEQA thresholds on state guidelines or on the category-specific reduction targets established by ARB in its scoping plan for implementing AB32. Resource constraints and other considerations associated with implementing CEQA without GHG thresholds for stationary sources would be similar to those outlined for other types of projects (see Chapter 5 – No Threshold Option).

Implementing CEQA with Threshold of Zero

A lead agency may find that any increase in GHG emissions is potentially significant under CEQA. The resources and other considerations for implementing a threshold of zero for stationary sources are the same as those outlined for other types of projects (see Chapter 6 – Zero Threshold Option).

Implementing CEQA with a Non-Zero Threshold

A lead agency may identify one or more non-zero thresholds for significance of emissions of GHG from stationary sources. The agency could elect to rely on existing thresholds for reviewing new or modified stationary sources of GHG, if the state or local air district has established any. The agency could also apply the threshold(s) established for non-stationary sources to GHG emissions from stationary sources. Significance thresholds could also be established by ordinance, rule, or policy for a given category of stationary sources; this approach is especially conducive to a tiered threshold approach. For example, the agency could establish significance and mitigation tiers for stationary compression-ignition diesel-fueled generators. Under such an approach, the project proponent could be first required to use a lower GHG-emitting power source if feasible, and if not, to apply mitigation based on the size of the generator and other defined considerations, such as hours of operation. Certain classes of generators could be found to be insignificant under CEQA (e.g., those used for emergency stand-by power only, with a limit on the annual hours of use). As with non-stationary projects, the goal of establishing non-zero thresholds is to maximize environmental protection, while minimizing resources used. Resource and other considerations outlined for non-stationary projects are applicable here (see Chapter 7 – Non-Zero Threshold Options).

Implementing CEQA with Different Thresholds for Stationary and Non-stationary Projects

Although a lead agency may apply the same thresholds to stationary and non-stationary projects, it is not required to do so. There are, in fact, some important distinctions between the two types of projects that could support applying different thresholds. The lead agency should consider the methods used to estimate emissions. Are the estimates a "best/worst reasonable scenario" or are they based on theoretical maximum operation? How accurate are the estimates (are they based on models, simulations, emission factors, source test data, manufacturer specifications, etc.)? To what extent could emissions be reduced through regulations after the project is constructed if they were found to be greater than originally expected (i.e., is it possible to retrofit emissions control technology onto the source(s) of GHG at a later date, how long is the expected project life, etc.)? Are there emission limits or emissions control regulations (such as New Source Review) that provide certainty that emissions will be mitigated? Generally, stationary source emissions are based on maximum emissions (theoretical or allowed under law or regulation), are more accurate, and are more amenable to retrofit at a later time than non-stationary source emissions. It is also more likely that category specific rules or some form of NSR will apply to stationary sources than non-stationary projects. Notwithstanding, it is almost always more effective and cost-efficient to apply emission reduction technology at the design phase of a project. There are, therefore, a number of considerations that need to be evaluated and weighed before establishing thresholds – and which may support different thresholds for stationary and non-stationary projects. Furthermore, the considerations may change over time as new regulations are established and as emissions estimation techniques and control technology evolves.

Direct GHG Emissions from Stationary Sources

The main focus of this paper has been the consideration of projects that do not, in the main, involve stationary sources of air pollution, because stationary source projects are generally a smaller percentage of the projects seen by most local land use agencies. That said, some discussion of stationary sources is warranted. As the broader program for regulating GHG from these sources is developed, the strategies for addressing them under CEQA will likely become more refined.

The primary focus of analysis of stationary source emissions has traditionally been those pollutants that are directly emitted by the source, whether through a stack or as fugitive releases (such as leaks). CAPCOA conducted a simplified analysis of permitting activity to estimate the number of stationary source projects with potentially significant emissions of greenhouse gases that might be seen over the course of a year. This analysis looked only at stationary combustion sources (such as boilers and generators), and only considered direct emissions. A lead agency under CEQA may see a different profile of projects than the data provided here suggest, depending on what other resources are affected by projects. In addition, air districts review like-kind replacements of equipment to ensure the new equipment meets current standards, but such actions might not constitute a project for many land use agencies or other media regulators. The data does provide a useful benchmark, however, for lead agencies to assess the order of magnitude of potential stationary source projects. A similar analysis is included for non-stationary projects in Chapter 7.

Table 1: Analysis of GHG Emissions from Stationary Combustion Equipment Permits[3]

	BAAQMD	SMAQMD	SJVUAPCD	SCAQMD
Total Applications for Year	1499	778	1535	1179
Affected at threshold of:				
900 metric tons/year	26	43	63	108
10,000 metric tons/year	7	5	26	8
25,000 metric tons/year	3	1	11	4

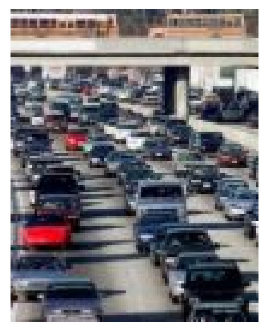
[3] District data varies based on specific local regulations and methodologies.

Emissions from Energy Use

In addition to the direct emissions of GHG from stationary projects, CEQA will likely need to consider the project's projected energy use. This could include an analysis of opportunities for energy efficiency, onsite clean power generation (e.g., heat/energy recovery, co-generation, geothermal, solar, or wind), and the use of dedicated power contracts as compared to the portfolio of generally available power. In some industries, water use and conservation may provide substantial GHG emissions reductions, so the CEQA analysis should consider alternatives that reduce water consumption and wastewater discharge. The stationary project may also have the opportunity to use raw or feedstock materials that have a smaller GHG footprint; material substitution should be evaluated where information is available to do so.

Emissions from Associated Mobile Sources

The stationary project will also include emissions from associated mobile sources. These will include three basic components: emissions from employee trips, emissions from delivery of raw or feedstock materials, and emissions from product transport. Employee trips can be evaluated using trip estimation as is done for non-stationary projects, and mitigations would include such measures as providing access to and incentives for use of public transportation, accessibility for bicycle and pedestrian modes of transport, employer supported car or vanpools (including policies such as guaranteed rides home, etc). Upstream and downstream emissions related to goods movement can also be estimated with available models. The evaluation will need to determine the extent of the transport chain that should be included (to ensure that all emissions in the chain have been evaluated and mitigated, but to avoid double counting). Mitigations could include direct actions by operators who own their own fleet, or could be implemented through contractual arrangements with independent carriers; again, the evaluation will need to consider how far up and down the chain mitigation is feasible and can be reasonably required.



Comparing Emissions Changes Across Pollutant Categories

The potential exists for certain GHG reduction measures to increase emissions of criteria and toxic pollutants known to cause or aggravate respiratory, cardiovascular, and other health problems. For instance, GHG reduction efforts such as alternative fuels and methane digesters may create significant levels of increased pollutants that are detrimental to the health of the nearby population (e.g.; particulate matter, ozone precursors, toxic air contaminants). Such considerations should be included in any CEQA analysis of a project's environmental impacts. While there are many win-win strategies that can reduce both GHG and criteria/toxic pollutant emissions, when faced with situations that involve tradeoffs between the two, the more immediate public health concerns that may arise from an increase in criteria or toxic pollutant emissions should take precedence. GHG emission reductions could be achieved offsite through other mitigation programs.

Introduction

Under state law, it is the purview of each lead agency to determine what, if any, significance thresholds will be established to guide its review of projects under CEQA. While the state does provide guidelines for implementing CEQA, the guidelines have left the decision of whether to establish thresholds (and if so, at what level) to individual lead agencies. Frequently, lead agencies consult with resource-specific agencies (such as air districts) for assistance in determining what constitutes a significant impact on that specific resource.

With the passage of AB 32, the ARB has broad authority to regulate GHG emissions as necessary to meet the emission reduction goals of the statute. This may include authority to establish emission reduction requirements for new land use projects, and may also enable them to recommend statewide thresholds for GHG under CEQA.

In developing this white paper, CAPCOA recognizes that, as the GHG reduction program evolves over time, GHG thresholds and other policies and procedures for CEQA may undergo significant revision, and that uniform statewide thresholds and procedures may be established. This paper is intended to serve as a resource for public agencies until such time that statewide guidance is established, recognizing that decisions will need to be made about GHG emissions from projects before such guidance is available. This paper is not, however, uniform statewide guidance. As stated before, it outlines several possible approaches without endorsing any one over the others.

Some air districts may choose to use this paper to support their establishment of guidance for GHG under CEQA, including thresholds. This paper does not, nor should it be construed to require a district to implement any of the approaches evaluated here. Decisions about whether to provide formal local guidance on CEQA for projects with GHG emissions, including the question of thresholds, will be made by individual district boards.

Each of the 35 air districts operates independently and has its own set of regulations and programs to address the emissions from stationary, area and mobile sources, consistent with state and federal laws, regulations, and guidelines. The independence of the districts allows specific air quality problems to be addressed on a local level. In addition, districts have also established local CEQA thresholds of significance for criteria pollutants – also to address the specific air quality problems relative to that particular district.

The overall goal of air district thresholds is to achieve and maintain health based air quality standards within their respective air basins and to reduce transport of emissions to other air basins. In establishing recommended thresholds, air districts consider the existing emission inventory of criteria pollutants and the amount of emission reductions needed to attain and maintain ambient air quality standards.

However, unlike criteria pollutants where individual districts are characterized by varying levels of pollutant concentrations and source types, greenhouse gases (GHG) and their attendant climate change ramifications are a global problem and, therefore, may suggest a uniform approach to solutions that ensure both progress and equity.

Under SB97, the Office of Planning and Research is directed to prepare, develop, and transmit to the Resources Agency guidelines for the feasible mitigation of GHG emissions or the effects of GHG emissions through CEQA by July 1, 2009. Those guidelines may recommend thresholds. As stated, this paper is intended to provide a common platform of information and tools to support local decision makers until such time that statewide guidance or requirements are promulgated.

Local Ability to Promulgate District-Specific GHG Thresholds

One of the primary reasons behind the creation of air districts in California is the recognition that some regions within the state face more critical air pollution problems than others and, as has often been pointed out – one size does not fit all. For example, a "Serious" federal nonattainment district would need greater emission reductions than a district already in attainment – and, therefore, the more "serious" district would set its criteria pollutant CEQA thresholds of significance much lower than the air district already in attainment.

The action of GHGs is global in nature, rather than local or regional (or even statewide or national). Ultimately there may be a program that is global, or at least national in scope. That said, actions taken by a state, region, or local government can contribute to the solution of the global problem. Local governments are not barred from developing and implementing programs to address GHGs. In the context of California and CEQA, lead agencies have the primary responsibility and authority to determine the significance of a project's impacts.

Further, air districts have primary authority under state law for "control of air pollution from all sources, other than emissions from motor vehicles." (H&SC §40000) The term air contaminant or "air pollutant" is defined extremely broadly, to mean "any discharge, release, or other propagation into the atmosphere" and includes, but is not limited to, soot, carbon, fumes, gases, particulate matter, etc. Greenhouse gases and other global warming pollutants such as black carbon would certainly be included in this definition, just as the U.S. Supreme Court held in Massachusetts v. EPA that greenhouse gases were air pollutants under the federal Clean Air Act. Therefore, air districts have the primary authority to regulate global warming pollutants from nonvehicular sources. AB 32 does not change this result. Although it gives wide responsibility to CARB to regulate greenhouse gases from all sources, including nonvehicular sources, it does not preempt the districts. AB 32 specifically states That "nothing in this division shall limit or expand the existing authority of any district..."(H&SC § 38594). Thus, districts and CARB retain concurrent authority over nonvehicular source greenhouse gas emissions.

Introduction

The CEQA statutes do not require an air district or any lead agency to establish significance thresholds under CEQA for any pollutant. While there are considerations that support the establishment of thresholds (which are discussed in other sections of this document), there is no obligation to do so.

An air district or other lead agency may elect not to establish significance thresholds for a number of reasons. The agency may believe that the global nature of the climate change problem necessitates a statewide or national framework for consideration of environmental impacts. SB 97 directs OPR to develop "guidelines for the mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions by July 1, 2009," and directs the California Resources Agency to certify and adopt the guidelines by June 30, 2010.

An agency may also believe there is insufficient information to support selecting one specific threshold over another. As described earlier, air districts have historically set CEQA thresholds for air pollutants in the context of the local clean air plan, or (in the case of toxic air pollutants) within the framework of a rule or policy that manages risks and exposures due to toxic pollutants. There is no current framework that would similarly manage impacts of greenhouse gas pollutants, although the CARB is directed to establish one by June 30, 2009, pursuant to AB 32. A local agency may decide to defer any consideration of thresholds until this framework is in place.

Finally, an agency may believe that the significance of a given project should be assessed on a case-by-case basis in the context of the project at the time it comes forward.

Implementing CEQA Without Significance Thresholds for GHG

The absence of a threshold does not in any way relieve agencies of their obligations to address GHG emissions from projects under CEQA. The implications of not having a threshold are different depending on the role the agency has under CEQA – whether it is acting in an advisory capacity, as a responsible agency, or as a lead agency.

<u>Implications of No Thresholds for an Agency Acting in an Advisory Capacity</u>

Air districts typically act in an advisory capacity to local governments in establishing the framework for environmental review of air pollution impacts under CEQA. This may include recommendations regarding significance thresholds, analytical tools to assess emissions and impacts, and mitigations for potentially significant impacts. Although districts will also address some of these issues on a project-specific basis as responsible agencies, they may provide general guidance to local governments on these issues that are program wide, and these are advisory (unless they have been established by regulation).

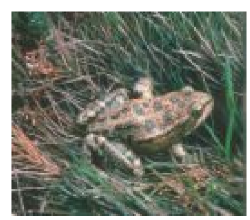
An air district that has not established significance thresholds for GHG will not provide guidance to local governments on this issue. This does not prevent the local government from establishing thresholds under its own authority. One possible result of this would be the establishment of different thresholds by cities and counties within the air district. Alternatively, the air district could advise local governments not to set thresholds and those jurisdictions may follow the air district's guidance.

It is important to note here (as has been clearly stated by the Attorney General in comments and filings) that lack of a threshold does *not* mean lack of significance. An agency may argue lack of significance for any project, but that argument would have to be carried forth on a case-by-case, project specific basis. By extension then, a decision not to establish thresholds for GHG is likely to result in a greater workload for responsible and lead agencies as they consider individual projects under CEQA.

Implications of No Thresholds for a Responsible Agency

If there are no established thresholds of significance, the significance of each project will have to be determined during the course of review. The responsible agency (e.g., the air district) will review each project referred by the lead agency. The review may be qualitative or quantitative in nature. A qualitative review would discuss the nature of GHG emissions expected and their potential effect on climate change as the district understands it. It could also include a discussion of the relative merits of alternative scenarios. A quantitative analysis would evaluate, to the extent possible, the expected GHG emissions; it would also need to evaluate their potential effect on climate change and might include corresponding analysis of alternatives. The air district, as a responsible agency, may also identify mitigation measures for the project.

The lack of established thresholds will make the determination of significance more resource intensive for each project. The district may defer to the lead agency to make this determination, however the district may be obligated, as a responsible agency, to evaluate the analysis and determination.



Implications of No Thresholds for a Lead Agency

The main impact of not having significance thresholds will be on the primary evaluation of projects by the lead agency. Without significance thresholds, the agency will have to conduct some level of analysis of every project to determine whether an environmental impact report is needed. There are three fundamental approaches to the case-by-case analysis of significance, including presumptions of significance or insignificance, or no presumption:

1. The agency can begin with a presumption of significance and the analysis would be used to support a case-specific finding of no significance. This is similar to establishing a threshold of zero, except that here, the "threshold" is rebuttable. This approach may result in a large number of projects proceeding to preparation of an environmental impact report. Because of the attendant costs, project proponents may challenge the determination of significance, although formal challenge is less likely than attempts to influence the determination.

2. The agency can begin with a presumption of insignificance, and the analysis would be used to support a case-specific finding of significance. A presumption of insignificance could be based on the perspective that it would be speculative to attempt to identify the significance of GHG emissions from a project relative to climate change on a global scale. This approach might reduce the number of projects proceeding to preparation of environmental impact reports. It is likely to have greater success with smaller projects than larger ones, and a presumption of *insignificance* may be more likely to be challenged by project opponents.

3. It is not necessary for the lead agency to have any presumption either way. The agency could approach each project from a *tabula rasa* perspective, and have the determination of significance more broadly tied to the specific context of the project; this approach is likely to be resource intensive, and creates the greatest uncertainty for project proponents. To the extent that it results in a lead agency approving similar projects based on different determinations of significance for GHG emissions, it may be more vulnerable to challenge from either proponents or opponents of the project. Alternatively, in the absence of either thresholds or presumptions, the lead agency could use each determination of significance to build its approach in the same way that subsequent judgments define the law.

Relevant Citations

The full text of relevant citations is in Appendix A.

Public Resources Code – §21082.2, Significant Effect on Environment; Determination; Environmental Impact Report Preparation.

State CEQA Guidelines – §15064, Determining the Significance of the Environmental Effects Caused by a Project.

Introduction

If an air district or lead agency determines that any degree of project-related increase in GHG emissions would contribute considerably to climate change and therefore would be a significant impact, it could adopt a zero-emission threshold to identify projects that would need to reduce their emissions. A lead agency may determine that a zero-emission threshold is justified even if other experts may disagree. A lead agency is not prevented from adopting any significance threshold it sees as appropriate, as long as it is based on substantial evidence.

If the zero threshold option is chosen, all projects subject to CEQA would be required to quantify and mitigate their GHG emissions, regardless of the size of the project or the availability of GHG reduction measures available to reduce the project's emissions. Projects that could not meet the zero-emission threshold would be required to prepare environmental impact reports to disclose the unmitigable significant impact, and develop the justification for a statement of overriding consideration to be adopted by the lead agency.

Implementing CEQA With a Zero Threshold for GHG

The scientific community overwhelmingly agrees that the earth's climate is becoming warmer, and that human activity is playing a role in climate change. Unlike other environmental impacts, climate change is a global phenomenon in that all GHG emissions generated throughout the earth contribute to it. Consequently, both large and small GHG generators cause the impact. While it may be true that many GHG sources are individually too small to make any noticeable difference to climate change, it is also true that the countless small sources around the globe combine to produce a very substantial portion of total GHG emissions.

A zero threshold approach is based on a belief that, 1) all GHG emissions contribute to global climate change and could be considered significant, and 2) not controlling emissions from smaller sources would be neglecting a major portion of the GHG inventory.

CEQA explicitly gives lead agencies the authority to choose thresholds of significance. CEQA defers to lead agency discretion when choosing thresholds. Consequently, a zero-emission threshold has merits.

The CEQA review process for evaluating a project's impact on global climate change under the zero threshold option would involve several components. Air quality sections would be written by lead agencies to include discussions on climate change in CEQA documents, GHG emissions would be calculated, and a determination of significance would be made. The local air districts would review and comment on the climate change discussions in environmental documents. Lead agencies may then revise final EIRs to accommodate air district comments. More than likely, mitigation measures will be specified for the project, and a mitigation monitoring program will need to be put in place to ensure that these measures are being implemented.

Since CEQA requires mitigation to a less than significant level, it is conceivable that many projects subjected to a zero threshold could only be deemed less than significant with offsite reductions or the opportunity to purchase greenhouse gas emission reduction credits. GHG emission reduction credits are becoming more readily available however the quality of the credits varies considerably. High quality credits are generated by actions or projects that have clearly demonstrated emission reductions that are real, permanent, verifiable, enforceable, and not otherwise required by law or regulation. When the pre- or post-project emissions are not well quantified or cannot be independently confirmed, they are considered to be of lesser quality. Similarly, if the reductions are temporary in nature, they are also considered to be poor quality. Adoption of a zero threshold should consider the near-term availability and the quality of potential offsets.

There are also environmental justice concerns about the effects of using offsite mitigations or emission reduction credits to offset, or mitigate, the impacts of a new project. Although GHGs are global pollutants, some of them are emitted with co-pollutants that have significant near-source or regional impacts. Any time that increases in emissions at a specific site will be mitigated at a remote location or using emission reduction credits, the agency evaluating the project should ensure that it does not create disproportionate impacts.

Administrative Considerations

If electing to pursue a zero threshold, an air district or lead agency should consider the administrative costs and the environmental review system capacity. Some projects that previously would have qualified for an exemption could require further substantial analysis, including preparation of a Negative Declaration (ND), a Mitigated Negative Declaration (MND) or an EIR. Moreover, the trade-offs between the volume of projects requiring review and the quality of consideration given to reviews should be considered. It may also be useful to consider whether meaningful mitigation can be achieved from smaller projects.

Consideration of Exemptions from CEQA

A practical concern about identifying GHG emissions as a broad cumulative impact is whether the zero threshold option will preclude a lead agency from approving a large set of otherwise qualified projects utilizing a Categorical Exemption, ND, or MND. The results could be a substantial increase in the number of EIR's. This is a valid and challenging concern, particularly for any threshold approach that is based on a zero threshold for net GHG emission increases.

CEQA has specified exceptions to the use of a categorical exception. Specifically, CEQA Guidelines §15300.2 includes the following exceptions:

"(b) Cumulative Impact. All exemptions for these classes are inapplicable when the cumulative impact of successive projects of the same type in the same place, over time is significant."

(c) Significant Effect. A categorical exemption shall not be used for an activity where there is a reasonable possibility that the activity will have a significant effect on the environment due to unusual circumstances."

These CEQA Guidelines sections could be argued to mean that any net increase in GHG emissions would preclude the use of a categorical exemption. However, as described below, if the following can be shown, then the exceptions above could be argued not to apply:

(1) Cumulative local, regional and/or state GHG emissions are being reduced or will be reduced by adopted, funded, and feasible measures in order to meet broader state targets.

(2) Mandatory state or local GHG reduction measures would apply to the project's emissions such that broader GHG reduction goals would still be met and the project contributions would not be cumulatively considerable.

(3) Project GHG emissions are below an adopted significance threshold designed to take into account the cumulative nature of GHG emissions.

A similar argument could be made relative to the use of a ND (provided no additional mitigation (beyond existing mandates) is required to control GHG emissions) and to the use of a MND instead of an EIR. However, due to the "fair argument" standard, which is discussed in Chapter 3, caution is recommended in use of a ND or MND unless all three elements above can be fully supported through substantial evidence and there is no substantial evidence to the contrary. Establishing a significance threshold of zero is likely to preclude the use of a categorical exemption.

Relevant Citations

The full text of relevant citations is in Appendix A.

Public Resources Code – §21004, Mitigating or Avoiding a Significant Effect; Powers of Public Agency.

State CEQA Guidelines – §15064, Determining the Significance of the Environmental Effects Caused by a Project.

State CEQA Guidelines – §15130, Discussion of Cumulative Impacts.

State CEQA Guidelines – §15064.7, Thresholds of Significance.

Introduction

A non-zero threshold could minimize the resources spent reviewing environmental analyses that do not result in real GHG reductions or to prevent the environmental review system from being overwhelmed. The practical advantages of considering non-zero thresholds for GHG significance determinations can fit into the concept regarding whether the project's GHG emissions represent a "considerable contribution to the cumulative impact" and therefore warrant analysis.

Specifying a non-zero threshold could be construed as setting a *de minimis* value for a cumulative impact. In effect, this would be indicating that there are certain GHG emission sources that are so small that they would not contribute substantially to the global GHG budget. This could be interpreted as allowing public agencies to approve certain projects without requiring any mitigation of their GHG. Any threshold framework should include a proper context to address the *de minimis* issue. However, the CEQA Guidelines recognize that there may be a point where a project's contribution, although above zero, would not be a *considerable contribution* to the cumulative impact and, therefore, not trigger the need for a significance determination.

GHG emissions from all sources are under the purview of CARB and as such may eventually be "regulated" no matter how small. Virtually all projects will result in some direct or indirect release of GHG. However, a decision by CARB to regulate a class of sources does not necessarily mean that an individual source in that class would constitute a project with significant GHG impacts under CEQA. For example, CARB has established criteria pollutant emission standards for automobiles, but the purchase and use of a single new car is not considered a project with significant impacts under CEQA. At the same time, it is important to note that it is likely that all meaningful sources of emissions, no matter how small are likely to be considered for regulation under AB 32. It is expected that projects will have to achieve some level of GHG reduction to comply with CARB's regulations meant to implement AB 32. As such all projects will have to play a part in reducing our GHG emissions budget and no project, however small, is truly being considered *de minimis* under CARB's regulations.

This chapter evaluates a range of conceptual approaches toward developing GHG significance criteria. The air districts retained the services of J&S an environmental consulting, firm to assist with the development of a Statute and Executive Order-based threshold (Approach 1) and a tiered threshold (Approach 2) based on a prescribed list of tasks and deliverables. Time and financial constraints limited the scope and depth of this analysis, however, the work presented here may be useful in developing interim guidance while AB 32 is being implemented. J&S recognized that approaches other than those described here could be used.

As directed, J&S explored some overarching issues, such as:

- what constitutes "new" emissions?

- how should "baseline emissions" be established?
- what is cumulatively "considerable" under CEQA?
- what is "business as usual" ? and
- should an analysis include "life-cycle" emissions?

The answers to these issues were key to evaluating each of the threshold concepts.

Approach 1 – Statute and Executive Order Approach

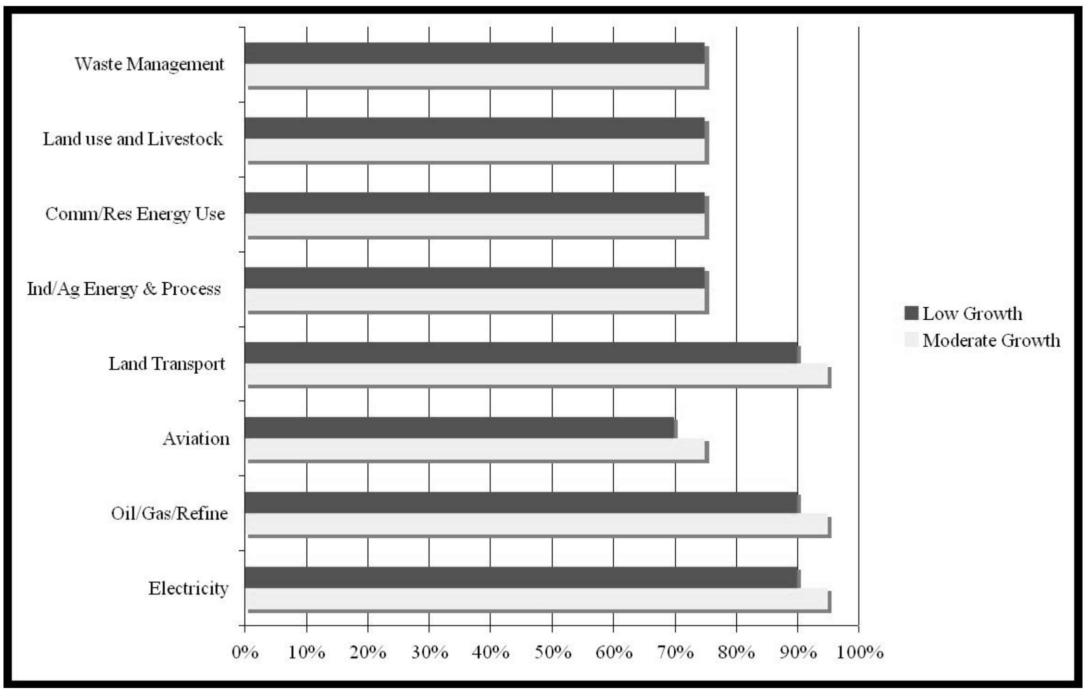
Thresholds could be grounded in existing mandates and their associated GHG emission reduction targets. A project would be required to meet the targets, or reduce GHG emissions to the targets, to be considered less than significant.

AB 32 and S-3-05 target the reduction of statewide emissions. It should be made clear that AB 32 and S-3-05 do not specify that the emissions reductions should be achieved through uniform reduction by geographic location or by emission source characteristics. For example, it is conceivable, although unlikely, that AB 32 goals could be achieved by new regulations that only apply to urban areas or that only apply to the transportation and/or energy sector. However, this approach to evaluating GHG under CEQA is based on the presumption that a new project must at least be consistent with AB 32 GHG emission reduction mandates.

The goal of AB 32 and S-3-05 is the significant reduction of future GHG emissions in a state that is expected to rapidly grow in both population and economic output. As such, there will have to be a significant reduction in the per capita GHG output for these goals to be met. CEQA is generally used to slow or zero the impact of new emissions, leaving the reduction of existing emission sources to be addressed by other regulatory means. With these concepts in mind, four options were identified for statute/executive order-based GHG significance thresholds and are described below.

<u>Threshold 1.1: AB 32/S-3-05 Derived Uniform Percentage-Based Reduction.</u> AB 32 requires the state to reduce California-wide GHG emissions to 1990 levels by 2020. Reducing greenhouse gas emission levels from 2020 to 1990 levels could require a 28 to 33 percent reduction of business-as-usual GHG emissions depending on the methodology used to determine the future emission inventories. The exact percent reduction may change slightly once CARB finalizes its 1990 and 2020 inventory estimates. In this context, business-as-usual means the emissions that would have occurred in the absence of the mandated reductions. The details of the business-as-usual scenario are established by CARB in the assumptions it uses to project what the state's GHG emissions would have been in 2020, and the difference between that level and the level that existed in 1990 constitutes the reductions that must be achieved if the mandated goals are to be met.

This threshold approach would require a project to meet a percent reduction target based on the average reductions needed from the business-as-usual emission from all GHG sources. Using the 2020 target, this approach would require all discretionary projects to achieve a 33 percent reduction from projected business-as-usual emissions in order to be considered less than significant. A more restrictive approach would use the 2050 targets. S-3-05 seeks to reduce GHG emissions to 80 percent below 1990 levels by 2050. To reach the 2050 milestone would require an estimated 90 percent reduction (effective immediately) of business-as-usual emissions. Using this goal as the basis for a significance threshold may be more appropriate to address the long-term adverse impacts associated with global climate change. Note that AB 32 and S-3-05 set emission inventory goals at milestone years; it is unclear how California will progress to these goals in non-milestone years.



SOURCE: ARB 2007

<u>Threshold 1.2: Uniform Percentage-Based (e.g.50%) Reduction for New Development</u>. This threshold is based on a presumption that new development should contribute a greater percent reduction from business-as-usual because greater reductions can be achieved at lower cost from new projects than can be achieved from existing sources. This approach would establish that new development emit 50 percent less GHG emissions than business-as-usual development. This reduction rate is greater than the recommended reduction rate for meeting the Threshold 1.1 2020 target (33 percent) but is significantly less restrictive than the Threshold 1.1 2050 target reduction rate (90 percent). If a 50 percent GHG reduction were achieved from new development, existing emissions would have to be reduced by 25 to 30 percent in order to meet the 2020 emissions goal depending on the year used to determine the baseline inventory. Although this reduction goal is reasonable for achieving the 2020 goal, it would not be possible to

reach the 2050 emissions target with this approach even if existing emissions were 100 percent controlled.

Threshold 1.3: Uniform Percentage-Based Reduction by Economic Sector. This threshold would use a discrete GHG reduction goal specific to the economic sector associated with the project. There would be specific reduction goals for each economic sector, such as residential, commercial, and industrial development. Specifying different reduction thresholds for each market sector allows selection of the best regulatory goal for each sector taking into account available control technology and costs. This approach would avoid over-regulating projects (i.e. requiring emissions to be controlled in excess of existing technology) or under-regulating projects (i.e. discouraging the use of available technology to control emissions in excess of regulations). This approach requires extensive information on the emission inventories and best available control technology for each economic sector. This data will be compiled as CARB develops its scoping plan under AB 32 and its implementing regulations; as a result, this approach will be more viable in the long term.

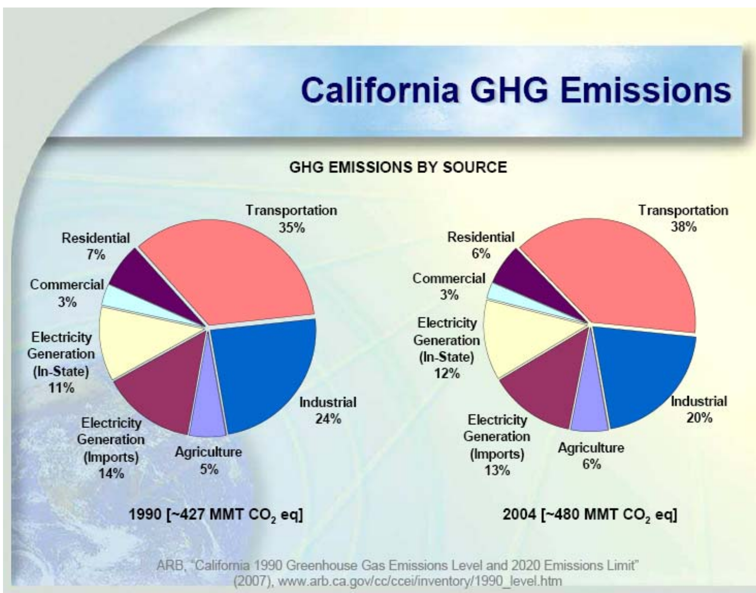
Threshold 1.4: Uniform Percentage-Based Reduction by Region. AB 32 and S-3-05 are written such that they apply to a geographic region (i.e. the entire state of California) rather than on a project or sector level. One could specify regions of the state such as the South Coast Air Basin, Sacramento Valley, or Bay Area which are required to plan (plans could be developed by regional governments, such as councils of governments) and demonstrate compliance with AB 32 and S-3-05 reduction goals at a regional level. To demonstrate that a project has less than significant emissions, one would have to show compliance with the appropriate regional GHG plan. Effectively this approach allows for analysis of GHG emissions at a landscape scale smaller than the state as a whole. Specifying regions in rough correlation to existing air basins or jurisdictional control allows for regional control of emissions and integration with regional emission reduction strategies for criteria and toxic air pollutants. Although differing GHG reduction controls for each region are possible, it is likely that all regions would be

required to achieve 1990 emission inventories by the year 2020 and 80 percent less emissions by 2050. Threshold 1.4 is considered viable long-term significance criteria that is unlikely to be used in the short term.

Implementing CEQA Thresholds Based on Emission Reduction Targets

<u>Characterizing Baseline and Project Emissions</u>

While the population and economy of California is expanding, all new projects can be considered to contribute new emissions. Furthermore, GHG impacts are exclusively cumulative impacts; there are no non-cumulative GHG emission impacts from a climate change perspective. “Business-as-usual” is the projection of GHG emissions at a future date based on current technologies and regulatory requirements in absence of other reductions. For example to determine the future emissions from a power plant for “business-as-usual” one would multiply the projected energy throughput by the current emission factor for that throughput. If adopted regulations (such as those that may be promulgated by CARB for AB 32) dictate that power plant emissions must be reduced at some time in the future, it is appropriate to consider these regulation standards as the new business-as-usual for a future date. In effect, business-as-usual will continue to evolve as regulations manifest. Note that “business-as-usual” defines the CEQA No Project conditions, but does not necessarily form the baseline under CEQA. For instance, it is common to subtract the future traffic with and without a project to determine the future cumulative contribution of a project on traffic conditions. However, existing conditions at the time of issuance of the notice of preparation is normally the baseline.



SOURCE: ARB 2007

<u>Establishing Emission Reduction Targets</u>

One of the obvious drawbacks to using a uniform percent reduction approach to GHG control is that it is difficult to allow for changes in the 1990 and future emission inventories estimates. To determine what emission reductions are required for new projects one would have to know accurately the 1990 budget and efficacy of other GHG promulgated regulations as a function of time. Since CARB will not outline its regulation strategy for several more years, it is difficult to determine accurately what the new project reductions should be in the short term. Future updates to the 1990 inventory could necessitate changes in thresholds that are based on that inventory. It is important to note that it is difficult to create near term guidance for a uniform reduction threshold strategy since it would require considerable speculation regarding the implementation and effectiveness of forthcoming CARB regulations.

Of greater importance are the assumptions used to make the projected 2020 emission inventories. Projecting future inventories over the next 15-50 years involves substantial uncertainty. Furthermore, there are likely to be federal climate change regulations and possibly additional international GHG emission treaties in the near future. To avoid such speculation, this paper defines all future emission inventories as hypothetical business-as-usual projections.

This white paper is intended to support local decisions about CEQA and GHG in the near term. During this period, it is unlikely that a threshold based on emission reduction targets would need to be changed. However, it is possible that future inventory updates will show that targets developed on the current inventory were not stringent enough, or were more stringent than was actually needed.

Approach 2 – Tiered Approach

The goal of a tiered threshold is to maximize reduction predictability while minimizing administrative burden and costs. This would be accomplished by prescribing feasible mitigation measures based on project size and type, and reserving the detailed review of an EIR for those projects of greater size and complexity. This approach may require inclusion in a General Plan, or adoption of specific rules or ordinances in order to fully and effectively implement it.

A tiered CEQA significance threshold could establish different levels at which to determine if a project would have a significant impact. The tiers could be established based on the gross GHG emission estimates for a project or could be based on the physical size and characteristics of the project. This approach would then prescribe a set of GHG mitigation strategies that would have to be incorporated into the project in order for the project to be considered less than significant.

The framework for a tiered threshold would include the following:

- disclosure of GHG emissions for all projects;
- support for city/county/regional GHG emissions reduction planning;
- creation and use of a “green list” to promote the construction of projects that have desirable GHG emission characteristics;
- a list of mitigation measures;

- a decision tree approach to tiering; and
- quantitative or qualitative thresholds.

Decision-Tree Approach to Tiering

CEQA guidance that allows multiple methodologies to demonstrate GHG significance will facilitate the determination of significance for a broad range of projects/plans that would otherwise be difficult to address with a single non-compound methodology. Even though there could be multiple ways that a project can determine GHG significance using a decision-tree approach, only one methodology need be included in any single CEQA document prepared by the applicant. The presence of multiple methodologies to determine significance is designed to promote flexibility rather than create additional analysis overhead. Figure 1 shows a conceptual approach to significance determination using a tiered approach that shows the multiple routes to significance determination.

Figure 1 Detail Description

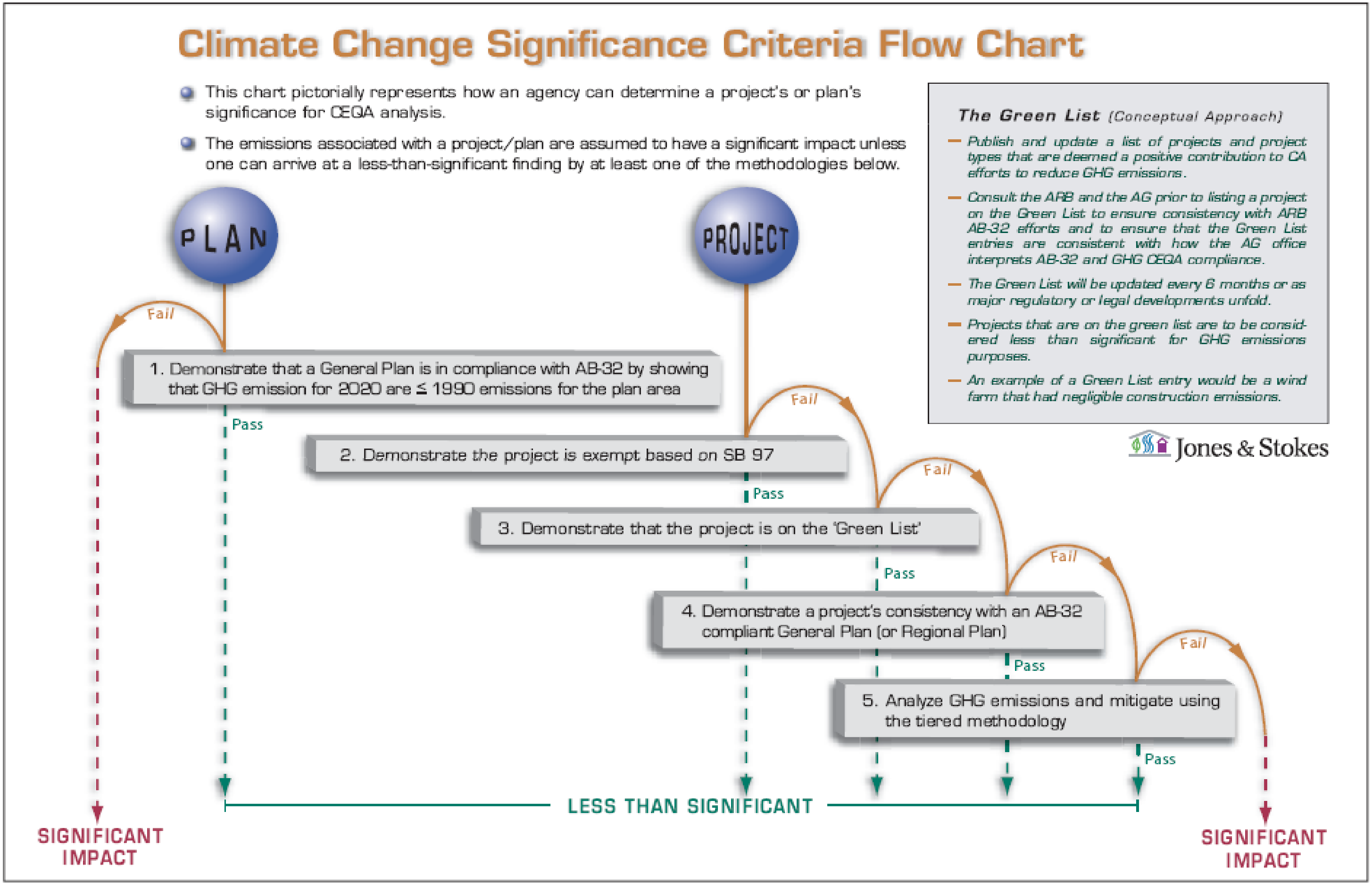
Figure 1 pictorially represents how an agency can determine a project's or plan's significance for CEQA analysis using the non-zero threshold methodology. The emissions associated with a project/plan are assumed to have a significant impact unless one can arrive at a less-than-significant finding by at least one of the methodologies below.

1. Demonstrate that a General Plan (GP) or Regional Plan is in Compliance with AB32

   - For most GPs or RPs this will require demonstration that projected 2020 emissions will be equal to or less than 1990 emissions.
   - GPs or RPs are expected to fully document 1990 and 2020 GHG emission inventories.
   - Projection of 2020 emissions is complicated by the fact that CARB is expected to promulgate emission reductions in the short term. Until explicit CARB regulations are in place, unmitigated GP 2020 emission inventories represent business-as-usual scenarios.
   - EIRs for GPs or RPs which demonstrate 2020 mitigated emissions are less than or equal to 1990 emissions are considered less than significant.

2. Demonstrate the Project is Exempt Based on SB 97

   - As specified in SB 97, projects that are funded under November 2006 Proposition 1B (Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act) and 1C (Disaster Preparedness and Flood Prevention Bond Act) may be exempt from analysis until January 1, 2010.



Jones & Stokes

Figure 1
Climate Change Significance Criteria Flow Chart

- An exemption can be used in an ND, MND, or EIR to support a less than significant finding for GHG impacts.

3. Demonstrate that the Project is on the 'Green List'

- This list would include projects that are deemed a positive contribution to California efforts to reduce GHG emissions. If the project is of the type described on the Green List it is considered less than significant.
- If the Green List entry description requires mitigation for impacts other than GHG, this methodology can be used in MNDs or EIRs; if the Green List entry does not require mitigation this methodology can be used in NDs, MNDs, or EIRs.

4. Demonstrate a Project's Compliance with a General Plan

- If a project is consistent with an appropriate General Plan's Greenhouse Gas Reduction Plan (GGRP), a project can be declared less than significant.
- Note that at this time there are no known jurisdictions that have a GGRP that has been fully subject to CEQA review. While Marin County has adopted a forward-thinking GGRP and it is described in the most recent GP update, the associated EIR does not analyze the secondary environmental impacts of some of the GGRP measures such as tidal energy. While one can reference GGRPs that have not been reviewed fully in CEQA, to attempt to show a project's compliance with such a plan as evidence that the project's GHG emission contributions are less than significant may not be supported by substantial evidence that cumulative emissions are being fully addressed in the particular jurisdiction.
- Compliance with a CEQA-vetted GGRP can be cited as evidence for all CEQA documents (Categorical Exemption, ND, MND, and EIR).

5. Analyze GHG Emissions and Mitigate using the Tiered Methodology

- Guidance and mitigation methodology for various development projects (residential, commercial, industrial) are listed in the form of tiered thresholds. If a project incorporates the mitigation measures specified in the tiered threshold tables the project is considered less than significant.
- All project emissions are considered less than significant if they are less than the threshold(s).
- If the tiered approach requires mitigation, this methodology can be used in MNDs or EIRs; if the tiered approach does not require mitigation this methodology can be used in NDs, MNDs, or EIRs.

The Green List

- The Green List would be a list of projects and project types that are deemed a positive contribution to California's efforts to reduce GHG emissions.
- If this approach is followed, it is suggested that CARB and the Attorney General (AG) are consulted prior to listing a project on the Green List to ensure consistency with CARB AB 32 efforts and to ensure that the Green List entries are consistent with how the AG office interprets AB 32 and GHG CEQA compliance.
- The Green List should be updated every 6 months or as major regulatory or legal developments unfold.
- Projects that are on the Green List are to be considered less than significant for GHG emissions purposes.
- A tentative list of potential Green List entries is presented below. Actual Green List entries should be far more specific and cover a broad range of project types and mitigation approaches. The list below is merely a proof-of-concept for the actual Green List.

1. Wind farm for the generation of wind-powered electricity
2. Extension of transit lines to currently developed but underserved communities
3. Development of high-density infill projects with easily accessible mass transit
4. Small hydroelectric power plants at existing facilities that generate 5 mw or less (as defined in Class 28 Categorical Exemption)
5. Cogeneration plants with a capacity of 50 mw or less at existing facilities (as defined in Class 29 Cat Exemption)
6. Increase in bus service or conversion to bus rapid transit service along an existing bus line
7. Projects with LEED "Platinum" rating
8. Expansion of recycling facilities within existing urban areas
9. Recycled water projects that reduce energy consumption related to water supplies that services existing development
10. Development of bicycle, pedestrian, or zero emission transportation infrastructure to serve existing regions

There are also several options for tiering and thresholds, as shown in Table 2 below. One could establish strictly numeric emissions thresholds and require mitigation to below the specific threshold to make a finding of less than significant. One could establish narrative emissions threshold that are based on a broader context of multiple approaches to GHG reductions and a presumption that projects of sufficiently low GHG intensity are less than significant.

In Concept 2A, a zero threshold would be applied to projects and thus only projects that result in a reduction of GHG emissions compared to baseline emissions would be less than significant absent mitigation. All projects would require quantified inventories. All projects that result in a net increase of GHG emissions would be required to mitigate their emissions to zero through direct mitigation or through fees or offsets or the impacts

Table 2: Approach 2 Tiering Options

	Concept 2A Zero	Concept 2B Quantitative	Concept 2C Qualitative
Tier 1	Project results in a net reduction of GHG emissions *Less than Significant*	Project in compliance with an AB 32-compliant General/Regional Plan, on the Green List, or below Tier 2 threshold. Level 1 Reductions (Could include such measures as: bike parking, transit stops for planned route, Energy Star roofs, Energy Star appliances, Title 24, water use efficiency, etc.) *Less than Significant*	Project in compliance with an AB 32-compliant General/Regional Plan, on the Green List, or below Tier 2 threshold. Level 1 Reductions (See measures under 2B) *Less than Significant*
Tier 2	Project results in net increase of GHG emissions Mitigation to zero (including offsets) *Mitigated to Less than Significant*	Above Tier 2 threshold Level 2 Mitigation (Could include such measures as: Parking reduction beyond code, solar roofs, LEED Silver or Gold Certification, exceed Title 24 by 20%, TDM measures, etc.) *Mitigated to Less than Significant*	Above Tier 2 threshold Level 2 Mitigation (See measures under 2B) *Mitigated to Less than Significant*
Tier 3	Mitigation infeasible to reduce emissions to zero (e.g., cost of offsets infeasible for project or offsets not available) *Significant and Unavoidable*	Above Tier 2 threshold With Level 1, 2 Mitigation Level 3 Mitigation: (Could include such measures as: On-site renewable energy systems, LEED Platinum certification, Exceed Title 24 by 40%, required recycled water use for irrigation, zero waste/high recycling requirements, mandatory transit passes, offsets/carbon impact fees) *Mitigated to Less than Significant*	Above Tier 3 thresholds Quantify Emissions, Level 3 Mitigation (see measures under 2B), and Offsets for 90% of remainder *Significance and Unavoidable*

would be identified as significant and unavoidable. This could be highly problematic and could eliminate the ability to use categorical exemptions and negative declarations for a wide range of projects.

In Concepts 2B and 2C, the first tier of a tiered threshold includes projects that are within a jurisdiction with an adopted greenhouse gas reduction plan (GGRP) and General Plan/Regional Plan that is consistent with AB 32 (and in line with S-3-05), or are on the Green List, or are below the Tier 2 threshold. All Tier 1 projects would be required to implement mandatory reductions required due to other legal authority (Level 1 reductions) such as AB 32, Title 24, or local policies and ordinances. With Level 1 reduction measures, qualifying Tier 1 projects would be considered less than significant without being required to demonstrate mitigation to zero.

In Concept 2B, the Tier 2 threshold would be quantitative, and quantified inventories would be required. Several quantitative threshold options are discussed below. A more comprehensive set of Level 2 mitigation would be required. If the project's emissions still exceed the Tier 2 threshold, an even more aggressive set of Level 3 mitigation measures would be required including offsets (when feasible) to reduce emissions below the Tier 2 threshold.

In Concept 2C, there would be two thresholds, a lower Tier 2 threshold (the "low bar") and a higher Tier 3 threshold (the "high bar"). The Tier 2 threshold would be the significance threshold for the purposes of CEQA and would be qualitative in terms of units (number of dwelling units, square feet of commercial space, etc.) or a per capita ratio. Projects above the Tier 2 threshold would be required to implement the comprehensive set of Level 2 mitigation. Projects below the Tier 2 threshold would not be required to quantify emissions or reductions. The Tier 3 threshold would be a threshold to distinguish the larger set of projects for which quantification of emissions would be required. Level 3 mitigation would be required and the project would be required to purchase offsets (when feasible) in the amount of 90 percent of the net emissions after application of Level 1 reductions and Level 2 and 3 mitigation. A variant on Concept 2C would be to require mandatory Level 3 mitigation without quantification and offsets.

Approach 2 Threshold Options

Seven threshold options were developed for this approach. The set of options are framed to capture different levels of new development in the CEQA process and thus allow different levels of mitigation. Options range from a zero first-tier threshold (Threshold 2.1) up to a threshold for GHG that would be equivalent to the capture level (i.e., number of units) of the current criteria pollutant thresholds used by some air districts (Threshold 2.4). The decision-based implementation approach discussed above could be used for any of these options. Table 3 below compares the results of each of the approaches discussed here.

Threshold 2.1: Zero First Tier Tiered Threshold.

This option would employ the decision tree concept and set the first tier cut-point at zero. The second tier cut-point could be one of the qualitative or quantitative thresholds discussed below. First-tier projects would be required to implement a list of very feasible and readily available mitigation measures.

Threshold 2.2: Quantitative Threshold Based on Market Capture

A single quantitative threshold was developed in order to ensure capture of 90 percent or more of likely future discretionary developments. The objective was to set the emission threshold low enough to capture a substantial fraction of future residential and non-residential development that will be constructed to accommodate future statewide population and job growth, while setting the emission threshold high enough to exclude small development projects that will contribute a relatively small fraction of the cumulative statewide GHG emissions.

The quantitative threshold was created by using the following steps:

- Reviewing data from four diverse cities (Los Angeles in southern California and Pleasanton, Dublin, and Livermore in northern California) on pending applications for development.

- Determining the unit (dwelling unit or square feet) threshold that would capture approximately 90 percent of the residential units or office space in the pending application lists.

- Based on the data from the four cities, the thresholds selected were 50 residential units and 30,000 square feet of commercial space.

- The GHG emissions associated with 50 single-family residential units and 30,000 square feet of office were estimated and were found to be 900 metric tons and 800 metric tons, respectively. Given the variance on individual projects, a single threshold of 900 metric tons was selected for residential and office projects.

- A 900 metric ton threshold was also selected for non-office commercial projects and industrial projects to provide equivalency for different projects in other economic sectors.

- If this threshold is preferred, it is suggested that a more robust data set be examined to increase the representativeness of the selected thresholds. At a minimum, a diverse set of at least 20 cities and/or counties from throughout the state should be examined in order to support the market capture goals of this threshold. Further, an investigation of market capture may need to be conducted for different commercial project types and for industrial projects in order to examine whether multiple quantitative emissions thresholds or different thresholds should be developed.

The 900-ton threshold corresponds to 50 residential units, which corresponds to the 84th percentile of projects in the City of Los Angeles, the 79th percentile in the City of Pleasanton, the 50th percentile in the City of Livermore and the 4th percentile in the City of Dublin. This is suggestive that the GHG reduction burden will fall on larger projects that will be a relatively small portion of overall projects within more developed central cities (Los Angeles) and suburban areas of slow growth (Pleasanton) but would be the higher portion of projects within moderately (Livermore) or more rapidly developing areas (Dublin). These conclusions are suggestive but not conclusive due to the small sample size. The proposed threshold would exclude the smallest proposed developments from potentially burdensome requirements to quantify and mitigate GHG emissions under CEQA. While this would exclude perhaps 10 percent of new residential development, the capture of 90 percent of new residential development would establish a strong basis for demonstrating that cumulative reductions are being achieved across the state. It can certainly serve as an interim measure and could be revised if subsequent regulatory action by CARB shows that a different level or different approach altogether is called for.

The 900-ton threshold would correspond to office projects of approximately 35,000 square feet, retail projects of approximately 11,000 square feet, or supermarket space of approximately 6,300 square feet. 35,000 square feet would correspond to the 46th percentile of commercial projects in the City of Los Angeles, the 54th percentile in the City of Livermore, and the 35th percentile in the City of Dublin. However, the commercial data was not separated into office, retail, supermarket or other types, and thus the amount of capture for different commercial project types is not known. The proposed threshold would exclude smaller offices, small retail (like auto-parts stores), and small supermarkets (like convenience stores) from potentially burdensome requirements to quantify and mitigate GHG emissions under CEQA but would include many medium-scale retail and supermarket projects.

The industrial sector is less amenable to a unit-based approach given the diversity of projects within this sector. One option would be to adopt a quantitative GHG emissions threshold (900 tons) for industrial projects equivalent to that for the residential/commercial thresholds described above. Industrial emissions can result from both stationary and mobile sources. CARB estimates that their suggested reporting threshold for stationary sources of 25,000 metric tons accounts for more than 90 percent of the industrial sector GHG emissions (see Threshold 2.3 for 25,000 metric ton discussion). If the CARB rationale holds, then a 900 metric ton threshold would likely capture at least 90 percent (and likely more) of new industrial and manufacturing sources. If this approach is advanced, we suggest further examination of industrial project data to determine market capture.

This threshold would require the vast majority of new development emission sources to quantify their GHG emissions, apportion the forecast emissions to relevant source categories, and develop GHG mitigation measures to reduce their emissions.

Threshold 2.3: CARB Reporting Threshold

CARB has recently proposed to require mandatory reporting from cement plants, oil refineries, hydrogen plants, electric generating facilities and electric retail providers, cogeneration facilities, and stationary combustion sources emitting $\geq$ 25,000 MT CO_2e/yr. AB 32 requires CARB to adopt a regulation to require the mandatory reporting and verification of emissions. CARB issued a preliminary draft version of its proposed reporting requirements in August 2007 and estimates that it would capture 94 percent of the GHG emissions associated with stationary sources.

This threshold would use 25,000 metric tons per year of GHG as the CEQA significance level. CARB proposed to use the 25,000 metric tons/year value as a reporting threshold, not as a CEQA significance threshold that would be used to define mitigation requirements. CARB is proposing the reporting threshold to begin to compile a statewide emission inventory, applicable only for a limited category of sources (large industrial facilities using fossil fuel combustion).

A 25,000 metric ton significance threshold would correspond to the GHG emissions of approximately 1,400 residential units, 1 million square feet of office space, 300,000 square feet of retail, and 175,000 square feet of supermarket space. This threshold would capture far less than half of new residential or commercial development.

As noted above, CARB estimates the industrial-based criteria would account for greater than 90 percent of GHG emissions emanating from stationary sources. However, industrial and manufacturing projects can also include substantial GHG emissions from mobile sources that are associated with the transportation of materials and delivery of products. When all transportation-related emissions are included, it is unknown what portion of new industrial or manufacturing projects a 25,000-ton threshold would actually capture.

An alternative would be to use a potential threshold of 10,000 metric tons considered by the Market Advisory Committee for inclusion in a Greenhouse Gas Cap and Trade System in California. A 10,000 metric ton significance threshold would correspond to the GHG emissions of approximately 550 residential units, 400,000 square feet of office space, 120,000 square feet of retail, and 70,000 square feet of supermarket space. This threshold would capture roughly half of new residential or commercial development.

Threshold 2.4: Regulated Emissions Inventory Capture

Most California air districts have developed CEQA significance thresholds for NOx and ROG emissions to try to reduce emissions of ozone precursors from proposed sources that are not subject to NSR pre-construction air quality permitting. The historical management of ozone nonattainment issues in urbanized air districts is somewhat analogous to today's concerns with greenhouse gas emissions in that regional ozone concentrations are a cumulative air quality problem caused by relatively small amounts of NOx and ROG emissions from thousands of individual sources, none of which emits enough by themselves to cause elevated ozone concentrations. Those same conditions apply to global climate change where the environmental problem is caused by emissions from a countless number of individual sources, none of which is large enough by itself to cause the problem. Because establishment of NOx/ROG emissions CEQA significance thresholds has been a well-tested mechanism to ensure that individual projects address cumulative impacts and to force individual projects to reduce emissions under CEQA, this threshold presumes the analogy of NOx/ROG emission thresholds could be used to develop similar GHG thresholds.

The steps to develop a GHG emission threshold based on the NOx/ROG analogy were as follows:

- For each agency, define its NOx/ROG CEQA thresholds.
- For each agency, define the regional NOx/ROG emission inventory the agency is trying to regulate with its NOx/ROG thresholds.
- For each agency, calculate the percentage of the total emission inventory for NOx represented by that agency's CEQA emission threshold. That value represents the "minimum percentage of regulated inventory" for NOx.
- The current (2004) California-wide GHG emission inventory is 499 million metric tons per year of CO_2 equivalent (MMT CO_2e). Apply the typical "minimum percentage of regulated inventory" value to the statewide GHG inventory, to develop a range of analogous GHG CEQA thresholds.

The preceding methodology was applied to two different air quality districts: the Bay Area Air Quality Management District (BAAQMD), a mostly-urbanized agency within which most emissions are generated from urban areas; and the San Joaquin Valley Air Pollution Control District (SJVAPCD), which oversees emissions emanating in part from rural areas that are generated at dispersed agricultural sources and area sources. For example, in the Bay Area the NOx threshold is 15 tons/year. The total NOx inventory for 2006 was 192,000 tons/year (525 tons/day). The threshold represents 0.008 percent of the total NOx inventory. Applying that ratio to the total statewide GHG emissions inventory of 499 MMT CO_2e (2004) yields an equivalent GHG threshold of 39,000 MMT CO_2e.

The range of analogous CEQA GHG thresholds derived from those two agencies is tightly clustered, ranging from 39,000 to 46,000 tons/year. A 39,000 to 46,000 metric ton threshold would correspond to the GHG emissions of approximately 2,200 to 2,600 residential units, 1.5 to 1.8 million square feet of office space, 470,000 to 560,000 square feet of retail, and 275,000 to 320,000 square feet of supermarket space. This threshold would capture far less than half of new residential or commercial development. Similarly, this threshold would capture less of new industrial/manufacturing GHG emissions inventory than Thresholds 2.2 or 2.3.

Threshold 2.5: Unit-Based Thresholds Based on Market Capture

Unit thresholds were developed for residential and commercial developments in order to capture approximately 90 percent of future development. The objective was to set the unit thresholds low enough to capture a substantial fraction of future housing and commercial developments that will be constructed to accommodate future statewide population and job growth, while setting the unit thresholds high enough to exclude small development projects that will contribute a relatively small fraction of the cumulative statewide GHG emissions. Sector-based thresholds were created by using the same steps and data used to create Threshold 2.2- Quantitative Threshold Based on Market Capture above.

The distribution of pending application data suggests that the GHG reduction burden will fall on larger projects that will be a relatively small portion of overall projects within more developed central cities and suburban areas of slow growth but would be the higher portion of projects within moderately or rapidly developing areas. The proposed threshold would exclude the smallest proposed developments from potentially burdensome requirements to quantify and mitigate GHG emissions under CEQA. While this would exclude perhaps 10 percent of new residential development, the capture of 90 percent of new residential development would establish a strong basis for demonstrating that cumulative reductions are being achieved across the state. It can certainly serve as an interim measure and could be revised if subsequent regulatory action by CARB shows that a different level or different approach altogether is called for.

A similar rationale can be applied to the development of a commercial threshold. Threshold 2.5 would exclude many smaller businesses from potentially burdensome requirements to quantify and mitigate GHG emissions under CEQA. It should be noted that the GHG emissions of commercial projects vary substantially. For example, the carbon dioxide emissions associated with different commercial types were estimated as follows:

- 30,000 square-foot (SF) office = 800 metric tons/year CO_2
- 30,000 SF retail = 2,500 metric tons/year CO_2
- 30,000 SF supermarket = 4,300 metric tons/year CO_2

Thus, in order to assure appropriate market capture on an emissions inventory basis, it will be important to examine commercial project size by type, instead of in the aggregate (which has been done in this paper).

The industrial sector is less amenable to a unit-based approach given the diversity of projects within this sector. One option would be to use a quantitative threshold of 900 tons for industrial projects in order to provide for rough equivalency between different sectors. Industrial emissions can result from both stationary and mobile sources. However, if the CARB rationale for > 90 percent stationary source capture with a threshold of 25,000 metric tons holds, then a 900 metric ton threshold would likely capture at least 90 percent (and likely more) of new industrial sources. Further examination of unit-based industrial thresholds, such as the number of employees or manufacturing floor space or facility size, may provide support for a unit-based threshold based on market capture.

This threshold would require the vast majority of new development emission sources to quantify their GHG emissions, apportion the forecast emissions to relevant source categories, and develop GHG mitigation measures to reduce their emissions.

Threshold 2.6. Projects of Statewide, Regional, or Areawide Significance

For this threshold, a set of qualitative, tiered CEQA thresholds would be adopted based on the definitions of "projects with statewide, regional or areawide significance" under the Guidelines for California Environmental Quality Act, CCR Title 14, Division 6, Section 15206(b).

Project sizes defined under this guideline include the following:

- Proposed residential development of more than 500 dwelling units.
- Proposed shopping center or business establishment employing more than 1,000 persons or encompassing more than 500,000 square feet of floor space.
- Proposed commercial office building employing more than 1,000 persons or encompassing more than 250,000 square feet of floor space.
- Proposed hotel/motel development of more than 500 rooms.
- Proposed industrial, manufacturing or processing plant or industrial park planned to house more than 1,000 persons, or encompassing more than 600,000 square feet of floor space.

These thresholds would correspond to the GHG emissions of approximately 9,000 metric tons for residential projects, 13,000 metric tons for office projects, and 41,000 metric tons for retail projects. These thresholds would capture approximately half of new residential development and substantially less than half of new commercial development. It is unknown what portion of the new industrial or manufacturing GHG inventory would be captured by this approach.

Threshold 2.7 Efficiency-Based Thresholds

For this approach, thresholds would be based on measurements of efficiency. For planning efforts, the metric could be GHG emissions per capita or per job or some combination thereof. For projects, the metric could be GHG emission per housing unit or per square foot of commercial space. In theory, one could also develop metrics for GHG emissions per dollar of gross product to measure the efficiency of the economy.

This approach is attractive because it seeks to benchmark project GHG intensity against target levels of efficiency. The thresholds would need to be set such that there is reasonably foreseeable and sufficient reductions compared to business as usual to support meeting AB 32 and S-3-05 goals in time (in combination with command and control regulations). Because this approach would require substantial data and modeling to fully develop, this is a concept considered as a potential future threshold and not appropriate for interim guidance in the short term. Thus, it is not evaluated in the screening evaluation in the next section.

Table 3 compares the results for each of the approaches.

Table 3: Comparison of Approach 2 Tiered Threshold Options

Threshold	**GHG Emission Threshold (metric tons/year)**	**Future Development Captured by GHG Threshold**
2.1: Zero Threshold	0 tons/year	All
2.2: Quantitative Threshold Based on Market Capture	~900 tons/year	Residential development > 50 dwelling units Office space > 36,000 ft^2 Retail space >11,000 ft^2 Supermarkets >6.300 ft^2 small, medium, large industrial
2.3: CARB GHG Mandatory Reporting Threshold OR Potential Cap and Trade Entry Level	25,000 metric tons/year OR 10,000 metric tons/year	Residential development >1,400 dwelling units OR 550 dwelling units Office space >1 million ft^2 OR 400,000 ft^2 Retail space >300,000 ft^2 OR 120,000 ft^2 Supermarkets >175,000 ft^2 OR 70,000 ft^2 medium/larger industrial
2.4: Regulated Inventory Capture	40,000 – 50,000 metric tons/year	Residential development >2,200 to 2,600 dwelling units Office space >1.5 to 1.8 million ft^2 Retail space >470,000 to 560,000 ft^2 Supermarkets >270,000 to 320,000 ft^2 medium/larger industrial
2.5: Unit-Based Threshold Based on Market Capture	Not applicable.	Residential development >50 dwelling units Commercial space >50,000 ft^2 > small, medium, large industrial (with GHG emissions > 900 tonsCO2e)
2.6: Projects of Statewide, Regional, or Areawide Significance	Not applicable.	Residential development >500 dwelling units Office space >250,000 ft^2 Retail space >500,000 ft^2 Hotels >500 units Industrial project >1,000 employees Industrial project >40 acre or 650,000 ft^2
2.7: Efficiency-Based Thresholds	TBD tons/year/person TBD tons/year/unit	Depends on the efficiency measure selected.

Implementing CEQA With Tiered Thresholds

Several issues related to Approach 2 are addressed below:

1. *Some applications of this approach may need to be embodied in a duly approved General Plan, or in some other formal regulation or ordinance to be fully enforceable.* Because CEQA does not expressly provide that projects may be deemed insignificant based on implementation of a set of mitigations, this approach may need to be supported with specific and enforceable mechanisms adopted with due public process.

2. *How would this concept affect adoption of air district rules and regulations?* Proposed air district rules and regulations may be subject to CEQA like other projects and plans. Thus, if significance thresholds were adopted by an APCD or AQMD, then they could also apply to air district discretionary actions. If GHG emissions would be increased by a rule or regulation for another regulated pollutant, that would be a potential issue for review under CEQA.

3. *Mitigation measures may not be all-inclusive; better measures now or new future technology would make these measures obsolete.* The mandatory mitigation measures could be periodically updated to reflect current technology, feasibility, and efficiency.

4. *Total reduction may not be quantified or difficult to quantify.* CEQA only requires the adoption of feasible mitigation and thus the reduction effectiveness of required mitigation should not be in question. However, the precise reduction effectiveness may indeed be difficult to identify. As described above, if a quantitative threshold is selected as the measure of how much mitigation is mandated, then best available evidence will need to be used to estimate resultant GHG emissions with mitigation adoption. If a qualitative threshold is selected, then it may not be necessary to quantify reductions.

5. *Difficult to measure progress toward legislative program goals.* One could require reporting of project inventories to the Climate Action Registry, air district, or regional council of governments, or other suitable body. Collection of such data would allow estimates of the GHG intensity of new development over time, which could be used by CARB to monitor progress toward AB 32 goals.

6. *Measures may have adverse impacts on other programs.* The identification of mandatory mitigation will need to consider secondary environmental impacts, including those to air quality.

7. *Consideration of life-cycle emissions.* In many cases, only direct and indirect emissions may be addressed, rather than life-cycle emissions. A project applicant has traditionally been expected to only address emissions that are closely related and within the capacity of the project to control and/or influence. The long chain

8. of economic production resulting in materials manufacture, for example, involves numerous parties, each of which in turn is responsible for the GHG emissions associated with their particular activity. However, there are situations where a lead agency could reasonably determine that a larger set of upstream and downstream emissions should be considered because they are being caused by the project and feasible alternatives and mitigation measures may exist to lessen this impact.

Approach 2 Tiered Threshold with Mandatory Mitigation

As shown in Table 2, due to the cumulative nature of GHG emissions and climate change impacts, there could be a level of mandatory reductions and/or mitigation for all projects integrated into a tiered threshold approach. In order to meet AB 32 mandates by 2020 and S-3-05 goals, there will need to be adoption of GHG reduction measures across a large portion of the existing economy and new development. As such, in an effort to support a determination under CEQA that a project has a less than considerable contribution to significant cumulative GHG emissions, mitigation could be required on a progressively more comprehensive basis depending on the level of emissions.

- Level 1 Reductions – These reduction measures would apply to all projects and would only consist of AB 32 and other local/state mandates. They would be applied to a project from other legal authority (not CEQA). Level 1 reductions could include such measures as bike parking, transit stops for planned routes, Energy Star roofs, Energy Star appliances, Title 24 compliance, water use efficiency, and other measures. All measures would have to be mandated by CARB or local regulations and ordinances.

- Level 2 Mitigation – Projects that exceed the determined threshold would be required to first implement readily available technologies and methodologies with widespread availability. Level 2 Mitigation could include such measures as: parking reduction below code minimum levels, solar roofs, LEED Silver or Gold Certification, exceed Title 24 building standards by 20 percent, Traffic Demand Management (TDM) measures, and other requirements.

- Level 3 Mitigation - If necessary to reduce emissions to the thresholds, more extensive mitigation measures that represent the top tier of feasible efficiency design would also be required. Level 3 Mitigation could include such measures as: on-site renewable energy systems, LEED Platinum certification, exceed Title 24 building requirements by 40 percent, required recycled water use for irrigation, zero waste/high recycling requirements, mandatory transit pass provision, and other measures.

- Offset Mitigation – If, after adoption of all feasible on-site mitigation, the project is still found to exceed a Tier 2 quantitative threshold, or exceed a Tier 3 qualitative threshold, or if a project cannot feasibly implement the mandatory on-site mitigation, then purchases of offsets could be used for mitigation. In the case of a quantitative threshold, the amount of purchase would be to offset below the Tier 2 significance threshold. In the case of a qualitative threshold, the amount of purchase could be to offset GHG emissions overall to below the lowest equivalent GHG emissions among the Tier 2 qualitative thresholds. With Threshold 2.5, this would be approximately 900 tons of GHG emissions (corresponding to 50 residential units). With Threshold 2.6, this would be approximately 9,000 tons (corresponding to 500 residential units). Alternatively, one could require purchase of offsets in the amount of a set percentage (such as 90% or 50% for example) of the residual GHG emissions (after other mitigation). As discussed earlier, any decision to include or require the use of emission reduction credits (or offsets) must consider issues of availability, quality, and environmental justice.

Substantial Evidence Supporting Different Thresholds

If a project can be shown by substantial evidence not to increase GHG emissions relative to baseline emissions, then no fair argument will be available that the project contributes considerably to a significant cumulative climate change impact.

It is more challenging to show that a project that increases GHG emissions above baseline emissions does not contribute considerably to a significant cumulative climate change impact. It is critical therefore, to establish an appropriate cumulative context, in which, although an individual project may increase GHG emissions, broader efforts will result in net GHG reductions.

Approach 1-based thresholds that by default will require an equal level of GHG reductions from the existing economy (Thresholds 1.1, 1.3, and 1.4) may be less supportable in the short run (especially before 2012) than Approach 1.2 (which requires new development to be relatively more efficient than a retrofitted existing economy). This is because, prior to 2012, there will only be limited mandatory regulations implementing AB 32 that could address the existing economy in a truly systematic way that can be relied upon to demonstrate that overall GHG reduction goals can be achieved by 2020. Approach 1.2 will still rely on substantial reductions in the existing economy but to a lesser degree.

Approach 1-based thresholds that would spread the mitigation burden across a sector (Threshold 1.3) or across a region (Threshold 1.4) will allow for tradeoffs between projects or even between municipalities. In order to demonstrate that a sector or a region is achieving net reductions overall, there would need to be feasible, funded, and mandatory requirements in place promoting an overall reduction scheme, in order for a project to result in nominal net increased GHG emissions.

Approach 2-based thresholds that capture larger portions of the new development GHG inventory (Thresholds 2.2 and 2.5) would promote growth that results in a smaller increase in GHG emissions; they may therefore be more supportable than thresholds that do not and that have a greater reliance on reductions in the existing economy (Thresholds

2.3, 2.4, and 2.6), especially in the next three to five years. With an established cumulative context that demonstrates overall net reductions, all threshold approaches could be effective in ensuring growth and development that significantly mitigates GHG emissions growth in a manner that will allow the CARB to achieve the emission reductions necessary to meet AB 32 targets. In that respect, all of these thresholds are supported by substantial evidence.

Evaluation of Non-Zero Threshold Options

Overarching issues concerning threshold development are reviewed below. Where appropriate, different features or application of the two conceptual approaches and the various options for thresholds under each conceptual approach described above are analyzed. The screening evaluation is summarized in Tables 4 (Approach 1) and 5 (Approach 2). The summary tables rate each threshold for the issues discussed below based on the level of confidence (low, medium or high) ascribed by J&S. The confidence levels relate to whether a threshold could achieve a particular attribute, such as emission reduction effectiveness. For example, a low emission reduction effectiveness rating means the threshold is not expected to capture a relatively large portion of the new development inventory.

As described above, Threshold 2.7 is not included in this evaluation because the data to develop an efficiency-based threshold has not been reviewed at this time and because this threshold is not considered feasible as an interim approach until more detailed inventory information is available across the California economy.

<u>What is the GHG Emissions Effectiveness of Different Thresholds?</u>

Effectiveness was evaluated in terms of whether a threshold would capture a large portion of the GHG emissions inventory and thus require mitigation under CEQA to control such emissions within the larger framework of AB 32. In addition, effectiveness was also evaluated in terms of whether a threshold would require relatively more or less GHG emissions reductions from the existing economy verses new development. This is presumptive that gains from the existing economy (through retrofits, etc.) will be more difficult and inefficient relative to requirements for new development.

Approach 1-based thresholds that require equivalent reductions relative to business-as-usual (Thresholds 1.1, 1.3, and 1.4) for both the existing and new economy will be less effective than thresholds that support lower-GHG intensity new development (Approach 1.2). However, since Approach 1-based thresholds do not establish a quantitative threshold below which projects do not have to mitigate, the market capture for new development is complete.

Approach 2-based thresholds can be more or less effective at capturing substantial portions of the GHG inventory associated with new development depending on where the quantitative or qualitative thresholds are set. Lower thresholds will capture a broader range of projects and result in greater mitigation. Based on the review of project data for the select municipalities described in the Approach 2 section above, thresholds based on the CARB Reporting Threshold/Cap and Trade Entry Level (Threshold 2.4) or CEQA definitions of "Statewide, Regional or Areawide" projects (Threshold 2.6) will result in a limited capture of the GHG inventory. Lower quantitative or qualitative thresholds (Thresholds 2.1, 2.2 and 2.5) could result in capture of greater than 90 percent of new development.

Are the Different Thresholds Consistent with AB 32 and S-3-05?

Thresholds that require reductions compared to business-as-usual for all projects or for a large portion of new development would be consistent with regulatory mandates. In time, the required reductions will need to be adjusted from 2020 (AB 32) to 2050 (S-3-05) horizons, but conceptually broad identification of significance for projects would be consistent with both of these mandates. Thresholds that exclude a substantial portion of new development would likely not be consistent, unless it could be shown that other more effective means of GHG reductions have already been, or will be adopted, within a defined timeframe.

All Approach 1-based thresholds would be consistent with AB 32 and S-3-05 if it can be demonstrated that other regulations and programs are effective in achieving the necessary GHG reduction from the existing economy to meet the overall state goals.

Approach 2-based thresholds that include substantive parts of the new development GHG inventory (Thresholds 2.1, 2.2 and 2.5) will be more consistent with AB 32 and S-3-05 than those that do not (Thresholds 2.3, 2.4, and 2.6) unless it can be demonstrated that other regulations and programs are effective in achieving the necessary GHG reduction from the existing economy to meet the overall state goals.

What are the Uncertainties Associated with Different Thresholds?

All thresholds have medium to high uncertainties associated with them due to the uncertainty associated with the effectiveness of AB 32 implementation overall, the new character of GHG reduction strategies on a project basis, the immaturity of GHG reduction technologies or infrastructure (such as widespread biodiesel availability), and the uncertainty of GHG reduction effectiveness of certain technologies (such as scientific debate concerning the relative lifecycle GHG emissions of certain biofuels, for example).

In general, Approach 1-based thresholds have higher uncertainties than Approach 2 thresholds because they rely on a constantly changing definition of business-as-usual. Threshold 1.2, with its relatively smaller reliance on the existing economy for GHG reductions has relatively less uncertainty than other Approach 1 thresholds. Thresholds that spread mitigation more broadly (Thresholds 1.3 and 1.4) have less uncertainty by avoiding the need for every project to mitigate equally.

Approach 2 thresholds with lower quantitative (2.1 and 2.2) or qualitative (2.5) thresholds will have uncertainties associated with the ability to achieve GHG reductions from small to medium projects. Approach 2 thresholds with higher quantitative (2.3, 2.4) or qualitative (2.6) thresholds will have uncertainties associated with the ability to achieve relatively larger GHG reductions from the existing economy.

What are Other Advantages/Disadvantages of the Different Thresholds?

Thresholds with a single project metric (Thresholds 1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 2.5, and 2.6) will be easier to apply to individual projects and more easily understood by project applicants and lead agencies broadly. Thresholds that spread mitigation across sectors (1.3) or regions (1.4), while simple in concept, will require adoption of more complicated cross-jurisdictional reduction plans or evaluation of broad sector-based trends in GHG intensity reduction over time. Approach 1 options would require all projects to quantify emissions in order to determine needed reductions relative to business-as-usual (which will change over time as described above). Concepts that are unit-based (Threshold 2.5 and 2.6) will not result in thresholds that have equal amount of GHG emissions, and thus equity issues may arise.

Table 4: Non-Zero Threshold Evaluation Matrix – Approach 1

Approach 1	**1.1**	**1.2**	**1.3**	**1.4**
	28% - 33% Reduction from BAU by 2020 by Project	**50% Reduction from BAU by 2020 by Project**	**28% - 33% Reduction by 2020 by Sector**	**28% - 33% Reduction by 2020 by Region**
GHG Emissions Reduction Effectiveness	**Low** - Captures all new projects but relies on a high level of reductions from the existing economy.	**Medium** - Captures all new projects and has a more realistic level of reductions from the existing economy.	**Low** - Captures all new projects but relies on a high level of reductions from the existing economy.	**Low** - Captures all new projects but relies on a high level of reductions from the existing economy.
Economic Feasibility	**Low** - Some projects will not be able to afford this level of reduction without effective market-based mechanisms like offsets.	**Low** - Some projects will not be able to afford this level of reduction without effective market-based mechanisms like offsets.	**Medium** - Sectors as a whole will be better able to achieve reductions than individual projects.	**Low** - Some regions and newly developed areas may not be able to afford this level of reduction without effective market-based mechanisms like offsets.
Technical Feasibility	**Medium** - Some projects will not be able to achieve this level of reduction without effective market-based mechanisms like offsets	**Low** - Relatively larger set of projects will not be able to achieve this level of reduction without effective market-based mechanisms like offsets	**High** - Some projects will not be able to achieve this level of reduction without effective market-based mechanisms like offsets	**Medium** - Some regions and newly developed areas may not be able to afford this level of reduction without effective market-based mechanisms like offsets.
Logistical Feasibility	**Low** - Absent broader reductions strategies, each project may reinvent the wheel each time to achieve mandated reductions.	**Low** - Absent broader reductions strategies, each project may reinvent the wheel each time to achieve mandated reductions.	**Low** - Absent broader reductions strategies, each project may reinvent the wheel each time to achieve mandated reductions.	**Low** - Absent broader reductions strategies, each project may reinvent the wheel each time to achieve mandated reductions.
Consistency with AB-32 and S-03-05	**Medium** - Would require heavy reliance on command and control gains.	**High**	**Medium-High** - Would rely on command and control gains, but would allow sectoral flexibility.	**Medium-High** - Would rely on command and control gains, but would allow regional flexibility.
Cost Effectiveness	**Low** - Will require all types of projects to reduce the same regardless of the cost/ton of GHG reductions.	**Low** - Will require all types of projects to reduce the same regardless of the cost/ton of GHG reductions.	**Low/Medium** - Allows tradeoffs within sector between high and low cost reduction possibilities but not between sectors.	**Low/Medium** - Allows tradeoffs within region between high and low cost reduction possibilities, but not between regions.
Uncertainties	**High** - BAU changes over time. Ability to reduce GHG emissions from existing economy will take years to demonstrate. Ability to limit GHG emissions from other new development will take years to demonstrate.	**Medium/High** - BAU changes over time. Ability to limit GHG emissions from other new development will take years to demonstrate.	**High** - BAU changes over time. Ability to reduce GHG emissions from existing economy will take years to demonstrate. Ability to limit GHG emissions from other new development will take years to demonstrate.	**High** - BAU changes over time. Ability to reduce GHG emissions from existing economy will take years to demonstrate. Ability to limit GHG emissions from other new development will take years to demonstrate.
Other Advantages	Simple/easy to explain.	Simple/easy to explain.	Spreads mitigation broadly	Spreads mitigation broadly
Other Disadvantages	Requires all projects to quantify emissions.	Requires all projects to quantify emissions.	Requires all projects to quantify emissions.	Requires all projects to quantify emissions.

Table 5: Non-Zero Threshold Evaluation Matrix – Approach 2

Approach 2	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**
	Zero Threshold	**Quantitative (900 tons)**	**Quantitative CARB Reporting Threshold/Cap and Trade (25,000 tons/ 10,000 tons)**	**Quantitative Regulated Inventory Capture (~40,000 - 50,000 tons)**	**Qualitative Unit-Based Thresholds**	**Statewide, Regional or Areawide (CEQA Guidelines 15206(b)).**
GHG Emissions Reduction Effectiveness	**High** - Captures all sources.	**High** - Market capture at >90%. Captures diverse sources.	**Medium** - Moderate market capture.	**Low** - Low market capture.	**High** - Market capture at ~90%. Captures diverse sources; excl. smallest proj.	**Medium** - Moderate market capture. Excludes small and med. projects.
Economic Feasibility	**Low** - Early phases will be substantial change in BAU, esp. for smaller projects; may be infeasible to mitigate.	**Medium** - Early phases will be substantial change in BAU, esp. for smaller projects; may be infeasible to mitigate.	**High** - Large projects have greater ability to absorb cost.	**High** - Large projects have greater ability to absorb cost.	**Medium** - Early phases will be substantial change in BAU, esp. for smaller projects; may be infeasible to mitigate.	**High** - Large projects have greater ability to absorb cost.
Technical Feasibility	**Low** - Early phases will be substantial change in BAU, esp. for smaller projects; may be infeasible to mitigate.	**Medium** - Early phases will be substantial change in BAU, esp. for smaller projects; may be inefficient to mitigate.	**High** - Greater opportunities for multiple reduction approaches.	**High** - Greater opportunities for multiple reduction approaches.	**Medium** - Early phases will be substantial change in BAU, particularly for smaller projects may be inefficient to mitigate.	**High** - Greater opportunities for multiple reduction approaches.
Logistical Feasibility	**Low** - Unless fee or offset basis,very difficult to mitigate all projects.	**Medium** - BMPs broadly written to allow diversity; new req. will take time to integrate into new dev.	**High** - Less mitigation.	**High** - Less mitigation.	**Medium** - BMPs broadly written to allow diversity; new req. will take time to integrate into new dev.	**High** - Less mitigation.
Consistency with AB-32 and S-03-05	**High** - Market capture.	**High** - Market capture at >90%.	**Low** - Would rely on command and control success heavily.	**Low** - Would rely on command and control success heavily.	**Medium** - Need to demonstrate adequate market capture over time.	**Low** - Would rely on command and control success heavily.
Cost Effectiveness	**Low** - Will result in inefficient mitigation approaches. Efficiency will improve in time.	**Medium** - Emphasis is on new dev., req. for mitigation will result in inefficient mitigation approaches in early phases. Efficiency will improve in time.	**Medium** - Relies on command and control reductions for existing economy more heavily. With focus on larger projects, eff. of mitigation for new dev. high.	**Medium** - Relies on command and control reductions for existing economy more heavily. With focus on larger projects, eff. of mitigation for new dev. high.	**Medium** - Emphasis is on new dev.; req. for mitigation will result in inefficient mitigation approaches in early phases. Efficiency will improve in time.	**Medium** - Relies on command and control reductions for existing economy more heavily. With focus on larger projects, eff. of mitigation for new dev. high.
Uncertainties	**High** - Time to adapt for res. and comm.. sectors. Ability to mitigate without market-based mechanism for smaller projects unlikely.	**Medium/High** - Time to adapt for res. and comm.. sectors. Ability to mitigate without market-based mechanism for smaller projects uncertain.	**High** - Gains from command and control likely longer to be realized.	**High** - Gains from command and control likely longer to be realized.	**Medium/High** - Time to adapt for res. and comm.. sectors. Ability to mitigate without market-based mechanism for smaller projects uncertain.	**High** - Gains from command and control likely longer to be realized.
Other Advantages	Single threshold.	Single threshold. BMPs can be updated. Greenlist can be updated.	Single threshold. Does not change CEQA processing for most projects. CARB inventory = project inv.. All projects treated same.	Single threshold. Does not change CEQA processing for most projects. Follows established SIP practice.	BMPs can be updated. Greenlist can be updated. Unit-Based thresholds can be updated.	Existing guideline. Does not change CEQA processing for most projects. Endorsed by Cal. Chapter of the APA.
Other Disadvantages	Requires all projects to quantify emissions.	Requires nearly all projects to quantify emissions.			Sectoral projects have different GHG emis. Only largest projects to quantify emis.	Sectoral projects have different GHG emissions.

Introduction

This chapter evaluates the availability of various analytical methods and modeling tools that can be applied to estimate the greenhouse gas emissions from different project types subject to CEQA. This chapter will also provide comments on the suitability of the methods and tools to accurately characterize a projects emissions and offer recommendations for the most favorable methodologies and tools available. Some sample projects will be run through the methodologies and modeling tools to demonstrate what a typical GHG analysis might look like for a lead agency to meet its CEQA obligations. The air districts retained the services of EDAW environmental consultants to assist with this effort.

Methodologies/Modeling Tools

There are wide varieties of discretionary projects that fall under the purview of CEQA. Projects can range from simple residential developments to complex expansions of petroleum refineries to land use or transportation planning documents. It is more probably than not, that a number of different methodologies would be required by any one project to estimate its direct and indirect GHG emissions. Table 10 contains a summary of numerous modeling tools that can be used to estimate GHG emissions associated with various emission sources for numerous types of project's subject to CEQA. The table also contains information about the models availability for public use, applicability, scope, data requirements and its advantages and disadvantages for estimating GHG emissions.

In general, there is currently not one model that is capable of estimating all of a project's direct and indirect GHG emissions. However, one of the models identified in Table 9 would probably be the most consistently used model to estimate a projects direct GHG emissions based on the majority of projects reviewed in the CEQA process. The Urban Emissions Model (URBEMIS) is designed to model emissions associated with development of urban land uses. URBEMIS attempts to summarize criteria air pollutants and CO_2 emissions that would occur during construction and operation of new development. URBEMIS is publicly available and already widely used by CEQA practitioners and air districts to evaluate criteria air pollutants emissions against air district-adopted significance thresholds. URBEMIS is developed and approved for statewide use by CARB. The administrative reasons for using URBEMIS are less important than the fact that this model would ensure consistency statewide in how CO_2 emissions are modeled and reported from various project types.

One of the shortfalls of URBEMIS is that the model does not contain emission factors for GHGs other than CO_2, except for methane (CH_4) from mobile-sources, which is converted to CO_2e. This may not be a major problem since CO_2 is the most important GHG from land development projects. Although the other GHGs have a higher global warming potential, a metric used to normalize other GHGs to CO_2e, they are emitted in far fewer quantities. URBEMIS does not calculate other GHG emissions associated with off-site waste disposal, wastewater treatment, emissions associated with goods and services consumed by the residents and workers supported by a project. Nor does URBEMIS calculate GHGs associated with consumption of energy produced off-site. (For that matter, URBEMIS does not report criteria air pollutant emissions from these sources either).

Importantly, URBEMIS does not fully account for interaction between land uses in its estimation of mobile source operational emissions. Vehicle trip rates are defaults derived from the Institute of Transportation Engineers trip generation manuals. The trip rates are widely used and are generally considered worst-case or conservative. URBEMIS does not reflect "internalization" of trips between land uses, or in other words, the concept that a residential trip and a commercial trip are quite possibly the same trip, and, thus, URBEMIS counts the trips separately. There are some internal correction settings that the modeler can select in URBEMIS to correct for "double counting"; however, a project-specific "double-counting correction" is often not available. URBEMIS does allow the user to overwrite the default trip rates and characteristics with more project-specific data from a traffic study prepared for a project.

Residential, Commercial, Mixed-Use Type Projects/ Specific Plans

<u>Direct Emissions</u>

URBEMIS can be used to conduct a project-specific model run and obtain CO_2e emissions for area and mobile sources from the project, and convert to metric tons CO_2e. When a project-specific traffic study is not available, the user should consult with their local air district for guidance. Many air district staff are experienced practitioners of URBEMIS and can advise the lead agency or the modeler on how to best tailor URBEMIS default input parameters to conduct a project-specific model run. When a traffic study has been prepared for the project, the user must overwrite default trip length and trip rates in URBEMIS to match the total number of trips and vehicle miles traveled (VMT) contained in the traffic study to successfully conduct a project-specific model run. URBEMIS is recommended as a calculation tool to combine the transportation study (if available) and EMFAC emission factors for mobile-sources. Use of a project-specific traffic study gets around the main shortfall of URBEMIS: the lack of trip internalization. URBEMIS also provides the added feature of quantifying direct area-source GHG emissions.

<u>Important steps for running URBEMIS</u>

1. Without a traffic study prepared for the project, the user should consult with the local air district for direction on which default options should be used in the modeling exercise. Some air districts have recommendations in the CEQA guidelines.

2. If a traffic study was prepared specifically for the project, the following information must be provided:

a. Total number of average daily vehicle trips *or* trip-generation rates by land use type per number of units; and,

b. Average VMT per residential *and* nonresidential trip.

c. The user overwrites the "Trip Rate (per day)" fields for each land use in URBEMIS such that the resultant "Total Trips" and the "Total VMT" match the number of total trips and total VMT contained in the traffic study.

d. Overwrite "Trip Length" fields for residential and nonresidential trips in UBEMIS with the project-specific lengths obtained form the traffic study.

3. Calculate results and obtain the CO_2 emissions from the URBEMIS output file (units of tons per year [TPY]).

<u>Indirect Emissions</u>

URBEMIS does estimate indirect emissions from landscape maintenance equipment, hot water heaters, etc. URBEMIS does not however, provide modeled emissions from indirect sources of emissions, such as those emissions that would occur off-site at utility providers associated with the project's energy demands. The California Climate Action Registry (CCAR) Protocol v.2.2 includes methodology, which could be used to quantify and disclose a project's increase in indirect GHG emissions from energy use. Some assumptions must be made for electrical demand per household or per square foot of commercial space, and would vary based on size, orientation, and various attributes of a given structure. An average rate of electrical consumption for residential uses is 7,000 kilowatt hours per year per household and 16,750 kilowatt hours per thousand square feet of commercial floor space. Commercial floor space includes offices, retail uses, warehouses, and schools. These values have been increasing steadily over the last 20 years. Energy consumption from residential uses has increased due to factors such as construction and occupation of larger homes, prices of electricity and natural gas, and increased personal income allowing residents to purchase more electronic appliances. Commercial energy consumption is linked to factors such as vacancy rates, population, and sales.

The modeler will look up the estimated energy consumption for the project's proposed land uses under year of project buildout, or use the values given in the previous paragraph for a general estimate. The CCAR Protocol contains emission factors for CO_2, CH_4, and nitrous oxide. The "CALI" region grid serves most of the State of California. If a user has information about a specific utility provider's contribution from renewable sources, the protocol contains methodology to reflect that, rather than relying on the statewide average grid. The incremental increase in energy production associated with project operation should be accounted for in the project's total GHG emissions for inclusion in the environmental document.

The incremental increase in energy production associated with project operation should be accounted for in the project's total GHG emissions, but it should be noted that these emissions would be closely controlled by stationary-source control-based regulations and additional regulations are expected under AB 32. However, in the interest of disclosing project-generated GHG emissions and mitigating to the extent feasible, the indirect emissions from off-site electricity generation can be easily calculated for inclusion in the environmental document.

Example Project Estimates for GHG Emissions

Residential Project

Project Attributes:

- 68 detached dwelling units
- 15.9 acres
- 179 residents
- 0 jobs
- Located in unincorporated Placer County (PCAPCD jurisdiction)
- Analysis year 2009

As shown in Table 6, the project's direct GHG emissions per service population (SP) would be approximately 8 metric tons CO_2e/SP/year.

Table 6: Residential Project Example GHG Emissions Estimates

URBEMIS Output (Project Specific)	Metric Tons/Year CO_2e	Demographic Data	
Area-source emissions	251	Residents	179
Mobile-source emissions	1,044	Jobs	0
Indirect emissions (from CCAR Protocol)	174		
Total operational emissions	**1,469**	Service population	179
Operational emissions/SP	**8.2**		

Notes:
CO_2e = carbon dioxide equivalent; CCAR = California Climate Action Registry; SP = service population(see definition of service population below in discussion of Normalization/Service Population Metric).

Sources: EDAW 2007, ARB 2007b, CCAR 2007, CEC 2000

Commercial Project

Project Attributes:

- Free Standing Discount Superstore: 241 thousand square feet (ksf)
- 0 residents

- 400 jobs
- Located in the San Joaquin Valley Air Pollution Control District's (SJVAPCD) jurisdiction
- Analysis year 2009

Table 7: Commercial Project Example GHG Emissions Estimates

URBEMIS Output (Project Specific)	Metric Tons/Year CO_2e	Demographic Data	
Area-source emissions	464	Residents	0
Mobile-source emissions	13,889	Jobs	400
Indirect emissions (from CCAR Protocol)	1,477		
Total operational emissions	**15,830**	Service population	400
Operational emissions/SP	**39.6**		

Notes:
CO_2e = carbon dioxide equivalent; CCAR = California Climate Action Registry; SP = service population (see definition of service population below in discussion of Normalization/Service Population Metric).

Sources: EDAW 2007, ARB 2007b, CCAR 2007, CEC 2000

Specific Plan

If used traditionally with default trip rates and lengths, rather than project-specific (Traffic Analysis Zone-specific) trip rates and lengths, URBEMIS does not work well for specific plan or general plan-sized projects with multiple land use types proposed. However, in all instances, projects of these sizes (several hundred or thousand acres) would be accompanied by a traffic study. Thus, for large planning-level projects, URBEMIS can be used as a calculation tool to easily obtain project-specific mobile-source emissions. The user should follow the steps discussed above; wherein he/she overwrites the default ITE trip rates for each land use type with that needed to make total VMT match that contained in the traffic study. The URBEMIS interface is a simple calculator to combine the traffic study and EMFAC emissions factors for mobile-source CO_2.

Project Attributes:

- 985 acres
- Total dwelling units: 5,634
- Commercial/Mixed Use: 429 ksf
- Educational: 2,565 ksf
- 14,648 residents
- 3,743 jobs
- Located in Sacramento County (SMAQMD jurisdiction)
- Analysis year 2009

Table 8: Specific Plan Example GHG Emissions Estimates

URBEMIS Output (Project Specific)	Metric Tons/Year CO_2e	Demographic Data	
Area-source emissions	23,273	Residents	14,648
Mobile-source emissions	73,691	Jobs	3,743
Indirect emissions (from CCAR Protocol)	32,744		
Total operational emissions	**129,708**	Service population	18,391
Operational emissions/SP	**7.1**		

Notes:
CO_2e = carbon dioxide equivalent; CCAR = California Climate Action Registry; SP = service population (see definition of service population below in discussion of Normalization/Service Population Metric).

Sources: EDAW 2007, ARB 2007b, CCAR 2007, CEC 2000

The specific plan example, when compared to the residential or commercial examples, illustrates the benefit of a mixed-use development when you look at CO_2e emissions per resident or job (service population) metric (see definition of service population below in discussion of Normalization/Service Population Metric). Though this particular specific plan is not an example of a true jobs/housing balance, the trend is clear: accommodating residents and jobs in a project is more efficient than residents or jobs alone.

Stationary- and Area-Source Project Types

GHG emissions from stationary or area sources that require a permit to operate from the air district also contain both direct and indirect sources of emissions. Examples of these types of sources would be fossil fuel power plants, cement plants, landfills, wastewater treatment plants, gas stations, dry cleaners and industrial boilers. All air districts have established procedures and methodologies for projects subject to air district permits to calculate their regulated pollutants. It is anticipated that these same procedures and methodologies could be extended to estimate a permitted facility's GHG calculations. For stationary and area sources that do not require air district permits, the same methodologies used for permitted sources could be used in addition to URBEMIS and CCAR GRP to calculate GHG emissions from these facilities.

Wastewater Treatment Facilities

Direct GHG emissions associated with a proposed waste water treatment plant can be calculated using AP-42 emission factors from Chapter 4.3.5 Evaporative Loss Sources: Waste Water-Greenhouse Gases and the CCAR methodology. In general, most wastewater operations recover CH_4 for energy, or use a flare to convert the CH_4 to CO_2. There are many types of wastewater treatment processes and the potential for GHG emissions from different types of plants varies substantially. There is not one standard set of emission factors that could be used to quantify GHG emissions for a state "average" treatment plant. Thus, research will need to be conducted on a case-by-case basis to determine the "Fraction Anaerobically Digested" which is a function of the type of treatment process. Indirect emissions from these facilities can be calculated using the CCAR energy use protocols and URBEMIS model for transportation emissions.

Solid Waste Disposal Facilities

Air districts will have emission estimate methodologies established for methane emissions at permitted landfills. In addition, EPA's Landfill Gas Emissions Model (LandGem) and the CCAR methodology could also be used to quantify GHG emissions from landfill off gassing; however, this model requires substantial detail be input. The model uses a decomposition rate equation, where the rate of decay is dependent on the quantity of waste in place and the rate of change over time. This modeling tool is free to the public, but substantial project detail about the operation of the landfill is needed to run the model. Indirect emissions from these facilities can be calculated using the CCAR energy use protocols and URBEMIS model for transportation emissions.

Construction Emissions

GHG emissions would occur during project construction, over a finite time. In addition, a project could result in the loss of GHG sequestration opportunity due primarily to the vegetation removed for construction. URBEMIS should be used to quantify the mass of CO_2 that would occur during the construction of a project for land development projects. Some construction projects would occur over an extended period (up to 20–30 years on a planning horizon for general plan buildout, or 5–10 years to construct a dam, for example). OFFROAD emission factors are contained in URBEMIS for CO_2 emissions from construction equipment. For other types of construction projects, such as roadway construction projects or levee improvement projects, SMAQMD's spreadsheet modeling tool, the Road Construction Emissions Model (RoadMod), should be used. This tool is currently being updated to include CO_2 emissions factors from OFFROAD.

The full life-cycle of GHG emissions from construction activities is not accounted for in the modeling tools available, and the information needed to characterize GHG emissions from manufacture, transport, and end-of-life of construction materials would be speculative at the CEQA analysis level. The emissions disclosed will be from construction equipment and worker commutes during the duration of construction activities. Thus, the mass emissions in units of metric tons CO_2e/year should be reported in the environmental document as new emissions.

General Plans

In the short-term, URBEMIS can be used as a calculation tool to model GHG emissions from proposed general plans, but only if data from the traffic study is incorporated into model input. The same methodology applied above in the specific plan example applies to general plans. The CCAR GRP can be used to approximate indirect emissions from increased energy consumption associated with the proposed plan area. The same models and methodologies discussed previously for wastewater, water supply and solid waste would be used to estimate indirect emissions resulting from buildout of the general plan.

In the longer-term, more complex modeling tools are needed, which would integrate GHG emission sources from land use interaction, such as I-PLACE^{3}S or CTG Energetics' Sustainable Communities Custom Model attempt to do. These models are not currently available to the public and only have applicability in certain areas of the state. It is important that a tool with statewide applicability be used to allow for consistency in project treatment, consideration, and approval under CEQA.

Scenarios

At the general plan level, the baseline used for analyzing most environmental impacts of a general plan update is typically no different from the baseline for other projects. The baseline for most impacts represents the existing conditions, normally on the date the Notice of Preparation is released. Several comparative scenarios could be relevant, depending on the exact methodological approach and significance criteria used for GHG assessment:

- Existing Conditions. The GHG emissions associated with the existing, on-the-ground conditions within the planning area.

- 1990 conditions. The GHG emissions associated with the general plan area in 1990. This is relevant due to the state's AB 32 GHG emission reduction goals' benchmark year of 1990. The GHG-efficiency of 1990 development patterns could be compared to that of the general plan buildout.

- Buildout of the Existing General Plan. The GHG emissions associated with buildout of the existing general plan (without the subject update). This is the no project alternative for the purposes of general plan CEQA analysis.

- Buildout of the Updated General Plan. The GHG emissions associated with buildout of the general plan, as proposed as a part of the subject update. This would include analysis of any changes included as a part of the general plan update for the existing developed portions of the planning area. Many communities include redevelopment and revitalization strategies as a part of the general plan update. The general plan EIR can include assumptions regarding what level and type of land use change could be facilitated by infill and redevelopment. Many jurisdictions wish to provide future projects consistent with these land use change assumptions with some environmental review streamlining. In addition, many communities include transit expansions, pedestrian/bicycle pathway improvements, multi-modal facility construction, travel demand policies, energy efficiency policies, or other measures that could apply to the existing developed area, just as they may apply to any new growth areas. Such policies could affect the overall GHG emissions of the built out general plan area.

- Increment between Buildout of Updated General Plan and Existing General Plan Area. There are many important considerations associated with the characterization of the impact of the General Plan update. The actual GHG emissions impact could be described as the difference between buildout under the existing and proposed land use plan (No-Build Alternative). However, the courts have held that an EIR should also analyze the difference between the proposed General Plan and the existing environment (*Environmental Planning & Information Council v. County of El Dorado* (EPIC) (1982) 131 Cal.App.3d 350). At the General Plan level, over the course of buildout, some new land uses are introduced, which could potentially add operational GHG emissions and potentially remove existing sequestration potential. Some properties become vacant and are not redeveloped. Other properties become vacant and then are redeveloped. Communities cannot pretend to understand fully in advance each component of land use change. The programmatic document is the preferred method of environmental analysis. Through this programmatic framework, communities develop buildout assumptions as a part of the General Plan that are normally used as a basis of environmental analysis. For certain aspects of the impact analysis, it becomes important not just to understand how much "new stuff" could be accommodated under the updated General Plan, but also the altered interactions between both "new" and "existing" land uses within the planning area. As addressed elsewhere, there are tools available for use in understanding land use/transportation interactions at the General Plan level. Without the GHG targets established by AB 32, a simple mass comparison of existing conditions to General Plan buildout might be appropriate.

However, within the current legal context, the GHG efficiency of the updated General Plan becomes the focus of analysis. Some options in this regard include:

- Estimate the GHG emissions associated with all the land uses included within the planning area upon buildout of the General Plan using no project specific information (regional, countywide, or statewide defaults). Estimate GHG emissions using project specific information from the transportation engineer, transportation demand policies, community design elements, energy efficiency requirements, wastewater treatment and other public infrastructure design changes, and other components. Compare these two calculations. Is the second calculation reduced by the percent needed to meet AB 32 goals compared to the first calculation?

- Estimate the GHG emissions associated with the 1990 planning area and the per-capita or per-service population GHG associated with the 1990 planning area. (Many communities are establishing GHG inventories using different tools). Estimate the GHG emissions associated with buildout of the proposed General Plan update and the resulting per-capita or per-service population GHG emissions. Compare the two calculations. Is the General Plan buildout per-capita or per-service population level greater than the 1990 estimate?

Example General Plan Update: Proposed new growth area

Project Attributes:

- 10,050 single family dwelling units
- 652 multi-family dwelling units
- 136 acres parks
- 2,047 ksf commercial (regional shopping center)
- 2,113 ksf office
- 383 acres industrial park
- 31,293 new residents
- 4,945 new jobs
- Located in Stanislaus County (SJVAPCD jurisdiction)
- Analysis year 2025

Table 9: General Plan Example GHG Emissions Estimates

URBEMIS Output (Project Specific)	**Metric CO_2e**	**Tons/Year**	**Demographic Data**	
Construction emissions	12,083*		Residents	31,293
Area-source emissions	45,708			
Mobile-source emissions	263,954		Jobs	4,945
Indirect emissions (from CCAR Protocol)	78,385			
Total operational emissions	**388,046**		Service population	36,238
Operational emissions/SP	**10.7**			

* Approximately 241,656 metric tons CO_2e total at general plan buildout (assumes 20-year buildout period). Construction emissions were not included in total operational emissions.
Notes:
CO_2e = carbon dioxide equivalent; CCAR = California Climate Action Registry; SP = service population (see definition of service population below in discussion of Normalization/Service Population Metric).
Sources: EDAW 2007, ARB 2007b, CCAR 2007, CEC 2000

Due to the programmatic level of analysis that often occurs at the general plan level, and potential for many relevant GHG emission quantities, it could be preferable to use a qualitative approach. Such an analysis could address the presence of GHG-reducing policy language in the general plan.

Three possible tiers of approaches to addressing GHG mitigation strategies, either as general plan policy, general plan EIR mitigation measures, or both, include:

- Forward planning
- Project toolbox
- Defer to GHG reductions plan

The three basic approaches are described below.

1. Bring reduction strategies into the plan itself. The most effective way for local jurisdictions to achieve GHG emissions reductions in the medium- and long-term is through land use and transportation policies that are built directly into the community planning document. This involves creating land use diagrams and circulation diagrams, along with corresponding descriptive standards, that enable and encourage alternatives to travel and goods movement via cars and trucks. The land use and circulation diagrams provide a general framework for a community where people can conduct their everyday business without necessarily using their cars. The overall community layout expressed as a part of the land use and circulation diagrams is accompanied by a policy and regulatory scheme designed to achieve this community layout. Impact fees, public agency spending, regulations, administrative procedures, incentives, and other techniques are designed to facilitate land use change consistent with the communities' overall vision, as expressed in policy and in the land use diagram. There are many widely used design principles that can be depicted in land use and circulation diagrams and implemented according to narrative objectives, standards, and policies:

- Connectivity. A finely-connected transportation network shortens trip lengths and creates the framework for a community where homes and destinations can be placed close in proximity and along direct routes. A hierarchical or circuitous transportation network can increase trip lengths and create obstacles for walking, bicycling, and transit access. This policy language would likely be found in the Circulation Element.

- Compactness. Compact development, by its nature, can increase the efficiency of infrastructure provision and enable travel modes other than the car. If communities can place the same level of activity in a smaller space, GHG emissions would be reduced concurrently with VMT and avoid unnecessary conversion of open space. This policy language would likely be found in the Land Use Element.

- Diversity. Multiple land use types mixed in proximity around central "nodes" of higher-activity land uses can accommodate travel through means other than a car. The character and overall design of this land use mix is, of course, different from community to community. This policy language would likely be found in the Land Use Element.

- Facilities. Pedestrian, bicycle, and public transportation improvements, planning, and programming are sometimes an afterthought. To get a more GHG-efficient mode share, safe and convenient bike lanes, pedestrian pathways, transit shelters, and other facilities are required to be planned along with the vehicular travel network. This policy language would likely be found in the Circulation Element.

- Redevelopment. One way to avoid GHG emissions is to facilitate more efficient and economic use of the lands in already-developed portions of a community. Reinvestment in existing neighborhoods and retrofit of existing buildings is appreciably more GHG efficient than greenfield development, and can even result in a net reduction in GHG emissions. This policy language would likely be found in the Conservation or Land Use Element.

- Housing and Employment. Most communities assess current and future economic prospects along with long-range land use planning. Part of the objective for many communities is to encourage the coalescence of a labor force with locally available and appropriate job opportunities. This concept is best known as "jobs-housing balance." This policy language would likely be found in the Housing Element.

- Planning Level Versus Project Level. For transportation-related GHG emissions that local governments can mitigate through land use entitlement authority, the overall community land use strategy and the overall transportation network are the most fruitful areas of focus. The reduction capacity of project-specific mitigation measures is greatly limited if supportive land use and transportation policies are lacking at the community planning level. The regional economic context, of course, provides an important backdrop for land use and transportation policy to address GHG emissions. Within this context, the general plan is the readily available tool for local governments to establish such land use and transportation strategies. This policy language would likely be found in the Land Use and Circulation Elements.

- Shipping Mode Shift. Locate shipping-intensive land uses in areas with rail access. Some modes of shipping are more GHG-intensive than others. Rail, for example, requires only about 15 to 25 percent of the energy used by trucks to ship freight equivalent distances and involves reduced transportation-related GHG emissions. Cities and counties have little direct control over the method of shipment that any business may choose. Nevertheless, as a part of the general planning process, cities and counties can address constraints on the use of rail for transporting goods. This policy language would likely be found in the Land Use and Circulation Elements.

2. Provide a "toolbox" of strategies after the project site has been selected. In addition to the examples of design principles that are built into the community planning process, communities can offer project applicants a range of tools to reduce GHG emissions. Mitigation strategies are elaborated in detail in Chapter 9.

3. Defer to General Plan implementation measure. Develop and implement a GHG Emissions Reduction Plan. Another option for local governments would be development of an implementation measure as a part of the general plan that outlines an enforceable GHG reduction program. Perhaps the most well known example of this approach is the result of California's Attorney General settlement of the lawsuit brought against San

Bernardino County. The County has agreed to create a 1990 GHG inventory and develop measures to reduce such emissions according to the state's overall goals. Other communities have pursued similar programs (i.e., the City of San Diego, Marin County). Along with the inventories, targets, and example reduction measures, these programs would include quantitative standards for new development; targets for reductions from retrofitting existing development; targets for government operations; fee and spending program for GHG reduction programs; monitoring and reporting; and other elements. The local government itself should serve as a model for GHG reduction plan implementation, by inventorying emissions from government operations and achieving emission reductions in accordance with the plan's standards. An optional climate change element could be added to contain goals, policies, and this implementation strategy, or this could belong in an optional air quality element.

Other Project Types

Air District Rules, Regulations and Air Quality Plans

Air district air quality plans, rules and regulations could have the potential to increase or decrease GHG emissions within their respective jurisdiction. In general, air district air quality plans, rules and regulations act to reduce ozone precursors, criteria air pollutant and toxic air contaminant emissions, which would almost always act to reduce GHG emissions simultaneously. However, this may not always be the case.

Air Quality Plans

Air districts will have to include GHG emissions analysis as part of their criteria air pollutant and toxic air contaminant air pollutant analysis when considering the adoption of air quality plans and their subsequent rules and regulations needed to implement the plans. Multiple models and methodologies will be needed to accomplish this analysis.

Regional Transportation Plans

Regional transportation plans would also need to be evaluated on a case-by-case basis to determine if a net increase or decrease in GHG emissions would occur. Complex interactions between the roadway network, operating conditions, alternative transportation availability (such as public transit, bicycle pathways, and pedestrian infrastructure), and many other independent parameters specific to a region should be considered. Regional transportation models exist to estimate vehicular emissions associated with regional transportation plans, which includes the ability to estimate GHG emissions.

Normalization/Service Population Metric

The above methodology would provide an estimate of the mass GHG emissions generated by a proposed project, which could be compared to a mass emission threshold. EDAW developed a methodology that would measure a project's overall GHG efficiency in order to determine if a project is more efficient than the existing statewide average for per capita GHG emissions. The following steps could be employed to estimate the GHG-"efficiency," which may be more directly correlated to the project's ability to help obtain objectives outlined in AB 32, although it relies on establishment of an efficiency-based significance threshold. The subcommittee believes this methodology may eventually be appropriate to evaluate the long-term GHG emissions from a project in the context of meeting AB 32 goals. However, this methodology will need substantially more work and is not considered viable for the interim guidance presented in this white paper.

- Divide the total operational GHG emissions by the Service Population (SP) supported by the project (where SP is defined as the sum of the number of residents and the number of jobs supported by the project). This value should be compared to that of the projected statewide GHG emissions inventory from the applicable end-use sectors (electricity generation, residential, commercial/institutional, and mobile-source) in 1990 divided by the projected statewide SP for the year 2020 (i.e., AB 32 requirements), to determine if the project would conflict with legislative goals.
    - If the project's operational GHG/SP falls below AB 32 requirements, then the project's GHG emissions are less than cumulatively considerable.
    - If the project's operational GHG/SP exceed AB 32 requirements (a substantial contribution), then the project's GHG emissions would conflict with legislative requirements, and the impact would be cumulatively considerable and mitigation would be required where feasible.
- New stationary and area sources/facilities: calculate GHG emissions using the CCAR GRP. All GHG emissions associated with new stationary or area sources should be treated as a net increase in emissions, and if deemed significant, should be mitigated where feasible.
- Road or levee construction projects or other construction-only projects: calculate GHG emissions using the RoadMod, which will be updated to contain GHG emission factors from EMFAC and OFFROAD. All construction-generated GHG emissions should be treated as a net increase, and if deemed significant, should be mitigated to the extent feasible.
- Air District rulemaking or air quality management plan-type projects should be evaluated on a case-by-case basis for secondary impacts of increased GHG emissions generation. In most cases, the types of projects that act to reduce regional air pollution simultaneously act to reduce GHG emissions, and would be beneficial, but should be evaluated for secondary effects from GHG emissions.
- Regional transportation plans should also be evaluated on a case-by-case basis for potential to either reduce or increase GHG emissions from the transportation sector. EMFAC can be utilized to determine the net change in GHG emissions

associated with projected vehicle VMT and from operating speed changes associated with additional or alleviated congestion.

To achieve the goals of AB 32, which are tied to GHG emission rates of specific benchmark years (i.e., 1990), California would have to achieve a lower rate of emissions per unit of population and per unit of economic activity than it has now. Further, in order to accommodate future population and economic growth, the state would have to achieve an even lower rate of emissions per unit than was generated in 1990. (The goal to achieve 1990 quantities of GHG emissions by 2020 means that this will need to be accomplished in light of 30 years of population and economic growth in place beyond 1990.) Thus, future planning efforts that would not encourage new development to achieve its fair share of reductions in GHG emissions would conflict with the spirit of the policy decisions contained in AB 32, thus impeding California's ability to comply with the mandate.

Thus, if a statewide context for GHG emissions were pursued, any net increase in GHG emissions within state boundaries would be considered "new" emissions. For example, a land development project, such as a specific plan, does not necessarily create "new" emitters of GHG, but would theoretically accommodate a greater number of residents in the state. Some of the residents that move to the project could already be California residents, while some may be from out of state (or would 'take the place' of in-state residents who 'vacate' their current residences to move to the new project). Some may also be associated with new births over deaths (net population growth) in the state. The out-of-state residents would be contributing new emissions in a statewide context, but would not necessarily be generating new emissions in a global context. Given the California context established by AB 32, the project would need to accommodate an increase in population in a manner that would not inhibit the state's ability to achieve the goals of lower total mass of emissions.

The average net influx of new residents to California is approximately 1.4 percent per year (this value represents the net increase in population, including the net contribution from births and deaths). With population growth, California also anticipates economic growth. Average statewide employment has grown by approximately 1.1 percent over the last 15 years. The average percentage of population employed over the last 15 years is 46 percent. Population is expected to continue growing at a projected rate of approximately 1.5 percent per year through 2050. Long-range employment projection data is not available from the California Department of Finance (DOF) and can be extrapolated in different ways (e.g., linear extrapolation by percentage rate of change, percentage of population employed, mathematical series expansion, more complex extrapolation based on further research of demographic projections such as age distribution). Further study would be needed to refine accurate employment projections from the present to 2050. For developing this framework, employment is assumed to have a constant proportionate relationship with the state's population. The projected number of jobs is assumed to be roughly 46 percent of the projected population.

In light of the statewide context established by California law, consistency is most important for evaluating GHG emissions from projects. Thus, URBEMIS and the CCAR GRP are the recommended tools for quantification of GHG emissions from most project types in the short term. Over the long term, more sophisticated models that integrate the relationship between GHG emissions and land use, transportation, energy, water, waste, and other resources, and have similar application statewide would have better application to the problem, but may not currently be as accessible or as easily operable. I-PLACE^{3}S and CTG Energetics' Sustainable Communities Model (SCM) are two examples of such models that contain emission factors for GHGs, which could be refined to have applicability statewide and made available to CEQA practitioners. Other models are likely to be developed, given the importance of this issue.

Short-Term and Long-Term Methodologies

The following tools can be used to quantify a project's GHG emissions until tools that are more comprehensive become available statewide:

1. Land development projects: URBEMIS 2007 v. 9.2 and the CCAR GRP v. 2.2 (short-term); further development of I-PLACE^{3}S or CTG's Sustainable Communities Model (long-term).
2. New stationary and area sources/facilities: AP-42 Chapter 4.3, LandGem v. 3.02, and/or CCAR GRP v. 2.2.
3. Road or levee construction projects or other construction-only projects: RoadMod/OFFROAD 2007.

Ideally, I-PLACE^{3}S or CTG's Sustainable Communities Model would be expanded to apply to all regions of the state. These types of models use an integrated approach, which is the best approach for reasonably approximating the emissions that result from interaction between land uses, but neither is available to the public and would create consistency problems in reporting emissions from projects across the state if these were used today. However, a similar model with statewide applicability will likely be developed due to the importance of the issue.Table 10 Summary of Modeling Tools for Estimating GHG Emissions and Project Applicability

Table 10: Summary of Modeling Tools for GHG Emissions

Method/Tool Description	Availability	Applicability	Scope	Ease of Use	Data Input (Requirements and Guidance)	Data Output	Recommendation Comments	Advantages/ Disadvantages
URBEMIS 2007	*Public domain -Download (www.urbemis.com) free of charge*	*Land development and construction projects (construction, mobile- and area-source emissions)*	*Local*	*Fairly Easy*	*Land use information, construction and operational data and assumptions (e.g., jurisdiction, acres of land use type, year of operation, etc.)*	*Mobile-source Construction & Operational CO_2 (lb/day or tons/year)*	*-Recommended for land use development and construction projects -Also recommended for net change in land use (zoning changes)*	*-Does not quantify indirect emissions from energy consumption or other GHGs (except methane from mobile-sources) -Free, available to public, and applicable statewide -Widely used for assessment of other air quality impacts*
California Climate Action Registry General Reporting Protocol v. 2.2	*Public guidance document*	*Indirect emissions from land development projects, stationary- and area-source facilities regulated under AB 32*	*State*	*Easy*	*Energy consumption*	*CO_2e (Metric tons/year)*	*-Recommended for indirect emissions from energy consumption for land use development projects, and for new stationary- or area- sources to be regulated*	*-Contains emission factors for CH_4 and N_2O in addition to CO_2 -Does not contain emission factors broken down by utility provider (statewide average grid only)*
Clean Air and Climate Projection (CACP) Software	*Public agencies (members of ICLEI, NACAA, or similar)*	*Local governments used for emissions inventories*	*Local*	*N/A*	*Energy usage, waste generation/disposal transportation*	*CO_2e (tons/year)*	*-Recommended for inventories of local government entities activities (must be a member of affiliated agency or group)*	*-Not available to public*
CTG Sustainable Communities Model	*Custom model*	*Land development*	*Regional, scalable*	*N/A*	*Land use information, operational (mobile, energy, economic, infrastructure) assumptions*	*CO_2e (tons/year)*	*-An integrated and comprehensive modeling tool, but cannot obtain*	*-Not available to public*

Method/Tool Description	Availability	Applicability	Scope	Ease of Use	Data Input (Requirements and Guidance)	Data Output	Recommendation Comments	Advantages/ Disadvantages
I-PLACE[3]S	*Access fee through local COG Only available for eight California counties*	*Land use change*	*Regional, scalable*	*Fairly Easy*	*Parcel information*	*CO_2 (lb/day or tons/year)*	*-Recommended for land use development projects and land use changes -Especially good for general plans*	*-Not freely available to public -Not applicable statewide -Actually provides insight into land use interaction -Can include very specific project attributes -Trip rates are from behavioral survey data, instead of ITE*
EMFAC 2007	*Public domain*	*On-road mobile-sources*	*Statewide, regional*	*Fairly Easy*	*Vehicle fleet information*	*CO_2 (grams/mile)*	*-Not recommended for most projects (URBEMIS preferred) -Could be used for certain Air District Rulemaking applications*	*-Can compare emissions based on speed-distribution -Emission factors contained in URBEMIS -Not a stand-alone model*
OFFROAD 2007	*Public domain*	*Off-road mobile sources (construction equipment)*	*Statewide, regional*	*Fairly Easy*	*Construction fleet information*	*CO_2 (lb/day)*	*-Not recommended (URBEMIS preferred) -could be used for certain Air District Rulemaking applications (re: construction equipment)*	*-Emission factors contained in URBEMIS*
RoadMod (to be updated to include CO_2)	*Public domain*	*Off-road and on-road mobile sources (construction equipment and material haul trucks)*	*Statewide*	*Easy*	*Construction information*	*CO_2 (lb/day or tons/project)*	*-Recommended for construction-only projects (linear in nature; i.e., levees, roads, pipelines)*	*-To be updated to support emissions factors from OFFROAD 2007*

Method/Tool Description	Availability	Applicability	Scope	Ease of Use	Data Input (Requirements and Guidance)	Data Output	Recommendation Comments	Advantages/ Disadvantages
DTIM	*Public domain*	*On-road mobile-sources*	*Statewide, regional*	*Difficult (consists of a series of three programs and requires input files from traffic and emissions modeling)*	*-EMFAC files* *-Traffic model output files (e.g., link, interzonal, and trip end data)* *-User options file* *-Optional files*	*CO_2 (tons/year)*	*-Not recommended*	*-Not updated to support EMFAC 2007 emission factors* *-Input files include output files from regional transportation models which more accurately reflect VMT*
Southeast Climate Change Partnership Spreadsheet Model (UK)	*Public domain http://www.climatesoutheast.org.uk/*	*UK Local government/ agencies/ organizations used for emissions inventories*	*Local, county, regional*	*Fairly easy*	*Energy usage, waste generation/disposal, transportation*	*CO_2 (tonnes/year)*	*-Not recommended for use in California, but could be a valuable source for building an applicable spreadsheet model*	*-Applicability for UK, but could be updated with CA-specific emission factors*
EPA AP-42; Evaporation Loss Sources Chapter 4.3.5	*Public reference document*	*GHG emissions from waste water treatment facilities*	*Facility level*	*Easy equation; substantial research needed to use*	*Biochemical oxygen demand (BOD) loading, Fraction anaerobically digested*	*CH4 (lb/year)*	*-Recommended for Publicly owned treatment works (POTW) projects*	*-Substantial research needed to determine the "fraction anaerobically digested" parameter, which is dependent on the type of treatment plant/process*
LandGem v. 3.02	*Public domain http://www.epa.gov/ttn/catc/dir1/landgem-v302.xls*	*GHG emissions from anaerobic decomposition associated with landfills*	*Facility Level*	*Moderate*	*Solid waste processing, year of analysis, lifetime of waste in place*	*CO_2, CH_4 (Mega grams/year)*	*-Recommended for landfill emissions*	*-Emission rates change dependent on years of decomposition, waste in place rates of change.* *-Complex decomposition rate equation, but good first approximation*

Method/Tool Description	Availability	Applicability	Scope	Ease of Use	Data Input (Requirements and Guidance)	Data Output	Recommendation Comments	Advantages/ Disadvantages
CARROT	*Registry members*	*Stationary source emissions, vehicle fleet mobile sources*	*Facility level*	*Moderate*	*Facility-specific information*	*All GHGs*	*-Recommended for reporting facilities under AB 32 and for indirect emissions from energy consumption (CCAR Protocol)*	*-Estimates all GHGs and normalizes to CO_2e* *-Not publicly available*

Notes:

GHG = greenhouse gas; AB = assembly bill; CO_2e = carbon dioxide equivalent; CH_4 = methane; N_2O = nitrous oxide; COG = council of governments ; ITE = Institute of Transportation Engineers; CCAR = California Climate Action Registry

Source: Data compiled by EDAW and the California Air Pollution Control Officers Association in 2007

Introduction

This chapter (and Appendix B) identifies existing and potential mitigation measures that could be applied to projects during the CEQA process to reduce a project's GHG emissions that would be identified using the analytical methodologies included in this white paper. The Subcommittee retained the services of EDAW to assist with this effort. EDAW performed a global search of mitigation measures currently in practice and under study that would reduce GHG emissions.

Table 16 (Appendix B) provides a brief description of each measure along with an assessment of their feasibility (from a standpoint of economical, technological, and logistical feasibility, and emission reduction effectiveness), and identifies their potential for secondary impacts to air quality. During the global search performed, EDAW also took note of GHG reduction strategies being implemented as rules and regulation (e.g., early action items under AB 32), which are summarized in Table 18 (Appendix C). It is important to note that though compliance with such would be required by regulation for some sources, such strategies may be applicable to other project and source types.

The recurring theme that echoes throughout a majority of these measures is the shift toward New Urbanism, and research has consistently shown that implementation of Neotraditional Development techniques reduces VMT and associated emissions. The material reviewed assessed reductions from transportation-related measures (e.g., bicycle, pedestrian, transit, and parking) as a single comprehensive approach to land use. This comprehensive approach focuses on development design criteria conducive to enhancing alternate modes of transportation, including transit, walking, and bicycling. Transportation Demand Management (TDM) programs are viewed as a mechanism to implement specific measures. TDM responsibilities may include offering incentives to potential users of alternative modes of transportation and monitoring and reporting mode split changes.

The comprehensive approach makes it more difficult to assess reductions attributable to each measure. Nevertheless, there is a strong interrelationship between many of the measures, which justifies a combined approach. Consider the relationship between bike parking nonresidential, bike parking residential, endtrip facilities, and proximity to bike path/bike lane measures. In reality, these measures combined act as incentives for one individual to bike to work, while implementation of a single measure without the others reduces effectiveness.

The global nature of GHG emissions is an important feature that enables unique mitigation: abatement. When designing a project subject to CEQA, the preferred practice is first to avoid, then to minimize, and finally to compensate for impacts. Where the impact cannot be mitigated on-site, off-site mitigation is often and effectively implemented in several resource areas, either in the form of offsetting the same impact or preserving the resource elsewhere in the region. Frequently, mitigation fee programs or funds are established, where the proponent pays into the program and fees collected throughout the region or state are used to implement projects that, in turn, proportionately offset the impacts of the projects to the given resource. It may be more cost-effective to reduce as much GHG on-site as feasible (economically and technologically). Then the proponent would pay into a "GHG retrofit fund" to reduce equivalent GHG emissions off-site. In contrast to regional air pollutant offset programs such as the Carl Moyer Program, it matters greatly where reductions of ozone precursors occur, as ozone affects regional air quality. The GHG retrofit fund could be used to provide incentives to upgrade older buildings and make them more energy efficient. This would reduce demand on the energy sector and reduce stationary source emissions associated with utilities. This program has been successfully implemented in the United Kingdom where developments advertise "carbon neutrality." Of course, some GHG emissions occur associated with operation of the development, but the development would offset the remainder of emissions through off-site retrofit. Avoiding emissions that would otherwise continue to occur at existing development would be a unique opportunity for mitigation of GHG emissions. Reduction of GHG emissions also may have important side benefits including reduction of other forms of pollution.

Depending on the significance threshold concept adopted, projects subject to the CEQA process would either qualitatively or quantitatively identify the amount of GHG emissions associated with their project using the analytical methodologies identified in the previous chapter. The analysis would then apply the appropriate number of mitigation measures listed in Appendix B to their project to reduce their GHG emissions below the significance level. Calculating the amount of GHG emission reductions attributable to a given mitigation measure would require additional research. The examples below illustrate how a project would be mitigated using this approach.

Residential Project Example

Project Attributes:

- 68 detached dwelling units
- 15.9 acres
- Located in unincorporated Placer County PCAPCD jurisdiction)
- Assume URBEMIS defaults for a rural project in Placer County, in absence of a traffic study (This is contrary to the recommendations contained under Task 1; a traffic study is necessary to asses project-specific GHG emissions).
- Analysis year 2009

Table 11: Residential Project Example GHG Emissions Estimates with Mitigation

URBEMIS Output (Unmitigated)	Metric Tons/Year CO_2e	URBEMIS Output (Mitigated)	Metric Tons/Year CO_2e	Percent Reduction
Area-source emissions	252	Area-source emissions	215	14.6
Mobile-source emissions	1,047	Mobile-source emissions	916	12.5
Total direct operational emissions (area + mobile)	1,299	Total operational emissions (area + mobile)	1,131	12.9

Notes:
CO_2e = carbon dioxide equivalent

Sources: Data compiled by EDAW in 2007

Using URBEMIS 2007 and assuming the project would implement the mitigation measures listed below, yearly project-generated emissions of CO_2e would be reduced by approximately 13 percent. Implementation of the following mitigation measures is assumed:

- 100 housing units within one-half-mile radius of project's center, including this project's 68 residential units;
- provision of 80 jobs in the study area;
- retail uses present with one-half-mile radius of project's center;
- 10 intersections per square mile;
- 100% of streets with sidewalks on one side;
- 50% of streets with sidewalks on both sides;
- 30% of collectors and arterials with bike lanes, or where suitable, direct parallel routes exist;
- 15% of housing units deed restricted below market rate;
- 20% energy efficiency increase beyond Title 24; and
- 100% of landscape maintenance equipment electrically powered and electrical outlets in front and rear of units.

Example Project Methodology and Mitigation

Table 12 –Residential Projects Example Methodology and Mitigation

Source	Methodology	Mitigation
Direct Emissions		
Construction	URBEMIS (OFFROAD emission factors)	MM C-1→MM C-4
Mobile Sources	URBEMIS (EMFAC emission factors)	MM T-3→MM T-8, MM T-10→MM T-14, MM T-16, MM T-19→MM T-21 MM D-2→MM D-8, MM D-10→MM D-15, MM D-17 MM S-1→MM S-2 MM M-1→MM M-2
Area Sources	URBEMIS	MM D-13→MM D-15, MM D-17
Indirect Emissions		
Energy Consumption	CCAR GRP & CEC	MM E-1→MM E-8, MM E-10, MM E-12→MM E-23 MM S-1→MM S-2 MM M-1→MM M-2

Table 13 –Commercial Projects Example Methodology and Mitigation

Source	Methodology	Mitigation
Direct Emissions		
Construction	URBEMIS (OFFROAD emission factors)	MM C-1→MM C-4
Mobile Sources	URBEMIS (EMFAC emission factors)	MM T-1→MM T-2, MM T-4→MM T-15, MM T-17→MM T-21 MM D-1→MM D-3, MM D-5→MM D-6, MM D-10, MM D-12, MM D-14→MM D-17 MM E-24 MM S-1→MM S-2 MM M-1→MM M-2
Area Sources	URBEMIS	MM D-14→MM D-17
Indirect Emissions		
Energy Consumption	CCAR GRP & CEC	MM E-1, MM E-4→MM E-13, MM E-16→MM E-24 MM S-1→MM S-2 MM M-1→MM M-2

Table 14 –Specific Plans Example Methodology and Mitigation

Source	Methodology	Mitigation
Direct Emissions		
Construction	URBEMIS (OFFROAD emission factors)	MM C-1→MM C-4
Mobile Sources	Short-term: URBEMIS (EMFAC emission factors). Long-term: I-PLACE^{3}S/CTG SCM	MM T-1→MM T-21 MM D-1→MM D-12, MM D-18→ MM D-19 MM E-24 MM S-1→MM S-2 MM M-1→MM M-2
Area Sources	Short-term: URBEMIS (EMFAC emission factors). Long-term: I-PLACE^{3}S/CTG SCM	MM D-13→MM D-19 MM E-1→MM E-24 MM S-1→MM S-2 MM M-1→MM M-2
Indirect Emissions		
Energy Consumption	Short-term: CCAR GRP & CEC. Long-term: I-PLACE^{3}S/CTG SCM	

General Plans

- Include a general plan policy to reduce emissions within planning area to a level consistent with legislative requirements.
- Implementation strategies include preparation of a GHG reduction plan.
- Projects consistent with a general plan could be responsible for complying with such a policy.

Table 15 –General Plans Example Methodology and Mitigation

Source	Methodology	Mitigation
Direct Emissions		
Construction	URBEMIS (OFFROAD emission factors).	MS G-1 MM G-15
Mobile Sources	Short-term: URBEMIS (EMFAC emission factors). Long-term: I-PLACE^{3}S/CTG SCM	MS G-1 MS G-2→MS C-7, MS G-9, MS G-12, MS-13→MS-14, MS-16→MS-23
Area Sources	Short-term: URBEMIS (EMFAC emission factors). Long-term: I-PLACE^{3}S/CTG SCM	MS G-1 MS G-8→MS C-11, MS G-134, MS G-12, MS-15, MS-17, MS-22
Indirect Emissions		
Energy Consumption	Short-term: CCAR GRP & CEC. Long-term: I-PLACE^{3}S/CTG SCM	

Other Project Types

Air District Rules and Regulations

Air district rules and regulations could have the potential to increase or decrease GHG emissions within the respective jurisdiction. In general, air district rules and regulations act to decrease criteria air pollutant or toxic air contaminant emissions, which would usually act to reduce GHG emissions simultaneously. However, this may not always be the case and air district rules and regulations could address emissions from a large variety of different source types. Reductions of GHG emissions associated with implementation of applicable mitigation, which could also vary greatly, would need to be evaluated on a case-by-case basis. However, once applicable mitigation measures are identified, percent reductions based on the best available research to date, such as those specified in Table 15, could be applied to determine mitigated emissions.

Air Quality Plans

Similarly to air district rules and regulations, air quality plans could have the potential to increase or decrease GHG emissions because of criteria air pollutant reduction strategies. In general, strategies implemented by air districts to reduce criteria air pollutants also act to reduce GHG emissions. However, this may not always be the case. Reductions of GHG emissions associated with implementation of applicable mitigation would need to be evaluated on a case-by-case basis. The methodology identified above for determining whether the strategies contained within the GHG reduction plan would adhere to the level specified in general plan policy could also be used to determine the reductions associated with CAP strategies.

Regional Transportation Plans

Regional transportation plans and reductions of GHG emissions associated with implementation of applicable mitigation would also need to be evaluated on a case-by-case basis to determine if a net increase or decrease in GHG emissions would occur. Complex interactions between the roadway network, operating conditions, alternative transportation availability (such as public transit, bicycle pathways, and pedestrian infrastructure), and many other independent parameters specific to a region should be considered. EMFAC 2007 can be used with VMT from the RTP to create an inventory of GHG emissions. Reductions associated with implementation of applicable measures contained in Table 16 could be accomplished by accounting for VMT reductions in the traffic model.

Many states, counties, and cities have developed policies and regulations concerning greenhouse gas emissions that seek to require or promote reductions in GHG emissions through standards for vehicle emissions, fuels, electricity production/renewables, building efficiency, and other means. However, we could only identify three public agencies in the United States that are considering formally requiring the analysis of greenhouse gas emissions and climate change for development projects during their associated environmental processes. There may be others, but they were not identified during research conducted during preparation of this paper.

The following is a summary of those three efforts.

Commonwealth of Massachusetts - MEPA Greenhouse Gas Emissions Policy and Protocol

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) has determined that the phrase “damage to the environment” as used in the Massachusetts Environmental Policy Act (MEPA) includes the emission of greenhouse gases caused by projects subjects to MEPA Review. EEA has published a Greenhouse Gas Emissions Policy (GGEP) to fulfill the statutory obligation to take all feasible measurers to avoid, minimize or mitigate damage to the environment.

The GGEP concerns the following projects only:

- The Commonwealth or a state agency is the proponent;
- The Commonwealth or a state agency is providing financial assistance;
- The project is privately funded, but requires an Air Quality Permit from the department of Environmental Protection;
- The project is privately funded, but will generate:
    - 3,000 or more new vehicle trips per day for office projects;
    - 6,000 or more new vehicle trips per day for mixed use projects that are 25% or more office space; or
    - 10,000 or more new vehicle trips per day for other projects.

As a comparison, the trip generation amounts correspond as follows:

- 3,000 vehicle trips per day = approximately 250,000 square foot office development;
- 6,000 or more new vehicle trips per day for mixed use projects that are 25% or more office space = if 25% office space, then equivalent to approximately 130,000 square feet of office and either 100,000 square feet of retail or 450 single-family residential units or some combination thereof.
- 10,000 or more new vehicle trips per day = approximately 1,000 single family residential units or 250,000 square feet retail.

The draft policy states it is not intended to create a numerical GHG emission limit or a numerical GHG emissions reduction target, but rather to ensure that project proponents and reviewers have considered the GHG emissions impacts of their projects and taken all feasible means and measure to reduce those impacts.

The draft policy notes that some projects within these categories will have little or no greenhouse gas emission and the policy will not apply to such projects. EEA intends to identify in the scoping certificate whether a project falls within this *de minimis* exception.

The GGEP requires qualifying projects to do the following:

- to quantify their GHG emissions;
- identify measures to minimize or mitigate such emissions;
- quantify the reduction in emissions and energy savings from mitigation.

Emissions inventories are intended to focus on carbon dioxide, but analysis of other GHGs may be required for certain projects. EEA will require analysis of direct GGH emissions and indirect (electricity and transportation) emissions. The GGEP references the protocols prepared by the World Resource Institute as guidance for inventory preparation.

The policy is still in draft form, but the comment period closed on August 10, 2007.

King County, Washington - Executive Order on the Evaluation of Climate Change Impacts through the State Environmental Policy Act (SEPA)

On June 27, 2007, the King County Executive Ron Sims directed all King County Departments, as follows:

> *"…effective September 1, 2007 to require that climate impacts, including, but not limited to those pertaining to greenhouse gases, be appropriately identified and evaluated when such Departments are acting as the lead agency in reviewing the environmental impacts of private or public proposals pursuant to the State Environmental Policy Act"*.

The Executive Order does not define what a "climate impact" is. Based on statements of the County Deputy Chief of Staff[*]

- County agencies will ask project proponents to supply information on transportation, energy usage and other impacts of proposed projects using the County's existing SEPA checklist.

[*] Marten Law Group: Environmental News, August 1, 2007, "King County (WA) First in Nation to Require Climate Change Impacts to be Considered During Environmental Review of New Projects".

- There is no current plan to require project proponents to take action to mitigate the impacts identifies.
- Development of emissions thresholds and mitigation requirements will be undertaken in connection with the County's upcoming 2008 update of its Comprehensive Plan.

Sacramento Metropolitan Air Quality Management District

The Sacramento Metropolitan Air Quality Management District released an interim guidance on addressing climate change in CEQA documents on September 6, 2007. While very general in nature, the District recommends that CEQA environmental documents include a discussion of anticipated GHG emissions during both the construction and operation phases of the project. This includes assessing the GHG emissions from projects (using readily available models) to determine whether a project may have a significant impact. If so, then the District recommends addressing all of the District's GHG mitigation measures (drawn from comments made by the California Attorney General) – with explanations on how the mitigation will be implemented or providing rationale for why a measure would be considered infeasible. The District provides assistance to agencies in their analysis of GHG emissions and the applicability of specific mitigation measures. The District's guidance can be found at: http://64.143.64.21/climatechange/ClimateChangeCEQAguidance.pdf

Mendocino Air Quality Management District – CEQA Guidelines

The Mendocino AQMD updated its "Guidelines for Use During Preparation of Air Quality Impacts in EIRs or Mitigated Negative Declarations" in May 2007. The guidelines call for preparing estimates of the increased emissions of air contaminations (including GHG) for projects.

The guidelines state that GHG emissions should be presumed to have a significant impact if CO emissions from District-approved modeling exceed either of the following:

- 80% of the level defined as significant for stationary sources in Regulation1, Rule 130 (s2) of the District (which is 550 lbs/day for CO, meaning a threshold of 440 lbs/day for CO for stationary sources); or
- levels established in District Regulation 1 Rule 130 (i2) for indirect sources (which is 690 lbs/day for CO for indirect sources).

If an average passenger vehicle emits 22 grams of CO/mile and 0.8 lb/mile of CO_2, then the 690-lb/day threshold for CO corresponds to approximately 11,400 lb/day CO_2 threshold for passenger vehicle-related emissions. If one assumes that the average passenger vehicle goes 12,500 miles/year (about 35 miles/day), then this is a threshold equivalent to about 420 vehicles. Using an average in California of about 1.77 vehicles/household, this would correspond to about 250 households/dwelling units.

Appendix A

Relevant Citations

Citations from the Public Resources Code (Division 13, §21000 et seq.) as amended through January 1, 2005.

Public Resources Code – Section 21004, MITIGATING OR AVOIDING A SIGNIFICANT EFFECT; POWERS OF PUBLIC AGENCY:
"In mitigating or avoiding a significant effect of a project on the environment, a public agency may exercise only those express or implied powers provided by law other than this division. However, a public agency may use discretionary powers provided by such other law for the purpose of mitigating or avoiding a significant effect on the environment subject to the express or implied constraints or limitations that may be provided by law."

Public Resources Code – Section 21082.2, SIGNIFICANT EFFECT ON ENVIRONMENT; DETERMINATION; ENVIRONMENTAL IMPACT REPORT PREPARATION:
(a) The lead agency shall determine whether a project may have a significant effect on the environment based on substantial evidence in light of the whole record.
(b) The existence of public controversy over the environmental effects of a project shall not require preparation of an environmental impact report if there is no substantial evidence in light of the whole record before the lead agency that the project may have a significant effect on the environment.
(c) Argument, speculation, unsubstantiated opinion or narrative, evidence which is clearly inaccurate or erroneous, or evidence of social or economic impacts which do not contribute to, or are not caused by, physical impacts on the environment, is not substantial evidence. Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts.
(d) If there is substantial evidence, in light of the whole record before the lead agency, that a project may have a significant effect on the environment, an environmental impact report shall be prepared.
(e) Statements in an environmental impact report and comments with respect to an environmental impact report shall not be deemed determinative of whether the project may have a significant effect on the environment.

Citations from the Guidelines for California Environmental Quality Act, CCR, Title 14, Division 6 (§15000 et seq.) as amended through July 27, 2007.

AG=Attorney General; ARB=California Air Resources Board; ASTM=American Society for Testing and Material; BAAQMD=Bay Area Air Quality Management District; BEES= Building for Environmental and Economic Sustainability; CA=California; Caltrans=California Department of Transportation; CAPs=Criteria Air Pollutants; CCAP=Center for Clean Air Policy; CF=Connectivity Factor; CIWMB=California Integrated Waste Management Board; CO= Carbon Monoxide; CO_2=Carbon Dioxide; DGS=Department of General Services; DOE=U.S. Department of Energy; DPF=Diesel particulate Filter; E85=85% Ethanol; EERE=Energy Efficiency and Renewable Energy; EOE=Encyclopedia of Earth; EPA=U.S. Environmental Protection Agency; ETC=Edmonton Trolley Coalition; EVs/CNG=Electric Vehicles/Compressed Natural Gas; FAR=Floor Area Ratio; GHG=Greenhouse Gas; ITE=Institute of Transportation Engineers; kg/m^2=kilogram per square meter; km=Kilometer; lb=pound; LEED=Leadership in Energy and Environmental Design; M=Million; NA=Not Available; NEV=Neighborhood Electric Vehicle; NIST=National Institute of Standards and Technology; NO_X=Oxides of Nitrogen; NREL=National Renewable Energy Laboratory; N/S=North/South; PG&E=Pacific Gas and Electric; PM=Particulate Matter; SJVAPCD=San Joaquin Valley Air Pollution Control District; SMAQMD=Sacramento Metropolitan Air Quality Management District; SMUD=Sacramento Municipal Utilities District; SO_x=Sulfur Oxides; SRI=Solar Reflectance Index; TACs=Toxic Air Contaminants; TDM=Transportation Demand Management; TMA=Transportation Management Association; THC=Total Hydrocarbon; ULEV=Ultra Low Emission Vehicle; USGBC=U.S. Green Building Council; and VTPI=Victoria Transit Policy.

State CEQA Guidelines – Section 15064, DETERMINING THE SIGNIFICANCE OF THE ENVIRONMENTAL EFFECTS CAUSED BY A PROJECT:

(a) Determining whether a project may have a significant effect plays a critical role in the CEQA process.

(1) If there is substantial evidence, in light of the whole record before a lead agency, that a project may have a significant effect on the environment, the agency shall prepare a draft EIR.

(2) When a final EIR identifies one or more significant effects, the Lead Agency and each Responsible Agency shall make a finding under Section 15091 for each significant effect and may need to make a statement of overriding considerations under Section 15093 for the project.

(b) The determination of whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on scientific and factual data. An ironclad definition of significant effect is not always possible because the significance of an activity may vary with the setting. For example, an activity which may not be significant in an urban area may be significant in a rural area.

(c) In determining whether an effect will be adverse or beneficial, the Lead Agency shall consider the views held by members of the public in all areas affected as expressed in the whole record before the lead agency. Before requiring the preparation of an EIR, the Lead Agency must still determine whether environmental change itself might be substantial.

(d) In evaluating the significance of the environmental effect of a project, the Lead Agency shall consider direct physical changes in the environment which may be caused by the project and reasonably foreseeable indirect physical changes in the environment which may be caused by the project.

(1) A direct physical change in the environment is a physical change in the environment which is caused by and immediately related to the project. Examples of direct physical changes in the environment are the dust, noise, and traffic of heavy equipment that would result from construction of a sewage treatment plant and possible odors from operation of the plant.

(2) An indirect physical change in the environment is a physical change in the environment which is not immediately related to the project, but which is caused indirectly by the project. If a direct physical change in the environment in turn causes another change in the environment, then the other change is an indirect physical change in the environment. For example, the construction of a new sewage treatment plant may facilitate population growth in the service area due to the increase in sewage treatment capacity and may lead to an increase in air pollution.

(3) An indirect physical change is to be considered only if that change is a reasonably foreseeable impact which may be caused by the project. A change which is speculative or unlikely to occur is not reasonably foreseeable.

(e) Economic and social changes resulting from a project shall not be treated as significant effects on the environment. Economic or social changes may be used, however, to determine that a physical change shall be regarded as a significant effect on the environment. Where a physical change is caused by economic or social effects of a

project, the physical change may be regarded as a significant effect in the same manner as any other physical change resulting from the project. Alternatively, economic and social effects of a physical change may be used to determine that the physical change is a significant effect on the environment. If the physical change causes adverse economic or social effects on people, those adverse effects may be used as a factor in determining whether the physical change is significant. For example, if a project would cause overcrowding of a public facility and the overcrowding causes an adverse effect on people, the overcrowding would be regarded as a significant effect.
(f) The decision as to whether a project may have one or more significant effects shall be based on substantial evidence in the record of the lead agency.
(1) If the lead agency determines there is substantial evidence in the record that the project may have a significant effect on the environment, the lead agency shall prepare an EIR (Friends of B Street v. City of Hayward (1980) 106 Cal.App.3d 988). Said another way, if a lead agency is presented with a fair argument that a project may have a significant effect on the environment, the lead agency shall prepare an EIR even though it may also be presented with other substantial evidence that the project will not have a significant effect (No Oil, Inc. v. City of Los Angeles (1974) 13 Cal.3d 68).
(2) If the lead agency determines there is substantial evidence in the record that the project may have a significant effect on the environment but the lead agency determines that revisions in the project plans or proposals made by, or agreed to by, the applicant would avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment would occur and there is no substantial evidence in light of the whole record before the public agency that the project, as revised, may have a significant effect on the environment then a mitigated negative declaration shall be prepared.
(3) If the lead agency determines there is no substantial evidence that the project may have a significant effect on the environment, the lead agency shall prepare a negative declaration (Friends of B Street v. City of Hayward (1980) 106 Cal.App. 3d 988).
(4) The existence of public controversy over the environmental effects of a project will not require preparation of an EIR if there is no substantial evidence before the agency that the project may have a significant effect on the environment.
(5) Argument, speculation, unsubstantiated opinion or narrative, or evidence that is clearly inaccurate or erroneous, or evidence that is not credible, shall not constitute substantial evidence. Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion support by facts.
(6) Evidence of economic and social impacts that do not contribute to or are not caused by physical changes in the environment is not substantial evidence that the project may have a significant effect on the environment.
(7) The provisions of sections 15162, 15163, and 15164 apply when the project being analyzed is a change to, or further approval for, a project for which an EIR or negative declaration was previously certified or adopted (e.g. a tentative subdivision, conditional use permit). Under case law, the fair argument standard does not apply to determinations of significance pursuant to sections 15162, 15163, and 15164.
(g) After application of the principles set forth above in Section 15064(f)(g), and in marginal cases where it is not clear whether there is substantial evidence that a project may have a significant effect on the environment, the lead agency shall be guided by the following principle: If there is disagreement among expert opinion supported by facts

over the significance of an effect on the environment, the Lead Agency shall treat the effect as significant and shall prepare an EIR.

(h)(1) When assessing whether a cumulative effect requires an EIR, the lead agency shall consider whether the cumulative impact is significant and whether the effects of the project are cumulatively considerable. An EIR must be prepared if the cumulative impact may be significant and the project's incremental effect, though individually limited, is cumulatively considerable. "Cumulatively considerable" means that the incremental effects of an individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.

(2) A lead agency may determine in an initial study that a project's contribution to a significant cumulative impact will be rendered less than cumulatively considerable and thus is not significant. When a project might contribute to a significant cumulative impact, but the contribution will be rendered less than cumulatively considerable through mitigation measures set forth in a mitigated negative declaration, the initial study shall briefly indicate and explain how the contribution has been rendered less than cumulatively considerable.

(3) A lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project will comply with the requirements in a previously approved plan or mitigation program which provides specific requirements that will avoid or substantially lessen the cumulative problem (e.g., water quality control plan, air quality plan, integrated waste management plan) within the geographic area in which the project is located. Such plans or programs must be specified in law or adopted by the public agency with jurisdiction over the affected resources through a public review process to implement, interpret, or make specific the law enforced or administered by the public agency. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding that the project complies with the specified plan or mitigation program addressing the cumulative problem, an EIR must be prepared for the project.

(4) The mere existence of significant cumulative impacts caused by other projects alone shall not constitute substantial evidence that the proposed project's incremental effects are cumulatively considerable.

State CEQA Guidelines – Section 15130, DISCUSSION OF CUMULATIVE IMPACTS:

(a)(3). "An EIR may determine that a project's contribution to a significant cumulative impact will be rendered less than cumulatively considerable and thus is not significant. A project's contribution is less than cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact. The lead agency shall identify facts and analysis supporting its conclusion that the contribution will be rendered less than cumulatively considerable.

State CEQA Guidelines – Section 15064.7, THRESHOLDS OF SIGNIFICANCE:

"Each public agency is encouraged to develop and publish thresholds of significance that the agency uses in the determination of the significance of environmental effects. A threshold of significance is an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant."

Appendix B

Mitigation Measure Summary

Table 16
Mitigation Measure Summary

Mitigation Measure	Applicable Project/Source Type[1]	Effective: Emissions Reduction/Score[2]	Feasible (Yes/No): Cost (Yes/No)[3]	Feasible (Yes/No): Technical[4]	Feasible (Yes/No): Logistical[5]	Secondary Effects (Yes/No)	Agency/Organization/Other[6]	Description/Comments
Transportation								
Bicycle/Pedestrian/Transit Measures								
MM T-1: Bike Parking	LD (C, M), I, SP, TP, AQP, RR, P/Mobile	1%-5%/High: CCAP presents combined % reductions for a range of mitigation measures (Dierkers et al. 2007). SMAQMD allocates combined reductions among individual measures (e.g., 2.5% reduction for all bicycle-related measures and one-quarter of 2.5% for each individual measure) (TIAX 2005, EDAW 2006, SMAQMD 2007). VTPI presents % reductions for showers and combined measures in the TDM encyclopedia (VTPI	Yes: Lockers ($1,200-$2,950, $700/bike on average), Racks ($70-$2,000, $70/bike on average).	Yes (Caltrans 2005, Dierkers et al. 2007, VTPI 2007)	Yes (Caltrans 2005, Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs	Caltrans, Portland Bicycle Master Plan (City of Portland 1998), CCAP Transportation Emissions Guidebook (Dierkers et al. 2007), SMAQMD Recommended Guidance for Land Use Emission Reductions (SMAQMD 2007), VTPI, CA air quality management and control districts, and cities/counties.	Nonresidential projects provide plentiful short- and long-term bicycle parking facilities to meet peak season maximum demand (e.g., one bike rack space per 20 vehicle/employee parking spaces.
MM T-2: End of Trip Facilities	LD (C, M), I, SP, TP, AQP, RR, P/Mobile		Yes	Yes (Caltrans 2005, Dierkers et al. 2007, VTPI 2007)	Yes (Caltrans 2005, Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs		Nonresidential projects provide "end-of-trip" facilities including showers, lockers, and changing space (e.g., four clothes lockers and one shower provided for every 80 employee parking spaces, separate facilities for each gender for projects with 160 or more employee parking spaces).
MM T-3: Bike-Parking at Multi-	LD (R, M), SP, AQP, RR,		Yes: Lockers ($1,200-	Yes (Caltrans 2005,	Yes (Caltrans	Adverse: No Beneficial:		Long-term bicycle parking is provided at apartment

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Unit Residential	P/Mobile	2007). JSA bases estimates on CCAP information (JSA 2004).	$2,950, $700/bike on average), Racks ($70-$2,000, $70/bike on average).	Dierkers et al. 2007, VTPI 2007)	2005, Dierkers et al. 2007, VTPI 2007)	CAPs, TACs		complexes or condominiums without garages (e.g., one long-term bicycle parking space for each unit without a garage). Long-term facilities shall consist of one of the following: a bicycle locker, a locked room with standard racks and access limited to bicyclists only, or a standard rack in a location that is staffed and/or monitored by video surveillance 24 hours per day.
MM T-4: Proximity to Bike Path/Bike Lanes	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile		Yes	Yes (Caltrans 2005, Dierkers et al. 2007, VTPI 2007)	Yes (Caltrans 2005, Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs		Entire project is located within one-half mile of an existing/planned Class I or Class II bike lane and project design includes a comparable network that connects the project uses to the existing offsite facility. Project design includes a designated bicycle route connecting all units, on-site bicycle parking facilities, offsite bicycle facilities, site entrances, and primary building entrances to existing Class I or Class II bike lane(s) within one-half mile. Bicycle route connects to all streets contiguous with project site. Bicycle route has minimum conflicts with automobile parking and circulation

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								facilities. All streets internal to the project wider than 75 feet have Class II bicycle lanes on both sides.

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		Emissions Reduction/Score[2]	Cost (Yes/No)[3]	Technical[4]	Logistical[5]			
MM T-5: Pedestrian Network	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	1%-10%/High: CCAP presents combined % reductions for a range of mitigation measures (Dierkers et al. 2007). SMAQMD allocates 1% for each individual measure (TIAX 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs	CCAP Transportation Emissions Guidebook (Dierkers et al. 2007), SMAQMD Recommended Guidance for Land Use Emission Reductions (SMAQMD 2007), VTPI, CA air quality management and control districts, and cities/counties.	The project provides a pedestrian access network that internally links all uses and connects to all existing/planned external streets and pedestrian facilities contiguous with the project site. Project design includes a designated pedestrian route interconnecting all internal uses, site entrances, primary building entrances, public facilities, and adjacent uses to existing external pedestrian facilities and streets. Route has minimal conflict with parking and automobile circulation facilities. Streets (with the exception of alleys) within the project have sidewalks on both sides. All sidewalks internal and adjacent to project site are minimum of five feet wide. All sidewalks feature vertical curbs. Pedestrian facilities and improvements such as grade separation, wider sidewalks, and traffic calming are implemented wherever feasible to minimize pedestrian barriers. All site entrances provide pedestrian access.
MM T-6: Pedestrian	LD (R, C, M), I, SP, TP,		Yes	Yes (Dierkers et al. 2007,	Yes (Dierkers et	Adverse: No Beneficial:		Site design and building placement minimize barriers to

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Barriers Minimized	AQP, RR, P/Mobile			VTPI 2007)	al. 2007, VTPI 2007)	CAPs, TACs		pedestrian access and interconnectivity. Physical barriers such as walls, berms, landscaping, and slopes between residential and nonresidential uses that impede bicycle or pedestrian circulation are eliminated.
MM T-7: Bus Shelter for Existing/Planned Transit Service	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	1%-2%/High: CCAP presents these % reductions (Dierkers et al., 2007). SMAQMD assigns from .25%-1%, depending on headway frequency (TIAX 2005, EDAW 2006, SMAQMD 2007).	Yes: \$15,000-\$70,000.	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs	CCAP Transportation Emissions Guidebook (Dierkers et al. 2007), SMAQMD Recommended Guidance for Land Use Emission Reductions (SMAQMD 2007), VTPI, City of Calgary (City of Calgary 2004), CA air quality management and control districts, and cities/counties.	Bus or streetcar service provides headways of one hour or less for stops within one-quarter mile; project provides safe and convenient bicycle/pedestrian access to transit stop(s) and provides essential transit stop improvements (i.e., shelters, route information, benches, and lighting).

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		Emissions Reduction/Score[2]	Cost (Yes/No)[3]	Technical[4]	Logistical[5]			
MM T-8: Traffic Calming	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	1%-10%/High: CCAP presents combined % reductions for a range of mitigation measures (Dierkers et al. 2007). SMAQMD allocates .25%-1.0% for each individual measure depending on percent of intersections and streets with improvements (TIAX 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs	CCAP Transportation Emissions Guidebook (Dierkers et al. 2007), SMAQMD Recommended Guidance for Land Use Emission Reductions (SMAQMD 2007), VTPI, CA air quality management and control districts, and cities/counties.	Project design includes pedestrian/bicycle safety and traffic calming measures in excess of jurisdiction requirements. Roadways are designed to reduce motor vehicle speeds and encourage pedestrian and bicycle trips by featuring traffic calming features. All sidewalks internal and adjacent to project site are minimum of five feet wide. All sidewalks feature vertical curbs. Roadways that converge internally within the project are routed in such a way as to avoid "skewed intersections;" which are intersections that meet at acute, rather than right, angles. Intersections internal and adjacent to the project feature one or more of the following pedestrian safety/traffic calming design techniques: marked crosswalks, count-down signal timers, curb extensions, speed tables, raised crosswalks, raised intersections, median islands, tight corner radii, and roundabouts or mini-circles. Streets internal and adjacent to the project feature pedestrian safety/traffic calming measures such as on-street parking, planter strips with street trees,

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								and chicanes/chokers (variations in road width to discourage high-speed travel).
Parking Measures								
MM T-9: Paid Parking (Parking Cash Out)	LD (C, M), I, SP, TP, AQP, RR, P/Mobile	1%-30%/High: CCAP presents a range of 15%-30% reduction for parking programs (Dierkers et al. 2007). SMAQMD presents a range of 1.0%-7.2%, depending on cost/day and distance to transit (TIAX 2005, EDAW 2006, SMAQMD 2007). Shoupe presents a 21% reduction [$5/day for commuters to downtown LA, with elasticity of -0.18 (e.g., if price increases 10%, then solo driving goes down by 1.8% more)] (Shoupe 2005). Urban Transit Institute	Yes: Vary by location and project size.	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs	CCAP Transportation Emissions Guidebook (Dierkers et al. 2007), SMAQMD Recommended Guidance for Land Use Emission Reductions (SMAQMD 2007), VTPI, CA air quality management and control districts, and cities/counties.	Project provides employee and/or customer paid parking system. Project must have a permanent and enforceable method of maintaining user fees for all parking facilities. The facility may not provide customer or employee validations. Daily charge for parking must be equal to or greater than the cost of a transit day/monthly pass plus 20%.

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		presents a range of 1%-10% reduction in trips to central city sites, and 2%-4% in suburban sites (VTPI 2007).						
MM T-10: Minimum Parking	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	1%-30%/High: CCAP presents a range of 15%-30% reduction for parking programs (Dierkers et al. 2007). SMAQMD presents a maximum of 6% (Nelson/Nygaard Consulting Associates, 2005, TIAX 2005, EDAW 2006).	Yes	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007), Note that in certain areas of the state, the minimum parking required by code is greater than the peak period parking demand for most land uses. Simply meeting minimum code requirements in these areas would not result in an emissions reduction.	Adverse: No Beneficial: CAPs, TACs	CCAP Transportation Emissions Guidebook (Dierkers et al. 2007), SMAQMD Recommended Guidance for Land Use Emission Reductions (SMAQMD 2007), VTPI, Governor's Office of Smart Growth (Annapolis, Maryland) (Zimbler), CA air quality management and control districts, and cities/counties.	Provide minimum amount of parking required. Once land uses are determined, the trip reduction factor associated with this measure can be determined by utilizing the ITE parking generation publication. The reduction in trips can be computed as shown below by the ratio of the difference of minimum parking required by code and ITE peak parking demand to ITE peak parking demand for the land uses multiplied by 50%. Percent Trip Reduction = 50 * [(min parking required by code – ITE peak parking demand)/ (ITE peak parking demand)]

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MM T-11: Parking Reduction Beyond Code/Shared Parking	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	1%-30%/High: CCAP presents a range of 15%-30% reduction for parking programs (Dierkers et al. 2007). SMAQMD presents a maximum of 12% (Nelson/Nygaard, 2005, TIAX 2005, EDAW 2006).	Yes	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs		Provide parking reduction less than code. This measure can be readily implemented through a shared parking strategy, wherein parking is utilized jointly among different land uses, buildings, and facilities in an area that experience peak parking needs at different times of day and day of the week.
MM T-12: Pedestrian Pathway Through Parking	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	1%-4%/Moderate: CCAP presents combined % reductions for a range of mitigation measures (Dierkers et al. 2007). SMAQMD allocates 0.5% reduction for this measure (TIAX 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs		Provide a parking lot design that includes clearly marked and shaded pedestrian pathways between transit facilities and building entrances.

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MM T-13: Off - Street Parking	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	1%-4%/Moderate: CCAP presents combined % reductions for a range of mitigation measures (Dierkers et al. 2007). SMAQMD allocates a range of 0.1%-1.5% for this measure (TIAX 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs		Parking facilities are not adjacent to street frontage.
MM T-14: Parking Area Tree Cover	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	Annual net CO_2 reduction of 3.1 kg/m^2 canopy cover/Moderate (McPherson 2001).	Yes: $19 per new tree for CA, cost varies for maintenance, removal and replacement (McPherson 2001).	Yes	Yes	Adverse: VOCs Beneficial: CAPs, TACs	AG, State of CA Department of Justice (Goldberg 2007) and cities/counties (e.g., parking lot ordinances in Sacramento, Davis, and Los Angeles, CA).	Provide parking lot areas with 50% tree cover within 10 years of construction, in particular low emitting, low maintenance, native drought resistant trees. Reduces urban heat island effect and requirement for air conditioning, effective when combined with other measures (e.g., electrical maintenance equipment and reflective paving material).
MM T-15: Valet Bicycle Parking	LD (C, M), SP, AQP, TP, RR, P/Mobile	NA/Low	Yes	Yes	Yes: Raley Field (Sacramento, CA)	Adverse: No Beneficial: CAPs, TACs	Raley Field (Sacramento, CA).	Provide spaces for the operation of valet bicycle parking at community event "centers" such as amphitheaters, theaters, and stadiums.
MM T-16: Garage Bicycle Storage	LD (R, M), SP, AQP, TP, RR, P/Mobile	NA/Low	Yes: Less than $200/multiple bike rack.	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	City of Fairview, OR	Provide storage space in one-car garages for bicycles and bicycle trailers.

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MM T-17: Preferential Parking for EVs/CNG Vehicles	LD (C, M), I, SP, TP, AQP, RR, P/Mobile	NA/Low	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	USGBC, CA air quality management and control districts and cities/counties (e.g., BAAQMD).	Provide preferential parking space locations for EVs/CNG vehicles.
MM T-18: Reduced/No Parking Fee for EVs/CNG Vehicles	LD (C, M), I, SP, TP, AQP, RR, P/Mobile	NA/Low	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	Hotels (e.g., Argonaut in San Francisco, CA)	Provide a reduced/no parking fee for EVs/CNG vehicles.

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Miscellaneous Measure								
MM T-19: TMA Membership	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	1%-28%/High: CCAP presents a range of 3%-25% for TDMs with complementary transit and land use measures (Dierkers et al. 2007). VTPI presents a range of 6%-7% in the TDM encyclopedia (VTPI 2007). URBEMIS offers a 2%-10% range in reductions for a TDM that has 5 elements that are pedestrian and transit friendly and 1%-5% for 3 elements. SMAQMD presents a reduction of 5% (TIAX 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007, VTPI 2007)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Include permanent TMA membership and funding requirement. Funding to be provided by Community Facilities District or County Service Area or other nonrevocable funding mechanism. TDMs have been shown to reduce employee vehicle trips up to 28% with the largest reductions achieved through parking pricing and transit passes. The impact depends on the travel alternatives.
MM T-20: ULEV	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	NA/Low	Yes: Higher than corresponding gasoline models.	Yes	Yes: Fueling stations might not be readily available depending on location. More than 900 E85 fueling	Adverse: No Beneficial: CAPs, TACs	DGS, CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Use of and/or provide ULEV that are 50% cleaner than average new model cars (e.g., natural gas, ethanol, electric).

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					stations in the U.S., 5 in CA. Vehicles available in select regions only			
MM T-21: Flex Fuel Vehicles	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	5466.97 lb GHG/year/Low (DOE Fuel Economy)	Yes: E85 costs less than gasoline per gallon, but results in lower fuel economy.	Yes	Yes: More than 900 E85 fueling stations in the U.S., 5 in CA. Vehicles available in select regions only	Adverse: Yes Issues with the energy intensive ethanol production process (e.g., wastewater treatment requirements). Beneficial: CAPs, TACs	DGS, CA air quality management and control districts and cities/counties (e.g., SJVAPCD).	Use of and/or provide vehicles that utilize gasoline/ethanol blends (e.g., E85).
Design								
Commercial & Residential Building Design Measures								
MM D-1: Office/Mixed Use Density	LD (C, M), SP, TP, AQP, RR, P/Mobile	0.05%-2%/Moderate: This range is from SMAQMD, depending	Yes	Yes (VTPI 2007)	Yes (VTPI 2007)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties	Project provides high density office or mixed-use proximate to transit. Project must provide

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		on FAR and headway frequencies (Nelson/Nygaard Consulting Associates 2005, EDAW 2006, SMAQMD 2007).					(e.g., SMAQMD).	safe and convenient pedestrian and bicycle access to all transit stops within one-quarter mile.
MM D-2: Orientation to Existing/Planned Transit, Bikeway, or Pedestrian Corridor	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	0.4%-1%/Moderate: CCAP attributes a 0.5% reduction per 1% improvement in transit frequency (Dierkers et al. 2007). SMAQMD presents a range of 0.25%-5% (JSA 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (Dierkers et al. 2007)	Yes (Dierkers et al. 2007)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project is oriented towards existing transit, bicycle, or pedestrian corridor. Setback distance between project and existing or planned adjacent uses is minimized or nonexistent. Setback distance between different buildings on project site is minimized. Setbacks between project buildings and planned or existing sidewalks are minimized. Buildings are oriented towards existing or planned street frontage. Primary entrances to buildings are located along planned or existing public street frontage. Project provides bicycle access to any planned bicycle corridor(s). Project provides pedestrian access to any planned pedestrian corridor(s).
MM D-3: Services Operational	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	0.5%-5%/Moderate	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project provides on-site shops and services for employees.

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MM D-4: Residential Density (Employ Sufficient Density for New Residential Development to Support the Use of Public Transit)	LD (R, M), SP, TP, AQP, RR, P/Mobile	1%-40%/High: #7, EPA presents a range of 32%-40% (EPA 2006). SMAQMD presents a range of 1%-12% depending on density and headway frequencies (Nelson/Nygaard Consulting Associates 2005, JSA 2005, EDAW 2006, SMAQMD 2007). Nelson/Nygaard presents a trip reduction formula: Trip Reduction = 0.6*(1-(19749*((4.814+ households per residential acre)/(4.814+7.14))^-06.39)/25914).	Yes	Yes (VTPI 2007, Holtzclaw 2007)	Yes (VTPI 2007, Holtzclaw 2007)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project provides high-density residential development. Transit facilities must be within one-quarter mile of project border. Project provides safe and convenient bicycle/pedestrian access to all transit stop(s) within one-quarter mile of project border.
MM D-5: Street Grid	LD (R, C, M), I, SP, TP, AQP, RR,	1%/Moderate: SMAQMD presents this % reduction (JSA	Yes	Yes (Dierkers et al. 2007, VTPI 2007)	Yes (Dierkers et al. 2007,	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties	Multiple and direct street routing (grid style). This measure only applies to projects

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	P/Mobile	2005, EDAW 2006, SMAQMD 2007).			VTPI 2007)		(e.g., SMAQMD).	with an internal CF >/= 0.80, and average of one-quarter mile or less between external connections along perimeter of project. [CF= # of intersections / (# of cul-de-sacs + intersections)]. Cul-de-sacs with bicycle/pedestrian through access may be considered “complete intersections” when calculating the project’s internal connectivity factor. External connections are bike/pedestrian pathways and access points, or streets with safe and convenient bicycle and pedestrian access that connect the project to adjacent streets, sidewalks, and uses. If project site is adjacent to undeveloped land; streets, pathways, access points, and right-of-ways that provide for future access to adjacent uses may count for up to 50% of the external connections. Block perimeter (the sum of the measurement of the length of all block sides) is limited to no more than 1,350 feet. Streets internal to the project should connect to streets external to the project whenever possible.

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MM D-6: NEV Access	LD (R, C, M), SP, TP, AQP, RR, P/Mobile	0.5%-1.5%/Low: SMAQMD presents this % reduction (EDAW 2006, SMAQMD 2007).	Yes	Yes (Litman 1999, Sperling 1994)	Yes (Litman 1999, Sperling 1994)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Make physical development consistent with requirements for neighborhood electric vehicles. Current studies show that for most trips, NEVs do not replace gas-fueled vehicles as the primary vehicle.
MM D-7: Affordable Housing Component	LD (R, M), SP, TP, AQP, RR, P/Mobile	0.4%-6%/Moderate: SMAQMD presents this % reduction (Nelson/Nygaard Consulting Associates 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Residential development projects of five or more dwelling units provide a deed-restricted low-income housing component on-site (or as defined in the code). Developers who pay into In-Lieu Fee Programs are not considered eligible to receive credit for this measure. The award of emission reduction credit shall be based only on the proportion of affordable housing developed on-site because in-lieu programs simply induce a net increase in development. Percentage reduction shall be calculated according to the following formula:

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								% reduction = % units deed-restricted below market rate housing * 0.04
MM D-8: Recharging Area	LD (R, M), SP, TP, AQP, RR, P/Mobile	NA/Low	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs		Provide residential buildings with a "utility" room or space for recharging batteries, whether for use in a car, electric lawnmower, other electric landscaping equipment, or even batteries for small items such as flashlights.
Mixed-Use Development Measures								
MM D-9: Urban Mixed-Use	LD (M), SP, TP, AQP, RR, P/Mobile	3%-9%/Moderate: SMAQMD presents this % reduction (TIAX 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (EPA 2006)	Yes (EPA 2006)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Development of projects predominantly characterized by properties on which various uses, such as office, commercial, institutional, and residential, are combined in a single building or on a single site in an integrated development project with functional interrelationships and a coherent physical design.
MM D-10: Suburban Mixed-Use	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	3%/Moderate: SMAQMD presents this % reduction (TIAX 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (EPA 2006)	Yes (EPA 2006)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Have at least three of the following on site and/or offsite within one-quarter mile: Residential Development, Retail Development, Park, Open Space, or Office.
MM D-11: Other Mixed-Use	LD (R, M), SP, TP, AQP, RR, P/Mobile	1%/Moderate: SMAQMD presents this % reduction (TIAX 2005, EDAW	Yes	Yes (EPA 2006)	Yes (EPA 2006)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	All residential units are within one-quarter mile of parks, schools or other civic uses.

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		2006, SMAQMD 2007).						
MM D-12: Infill Development	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	3%-30%/High: Infill development reduces vehicle trips and VMT by 3% and 20%, respectively (Fehr & Peers 2007). CCAP identifies a site level VMT reduction range of 20%-30% (Dierkers et al. 2007).	Yes	Yes (Dierkers et al. 2007)	Yes (Dierkers et al. 2007)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project site is on a vacant infill site, redevelopment area, or brownfield or greyfield lot that is highly accessible to regional destinations, where the destinations rating of the development site (measured as the weighted average travel time to all other regional destinations) is improved by 100% when compared to an alternate greenfield site.
Miscellaneous Measures								
MM D-13: Electric Lawnmower	LD (R, M), SP, AQP, RR, P/Area	1%/Low: SMAQMD presents this % reduction (EDAW 2006, SMAQMD 2007).	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Provide a complimentary electric lawnmower to each residential buyer.

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MM D-14: Enhanced Recycling/Waste Reduction, Reuse, Composting	LD (R, C, M), I, SP, AQP, RR, P/Stationary & Area	NA/Low	Yes	Yes	Yes: Association with social awareness.	Adverse: No Beneficial: CAPs, TACs	CIWMB	Provide infrastructure/education that promotes the avoidance of products with excessive packaging, recycle, buying of refills, separating of food and yard waste for composting, and using rechargeable batteries.
MM D-15: LEED Certification	LD (R, C, M), I, SP, AQP, RR, P/Stationary & Area	NA/Moderate	Yes: Receive tax rebates, incentives (e.g., EDAW San Diego office interior remodel cost $1,700,000 for 32,500 square feet) (USGBC 2007)	Yes	Yes: More than 700 buildings of different certifications in CA (USGBC 2007).	Adverse: No Beneficial: CAPs, TACs	USGBC, CA air quality management and control districts and cities/counties (e.g., BAAQMD).	LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.
MM D-16: Retro-Commissioning	LD (C, M), I, SP, AQP, RR, P/Stationary & Area	8%-10% reduction in energy usage/Moderate: (Mills et al. 2004)	Yes: Average $0.28/square feet, varies with building size (Haasl and Sharp 1999).	Yes	Yes: 27 projects underway in CA, 21 more to be completed in 2007, mostly state buildings owned by DGS (DGS 2007).	Adverse: No Beneficial: CAPs, TACs	DGS, CA air quality management and control districts and cities/counties (e.g., BAAQMD).	The process ensures that all building systems perform interactively according to the contract documents, the design intent and the owner's operational needs to optimize energy performance.
MM D-17 Landscaping	LD (R, C, M), I, SP, AQP, RR,	NA/Low	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	Alliance for the Chesapeake Bay, EPA Green Landscaping	Project shall use drought resistant native trees, trees with low emissions and high carbon

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	P/Stationary & Area						Resources	sequestration potential. Evergreen trees on the north and west sides afford the best protection from the setting summer sun and cold winter winds. Additional considerations include the use of deciduous trees on the south side of the house that will admit summer sun; evergreen plantings on the north side will slow cold winter winds; constructing a natural planted channel to funnel summer cooling breezes into the house. Neighborhood CCR's not requiring that front and side yards of single family homes be planted with turf grass. Vegetable gardens, bunch grass, and low-water landscaping shall also be permitted, or even encouraged.
MM D-18: Local Farmers' Market	LD (M), SP/Mobile, Stationary, &	NA/Low	Yes	Yes	Yes: Associated with social	Adverse: No Beneficial: CAPs, TACs	Cities/counties (e.g., Davis, Sacramento)	Project shall dedicate space in a centralized, accessible location for a weekly farmers' market.

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	Area				choice and public awareness.			
MM D-19: Community Gardens	LD (M), SP/Mobile, Stationary, & Area	NA/Low	Yes	Yes	Yes: Associated with social choice and public awareness.	Adverse: No Beneficial: CAPs, TACs	Cities/counties (e.g., Davis)	Project shall dedicate space for community gardens.
Energy Efficiency/Building Component								
MM E-1: High-Efficiency Pumps	LD (R, C, M), SP, AQP, RR, P/Stationary & Area	NA/Low	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., BAAQMD).	Project shall use high-efficiency pumps.
MM E-2: Wood Burning Fireplaces/Stoves	LD (R, M), SP, AQP, RR, P/Stationary & Area	NA/Low: EDAW 2006	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project does not feature fireplaces or wood burning stoves.
MM E-3: Natural Gas Stove	LD (R, M), SP, AQP, RR, P/Stationary & Area	NA/Low: EDAW 2006	Yes: Cost of stove—$350 (gas) and $360 (electric) same brand, total yearly cost of $42.17 as opposed to $56.65 for electric (Saving Electricity 2006).	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project features only natural gas or electric stoves in residences.

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MM E-4: Energy Star Roof	LD (R, C, M), I, SP, AQP, RR, P/Stationary & Area	0.5%-1%/Low: SMAQMD presents this % reduction (EDAW 2006, SMAQMD 2007).	Yes	Yes	Yes: 866 Energy Star labeled buildings in California (Energy Star 2007)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project installs Energy Star labeled roof materials.
MM E-5: On-site Renewable Energy System	LD (R, C, M), I, SP, AQP, RR, P/Stationary & Area	1%-3%/Moderate: SMAQMD presents this % reduction (USGBC 2002 and 2005, EDAW 2006, SMAQMD 2007).	Yes	Yes (USGBC 2002 and 2005)	Yes (USGBC 2002 and 2005)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project provides onsite renewable energy system(s). Nonpolluting and renewable energy potential includes solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies. When applying these strategies, projects may take advantage of net metering with the local utility.

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		Emissions Reduction/Score[2]	Cost (Yes/No)[3]	Technical[4]	Logistical[5]			
MM E-6: Exceed Title 24	LD (R, C, M), I, GSP, AQP, RR, P/Stationary & Area	1%/Moderate: SMAQMD presents this % reduction (EDAW 2006, SMAQMD 2007).	Yes	Yes (PG&E 2002, SMUD 2006)	Yes (PG&E 2002, SMUD 2006)	Adverse: No Beneficial: CAPs, TACs	PG&E, SMUD, CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project exceeds title 24 requirements by 20%.
MM E-7: Solar Orientation	LD (R, C, M), I, SP, AQP, RR, P/Stationary & Area	0.5%/Low: SMAQMD presents this % reduction (EDAW 2006, SMAQMD 2007).	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project orients 75% or more of homes and/or buildings to face either north or south (within 30° of N/S). Building design includes roof overhangs that are sufficient to block the high summer sun, but not the lower winter sun, from penetrating south facing windows. Trees, other landscaping features and other buildings are sited in such a way as to maximize shade in the summer and maximize solar access to walls and windows in the winter.
MM E-8: Nonroof Surfaces	LD (R, C, M), I, GSP, AQP, RR, P/Stationary & Area	1.0%/Low: SMAQMD presents this % reduction (EDAW 2006, SMAQMD 2007).	Yes	Yes (USGBC 2002 and 2005)	Yes (USGBC 2002 and 2005)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Provide shade (within 5 years) and/or use light-colored/high-albedo materials (reflectance of at least 0.3) and/or open grid pavement for at least 30% of the site's nonroof impervious surfaces, including parking lots, walkways, plazas, etc.; OR place a minimum of 50% of parking spaces underground or covered by structured parking; OR use an open-grid pavement system (less than 50% impervious) for a minimum of

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								50% of the parking lot area. The mitigation measure reduces heat islands (thermal gradient differences between developed and undeveloped areas to minimize impact on microclimate and human and wildlife habitats. This measure requires the use of patented or copyright protected methodologies created by the ASTM. The SRI is a measure of the constructed surface's ability to reflect solar heat, as shown by a small rise in temperature. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is "0" and a standard white (reflectance 0.80, emittance 0.90) is 100. To calculate SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980-01. Reflectance is measured

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		Emissions Reduction/Score[2]	Cost (Yes/No)[3]	Technical[4]	Logistical[5]			
								according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371. Default values for some materials will be available in the LEED-NC v2.2 Reference Guide.
MM E-9: Low-Energy Cooling	LD (C, M), I, SP, AQP, RR, P/Stationary & Area	1%-10%/Low: EDAW presents this percent reduction range (EDAW 2006).	Yes	Yes (USGBC 2002 and 2005)	Yes (USGBC 2002 and 2005)	Adverse: No Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Project optimizes building's thermal distribution by separating ventilation and thermal conditioning systems.
MM E-10: Green Roof	LD (R, C, M), I, SP, AQP, RR, P/Stationary & Area	1.0%/Moderate: SMAQMD presents this % reduction (EDAW 2006, SMAQMD 2007).	Yes	Yes (USGBC 2002 and 2005)	Yes (USGBC 2002 and 2005)	Adverse: Increased Water Consumption Beneficial: CAPs, TACs	CA air quality management and control districts and cities/counties (e.g., SMAQMD).	Install a vegetated roof that covers at least 50% of roof area. The reduction assumes that a vegetated roof is installed on a least 50% of the roof area or that a combination high albedo and vegetated roof surface is installed that meets the following standard: (Area of SRI Roof/0.75)+(Area of vegetated roof/0.5) >= Total Roof Area. Water consumption reduction measures shall be considered in the design of the green roof.
MM E-11: EV Charging Facilities	LD (C, M), SP, AQP, RR, P/Stationary & Area	NA/Low	Yes: $500-$5000/ vehicle site (PG&E 1999)	Yes	Yes: 381 facilities in CA (Clean Air Maps 2007).	Adverse: No Beneficial: CAPs, TACs	DOE, EERE, CA air quality management and control districts and cities/counties (e.g., BAAQMD).	Project installs EV charging facilities.
MM E-12:	LD (R, C, M),	NA/Low: Increasing	Yes: Light	Yes	Yes: Apply	Adverse: No		Project provides light-colored

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Light-Colored Paving	I, SP, AQP, RR, P/Stationary & Area	the albedo of 1,250 km of pavement by 0.25 would save cooling energy worth $15M per year.	colored aggregates and white cement are more expensive than gray cement. Certain blended cements are very light in color and may reflect similarly to white cement at an equivalent cost to normal gray cement.		natural sand or gravel colored single surface treatments to asphalt (EOE 2007).	Beneficial: CAPs, TACs		paving (e.g., increased albedo pavement).
MM E-13: Cool Roofs	LD (R, C, M), I, SP, AQP, RR, P/Stationary & Area	NA/Low	Yes: 0.75–1.5/square feet coating (EPA 2007a)	Yes	Yes: Over 90% of the roofs in the United States are dark colored	Adverse: No Beneficial: CAPs, TACs	CEC	Project provides cool roofs. Highly reflective, highly emissive roofing materials that stay 50-60°F cooler than a normal roof under a hot summer sun. CA's Cool Savings

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Mitigation Measure	Applicable Project/Source Type[1]	Effective: Emissions Reduction/Score[2]	Effective: Cost (Yes/No)[3]	Feasible (Yes/No): Technical[4]	Feasible (Yes/No): Logistical[5]	Secondary Effects (Yes/No)	Agency/Organization/Other[6]	Description/Comments
					(EPA 2007a).			Program provided rebates to building owners for installing roofing materials with high solar reflectance and thermal emittance. The highest rebate went to roofs on air conditioned buildings, while buildings with rooftop ducts and other nonresidential buildings were eligible for slightly less. The program aimed to reduce peak summer electricity demand and was administered by the CEC.
MM E-14: Solar Water Heaters	LD (R, M), SP, AQP, RR, P/Stationary & Area	20%–70% reduction in cooling energy needs/Moderate	Yes: $1675/20 square feet, requires a 50 gallon tank, annual operating cost of $176 (DOE 2007).	Yes	Yes: Based on solar orientation, building codes, zoning ordinances.	Adverse: No Beneficial: CAPs, TACs	Europe	Project provides solar water heaters.
MM E-15: Electric Yard Equipment Compatibility	LD (R, M), SP, AQP, RR, P/Stationary & Area	NA/Low	Yes: $75–$250/outlet from existing circuit (Cost Helper 2007).	Yes	Yes	Adverse: No Beneficial: CAPs, TACs		Project provides electrical outlets at building exterior areas.
MM E-16: Energy Efficient Appliance Standards	LD (R, C, M), SP, AQP, RR, P/Stationary & Area	NA/Low	Yes: Varies for each appliance—higher capital costs, lower operating costs (Energy	Yes	Yes: Major retail stores.	Adverse: No Beneficial: CAPs, TACs		Project uses energy efficient appliances (e.g., Energy Star).

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			Star 2007).					
MM E-17: Green Building Materials	LD (R, C, M), SP, AQP, RR, P/Stationary & Area	NA/Low: 25-30% more efficient on average.	Yes	Yes: BEES software allows users to balance the environmental and economic performance of building products; developed by NIST (NIST 2007).	Yes	Adverse: No Beneficial: CAPs, TACs		Project uses materials which are resource efficient, recycled, with long life cycles and manufactured in an environmentally friendly way.
MM E-18: Shading Mechanisms	LD (R, C, M), I, SP, AQP, RR, P/Stationary, & Area	NA/Low: Up to $450 annual energy savings (Energy Star 2007).	Yes: Higher capital costs, lower operating and maintenance costs (Energy Star 2007).	Yes	Yes: Major retail stores.	Adverse: No Beneficial: CAPs, TACs		Install energy-reducing shading mechanisms for windows, porch, patio and walkway overhangs.

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		Emissions Reduction/Score[2]	Cost (Yes/No)[3]	Technical[4]	Logistical[5]			
MM E-19: Ceiling/Whole-House Fans	LD (R, C, M), I, SP, AQP, RR, P/Stationary, & Area	NA/Low: 50% more efficient than conventional fans (Energy Star 2007).	Yes: $45-$200/fan, installation extra (Lowe's 2007).	Yes	Yes: Major retail stores.	Adverse: No Beneficial: CAPs, TACs		Install energy-reducing ceiling/whole-house fans.
MM E-20: Programmable Thermostats	LD (R, C, M), I, SP, AQP, RR, P/Stationary, & Area	NA/Low: $100 annual savings in energy costs (Energy Star 2007).	Yes: $60/LCD display and 4 settings for typical residential use (Lowe's 2007).	Yes	Yes: Major retail stores.	Adverse: Yes, Mercury Beneficial: CAPs, TACs		Install energy-reducing programmable thermostats that automatically adjust temperature settings.
MM E-21: Passive Heating and Cooling Systems	LD (R, C, M), I, SP, AQP, RR, P/Stationary, & Area	NA/Low	Yes: $800 (wall heaters) to $4,000+ (central systems)	Yes	Yes	Adverse: No Beneficial: CAPs, TACs		Install energy-reducing passive heating and cooling systems (e.g., insulation and ventilation).
MM E-22: Day Lighting Systems	LD (R, C, M), I, SP, AQP, RR, P/Stationary, & Area	NA/Low	Yes: $1,300 to $1,500 depending upon the kind of roof (Barrier 1995), installation extra.	Yes	Yes: Work well only for space near the roof of the building, little benefit in multi-floor buildings.	Adverse: No Beneficial: CAPs, TACs		Install energy-reducing day lighting systems (e.g., skylights, light shelves and interior transom windows).
MM E-23: Low-Water Use Appliances	LD (R, C, M), I, SP, AQP, RR, P/Stationary, & Area	NA/Low: Avoided water agency cost for using water-efficient kitchen pre-rinse spray valves of $65.18 per acre-foot.	Yes: Can return their cost through reduction in water consumption,	Yes	Yes	Adverse: No Beneficial: CAPs, TACs		Require the installation of low-water use appliances.

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			pumping, and treatment.					
MM E-24: Goods Transport by Rail	LD (C, M), I, SP, AQP, RR, P/Mobile	NA/Moderate	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs	ARB Goods Movement Plan (ARB 2007)	Provide a spur at nonresidential projects to use nearby rail for goods movement.
Social Awareness/Education								
MM S-1: GHG Emissions Reductions Education	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile, Stationary, & Mobile	NA/Low	Yes	Yes	Yes: Similar programs currently exist in CA.	Adverse: No Beneficial: CAPs, TACs		Provide local governments, businesses, and residents with guidance/protocols/information on how to reduce GHG emissions (e.g., energy saving, food miles).
MM S-2: School Curriculum	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile, Stationary, & Mobile	NA/Low	Yes	Yes	Yes: Similar programs currently exist in CA.	Adverse: No Beneficial: CAPs, TACs		Include how to reduce GHG emissions (e.g., energy saving, food miles) in the school curriculum.
Construction								
MM C-1: ARB-Certified Diesel Construction Equipment	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	NA/Low	Yes: Oxidation Catalysts, $1,000-	Yes	Yes	Adverse: Yes, NO_x Beneficial: CAPs, TACs	AG, EPA, ARB, and CA air quality management and pollution control districts.	Use ARB-certified diesel construction equipment. Increases CO_2 emissions when trapped CO and carbon particles

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			$2,000. DPF, $5000-$10,000; installation extra (EPA 2007b).					are oxidized (Catalyst Products 2007, ETC 2007).
MM C-2: Alternative Fuel Construction Equipment	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	NA/Low	Yes	Yes	Yes	Adverse: Yes, THC, NO_x Beneficial: CO, PM, SO_x	AG, EPA, ARB, and CA air quality management and pollution control districts.	Use alternative fuel types for construction equipment. At the tailpipe biodiesel emits 10% more CO_2 than petroleum diesel. Overall lifecycle emissions of CO_2 from 100% biodiesel are 78% lower than those of petroleum diesel (NREL 1998, EPA 2007b).
MM C-3: Local Building Materials	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	NA/Low	Yes	Yes	Yes: Depends on location of building material manufacture sites.	Adverse: No Beneficial: CAPs, TACs		Use locally made building materials for construction of the project and associated infrastructure.
MM C-4: Recycle Demolished Construction Material	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile	NA/Low	Yes	Yes	Yes	Adverse: No Beneficial: CAPs, TACs		Recycle/Reuse demolished construction material. Use locally made building materials for construction of the project and associated infrastructure.

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		Emissions Reduction/Score[2]	Cost (Yes/No)[3]	Technical[4]	Logistical[5]			
Miscellaneous								
MM M-1: Off-Site Mitigation Fee Program	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile & Area	NA/Moderate-High: Though there is currently no program in place, the potential for real and quantifiable reductions of GHG emissions could be high if a defensible fee program were designed.	Yes	Yes	No: Program does not exist in CA, but similar programs currently exist (e.g., Carl Moyer Program, SJVAPCD Rule 9510, SMAQMD Off-Site Construction Mitigation Fee Program).	Adverse: No Beneficial: CAPs, TACs		Provide/Pay into an off-site mitigation fee program, which focuses primarily on reducing emissions from existing development and buildings through retro-fit (e.g., increased insulation).
MM M-2: Offset Purchase	LD (R, C, M), I, SP, TP, AQP, RR, P/Mobile, Stationary, & Area	NA/Low	Yes	Yes	No: ARB has not adopted official program, but similar programs	No		Provide/purchase offsets for additional emissions by acquiring carbon credits or engaging in other market "cap and trade" systems.

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					currently exist.			
Regional Transportation Plan Measures								
MM RTP-1: Dedicate High Occupancy Vehicle (HOV) lanes prior to adding capacity to existing highways.	RTP		Yes	Yes	Yes	Adverse: possible local CO Beneficial: regional CAPs, TACs	Caltrans, local government	Evaluate the trip reduction (and GHG reduction) potential of adding HOV lanes prior to adding standard lanes.
MM RTP-2: Implement toll/user fee programs prior to adding capacity to existing highways.	RTP		Yes	Yes	Yes	Adverse: possible local CO. Beneficial: regional CAPs, TACs	Caltrans	Evaluate price elasticity and associated trip reduction (and GHG reduction) potential with adding or increasing tolls prior to adding capacity to existing highways.

Note:
[1] Where LD (R, C, M) =Land Development (Residential, Commercial, Mixed-Use), I=Industrial, GP=General Plan, SP=Specific Plan, TP=Transportation Plans, AQP=Air Quality Plans, RR=Rules/Regulations, and P=Policy. It is important to note that listed project types may not be directly specific to the mitigation measure (e.g., TP, AQP, RR, and P) as such could apply to a variety of source types, especially RR and P.
[2] This score system entails ratings of high, moderate, and low that refer to the level of the measure to provide a substantive, reasonably certain (e.g., documented emission reductions with proven technologies), and long-term reduction of GHG emissions.
[3] Refers to whether the measure would provide a cost-effective reduction of GHG emissions based on available documentation.
[4] Refers to whether the measure is based on currently, readily available technology based on available documentation.
[5] Refers to whether the measure could be implemented without extraordinary effort based on available documentation.
[6] List is not meant to be all inclusive.
Source: Data complied by EDAW in 2007

Table 17
General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
MS G-1: Adopt a GHG reduction plan	GP/ Mobile, Stationary, & Area	City of San Bernardino	- Adopt GHG reduction targets for the planning area, based on the current legislation providing direction for state-wide targets, and update the plan as necessary. -The local government agency should serve as a model by inventorying its GHG emissions from agency operations, and implementing those reduction goals.
Circulation			
MS G-2: Provide for convenient and safe local travel	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	- Create a gridded street pattern with small block sizes. This promotes walkability through direct routing and ease of navigation. -Maintain a high level of connectivity of the roadway network. Minimize cul-de-sacs and incomplete roadway segments. -Plan and maintain an integrated, hierarchical and multi-modal system of roadways, pedestrian walks, and bicycle paths throughout the area. -Apply creative traffic management approaches to address congestion in areas with unique problems, particularly on roadways and intersections in the vicinity of schools in the morning and afternoon peak hours, and near churches, parks and community centers. -Work with adjacent jurisdictions to address the impacts of regional development patterns (e.g. residential development in surrounding communities, regional universities, employment centers, and commercial developments) on the circulation system. -Actively promote walking as a safe mode of local travel, particularly for children attending local schools. -Employ traffic calming methods such as median landscaping and provision of bike or transit lanes to slow traffic, improve roadway capacity, and address safety issues.
MS G-3: Enhance the regional transportation network and maintain effectiveness	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Encourage the transportation authority to reduce fees for short distance trips. -Ensure that improvements to the traffic corridors do not negatively impact the operation of local roadways and land uses.

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General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
			-Cooperate with adjacent jurisdictions to maintain adequate service levels at shared intersections and to provide adequate capacity on regional routes for through traffic. -Support initiatives to provide better public transportation. Work actively to ensure that public transportation is part of every regional transportation corridor. - Coordinate the different modes of travel to enable users to transfer easily from one mode to another. -Work to provide a strong paratransit system that promotes the mobility of all residents and educate residents about local mobility choices. - Promote transit-oriented development to facilitate the use of the community's transit services.
MS G-4: Promote and support an efficient public transportation network connecting activity centers in the area to each other and the region.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Promote increased use of public transportation and support efforts to increase bus service range and frequency within the area as appropriate. -Enhance and encourage provision of attractive and appropriate transit amenities, including shaded bus stops, to encourage use of public transportation. -Encourage the school districts, private schools and other operators to coordinate local bussing and to expand ride-sharing programs. All bussing options should be fully considered before substantial roadway improvements are made in the vicinity of schools to ease congestion.
MS G-5: Establish and maintain a comprehensive system, which is safe and convenient, of pedestrian ways and bicycle routes that provide viable options to travel by automobile.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Improve area sidewalks and rights-of-way to make them efficient and appealing for walking and bicycling safely. Coordinate with adjacent jurisdictions and regional agencies to improve pedestrian and bicycle trails, facilities, signage, and amenities. -Provide safe and convenient pedestrian and bicycle connections to and from town centers, other commercial districts, office complexes, neighborhoods, schools, other major activity centers, and surrounding communities. -Work with neighboring jurisdictions to provide well-designed pedestrian and bicycle crossings of major roadways. -Promote walking throughout the community. Install sidewalks where missing and make improvements

Table 17
General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
			to existing sidewalks for accessibility purposes. Particular attention should be given to needed sidewalk improvement near schools and activity centers. -Encourage businesses or residents to sponsor street furniture and landscaped areas. - Strive to provide pedestrian pathways that are well shaded and pleasantly landscaped to encourage use. - Attract bicyclists from neighboring communities to ride their bicycles or to bring their bicycles on the train to enjoy bicycling around the community and to support local businesses. - Meet guidelines to become nationally recognized as a Bicycle-Friendly community. - Provide for an education program and stepped up code enforcement to address and minimize vegetation that degrades access along public rights-of-way. -Engage in discussions with transit providers to increase the number of bicycles that can be accommodated on buses
MS G-6: Achieve optimum use of regional rail transit.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Support regional rail and work with rail authority to expand services. - Achieve better integration of all transit options. -Work with regional transportation planning agencies to finance and provide incentives for multimodal transportation systems. - Promote activity centers and transit-oriented development projects around the transit station.
MS G-7: Expand and optimize use of local and regional bus and transit systems.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Encourage convenient public transit service between area and airports. -Support the establishment of a local shuttle to serve commercial centers. -Promote convenient, clean, efficient, and accessible public transit that serves transit-dependent riders and attracts discretionary riders as an alternative to reliance on single-occupant automobiles.

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General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
			- Empower seniors and those with physical disabilities who desire maximum personal freedom and independence of lifestyle with unimpeded access to public transportation. -Integrate transit service and amenities with surrounding land uses and buildings.
Conservation, Open Space			
MS G-8: Emphasize the importance of water conservation and maximizing the use of native, low-water landscaping.	GP/Stationary & Area	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Reduce the amount of water used for landscaping and increase use of native and low water plants. Maximize use of native, low-water plants for landscaping of areas adjacent to sidewalks or other impermeable surfaces. -Encourage the production, distribution and use of recycled and reclaimed water for landscaping projects throughout the community, while maintaining urban runoff water quality objectives. -Promote water conservation measures, reduce urban runoff, and prevent groundwater pollution within development projects, property maintenance, area operations and all activities requiring approval. -Educate the public about the importance of water conservation and avoiding wasteful water habits. -Work with water provider in exploring water conservation programs, and encourage the water provider to offer incentives for water conservation.
MS G-9: Improve air quality within the region.	GP/ Mobile, Stationary, & Area	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Integrate air quality planning with area land use, economic development and transportation planning efforts. -Support programs that reduce air quality emissions related to vehicular travel. -Support alternative transportation modes and technologies, and develop bike- and pedestrian-friendly neighborhoods to reduce emissions associated with automobile use. -Encourage the use of clean fuel vehicles. -Promote the use of fuel-efficient heating and cooling equipment and other appliances, such as water

Table 17
General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
			heaters, swimming pool heaters, cooking equipment, refrigerators, furnaces, and boiler units. - Promote the use of clean air technologies such as fuel cell technologies, renewable energy sources. UV coatings, and alternative, non-fossil fuels. -Require the planting of street trees along streets and inclusion of trees and landscaping for all development projects to help improve airshed and minimize urban heat island effects. - Encourage small businesses to utilize clean, innovative technologies to reduce air pollution. - Implement principles of green building. - Support jobs/housing balance within the community so more people can both live and work within the community. To reduce vehicle trips, encourage people to telecommute or work out of home or in local satellite offices.
MS G-10: Encourage and maximize energy conservation and identification of alternative energy sources.	GP/ Stationary & Area	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Encourage green building designs for new construction and renovation projects within the area. -Coordinate with regional and local energy suppliers to ensure adequate supplies of energy to meet community needs, implement energy conservation and public education programs, and identify alternative energy sources where appropriate. -Encourage building orientations and landscaping that enhance natural lighting and sun exposure. -Encourage expansion of neighborhood-level products and services and public transit opportunities throughout the area to reduce automobile use. - Incorporate the use of energy conservation strategies in area projects. - Promote energy-efficient design features, including appropriate site orientation, use of light color roofing and building materials, and use of evergreen trees and wind-break trees to reduce fuel consumption for heating and cooling.

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General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
			-Explore and consider the cost/benefits of alternative fuel vehicles including hybrid, natural gas, and hydrogen powered vehicles when purchasing new vehicles. -Continue to promote the use of solar power and other energy conservation measures. - Encourage residents to consider the cost/benefits of alternative fuel vehicles. - Promote the use of different technologies that reduce use of non-renewable energy resources. -Facilitate the use of green building standards and LEED in both private and public projects. -Promote sustainable building practices that go beyond the requirements of Title 24 of the California Administrative Code, and encourage energy-efficient design elements, as appropriate. -Support sustainable building practices that integrate building materials and methods that promote environmental quality, economic vitality, and social benefit through the design, construction, and operation of the built environment. - Investigate the feasibility of using solar (photovoltaic) street lights instead of conventional street lights that are powered by electricity in an effort to conserve energy. - Encourage cooperation between neighboring development to facilitate on-site renewable energy supplies or combined heat and power co-generation facilities that can serve the energy demand of contiguous development.

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General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
MS G-11: Preserve unique community forests, and provide for sustainable increase and maintenance of this valuable resource.	GP/Stationary & Area	Cities/Counties (e.g., Aliso Viejo, Claremont)	- Develop a tree planting policy that strives to accomplish specific % shading of constructed paved and concrete surfaces within five years of construction. -Provide adequate funding to manage and maintain the existing forest, including sufficient funds for tree planting, pest control, scheduled pruning, and removal and replacement of dead trees. -Coordinate with local and regional plant experts in selecting tree species that respect the natural region in which Claremont is located, to help create a healthier, more sustainable urban forest. - Continue to plant new trees (in particular native tree species where appropriate), and work to preserve mature native trees. -Increase the awareness of the benefits of street trees and the community forest through a area wide education effort. -Encourage residents to properly care for and preserve large and beautiful trees on their own private property.
Housing			
MS G-12: Provide affordability levels to meet the needs of community residents.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Encourage development of affordable housing opportunities throughout the community, as well as development of housing for elderly and low and moderate income households near public transportation services. -Ensure a portion of future residential development is affordable to low and very low income households.
Land Use			
MS G-13: Promote a visually-cohesive urban form and establish connections between the urban core and outlying portions of the	GP/ Mobile, Stationary, & Area	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Preserve the current pattern of development that encourages more intense and higher density development at the core of the community and less intense uses radiating from the central core. -Create and enhance landscaped greenway, trail and sidewalk connections between neighborhoods and to commercial areas, town centers, and parks.

Table 17 General Planning Level Mitigation Strategies Summary			
Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
community.			-Identify ways to visually identify and physically connect all portions of the community, focusing on enhanced gateways and unifying isolated and/or outlying areas with the rest of the area. -Study and create a diverse plant identity with emphasis on drought-resistant native species.
MS G-14: Provide a diverse mix of land uses to meet the future needs of all residents and the business community.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Attract a broad range of additional retail, medical, and office uses providing employment at all income levels. -Support efforts to provide beneficial civic, religious, recreational, cultural and educational opportunities and public services to the entire community. -Coordinate with public and private organizations to maximize the availability and use of parks and recreational facilities in the community. -Support development of hotel and recreational commercial land uses to provide these amenities to local residents and businesses.
MS G-15: Collaborate with providers of solid waste collection, disposal and recycling services to ensure a level of service that promotes a clean community and environment.	GP/ Stationary, & Area	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Require recycling, composting, source reduction and education efforts throughout the community, including residential, businesses, industries, and institutions, within the construction industry, and in all sponsored activities.
MS G-16: Promote construction, maintenance and active use of publicly- and privately-operated parks, recreation programs, and a community center.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Work to expand and improve community recreation amenities including parks, pedestrian trails and connections to regional trail facilities. -As a condition upon new development, require payment of park fees and/or dedication and provision of parkland, recreation facilities and/or multi-use trails that improve the public and private recreation system. -Research options or opportunities to provide necessary or desired community facilities.

Table 17
General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
MS G-17: Promote the application of sustainable development practices.	GP/ Mobile, Stationary, & Area	Cities/Counties (e.g., Aliso Viejo, Claremont)	- Encourage sustainable development that incorporates green building best practices and involves the reuse of previously developed property and/or vacant sites within a built-up area. - Encourage the conservation, maintenance, and rehabilitation of the existing housing stock. -Encourage development that incorporates green building practices to conserve natural resources as part of sustainable development practices. -Avoid development of isolated residential areas in the hillsides or other areas where such development would require significant infrastructure investment, adversely impact biotic resources. - Provide land area zoned for commercial and industrial uses to support a mix of retail, office, professional, service, and manufacturing businesses.
MS G-18: Create activity nodes as important destination areas, with an emphasis on public life within the community.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Provide pedestrian amenities, traffic-calming features, plazas and public areas, attractive streetscapes, shade trees, lighting, and retail stores at activity nodes. -Provide for a mixture of complementary retail uses to be located together to create activity nodes to serve adjacent neighborhoods and to draw visitors from other neighborhoods and from outside the area.
MS G-19: Make roads comfortable, safe, accessible, and attractive for use day and night.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Provide crosswalks and sidewalks along streets that are accessible for people with disabilities and people who are physically challenged. -Provide lighting for walking and nighttime activities, where appropriate. -Provide transit shelters that are comfortable, attractive, and accommodate transit riders.
MS G-20: Maintain and expand where possible the system of neighborhood connections that attach neighborhoods to larger roadways.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	- Provide sidewalks where they are missing, and provide wide sidewalks where appropriate with buffers and shade so that people can walk comfortably. -Make walking comfortable at intersections through traffic-calming, landscaping, and designated crosswalks.

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General Planning Level Mitigation Strategies Summary

Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
			-Look for opportunities for connections along easements & other areas where vehicles not permitted.
MS G-21: Create distinctive places throughout the area.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	-Provide benches, streetlights, public art, and other amenities in public areas to attract pedestrian activities. -Encourage new developments to incorporate drought tolerant and native landscaping that is pedestrian friendly, attractive, and consistent with the landscaped character of area. -Encourage all new development to preserve existing mature trees. -Encourage streetscape design programs for commercial frontages that create vibrant places which support walking, bicycling, transit, and sustainable economic development. -Encourage the design and placement of buildings on lots to provide opportunities for natural systems such as solar heating and passive cooling. - Ensure that all new industrial development projects are positive additions to the community setting, provide amenities for the comfort of the employees such as outdoor seating area for breaks or lunch, and have adequate landscape buffers.
MS G-22: Reinvest in existing neighborhoods and promote infill development as a preference over new, greenfield development	GP/ Mobile, Stationary, & Area	Cities/Counties (e.g., Aliso Viejo, Claremont)	- Identify all underused properties in the plan area and focus development in these opportunity sites prior to designating new growth areas for development. - Implement programs to retro-fit existing structures to make them more energy-efficient. -Encourage compact development, by placing the desired activity areas in smaller spaces.

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Strategy	Source Type[1]	Agency/Organization[2]	Description/Comments
Public Safety			
MS G-23: Promote a safe community in which residents can live, work, shop, and play.	GP/ Mobile	Cities/Counties (e.g., Aliso Viejo, Claremont)	- Foster an environment of trust by ensuring non-biased policing, and by adopting policies and encouraging collaboration that creates transparency. - Facilitate traffic safety for motorists and pedestrians through proper street design and traffic monitoring.

Note:
[1] Where GP=General Plan.
[2] List is not meant to be all inclusive.
Source: Data complied by EDAW in 2007

Appendix C

Rule and Regulation Summary

Table 18
Rule and Regulation Summary

Rule/Regulation	Reduction	Implementation Date	Agency	Description	Comments
Low Carbon Fuel Standard	10-20 MMT CO_2e by 2020	January 1, 2010	ARB	This rule/regulation will require fuel providers (e.g., producers, importers, refiners and blenders) to ensure that the mix of fuels they sell in CA meets the statewide goal to reduce the carbon intensity of CA's transportation fuels by at least 10% by the 2020 target.	ARB Early Action Measure
Reduction of HFC-134a Emissions from Nonprofessional Servicing of Motor Vehicle Air Conditioning Systems	1-2 MMT CO_2e by 2020	January 1, 2010	ARB	This rule/regulation will restrict the use of high GWP refrigerants for nonprofessional recharging of leaky automotive air conditioning systems.	ARB Early Action Measure
Landfill Gas Recovery	2-4 MMT CO_2e by 2020	January 1, 2010	IWMB, ARB	This rule/regulation will require landfill gas recovery systems on small to medium landfills that do not have them and upgrade the requirements at landfills with existing systems to represent best capture and destruction efficiencies.	ARB Early Action Measure
Vehicle Climate Change Standards (AB 1493 Pavley, Chapter 200, Statutes of 2002)	30 MMT CO_2e by 2020	2009	ARB	This rule/regulation will require ARB to achieve the maximum feasible and cost effective reduction of GHG emissions from passenger vehicles and light-duty trucks.	ARB Early Action Measure
Reduction of PFCs from the Semiconductor Industry	0.5 MMT CO_2e by 2020	2007–2009	ARB	This rule/regulation will reduce GHG emissions by process improvements/source reduction, alternative chemicals capture and beneficial reuse, and destruction technologies	Underway or to be initiated by CAT members in 2007-2009 period

AB=Assembly Bill; ARB=California Air Resources Board; Calfire=California Fire; CA=California; Caltrans=California Department of Transportation; CAT=California Action Team; CEC=California Energy Commission; CDFA=California Department of Food and Agriculture; CH_4=Methane; CO_2=Carbon Dioxide; CPUC=California Public Utilities Commission; CUFR=California Urban Forestry; DGS=Department of General Services; DWR=Department of Water Resources; GHG=Greenhouse Gas; GWP=Global Warming Potential; IGCC= Integrated Gasification Combined Cycle; IOU= Investor-Owned Utility; IT=Information Technology; IWCB= Integrated Waste Management Board; LNG= Liquefied Natural Gas; MMT CO_2e=Million Metric Tons Carbon Dioxide Equivalent; MW=Megawatts; NA=Not Available; N_2O=Nitrous Oxide; PFC= Perfluorocompound; POU= Publicly Owned Utility; RPS= Renewable Portfolio Standards; RTP=Regional Transportation Plan SB=Senate Bill; SWP=State Water Project; TBD=To Be Determined; UC/CSU=University of California/California State University; ULEV=Ultra Low Emission Vehicle.

Table 18
Rule and Regulation Summary

Rule/Regulation	Reduction	Implementation Date	Agency	Description	Comments
Restrictions on High GWP Refrigerants	9 MMT CO_2e by 2020	2010	ARB	This rule/regulation will expand and enforce the national ban on release of high GWP refrigerants during appliance lifetime.	ARB Early Action Measure
Cement Manufacture	<1 MMT CO_2e per year (based on 2004 production levels)	2010	Caltrans	This rule/regulation will allow 2.5% interground limestone concrete mix in cement use.	CAT Early Action Measure
Hydrogen Fuel Standards (SB 76 of 2005)	TBD	By 2008	CDFA	This rule/regulation will develop hydrogen fuel standards for use in combustion systems and fuel cells.	CAT Early Action Measure
Regulation of GHG from Load Serving Entities (SB 1368)	15 MMT CO_2e by 2020	May 23, 2007	CEC, CPUC	This rule/regulation will establish a GHG emission performance standard for baseload generation of local publicly owned electric utilities that is no higher than the rate of emissions of GHG for combined-cycle natural gas baseload generation.	CAT Early Action Measure
Energy Efficient Building Standards	TBD	In 2008	CEC	This rule/regulation will update of Title 24 standards.	CAT Early Action Measure
Energy Efficient Appliance Standards	TBD	January 1, 2010	CEC	This rule/regulation will regulate light bulb efficiency	CAT Early Action Measure
Tire Efficiency (Chapter 8.7 Division 15 of the Public Resources Code)	<1 MMT CO_2e by 2020	January 1, 2010	CEC & IWMB	This rule/regulation will ensure that replacement tires sold in CA are at least as energy efficient, on average, as tires sold in the state as original equipment on these vehicles.	CAT Early Action Measure
New Solar Homes Partnership	TBD	January 2007	CEC	Under this rule/regulation, approved solar systems will receive incentive funds based on system performance above building standards.	CAT Early Action Measure

Table 18
Rule and Regulation Summary

Rule/Regulation	Reduction	Implementation Date	Agency	Description	Comments
Water Use Efficiency	1 MMT CO_2e by 2020	2010	DWR	This rule/regulation will adopt standards for projects and programs funded through water bonds that would require consideration of water use efficiency in construction and operation.	CAT Early Action Measure
State Water Project	TBD	2010	DWR	This rule/regulation will include feasible and cost effective renewable energy in the SWP's portfolio.	CAT Early Action Measure
Cleaner Energy for Water Supply	TBD	2010	DWR	Under this rule/regulation, energy supply contracts with conventional coal power plants will not be renewed.	CAT Early Action Measure
IOU Energy Efficiency Programs	4 MMT CO_2e by 2020	2010	CPUC	This rule/regulation will provide a risk/reward incentive mechanism for utilities to encourage additional investment in energy efficiency; evaluate new technologies and new measures like encouraging compact fluorescent lighting in residential and commercial buildings	CAT Early Action Measure
Solar Generation	TBD	2007–2009	DGS	3 MW of clean solar power generation implemented in CA last year, with another 1 MW coming up. The second round is anticipated to total additional 10 MW and may include UC/CSU campuses and state fairgrounds.	Underway or to be initiated by CAT members in 2007-2009 period

AB=Assembly Bill; ARB=California Air Resources Board; Calfire=California Fire; CA=California; Caltrans=California Department of Transportation; CAT=California Action Team; CEC=California Energy Commission; CDFA=California Department of Food and Agriculture; CH_4=Methane; CO_2=Carbon Dioxide; CPUC=California Public Utilities Commission; CUFR=California Urban Forestry; DGS=Department of General Services; DWR=Department of Water Resources; GHG=Greenhouse Gas; GWP=Global Warming Potential; IGCC= Integrated Gasification Combined Cycle; IOU= Investor-Owned Utility; IT=Information Technology; IWCB= Integrated Waste Management Board; LNG= Liquefied Natural Gas; MMT CO_2e=Million Metric Tons Carbon Dioxide Equivalent; MW=Megawatts; NA=Not Available; N_2O=Nitrous Oxide; PFC= Perfluorocompound; POU= Publicly Owned Utility; RPS= Renewable Portfolio Standards; RTP=Regional Transportation Plan SB=Senate Bill; SWP=State Water Project; TBD=To Be Determined; UC/CSU=University of California/California State University; ULEV=Ultra Low Emission Vehicle.

Table 18
Rule and Regulation Summary

Rule/Regulation	Reduction	Implementation Date	Agency	Description	Comments
Transportation Efficiency	9 MMT CO_2e by 2020	2007–2009	Caltrans	This rule/regulation will reduce congestion, improve travel time in congested corridors, and promote coordinated, integrated land use.	Underway or to be initiated by CAT members in 2007-2009 period
Smart Land Use and Intelligent Transportation	10 MMT CO_2e by 2020	2007–2009	Caltrans	This rule/regulation will integrate consideration of GHG reduction measures and energy efficiency factors into RTPs, project development etc.	Underway or to be initiated by CAT members in 2007-2009 period
Cool Automobile Paints	1.2 to 2.0 MMT CO_2e by 2020	2009	ARB	Cool paints would reduce the solar heat gain in a vehicle and reduce air conditioning needs.	ARB Early Action Measure
Tire Inflation Program	TBD	2009	ARB	This rule/regulation will require tires to be checked and inflated at regular intervals to improve fuel economy.	ARB Early Action Measure
Electrification of Stationary Agricultural Engines	0.1 MMT CO_2e by 2020	2010	ARB	This rule/regulation will provide incentive funding opportunities for replacing diesel engines with electric motors.	ARB Early Action Measure
Desktop Power Management	Reduce energy use by 50%	2007–2009	DGS, ARB	This rule/regulation will provide software to reduce electricity use by desktop computers by up to 40%.	Currently deployed in DGS
Reducing CH_4 Venting/Leaking from Oil and Gas Systems (EJAC-3/ARB 2-12)	1 MMT CO_2e by 2020	2010	ARB	This rule/regulation will reduce fugitive CH_4 emissions from production, processing, transmission, and distribution of natural gas and oil.	ARB Early Action Measure
Replacement of High GWP Gases Used in Fire Protection Systems with Alternate Chemical (ARB 2-10)	0.1 MMT CO_2e by 2020	2011	ARB	This rule/regulation will require the use of lower GWP substances in fire protection systems.	ARB Early Action Measure
Contracting for Environmentally Preferable Products	NA	2007–2009	DGS	New state contracts have been or are being created for more energy and resource efficient IT goods, copiers, low mercury fluorescent lamps, the CA Gold Carpet Standard and office furniture.	Underway or to be initiated by CAT members in 2007-2009 period
Hydrogen Fuel Cells	NA	2007–2009	DGS	This rule/regulation will incorporate clean hydrogen fuel cells in stationary applications	Underway or to be initiated by CAT members in 2007-2009

Table 18
Rule and Regulation Summary

Rule/Regulation	Reduction	Implementation Date	Agency	Description	Comments
				at State facilities and as back-up generation for emergency radio services.	period
High Performance Schools	NA	2007–2009	DGS	New guidelines adopted for energy and resource efficient schools; up to $100 million in bond money for construction of sustainable, high performance schools.	Underway or to be initiated by CAT members in 2007-2009 period
Urban Forestry	1 MMT CO_2e by 2020	2007–2009	Calfire, CUFR	This rule/regulation will provide five million additional trees in urban areas by 2020.	Underway or to be initiated by CAT members in 2007-2009 period
Fuels Management/Biomass	3 MMT CO_2e by 2020	2007–2009	Calfire	This rule/regulation will provide biomass from forest fuel treatments to existing biomass utilization facilities.	Underway or to be initiated by CAT members in 2007-2009 period
Forest Conservation and Forest Management	10 MMT CO_2e by 2020	2007–2009	Calfire, WCB	This rule/regulation will provide opportunities for carbon sequestration in Proposition 84 forest land conservation program to conserve an additional 75,000 acres of forest landscape by 2010.	Underway or to be initiated by CAT members in 2007-2009 period
Afforestation/Reforestation	2 MMT CO_2e by 2020	2007–2009	Calfire	This rule/regulation will subsidize tree planting.	Underway or to be initiated by CAT members in 2007-2009 period
Dairy Digesters	TBD	January 1, 2010	CDFA	This rule/regulation will develop a dairy digester protocol to document GHG emission reductions from these facilities.	ARB Early Action Measure

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Table 18
Rule and Regulation Summary

Rule/Regulation	Reduction	Implementation Date	Agency	Description	Comments
Conservation Tillage and Enteric Fermentation	1 MMT CO_2e by 2020	2007–2009	CDFA	This rule/regulation will develop and implement actions to quantify and reduce enteric fermentation emissions from livestock and sequester soil carbon using cover crops and conservation tillage.	Underway or to be initiated by CAT members in 2007-2009 period
ULEV	TBD	2007–2009	DGS	A new long term commercial rental contract was released in March 2007 requiring a minimum ULEV standard for gasoline vehicles and requires alternative fuel and hybrid-electric vehicles.	Underway or to be initiated by CAT members in 2007-2009 period
Flex Fuel Vehicles	370 metric tons CO_2, 0.85 metric tons of CH_4, and 1.14 metric tons of N_2O	2007–2009	DGS	Under this rule/regulation, DGS is replacing 800 vehicles with new, more efficient vehicles.	Underway or to be initiated by CAT members in 2007-2009 period
Climate Registry	TBD	2007–2009	DGS	Benchmarking and reduction of GHG emissions for state owned buildings, leased buildings and light duty vehicles.	Underway or to be initiated by CAT members in 2007-2009 period
Municipal Utilities Electricity Sector Carbon Policy	Included in SB 1368 reductions	2007–2009	CEC, CPUC, ARB	Under this rule/regulation, GHG emissions cap policy guidelines for CA's electricity sector (IOUs and POUs).	Underway or to be initiated by CAT members in 2007-2009 period
Alternative Fuels: Nonpetroleum Fuels	TBD	2007–2009	CEC	State plan to increase the use of alternative fuels for transportation; full fuel cycle assessment.	Underway or to be initiated by CAT members in 2007-2009 period
Zero Waste/High Recycling Strategy	5 MMT CO_2e by 2020	2007–2009	IWMB	This rule/regulation will identify materials to focus on to achieve GHG reduction at the lowest possible cost; Builds on the success of 50% Statewide Recycling Goal.	Underway or to be initiated by CAT members in 2007-2009 period
Organic Materials Management	TBD	2007–2009	IWMB	This rule/regulation will develop a market incentive program to increase organics diversion to the agricultural industry.	Underway or to be initiated by CAT members in 2007-2009 period
Landfill Gas Energy	TBD	2007–2009	IWMB	Landfill Gas to Energy & LNG/biofuels	Underway or to be initiated by CAT members in 2007-2009 period

Table 18
Rule and Regulation Summary

Rule/Regulation	Reduction	Implementation Date	Agency	Description	Comments
Target Recycling	TBD	2007–2009	IWMB	This rule/regulation will focus on industry/public sectors with high GHG components to implement targeted commodity recycling programs.	Underway or to be initiated by CAT members in 2007-2009 period
Accelerated Renewable Portfolio Standard	Included in SB 1368 reductions	2007–2009	CPUC	This rule/regulation will examine RPS long term planning and address the use of tradable renewable energy credits for RPS compliance.	Underway or to be initiated by CAT members in 2007-2009 period
CA Solar Initiative	1 MMT CO_2e by 2020	2007–2009	CPUC	Initiative to deliver 2000 MWs of clean, emissions free energy to the CA grid by 2016.	Underway or to be initiated by CAT members in 2007-2009 period
Carbon Capture and Sequestration	TBD	2007–2009	CPUC	Proposals for power plants with IGCC and/or carbon capture in the next 18 months.	Underway or to be initiated by CAT members in 2007-2009
Source: Data complied by EDAW in 2007					

AB=Assembly Bill; ARB=California Air Resources Board; Calfire=California Fire; CA=California; Caltrans=California Department of Transportation; CAT=California Action Team; CEC=California Energy Commission; CDFA=California Department of Food and Agriculture; CH_4=Methane; CO_2=Carbon Dioxide; CPUC=California Public Utilities Commission; CUFR=California Urban Forestry; DGS=Department of General Services; DWR=Department of Water Resources; GHG=Greenhouse Gas; GWP=Global Warming Potential; IGCC= Integrated Gasification Combined Cycle; IOU= Investor-Owned Utility; IT=Information Technology; IWCB= Integrated Waste Management Board; LNG= Liquefied Natural Gas; MMT CO_2e=Million Metric Tons Carbon Dioxide Equivalent; MW=Megawatts; NA=Not Available; N_2O=Nitrous Oxide; PFC= Perfluorocompound; POU= Publicly Owned Utility; RPS= Renewable Portfolio Standards; RTP=Regional Transportation Plan SB=Senate Bill; SWP=State Water Project; TBD=To Be Determined; UC/CSU=University of California/California State University; ULEV=Ultra Low Emission Vehicle.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

California Environmental Quality Act Guidelines Update

Proposed Thresholds of Significance

December 7, 2009

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Bay Area Air Quality Management District

Proposed Air Quality CEQA Thresholds of Significance

1 INTRODUCTION

Bay Area Air Quality Management District (BAAQMD or Air District) staff analyzed various options for California Environmental Quality Act (CEQA) air quality thresholds of significance for use within BAAQMD's jurisdiction. The analysis and evaluation undertaken by Air District staff is documented in the *Revised Draft Options and Justification Report – California Environmental Quality Act Thresholds of Significance* (Draft Options Report) (BAAQMD October 2009).

Air District staff hosted public workshops in February, April, September and October 2009 at several locations around the Bay Area. In addition, Air District staff met with regional stakeholder groups to discuss and receive input on the threshold options being evaluated. Throughout the course of the public workshops and stakeholder meetings Air District staff received many comments on the various options under consideration. Based on comments received and additional staff analysis, the threshold options and staff-recommended thresholds were further refined. The culmination of this year-long effort was presented in the Proposed Thresholds of Significance Report published on November 2, 2009 as the Air District staff's proposed air quality thresholds of significance.

The Air District Board of Directors (Board) held public hearings on November 18 and December 2, 2009, to receive comments on staff's Proposed Thresholds of Significance (November 2009). After public testimony and Board deliberations, the Board requested staff to present additional options for risk and hazard thresholds for Board consideration. This Report includes risks and hazards threshold options, as requested by the Board, in addition to staff's previously recommended thresholds of significance. The proposed thresholds presented herein, upon adoption by the Air District Board of Directors, are intended to replace all of the Air District's currently recommended thresholds. The proposed air quality thresholds of significance, and Board-requested risk and hazard threshold options, are provided in Table 1 at the end of this introduction.

1.1 BAAQMD/CEQA REGULATORY AUTHORITY

The BAAQMD has direct and indirect regulatory authority over sources of air pollution in the San Francisco Bay Area Air Basin (SFBAAB). CEQA requires that public agencies consider the potential adverse environmental impacts of any project that a public agency proposes to carry out, fund or approve. CEQA requires that a lead agency prepare an Environmental Impact Report (EIR) whenever it can be fairly argued (the "fair argument" standard), based on substantial evidence,[1] that a project may have a significant effect[2] on

[1] "Substantial evidence" includes facts, reasonable assumptions predicated upon facts, or expert opinions supported by facts, but does not include argument, speculation, unsubstantiated opinion or narrative, evidence that is clearly inaccurate or erroneous, or evidence of social or

the environment, even if there is substantial evidence to the contrary (CEQA Guidelines §15064). CEQA requires that the lead agency review not only a project's direct effects on the environment, but also the cumulative impacts of a project and other projects causing related impacts. When the incremental effect of a project is cumulatively considerable, the lead agency must discuss the cumulative impacts in an EIR. (CEQA Guidelines §15064).

The "fair argument" standard refers to whether a fair argument can be made that a project may have a significant effect on the environment (*No Oil, Inc. v. City of Los Angeles* (1974) 13 Cal.3d 68, 84). The fair argument standard is generally considered a low threshold requirement for preparation of an EIR. The legal standards reflect a preference for requiring preparation of an EIR and for "resolving doubts in favor of environmental review." *Meija v. City of Los Angeles* (2005) 130 Cal. App. 4th 322, 332. "The determination of whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on scientific and factual data." (CEQA Guidelines §15064(b).

In determining whether a project may have a significant effect on the environment, CEQA Guidelines Section 15064.7 provides that lead agencies may adopt and/or apply "thresholds of significance." A threshold of significance is "an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant" (CEQA Guidelines §15064.7).

While thresholds of significance give rise to a presumption of insignificance, thresholds are not conclusive, and do not excuse a public agency of the duty to consider evidence that a significant effect may occur under the fair argument standard. *Meija*, 130 Cal. App. 4th at 342. "A public agency cannot apply a threshold of significance or regulatory standard 'in a way that forecloses the consideration of any other substantial evidence showing there may be a significant effect.'" *Id.* This means that if a public agency is presented with factual information or other substantial evidence establishing a fair argument that a project may have a significant effect on the environment, the agency must prepare an EIR to study those impacts even if the project's impacts fall below the applicable threshold of significance.

Thresholds of significance must be supported by substantial evidence. This Report provides the substantial evidence in support of the thresholds of significance developed by the BAAQMD. If adopted by the BAAQMD Board of Directors, the Air District will recommend that lead agencies within the nine counties of the BAAQMD's jurisdiction

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economic impacts that do not contribute to, or are not caused by, physical impacts on the environment. Cal. Pub. Res. C. §21080(c); *see also* CEQA Guidelines §15384.

[2] A "significant effect" on the environment is defined as a "substantial, or potentially substantial, adverse change in the environment." Cal. Pub. Res. C. §21068; *see also* CEQA Guidelines §15382.

use the thresholds of significance in this Report when considering the air quality impacts of projects under their consideration.

1.2 JUSTIFICATION FOR UPDATING CEQA THRESHOLDS

Any analysis of environmental impacts under CEQA includes an assessment of the nature and extent of each impact expected to result from the project to determine whether the impact will be treated as significant or less than significant. CEQA gives lead agencies discretion whether to classify a particular environmental impact as significant. Ultimately, formulation of a standard of significance requires the lead agency to make a policy judgment about where the line should be drawn distinguishing adverse impacts it considers significant from those that are not deemed significant. This judgment must, however, be based on scientific information and other factual data to the extent possible (CEQA Guidelines §15064(b)).

In the sense that advances in science provide new or refined factual data, combined with advances in technology and the gradual improvement or degradation of an environmental resource, the point where an environmental effect is considered significant is fluid over time. Other factors influencing this fluidity include new or revised regulations and standards, and emerging, new areas of concern.

In the ten years since BAAQMD last reviewed its recommended CEQA thresholds of significance for air quality, there have been tremendous changes that affect the quality and management of the air resources in the Bay Area. Traditional criteria air pollutant ambient air quality standards, at both the state and federal levels, have become increasingly more stringent. A new criteria air pollutant standard for fine particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) has been added to federal and state ambient air quality standards. We have found, through technical advances in impact assessment, that toxic air contaminants are not only worse than previously thought from a health perspective, but that certain communities experience high levels of toxic air contaminants, giving rise to new regulations and programs to reduce the significantly elevated levels of ambient toxic air contaminant concentrations in the Bay Area.

In response to the elevated levels of toxic air contaminants in some Bay Area communities, the Air District created the Community Air Risk Evaluation (CARE) Program. Phase 1 of the BAAQMD's CARE program compiled and analyzed a regional emissions inventory of toxic air contaminants (TACs), including emissions from stationary sources, area sources, and on-road and off-road mobile sources. Phase 2 of the CARE Program conducted regional computer modeling of selected TAC species, species which collectively posed the greatest risk to Bay Area residents. In both Phases 1 and 2, demographic data were combined with estimates of TAC emissions or concentrations to identify communities that are disproportionally impacted from high concentrations of TACs. Bay Area Public Health Officers, in discussions with Air District staff and in comments to the Air District's Advisory Council (February 11, 2009, Advisory Council Meeting on Air Quality and Public Health), have recommended that $PM_{2.5}$, in addition to TACs, be considered in assessments of community-scale impacts of air pollution.

Another significant issue that affects the quality of life for Bay Area residents is the growing concern with global climate change. In just the past few years, estimates of the global atmospheric temperature and greenhouse gas concentration limits needed to stabilize climate change have been adjusted downward and the impacts of greenhouse gas emissions considered more dire. Previous scientific assessments assumed that limiting global temperature rise to 2-3°C above pre-industrial levels would stabilize greenhouse gas concentrations in the range of 450-550 parts per million (ppm) of carbon dioxide-equivalent (CO_2e). Now the science indicates that a temperature rise of 2°C would not prevent dangerous interference with the climate system. Recent scientific assessments suggest that global temperature rise should be kept below 2°C by stabilizing greenhouse gas concentrations below 350 ppm CO_2e, a significant reduction from the current level of 385 ppm CO_2e.

For the reasons stated above, and to further the goals of other District programs such as encouraging transit-oriented and infill development, BAAQMD has undertaken an effort to review all of its currently-recommended CEQA thresholds, revise them as appropriate, and develop new thresholds where appropriate. The overall goal of this effort is to develop CEQA significance criteria that ensure new development implements appropriate and feasible emission reduction measures to mitigate significant air quality impacts. The Air District's recommended CEQA significance thresholds have been vetted through a public review process and will be presented to the BAAQMD Board of Directors for adoption.

Table 1 – Proposed Air Quality CEQA Thresholds of Significance

Pollutant	Construction-Related	Operational-Related	
Project-Level			
Criteria Air Pollutants and Precursors (Regional)	**Average Daily Emissions (lb/day)**	**Average Daily Emissions (lb/day)**	**Maximum Annual Emissions (tpy)**
ROG	54	54	10
NO_X	54	54	10
PM_{10} (exhaust)	82	82	15
$PM_{2.5}$ (exhaust)	54	54	10
$PM_{10}/PM_{2.5}$ (fugitive dust)	Best Management Practices	None	
Local CO	None	9.0 ppm (8-hour average), 20.0 ppm (1-hour average)	
GHGs **Projects other than Stationary Sources**	None	Compliance with Qualified Climate Action Plan OR 1,100 MT of CO_2e/yr OR 4.6 MT CO_2e/SP/yr (residents + employees)	

Table 1 – Proposed Air Quality CEQA Thresholds of Significance

Pollutant	Construction-Related	Operational-Related
GHGs **Stationary Sources**	None	10,000 MT/yr
Risks and Hazards (Individual Project) **<u>Staff Proposal</u>**	Same as Operational Thresholds*	<u>**All Areas:** Siting a New Source or Receptor</u> Compliance with Qualified Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average <u>Zone of Influence</u>: 1,000-foot radius from fence line of source or receptor
Risks and Hazards (Individual Project) **<u>Board Option 1</u>** **Tiered Thresholds**	Same as Operational Thresholds*	<u>**Impacted Communities:** Siting a New Source</u> Compliance with Qualified Risk Reduction Plan OR Increased cancer risk of >5.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.2 µg/m^3 annual average <u>Zone of Influence</u>: 1,000-foot radius from fence line of source or receptor
	Same as Operational Thresholds*	<u>**Impacted Communities:** Siting a New Receptor</u> <u>**All Other Areas:** Siting a New Source or Receptor</u> Compliance with Qualified Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average <u>Zone of Influence</u>: 1,000-foot radius from fence line of source or receptor
Risks and Hazards (Individual Project) **<u>Board Option 2</u>** **Quantitative Thresholds**	Same as Operational Thresholds*	<u>**All Areas**</u>: <u>Siting a New Source or Receptor</u> Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average <u>Zone of Influence</u>: 1,000-foot radius from fence line of source or receptor

Table 1 – Proposed Air Quality CEQA Thresholds of Significance		
Pollutant	**Construction-Related**	**Operational-Related**
Risks and Hazards (Cumulative Thresholds)	Same as Operational Thresholds*	**<u>All Areas</u>**: <u>Siting a New Source or Receptor</u> Compliance with Qualified Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 1.0 Hazard Index (from all local sources) (Chronic or Acute) $PM_{2.5}$: > 0.8 $\mu g/m^3$ annual average (from all local sources) <u>Zone of Influence</u>: 1,000-foot radius from fence line of source or receptor
Accidental Release of Acutely Hazardous Air Pollutants	None	Storage or use of acutely hazardous materials locating near receptors or receptors locating near stored or used acutely hazardous materials considered significant
Odors	None	Screening Level Distances and Complaint History
Plan-Level		
Criteria Air Pollutants and Precursors (Regional and Local)	None	1. Consistency with Current Air Quality Plan control measures 2. Projected VMT or vehicle trip increase is less than or equal to projected population increase
GHGs	None	Compliance with Qualified Climate Action Plan (or similar criteria included in a General Plan) OR 6.6 MT CO2e/ SP/yr (residents + employees)
Risks and Hazards/Odors	None	1. Overlay zones around existing and planned sources of TACs (including adopted Risk Reduction Plan areas) and odors 2. Overlay zones of at least 500 feet (or Air District-approved modeled distance) from all freeways and high volume roadways
Accidental Release of Acutely Hazardous Air Pollutants	None	None

Notes: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; GHGs = greenhouse gases; lb/day = pounds per day; MT = metric tons; NO_X = oxides of nitrogen; $PM_{2.5}$= fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less; PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less; ppm = parts per million; ROG = reactive organic gases; SO_2 = sulfur dioxide; SP = service population; TACs = toxic air contaminants; TBP = toxic best practices; tons/day = tons per day; tpy = tons per year; yr= year.

* Note: The Air District recommends that for construction projects that are less than one year duration, Lead Agencies should annualize impacts over the scope of actual days that peak impacts are to occur, rather than the full year.

2 GREENHOUSE GAS THRESHOLDS

BAAQMD does not currently have an adopted threshold of significance for GHG emissions. BAAQMD currently recommends that lead agencies quantify GHG emissions resulting from new development and apply all feasible mitigation measures to lessen the potentially adverse impacts. One of the primary objectives in updating the current CEQA Guidelines is to identify a GHG significance threshold, analytical methodologies, and mitigation measures to ensure new land use development meets its fair share of the emission reductions needed to address the cumulative environmental impact from GHG emissions. GHG emissions contribute, on a cumulative basis, to the significant adverse environmental impacts of global climate change. As reviewed herein, climate change impacts include an increase in extreme heat days, higher ambient concentrations of air pollutants, sea level rise, impacts to water supply and water quality, public health impacts, impacts to ecosystems, impacts to agriculture, and other environmental impacts. No single land use project could generate enough GHG emissions to noticeably change the global average temperature. The combination of GHG emissions from past, present, and future projects contribute substantially to the phenomenon of global climate change and its associated environmental impacts.

2.2 PROPOSED THRESHOLDS OF SIGNIFICANCE

Project Type	Proposed Thresholds
Projects other than Stationary Sources	Compliance with Qualified Climate Action Plan OR 1,100 MT of CO_2e/yr OR 4.6 MT CO_2e/SP/yr* (residents + employees)
Stationary Sources	10,000 MT of CO_2e/yr
Plans	Compliance with Qualified Climate Action Plan (or similar criteria included in a General Plan) OR 6.6 MT CO_2e/SP/yr (residents + employees)

* Staff notes that the efficiency-based thresholds should be applied to individual projects with caution. As explained herein, lead agencies may determine that the efficiency-based GHG thresholds for individual land use projects may not be appropriate for very large projects. If there is a fair argument that the project's emissions on a mass level will have a cumulatively considerable impact on the region's GHG emissions, the insignificance presumption afforded to a project that meets an efficiency-based GHG threshold would be overcome.

2.3 JUSTIFICATION AND SUBSTANTIAL EVIDENCE SUPPORTING THRESHOLDS

BAAQMD's approach to developing a threshold of significance for GHG emissions is to identify the emissions level for which a project would not be expected to substantially conflict with existing California legislation adopted to reduce statewide GHG emissions.

If a project would generate GHG emissions above the threshold level, it would be considered to contribute substantially to a cumulative impact, and would be considered significant. If mitigation can be applied to lessen the emissions such that the project meets its share of emission reductions needed to address the cumulative impact, the project would normally be considered less than significant.

As explained in the District's *Revised Draft Options and Justifications Report* (BAAQMD 2009), there are several types of thresholds that may be supported by substantial evidence and be consistent with existing California legislation and policy to reduce statewide GHG emissions. In determining which thresholds to recommend, Staff studied numerous options, relying on reasonable, environmentally conservative assumptions on growth in the land use sector, predicted emissions reductions from statewide regulatory measures and resulting emissions inventories, and the efficacies of GHG mitigation measures. The thresholds recommended herein were chosen based on the substantial evidence that such thresholds represent quantitative and/or qualitative levels of GHG emissions, compliance with which means that the environmental impact of the GHG emissions will normally not be cumulatively considerable under CEQA. Compliance with such thresholds will be part of the solution to the cumulative GHG emissions problem, rather than hinder the state's ability to meet its goals of reduced statewide GHG emissions. Staff notes that it does not believe there is only one threshold for GHG emissions that can be supported by substantial evidence.

GHG CEQA significance thresholds recommended herein are intended to serve as interim levels during the implementation of the AB 32 Scoping Plan and SB 375, which will occur over time. Until AB 32 has been fully implemented in terms of adopted regulations, incentives, and programs and until SB 375 required plans have been fully adopted, or the California Air Resources Board (ARB) adopts a recommended threshold, the BAAQMD recommends that local agencies in the Bay Area apply the GHG thresholds recommended herein.

If left unchecked, GHG emissions from new land use development in California will result in a cumulatively considerable amount of GHG emissions and a substantial conflict with the State's ability to meet the goals within AB 32. Thus, BAAQMD proposes to adopt interim GHG thresholds for CEQA analysis, which can be used by lead agencies within the Bay Area. This would help lead agencies navigate this dynamic regulatory and technological environment where the field of analysis has remained wide open and inconsistent. BAAQMD's framework for developing a GHG threshold for land development projects that is based on policy and substantial evidence follows.

2.3.1 Scientific and Regulatory Justification

Climate Science Overview

Prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, chlorofluorocarbons, and sulfur hexafluoride. Human-caused emissions of these GHGs in excess of natural ambient concentrations are responsible for intensifying the greenhouse effect and have led to a trend of unnatural warming of the earth's climate, known as global climate change or global warming. It is *extremely unlikely* that global climate change of the past 50 years can be explained without the contribution from human activities (IPCC 2007a).

According to Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC), "Avoiding Dangerous Climate Change" means: *"stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."* Dangerous climate change defined in the UNFCCC is based on several key indicators including the potential for severe degradation of coral reef systems, disintegration of the West Antarctic Ice Sheet, and shut down of the large-scale, salinity- and thermally-driven circulation of the oceans. (UNFCCC 2009). The global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005 (IPCC 2007a). "Avoiding dangerous climate change" is generally understood to be achieved by stabilizing global average temperatures between 2 and 2.4°C above pre-industrial levels. In order to limit temperature increases to this level, ambient global CO_2 concentrations must stabilize between 350 and 400 ppm (IPCC 2007b).

Executive Order S-3-05

Executive Order S-3-05, which was signed by Governor Schwarzenegger in 2005, proclaims that California is vulnerable to the impacts of climate change. It declares that increased temperatures could reduce the Sierra's snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea levels. To combat those concerns, the Executive Order established total GHG emission targets. Specifically, emissions are to be reduced to the 2000 level by 2010, the 1990 level by 2020, and to 80 percent below the 1990 level by 2050.

Assembly Bill 32, the California Global Warming Solutions Act of 2006

In September 2006, Governor Arnold Schwarzenegger signed Assembly Bill 32, the California Global Warming Solutions Act of 2006, which set the 2020 greenhouse gas emissions reduction goal into law. AB 32 finds and declares that "Global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California." AB 32 requires that statewide GHG emissions be reduced to 1990 levels by 2020, and establishes regulatory, reporting, voluntary, and market mechanisms to achieve quantifiable reductions in GHG emissions to meet the statewide goal.

In December of 2008, ARB adopted its *Climate Change Scoping Plan* (*Scoping Plan*), which is the State's plan to achieve GHG reductions in California, as required by AB 32 (ARB 2008). The Scoping Plan contains strategies California will implement to achieve a reduction of 169 MMT CO_2e emissions, or approximately 28 percent from the state's projected 2020 emission level of 596 MMT of CO_2e under a business-as-usual scenario (this is a reduction of 42 MMT of CO_2e, or almost 10 percent, from 2002-2004 average emissions), so that the state can return to 1990 emission levels, as required by AB 32.

While the Scoping Plan establishes the policy intent to control numerous GHG sources through regulatory, incentive, and market means, given the early phase of implementation and the level of control that local CEQA lead agencies have over numerous GHG sources, CEQA is an important and supporting tool in achieving GHG reductions overall in compliance with AB 32. In this spirit, BAAQMD is considering the adoption of thresholds of significance for GHG emissions for stationary source and land use development projects.

Senate Bill 375

Senate Bill (SB) 375, signed in September 2008, aligns regional transportation planning efforts, regional GHG reduction targets, and land use and housing allocation. SB 375 requires Metropolitan Planning Organizations (MPOs) to adopt a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS), which will prescribe land use allocation in that MPO's Regional Transportation Plan (RTP). ARB, in consultation with MPOs, will provide each affected region with reduction targets for GHGs emitted by passenger cars and light trucks in the region for the years 2020 and 2035. These reduction targets will be updated every eight years, but can be updated every four years if advancements in emission technologies affect the reduction strategies to achieve the targets. ARB is also charged with reviewing each MPO's SCS or APS for consistency with its assigned targets. If MPOs do not meet the GHG reduction targets, transportation projects would not be eligible for State funding programmed after January 1, 2012. New provisions of CEQA would incentivize qualified projects that are consistent with an approved SCS or APS, categorized as "transit priority projects."

While SB 375 is considered in the development of these thresholds, given that the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) development of the SCS for the Bay Area is in its early stages and the ARB GHG reduction target for light duty and passenger vehicles in the Bay Area has not yet been proposed, it is not appropriate from a CEQA perspective to expect SB 375 to completely address the emission reductions needed from this transportation sector in meeting AB 32 goals. In the future, as SB 375 implementation progresses, BAAQMD may need to revisit GHG thresholds.

2.3.2 PROJECT-LEVEL GHG THRESHOLDS

Staff recommends setting GHG significance thresholds based on AB 32 GHG emission reduction goals while taking into consideration emission reduction strategies outlined in ARB's Scoping Plan. Staff proposes two quantitative thresholds for land use projects: a bright line threshold based on a "gap" analysis and an efficiency threshold based on emission levels required to be met in order to achieve AB 32 goals.

Staff also proposes one qualitative threshold for land use projects: if a project complies with a Qualified Climate Action Plan (as defined in Section 2.3.4 below) that addresses the project it would be considered less than significant. As explained in detail in Section 2.3.4 below, compliance with a Qualified Climate Action Plan (or similar adopted policies, ordinances and programs), would provide the evidentiary basis for making

CEQA findings that development consistent with the plan would result in feasible, measureable, and verifiable GHG reductions consistent with broad state goals such that projects approved under qualified Climate Action Plans or equivalent demonstrations would achieve their fair share of GHG emission reductions.

2.3.2.1 Land Use Projects "Gap-Based" Threshold

Staff took eight steps in developing this threshold approach, which are summarized here and detailed in the sections that follow. It should be noted that the "gap-based approach" used for threshold development is a conservative approach that focuses on a limited set of state mandates that appear to have the greatest potential to reduce land use development-related GHG emissions at the time of this writing. It is also important to note that over time, as the effectiveness of the State's implementation of AB 32 (and SB 375) progresses, BAAQMD will need to reconsider the extent of GHG reductions needed over and above those from the implementation thereof for the discretionary approval of land use development projects. Although there is an inherent amount of uncertainty in the estimated capture rates (i.e., frequency at which project-generated emissions would exceed a threshold and would be subject to mitigation under CEQA) and the aggregate emission reductions used in the gap analysis, they are based on BAAQMD's expertise, the best available data, and use conservative assumptions for the amount of emission reductions from legislation in derivation of the gap (e.g., only adopted legislation was relied upon). This approach is intended to attribute an appropriate share of GHG emission reductions necessary to reach AB 32 goals to new land use development projects in BAAQMD's jurisdiction that are evaluated pursuant to CEQA.

Step 1 Estimate from ARB's statewide GHG emissions inventory the growth in emissions between 1990 and 2020 attributable to "land use-driven" sectors of the emission inventory as defined by OPR's guidance document (*CEQA and Climate Change*). Land use-driven emission sectors include Transportation (On-Road Passenger Vehicles; On-Road Heavy Duty), Electric Power (Electricity; Cogeneration), Commercial and Residential (Residential Fuel Use; Commercial Fuel Use) and Recycling and Waste (Domestic Waste Water Treatment).

Result: 1990 GHG emissions were 295.53 MMT CO_2e/yr and projected 2020 business-as-usual GHG emissions would be 400.22 MMT CO_2e/yr; thus a 26.2 percent reduction from statewide land use-driven GHG emissions would be necessary to meet the AB 32 goal of returning to 1990 emission levels by 2020. (See Table 2)

Step 2 Estimate the anticipated GHG emission reductions affecting the same land use-driven emissions inventory sectors associated with adopted statewide regulations identified in the AB 32 Scoping Plan.

Result: Estimated a 23.9 percent reduction can be expected in the land use-driven GHG emissions inventory from adopted Scoping Plan regulations, including AB 1493 (Pavley), LCFS, Heavy/Medium Duty Efficiency, Passenger Vehicle Efficiency, Energy-Efficiency

Measures, Renewable Portfolio Standard, and Solar Roofs. (See Table 3)

Step 3 Determine any short fall or "gap" between the 2020 statewide emission inventory estimates and the anticipated emission reductions from adopted Scoping Plan regulations. This "gap" represents additional GHG emission reductions needed statewide from the land use-driven emissions inventory sectors, which represents new land use development's share of the emission reductions needed to meet statewide GHG emission reduction goals.

Result: With the 23.9 percent reductions from AB 32 Scoping Measures, there is a "gap" of 2.3 percent in necessary additional GHG emissions reductions to meet AB 32 goals of a 26.2 percent reduction from statewide land use-driven GHG emissions to return to 1990 levels in 2020. (See Table 2)

Step 4 Determine the percent reduction this "gap" represents in the "land use-driven" emissions inventory sectors from BAAQMD's 2020 GHG emissions inventory. Identify the mass of emission reductions needed in the SFBAAB from land use-driven emissions inventory sectors.

Result: Estimated that a 2.3 percent reduction in BAAQMD's projected 2020 emissions projections requires emissions reductions of 1.6 MMT CO_2e/yr from the land use-driven sectors. (See Table 4)

Step 5 Assess BAAQMD's historical CEQA database (2001-2008) to determine the frequency distribution trend of project sizes and types that have been subject to CEQA over the past several years.

Result: Determined historical patterns of residential, commercial and industrial development by ranges of average sizes of each development type. Results were used in Step 6 below to distribute anticipated Bay Area growth among different future project types and sizes.

Step 6 Forecast new land use development for the Bay Area using DOF/EDD population and employment projections and distribute the anticipated growth into appropriate land use types and sizes needed to accommodate the anticipated growth (based on the trend analysis in Step 5 above). Translate the land use development projections into land use categories consistent with those contained in the Urban Emissions Model (URBEMIS).

Result: Based on population and employment projections and the trend analysis from Step 5 above, forecasted approximately 4,000 new development projects, averaging about 400 projects per year through 2020 in the Bay Area.

Step 7 Estimate the amount of GHG emissions from each land use development project type and size using URBEMIS and post-model manual calculation methods (for emissions not included in URBEMIS). Determine the amount of GHG emissions that can reasonably and feasibly be reduced through currently available mitigation measures ("mitigation effectiveness") for future land use development projects subject to CEQA (based on land use development projections and frequency distribution from Step 6 above).

Result: Based on the information available and on sample URBEMIS calculations, found that mitigation effectiveness of between 25 and 30 percent is feasible.

Step 8 Conduct a sensitivity analysis of the numeric GHG mass emissions threshold needed to achieve the desired emissions reduction (i.e., "gap") determined in Step 4. This mass emission GHG threshold is that which would be needed to achieve the emission reductions necessary by 2020 to meet the Bay Area's share of the statewide "gap" needed from the land use-driven emissions inventory sectors.

Result: The results of the sensitivity analysis conducted in Step 8 found that reductions between about 125,000 MT/yr (an aggregate of 1.3 MMT in 2020) and over 200,000 MT/yr (an aggregate of over 2.0 MMT in 2020) were achievable and feasible. A mass emissions threshold of 1,100 MT of CO_2e/yr would result in approximately 59 percent of all projects being above the significance threshold (e.g., this is approximately the operational GHG emissions that would be associated with a 60 residential unit subdivision) and must implement feasible mitigation measures to meet CEQA requirements. With an estimated 26 percent mitigation effectiveness, the 1,100 MT threshold would achieve 1.6 MMT CO_2e/yr in GHG emissions reductions.

2.3.2.2 DETAILED BASIS AND ANALYSIS

Derivation of Greenhouse Gas Reduction Goal

To meet the target emissions limit established in AB 32 (equivalent to levels in 1990), total GHG emissions would need to be reduced by approximately 28 percent from projected 2020 forecasts (ARB 2009a). The AB 32 Scoping Plan is ARB's plan for meeting this mandate (ARB 2008). While the Scoping Plan does not specifically identify GHG emission reductions from the CEQA process for meeting AB 32 derived emission limits, the scoping plan acknowledges that "other strategies to mitigate climate change . . . should also be explored." The Scoping Plan also acknowledges that "Some of the measures in the plan may deliver more emission reductions than we expect; others less . . . and new ideas and strategies will emerge." In addition, climate change is considered a significant environmental issue and, therefore, warrants consideration under CEQA. SB 97 represents the State Legislature's confirmation of this fact, and it directed the Governor's Office of Planning and Research (OPR) to develop CEQA Guidelines for evaluation of GHG emissions impacts and recommend mitigation strategies. In response, OPR released the *Technical Advisory: CEQA and Climate Change* (OPR 2008), and has released proposed CEQA guidelines (April 14, 2009) for consideration of GHG emissions. It is known that new land use development must also do its fair share toward achieving AB 32 goals (or, at a minimum, should not hinder the State's progress toward the mandated emission reductions).

Foreseeable Scoping Plan Measures Emission Reductions and Remaining "Gap"

Step 1 of the Gap Analysis entailed estimating from ARB's statewide GHG inventory the growth in emissions between 1990 and 2020 attributable to land use driven sectors of the emissions inventory. As stated above, to meet the requirements set forth in AB 32 (i.e., achieve California's 1990-equivalent GHG emissions levels by 2020) California would need to achieve an approximate 28 percent reduction in emissions across all sectors of the GHG emissions inventory compared with 2020 projections. However, to meet the AB 32 reduction goals in the emissions sectors that are related to land use development (e.g., on-road passenger and heavy-duty motor vehicles, commercial and residential area sources [i.e., natural gas], electricity generation/consumption, wastewater treatment, and water distribution/consumption), staff determined that California would need to achieve an approximate 26 percent reduction in GHG emissions from these land use-driven sectors (ARB 2009a) by 2020 to return to 1990 land use emission levels.

Next, in Step 2 of the Gap Analysis, Staff determined the GHG emission reductions within the land use-driven sectors that are anticipated to occur from implementation of the Scoping Plan measures statewide, which are summarized in Table 2 and described below. Since the GHG emission reductions anticipated with the Scoping Plan were not accounted for in ARB's or BAAQMD's 2020 GHG emissions inventory forecasts (i.e., business as usual), an adjustment was made to include (i.e., give credit for) GHG emission reductions associated with key Scoping Plans measures, such as the Renewable Portfolio Standard, improvements in energy efficiency through periodic updates to Title 24, AB 1493 (Pavley) (which recently received a federal waiver to allow it to be enacted in law), the Low Carbon Fuel Standard (LCFS), and other measures. With reductions from these State regulations (Scoping Plan measures) taken into consideration and accounting for an estimated 23.9 percent reduction in GHG emissions, in Step 3 of the Gap Analysis Staff determined that the Bay Area would still need to achieve an additional 2.3 percent reduction from projected 2020 GHG emissions to meet the 1990 GHG emissions goal from the land-use driven sectors. This necessary 2.3 percent reduction in projected GHG emissions from the land use sector is the "gap" the Bay Area needs to fill to do its share to meet the AB 32 goals. Refer to the following explanation and Tables 2 through 4 for data used in this analysis.

Because the transportation sector is the largest emissions sector of the state's GHG emissions inventory, it is aggressively targeted in early actions and other priority actions in the Scoping Plan including measures concerning gas mileage (Pavley), fuel carbon intensity (LCFS) and vehicle efficiency measures.

Table 2 – California 1990, 2002-2004, and 2020 Land Use Sector GHG[1] (MMT CO_2e/yr)

Sector	1990 Emissions	2002-2004 Average	2020 BAU Emissions Projections	% of 2020 Total
Transportation	**137.98**	**168.66**	**209.06**	**52%**
On-Road Passenger Vehicles	108.95	133.95	160.78	40%
On-Road Heavy Duty	29.03	34.69	48.28	12%
Electric Power	**110.63**	**110.04**	**140.24**	**35%**
Electricity	95.39	88.97	107.40	27%
Cogeneration[2]	15.24	21.07	32.84	8%
Commercial and Residential	**44.09**	**40.96**	**46.79**	**12%**
Residential Fuel Use	29.66	28.52	32.10	8%
Commercial Fuel Use	14.43	12.45	14.63	4%
Recycling and Waste[1]	**2.83**	**3.39**	**4.19**	**1%**
Domestic Wastewater Treatment	2.83	3.39	4.19	1%
TOTAL GROSS EMISSIONS	**295.53**	**323.05**	**400.22**	
% Reduction Goal from Statewide land use driven sectors (from 2020 levels to reach 1990 levels in these emission inventory sectors)			26.2%	
% Reduction from AB32 Scoping Plan measures applied to land use sectors (see Table 3)			-23.9%	
% Reduction needed statewide beyond Scoping Plan measures (Gap)			2.3%	

Notes: MMT CO_2e /yr = million metric tons of carbon dioxide equivalent emissions per year.
[1] Landfills not included. See text.
[2] Cogeneration included due to many different applications for electricity, in some cases provides substantial power for grid use, and because electricity use served by cogeneration is often amenable to efficiency requirements of local land use authorities.
Sources: Data compiled by EDAW and ICF Jones & Stokes from ARB data.

Pavley Regulations. The AB 32 Scoping Plan assigns an approximate 20 percent reduction in emissions from passenger vehicles associated with the implementation of AB 1493. The AB 32 Scoping Plan also notes that "AB 32 specifically states that if the Pavley regulations do not remain in effect, ARB shall implement alternative regulations to control mobile sources to achieve equivalent or greater reductions of greenhouse gas emissions (HSC §38590)." Thus, it is reasonable to assume full implementation of AB 1493 standards, or equivalent programs that would be implemented by ARB. While the Obama administration has proposed national CAFE standards that may be equivalent to or even surpass AB 1493, the timing for implementation of the proposed federal standards is uncertain such that development of thresholds based on currently unadopted federal standards would be premature. BAAQMD may need to revisit this methodology as the federal standards come on line, particularly if such standards are more aggressive than that forecast under state law.

Table 3 – 2020 Land Use Sector GHG Emission Reductions from State Regulations and AB 32 Measures				
Affected Emissions Source	**California Legislation**	**% Reduction from 2020 GHG inventory**	**End Use Sector (% of Bay Area LU Inventory)**	**Scaled % Emissions Reduction (credit)**
Mobile	AB 1493 (Pavley)	19.7%	On road passenger/light truck transportation (45%)	8.9%
	LCFS	7.2%	On road passenger/light truck transportation (45%)	3.2%
	LCFS	7.2%	On road Heavy/Medium Duty Transportation (5%)	0.4%
	Heavy/Medium Duty Efficiency	2.9%	On road Heavy/Medium Duty Transportation (5%)	0.2%
	Passenger Vehicle Efficiency	2.8%	On road passenger/light truck transportation (45%)	1.3%
Area	Energy-Efficiency Measures	9.5%	Natural gas (Residential, 10%)	1.0%
			Natural gas (Non-residential,13%)	1.2%
Indirect	Renewable Portfolio Standard	21.0%	Electricity (excluding cogen) (17%)	3.5%
	Energy-Efficiency Measures	15.7%	Electricity (26%)	4.0%
	Solar Roofs	1.5%	Electricity (excluding cogen) (17%)	0.2%
Total credits given to land use-driven emission inventory sectors from Scoping Plan measures				**23.9%**
Notes: AB = Assembly Bill; LCFS = Low Carbon Fuel Standard; SB = Senate Bill; RPS = Renewable Portfolio Standard Please refer to Appendix D for detailed calculations. Sources: Data compiled by ICF Jones & Stokes.				

<u>LCFS</u>. According to the adopted LCFS rule (CARB, April 2009), the LCFS is expected to result in approximately 10 percent reduction in the carbon intensity of transportation fuels. However, a portion of the emission reductions required from the LCFS would be achieved over the life cycle of transportation fuel production rather than from mobile-source emission factors. Based on CARB's estimate of nearly 16 MMT reductions in on-road emissions from implementation of the LCFS and comparison to the statewide on-road emissions sector, the LCFS is assumed to result in a 7.2 percent reduction compared to 2020 BAU conditions (CARB 2009e).

Table 4 – SFBAAB 1990, 2007, and 2020 Land Use Sector GHG Emissions Inventories and Projections (MMT CO_2e/yr)				
Sector	**1990 Emissions**	**2007 Emissions**	**2020 Emissions Projections**	**% of 2020 Total[2]**
Transportation	**26.1**	**30.8**	**35.7**	**50%**
On-Road Passenger Vehicles	23.0	27.5	32.0	
On-Road Heavy Duty	3.1	3.3	3.7	
Electric Power	**25.1**	**15.2**	**18.2**	**26%**
Electricity	16.5	9.9	11.8	
Cogeneration	8.6	5.3	6.4	
Commercial and Residential	**8.9**	**15.0**	**16.8**	**24%**
Residential Fuel Use	5.8	7.0	7.5	
Commercial Fuel Use	3.1	8.0	9.3	
Recycling and Waste[1]	**0.2**	**0.4**	**0.4**	**1%**
Domestic Waste Water Treatment	0.2	0.4	0.4	
TOTAL GROSS EMISSIONS	**60.3**	**61.4**	**71.1**	
SFBAAB's "Fair Share" % Reduction (from 2020 levels to reach 1990 levels) with AB-32 Reductions (from Table 3)			2.3%	
SFBAAB's Equivalent Mass Emissions Land Use Reduction Target at 2020 (MMT CO2e/yr)			1.6	

Notes: MMT CO_2e /yr = million metric tons of carbon dioxide equivalent emissions per year; SFBAAB = San Francisco Bay Area Air Basin.
[1] Landfills not included.
[2] Percentages do not sum exactly to 100% in table due to rounding.
Please refer to Appendix D for detailed calculations.
Sources: Data compiled by EDAW 2009, ICF Jones & Stokes 2009, BAAQMD 2008.

Renewable Portfolio Standard, Energy Efficiency and Solar Roofs. Energy efficiency and renewable energy measures from the Scoping Plan were also included in the gap analysis. The Renewable Portfolio Standard (rules) will require the renewable energy portion of the retail electricity portfolio to be 33 percent in 2020. For PG&E, the dominant electricity provider in the Basin, approximately 12 percent of their current portfolio qualifies under the RPS rules and thus the gain by 2020 would be approximately 21 percent. The Scoping Plan also estimates that energy efficiency gains with periodic improvement in building and appliance energy standards and incentives will reach 10 to 15 percent for natural gas and electricity respectively. The final state measure included in this gap analysis is the solar roof initiative, which is estimated to result in reduction of the overall electricity inventory of 1.5 percent.

Landfill emissions are excluded from this analysis. While land use development does generate waste related to both construction and operations, the California Integrated Waste Management Board (CIWMB) has mandatory diversion requirements that will, in all probability, increase over time to promote waste reductions, reuse, and recycle. The Bay Area has relatively high levels of waste diversion and extensive recycling efforts. Further, ARB has established and proposes to increase methane capture requirements for all major landfills. Thus, at this time, landfill emissions associated with land use development waste generation is not included in the land use sector inventory used to develop this threshold approach.

Industrial stationary sources thresholds were developed separately from the land use threshold development using a market capture approach as described below. However, mobile source and area source emissions, as well as indirect electricity emissions that derive from industrial use are included in the land use inventory above as these particular activities fall within the influence of local land use authorities in terms of the affect on trip generation and energy efficiency.

AB 32 mandates reduction to 1990-equivalent GHG levels by 2020, with foreseeable emission reductions from State regulations and key Scoping Plan measures taken into account, were applied to the land use-driven emission sectors within the SFBAAB (i.e., those that are included in the quantification of emissions from a land use project pursuant to a CEQA analysis [on-road passenger vehicles, commercial and residential natural gas, commercial and residential electricity consumption, and domestic waste water treatment], as directed by OPR in the Technical Advisory: *Climate Change and CEQA* [OPR 2008]). This translates to a 2.3 percent gap in necessary GHG emission reductions by 2020 from these sectors.

2.3.2.3 LAND USE PROJECTS BRIGHT LINE THRESHOLD

In Steps 4 and 5 of the gap analysis, Staff determined that applying a 2.3 percent reduction to these land use emissions sectors in the SFBAAB's GHG emissions inventory would result in an equivalent fair share of 1.6 million metric tons per year (MMT/yr) reductions in GHG emissions from new land use development. As additional regulations and legislation aimed at reducing GHG emissions from land use-related sectors become available in the future, the 1.6 MMT GHG emissions reduction goal may be revisited and recalculated by BAAQMD.

In order to derive the 1.6 MMT "gap," a projected development inventory for the next ten years in the SFBAAB was calculated. (See Table 4 and *Revised Draft Options and Justifications Report* (BAAQMD 2009).) CO_2e emissions were modeled for projected development in the SFBAAB and compiled to estimate the associated GHG emissions inventory. The GHG (i.e., CO_2e) CEQA threshold level was adjusted for projected land use development that would occur within BAAQMD's jurisdiction over the period from 2010 through 2020.

Projects with emissions greater than the threshold would be required to mitigate to the threshold level or reduce project emissions by a percentage (mitigation effectiveness) deemed feasible by the Lead Agency under CEQA compared to a base year condition. The base year condition is defined by an equivalent size and character of project with annual emissions using the defaults in URBEMIS and the California Climate Action Registry's General Reporting Protocol for 2008. By this method, land use project mitigation subject to CEQA would help close the "gap" remaining after application of the key regulations and measures noted above supporting overall AB 32 goals.

This threshold takes into account Steps 1-8 of the gap analysis described above to arrive at a numerical mass emissions threshold. Various mass emissions significance threshold levels (i.e., bright lines) could be chosen based on the mitigation effectiveness and performance anticipated to be achieved per project to meet the aggregate emission reductions of 1.6 MMT needed in the SFBAAB by 2020. (See Table 5 and *Revised Draft Options and Justifications Report* (BAAQMD 2009).) Staff recommends a 1,100 MT CO_2e per year threshold. Choosing a 1,100 MT mass emissions significance threshold level (equivalent to approximately 60 single-family units), would result in about 59 percent of all projects being above the significance threshold and having to implement feasible mitigation measures to meet their CEQA obligations. These projects account for approximately 92 percent of all GHG emissions anticipated to occur between now and 2020 from new land use development in the SFBAAB.

Project applicants and lead agencies could use readily available computer models to estimate a project's GHG emissions, based on project specific attributes, to determine if they are above or below the bright line numeric threshold. With this threshold, projects that are above the threshold level, after consideration of emission-reducing characteristics of the project as proposed, would have to reduce their emissions to below the threshold to be considered less than significant.

Establishing a "bright line" to determine the significance of a project's GHG emissions impact provides a level of certainty to lead agencies in determining if a project needs to reduce its GHG emissions through mitigation measures and when an EIR is required.

Table 5 – Operational GHG Threshold Sensitivity Analysis

Option	Mitigation Effectiveness Assumptions: Performance Standards Applied to All Projects with Emissions < Threshold Level	Mitigation Effectiveness Assumptions: Mitigation Effectiveness Applied to Emissions > Threshold Level	Mass Emission Threshold Level (MT CO_2e/yr)	% of Projects Captured (>threshold)	% of Emissions Captured (> threshold)	Emissions Reduction per year (MT/yr)	Aggregate Emissions Reduction (MMT) at 2020	Threshold Project Size Equivalent (single family dwelling units)
1A	N/A	30%	975	60%	93%	201,664	2.0	53
1A	N/A	25%	110	96%	100%	200,108	2.0	66
1A	N/A	30%	1,225	21%	67%	159,276	1.6	67
1A	N/A	26%	1,100	59%	92%	159,877	1.6	60
1A	N/A	30%	2,000	14%	61%	143,418	1.4	109
1A	N/A	25%	1,200	58%	92%	136,907	1.4	66
1A	N/A	30%	3,000	10%	56%	127,427	1.3	164
1A	N/A	25%	1,500	20%	67%	127,303	1.3	82
1B	26%	N/A	N/A	100%	100%	208,594	2.1	N/A[1]
1C	5%	30%	1,900	15%	62%	160,073	1.6	104
1C	10%	25%	1,250	21%	67%	159,555	1.6	68
1C	5%	30%	3,000	10%	56%	145,261	1.5	164
1C	10%	25%	2,000	4%	61%	151,410	1.5	109
1C	10%	30%	10,000	2%	33%	125,271	1.3	547

Notes: MMT = million metric tons per year; MT CO_2e/yr = metric tons of carbon dioxide equivalent emissions per year; MT/yr = metric tons per year; N/A = not applicable.

[1] Any project subject to CEQA would trigger this threshold.

Please refer to Appendix E for detailed calculations.

Source: Data modeled by ICF Jones & Stokes.

2.3.2.4 LAND USE PROJECTS EFFICIENCY-BASED THRESHOLD

GHG efficiency metrics can also be utilized as thresholds to assess the GHG efficiency of a project on a per capita basis (residential only projects) or on a "service population" basis (the sum of the number of jobs and the number of residents provided by a project) such that the project will allow for consistency with the goals of AB 32 (i.e., 1990 GHG emissions levels by 2020). GHG efficiency thresholds can be determined by dividing the GHG emissions inventory goal (allowable emissions), by the estimated 2020 population and employment. This method allows highly efficient projects with higher mass emissions to meet the overall reduction goals of AB 32. Staff believes it is more appropriate to base the land use efficiency threshold on the service population metric for the land use-driven emission inventory. This approach is appropriate because the threshold can be applied evenly to all project types (residential or commercial/retail only and mixed use) and uses only the land use emissions inventory that is comprised of all land use projects. Staff will provide the methodology to calculate a project's GHG emissions in the revised CEQA Guidelines, such as allowing infill projects up to a 50 percent or more reduction in daily vehicle trips if the reduction can be supported by close proximity to transit and support services, or a traffic study prepared for the project.

Table 6 – California 2020 GHG Emissions, Population Projections and GHG Efficiency Thresholds - Land Use Inventory Sectors

Land Use Sectors Greenhouse Gas Emissions Target	295,530,000
Population	44,135,923
Employment	20,194,661
California Service Population (Population + Employment)	64,330,584
AB 32 Goal GHG emissions (metric tons CO_2e)/SP[1]	**4.6**

Notes: AB = Assembly Bill; CO_2e = carbon dioxide equivalent; GHG = greenhouse gas; SP = service population.
[1] Greenhouse gas efficiency levels were calculated using only the "land use-related" sectors of ARB's emissions inventory.
Please refer to Appendix D for detailed calculations.
Sources: Data compiled by EDAW 2009, ARB 2009a, DOF 2009, EDD 2009, ICF Jones & Stokes 2009.

Staff proposes a project-level efficiency threshold of 4.6 MT CO_2e/SP, the derivation of which is shown Table 6. This efficiency-based threshold reflects very GHG-efficient projects. As stated previously and below, staff anticipates that significance thresholds (rebuttable presumptions of significance at the project level) will function on an interim basis only until adequate programmatic approaches are in place at the city, county, and regional level that will allow the CEQA streamlining of individual projects. (See Draft CEQA Guidelines, proposed section 15183.5 ["Tiering and Streamlining the Analysis of Greenhouse Gas Emissions"]). In advance of such programmatic approaches, local agencies may wish to apply this efficiency-based recommended threshold with some discretion, taking into account not only the project's efficiency, but also its total GHG emissions. Even where a project is relatively GHG-efficient as compared to other projects, in approving the project, the lead agency is committing to use what is essentially its GHG "budget" in a given way. Expending this "budget" on the proposed project may affect other development opportunities and associated obligations to mitigate or conflict with other actions that the community may wish to take to reduce its overall GHG emissions after it has conducted its programmatic analysis.

Accordingly, in applying the efficiency-based threshold of 4.6 MT CO_2e/SP, the lead agency might also wish to consider the project's total emissions. Where a project meets the efficiency threshold but would still have very large GHG emissions, the lead agency may wish to consider whether the project's contributions to climate change might still be cumulatively considerable and whether additional changes to the project or mitigation should be required. Staff notes that even where the project may be significant as it relates to climate change, the lead agency may find that the project should nonetheless be approved in light of its benefits; in that case, the lead agency may wish to note the project's efficiency and any innovative design features in the Statement of Overriding Considerations.

2.3.3 PLAN-LEVEL GHG THRESHOLDS

Staff proposes using a two step process for determining the significance of proposed plans and plan amendments for GHG. As a first step in assessing plan-level impacts, Staff is proposing that agencies that have adopted a qualified climate action plan (or have incorporated similar criteria in their General Plan) and the General Plan or Transportation Plan are consistent with the climate action plan, the General Plan or Transportation Plan would be considered less than significant. In addition, as discussed above for project-level GHG impacts, Staff is proposing an efficiency threshold to assess plan-level impacts. Staff believes a programmatic approach to limiting GHG emissions is appropriate at the plan-level. Thus, as projects consistent with the climate action plan are proposed, they may be able to tier off the plan and its environmental analysis.

2.3.3.1 GHG EFFICIENCY METRICS FOR PLANS

For local land use plans, a GHG-efficiency metric (e.g., GHG emissions per unit) would enable comparison of a proposed general plan to its alternatives and to determine if the proposed general plan meets AB 32 emission reduction goals.

AB 32 identifies local governments as essential partners in achieving California's goal to reduce GHG emissions. Local governments have primary authority to plan, zone, approve, and permit how and where land is developed to accommodate population growth and the changing needs of their jurisdiction. ARB has developed the Local Government Operations Protocol and is developing a protocol to estimate community-wide GHG emissions. ARB encourages local governments to use these protocols to track progress in reducing GHG emissions. ARB encourages local governments to institutionalize the community's strategy for reducing its carbon footprint in its general plan. SB 375 creates a process for regional integration of land development patterns and transportation infrastructure planning with the primary goal of reducing GHG emissions from the largest sector of the GHG emission inventory, light duty vehicles.

If the statewide AB 32 GHG emissions reduction context is established, GHG efficiency can be viewed independently from the jurisdiction in which the plan is located. Expressing projected 2020 mass of emissions from land use-related emissions sectors by comparison to a demographic unit (e.g., population and employment) provides evaluation of the GHG efficiency of a project in terms of what emissions are allowable while meeting AB 32 targets.

Two approaches were considered for efficiency metrics. The "service population" (SP) approach would consider efficiency in terms of the GHG emissions compared to the sum of the number of jobs and the number of residents at a point in time. The per capita option would consider efficiency in terms of GHG emissions per resident only. Staff recommends that the efficiency threshold for plans be based on all emission inventory sectors because, unlike land use projects, community-wide or regional plans comprise more than just land use related emissions (e.g. industrial). Further, Staff recommends that plan threshold be based on the service population metric as community-wide plans or regional plans include a mix of residents and employees. The Service Population metric would allow decision makers to compare GHG efficiency of general plan alternatives that vary residential and non-residential development totals, encouraging GHG efficiency through improving jobs/housing balance. This approach would not give preference to communities that accommodate more residential (population-driven) land uses than non-residential (employment driven) land uses which could occur with the per capita approach.

A SP-based GHG efficiency metric (see Table 7) was derived from the emission rates at the State level that would accommodate projected population and employment growth under trend forecast conditions, and the emission rates needed to accommodate growth while allowing for consistency with the goals of AB 32 (i.e., 1990 GHG emissions levels by 2020).

Table 7 – California 2020 GHG Emissions, Population Projections and GHG Efficiency Thresholds - All Inventory Sectors

All Inventory Sectors Greenhouse Gas Emissions Target	426,500,000
Population	44,135,923
Employment	20,194,661
California Service Population (Population + Employment)	64,330,584
AB 32 Goal GHG emissions (metric tons CO_2e)/SP[1]	**6.6**

Notes: AB = Assembly Bill; CO_2e = carbon dioxide equivalent; GHG = greenhouse gas; SP = service population.
[1] Greenhouse gas efficiency levels were calculated using only the "land use-related" sectors of ARB's emissions inventory.
Please refer to Appendix D for detailed calculations.
Sources: Data compiled by EDAW 2009, ARB 2009a, DOF 2009, EDD 2009, ICF Jones & Stokes 2009.

If a general plan demonstrates, through dividing the emissions inventory projections (MT CO_2e) by the amount of growth that would be accommodated in 2020, that it could meet the GHG efficiency metrics proposed in this section (6.6 MT CO_2e/SP from all emission sectors, as noted in Table 7), then the amount of GHG emissions associated with the general plan would be considered less than significant, regardless of its size (and magnitude of GHG emissions). In other words, the general plan would accommodate growth in a manner that would not hinder the State's ability to achieve AB 32 goals, and thus, would be less than significant for GHG emissions and their contribution to climate change. The efficiency metric would not penalize well-planned communities that propose a large amount of development. Instead, the SP-based GHG efficiency metric acts to encourage the types of development that BAAQMD and OPR support (i.e., infill and transit-oriented development) because it tends to reduce GHG and other air pollutant emissions overall, rather than discourage large developments for being accompanied by a large mass of GHG emissions. Plans that are more GHG efficient would have no or limited mitigation requirements to help them complete the CEQA process more readily than plans that promote GHG inefficiencies, which will require detailed design of mitigation during the CEQA process and could subject a plan to potential challenge as to whether all feasible mitigation was identified and adopted. This type of threshold can shed light on a well-planned general plan that accommodates a large amount of growth in a GHG-efficient way.

When analyzing long-range plans, such as general plans, it is important to note that the planning horizon will often surpass the 2020 timeframe for implementation of AB 32. Executive Order S-3-05 establishes a more aggressive emissions reduction goal for the year 2050 of 80 percent below 1990 emissions levels. The year 2020 should be viewed as a milestone year, and the general plan should not preclude the community from a trajectory toward the 2050 goal. However, the 2020 timeframe is examined in this threshold evaluation because doing so for the 2050 timeframe (with respect to population, employment, and GHG emissions projections) would be too speculative. Advances in technology and policy decisions at the state level will be needed to meet the aggressive 2050 goals. It is beyond the scope of the analysis tools available at this time to examine reasonable emissions reductions that can be achieved through CEQA analysis in the year 2050. As the 2020 timeframe draws nearer, BAAQMD will need to reevaluate the threshold to better represent progress toward 2050 goals.

2.3.4 CLIMATE ACTION PLANS

Finally, many local agencies have already undergone or plan to undergo efforts to create general or other plans that are consistent with AB 32 goals. The Air District encourages such planning efforts and recognizes that careful upfront planning by local agencies is invaluable to achieving the state's GHG reduction goals. If a project is consistent with an adopted Qualified Climate Action Plan that addresses the project's GHG emissions, it can be presumed that the project will not have significant GHG emission impacts. This approach is consistent with CEQA Guidelines Section 15064(h)(3), which provides that a "lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project will comply with the requirements in a previously approved plan or mitigation program which provides specific requirements that will avoid or substantially lessen the cumulative problem."

A qualified Climate Action Plan (or similar adopted policies, ordinances and programs) is one that is consistent with all of the AB 32 Scoping Plan measures and goals. The Climate Action Plan should identify a land use design, transportation network, goals, policies and implementation measures that would achieve AB 32 goals. Plans with horizon years beyond 2020 should consider continuing the downward reduction path set by AB 32 and move toward climate stabilization goals established in Executive Order S-3-05.

Qualified Climate Action Plans

A qualified Climate Action Plan adopted by a local jurisdiction should include the following. The District's revised CEQA Guidelines will provide the methodology to determine if a Climate Action Plan meets these requirements.

- GHG Inventory for Current Year and Forecast for 2020 (and for 1990 if the reduction goal is based on 1990 emission levels).
- An adopted GHG Reduction Goal for 2020 for the jurisdiction from all sources (existing and future) which is at least one of the following: 1990 GHG emission levels, 15 percent below 2008 emission levels, or 28 percent below BAU Forecasts for 2020 (if including non-land use sector emissions in the local inventory; otherwise can use 26.2 percent if only including land use sector emissions).
- Identification of feasible reduction measures to reduce GHG emissions for 2020 to the identified target.
- Application of relevant reduction measures included in the AB 32 Scoping Plan that are within the jurisdiction of the local land use authority (such as building energy efficiency, etc.).
- Quantification of the reduction effectiveness of each of the feasible measures identified including disclosure of calculation method and assumptions.
- Identification of implementation steps and financing mechanisms to achieve the identified goal by 2020.
- Procedures for monitoring and updating the GHG inventory and reduction measures at least twice before 2020 or at least every five years.
- Identification of responsible parties for Implementation.
- Schedule of implementation.
- Certified CEQA document, or equivalent process (see below).

Local Climate Action Policies, Ordinances and Programs

Air District staff recognizes that many communities in the Bay Area have been proactive in planning for climate change but have not yet developed a stand-alone Climate Action

Plan that meets the above criteria. Many cities and counties have adopted climate action policies, ordinances and program that may in fact achieve the goals of a qualified climate action plan. Staff recommends that if a local jurisdiction can demonstrate that its collective set of climate action policies, ordinances and other programs is consistent with AB 32, includes requirements or feasible measures to reduce GHG emissions and achieves one of the following GHG emission reduction goals,[3] the AB 32 consistency demonstration should be considered equivalent to a qualified climate action plan:

- 1990 GHG emission levels,
- 15 percent below 2008 emission levels, or
- 28 percent below BAU Forecasts for 2020 (if including non-land use sector emissions in the local inventory; otherwise can use 26.2 percent if only including land use sector emissions).

Qualified Climate Action Plans that are tied to the AB 32 reduction goals would promote reductions on a plan level without impeding the implementation of GHG-efficient development, and would recognize the initiative of many Bay Area communities who have already developed or are in the process of developing a GHG reduction plan. The details required above for a qualified Climate Action Plan (or similar adopted policies, ordinances and programs) would provide the evidentiary basis for making CEQA findings that development consistent with the plan would result in feasible, measureable, and verifiable GHG reductions consistent with broad state goals such that projects approved under qualified Climate Action Plans or equivalent demonstrations would achieve their fair share of GHG emission reductions.

2.3.5 STATIONARY SOURCE GHG THRESHOLD

Staff's recommended threshold for stationary source GHG emissions is based on estimating the GHG emissions from combustion sources for all permit applications submitted to the Air District in 2005, 2006 and 2007. The analysis is based only on CO_2 emissions from stationary sources, as that would cover the vast majority of the GHG emissions due to stationary combustion sources in the SFBAAB. The estimated CO_2 emissions were calculated for the maximum permitted amount, i.e. emissions that would be emitted if the sources applying for a permit application operate at maximum permitted load and for the total permitted hours. All fuel types are included in the estimates. For boilers burning natural gas, diesel fuel is excluded since it is backup fuel and is used only if natural gas is not available. Emission values are estimated before any offsets (i.e., Emission Reduction Credits) are applied. GHG emissions from mobile sources, electricity use and water delivery associated with the operation of the permitted sources are not included in the estimates.

[3] Lead agencies using consistency with their jurisdiction's climate action policies, ordinances and programs as a measure of significance under CEQA Guidelines section 15064(h)(3) should ensure that the policies, ordinances and programs satisfy all of the requirements of that subsection before relying on them in a CEQA analysis.

It is projected that a threshold level of 10,000 metric tons of CO_2e per year would capture approximately 95 percent of all GHG emissions from new permit applications from stationary sources in the SFBAAB. That threshold level was calculated as an average of the combined CO_2 emissions from all stationary source permit applications submitted to the Air District during the three year analysis period.

Staff recommends this 10,000 MT of CO_2/yr as it would address a broad range of combustion sources and thus provide for a greater amount of GHG reductions to be captured and mitigated through the CEQA process. As documented in the Scoping Plan, in order to achieve statewide reduction targets, emissions reductions need to be obtained through a broad range of sources throughout the California economy and this threshold would achieve this purpose. While this threshold would capture 95 percent of the GHG emissions from new permit applications, the threshold would do so by capturing only the large, significant projects. Permit applications with emissions above the 10,000 MT of CO_2/yr threshold account for less than 10 percent of stationary source permit applications which represent 95 percent of GHG emissions from new permits analyzed during the three year analysis period.

This threshold would be considered an interim threshold and Air District staff will reevaluate the threshold as AB 32 Scoping Plan measures such as cap and trade are more fully developed and implemented at the state level.

2.3.6 Summary of Justification for GHG Thresholds

The bright-line numeric threshold of 1,100 MT CO_2e/yr is a numeric emissions level below which a project's contribution to global climate change would be less than "cumulatively considerable." This emissions rate is equivalent to a project size of approximately 60 single-family dwelling units, and approximately 59 percent of all future projects and 92 percent of all emissions from future projects would exceed this level. For projects that are above this bright-line cutoff level, emissions from these projects would still be less than cumulatively significant if the project as a whole would result in an efficiency of 4.6 MT CO_2e per service population or better for mixed-use projects. Projects with emissions above 1,100 MT CO_2e/yr would therefore still be less than significant if they achieved project efficiencies below these levels. If projects as proposed exceed these levels, they would be required to implement mitigation measures to bring them back below the 1,100 MT CO_2e/yr bright-line cutoff or within the 4.6 MT CO_2e Service Population efficiency threshold. If mitigation did not bring a project back within the threshold requirements, the project would be cumulatively significant and could be approved only with a Statement of Overriding Considerations and a showing that all feasible mitigation measures have been implemented. Projects' GHG emissions would also be less than significant if they comply with a Qualified Climate Action Plan.

As explained in the preceding analyses of these thresholds, the greenhouse gas emissions from land use projects expected between now and 2020 built in compliance with these thresholds would be approximately 26 percent below BAU 2020 conditions and thus would be consistent with achieving an AB 32 equivalent reduction. The 26 percent reduction from BAU 2020 from new projects built in conformance with these proposed thresholds would achieve an aggregate reduction of approximately 1.6 MMT CO_2e/yr, which is the level of emission reductions from new Bay Area land use sources needed to meet the AB 32 goals, per ARB's Scoping Plan as discussed above.

Projects with greenhouse gas emissions in conformance with these proposed thresholds would therefore not be considered significant for purposes of CEQA. Although the emissions from such projects would add an incremental amount to the overall greenhouse gas emissions that cause global climate change impacts, emissions from projects consistent with these thresholds would not be a "cumulatively considerable" contribution under CEQA. Such projects would not be "cumulatively considerable" because they would be helping to solve the cumulative problem as a part of the AB 32 process.

California's response to the problem of global climate change is to reduce greenhouse gas emissions to 1990 levels by 2020 under AB 32 as a near-term measure and ultimately to 80 percent below 1990 levels by 2050 as the long-term solution to stabilizing greenhouse gas concentrations in the atmosphere at a level that will not cause unacceptable climate change impacts. To implement this solution, the Air Resources Board has adopted a Scoping Plan and budgeted emissions reductions that will be needed from all sectors of society in order to reach the interim 2020 target.

The land-use sector in the Bay Area needs to achieve aggregate emission reductions of approximately 1.6 MMT CO_2e/yr from new projects between now and 2020 to achieve this goal, as noted above, and each individual new project will need to achieve its own respective portion of this amount in order for the Bay Area land use sector as a whole to achieve its allocated emissions target. Building all of the new projects expected in the Bay Area between now and 2020 in accordance with the thresholds that District staff are proposing will achieve the overall appropriate share for the land use sector, and building each individual project in accordance with the proposed thresholds will achieve that individual project's respective portion of the emission reductions needed to implement the AB 32 solution. For these reasons, projects built in conformance with the proposed thresholds will be part of the solution to the cumulative problem, and not part of the continuing problem. They will allow the Bay Area's land use sector to achieve the emission reductions necessary from that sector for California to implement its solution to the cumulative problem of global climate change. As such, even though such projects will add an incremental amount of greenhouse gas emissions, their incremental contribution will be less than "cumulatively considerable" because they are helping to achieve the cumulative solution, not hindering it. Such projects will therefore not be "significant" for purposes of CEQA. (*See* CEQA Guidelines §15064(h)(1).)

The conclusion that land use projects that comply with these proposed thresholds is also supported by CEQA Guidelines Section 15030(a)(3), which provides that a project's contribution to a cumulative problem can be less that cumulatively considerable "if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact." In the case of greenhouse gas emissions associated with land use projects, achieving the amount of emission reductions below BAU that will be required to achieve the AB 32 goals is the project's "fair share" of the overall emission reductions needed under ARB's scoping plan to reach the overall statewide AB 32 emissions levels for 2020. If a project is designed to implement greenhouse gas mitigation measures that achieve a level of reductions consistent with what is required from all new land use projects to achieve the land use sector "budget" – *i.e.*, keeping overall project emissions below 1,100 MT CO_2e/yr or ensuring that project efficiency is better than 4.6 MT CO_2e/service population – then it will be implementing its share of the mitigation measures necessary to alleviate the cumulative impact, as shown in the analyses set forth above.

It is also worth noting that this "fair share" approach is flexible and will allow a project's significance to be determined by how well it is designed from a greenhouse-gas efficiency standpoint, and not just by the project's size. For example, a large high-density infill project located in an urban core nearby to public transit and other alternative transportation options, and built using state-of-the-art energy efficiency methods and improvements such as solar panels, as well as all other feasible mitigation measures, would not become significant for greenhouse gas purposes (and thus require a Statement of Overriding Considerations in order to be approved) simply because it happened to be a large project. Projects such as this hypothetical development with low greenhouse-gas emissions per service population are what California will need in the future in order to do its part in achieving a solution to the problem of global climate change. The determination of significance under CEQA should therefore take these factors into account, and staff's proposed significance thresholds would achieve this important policy goal. In all, land use sector projects that comply with the GHG thresholds would not be "cumulatively considerable" because they would be helping to solve the cumulative problem as a part of the AB 32 process.

Likewise, new Air District permit applications for stationary sources that comply with the quantitative threshold of 10,000 MT CO_2e/yr would not be "cumulatively considerable" because they also would not hinder the state's ability to solve the cumulative greenhouse gas emissions problem pursuant to AB 32. Unlike the land use sector, the AB 32 Scoping Plan measures, including the cap-and-trade program, provide for necessary emissions reductions from the stationary source sector to achieve AB 32 2020 goals.

While stationary source projects will need to comply with the cap-and-trade program once it is enacted and reduce their emissions accordingly, the program will be phased in over time starting in 2012 and at first will only apply to the very largest sources of GHG emissions. In the mean time, certain stationary source projects, particularly those with large GHG emissions, still will have a cumulatively considerable impact on climate change. The 10,000 MT CO_2e/yr threshold will capture 95 percent of the stationary source sector GHG emissions in the Bay Area. The five percent of emissions that are from stationary source projects below the 10,000 MT CO_2e/yr threshold account for a small portion of the Bay Area's total GHG emissions from stationary sources and these emissions come from very small projects. Such small stationary source projects will not significantly add to the global problem of climate change, and they will not hinder the Bay Area's ability to reach the AB 32 goal in any significant way, even when considered cumulatively. In Air District's staff's judgment, the potential environmental benefits from requiring EIRs and mitigation for these projects would be insignificant. In all, based on staff's expertise, stationary source projects with emissions below 10,000 MT CO_2e/yr will not provide a cumulatively considerable contribution to the cumulative impact of climate change.

3 COMMUNITY RISK AND HAZARD THRESHOLDS

To address community risk from air toxics, the Air District initiated the Community Air Risk Evaluation (CARE) program in 2004 to identify locations with high levels of risk from ambient toxic air contaminants (TAC) co-located with sensitive populations and use the information to help focus mitigation measures. Through the CARE program, the Air District developed an inventory of TAC emissions for 2005 and compiled demographic and heath indicator data. According to the findings of the CARE Program, diesel PM—mostly from on and off-road mobile sources—accounts for over 80 percent of the inhalation cancer risk from TACs in the Bay Area (BAAQMD 2006).

The Air District applied a regional air quality model using the 2005 emission inventory data to estimate excess cancer risk from ambient concentrations of important TAC species, including diesel PM, 1,3-butadiene, benzene, formaldehyde and acetaldehyde. The highest cancer risk levels from ambient TAC in the Bay Area tend to occur in the core urban areas, along major roadways and adjacent to freeways and port activity. Cancer risks in areas along these major freeways are estimated to range from 200 to over 500 excess cases in a million for a lifetime of exposure. Priority communities within the Bay Area – defined as having higher emitting sources, highest air concentrations, and nearby low income and sensitive populations – include the urban core areas of Concord, eastern San Francisco, western Alameda County, Redwood City/East Palo Alto, Richmond/San Pablo, and San Jose.

Fifty percent of BAAQMD's population was estimated to have an ambient background inhalation cancer risk of less than 500 cases in one million, based on emission levels in 2005. Table 8 presents a summary of percentages of the population exposed to varying levels of cancer risk from ambient TACs. Approximately two percent of the SFBAAB population is exposed to background risk levels of less than 200 excess cases in one million. This is in contrast to the upper percentile ranges where eight percent of the SFBAAB population is exposed to background risk levels of greater than 1,000 excess cases per one million. To identify and reduce risks from TAC, this chapter presents thresholds of significance for both cancer risk and non-cancer health hazards.

Table 8 – Statistical Summary of Estimated Population-Weighted Ambient Cancer Risk in 2005

Percentage of Population (Percent below level of ambient risk)	Ambient Cancer Risk (inhalation cancer cases in one million)
92	1,000
90	900
83	800
77	700
63	600
50	500
32	400
13	300
2	200
<1	100

Source: Data compiled by EDAW 2009.

Many scientific studies have linked fine particulate matter and traffic-related air pollution to respiratory illness (Hiltermann et al. 1997, Schikowski et al 2005, Vineis et al. 2007) and premature mortality (Dockery 1993, Pope et al. 1995, Jerrett et al. 2005). Traffic-related air pollution is a complex mix of chemical compounds (Schauer et al. 2006), often spatially correlated with other stressors, such as noise and poverty (Wheeler and Ben-Shlomo 2005). While such correlations can be difficult to disentangle, strong evidence for adverse health effects of fine particulate matter ($PM_{2.5}$) has been developed for regulatory applications in a recent consensus-based study by the California Air Resources Board. This study found that a 10 percent increase in $PM_{2.5}$ concentrations increased the non-injury death rate by 10 percent (ARB 2008).

Public Health Officers for four counties in the San Francisco Bay Area in 2009 provided testimony to the Air District's Advisory Council (February 11, 2009, Advisory Council Meeting on Air Quality and Public Health). Among the recommendations made, was that $PM_{2.5}$, in addition to TACs, be considered in assessments of community-scale impacts of air pollution. In consideration of the scientific studies and recommendations by the Bay Area Health Directors, it is apparent that, in addition to the significance thresholds for local-scale TAC, thresholds of significance are required for near-source, local-scale concentrations of $PM_{2.5}$.

3.2 PROPOSED THRESHOLDS OF SIGNIFICANCE

Proposed thresholds of significance and Board-requested options are presented in this section:

- The **Staff Proposal** includes thresholds for cancer risk, non-cancer health hazards, and fine particulate matter.

- **Board Option 1** includes tiered thresholds for new sources in impacted communities. Thresholds for receptors and cumulative impacts are the same as the Staff Proposal.
- **Board Option 2** removes the option for a qualified Community Risk Reduction Plan from the Staff Proposal.

Proposal/Option	Construction-Related	Operational-Related
Project-Level – Individual Project		
Risks and Hazards (Individual Project) **Staff Proposal**	Same as Operational Thresholds*	**All Areas:** Siting a New Source or Receptor Compliance with Qualified Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor
Risks and Hazards (Individual Project) **Board Option 1** **Tiered Thresholds**	Same as Operational Thresholds*	**Impacted Communities:** Siting a New Source Compliance with Qualified Risk Reduction Plan OR Increased cancer risk of >5.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.2 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor
	Same as Operational Thresholds*	**Impacted Communities:** Siting a New Receptor **All Other Areas:** Siting a New Source or Receptor Compliance with Qualified Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor

Proposal/Option	Construction-Related	Operational-Related
Risks and Hazards (Individual Project) **Board Option 2** **Quantitative Thresholds**	Same as Operational Thresholds*	**All Areas**: Siting a New Source or Receptor Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 $\mu g/m^3$ annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor
Accidental Release of Acutely Hazardous Air Pollutants	None	Storage or use of acutely hazardous materials locating near receptors or receptors locating near stored or used acutely hazardous materials considered significant
Project-Level – Cumulative		
Risks and Hazards (Cumulative Thresholds)	Same as Operational Thresholds*	**All Areas**: Siting a New Source or Receptor Compliance with Qualified Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 1.0 Hazard Index (from all local sources) (Chronic or Acute) $PM_{2.5}$: > 0.8 $\mu g/m^3$ annual average (from all local sources) Zone of Influence: 1,000-foot radius from fence line of source or receptor
Plan-Level		
Plans	None	1. Overlay zones around existing and planned sources of TACs (including adopted Risk Reduction Plan areas) and odors. 2. Overlay zones of at least 500 feet (or Air District-approved modeled distance) from all freeways and high volume roadways.
Accidental Release of Acutely Hazardous Air Pollutants	None	None

* Note: The Air District recommends that for construction projects that are less than one year duration, Lead Agencies should annualize impacts over the scope of actual days that peak impacts are to occur, rather than the full year.

3.3 JUSTIFICATION AND SUBSTANTIAL EVIDENCE SUPPORTING THRESHOLDS

The goal of the proposed thresholds is to ensure that no source creates, or receptor endures, a significant adverse impact from any individual project, and that the total of all nearby directly emitted risk and hazard emissions is also not significantly adverse. The thresholds for local risks and hazards from TAC and $PM_{2.5}$ are intended to apply to all sources of emissions, including both permitted stationary sources and on- and off-road mobile sources, such as sources related to construction, busy roadways, or freight movement.

Thresholds for an individual new source are designed to ensure that the source does not contribute a cumulatively significant impact. Cumulative thresholds for sources recognize that some areas are already near or at levels of significant impact. If within such an area there are receptors, or it can reasonably be foreseen that there will be receptors, then a cumulative significance threshold sets a level beyond which any additional risk is significant.

For new receptors – sensitive populations or the general public – thresholds of significance are designed to identify levels of contributed risk or hazards from existing local sources that pose a significant risk to the receptors. Single-source thresholds for receptors are provided to recognize that within the area defined there can be variations in risk levels that may be significant. Single-source thresholds assist in the identification of significant risks, hazards, or concentrations in a subarea, within the area defined by the selected radius. Cumulative thresholds for receptors are designed to account for the effects of all sources within the defined area.

Cumulative thresholds, for both sources and receptors, must consider the size of the source area, defined by a radius from the proposed project. To determine cumulative impacts from a prescribed zone of influence requires the use of modeling. The larger the radius, the greater the number of sources considered that may contribute to the modeled risk and, until the radius approaches a regional length scale, the greater the expected modeled risk increment. If the area of impact considered were grown to the scale of a city, the modeled risk increment would approach the risk level present in the ambient air.

3.3.1 SCIENTIFIC AND REGULATORY JUSTIFICATION

Regulatory Framework for TACs

Prior to 1990, the Clean Air Act required EPA to list air toxics it deemed hazardous and to establish control standards which would restrict concentrations of hazardous air pollutants (HAP) to a level that would prevent any adverse effects "with an ample margin of safety." By 1990, EPA had regulated only seven such pollutants and it was widely acknowledged by that time that the original Clean Air Act had failed to address toxic air emissions in any meaningful way. As a result, Congress changed the focus of regulation in 1990 from a risk-based approach to technology-based standards. Title III, Section 112(b) of the 1990 Clean Air Act Amendment established this new regulatory approach.

Under this framework, prescribed pollution control technologies based upon maximum achievable control technology (MACT) were installed without the a priori estimation of the health or environmental risk associated with each individual source. The law listed 188 HAPs that would be subject to the MACT standards. EPA issued 53 standards for 89 different types of major industrial sources of air toxics and eight categories of smaller sources such as dry cleaners. These requirements took effect between 1996 and 2002. Under the federal Title V Air Operating Permit Program, a facility with the potential to emit 10 tons of any toxic air pollutant, or 25 tons per year of any combination of toxic air pollutants, is defined as a major source HAPs. Title V permits include requirements for these facilities to limit toxic air pollutant emissions.

Several state and local agencies adopted programs to address gaps in EPA's program prior to the overhaul of the national program in 1990. California's program to reduce exposure to air toxics was established in 1983 by the Toxic Air Contaminant Identification and Control Act (AB 1807, Tanner 1983) and the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588, Connelly 1987). Under AB 1807, ARB and the Office of Environmental Health Hazard Assessment (OEHHA) determines if a substance should be formally identified as a toxic air contaminant (TAC) in California. OEHHA also establishes associated risk factors and safe concentrations of exposure.

AB 1807 was amended in 1993 by AB 2728, which required ARB to identify the 189 federal hazardous air pollutants as TACs. AB 2588 (Connelly, 1987) supplements the AB 1807 program, by requiring a statewide air toxics inventory, notification of people exposed to a significant health risk, and facility plans to reduce these risks. In September 1992, the "Hot Spots" Act was amended by Senate Bill 1731 which required facilities that pose a significant health risk to the community to reduce their risk through a risk management plan.

Cancer Risk

Cancer risk from TACs is typically expressed in numbers of excess cancer cases per million persons exposed over a defined period of exposure, for example, over an assumed 70 year lifetime. The Air District is not aware of any agency that has established an acceptable level of cancer risk for TACs. However, a range of what constitutes a significant increment of cancer risk from any compound has been established by the U.S. EPA. EPA's guidance for conducting air toxics analyses and making risk management decisions at the facility- and community-scale level considers a range of acceptable cancer risks from one in a million to one in ten thousand (100 in a million). The guidance considers an acceptable range of cancer risk increments to be from one in a million to one in ten thousand. In protecting public health with an ample margin of safety, EPA strives to provide maximum feasible protection against risks to health from HAPs by limiting additional risk to a level no higher than the one in ten thousand estimated risk that a person living near a source would be exposed to at the maximum pollutant concentrations for 70 years. This goal is described in the preamble to the benzene National Emissions Standards for Hazardous Air Pollutants (NESHAP) rulemaking (54 Federal Register 38044, September 14, 1989) and is incorporated by Congress for EPA's residual risk program under Clean Air Act section 112(f).

Regulation 2, Rule 5 of the Air District specifies permit requirements for new and modified stationary sources of TAC. The Project Risk Requirement (2-5-302.1) states that the Air Pollution Control Officer shall deny an Authority to Construct or Permit to Operate for any new or modified source of TACs if the project cancer risk exceeds 10.0 in one million.

Hazard Index for Non-cancer Health Effects

Non-cancer health hazards for chronic and acute diseases are expressed in terms of a hazard index (HI), a ratio of TAC concentration to a reference exposure level (REL), below which no adverse health effects are expected, even for sensitive individuals. As such, OEHHA has defined acceptable concentration levels, and also significant concentration increments, for compounds that pose non-cancer health hazards. If the HI for a compound is less than one, non-cancer chronic and acute health impacts have been determined to be less than significant.

State and Federal Ambient Air Quality Standards for $PM_{2.5}$

The Children's Environmental Health Protection Act (Senate Bill 25), passed by the California state legislature in 1999, requires ARB, in consultation with OEHHA, to "review all existing health-based ambient air quality standards to determine whether, based on public health, scientific literature and exposure pattern data, these standards adequately protect the public, including infants and children, with an adequate margin of safety." As a result of the review requirement, in 2002 ARB adopted an annual average California Ambient Air Quality Standard (CAAQS) for $PM_{2.5}$ of 12 ug/m^3 that is not to be exceeded (California Code of Regulations, Title 17 § 70200, Table of Standards.) The National Ambient Air Quality Standard (NAAQS) established an annual standard for $PM_{2.5}$ (15 ug/m^3) that is less stringent that the CAAQS, but also set a 24-hour average standard (35 ug/m^3), which is not included in the CAAQS (Code of Federal Regulations, Title 40, Part 50.7).

Significant Impact Levels for $PM_{2.5}$

EPA recently proposed and documented alternative options for $PM_{2.5}$ Significant Impact Levels (SILs) (Federal Register 40 CFR Parts 51 and 52, September 21, 2007). The EPA is proposing to facilitate implementation of a $PM_{2.5}$ Prevention of Significant Deterioration (PSD) program in areas attaining the $PM_{2.5}$ NAAQS by developing $PM_{2.5}$ increments, or SILs. These "increments" are maximum increases in ambient $PM_{2.5}$ concentrations ($PM_{2.5}$ increments) allowed in an area above the baseline concentration.

The SIL is a threshold that would be applied to individual facilities that apply for a permit to emit a regulated pollutant in an area that meets the NAAQS. The State and EPA must determine if emissions from that facility will cause the air quality to worsen. If an individual facility projects an increase in emissions that result in ambient impacts greater than the established SIL, the permit applicant would be required to perform additional analyses to determine if those impacts will be more than the amount of the PSD increment. This analysis would combine the impact of the proposed facility when added to all other sources in the area.

The EPA is proposing such values for $PM_{2.5}$ that will be used as screening tools by a major source subject to PSD to determine the subsequent level of analysis and data gathering required for a PSD permit application for emissions of $PM_{2.5}$. The SIL is one element of the EPA program to prevent deterioration in regional air quality and is utilized in the new source review (NSR) process. New source review is required under Section 165 of the Clean Air Act, whereby a permit applicant must demonstrate that emissions from the proposed construction and operation of a facility "will not cause, or contribute to, air pollution in excess of any maximum allowable increase or maximum allowable concentration for any pollutant." The purpose of the SIL is to provide a screening level that triggers further analysis in the permit application process.

For the purpose of NSR, SILs are set for three types of areas: Class I areas where especially clean air is most desirable, including national parks and wilderness areas; Class II areas where there is not expected to be substantial industrial growth; and Class III areas where the highest relative level of industrial development is expected. In Class II and Class III areas, a $PM_{2.5}$ concentration of 0.3, 0.8, and 1 $\mu g/m^3$ has been proposed as a SIL. To arrive at the SIL $PM_{2.5}$ option of 0.8 $\mu g/m^3$, EPA scaled an established PM_{10} SILs of 1.0 $\mu g/m^3$ by the ratio of emissions of $PM_{2.5}$ to PM_{10} using the EPA's 1999 National Emissions Inventory. To arrive at the SIL option of 0.3 $\mu g/m^3$, EPA scaled the PM_{10} SIL of 1.0 $\mu g/m^3$ by the ratio of the current Federal ambient air quality standards for $PM_{2.5}$ and PM_{10} (15/50). These options represent what EPA currently considers as a range of appropriate SIL values.

EPA interprets the SIL to be the level of $PM_{2.5}$ increment that represents a "significant contribution" to regional non-attainment. While SIL options were not designed to be thresholds for assessing community risk and hazards, they are being considered to protect public health at a regional level by helping an area maintain the NAAQS. Furthermore, since it is the goal of the Air District to achieve and maintain the NAAQS and CAAQS at both regional and local scales, the SILs may be reasonably be considered as thresholds of significance under CEQA for local-scale increments of $PM_{2.5}$.

Roadway Proximity Health Studies

Several medical research studies have linked near-road pollution exposure to a variety of adverse health outcomes impacting children and adults. Kleinman et al. (2007) studied the potential of roadway particles to aggravate allergic and immune responses in mice. Using mice that were not inherently susceptible, the researchers placed these mice at various distances downwind of State Road 60 and Interstate 5 freeways in Los Angeles to test the effect these roadway particles have on their immune system. They found that within five meters of the roadway, there was a significant allergic response and elevated production of specific antibodies. At 150 meters (492 feet) and 500 meters (1,640 feet) downwind of the roadway, these effects were not statistically significant.

Another significant study (Ven Hee et al. 2009) conducted a survey involving 3,827 participants that aimed to determine the effect of residential traffic exposure on two preclinical indicators of heart failure; left ventricular mass index (LVMI), measured by the cardiac magnetic resonance imaging (MRI), and ejection fraction. The studies classified participants based on the distance between their residence and the nearest interstate highway, state or local highway, or major arterial road. Four distance groups were defined: less than 50 meters (165 feet), 50-100 meters, 101-150 meters, and greater than 150 meters. After adjusting for demographics, behavioral, and clinical covariates, the study found that living within 50 meters of a major roadway was associated with a 1.4 g/m^2 higher LVMI than living more than 150 meters from one. This suggests an association between traffic-related air pollution and increased prevalence of a preclinical predictor of heart failure among people living near roadways.

To quantify the roadway concentrations of $PM_{2.5}$ that contributed to the health impacts reported by Kleinman et al (2007), the Air District modeled the emissions and associated particulate matter concentrations for the roadways studied. To perform the modeling, emissions were estimated for Los Angeles using the EMFAC model and annual average vehicle traffic data taken from Caltrans was used in the roadway model (CAL3QHCR) to estimate the downwind $PM_{2.5}$ concentrations at 50 meters and 150 meters. Additionally, emissions were assumed to occur from 10:00 a.m. to 2:00 p.m. corresponding to the time in which the mice were exposed during the study. The results of the modeling indicate that at 150 meters, where no significant health effects were found, the downwind concentration of $PM_{2.5}$ was 0.78 $\mu g/m^3$, consistent with the proposed EPA SIL option of 0.8 $\mu g/m^3$.

Concentration-Response Function for $PM_{2.5}$

In a recent report, ARB reevaluated the relative risk of premature death associated with $PM_{2.5}$ exposure based on a review of all relevant scientific literature available, and a new relative risk factor was developed (ARB 2008). This consensus-based review found that a 10 $\mu g/m^3$ increase in $PM_{2.5}$ concentrations increased the risk of premature death by 10 percent (uncertainty interval: 3 percent to 20 percent) and provides a basis for determining the risk increment from an increase in $PM_{2.5}$ concentration. Twelve experts participated in the study to review the literature and develop the concentration response function. The experts were selected through a two-part peer nomination process, designed to obtain a balanced set of views and included experts in epidemiology, toxicology, and medicine.

The methodologies and results presented in this report were endorsed by scientific advisors from Harvard University, OEHHA, and Brigham Young University. The report underwent an external peer review by experts selected through an independent process involving the University of California at Berkeley, Institute of the Environment. The results of the peer review process were incorporated into the report. Subsequent to the peer review, Schwartz et al. (2008) examined the linearity of the concentration-response function of $PM_{2.5}$-mortality and showed that the response function is in agreement with Laden et al. (2006) and, moreover, found that this response function was linear down to background levels.

San Francisco Ordinance on Roadway Proximity Health Effects

In 2008, the City and County of San Francisco adopted an ordinance (San Francisco Health Code, Article 38 - Air Quality Assessment and Ventilation Requirement for Urban

Infill Residential Development, Ord. 281-08, File No. 080934, December 5, 2008) requiring that public agencies in San Francisco take regulatory action to prevent future air quality health impacts from new sensitive uses proposed near busy roadways (SFDPH 2008). The regulation requires that developers screen sensitive use projects for proximity to traffic and calculate the concentration of $PM_{2.5}$ from traffic sources where traffic volumes suggest a potential hazard. If modeled levels of traffic-attributable $PM_{2.5}$ at a project site exceed an action level (currently set at 0.2 $\mu g/m^3$) developers would be required to incorporate ventilation systems to remove 80 percent of $PM_{2.5}$ from outdoor air. The regulation does not place any requirements on proposed sensitive uses if modeled air pollutant levels fall below the action threshold. This ordinance only considers impacts from on-road motor vehicles, not impacts related to construction equipment or stationary sources.

A report with supporting documentation for the ordinance (SFPHD 2008) provided a threshold to trigger action or mitigation of 0.2 $\mu g/m^3$ of $PM_{2.5}$ annual average exposure from roadway vehicles within a 150 meter (492 feet) maximum radius of a sensitive receptor. The report applied the concentration-response function from Jerrett et al. (2005) that attributed 14 percent increase in mortality to a 10 $\mu g/m^3$ increase in $PM_{2.5}$ to estimate an increase in non-injury mortality in San Francisco of about 21 excess deaths per year from a 0.2 $\mu g/m^3$ increment of annual average $PM_{2.5}$.

Distance for Significant Impact

The distance used for the radius around the project boundary should reflect the zone or area over which sources may have a significant influence. For cumulative thresholds, for both sources and receptors, this distance also determines the size of the source area, defined. To determine cumulative impacts from a prescribed zone of influence requires the use of modeling. The larger the radius, the greater the number of sources considered that may contribute to the risk and the greater the expected modeled risk increment. If the area of impact considered were grown to approach the scale of a city, the modeled risk increment would approach the risk level present in the ambient air.

A summary of research findings in ARB's Land Use Compatibility Handbook (ARB 2005) indicates that traffic-related pollutants were higher than regional levels within approximately 1,000 feet downwind and that differences in health-related effects (such as asthma, bronchitis, reduced lung function, and increased medical visits) could be attributed in part to the proximity to heavy vehicle and truck traffic within 300 to 1,000 feet of receptors. In the same summary report, ARB recommended avoiding siting sensitive land uses within 1,000 feet of a distribution center and major rail yard, which supports the use of a 1,000 feet evaluation distance in case such sources may be relevant to a particular project setting. A 1,000 foot zone of influence is also supported by Health & Safety Code §42301.6 (Notice for Possible Source Near School).

Some studies have shown that the concentrations of particulate matter tend to be reduced substantially or can even be indistinguishable from upwind background concentrations at a distance 1,000 feet downwind from sources such as freeways or large distribution centers. Zhu et al. (2002) conducted a systematic ultrafine particle study near Interstate

710, one of the busiest freeways in the Los Angeles Basin. Particle number concentration and size distribution were measured as a function of distances upwind and downwind of the I-710 freeway. Approximately 25 percent of the 12,180 vehicles per hour are heavy duty diesel trucks based on video counts conducted as part of the research. Measurements were taken at 13 feet, 23 feet, 55 feet, 252 feet, 449 feet, and 941 feet downwind and 613 feet upwind from the edge of the freeway. The particle number and supporting measurements of carbon monoxide and black carbon decreased exponentially and all constituents simultaneously tracked with each other as one moves away from the freeway. Ultrafine particle size distribution changed markedly and its number concentrations dropped dramatically with increasing distance. The study found that ultrafine particle concentrations measured 941 feet downwind of I-710 were indistinguishable from the upwind background concentration.

Impacted Communities

Starting in 2006, the Air District's CARE program developed gridded TAC emissions inventories and compiled demographic information that were used to identify communities that were particularly impacted by toxic air pollution for the purposes of distributing grant and incentive funding. In 2009, the District completed regional modeling of TAC on a one kilometer by one kilometer grid system. This modeling was used to estimate cancer risk and TAC population exposures for the entire District. The information derived from the modeling was then used to update and refine the identification of impacted communities. One kilometer modeling yielded estimates of annual concentrations of five key compounds – diesel particulate matter, benzene, 1,3-butadiene, formaldehyde, and acetaldehyde – for year 2005. These concentrations were multiplied by their respective unit cancer risk factors, as established by OEHHA, to estimate the expected excess cancer risk per million people from these compounds.

Sensitive populations from the 2000 U.S. Census database were identified as youth (under 18) and seniors (over 64) and mapped to the same one kilometer grid used for the toxics modeling. Excess cancers from TAC exposure were determined by multiplying these sensitive populations by the model-estimated excess risk to establish a data set representing sensitive populations with high TAC exposures. TAC emissions (year 2005) were mapped to the one kilometer grid and also scaled by their unit cancer risk factor to provide a data set representing source regions for TAC emissions. Block-group level household income data from the U.S. Census database were used to identify block groups with family incomes where more than 40 percent of the population was below 185 percent of the federal poverty level (FPL). Poverty-level polygons that intersect high (top 50 percent) exposure cells and are within one grid cell of a high emissions cell (top 25 percent) were used to identify impacted areas. Boundaries were constructed along major roads or highways that encompass nearby high emission cells and low income areas. This method identified the following six areas as priority communities: (1) portions of the City of Concord; (2) Western Contra Costa County (including portions of the Cities of Richmond and San Pablo); (3) Western Alameda County along the Interstate-880 corridor (including portions of the Cities of Berkeley, Oakland, San Leandro, San Lorenzo, Hayward; (4) Portions of the City of San Jose. (5) Eastern San Mateo County (including portions of the Cities of Redwood City and East Palo Alto); and (6) Eastern portions of the City of San Francisco.

3.3.2 CONSTRUCTION, LAND USE AND STATIONARY SOURCE RISK AND HAZARD THRESHOLDS

The proposed options for local risk and hazards thresholds of significance are based on U.S. EPA guidance for conducting air toxics analyses and making risk management decisions at the facility and community-scale level. The thresholds consider reviews of recent health effects studies that link increased concentrations of fine particulate matter to increased mortality. The proposed thresholds would apply to both siting new sources and siting new receptors.

For new sources of TACs, thresholds of significance for a single source are designed to ensure that emissions do not raise the risk of cancer or non-cancer health impacts to cumulatively significant levels. For new sources of $PM_{2.5}$, thresholds are designed to ensure that $PM_{2.5}$ concentrations are maintained below state and federal standards in all areas where sensitive receptors or members of the general public live or may foreseeably live, even if at the local- or community-scale where sources of TACs and PM may be nearby.

Project Radius for Assessing Impacts

For a project proposing a new source or receptor it is recommended to assess impacts within 1,000 feet, taking into account both its individual and nearby cumulative sources (i.e. proposed project plus existing and foreseeable future projects). Cumulative sources are the combined total risk values of each individual source within the 1,000-foot evaluation zone. A lead agency should enlarge the 1,000-foot radius on a case-by-case basis if an unusually large source or sources of risk or hazard emissions that may affect a proposed project is beyond the recommended radius.

The 1,000 foot radius is consistent with findings in ARB's Land Use Compatibility Handbook (ARB 2005), the Health & Safety Code §42301.6 (Notice for Possible Source Near School), and studies such as that of Zhu et al (2002) which found that concentrations of particulate matter tend to be reduced substantially at a distance 1,000 feet downwind from sources such as freeways or large distribution centers.

Qualified Community Risk Reduction Plan

Within the framework of these thresholds, proposed projects would be considered to be less than significant if they are consistent with a qualified Community Risk Reduction Plan (CRRP) adopted by the local jurisdiction with enforceable measures to reduce the community risk. Board Option 2 does not include the CCRP as a significance threshold.

Project proposed in areas where a CRRP has been adopted that are not consistent with the CRRP would be considered to have a significant impact.

Projects proposed in areas where a CRRP has not been adopted and that have the potential to expose sensitive receptors or the general public to emissions-related risk in excess of the thresholds below from any source would be considered to have a significant air quality impact.

The conclusion that land use projects that comply with qualified Community Risk Reduction Plans are less than significant is supported by CEQA Guidelines Sections 15030(a)(3) and 15064(h)(3), which provides that a project's contribution to a cumulative problem can be less that cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact.

Increased Cancer Risk to Maximally Exposed Individual (MEI)

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of carcinogenic TACs from any source result in an increased cancer risk greater than 10.0 in one million, assuming a 70 year lifetime exposure. Under Board Option 1, within Impacted Communities as defined through the CARE program, the significance level for cancer would be reduced to 5.0 in one million for new sources.

The 10.0 in one million cancer risk threshold for a single source is supported by EPA's guidance for conducting air toxics analyses and making risk management decisions at the facility and community-scale level. It is also the level set by the Project Risk Requirement in the Air District's Regulation 2, Rule 5 new and modified stationary sources of TAC, which states that the Air Pollution Control Officer shall deny an Authority to Construct or Permit to Operate for any new or modified source of TACs if the project risk exceeds a cancer risk of 10.0 in one million.

This threshold for an individual new source is designed to ensure that the source does not contribute a cumulatively significant impact. The justification for the Board Option 1 threshold of 5.0 in one million for new sources in an impacted community is that in these areas the cancer risk burden is higher than in other parts of the Bay Area; the threshold at which an individual source becomes significant is lower for an area that is already at or near unhealthy levels. However, even without a tiered approach, the recommended thresholds already address the burden of impacted communities via the cumulative thresholds: specifically, if an area has many existing TAC sources near receptors, then the cumulative threshold will be reached sooner than it would in another area with fewer TAC sources.

The single-source threshold for receptors is provided to address the possibility that within the area defined by the 1,000 foot radius there can be variations in risk levels that may be significant, below the corresponding cumulative threshold. Single-source thresholds assist in the identification of significant risks, hazards, or concentrations in a subarea, within the 1,000 foot radius.

Increased Non-Cancer Risk to MEI

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of non-carcinogenic TACs result in an increased chronic or acute Hazard Index (HI) from any source greater than 1.0. This threshold is unchanged under Board Option 1.

A HI less than 1.0 represents a TAC concentration, as determined by OEHHA that is at a health protective level. While some TACs pose non-carcinogenic, chronic and acute health hazards, if the TAC concentrations result in a HI less than one, those concentrations have been determined to be less than significant.

Increased Ambient Concentration of $PM_{2.5}$

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of $PM_{2.5}$ from any source would result in an average annual increase greater than 0.3 $\mu g/m^3$. Under Board Option 1, within Impacted Communities as defined through the CARE program, the significance level for a $PM_{2.5}$ increment is 0.2 $\mu g/m^3$.

If one applies the concentration-response function from the ARB consensus review (ARB 2008) and attribute a 10 percent increase in mortality to a 10 $\mu g/m^3$ increase in $PM_{2.5}$, one finds an increase in non-injury mortality in the Bay Area of about 20 excess deaths per year from a 0.3 $\mu g/m^3$ increment of $PM_{2.5}$. This is consistent with the impacts reported and considered significant by SFDPH (2008) using an earlier study (Jerrett et al. 2005) to estimate the increase in mortality from a 0.2 $\mu g/m^3$ $PM_{2.5}$ increment.

The SFDPH recommended a lower threshold of significance for multiple sources but only considered roadway emissions within a 492 foot radius. This recommendation applies to a single source but considers all types of emissions within 1,000 feet. On balance, the Air District estimates that the SFDPH threshold and this proposed one, in combination with the cumulative threshold for $PM_{2.5}$, will afford similar levels of health protection.

The proposed $PM_{2.5}$ threshold represents the lower range of an EPA proposed Significant Impact Level (SIL). EPA interprets the SIL to be the level of ambient impact that is considered to represent a "significant contribution" to regional non-attainment. While this threshold was not designed to be a threshold for assessing community risk and hazards, it was designed to protect public health at a regional level by helping an area maintain the NAAQS. Since achieving and maintaining state and federal AAQS is a reasonable goal at the local scale, the SIL provides a useful reference for comparison.

This threshold for an individual new source is designed to ensure that the source does not contribute a cumulatively significant impact. The justification for the Board Option 1 threshold of 0.2 $\mu g/m^3$ for new sources in an impacted community is that these areas have higher levels of diesel particulate matter than do other parts of the Bay Area; the threshold at which an individual source becomes significant is lower for an area that is already at or near unhealthy levels. However, even without a tiered approach, the recommended thresholds already address the burden of impacted communities via the cumulative thresholds: specifically, if an area has many existing $PM_{2.5}$ sources near receptors, then the cumulative threshold will be reached sooner than it would in another area with fewer $PM_{2.5}$ sources.

The single-source threshold for receptors is provided to address the possibility that within the area defined by the 1,000 foot radius there can be variations in risk levels that may be significant, below the corresponding cumulative threshold. Single-source thresholds assist in the identification of significant risks, hazards, or concentrations in a subarea, within the 1,000 foot radius.

3.3.2.1 ACCIDENTAL RELEASE OF ACUTELY HAZARDOUS AIR EMISSIONS

The BAAQMD currently recommends, at a minimum, that the lead agency, in consultation with the administering agency of the Risk Management Prevention Program (RMPP), find that any project resulting in receptors being within the Emergency Response Planning Guidelines (ERPG) exposure level 2 for a facility has a significant air quality impact. ERPG exposure level 2 is defined as "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action."

Staff proposes continuing with the current threshold for the accidental release of hazardous air pollutants. Staff recommends that agencies consult with the California Emergency Management Agency for the most recent guidelines and regulations for the storage of hazardous materials. Staff proposes that projects using or storing acutely hazardous materials locating near existing receptors, and projects resulting in receptors locating near facilities using or storing acutely hazardous materials be considered significant.

The current Accidental Release/Hazardous Air Emissions threshold of significance could affect all projects, regardless of size, and require mitigation for Accidental Release/Hazardous Air Emissions impacts.

3.3.3 CUMULATIVE RISK AND HAZARD THRESHOLDS

Qualified Community Risk Reduction Plan

Proposed projects would be considered to be less than significant if they are consistent with a qualified Community Risk Reduction Plan (CRRP) adopted by the local jurisdiction with enforceable measures to reduce the community risk. Board Option 2 does not include the CCRP as a significance threshold.

Project proposed in areas where a CRRP has been adopted that are not consistent with the CRRP would be considered to have a significant impact.

Projects proposed in areas where a CRRP has not been adopted and that have the potential to expose sensitive receptors or the general public to emissions-related risk in excess of the following thresholds from the aggregate of cumulative sources would be considered to have a significant air quality impact.

The conclusion that land use projects that comply with qualified Community Risk Reduction Plans are less than significant is supported by CEQA Guidelines Sections 15030(a)(3) and 15064(h)(3), which provides that a project's contribution to a cumulative problem can be less that cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact.

Increased Cancer Risk to Maximally Exposed Individual (MEI)

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of carcinogenic TACs from any source result in an increased cancer risk greater than 100.0 in one million.

The significance threshold of 100 in a million increased excess cancer risk would be applied to the cumulative emissions. The 100 in a million threshold is based on EPA guidance for conducting air toxics analyses and making risk management decisions at the facility and community-scale level. In protecting public health with an ample margin of safety, EPA strives to provide maximum feasible protection against risks to health from hazardous air pollutants (HAPs) by limiting risk to a level no higher than the one in ten thousand (100 in a million) estimated risk that a person living near a source would be exposed to at the maximum pollutant concentrations for 70 years (NESHAP 54 Federal Register 38044, September 14, 1989; CAA section 112(f)). One hundred in a million excess cancer cases is also consistent with the ambient cancer risk in the most pristine portions of the Bay Area based on the District's recent regional modeling analysis.

Increased Non-Cancer Risk to MEI

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of non-carcinogenic TACs result in an increased chronic or acute Hazard Index from any source greater than 1.0.

OEHHA has defined acceptable concentration levels for compounds that pose non-cancer health hazards. If the HI for a compound is less than one, non-cancer chronic and acute health impacts have been determined to be less than significant.

Increased Ambient Concentration of $PM_{2.5}$

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of $PM_{2.5}$ from any source would result in an average annual increase greater than 0.8 $\mu g/m^3$.

If one applies the concentration-response function from the ARB consensus review (ARB 2008) and attributes a 10 percent increase in mortality to a 10 $\mu g/m^3$ increase in $PM_{2.5}$, one finds an increase in non-injury mortality in the Bay Area of about 50 excess deaths per year from a 0.8 $\mu g/m^3$ increment of $PM_{2.5}$. This is greater the impacts reported and considered significant by SFDPH (2008) using an earlier study (Jerrett et al. 2005) to estimate the increase in mortality from a 0.2 $\mu g/m^3$ $PM_{2.5}$ increment (SFDPH reported 21 excess deaths per year). However, SFDPH only considered roadway emissions within a 492 foot radius. This proposed threshold applies to all types of emissions within 1,000 feet. In modeling applications for proposed projects, a larger radius results in a greater number of sources considered and higher modeled concentrations. On balance, the Air District estimates that the SFDPH threshold and this proposed one, in combination with the individual source threshold for $PM_{2.5}$, will afford similar levels of health protection.

The proposed cumulative $PM_{2.5}$ threshold represents the middle range of an EPA proposed Significant Impact Level (SIL). EPA interprets the SIL to be the level of ambient impact that is considered to represent a "significant contribution" to regional non-attainment. While this threshold was not designed to be a threshold for assessing community risk and hazards, it was designed to protect public health at a regional level by helping an area maintain the NAAQS. Since achieving and maintaining state and federal AAQS is a reasonable goal at the local scale, the SIL provides a useful reference for comparison. Furthermore, the 0.8 $\mu g/m^3$ threshold is consistent with studies (Kleinman et al 2007) that examined the potential health impacts of roadway particles.

3.3.4 PLAN-LEVEL RISK AND HAZARD THRESHOLDS

Staff proposes plan-level thresholds that will encourage a programmatic approach to addressing the overall adverse conditions resulting from risks and hazards that many Bay Area communities experience. By designating overlay zones in land use plans, local land use jurisdictions can take preemptive action before project-level review to reduce the potential for significant exposures to risk and hazard emissions. While this will require more up-front work at the general plan level, in the long-run this approach is a more feasible approach consistent with Air District and CARB guidance about siting sources and sensitive receptors that is more effective than project by project consideration of effects that often has more limited mitigation opportunities. This approach would also promote more robust cumulative consideration of effects of both existing and future development for the plan-level CEQA analysis as well as subsequent project-level analysis.

For local plans to have a less-than-significant impact with respect to potential risks and hazards, overlay zones would have to be established around existing and proposed land uses that would emit these air pollutants. Overlay zones to avoid risk impacts should be reflected in local plan policies, land use map(s), and implementing ordinances (e.g., zoning ordinance). The overlay zones around existing and future risk sources would be delineated using the quantitative approaches described above for project-level review and the resultant risk buffers would be included in the General Plan (or the EIR for the General Plan) to assist in site planning. BAAQMD will provide guidance as to the methods used to establish the TAC buffers and what standards to be applied for acceptable exposure level in the updated CEQA Guidelines document. Special overlay zones of at least 500 feet (or an appropriate distance determined by modeling and approved by the Air District) on each side of all freeways and high volume roadways would be included in this proposed threshold.

The threshold of significance for plan impacts could affect all plan adoptions and amendments and require mitigation for a plan's air quality impacts. Where sensitive receptors would be exposed above the acceptable exposure level, the plan impacts would be considered significant and mitigation would be required to be imposed either at the plan level (through policy) or at the project level (through project level requirements).

3.3.5 COMMUNITY RISK REDUCTION PLANS

The goal of a Community Risk Reduction Plan would be to bring TAC and $PM_{2.5}$ concentrations for the entire community covered by the Plan down to acceptable levels as identified by the local jurisdiction and approved by the Air District. This approach provides local agencies a proactive alternative to addressing communities with high levels of risk on a project-by-project approach. This approach is supported by CEQA Guidelines Section 15030(a)(3), which provides that a project's contribution to a cumulative problem can be less than cumulatively considerable "if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact." This approach is also further supported by CEQA Guidelines Section 15064(h)(3), which provides that a project's contribution to a cumulative effect is not considerable "if the project will comply with the requirements in a previously approved plan or mitigation program which provides specific requirements that will avoid or substantially lessen the cumulative problem."

Qualified Community Risk Reduction Plans

A qualified Community Risk Reduction Plan adopted by a local jurisdiction should:

- Include a defined CRRP planning area.
- Include base year and future year emissions inventories of TACs and $PM_{2.5}$.
- Establish risk and exposure reduction targets for the community.
- Identify measures to reduce emissions and exposures.
- Include Air District–approved risk modeling.
- Include procedures for monitoring and updating the TAC inventory, modeling and reduction measures, in coordination with Air District staff.
- Include public participation processes to facilitate community input into goals and strategies.

4 CRITERIA POLLUTANT THRESHOLDS

4.2 PROPOSED THRESHOLDS OF SIGNIFICANCE

Project Construction	
Pollutant	**Average Daily (pounds/day)**
ROG (reactive organic gases)	54
NO_X (nitrogen oxides)	54
PM_{10} (exhaust) (particulate matter-10 microns)	82
$PM_{2.5}$ (exhaust) (particulate matter-2.5 microns)	54
$PM_{10}/PM_{2.5}$ (fugitive dust)	Best Management Practices
Local CO (carbon monoxide)	None

Project Operations		
Pollutant	**Average Daily (pounds/day)**	**Maximum Annual (tons/year)**
ROG	54	10
NO_X	54	10
PM_{10}	82	15
$PM_{2.5}$	54	10
Local CO	9.0 ppm (8-hour average), 20.0 ppm (1-hour average)	

Plans
1. Consistency with Current Air Quality Plan control measures 2. Projected VMT or vehicle trip increase is less than or equal to projected population increase

4.3 JUSTIFICATION AND SUBSTANTIAL EVIDENCE SUPPORTING THRESHOLDS

4.3.1 PROJECT CONSTRUCTION CRITERIA POLLUTANT THRESHOLDS

Staff proposes criteria pollutant construction thresholds that add significance criteria for exhaust emissions to the existing fugitive dust criteria employed by the Air District. While our current Guidelines considered construction exhaust emissions controlled by the overall air quality plan, the implementation of new and more stringent state and federal standards over the past ten years now warrants additional control of this source of emissions.

The average daily criteria air pollutant and precursor emission levels shown above are recommended as the thresholds of significance for construction activity for exhaust emissions. These thresholds represent the levels above which a project's individual emissions would result in a considerable contribution (i.e., significant) to the SFBAAB's existing non-attainment air quality conditions and thus establish a nexus to regional air quality impacts that satisfies CEQA requirements for evidence-based determinations of significant impacts.

For fugitive dust emissions, staff recommends following the current best management practices approach which has been a pragmatic and effective approach to the control of fugitive dust emissions. Studies have demonstrated (Western Regional Air Partnership, U.S.EPA) that the application of best management practices at construction sites have significantly controlled fugitive dust emissions. Individual measures have been shown to reduce fugitive dust by anywhere from 30 percent to more than 90 percent. In the aggregate best management practices will substantially reduce fugitive dust emissions from construction sites. These studies support staff's recommendation that projects implementing construction best management practices will reduce fugitive dust emissions to a less than significant level.

4.3.2 Project Operation Criteria Pollutant Thresholds

The proposed thresholds for project operations are the average daily and maximum annual criteria air pollutant and precursor levels shown above. These thresholds are based on the federal BAAQMD Offset Requirements to ozone precursors for which the SFBAAB is designated as a non-attainment area which is an appropriate approach to prevent further deterioration of ambient air quality and thus has nexus and proportionality to prevention of a regionally cumulative significant impact (e.g. worsened status of non-attainment). Despite non-attainment area for state PM_{10} and pending nonattainment for federal $PM_{2.5}$, the federal NSR Significant Emission Rate annual limits of 15 and 10 tons per year, respectively, are proposed thresholds as BAAQMD has not established an Offset Requirement limit for $PM_{2.5}$ and the existing limit of 100 tons per year is much less stringent and would not be appropriate in light of our pending nonattainment designation for the federal 24-hour $PM_{2.5}$ standard. These thresholds represent the emission levels above which a project's individual emissions would result in a cumulatively considerable contribution to the SFBAAB's existing air quality conditions. The thresholds would be an evaluation of the incremental contribution of a project to a significant cumulative impact. These threshold levels are well-established in terms of existing regulations as promoting review of emissions sources to prevent cumulative deterioration of air quality. Using existing environmental standards in this way to establish CEQA thresholds of significance under Guidelines section 15067.4 is an appropriate and effective means of promoting consistency in significance determinations and integrating CEQA environmental review activities with other areas of environmental regulation. (*See Communities for a Better Environment v. California Resources Agency* (2002) 103 Cal. App. 4th 98, 111.[4])

[4] The Court of Appeal in the *Communities for a Better Environment* case held that existing regulatory standards could not be used as a definitive determination of whether a project would be significant under CEQA where there is substantial evidence to the contrary. Staff's proposed thresholds would not do that. The thresholds are levels at which a project's emissions would normally be significant, but would not be binding on a lead agency if there is contrary evidence in the record.

4.3.3 LOCAL CARBON MONOXIDE THRESHOLDS

The proposed carbon monoxide thresholds are based solely on ambient concentration limits set by the California Clean Air Act for Carbon Monoxide and Appendix G of the State of California CEQA Guidelines.

Since the ambient air quality standards are health-based (i.e., protective of public health), there is substantial evidence (i.e., health studies that the standards are based on) in support of their use as CEQA significance thresholds. The use of the ambient standard would relate directly to the CEQA checklist question. By not using a proxy standard, there would be a definitive bright line about what is or is not a significant impact and that line would be set using a health-based level.

The CAAQS of 20.0 ppm and 9 ppm for 1-hour and 8-hour CO, respectively, would be used as the thresholds of significance for localized concentrations of CO. Carbon monoxide is a directly emitted pollutant with primarily localized adverse effects when concentrations exceed the health based standards established by the California Air Resources Board (ARB).

In addition, Appendix G of the State of California CEQA Guidelines includes the checklist question: Would the project violate any air quality standard or contribute substantially to an existing or projected air quality violation? Answering yes to this question would indicate that the project would result in a significant impact under CEQA. The use of the ambient standard would relate directly to this checklist question.

4.3.4 PLAN-LEVEL CRITERIA POLLUTANT THRESHOLDS

This proposed threshold achieves the same goals as the Air District's current approach while alleviating the existing analytical difficulties and the inconsistency of comparing a plan update with AQP growth projections that may be up to several years old. Eliminating the analytical inconsistency provides better nexus and proportionality for evaluating air quality impacts for plans.

Over the years staff has received comments on the difficulties inherent in the current approach regarding the consistency tests for population and VMT growth. First, the population growth estimates used in the most recent AQP can be up to several years older than growth estimates used in a recent plan update, creating an inconsistency in this analysis. Staff recommends that this test of consistency be eliminated because the Air District and local jurisdictions all use regional population growth estimates that are disaggregated to local cities and counties. In addition, the impact to air quality is not necessarily growth but where that growth is located. The second test, rate of increase in vehicle use compared to growth rate, will determine if planned growth will impact air quality. Compact infill development inherently has less vehicle travel and more transit opportunities than suburban sprawl.

Second, the consistency test of comparing the rate of increase in VMT to the rate of increase in population has been problematic at times for practitioners because VMT is not always available with the project analysis. Staff recommends that either the rate of increase in VMT or vehicle trips be compared to the rate of increase in population. Staff also recommends that the growth estimates used in this analysis be for the years covered by the plan. Staff also recommends that the growth estimates be obtained from the Association of Bay Area Governments since the Air District uses ABAG growth estimates for air quality planning purposes.

5 ODOR THRESHOLDS

5.2 PROPOSED THRESHOLDS OF SIGNIFICANCE

Project Operations – Source or Receptor	Plans
1. More than one confirmed complaint per year averaged over a three year period; or 2. More than three unconfirmed complaints per year averaged over a three year period	Identify (Overlay Zones) and include policies to reduce the impacts of existing or planned sources of odors

5.3 JUSTIFICATION AND SUBSTANTIAL EVIDENCE SUPPORTING THRESHOLDS

Staff proposes continuing the current CEQA significance threshold for odors (based on complaint history). The current approach has proven adaptable to different projects and locations and thus continuation of the current approach with more qualitative guidance is considered an appropriate approach to CEQA evaluation.

Odors are generally considered a nuisance, but can result in a public health concern. Some land uses that are needed to provide services to the population of an area can result in offensive odors, such as filling portable propane tanks or recycling center operations. When a proposed project includes the siting of sensitive receptors in proximity to an existing odor source, or when siting a new source of potential odors, the following qualitative evaluation should be performed.

When determining whether potential for odor impacts exists, it is recommended that Lead Agencies consider the following factors and make a determination based on evidence in each qualitative analysis category:

- **Distance**: Use the screening-level distances in Table 9.

- **Wind Direction:** Consider whether sensitive receptors are located upwind or downwind from the source for the most of the year. If odor occurrences associated with the source are seasonal in nature, consider whether sensitive receptors are located downwind during the season in which odor emissions occur.

- **Complaint History:** Consider whether there is a history of complaints associated with the source. If there is no complaint history associated with a particular source (perhaps because sensitive receptors do not already exist in proximity to the source), consider complaint-history associated with other similar sources in BAAQMD's jurisdiction with potential to emit the same or similar types of odorous chemicals or compounds, or that accommodate similar types of processes.

- **Character of Source:** Consider the character of the odor source, for example, the type of odor events according to duration of exposure or averaging time (e.g., continuous release, frequent release events, or infrequent events).

- **Exposure:** Consider whether the project would result in the exposure of a substantial number of people to odorous emissions.

Table 9 – Screening Distances for Potential Odor Sources

Type of Operation Project Screening	Distance
Wastewater Treatment Plant	2 miles
Wastewater Pumping Facilities	1 mile
Sanitary Landfill	2 miles
Transfer Station	1 mile
Composting Facility	1 mile
Petroleum Refinery	2 miles
Asphalt Batch Plant	2 miles
Chemical Manufacturing	2 miles
Fiberglass Manufacturing	1 mile
Painting/Coating Operations	1 mile
Rendering Plant	2 miles
Food Processing Facility	1 mile
Confined Animal Facility/Feed Lot/Dairy	1 mile
Green Waste and Recycling Operations	1 mile
Coffee Roaster	1 mile

California Integrated Waste Management Board (CIWMB). Facilities that are regulated by the CIWMB (e.g. landfill, composting, etc.) are required to have Odor Impact Minimization Plans (OIMP) in place and have procedures that establish fence line odor detection thresholds. The Air District recognizes a Lead Agency's discretion under CEQA to use established odor detection thresholds as thresholds of significance for CEQA review for CIWMB regulated facilities with an adopted OIMP.

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Prepared by:
U.S. Department of Transportation
Research and Innovative Technology Administration
John A. Volpe National Transportation Systems Center
Environmental Measurement and Modeling Division, Acoustics Facility
Cambridge, MA 02142

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4.0 CONSTRUCTION NOISE CRITERIA AND DESCRIPTORS

4.1 Criteria

Construction noise levels may be evaluated in terms of human response and considered in the assessment of effects on wildlife and other non-human species. Noise levels and criteria are expressed in English, metric, or both conventions, depending upon the geographic area or the policies of the controlling agency. Typically, the English convention is used mostly in the United States, with the metric convention used in Canada and other countries.

While the issue of construction noise must be addressed as part of the planning of any transportation project, there are no standardized criteria on the federal level for assessing construction noise impacts related to transportation projects. Where project-specific construction noise criteria have been developed by individual agencies or municipalities, they typically consider the following factors which form the fundamentals for defining construction noise impact:

- Difference between existing noise levels prior to construction startup and expected noise levels during construction: This takes into account specific construction operations and/or individual pieces of equipment.

- Absolute level of expected construction noise: This may constitute the combined levels of all equipment and operations at a given time or be specifically related to the absolute noise level of a specific operation and/or piece of equipment.

- Adjacent land uses: Consideration of this factor provides an indicator of the degree of sensitivity that may be expected and will likely have a major effect on the operational time restraints and the noise level increases tolerated. For example, residential areas may typically have a restriction on night operations and possibly a noise level restriction during the day. Industrial areas may have no restrictions at all, and offices may or may not have a restriction on the noise levels during the day, with possibly no restriction for night operations. Examples of absolute and relative construction noise level criteria are provided in Table 7.1.

- Duration of construction/operation: The duration of high noise levels may play a significant role in how a noise impact is perceived and/or mitigated. If the levels are of a brief nature, possibly only occurring once or twice during the project, the perceived impact could be quite different than that associated with a constant noise source. Similarly, any related noise mitigation techniques employed could be substantially different in terms of type and/or duration of application.

4.1.1 History of Construction Noise Criteria

4.1.1.1 United States

While noise impact and abatement criteria have been established for the operation of transportation facilities in the United States, standardized criteria have not yet been established related to noise associated with the construction of such facilities. However, since the publication of the original 1977 Report[ref001], additional guidance has been disseminated (through agencies such as FHWA and FTA) and analysis tools developed to better address construction noise. For example, the FTA Transit Noise and Vibration Impact Assessment document[ref014] presents guidelines that “can be considered reasonable criteria for assessment” of construction noise impacts. In addition, a number of agencies, municipalities, and other entities have developed procedures for addressing construction noise impacts and implementing related noise mitigation for their areas of jurisdiction or on a project-specific basis.

In some instances, local entities may have developed noise ordinances that contain restrictions associated with construction noise levels. Noise practitioners and others involved in the project development process are encouraged to become familiar with such ordinances and their relationship to other State and/or municipal ordinances. In certain instances, the State jurisdiction may supersede any local noise ordinances.

Figure 4.1 Local noise ordinance
(Photo #314)

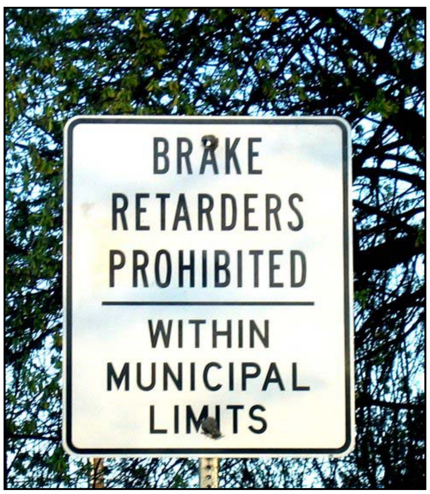

Figure 4.2 Local noise restrictions
(Photo #1206)

Noise restrictions may also be imposed by local and/or State authorities to deal with specific activities or operations. An example is the growing practice of restricting the use of engine compression brakes on heavy trucks in residential areas.

Noise restrictions may also be applied within the workplace associated with employee/worker exposure to noise levels over varying durations. These criteria have been established by OSHA. However, such criteria are typically not relevant or applicable to the transportation-related project construction noise levels experienced by people residing or working in areas adjacent to such projects. As such, they are not discussed within this Handbook.

Construction noise criteria within the United States vary considerably in terms of both scope and specificity and can be broadly categorized as follows, in order of complexity:

- No criteria specified;
- Qualitative criteria, e.g. “Noise levels shall not cause a disturbance”;

- Relative criteria, e.g. "Noise levels shall not exceed existing (or ambient, or background) noise levels by more than x dB";
- Absolute criteria, e.g. "Maximum noise levels shall not exceed xx dB";
- Criteria containing a combination absolute and relative noise level limits; and
- Combinations of the above criteria elements with additional restrictions placed on time periods and types of land uses or activities.

An example of more complex criteria is that associated with the Central Artery/Tunnel Project in Boston, MA. Data related to these criteria are discussed in Reference 023 and illustrated in Table 7.1 of this Handbook. This project established criteria that include both L_{10} and L_{max} absolute noise level limits for defined noise sensitive locations (residences, institutions, hotels, etc.) for daytime, evening, and nighttime periods. In addition, the criteria established maximum noise level increases relative to established baseline noise levels. Relative and absolute noise level limits were also established for commercial and industrial areas.

From the standpoint of construction noise criteria, the intent of this Handbook is not to address all State and local noise ordinances and/or criteria, but rather, to address the approaches and techniques that may be contained in such criteria. As such, the discussions contained within this Handbook are meant to provide a summary of considerations related to all aspects of construction noise. The reader is encouraged to refer to specific references in Table 10.1 for more detailed information on noise criteria and other factors related to construction noise.

4.1.1.2 Canada

Similar to the United States, no standardized Canadian criteria exist related to transportation project construction noise. Where project-specific analysis techniques have been employed to address and/or mitigate construction-related noise and its impacts, such methods have been similar to those employed in the United States. Examples of such efforts may be found in References 010 and 019.

4.1.1.3 Other International

While an exhaustive survey of international criteria was not conducted, several criteria are discussed here for informational use only. More specifics may be found by accessing the relative links found in the Reference Database in Chapter 10.

- The Official Journal of the European Communities' Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000[ref017] establishes legislation dictating specific noise levels for individual pieces of construction equipment. It also contains specifics related to the measurement locations and equipment operating conditions relative to the testing of individual pieces of equipment.
- The Australian EPA's Environmental Noise Control Manual[ref015] establishes the following criteria which officers may specify related to construction noise:
    - For a construction period of four (4) weeks or less, the maximum L_{10} noise level measured over a period of not less than 15 minutes when the construction site is operating must not exceed the background noise level by more than 20 dBA;

- For a construction period greater than four (4) weeks, the maximum L_{10} noise level measured over a period of not less than 15 minutes when the construction site is operating must not exceed the background noise level by more than 10 dBA;
- Construction limited to 0700 to 1800 time period on Monday through Friday;
- Construction limited on Saturdays to 0700 to 1300 time period if inaudible on residential premises; otherwise, 0800 to 1300;
- No construction work may take place on Sundays or public holidays; and
- All possible steps should be taken to silence construction site equipment. It is particularly important that silenced equipment should be used on road or rail works where 24-hour operation is necessary.

4.2 Descriptors

While it is not the intent of this Handbook to establish criteria for evaluating construction noise impacts, it is important to stress that reasonable and defensible noise descriptors must be used to describe construction noise levels. The following are important elements related to selecting a workable noise descriptor for use in measuring and analyzing construction noise:

- Suitable for practical measuring methods;
- Accounts for temporal variations in equipment noise levels;
- Accounts for temporal variations in overall site noise level;
- Suitable for prediction modeling;
- Suitable for combining noise levels from various source types; and
- Relative to subjective responses.

The descriptor most commonly chosen for use is the A-weighted equivalent sound level (energy basis), L_{Aeq}. In many cases, the time average period applied to the L_{Aeq} value is one hour (designated L_{Aeq1h}). For certain projects and operations, the time period over which the L_{Aeq} is applied may need to be examined on a case-by-case basis. For several major construction projects in the United States and Canada, the L_{10} (applied generally during daytime periods) and L_{max} (applied for specific equipment and/or nighttime operations) descriptors have been used over varying time periods.

The L_{dn} descriptor has been used to assess annoyance and community reaction to construction noise. L_{dn} is an L_{Aeq}-based descriptor that applies a 10 dBA penalty to nighttime noise levels.

The L_{Aeq}-based and L_{10}-based descriptors satisfy the first four elements listed above. The L_{Aeq} satisfies the fifth element and may also satisfy the sixth element (relative to subjective responses). However, the L_{Aeq}, L_{10}, and L_{max} descriptors may not be suited for determining responses by some aquatic wildlife (where using an un-weighted sound pressure level may be more suitable) or for owls (where use of a different weighting category such as dBO or a descriptor such as SEL may be more suitable to account for effects such as air blasts associated with blasting). More detailed information related to these specific conditions might be found in documents listed in Section 3.2.6 of this document.

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9.0 CONSTRUCTION EQUIPMENT NOISE LEVELS AND RANGES

9.1 Equipment Type Inventory and Related Emission Levels

Noise levels generated by individual pieces of construction equipment and specific construction operations form the basis for the prediction of construction-related noise levels. A variety of information exists related to sound emissions related to such equipment and operations. This data transcends the period beginning in the 1970s thru 2006. This information exists for both stationary and mobile sources and for steady, intermittent, and impulse type generators of noise.

9.1.1 Stationary Equipment

Stationary equipment consists of equipment that generates noise from one general area and includes items such as pumps, generators, compressors, etc. These types of equipment operate at a constant noise level under normal operation and are classified as non-impact equipment. Other types of stationary equipment such as pile drivers, jackhammers, pavement breakers, blasting operations, etc., produce variable and sporadic noise levels and often produce impact-type noises. Impact equipment is equipment that generates impulsive noise, where impulsive noise is defined as noise of short duration (generally less than one second), high intensity, abrupt onset, rapid decay, and often rapidly changing spectral composition. For impact equipment, the noise is produced by the impact of a mass on a surface, typically repeating over time.

9.1.2 Mobile Equipment

Mobile equipment such as dozers, scrapers, graders, etc., may operate in a cyclic fashion in which a period of full power is followed by a period of reduced power. Other equipment such as compressors, although generally considered to be stationary when operating, can be readily relocated to another location for the next operation.

9.2 Sources of Information

Construction-related equipment and operation noise level data may be provided by numerous sources, including suppliers, manufacturers, agencies, organizations, etc. Some information is included in this document, and many web-based links are given for equipment manufacturers.

9.3 Specifics of Construction Equipment and Operation Noise Inventories

Details included in each specific inventory of construction equipment and operation noise emission levels are often variable in terms of how data is represented. Some inventories include ranges of noise levels while others present single numbers for each equipment type. Others provide levels for specific models of each type of construction equipment. Often, different noise descriptors are used, such as L_{Aeq}, L_{max}, L_{10}, sound power level, etc. As such, the array of data does not readily lend itself to being combined into a single table or easily compared. As such, this Handbook attempts to summarize a variety of such inventories and provide links to each, thereby providing the reader with a variety of sources from which to choose the appropriate levels for use in his or her respective analysis.

9.4 Summaries of Referenced Inventories

Included below are examples of several inventories of construction-related noise emission values. These and additional inventories are included on the companion CD-ROM.

9.4.1 RCNM Inventory

Equipment and operation noise levels in this inventory are expressed in terms of L_{max} noise levels and are accompanied by a usage factor value. They have been recently updated and are based on extensive measurements taken in conjunction with the Central Artery/Tunnel (CA/T) Project. Table 9.1 summarizes the equipment noise emissions database used by the CA/T Project. While these values represent the "default" values for use in the RCNM, user-defined equipment and corresponding noise levels can be added.

Table 9.1 RCNM Default Noise Emission Reference Levels and Usage Factors.

Equipment Description	Impact Device?	Acoustical Usage Factor (%)	Spec. 721.560 L_{max} @ 50 feet (dBA, slow)	Actual Measured L_{max} @ 50 feet (dBA, slow) (Samples Averaged)	Number of Actual Data Samples (Count)
All Other Equipment > 5 HP	No	50	85	N/A	0
Auger Drill Rig	No	20	85	84	36
Backhoe	No	40	80	78	372
Bar Bender	No	20	80	N/A	0
Blasting	Yes	N/A	94	N/A	0
Boring Jack Power Unit	No	50	80	83	1
Chain Saw	No	20	85	84	46
Clam Shovel (dropping)	Yes	20	93	87	4
Compactor (ground)	No	20	80	83	57
Compressor (air)	No	40	80	78	18
Concrete Batch Plant	No	15	83	N/A	0
Concrete Mixer Truck	No	40	85	79	40
Concrete Pump Truck	No	20	82	81	30
Concrete Saw	No	20	90	90	55
Crane	No	16	85	81	405
Dozer	No	40	85	82	55
Drill Rig Truck	No	20	84	79	22
Drum Mixer	No	50	80	80	1
Dump Truck	No	40	84	76	31
Excavator	No	40	85	81	170
Flat Bed Truck	No	40	84	74	4
Front End Loader	No	40	80	79	96
Generator	No	50	82	81	19
Generator (<25KVA, VMS Signs)	No	50	70	73	74
Gradall	No	40	85	83	70
Grader	No	40	85	N/A	0
Grapple (on backhoe)	No	40	85	87	1

Equipment Description	Impact Device?	Acoustical Usage Factor (%)	Spec. 721.560 L_{max} @ 50 feet (dBA, slow)	Actual Measured L_{max} @ 50 feet (dBA, slow) (Samples Averaged)	Number of Actual Data Samples (Count)
Horizontal Boring Hydraulic Jack	No	25	80	82	6
Hydra Break Ram	Yes	10	90	N/A	0
Impact Pile Driver	Yes	20	95	101	11
Jackhammer	Yes	20	85	89	133
Man Lift	No	20	85	75	23
Mounted Impact Hammer (hoe ram)	Yes	20	90	90	212
Pavement Scarifier	No	20	85	90	2
Paver	No	50	85	77	9
Pickup Truck	No	40	55	75	1
Pneumatic Tools	No	50	85	85	90
Pumps	No	50	77	81	17
Refrigerator Unit	No	100	82	73	3
Rivit Buster/Chipping Gun	Yes	20	85	79	19
Rock Drill	No	20	85	81	3
Roller	No	20	85	80	16
Sand Blasting (single nozzle)	No	20	85	96	9
Scraper	No	40	85	84	12
Sheers (on backhoe)	No	40	85	96	5
Slurry Plant	No	100	78	78	1
Slurry Trenching Machine	No	50	82	80	75
Soil Mix Drill Rig	No	50	80	N/A	0
Tractor	No	40	84	N/A	0
Vacuum Excavator (Vac-Truck)	No	40	85	85	149
Vacuum Street Sweeper	No	10	80	82	19
Ventilation Fan	No	100	85	79	13
Vibrating Hopper	No	50	85	87	1
Vibratory Concrete Mixer	No	20	80	80	1
Vibratory Pile Driver	No	20	95	101	44
Warning Horn	No	5	85	83	12
Welder/Torch	No	40	73	74	5

For each generic type of equipment listed in Table 9.1, the following information is provided:

- an indication as to whether or not the equipment is an impact device;
- the acoustical usage factor to assume for modeling purposes;
- the specification "Spec" limit for each piece of equipment expressed as an L_{max} level in dBA "slow" at a reference distance of 50 foot from the loudest side of the equipment;
- the measured "Actual" emission level at 50 feet for each piece of equipment based on hundreds of emission measurements performed on CA/T work sites; and
- the number of samples that were averaged together to compute the "Actual" emission level.

A comparison of the "Spec" emission limits against the "Actual" emission levels reveals that the Spec limits were set, in general, to realistically obtainable noise levels based on the equipment used by contractors on the CA/T Project. When measured in the field, some equipment such as pile drivers, sand blasting, demolition shears, and pumps tended to exceed their applicable emission limit. As such, these noisy devices needed to have some form of noise mitigation in place in order to comply with the Spec emission limits. Other equipment, such as clamshell shovels, concrete mixer trucks, truck-mounted drill rigs, man-lifts, chipping guns, ventilation fans, pavers, dump trucks, and flatbed trucks, easily complied. Therefore, the Spec emission limits for these devices could have been reduced somewhat further. It is recommended that the user review the RCNM User's Guide contained in Appendix A for detailed guidance regarding application of values contained in Table 9.1.

9.4.2 FHWA Special Report Inventories

Appendix A of the 1977 Handbook provides tables of construction equipment noise levels and ranges. The majority of the data were provided by the American Road Builders Association. These data were taken during a 1973 survey in which member contractors were asked to secure readings of noise exposure to operators of various types of equipment. Additionally, the contractors were asked to take readings at 50 feet from the machinery. These 50-foot peak readings are provided in Tables 9.2 through 9.8. Though the data were produced under varying conditions and degrees of expertise, the values are relatively consistent.

Table 9.2 Construction Equipment Noise Levels Based on Limited Data Samples - Cranes.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Northwestern	80D	77	Within 15m 1958 mod
Northwestern	8	84	Within 15m 1940 mod
Northwestern	6	72	Within 15m 1965 mod
American	7260	82	Within 15m 1967 mod
American	599	76	Within 15m 1969 mod
American	5299	70	Within 15m 1972 mod
American	4210	82	Within 15m 1968 mod
Buck Eye	45C	79	Within 15m 1972 mod
Buck Eye	308	74	Within 15m 1968 mod
Buck Eye	30B	73	Within 15m 1965 mod
Buck Eye	30B	70	Within 15m 1959 mod
Link Belt	LS98	76	Within 15m 1956 mod
Manitowoc	4000	94	Within 15m 1956 mod
Grove	RF59	82	Within 15m 1973 mod
Koehr	605	76	Within 15m 1967 mod
Koehr	435	86	Within 15m 1969 mod
Koehr	405	84	Within 15m 1969 mod

Table 9.3 Construction Equipment Noise Levels Based on Limited Data Samples - Backhoes.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Link Belt	4000	92	Within 15m 1971 mod
John Deere	609A	85	Within 15m 1971 mod
Case	680C	74	Within 15m 1973 mod
Drott	40 yr.	82	Within 15m 1971 mod
Koehr	1066	81 & 84	Within 15m 2 tested

Table 9.4 Construction Equipment Noise Levels Based on Limited Data Samples - Front Loaders.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	980	84	Within 15m 1972 mod
Caterpillar	977K	79	Within 15m 1969 mod
Caterpillar	977	87	Within 15m 1971 mod
Caterpillar	977	94	Within 15m 1967 mod
Caterpillar	966C	84	Within 15m 1973 mod
Caterpillar	966C	85	Within 15m 1972 mod
Caterpillar	966	81	Within 15m 1972 mod
Caterpillar	966	77	Within 15m 1972 mod
Caterpillar	966	85	Within 15m 1966 mod
Caterpillar	955L	90	Within 15m ;1973 mod
Caterpillar	955K	79	Within 15m 1969 mod
Caterpillar	955H	94	Within 15m 1963 mod
Caterpillar	950	78 & 80	Within 15m 1972 mod
Caterpillar	950	75	Within 15m 1968 mod
Caterpillar	950	88	Within 15m 1967 mod
Caterpillar	950	86	Within 15m 1965 mod
Caterpillar	944A	80	Within 15m 1965 mod
Caterpillar	850	82	Within 15m 1968 mod
Michigan	75B	90	Within 15m 1969 mod
Michigan	475A	96	Within 15m 1967 mod
Michigan	275	85	Within 15m 1971 mod

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Michigan	125	87	Within 15m 1967 mod
Hough	65	82	Within 15m 1971 mod
Hough	60	91	Within 15m 1961 mod
Hough	400B	94	Within 15m 1961 mod
Hough	H90	86	Within 15m 1961 mod
Trojan	3000	85	Within 15m 1956 mod
Trojan	RT	82	Within 15m 1965 mod
Payloader	H50	85	Within 15m 1963 mod

Table 9.5 Construction Equipment Noise Levels Based on Limited Data Samples - Dozers.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	D5	83	Within 15m 1967 mod
Caterpillar	D6	85	Within 15m 1967 mod
Caterpillar	D6	86	Within 15m 1964 mod
Caterpillar	D6	81	Within 15m 1967 mod
Caterpillar	D6B	83	Within 15m 1967 mod
Caterpillar	D6C	82	Within 15m 1962 mod
Caterpillar	D7	85	Within 15m 1956 mod
Caterpillar	D7	86	Within 15m 1969 mod
Caterpillar	D7	84	Within 15m 1969 mod
Caterpillar	D7	78	Within 15m 1970 mod
Caterpillar	D7	78	Within 15m 1972 mod
Caterpillar	D7E	86	Within 15m 1965 mod
Caterpillar	D7E	78	Within 15m 1970 mod
Caterpillar	D7E	84	Within 15m 1973 mod
Caterpillar	D7F	80	Within 15m 1972 mod
Caterpillar	D8	92	Within 15m 1954 mod
Caterpillar	D8	95	Within 15m 1968 mod
Caterpillar	D8	86	Within 15m 1972 mod
Caterpillar	D8H	88	Within 15m 1966 mod
Caterpillar	D8H	82	Within 15m 1972 mod

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	D9	85	Within 15m 1972 mod
Caterpillar	D9	94	Within 15m 1972 mod
Caterpillar	D9	90	Within 15m 1963 mod
Caterpillar	D9	87	Within 15m 1965 mod
Caterpillar	D9	90	Within 15m 1965 mod
Caterpillar	D9	88	Within 15m 1968 mod
Caterpillar	D9	92	Within 15m 1972 mod
Caterpillar	D9G	85	Within 15m 1965 mod
Allis Chambers	HD41	93	Within 15m 1970 mod
International	TD15	79	Within 15m 1970 mod
International	TD20	87	Within 15m 1970 mod
International	TD25	90	Within 15m 1972 mod
International	TD8	83	Within 15m 1970 mod
Case	1150	82	Within 15m 1972 mod
John Deer	350B	77	Within 15m 1971 mod
John Deer	450B	65	Within 15m 1972 mod
Terex	8230	70	Within 15m 1972 mod
Terex	8240	93	Within 15m 1969 mod
Michigan	280	85	Within 15m 1961 mod
Michigan	280	90	Within 15m 1962 mod
Caterpillar	824	90	Within 15m 1968 mod

Table 9.6 Construction Equipment Noise Levels Based on Limited Data Samples - Graders.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	16	91	Within 15m 1969 mod
Caterpillar	16	86	Within 15m 1968 mod
Caterpillar	140	83	Within 15m 1970 mod
Caterpillar	14E	84	Within 15m 1972 mod
Caterpillar	14E	85	Within 15m 1971 mod
Caterpillar	14C	85	Within 15m 1971 mod
Caterpillar	14B	84	Within 15m 1967 mod

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	12F	82	Within 15m 1961-72 mod
Caterpillar	12F	72-92	Within 15m 1961-72 mod
Caterpillar	12E	81.3	Within 15m 1959-67 mod
Caterpillar	12E	80-83	Within 15m 1959-67 mod
Caterpillar	12	84.7	Within 15m 1960-67 mod
Caterpillar	12	82-88	Within 15m 1960-67 mod
Gallon	T500	84	Within 15m 1964 mod
Allis Chambers		87	Within 15m 1964 mod

Table 9.7 Construction Equipment Noise Levels Based on Limited Data Samples - Scrapers.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	660	92	Within 15m
Caterpillar	641B	85	Within 15m 1972 mod
Caterpillar	641B	86	Within 15m 1972 mod
Caterpillar	641	80 & 84	Within 15m 1972 mod
Caterpillar	641	83 & 89	Within 15m 1965 mod
Caterpillar	637	87	Within 15m 1971 mod
Caterpillar	633	87	Within 15m 1972 mod
Caterpillar	631C	89	Within 15m 1973 mod
Caterpillar	631C	83	Within 15m 1972 mod
Caterpillar	631B	94	Within 15m 1969 mod
Caterpillar	631B	84-87	Within 15m 1968 mod
Caterpillar		85 avg.	Within 15m 1968 mod
Caterpillar	621	90	Within 15m 1970 mod
Caterpillar	621	86	Within 15m 1967 mod
Caterpillar	613	76	Within 15m 1972 mod
Terex	TS24	87	Within 15m 1972 mod
Terex	TS24	84-91	
Terex	TS24	82	Within 15m 1971 mod
Terex	TS24	81-83	Within 15m 1971 mod
Terex	TS24	94	Within 15m 1966 mod

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Terex	TS24	92-98	Within 15m 1966 mod
Terex	TS24	94.7	Within 15m 1963 mod
Terex	TS24	94-95	Within 15m 1963 mod
Terex	TS14	82	Within 15m 1969 mod
Terex	S35E	84	Within 15m 1971 mod

Table 9.8 Noise Levels of Standard Compressors.

Manufacturer	Model	Silenced or Standard	Type Eng.	Type Comp.	Test Avg. Cond. (cfm.psi)	Avg. Cond. Noise Lev. (cfm.psi) (dBA) at 7m*
Atlas	ST-48	Standard	Diesel	Reciprocal	160,100	83.6
Atlas	ST-95	Standard	Diesel	Reciprocal	330,105	80.2
Atlas	VSS-170Dd	Silenced	Diesel	Reciprocal	170,850	70.2
Atlas	VT-85M	Standard	Gas	Reciprocal	85,100	81.4
Atlas	VS-85Dd	Silenced	Gas	Reciprocal	85,100	75.5
Atlas	VSS-125Dd	Silenced	Diesel	Reciprocal	125,100	70.1
Atlas	STS-35Dd	Silenced	Diesel	Reciprocal	125,100	73.5
Atlas	VSS-170Dd	Silenced	Diesel	Reciprocal	170,100	
Gardner-Denver	SPWDA/2	Silenced	Diesel	Rotary-Screw	1200,000	73.3
Gardner-Denver	SPQDA/2	Silenced	Diesel	Rotary-Screw	750,000	78.2
Gardner-Denver	SPHGC	Silenced	Gas	Rotary-Screw	185,000	77.1
Ingersoll-Rand	DXL 1200	Standard	Diesel	Rotary-Screw	1200,125	92.6
Ingersoll-Rand	DXL 1200 (doors open)	Standard	Diesel	Rotary-Screw	1200,125	
Ingersoll-Rand	DXL 900S	Silenced	Diesel	Rotary-Screw	900,125	76.0
Ingersoll-Rand	DXL 900S	Silenced	Diesel	Rotary-Screw	900,125	75.1
Ingersoll-Rand	DXLCU1050	Standard	Diesel	Rotary-Screw	1050,125	90.2
Ingersoll-Rand	DXL 900S	Silenced	Diesel	Rotary-Screw	900,125	75.3
Ingersoll-Rand	DXL 900S	Silenced	Diesel	Rotary-Screw	900,125	75.0
Ingersoll-Rand	DXL 900	Standard	Diesel	Rotary-Screw	900,125	89.9
Ingersoll-Rand	DXL 750	Standard	Diesel	Rotary-Screw	750,125	87.7
Jaeger	A	Standard	Gas	Rotary-Screw	175,100	88.2
Jaeger	A(doors	Standard	Gas	Rotary-	175,100	

Manufacturer	Model	Silenced or Standard	Type Eng.	Type Comp.	Test Avg. Cond. (cfm.psi)	Avg. Cond. Noise Lev. (cfm.psi) (dBA) at 7m*
	open)			Screw		
Jaeger	E	Standard	Gas	Vane	85,100	81.5
Jaeger	E(doors open)	Standard	Gas	Vane	85,100	
Worthington	60 G/2Qt	Silenced	Gas	Vane	160,100	74.2
Worthington	750-QTEX	Silenced	Diesel	Rotary-Screw	750,100	74.7

*Data taken from EPA Report - EPA 550/9-76-004.

9.4.3 FTA Noise and Vibration Assessment Procedure

Chapter 12 of the FTA Transit Noise and Vibration Guidance Handbook discusses construction noise evaluation methodology and contains the noise emission levels for construction equipment displayed in Table 9.9.

Table 9.9 FTA Construction Equipment Noise Emission Levels.

Equipment	Typical Noise Level (dBA) 50 ft from Source*
Air Compressor	81
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	85
Paver	89
Pile Driver (Impact)	101
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rail Saw	90
Rock Drill	98
Roller	74
Saw	76
Scarifier	83
Scraper	89
Shovel	82
Spike Driver	77
Tie Cutter	84

Equipment	Typical Noise Level (dBA) 50 ft from Source*
Tie Handler	80
Tie Inserter	85
Truck	88

*Table based on EPA Report, measured data from railroad construction equipment taken during Northeast Corridor improvement project and other measured data.

9.5 Links to Equipment Manufacturers

Table 9.10 contains web-based links to manufacturers of construction equipment. While few of these links contain noise-related data associated with the equipment, they provide descriptions and/or specifications related to the equipment, as well as sources for possibly obtaining additional information related to the equipment. Information in this table is by no means all-inclusive and does not represent any type of endorsement of the manufacturers, suppliers, or equipment. Users are hereby advised that the referenced websites may have certain restrictions, copyrights, etc., associated with any use of data contained therein.

Table 9.10 Equipment Manufacturers and Websites.

Equipment	Manufacturer	Website Address
Arrow Boards		
	North Star	http://northstar-traffic.com/index.cfm?SC=14&PT=1
	Trafcom	http://www.trafcon.com
	Allmand	http://www.allmand.com/MB%20AB%20page.htm
Articulated Trucks		
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=196
	Hitachi	http://www.hitachi-c-m.com/global/products/articulate/index.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=182b2104d7a1ce2c68b57b49f8c1436c&nav=prod#nb_0fb692066603522ee229a7ff28293d18
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/articulatedhaulers/
Asphalt Saws		
	Allied	http://www.alliedcp.com/products/rotocut.asp
Augers – See Drills / Augers		
Backhoes – See Loaders/Backhoes		
Boring Equipment – See Pile Drivers/Boring Equipment		
Compaction Equipment		
	Allied	http://www.alliedcp.com/products/compactor.asp
Compressors		

Equipment	Manufacturer	Website Address
	Sullair	http://www.sullair.com/corp/details/0,10294,CLI1_DIV61_ETI5714,00.html
	Compair	http://www.compair.com/Products/Portable_Compressors.aspx
Concrete and Asphalt Batch/Mixing Plants and Equipment		
	Con-E-Co	http://www.con-e-co.com/products.cfm
	Terex	http://www.terex.com/main.php?obj=prod&action=VIEW&id=a253f234f9c3bd69195320d1fe6e1cd9&nav=prod&cid=7713bf85ccb5a97458457e944ca4ed76
	Gunter &	http://www.guntert.com/concrete_mobilebatching.asp
	Rex Con	http://www.rexcon.com/products.html
Concrete Breakers/ Hydraulic Hammers/Hydraulic Breakers		
	Drillman	http://www.drillmanindia.com/concrete-breaker.html
	Hydro Khan	http:/www.sangi.co.kr/english/e_product1_2.php
	Stanley	http://www.stanley-hydraulic-tools.com/Hand%20Held/NoAmbreakers.htm
	Lynx	http://www.stanley-hydraulic-tools.com/Lynx/breakers.htm
Concrete Chain Saws		
	Lynx	http://www.stanley-hydraulic-tools.com/Lynx/concrete-saws.htm
Concrete Core Drilling Machines		
	Multiquip	http://www.multiquip.com/multiquip/318_ENU_HTML.htm
Concrete Cutters		
	Vermeer	http://www.vermeermfg.com/vcom/TrenchingEquipment/Line.jsp?PrdlnID=3618
Concrete/Material Pumps		
	Multiquip	http://www.multiquip.com/multiquip/309_ENU_HTML.htm
	Reed	http://www.reedpumps.com/
Concrete Mixer Trucks		
	Oshkosh	http://www.oshkoshtruck.com/concrete/products~overview~home.cfm
	London	http://www.lmi.ca/mixers.cfm
	Terex/Advance	http://www.advancemixer.com/trucks.asp
Concrete Saws		
	Multiquip	http://www.multiquip.com/multiquip/315_ENU_HTML.htm
	Diamond Core Cut	http://www.diamondproducts.com/dp_home.htm
Concrete Screeds		
	Multiquip	http://www.multiquip.com/multiquip/317_ENU_HTML.htm

Equipment	Manufacturer	Website Address
Concrete Vibrators		
	Multiquip	http://www.multiquip.com/multiquip/313_ENU_HTML.htm
	Sullair	http://www.sullair.com/corp/details/0,10294,CLI1_DIV61_ETI5722,00.html
Cranes		
	Malcolm Drilling	www.malcolmdrilling.com
	Link-Belt	http://www.linkbelt.com/lit/products/frameproducthome.htm
	Casagrande	http://www.casagrandegroup.com/home_fond.php
	Liebherr	http://www.liebherr.com/em/en/35381.asp
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=487c16c8ff145d0843f57512eafb8592&nav=prod
Crawler Tractors – See Dozers/Crawler Tractors		
Crushing and Screening Equipment		
	Cedarapids	http://www.cedarapids.com/crushscr.htm
	Hitachi	http://www.hitachi-c-m.com/global/products/crusher/index.html
	Komatsu	http://www.komatsu.com/ce/products/mobile_crushers.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=e75ed9c85681b27ffcfe5cadbd68c04e&nav=prod
Crushers/Pulverizers		
	Hydro Khan	http://www.sangi.co.kr/english/e_product3.php
Cutoff Saws		
	Multiquip	http://www.multiquip.com/multiquip/309_ENU_HTML.htm
	Lynx	http://www.stanley-hydraulic-tools.com/Lynx/cutoff%20saw.htm
Dozers/CrawlerTractors		
	John Deere	http://www.deere.com/en_US/cfd/construction/deere_const/crawlers/deere_dozer_selection.html
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=2
	Komatsu	http://www.komatsu.com/ce/products/crawler_dozers.html
Dewatering Pumps		
	Multiquip	http://www.multiquip.com/multiquip/371_ENU_HTML.htm
Drills / Augers		
	Malcolm Drilling	www.malcolmdrilling.com
	Casagrande	www.casagrandegroup.com/home_fond.php
	Soilmec	http://www.soilmec.com/_vti_g1_techno.aspx?rpstry=4_

Equipment	Manufacturer	Website Address
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=702f2c2ab1d75e021729f249258879f4&nav=prod#nb_cd8eeb0c300ecd6c7df8a7462718172d
Excavators		
	Hitachi	http://www.hitachi-c-m.com/global/products/excavator/index.html
	Caterpiller	http://www.cat.com/cda/layout?m=37840&x=7
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/compactexcavators/
		http://www.volvo.com/constructionequipment/na/en-us/products/wheeledexcavators/
		http://www.volvo.com/constructionequipment/na/en-us/products/crawlerexcavators/
	John Deere	http://www.deere.com/en_US/cfd/construction/deere_const/excavators/deere_excavator_selection.html
	Liebherr	http://www.liebherr.com/em/en/18891.asp
	Soilmec	http://www.soilmec.com/_vti_g1_t02.aspx?rpstry=29_
	Gehl	http://www.gehl.com/const/prod_sl.html
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=216
	Komatsu	http://www.komatsu.com/ce/products/crawler_excavators.html
		http://www.komatsu.com/ce/products/wheel_excavators.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=477c69a0ac11ed40efe034eb1420b8c6&nav=prod
	Link-Belt	http://www.lbxco.com/lx_series.asp
	Gradall	http://www.gradall.com/
	Badger Daylighting	http://www.badgerinc.com/
Fork Lifts – See Lifts / Variable Reach Fork Lifts/ Material Handlers		
Generators		
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=6cde2dee72c250aafbd68c5b8c8d028b&nav=prod
	Multiquip	http://www.multiquip.com/multiquip/212_ENU_HTML.htm
	Sullair	http://www.sullair.com/corp/details/0,10294,CLI1_DIV61_ETI5714,00.html
	Baldor	http://www.baldor.com/products/generators/ts.asp
Graders		
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=190
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/MotorGraders/

Equipment	Manufacturer	Website Address
	Komatsu	http://www.komatsu.com/ce/products/motor_graders.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=b71fa964f478a2243ebbbafa04bf814&nav=prod
Hand Compaction Equipment		
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=4c93fdc86b1c7733c1564fc8c41ee691&nav=prod#nb_cbcf35494fa399b7350f8edf5bc27373
	Multiquip	http://www.multiquip.com/multiquip/56_ENU_HTML.htm
Hydraulic Hammers/Hydraulic Breakers – See Concrete Breakers/ Hydraulic Hammers/Hydraulic Breakers		
Jackhammers – See Rock Drilling Equipment/Jackhammers		
Lifts / Variable Reach Fork Lifts/ Material Handlers		
	Genie Lift	www.genielift.com
	Sky Track	www.kirby-smith.com/
	Ingersol-Rand	www.ingersollrand.com
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=6d18d9a15fdb6da73f44a893c21c0fb4&nav=prod
	Roadtec	http://www.roadtec.com/products/mtv/default.htm
Light Towers		
	Baldor	http://www.baldor.com/products/generators/mlt.asp
	Multiquip	http://www.multiquip.com/multiquip/293_ENU_HTML.htm
	Allmand	http://www.allmand.com/Night%20Lite%20Pro%20page.htm
Loaders/Backhoes		
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=54
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/backhoeloaders/
	John Deere	http://www.deere.com/en_US/cfd/construction/deere_const/backhoes/deere_backhoe_selection.html
	Komatsu	http://www.komatsu.com/ce/products/backhoe_loaders.html
Material Handlers – See Lifts / Variable Reach Fork Lifts/ Material Handlers		
Milling Machines		
	Wirtgen	https://www.wirtgenamerica.com/noflash.html
Mining Trucks – See Rigid Dump Trucks/Mining Trucks		
Pans – See Scrapers/Pans		
Pavers/Paving Equipment		

Equipment	Manufacturer	Website Address
	Caterpillar/ Barber Greene	http://www.cat.com/cda/layout?m=37840&x=7
	Rosco	http://www.leeboy.com/rosco/
	Bomag	http://www.bomag.com/americas/index.aspx?&Lang=478
	Gehl	http://www.gehl.com/const/prodpg_ap.html
	Leeboy	http://www.leeboy.com/leeboy/
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=7713bf85ccb5a97458457e944ca4ed76&nav=prod#nb_70af03a93dfc933f83a7e6afdc2dc833
	Ingersoll-Rand	http://www.road-development.irco.com/Default.aspx?MenuItemID=12
	Vogele	http://www.vogeleamerica.com/noflash.html
	GOMACO	http://www.gomaco.com/index.html
	Roadtec	http://www.roadtec.com/products/asphalt_pavers/default.htm
Pile Drivers/Boring Equipment		
	Soilmec	http://www.soilmec.com/_vti_g1_t09.aspx?rpstry=29_
	Leffer	http://www.leffer.com/hme.html
	Bauer	http://www.bauer.de/en/maschinenbau/produkte/drehbohrgeraete/bg_reihe/usbg15h.htm
Pipelayers/Trenchers		
	Liebherr	http://www.liebherr.com/em/en/18908.asp
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=28&archived=1
	Vermeer	http://www.vermeermfg.com/vcom/TrenchingEquipment/trenching-equipment.htm
	Ditchwitch	http://www.ditchwitch.com/dwcom/Product/ProductView/115
	Eagle	http://www.guntert.com/trenchers_home.asp
Profilers – See Roadway Planers/Profilers		
Rammers		
	Multiquip	http://www.multiquip.com/multiquip/56_ENU_HTML.htm
Rebar Benders/Cutters		
	Multiquip	http://www.multiquip.com/multiquip/1316_ENU_HTML.htm
Recyclers – See Stabilizers/Recyclers		
Rigid Dump Trucks/Mining Trucks		
	Hitachi	http://www.hitachi-c-m.com/global/products/rigid/index.html
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Liebherr	http://www.liebherr.com/em/en/18898.asp
	Komatsu	http://www.komatsu.com/ce/products/dump_trucks.html

Equipment	Manufacturer	Website Address
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=182b2104d7a1ce2c68b57b49f8c1436c&nav=prod#nb_d97e204d5e73962e595735d68fad8ae3
Roadway Planers/Profilers		
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=7713bf85ccb5a97458457e944ca4ed76&nav=prod#nb_c9b8a083c7d9ebb936cd1e4f642eba59
	Roadtec	http://www.roadtec.com/products/cold_planers/default.htm
Rock Drilling Equipment/Jackhammers		
	Drillman	http://www.drillmanindia.com/rock-drilling-machine.html
	Whaker	http://www.wackergroup.com/webapp/wcs/stores/servlet/ViewAllModels?storeId=10051&prodgrpId=10070&langId=-1
	Sullair	http://www.sullair.com/corp/details/0,10294,CLI1_DIV61_ETI5721,00.html
	Allied	http://www.alliedcp.com/products/hammers.asp
Rollers – See Tampers/Rollers		
Scrapers/Pans		
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=e3959eefdc65adcc4e0e616b833694b1&nav=prod
Screening Equipment – See Crushing and Screening Equipment		
Slabbuster		
	Allied	http://www.alliedcp.com/products/slabbuster.asp
Slip Form Pavers		
	Huron	http://www.huronmanufacturing.com/
	Guntert & Zimmerman	http://www.guntert.com/concreteSlipformPavers.asp
Stabilizers/Recyclers		
	Bomag	http://www.bomag.com/americas/index.aspx?&Lang=478
	Komatsu	http://www.komatsu.com/ce/products/mobile_crushers.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=7713bf85ccb5a97458457e944ca4ed76&nav=prod#nb_d920dd8094cc1af5cb5d82359f8f227b
	Wirtgen	https://www.wirtgenamerica.com/noflash.html
	Roadtec	http://www.roadtec.com/products/cir/default.htm
Sweepers		
	Elgin	http://www.elginsweeper.com/index.asp
	Johnston	http://www.johnstonsweepers.com/
Tampers/ Rollers		

Equipment	Manufacturer	Website Address
	Bomag	http://www.bomag.com/americas/index.aspx?&Lang=478
	Komatsu	http://www.komatsu.com/ce/products/vibratory_rollers.html
	Whaker	http://www.wackergroup.com/webapp/wcs/stores/servlet/ViewAllModels?storeId=10051&prodgrpId=10070&langId=-1
	Lynx	http://www.stanley-hydraulic-tools.com/Lynx/tamper.htm
	Multiquip	http://www.multiquip.com/multiquip/181_ENU_HTML.htm
	Ingersoll-Rand	http://www.road-development.irco.com/Default.aspx?MenuItemID=15
Trenchers – See Pipelayers/Trenchers		
Trucks – See Articulated Trucks, Concrete Mixer Trucks, Rigid Dump Trucks/Mining Trucks		
Vacuum Units		
	Advanced Recycling Systems	www.arsrecycling.com/
	Vacmasters	http://www.vacmasters.com/airsystm.htm
	Vector	http://www.vector-vacuums.com/
Variable Message Signs		
	Allmand	http://www.allmand.com/MB%20only%20page.htm
	North Star	http://northstar-traffic.com/index.cfm?SC=13&PT=1
	Trafcom	http://www.trafcon.com
	Daktronics	http://www.daktronics.com/vms_prod/dak_vms_products.cfm
Vibratory Rammers		
	Whaker	http://www.wackergroup.com/webapp/wcs/stores/servlet/ViewAllModels?storeId=10051&prodgrpId=10070&langId=-1
Welders/Welding Equipment		
	Airgas	www.airgas.com
	Multiquip	http://www.multiquip.com/multiquip/408_ENU_HTML.htm
	Miller	http://www.millerwelds.com/products/
	Lincoln	http://www.mylincolnelectric.com/Catalog/equipmentseries.asp?browse=101|400|
Wheel Loaders		
	Hitachi	http://www.hitachi-c-m.com/global/products/loader/index.html
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=30
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/wheelloaders/
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=ad8a2ae2f52f113b6d143bfd7765b165&nav=prod

Equipment	Manufacturer	Website Address
	Komatsu	http://www.komatsu.com/ce/products/wheel_loaders.html
	TCM	http://www.tcmglobal.net/products/main02.html

U.S. Department of Housing and Urban Development
Office of Community Planning and Development

The Noise Guidebook

The Noise Guidebook

A Reference Document for Implementing the Department of Housing and Urban Development's Noise Policy

Prepared By The Environmental Planning Division,
Office of Environment and Energy

Table of Contents

Preface

Introduction

This *Noise Guidebook* has been prepared to serve as the basic reference document for all HUD field staff who are responsible for implementing the Department's noise policy. It brings together in one place all the various reports, informational papers and other items that have been put out by the Department over the past several years. It also contains several new items designed to make your job easier.

This *Guidebook* is designed to serve not only the experienced HUD staff member but also the new employee or the old employee who is new to the noise field. Because of this, the *Guidebook* contains some fairly basic background material as well as quizzes and other material specifically geared for the "learner."

ERRATA SHEET

The Noise Guidebook

Railway Noise Guidance and Calculation Corrections

February 2009

The following should replace the paragraph entitled "Horns and Whistles" on page 63 (also marked 15) in the Noise Assessment Guidelines, Chapter 5, of *The Noise Guidebook* (September 1991).

> If the Noise Assessment Location (NAL) is perpendicular to any point on along a railroad track between the whistle posts for a road crossing, a factor to account for the noise of warning horns or whistles must be included in the calculation. There are 2 factors to be used based on the type of locomotive. If the locomotive is diesel-powered, enter the number 10 in column 11 of Worksheet D. If the locomotive is electric-powered, enter the number 100 in column 18 of Worksheet D. If the NAL is not between the whistle posts for a road crossing, enter the number 1 in each column.
>
> *Note: Whichever horn factor is appropriate, it must only be applied once. If a factor is applied for diesel locomotives in the first section of the worksheet, it must not be applied to the railcar noise calculation in the second part. In that instance, enter the number 10 in column 11 and the number 1 in column 18.*

A revised Worksheet D also accompanies this correction. It is easily distinguished from the original. The new Worksheet D has an additional column in the second section of page 2 for a total of 27 columns. The original version, with 26 columns, is hereby void.

Railway Noise
Data Sheet

Noise Assessment Guidelines

List All Railways within 3000 feet of the site: **Notes**

1. ______________________________

2. ______________________________

3. ______________________________

Necessary Information	**Railway No. 1**	**Railway No. 2**	**Railway No. 3**	**Notes**
1. Effective distance:	________	________	________	Measured in feet from NAL to center of track
2. Number of Trains in 24 hours:				
a. diesel	________	________	________	
b. electrified	________	________	________	
3. Fraction of operations occuring at night:	________	________	________	10 p.m. - 7a.m.
4. Number of diesel locomotives per train:	________	________	________	
5. Number of rail cars per train:				
a. diesel trains	________	________	________	
b. electrified trains	________	________	________	Include locomotive for electrified trains
6. Average train speed:	________	________	________	
7. Is track welded or bolted?	________	________	________	
8. Is the site opposite a section of tracks between whistle stops?	________	________	________	

Railway Noise
Computations and Findings

Noise Assessment Guidelines

Adjustments for Diesel Locomotives

	9 No. of Locomotives 2		10 Average Speed (Table 9)		11 Horns (Enter 10)		12 Night-time (Table 5)		13 No. of Trains (Line 2a)		14 Adj. No of Opns.	15 DNL (Workchart 3)		16 Barrier Attn.		17 Partial DNL
Railway No. 1	________	x	________	x	________	x	________	x	________	=	________	________	-	________	=	________
Railway No. 2	________	x	________	x	________	x	________	x	________	=	________	________	-	________	=	________
Railway No. 3	________	x	________	x	________	x	________	x	________	=	________	________	-	________	=	________

Adjustments for Railway Cars or Rapid Transit Trains and Electric Locomotives

	18 Horns on Electric Trains only (Enter 100)		19 Number of cars 50		20 Average Speed (Table 10)		21 Bolted Rails (Enter 4) Welded (Enter 1)		22 Night-time (Table 5)		23 No. of Trains (Lines 2a and 2b)		24 Adj. No. of Opns.	25 DNL (Workchart 4)		26 Barrier Attn.		27 Partial DNL
Railway No. 1	________	x	________	x	________	x	________	x	________	x	________	=	________	________	-	________	=	________
Railway No. 2	________	x	________	x	________	x	________	x	________	x	________	=	________	________	-	________	=	________
Railway No. 3	________	x	________	x	________	x	________	x	________	x	________	=	________	________	-	________	=	________

Combined Locomotive and Railway Car DNL (See combining noise levels table for procedures)

Partial DNL Railway No. 1 ________

Partial DNL Railway No. 2 ________

Partial DNL Railway No. 3 ________

Partial DNL Total DNL for all Railways ________

Signed ______________________________ Date ______________________________

Chapter 1

Basic Overview of the Environmental Noise Problem

Introduction

Background

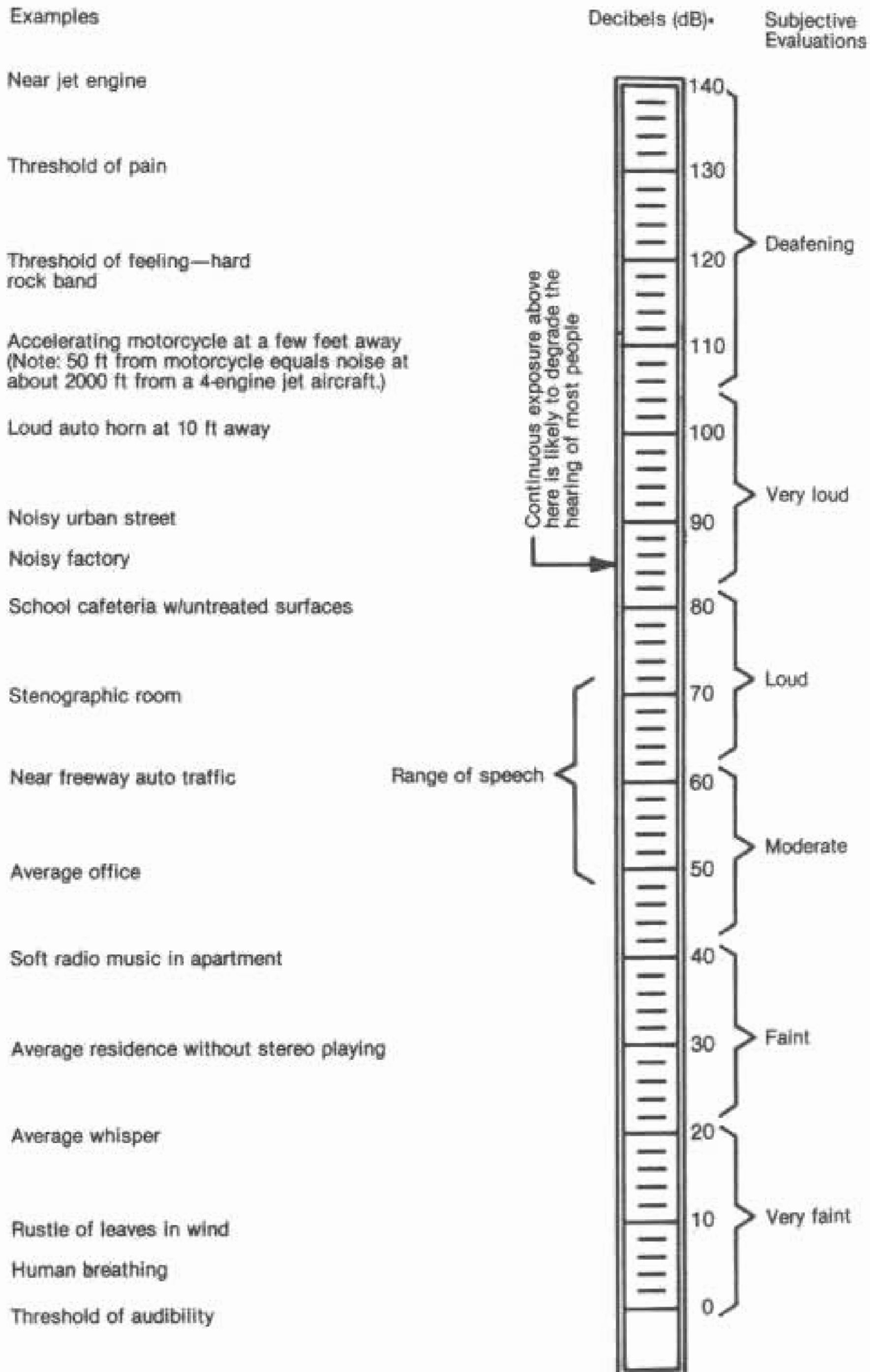
Definition and Scope of the Noise Problem

The air around us is constantly filled with sounds, yet most of us would probably not say we are surrounded by noise. What then is the difference between ordinary sound and what we call noise? The traditional definition of noise is that it is "unwanted sound." Sound becomes unwanted when it either interferes with our normal activities such as sleeping, conversation or recreation, when it causes actual physical harm such as hearing loss or has adverse effects on mental health. As we have become a more urbanized country and as technology has advanced, the level of sound in our environment has reached the point when it sometimes does cause interference and does cause physical and psychological harm, and thus we have developed a noise problem. (See Figure 1 for a listing of common sounds.)

The dimensions of the noise problem have grown larger and larger over the past few decades. In its 1979 Annual Report, The Council on Environmental Quality stated that "nearly half the US population is regularly exposed to levels of noise that interfere with ...normal activities" and about "1 in 10 ...are exposed to noises of duration and intensity sufficient to cause a permanent reduction in their ability to hear."

Figure 1
Common Sounds
Basic Theory: Common Sounds in Decibels (dB)

Some common, easily recognized sounds are listed below in order of increasing sound intensity levels in decibels. The sound levels shown for occupied rooms are typical general activity levels only and do *not* represent criteria for design.



*dB are "average" values as measured on the A-scale of a sound-level meter
(From *Concepts in Architectural Acoustics:* M. David Egan, McGraw Hill, 1972.)

The Dynamics of the Noise Problem

There are basically two types of noise problems. There is the specific, job related, occupational noise problem created by extremely loud machinery. Then there is the community noise problem where the combined effect of many individual noise sources creates an overall noise level that is unacceptable. In the following pages we will be addressing the community noise problem only.

The main contributors to a community noise problem are transportation sources such as highways, railroads and airports. These sources are the most pervasive and continuing of the noise sources within the community. Of course, at any given site, there may be other noise sources which add to the problem, sources such as jackhammers at a construction site. But in general, and for the purposes of this section, the main concern is with the transportation sources.

The dynamics of a noise problem are based on the relationship between the noise source, the person or place exposed to the noise (hereafter called the receiver) and the path the noise will travel from source to receiver.

The source generates a given amount of noise which travels along the path and arrives at the receiver. The amount of noise will be reduced to some extent as a result of how long that path is or whether there are any barriers along the path. The severity of the impact on the receiver is a function of what type of activity is taking place, whether it is indoors or outdoors, and what type of building it is in if the activity is indoors. Figure 3 contains some basic compatibility guidelines.

The impact of the noise can be altered or mitigated by changing the characteristics of any of the three elements: source, path or receiver. Later on we will look at the various mitigation measures that are possible. Our concern however will be primarily with the receiver and the path. Control of the sources themselves is the specific responsibility of agencies such as the Environmental Protection Agency (EPA) or the Federal Aviation Administration (FAA).

Figure 2
Dynamics of a Noise Problem

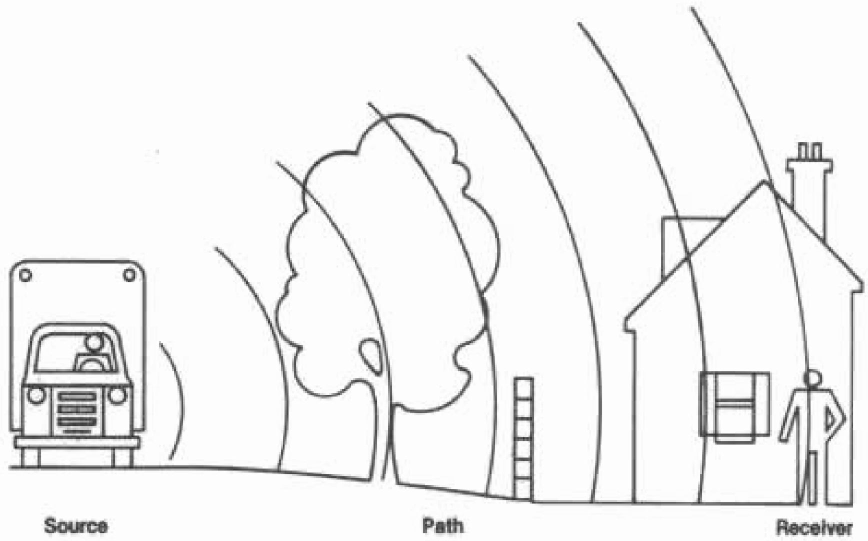
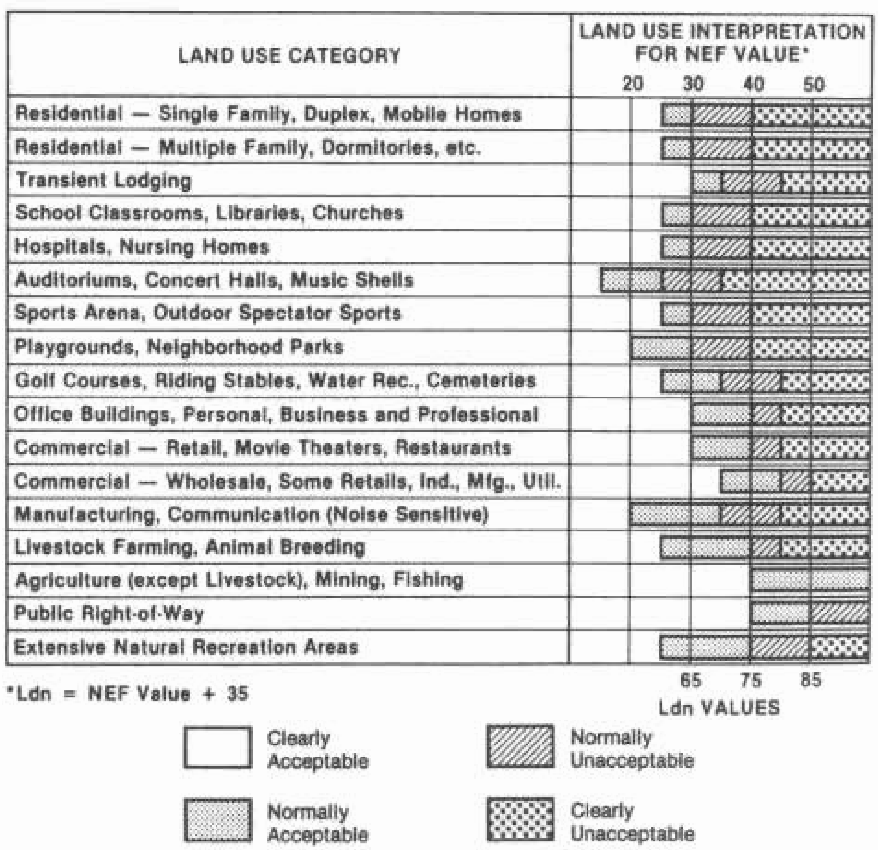


Figure 3
Land Use Compatibility Guidelines



The ideal solution to a potential problem is to reduce the noise being produced by the source. The best solution available to HUD, or the community, however, is to make sure that noise sensitive uses are located where they will not be exposed to high noise levels. The next best approach to mitigating noise impact is to attempt to reduce the amount of noise that reaches the receiver. This can be accomplished through the use of barriers such as walls or earthen berms, or combinations of both, along the noise path. If the use of barriers is not possible then the only alternative available is to provide noise reduction measures in any structures associated with the activity so that at least the interior spaces are not exposed to high noise levels. This approach is considered the least desirable because most of the land uses we are concerned about, such as residential, do have outdoor areas and activities associated with them which would remain exposed to high noise levels.

A Note on Descriptors

A key factor in the growth of our ability to evaluate and reduce noise impacts has been the development of better tools to measure and describe the noise levels generated by various sources. The development of better tools (called noise descriptors or metrics) has been particularly important for dealing with community noise problems. Many of the older descriptor systems could only be used for one or two sources such as cars and railroads, but not airplanes. Since the community noise problem very often includes noise from all these sources the lack of an adequate descriptor made it difficult to do an adequate evaluation.

The most advanced descriptor currently in general use is the day night average sound level system, abbreviated as DNL and symbolized mathematically as L_{dn}. The day night average sound level is the 24 hour average sound level, expressed in decibels, obtained after the addition of a 10 decibel penalty for sound levels which occur at night between 10 PM and 7 AM. This nighttime penalty is based on the fact that many studies have shown that people are much more disturbed by noise at night than at any other time. This is not unusual in that background noise is often much less at night and also people tend to be doing very noise sensitive things at night, such as trying to sleep.

Another feature of the DNL system that is very important is that it can be used to describe noise from all sources. Thus, using the DNL system, we can describe the total noise exposure at a site, something many other descriptor systems couldn't do.

The DNL system has been adopted by the EPA, the Department of Defense (DOD) and HUD, and more recently by the FAA, specifically for describing environmental impacts for airport actions. We expect that very soon it will be in almost universal use in the U.S.

Issues

The main issues involved in any noise analysis can be summarized briefly.

- How much noise is a site exposed to
- What types of activities are being affected and how severely
- Is it reasonable to redesign the site to relocate noise sensitive activities
- And, if not, how much protection can be provided through various attenuation measures.

Your approach to these issues will be affected in many ways by the location of the project in question. Projects in suburban or rural areas can be approached differently because the available mitigation options are greater and often the noise exposure itself is not so severe. In urban situations, however, the noise exposure is often more severe but at the same time the options for mitigation or resiting are more limited. In the urban setting innovative design and the use of advanced attenuation measures becomes critical. Fortunately our experience has shown that good design and construction can relieve or substantially reduce major noise problems.

Legal Provisions

General Legislation and Background

The Federal legislation which addresses noise issues is somewhat different from other environmental legislation. The Clean Air Act, for example, required the Environmental Protection Agency to set up actual mandatory standards for air quality which were supposed to be met by all jurisdictions. EPA even has the authority to take punitive steps against cities which are not making "reasonable further progress" towards achieving these air quality goals. There is no similar legislation that covers noise. The approach has been to tackle the noise problem at the source by controlling the amount of noise that can be emitted by the individual airplane engine or the individual jackhammer. Agencies like HUD or the Farmers Home Administration have developed regulations which are related to the overall community noise level, but they only affect their own programs and are not binding on local communities. The Veterans Administration program only relates to aircraft noise and also only affects its own programs.

The major pieces of Federal legislation related to noise include:

The Noise Control Act of 1972 directed EPA to promote an environment for all Americans free from noise that jeopardizes their health and welfare. It also included a requirement for EPA to set a criterion for noise level adequate to protect health and welfare with an adequate margin of safety but without regard to cost or feasibility.

Quiet Communities Act of 1978 amended The Noise Control Act of 1972 to encourage noise control programs at the State and community level.

Federal Aid Highway Act of 1970 established the requirement that noise control be a part of the planning and design of all federally aided highways.

Aviation Safety and Noise Abatement Act of 1979 requires FAA to develop a single system for measuring noise at airports and under certain conditions to prepare and publish noise maps.

HUD Regulations

While the Department of Housing and Urban Development has no specific responsibility to try to reduce the noise problem at the source the way the Environmental Protection Agency and the Federal Aviation Administration do, it does have the responsibility to be aware of the noise problem and its impact on the housing environment. The most basic mandate which drives the Department's involvement with the noise issue is the Housing Act of 1949 (Public Law 81-171) which sets forth the national goal of "a decent home and suitable living environment for every American family." This goal was affirmed by the Housing and Urban Development Act of 1968 (Public Law 90-448). The Department was tasked by the Housing and Urban Development Act of 1965 (Public Law 89-117) "to determine feasible methods of reducing the economic loss and hardships suffered by homeowners as a result of the depreciation in the value of their properties following the construction of airports in the vicinity of their homes." The Noise Control Act of 1972, in addition to its specific tasking to EPA, tasked all Federal agencies to administer their programs in ways which reduce noise pollution. Finally, the Department is tasked by Federal Management Circular 75-2: *Compatible Land Uses at Federal Airfields* to make sure that its actions do not promote incompatible land uses around Federal airfields.

All of these legislative and regulatory mandates combine to create a serious requirement for the Department of Housing and Urban Development to be aware of the problem of noise and to take positive steps to protect residential and other sensitive land uses from high noise levels.

The Department of Housing and Urban Development first issued formal requirements related specifically to noise in 1971 (HUD Circular 1390.2). These requirements contained standards for exterior noise levels along with policies for approving HUD supported or assisted housing projects in high noise areas. In general the requirements established three zones: an acceptable zone where all projects could be approved, a normally unacceptable zone where mitigation measures would be required and where each project would have to be individually evaluated for approval or denial, and an unacceptable zone in which projects would not, as a rule, be approved.

In 1979, the Department issued revised regulations (24 CFR Part 51B) which kept the same basic standards but adopted new descriptor systems which were considerably advanced over those in use under the old requirements.

HUD's regulations also require that recipients of Community Development Block Grants (CDBG) and Urban Development Action Grants (UDAG) take into consideration the noise criteria and standards in the environmental review process and consider ameliorative actions when noise sensitive land developments are proposed in noise exposed areas. If CDBG or UDAG activities are planned in a noisy area, and HUD assistance is contemplated later for housing and/or other noise sensitive activities, the HUD standards must be met for those activities.

Project Analysis

General

While most of the analysis for noise focuses on noise sources located around the project site, there are some characteristics of the project itself that you should know about. These characteristics will help you to determine what is called the noise assessment location (NAL) for site analysis. (The NAL is a representative point (or points) on the site where significant noise exposure is expected. All distances, etc. are measured from the NAL). This information will also be helpful later in evaluating the potential for mitigating or reducing the impact of noise. All of this data should be available from preliminary plans and specifications. If not, a quick phone call to the developer/sponsor should get you all the information you need.

Data Required

- Location of outdoor noise sensitive uses relative to the noise source.
- Location of buildings containing noise sensitive activities.
- Location of other buildings, particularly ones which might serve to shield sensitive buildings or areas from the noise source.
- Design and construction features of buildings, particularly features such as use of central air conditioning which could provide noise reduction benefits by permitting windows to be kept closed.

Analysis of Site and Environs

General

The primary focus of this impact analysis is on noise sources and the primary item to be determined is the noise level created by those sources. In many instances, particularly with airports, data on the noise levels generated by the source will have already been prepared by another agency such as the airport operator, the local or State highway/transportation department or other similar agency. (Figure 4 shows typical airport noise contours.) In those cases no site or environs analysis is necessary and one can proceed directly to impact analysis. For those instances where there are no current data already prepared, the Department of Housing and Urban Development has developed a handbook called the *Noise Assessment Guidelines* which contains a detailed desk top methodology for use by individuals to determine noise impacts (see Chapter 5). Included in the handbook is a complete listing of the data about the site and its environs that are necessary to conduct an analysis. We don't want to repeat all the detailed requirements here, but the following are some of the types of information you would have to collect if you were to do your own analysis. You might note that most of the information is related to the noise sources themselves.

For the purpose of analysis, the *Noise Assessment Guidelines* require that you consider all military/civilian airports within 15 miles of the project, all significant roads within 1000 feet and basically all railroads within 3000 feet.

Types of Data Required

- Number and type of vehicles
- Operational data:
  - speed
  - daytime/nighttime split
- Conditions where the vehicles are operated, i.e., freely flowing traffic versus stop and go, level versus hilly, welded railroad track versus bolted railroad track.

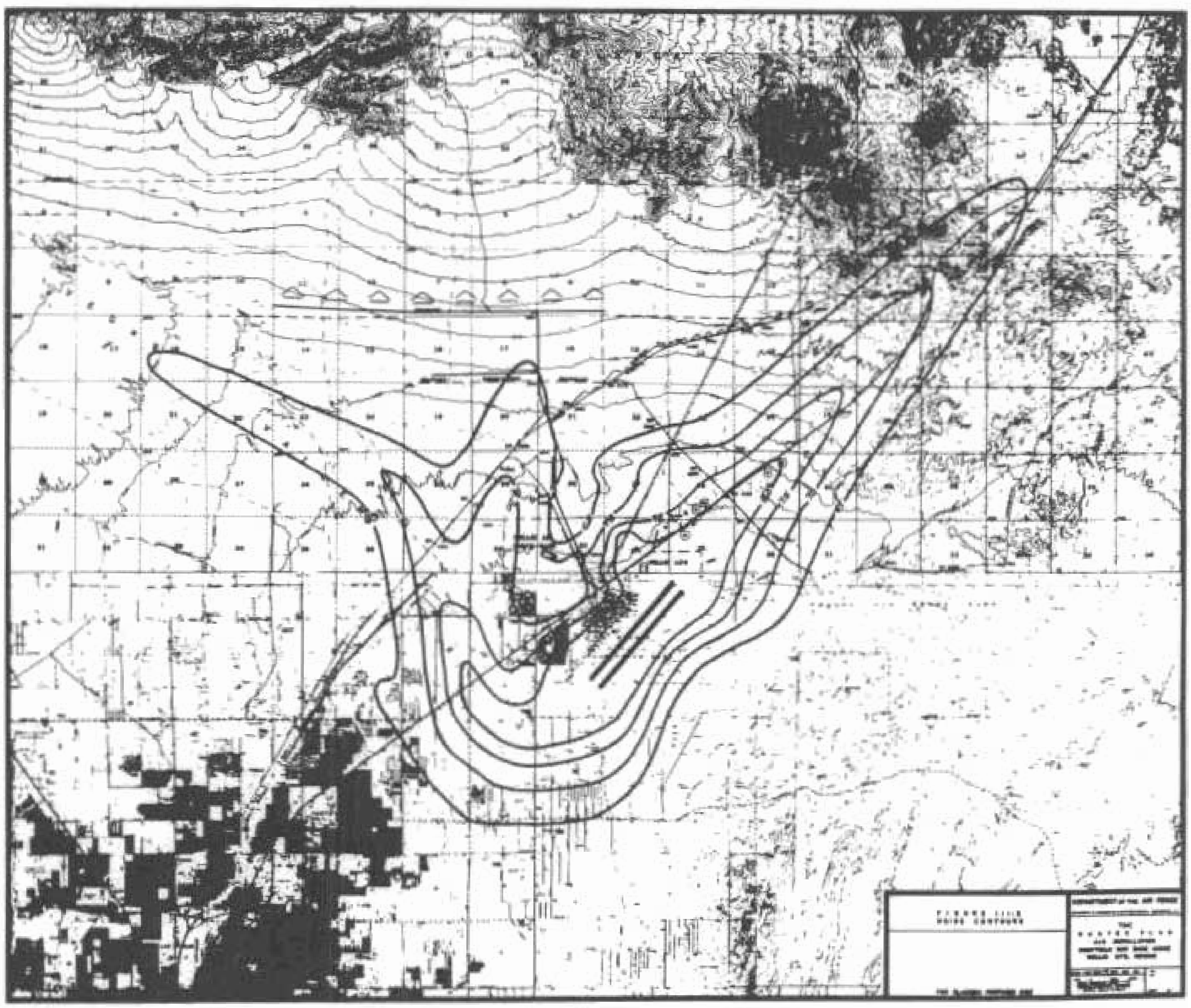
The *Noise Assessment Guidelines* contain guidance on sources for this data. Most of them are obtained from the "operator" of the transportation source. The *Guidelines* also contains model figures which can be used when actual data is unavailable. For example, if the actual number of vehicles traveling at night is not available then the *Guidelines* state that a figure of 15% should be used. Thus it is possible to make reasonably accurate noise level determinations even if some information is not available.

Determination of Impact

General

The specific procedures for determining the noise exposure levels for a site are clearly spelled out in the *Noise Assessment Guidelines*. The process is a fairly simple one in which the noise level from each source affecting the site is calculated and then combined to derive the overall exposure. If some kind of barrier exists or is proposed, the noise levels can be adjusted to reflect the mitigation provided by the barrier. The overall noise level is then compared to HUD's standards and the appropriate action, as spelled out in the regulations, is taken.

Figure 4
Noise Contours



Evaluation of Impact

HUD Regulations set forth the following exterior noise standards for new housing construction assisted or supported by the Department:

65 L_{dn} or less - Acceptable

Exceeding 65 L_{dn} but not exceeding 75 L_{dn} - Normally Unacceptable - appropriate sound attenuation measures must be provided: 5 decibels attenuation above the attenuation provided by standard construction required in 65 L_{dn} to 70 L_{dn} zone; 10 decibels additional attenuation in 70 L_{dn} to 75 L_{dn} zone.

Exceeding 75 L_{dn} - Unacceptable

HUD's regulations do not contain standards for interior noise levels. Rather a goal of 45 decibels is set forth and the attenuation requirements are geared towards achieving that goal. It is assumed that with standard construction any building will provide sufficient attenuation so that if the exterior level is 65 L_{dn} or less, the interior level will be 45 L_{dn} or less.

Once you have determined the overall noise exposure for the site you compare it to the above standards. If the overall site exposure is 65 L_{dn} or less the project is acceptable. If the exposure is between 65 L_{dn} and 75 L_{dn} you should consider alternative locations or providing adequate attenuation with the first preference, as we've noted, being for the construction of some kind of barrier to prevent noise from reaching the site. If providing adequate attenuation is impossible or impractical then the project should be considered unacceptable.

Suggested Mitigation

General Considerations

As discussed briefly earlier, there are three basic approaches for mitigating the high noise exposures. The first and best is to relocate noise sensitive uses out of the high noise area. The second is to prevent noise from reaching the noise sensitive user through some sort of barrier. And the third, and least desirable approach, is to provide attenuation for at least the interiors of any buildings located in the high noise areas.

Specific Considerations

Relocating Noise Sensitive Uses

By far the most desirable mitigation approach is to relocate noise sensitive uses out of the high noise area although. If the site is large enough it may be possible to locate non-noise sensitive uses between the source and the sensitive use, for example a parking lot might be located between a road and a park (see Figure 5). The workcharts in the *Noise Assessment Guidelines* can be used in reverse to tell you exactly how far away from the noise source you need to be.

When sites are small, very dense or when the source affects the entire site it is very difficult to mitigate by changing the site plan. Then the next option must be considered: erecting some type of barrier between the source and the receiver.

Barriers

Barriers are most effective for at or below ground level sources. They have no effect on noise from aircraft overflights and are limited in practical application with elevated sources such as elevated trains. The key to the effectiveness of a barrier is whether or not it breaks the line of sight between the source and the receiver. If a barrier does not completely break the line of sight either because it is not high enough, or not long enough then its effectiveness is greatly reduced.

Barriers can be actual walls, earthen mounds (called berms) or even other buildings. The use of other non-noise sensitive buildings as barriers is a particularly good approach in that it need not add to the cost of the project and may not create the aesthetic problem a large wall might create (see Figure 6).

Figure 5
The Audible Landscape

In cluster development, open space can be placed near the highway to reduce noise impacts on residences

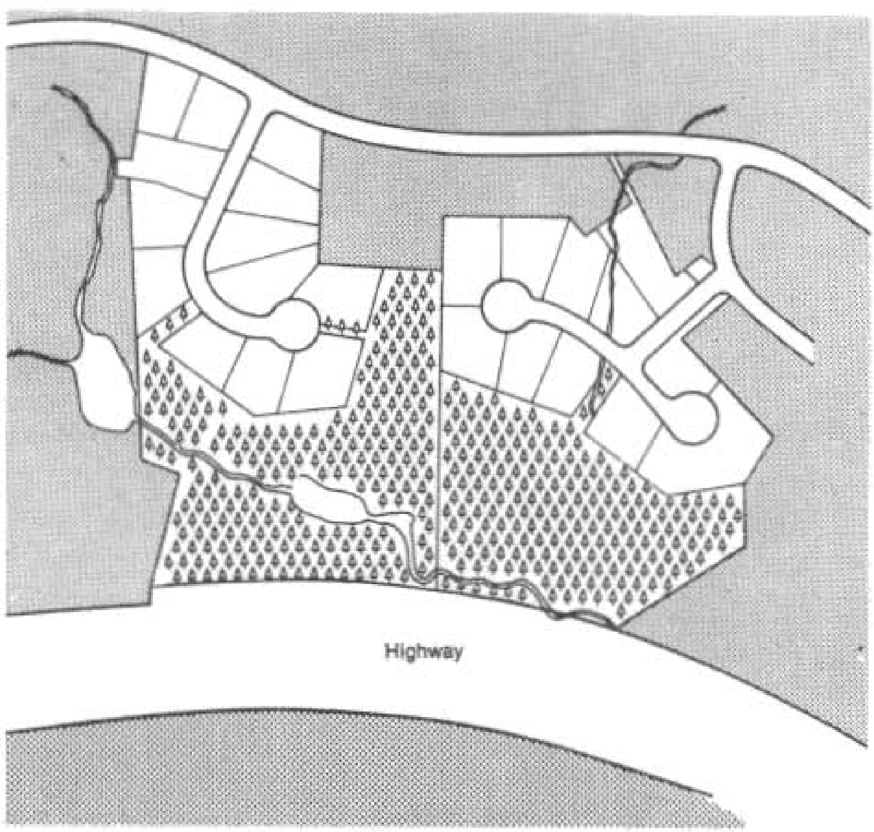


Figure 6
The Audible Landscape

Placement of noise compatible land uses near highway in Planned Unit Development

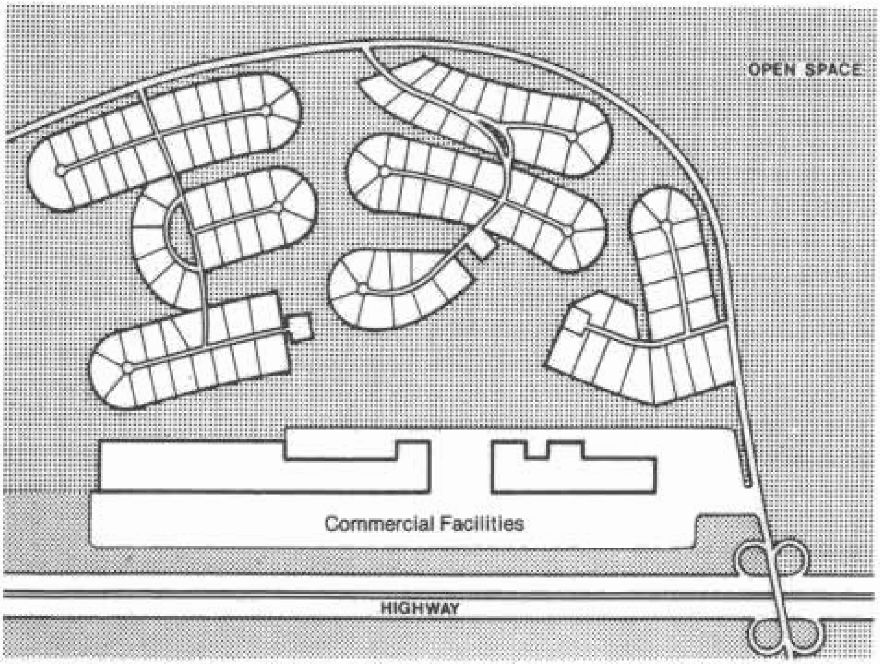
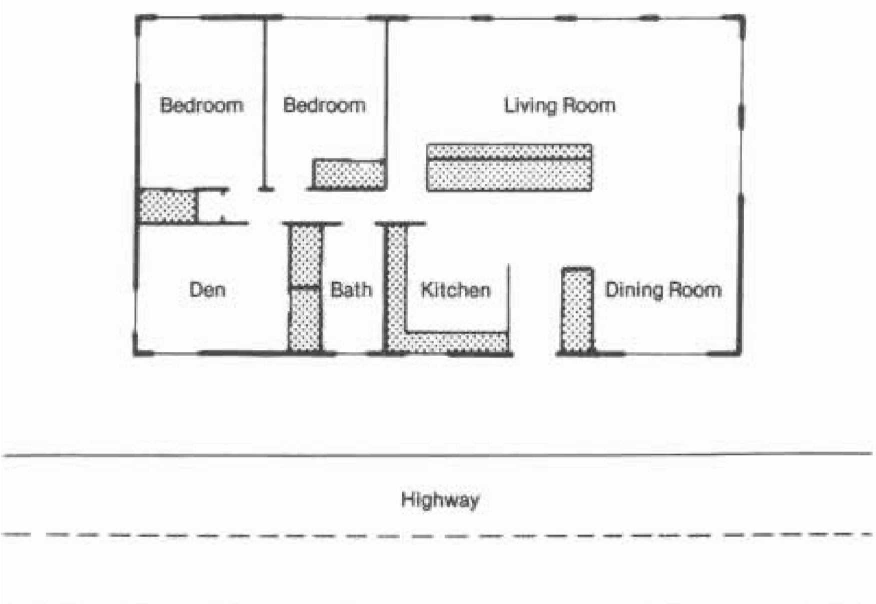


Figure 7
The Audible Landscape

Use of acoustical architectural design to reduce noise impacts on more noise sensitive living spaces



As pointed out earlier, the effectiveness of a barrier is determined in large part by its height and length. Some studies have shown that the effectiveness of a barrier can be reduced by as much as 50% if it isn't long enough. Again, the *Noise Assessment Guidelines* contain procedures for determining the effectiveness of barriers.

Incorporating Noise Attenuation Measures into the Building

If neither relocation or barriers is a reasonable noise attenuation option, the last resort is to incorporate noise attenuation measures into the buildings themselves. This is not considered the best solution because it leaves the outdoor areas, some of which may be for quiet recreation, exposed to high noise levels. But if development **must** take place and barriers are impossible, then the noise attenuation measures should be employed in building design and construction.

Without going into great technical detail, noise attenuation construction measures generally fall into four categories.

(1) Reducing the total area of windows or other acoustically weaker building elements

(2) Sealing off "leaks" around windows, doors, vents.

(3) Improving the actual sound attenuating properties of small building elements such as windows, doors, etc.

(4) Improving the actual sound attenuating properties of major building elements such as roof and wall construction.

In addition, noise attenuation in buildings can be provided by designing interior spaces so that "dead" spaces such as closets or corridors act as buffer zones (see Figure 7). And finally noise attenuation can be provided by reducing the need for open windows by providing air conditioning.

Many of the steps that would be taken to provide noise attenuation also help conserve energy. Good weatherstripping around windows and doors is one example. Another might be reducing window areas in walls if the noise source is to the north or west. Because many of these measures serve two purposes, they should not necessarily be considered a burdensome requirement but rather just good design and construction.

Information Resources

Publications

HUD Regulation 24 CFR Part 51 Subpart B – Noise Abatement and Control.

Noise Assessment Guidelines, HUD 1983, basic technical procedural resource.

Aircraft Noise Impact, HUD 1972, a bit dated but good overview of problem.

The Audible Landscape, DOT (FHWA) 1974, an excellent discusson of mitigation measures including land use planning and building design and construction.

Information on Levels of Environmental Noise Requisite to Protect Public health and Welfare With an Adequate margin of Safety, EPA, 1974. The "levels document" that explains basis for EPA standards.

Noise Barrier Design Handbook, Federal Highway Administration 1976. Good discussion of barriers, technical but readable.

Handbook of Noise Control, 2nd edition, 1979, McGraw Hill. A basic technical handbook covering all aspects of noise for those who wish to go into the subject further.

Experts

HUD environmental officers have been trained in the use of the *Noise Assessment Guidelines* and can help you work with them. Many architects are trained in acoustics and can help in development of noise attenuation strategies.

Quiz

Questions

1. Why is noise considered "unwanted sound"?
2. What is a community noise problem?
3. What are the three main contributors to a community noise problem?
4. What are the three components of a noise problem?
5. What are two key characteristics of the day-night average sound level descriptor system?
6. What are HUD's noise standards?
7. How do HUD's standards apply to CDBG recipients?
8. What are the three general mitigation measures available to HUD and the community and in what order of preference?
9. When are barriers effective and when are they not effective?
10. Describe how the *Noise Assessment Guidelines* can be used to determine appropriate mitigation measures.

Quiz

Answers

1. because it interferes with normal activities or causes physical or psychological damage
2. a community noise problem is where the combined effect of many individual sources creates an overall noise level that is unacceptable
3. highways, railroads and aircraft
4. the source, the path, the receiver
5. it is an average sound level and it can be used for all sources.
6. 65 L_{dn} or below: Acceptable
65 to 75 L_{dn}: Normally unacceptable, noise attenuation measures required,
above 75 L_{dn}: Unacceptable
7. CDBG recipients must take into consideration the standards in their planning and environmental review. If they expect to use HUD assistance later for housing or other noise sensitive activities the standards must be met for those activities.
8. 1st relocate noise sensitive uses
2nd reduce noise reaching receiver
3rd redesign buildings
9. barriers are effective for at or below ground level sources. Are not effective for aircraft overflights or most elevated sources
10. can be used to determine separation distance required for relocation and the height and length of barriers required

Chapter 2

The Noise Regulation

Introduction

The basic foundation for and structure of the HUD noise program is set out in the noise regulation, 24 CFR 51B. The regulation establishes the actual standards, assigns implementation responsibilities, describes review and approval procedures, and identifies special situations which may warrant waivers of procedures or standards. Therefore, the key to your understanding and implementation of the HUD noise program is a clear understanding of the regulation.

There is no way to escape the task of sitting down and simply reading the regulations, over and over until you thoroughly understand them. We have however done two things that will help you apply the regulations. First, for quick reference, we have prepared a list of the key sections in the regulation and second we have prepared an annotated copy of the regulation.

The list of key sections was prepared to help you find the specific section you need for a specific question or issue. While the regulation itself is not really long, an index is always useful. We caution you, however, against using the index to avoid learning the regulations. The list was prepared for your convenience in applying the regulation once you have come to understand it.

We prepared the annotated regulation because, try as we might, it was impossible to anticipate all the questions, implementation problems and special situations that might arise and to address them in the regulation. So, now that we have had a few years' experience with the regulation, we have gathered together the important questions, notes, second thoughts etc. and prepared this annotated regulation. We hope it will give you further insight into what the regulation means when it is applied in the field.

Key Sections in Noise Regulation

Section	Subject
51.101(a)(2)	Application of Policy to Block Grants
51.101(a)(3)	Policy for New Construction
51.101(a)(4)	Policy for Existing Construction
51.101(a)(5)	Policy for Modernization and Rehabilitation
51.101(a)(8)	The Exterior Noise Goal
51.101(a)(9)	The Interior Noise Goal
51.102(a)	Authority to Approve Projects
51.103(a)	Identification of DNL as *The* Noise Descriptor to be Used
51.103(b)	How to Measure Loud Impulsive Noises
51.103(c)	The Noise Standards
51.104(a)	Attenuation Requirements Discussed
51.104(b)(1)	Special Approval and Environmental Review Requirements for the Normally Unacceptable Zone
51.104(b)(2)	Special Approval and Environmental Review Requirements for the Unacceptable zone
51.105(a)	Flexibility for Non-acoustic Benefits Provisions
51.106(a)	How to Tell If Existing Data on Noise Are Acceptable
51.106(a)(4)	Specific Review and Approval Procedures For Airport Noise Contours
51.106(d)	When Noise Measurements May be Used Instead of Calculated Levels
51.106(f)	When to Give Credit for Proposed Barriers

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Part 51—Environmental Criteria and Standards

Subpart A—General Provisions

Authority: Sec. 7(d). Department of HUD Act (42 U.S.C. 3535(d)).

Subpart B—Noise Abatement and Control

§51.100 Purpose and authority.

(a) *Purpose.* The Department of Housing and Urban Development finds that noise is a major source of environmental pollution which represents a threat to the serenity and quality of life in population centers and that noise exposure may be a cause of adverse physiological and psychological effects as well as economic losses.

It is the purpose of this Subpart to:

(1) Call attention to the threat of noise pollution;

(2) Encourage the control of noise at its source in cooperation with other Federal departments and agencies;

(3) Encourage land use patterns for housing and other noise sensitive urban needs that will provide a suitable separation between them and major noise sources;

(4) Generally prohibit HUD support for new construction of noise sensitive uses on sites having unacceptable noise exposure;

(5) Provide policy on the use of structural and other noise attenuation measures where needed; and

(6) Provide policy to guide implementation of various HUD programs.

(b) *Authority.* Specific authorities for noise abatement and control are contained in:

(1) The Noise Control Act of 1972 (Pub. L. 92-574) which directs Federal agencies to administer their programs in ways which reduce noise pollution.

(2) The Quiet Communities Act of 1978 (Pub. L. 95-609) which amended Pub. L. 92-574.

(3) The General Services Administration, Federal Management Circular 75-2: *Compatible Land Uses at Federal Airfields* prescribes the Executive Branch's general policy with respect to achieving compatible land uses on either public or privately owned property at or in the vicinity of Federal airfields.

(4) Section 1113 of the Housing and Urban Development Act of 1965 (Pub. L. 89-117) directs the Secretary "* * * to determine feasible methods of reducing the economic loss and hardships suffered by homeowners as a result of the depreciation in the value of their properties following the construction of airports in the vicnity of their homes, including a study of feasible methods of insulating such homes from the noise of aircraft."

This regulation replaces HUD Circular 1390.2, Noise Abatement and Control, 1971, which is now cancelled, along with all instructions and clarifying memoranda pertaining to the circular.

§51.101 General policy.

(a) It is HUD's general policy to provide minimum national standards applicable to HUD programs to protect citizens against excessive noise in their communities and places of residence.

(1) *Comprehensive planning assistance.* HUD requires that grantees give adequate consideration to noise exposures and sources of noise as an integral part of the urban environment in HUD assisted comprehensive planning, as follows:

(i) Particular emphasis shall be placed on the importance of compatible land use planning in relation to airports, highways and other sources of high noise.

(ii) Applicants shall take into consideration HUD environmental standards impacting the use of land as required in 24 CFR Part 600.

(iii) Environmental studies, including noise assessments, are allowable costs.

(2) *Community Development Block Grants.* Recipients of community development block grants under the Housing and Community Development Act of 1974 (Pub. L. 93-383), as amended by the Housing and Community Development Act of 1977 (Pub. L. 95-128), must take into

consideration the noise criteria and standards in the environmental review process and consider ameliorative actions when noise sensitive land development is proposed in noise exposed areas. Grant recipients shall address deviations from the standards in their environmental reviews as required in 24 CFR Part 58.

Where CDBG activities are planned in a noisy area, and HUD assistance is contemplated later for housing and/or other noise sensitive activities, the CDBG grantee risks denial of the HUD assistance unless the HUD standards are met. Environmental studies, including noise assessments, are allowable costs.

(3) *HUD support for new construction.* HUD assistance for the construction of new noise sensitive uses is prohibited generally for projects with Unacceptable noise exposures and is discouraged for projects with Normally Unacceptable noise exposure. (Standards of acceptability are contained in §51.103(c).) This policy applies to all HUD programs providing assistance, subsidy or insurance for housing, college housing, mobile home parks, nursing homes, hospitals, and all programs providing assistance or insurance for land development, new communities, redevelopment or any other provision of facilities and services which are directed to make land available for housing or noise sensitive development. The policy does not apply to research demonstration projects which do not result in new construction or reconstruction, flood insurance, interstate land sales registration, or any action or emergency assistance under disaster assistance programs which are provided to save lives, protect property, protect public health and safety, remove debris and wreckage, or assistance provided that has the effect of restoring facilities substantially as they existed prior to the disaster.

(4) *HUD support for existing construction.* Noise exposure by itself will not result in the denial of HUD support for the resale and purchase of otherwise acceptable existing buildings. However, environmental noise is a marketability factor which HUD will consider in determining the amount of insurance or other assistance that may be given.

Existing construction means units which are either more than 1 year old or for which this is the second or subsequent purchaser.

The old definition of major or substantial rehabilitation and modernization as being any project where cost is 75% or more of replacement cost no longer applies. Now the criteria contained in individual program guidance applies.

(5) *HUD support of modernization and rehabilitation.* For modernization projects located in all noise exposed areas, HUD shall encourage noise attenuation features in alterations. For major or substantial rehabilitation projects in the Normally Unacceptable and Unacceptable noise zones, HUD actively shall seek to have project sponsors incorporate noise attenuation features, given the extent of the rehabilitation being undertaken and the level of exterior noise exposure. In Unacceptable noise zones, HUD shall strongly encourage conversion of noise-exposed sites to land uses compatible with the high noise levels.

(6) *Research, guidance and publications.* HUD shall maintain a continuing program designed to provide new knowledge of noise abatement and control to public and private bodies, to develop improved methods for anticipating noise encroachment, to develop noise abatement measures through land use and building construction practices, and to foster better understanding of the consequences of noise. It shall be HUD's policy to issue guidance documents periodically to assist HUD personnel in assigning an acceptability category to projects in accordance with noise exposure standards, in evaluating noise attenuation measures, and in advising local agencies about noise abatement strategies. The guidance documents shall be updated periodically in accordance with advances in the state-of-the-art.

(7) *Construction equipment, building equipment and appliances.* HUD shall encourage the use of quieter construction equipment and methods in population centers, the use of quieter equipment and appliances in buildings, and the use of appropriate noise abatement techniques in the design of residential structures with potential noise problems.

(8) *Exterior noise goals.* It is a HUD goal that exterior noise levels do not exceed a day-night average sound level of 55 decibels. This level is recommended by the Environmental Protection Agency as a goal for outdoors in residential areas. The levels recommended by EPA are not standards and do not take into account cost or feasibility. For the purposes of this regulation and to meet other program objectives, sites with a day-night average sound level of 65 and below are acceptable and are allowable (see Standards in §51.103(c)).

(9) *Interior noise goals.* It is a HUD goal that the interior auditory environment shall not exceed a day-night average sound level of 45 decibels. Attenuation measures to meet these interior goals shall be employed where feasible. Emphasis shall be given to noise sensitive interior spaces such as bedrooms. Minimum attenuation requirements are prescribed in §51.104(a).

(10) *Acoustical privacy in multifamily buildings.* HUD shall require the use of building design and acoustical treatment to afford acoustical privacy in multifamily buildings pursuant to requirements of the Minimum Property Standards.

§51.102 Responsibilities.

(a) *Authority to approve projects.* (1) Decisions on proposed projects with acceptable noise exposures shall be delegated to the program personnel within field offices, including projects where increased noise levels are considered acceptable because of non-acoustic benefits under §51.105(a). Field office program personnel may also approve projects in normally unacceptable noise exposed areas where adequate sound attenuation is provided and where the project does not require an Environmental Impact Statement under §51.104(b).

(2) Other approvals in normally unacceptable noise exposed areas require the concurrence of the Regional Administrator.

(3) Requests for approvals of projects or portions of projects with unacceptable noise exposures shall be referred through the Regional Office to the Assistant Secretary for Community Planning and Development for approval pursuant to §51.104(b).

The Noise Control Act of 1972 required EPA to "publish information on the levels of environmental noise. . .which. . .are requisite to protect the public health and welfare with an adequate margin of safety." EPA has interpreted this to mean that the levels should not reflect technical feasibility or economic costs. "Health and welfare" is defined as being "complete physical, mental and social well-being and not merely the absence of disease and infirmity."

(4) In cases where the Regional Administrator determines that an important precedent or issue is involved, such cases shall be referred with recommendations to the Assistant Secretary for Community Planning and Development.

(b) *Surveillance of noise problem areas.* Appropriate field staff shall maintain surveillance of potential noise problem areas and advise local officials, developers, and planning groups of the unacceptability of sites because of noise exposure at the earliest possible time in the decision process. Every attempt shall be made to insure that applicants' site choices are consistent with the policy and standards contained herein.

(c) *Notice to applicants.* At the earliest possible stage, HUD program administrators shall:

(1) Determine the suitability of the acoustical environment of proposed projects;

(2) Notify applicants of any adverse or questionable situations; and

(3) Assure that prospective applicants are apprised of the standards contained herein so that future site choices will be consistent with these standards.

(d) *Technical assistance.* Technical assistance in the measurement, estimation, interpretation, or prediction of noise exposure is available from the Office of Community Planning and Development and the Office of Policy Development and Research. Field office questions shall be forwarded through the Regional Office to the Assistant Secretary for Community Planning and Development or his designee.

(e) *Interdepartmental coordination.* Regional Administrators shall foster appropriate coordination between field offices and other departments and agencies, particularly the Environmental Protection Agency, the Department of Transportation, Department of Defense representatives, and the Veterans Administration. HUD staff shall utilize the acceptability standards in commenting on the prospective impacts of transportation facilities and other noise generators in the Environmental Impact Statement review process.

§51.103 Criteria and standards.

These standards apply to all programs as indicated in §51.101.

(a) *Measure of external noise environments.* The magnitude of the external noise environment at a site is determined by the value of the day-night average sound level produced as the result of the accumulation of noise from all sources contributing to the external noise environment at the site. Day-night average sound level, abbreviated as DNL and symbolized as L_{dn}, is the 24-hour average sound level, in decibels, obtained after addition of 10 decibels to sound levels in the night from 10 p.m. to 7 a.m. Mathematical expressions for average sound level and day-night average sound level are stated in the Appendix.

(b) *Loud impulsive sounds.* On an interim basis, when loud impulsive sounds, such as explosions or sonic booms, are experienced at a site, the day-night average sound level produced by the loud impulsive sounds alone shall have 8 decibels added to it in assessing the acceptability of the site (see Appendix). Alternatively, the C-weighted day-night average sound level (L_{Cdn}) may be used without the 8 decibel addition, as indicated in Section 51.106(a)(3).

Methods for assessing the contribution of loud impulsive sounds to day-night average sound level at a site and mathematical expressions for determining whether a sound is classed as "loud impulsive" are provided in the Appendix.

(c) *Exterior standards.* The degree of acceptability of the noise environment at a site is determined by the sound levels external to buildings or other facilities containing noise sensitive uses. The standards shall usually apply at a location 2 meters (6.5 feet) from the building housing noise sensitive activities in the direction of the predominant noise source. Where the building location is undetermined, the standards shall apply 2 meters (6.5 feet) from the building setback line nearest to the predominant noise source. The standards shall also apply at other locations where it is determined that quiet outdoor space is required in an area ancillary to the principal use on the site.

The noise environment inside a building is considered acceptable if (a) the noise environment external to the building complies with these standards, and (b) the building is constructed in a manner common to the area or, if of uncommon construction, has at least the equivalent noise attenuation characteristics.

This is because the reverberation effect of sound waves hitting the wall will increase the noise levels at the site. You won't pick this up unless you back off from the wall to measure.

Site Acceptability Standards

	Day-night average sound level (in decibels)	Special approvals and requirements
Acceptable	Not exceeding 65 dB(1)	None
Normally Unacceptable	Above 65 dB but not exceeding 75 dB	Special Approvals (2) Environmental Review (3) Attenuation (4)
Unacceptable	Above 75 dB	Special Approvals (2) Environmental Review (3) Attenuation (5)

Notes.—(1) Acceptable threshold may be shifted to 70 dB in special circumstances pursuant to Section 51.105(a)

(2) See Section 51.104(b) for requirements.

(3) See Section 51.104(b) for requirements.

(4) 5 dB additional attenuation required for sites above 65 dB but not exceeding 70 dB and 10 dB additional attenuation required for sites above 70 dB but not exceeding 75 dB. (See Section 51.104(a).)

(5) Attenuation measures to be submitted to the Assistant Secretary for CPD for approval on a case-by-case basis.

§51.104 Special requirements.

(a) *Noise attenuation.* Noise attenuation measures are those required in addition to attenuation provided by buildings as commonly constructed in the area, and requiring open windows for ventilation. Measures that reduce external noise at a site shall be used wherever practicable in preference to the incorporation of additional noise attenuation in buildings. Building designs and construction techniques that provide more noise attenuation than typical construction may be employed also to meet the noise attenuation requirements.

(1) *Normally Unacceptable noise zone.* Approvals in this zone require a minimum of 5 decibels additional sound attenuation for buildings having noise-sensitive uses if the day-night average sound level is greater than 65 decibels but does not exceed 70 decibels, or a minimum of 10 decibels of additional sound attenuation if the day-night average sound level is greater than 70 decibels but does not exceed 75 decibels.

(2) *Unacceptable noise zone.* Noise attenuation measures require the approval of the Assistant Secretary for Community Planning and Development (See §51.104(b)(2).)

(b) *Special Approvals and Environmental Review Requirements.* Environmental clearances shall be conducted pursuant to the requirements of HUD's Departmental Policies, Responsibilities and Procedures for Protection and Enhancement of Environmental Quality (38 FR 19182 as amended) or other environmental regulations which may be issued by the Department. The Special Clearance and Environmental Impact Statement (EIS) threshold requirements are hereby modified for all projects proposed in the Normally Unacceptable and Unacceptable noise exposure zones as follows:

(1) *Normally Unacceptable noise zone.* (i) All projects located in the Normally Unacceptable Noise Zone require a Special Environmental Clearance except an EIS is required for a proposed project located in a largely undeveloped area, or where the HUD action is likely to encourage the establishment of incompatible land use in this noise zone.

Berms and barriers are our first choice because they provide protection for yards, playgrounds, etc. Since outdoor activity is often very important to residents we want to protect the outdoor areas as much as possible.

By definition a barrier must be separate from the building or area it is providing attenuation for. After all barriers are preferred because they improve exterior as well as interior levels. Non-noise sensitive buildings can, however, be used as barriers for noise sensitive buildings or exterior areas.

Assumption is that standard construction provides an average of 20 L_{dn} attenuation. At 65 L_{dn} or below this amount of attenuation would be sufficient to meet interior level of 45 L_{dn}. Additional requirements are designed to meet this goal even when exterior noise levels are higher.

Substitute Environmental Assessment (with ECO concurrence) wherever you see Special Clearance.

(ii) When an EIS is required, the concurrence of the Regional Administrator is also required before a project can be approved. For the purposes of this paragraph, an area will be considered as largely undeveloped unless the area within a 2-mile radius of the project boundary is more than 50 percent developed for urban uses and infrastructure (particularly water and sewers) is available and has capacity to serve the project.

(iii) All other projects in the Normally Unacceptable zone require a Special Environmental Clearance, except where an EIS is required for other reasons pursuant to HUD environmental policies.

(2) *Unacceptable noise zone.* An EIS is required prior to the approval of projects with unacceptable noise exposure. Projects in or partially in an Unacceptable Noise Zone shall be submitted through the Regional Administrator to the Assistant Secretary for Community Planning and Development for approval. The Assistant Secretary may waive the EIS requirement in cases where noise is the only environmental issue and no outdoor sensitive activity will take place on the site. In such cases, a Special Environmental Clearance is required.

When the area in question is in a small community outside an SMSA and the application of the 2 mile radius rule would be unreasonable, an area can be considered largely developed if it is contiguous to existing development and infrastructure is available and has capacity to serve the project. The Assistant Secretary will review them on a case-by-case basis. In all other cases the 2 mile radius/50% rule still applies.

Caution—every effort should be made to get official contours—particularly for military installations and large air carrier airports rather than trying to use the *Noise Assessment Guidelines.*

§51.105 Exceptions.

(a) *Flexibility for non-acoustic benefits.* Where it is determined that program objectives cannot be achieved on sites meeting the acceptability standard of 65 decibels, the Acceptable Zone may be shifted to L_{dn} 70 on a case-by-case basis if all the following conditions are satisfied:

(1) The project does not require an Environmental Impact Statement under provisions of section 104(b)(1) and noise is the only environmental issue.

(2) The project has received a Special Environmental Clearance and has received the concurrence of the Environmental Clearance Officer.

(3) The project meets other program goals to provide housing in proximity to employment, public facilities and transportation.

(4) The project is in conformance with local goals and maintains the character of the neighborhood.

(5) The project sponsor has set forth reasons, acceptable to HUD, as to why the noise attenuation measures that would normally be required for new construction in the L_{dn} 65 to L_{dn} 70 zone cannot be met.

What this really means is that the 5db attenuation requirement for the 65–70 L_{dn} zone is waived. Primarily intended for urban areas where alternative sites are not available. Note that *all* conditions must be met.

These requirements are very important. Be careful with design hour values.

(6) Other sites which are not exposed to noise above L_{dn} 65 and which meet program objectives are generally not available.

The above factors shall be documented and made part of the project file.

§51.106 Implementation.

(a) *Use of available data.* HUD field staff shall make maximum use of noise data prepared by others when such data are determined to be current and adequately projected into the future and are in terms of the following:

(1) *Sites in the vicinity of airports.* The noise environment around airports is described sometimes in terms of Noise Exposure Forecasts, abbreviated as NEF or, in the State of California, as Community Noise Equivalent Level, abbreviated as CNEL. The noise environment for sites in the vicinity of airports for which day-night average sound level data are not available may be evaluated from NEF or CNEL analyses using the following conversions to DNL:

$DNL \approx NEF + 35$
$DNL \approx CNEL$

(2) *Sites in the vicinity of highways.* Highway projects receiving Federal aid are subject to noise analyses under the procedures of the Federal Highway Administration.

Where such analyses are available they may be used to assess sites subject to the requirements of this standard. The Federal Highway Administration employs two alternate sound level descriptors: (a) The A-weighted sound level not exceeded more than 10 percent of the time for the highway design hour traffic flow, symbolized as L_{10}; or (b) the equivalent sound level for the design hour, symbolized as L_{eq}. The day-night average sound level may be estimated from the design hour L_{10} or L_{eq} values by the following relationships, provided heavy trucks do not exceed 10 percent of the total traffic flow in vehicles per 24 hours and the traffic flow between 10 p.m. and 7 a.m. does not exceed 15 percent of the average daily traffic flow in vehicles per 24 hours:

$DNL \approx L_{10}$ (design hour)—3 decibels
$DNL \approx L_{eq}$ (design hour) decibels

Where the auto/truck mix and time of day relationships as stated in this Section do not exist, the HUD Noise Assessment Guidelines or other noise analysis shall be used.

(3) *Sites in the vicinity of installations producing loud impulsive sounds.* Certain Department of Defense installations produce loud impulsive sounds from artillery firing and bombing practice ranges. Noise analyses for these facilities sometimes encompass sites that may be subject to the requirements of this standard. Where such analyses are available they may be used on an interim basis to establish the acceptability of sites under this standard.

The Department of Defense uses day-night average sound level based on C-weighted sound level, symbolized L_{Cdn}, for the analysis of loud impulsive sounds. Where such analyses are provided, the 8 decibel addition specified in 51.103(b), is not required, and the same numerical values of day-night average sound level used on an interim basis to determine site suitability for non-impulsive sounds apply to the L_{Cdn}.

(4) *Use of areawide acoustical data.* HUD encourages the preparation and use of areawide acoustical information, such as noise contours for airports. Where such new or revised contours become available for airports (civil or military) and military installations they shall first be referred to the Regional Office (Environmental Clearance Officer) for review, evaluation and decision on appropriateness for use by HUD. The Regional Office shall submit revised contours to the Assistant Secretary of Community Planning and Development for review, evaluation and decison whenever the area affected is changed by 20 percent or more, or whenever it is determined that the new contours will have a significant effect on HUD programs, or whenever the contours are not provided in a methodology acceptable under §51.106(a)(1) or in other cases where the Regional Office determines that Headquarters review is warranted. For other areawide acoustical data, review is required only where existing areawide data are being utilized and where such data have been changed to reflect changes in the measurement methodology or underlying noise source assumptions.

Contours for future noise levels based on new construction, mission changes etc. which become available as part of the Environmental Impact Statement process shall not be used until the NEPA process is complete and a decision on the proposed action is made.

When new or revised contours are approved, make sure all interested people in local area are informed that HUD will be using different contours. Make a special effort to inform the most active developers in area or developers who have worked with HUD before.

This is also required for noise studies for developers by consultants, whether to provide original data, or to contest existing data or a HUD analysis. It is particularly important to make sure the same traffic, vehicle or operational data were used for each study, when one study is being contested.

Requests for determination on usage of new or revised areawide data shall include the following:

(i) Maps showing old, if applicable, and new noise contours, along with brief description of data source and methodology.

(ii) Impact on existing and prospective urbanized areas and on development activity.

(iii) Impact on HUD-assisted projects currently in processing.

(iv) Impact on future HUD program activity. Where a field office has determined that immediate approval of new areawide data is necessary and warranted in limited geographic areas, the request for approval should state the circumstances warranting such approval. Actions on proposed projects shall not be undertaken while new areawide noise data are being considered for HUD use except where the proposed location is affected in the same manner under both the old and new noise data.

(b) *Site assessments.* Compliance with the standards contained in §51.103(c) shall, where necessary, be determined using noise assessment guidelines, handbooks, technical documents and procedures issued by the Department.

(c) *Variations in site noise levels.* In many instances the noise environment will vary across a site, with portions of the site being in an Acceptable noise environment and other portions in a Normally Unacceptable noise environment. The standards in §51.103(c) shall apply to the portions of a building or buildings used for residential purposes and for ancillary noise sensitive open spaces.

(d) *Noise measurements.* Where noise assessments result in a finding that the site is borderline or questionable, or is controversial, noise measurements may be performed. Where it is determined that noise measurements are required, such measurements will be conducted in accordance with methods and measurement criteria established by the Department. Locations for noise measurements will depend on the location of noise sensitive uses that are nearest to the predominant noise source (see §51.103(c)).

(e) *Projections of noise exposure.* In addition to assessing existing exposure, future conditions should be projected. To the extent possible, noise exposure shall be projected to be representative of conditions that are expected to exist at a time at least 10 years beyond the date of the project or action under review.

When projections for airports are based on new construction or similar actions the likelihood that such major action will actually take place should be carefully evaluated. This is particularly important if local funding is required. Check to see if initial actions such as land purchases, bonds etc. been taken. If projections are just based on expanded traffic levels make sure they are reasonable for the area. Projections for smaller communities are often overly optimistic.

(f) *Reduction of site noise by use of berms and/or barriers.* If it is determined by adequate analysis that a berm and/or barrier will reduce noise at a housing site, and if the barrier is existing or there are assurances that it will be in place prior to occupancy, the environmental noise analysis for the site may reflect the benefits afforded by the berm and/or barrier.

In the environmental review process under §51.104(b), the location height and design of the berm and/or barrier shall be evaluated to determine its effectiveness, and impact on design and aesthetic quality, circulation and other environmental factors.

This provision should be used with caution. Very clear and strong assurances that berms or barriers will be constructed should be obtained in writing before approval.

Again also note that by definition a barrier must be physically separate from the building or area it is providing attenuation for.

The *Noise Assessment Guidelines* contain procedures for evaluating barrier effectiveness.

Appendix to Subpart B—definition of acoustical quantities

1. *Sound Level.* The quantity in decibels measured with an instrument satisfying requirements of American National Standard Specification for Type 1 Sound Level Meters S1.4–1971. Fast time-averaging and A-frequency weighting are to be used, unless others are specified. The sound level meter with the A-weighting is progressively less sensitive to sounds of frequency below 1,000 hertz (cycles per second), somewhat as is the ear. With fast time averaging the sound level meter responds particularly to recent sounds almost as quickly as does the ear in judging the loudness of a sound.

(2) *Average Sound Level.* Average sound level, in decibels, is the level of the mean-square A-weighted sound pressure during the stated time period, with reference to the square of the standard reference sound pressure of 20 micropascals.

$$L_{dn} = 10 \log_{10} \left[\frac{1}{86400} \left(\int_{0000}^{0700} 10^{[L_A(t) + 10]/10} \, dt + \int_{0700}^{2200} 10^{L_A(t)/10} \, dt + \int_{2200}^{2400} 10^{[L_A(t) + 10]/10} \, dt \right) \right]$$

Time t is in seconds, so the limits shown in hours and minutes are actually interpreted in seconds. $L_A(t)$ is the time varying value of A-weighted sound level, the quantity in decibels measured by an instrument satisfying requirements of American National Standard Specification for Type 1 Sound Level Meters S1.4-1971.

3. *Loud Impulsive Sounds.* When loud impulsive sounds such as sonic booms or explosions are anticipated contributors to the noise environment at a site, the contribution to day-night average sound level produced by the loud impulsive sounds shall have 8 decibels added to it in assessing the acceptability of a site.

A loud impulsive sound is defined for the purpose of this regulation as one for which:

(i) The sound is definable as a discrete event wherein the sound level increases to a maximum and then decreases in a total time interval of approximately one second or less to the ambient background level that exists without the sound; and

(ii) The maximum sound level (obtained with slow averaging time and A-weighting of a Type 1 sound level meter whose characteristics comply with ANSI S1.4-1971) exceeds the sound level prior to the onset of the event by at least 6 decibels; and

(iii) The maximum sound level obtained with fast averaging time of a sound level meter exceeds the maximum value obtained with slow averaging time by at least 4 decibels.

Issued at Washington, D.C., on July 5, 1979.

Patricia Roberts Harris,
Secretary of Housing and Urban Development.

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Quiz on the Noise Regulations

Questions

1. What is the HUD policy on support for existing constructon in high noise areas?
2. What is the definition of "major or substantial rehabilitation"?
3. What is HUD's Interior noise goal?
4. What project approval authority does the Field Office have?
5. Who approves projects in the Unacceptable Zone?
6. What noise descriptor is used to express noise levels in the regulation?
7. How are loud impulsive sounds to be evaluated?
8. At what point on a building's exterior are sound levels to be determined?
9. What is the basic assumption behind the attenuation levels required?
10. What type of attenuation measures are preferred?
11. When should building attenuation measures be considered?
12. When are EIS's required?
13. When is an area considered "largely undeveloped"?
14. What is "Flexibility for Non-Acoustic Benefits"?
15. Six conditions are listed for waiving the attenuation requirement under the Flexibility for Non-Acoustic Benefits provision, how many must be met for the waiver to be granted?
16. Who has the authority to grant the attenuation requirements waiver under the "flexibility" provision?
17. What noise descriptors other than DNL are acceptable for aircraft noise contours?
18. Who normally approves areawide noise data such as airport noise contours?
19. If a site is partially in the Unacceptable Zone and partially in the Normally Unacceptable Zone, which review and approval procedures apply?
20. When should noise measurements be used in lieu of areawide data or *Noise Assessment Guidelines* calculations?

Quiz on the Noise Regulations

Answers

1. Noise exposure can not, by itself, be the basis for denying support for resale and purchase of existing buildings. (Section 51.101(a)(4))
2. "Major or substantial rehabilitation" is defined in individual program guidance. There is no single definition. (51.101(a)(5) marginal note)
3. 45 L_{dn} (Section 51.101(a)(9))
4. projects in Acceptable Zone; also projects in Normally Unacceptable Zone provided that
   - adequate sound attenuation is provided
   - no EIS is required

   (Section 51.102(a)(1))
5. The Assistant Secretary for Community Planning and Development. (Section 51.102(A)(3) and 51.104(b))
6. The day night average sound level system (DNL). (Section 51.103(a))
7. Two ways:
   - If plain DNL levels have been calculated or measured, add a 8 decibel penalty.
   - Alternatively, the C weighted day night average sound level system (L_{Cdn}) can be used as is.

   (Section 51.103(b))
8. Two meters (6.5 feet) away from the building exterior, moving towards the predominant noise source. (Section 51.103(c))
9. That current construction practices provide about 20 db attenuation. Thus in a 65 L_{dn} or lower area the interior goal of 45 L_{dn} would be met with standard construction. The additional attenuation required is the increment over that provided by standard construction necessary to achieve the interior goal of 45 L_{dn}. (Section 51.104(a) marginal note)
10. Measures which reduce **exterior** noise levels. (51.104(a))
11. Only after it has been determined that berms and barriers or site redesign are not practical alternatives. (Section 51.104(a))
12. When the project is located in the Unacceptable Zone or the project is located in a largely undeveloped area and the project is in the Normally Unacceptable Zone. (Section 51.104(b))
13. When the area within a 2 mile radius of the project is less than 50% developed for urban uses and infrastructure is not in place and available to serve the project. (Section 51.104(b)(1)(ii))
14. A provision in the regulations which allows the attenuation requirements for the 65-70 L_{dn} zone to be waived. (Section 51.105(a) and marginal note)
15. **All** six conditions must be met. (Section 51.105(a))
16. The field office. (Section 51.102(a))
17. NEF and CNEL. (Section 51.106(a)(1))
18. The Regional Office. (Section 51.106(a)(4))
19. The review and approval procedures for projects in the Unacceptable Zone apply. (Section 51.104(b)(2))
20. Only when the noise assessment indicates that the site is on the borderline between Acceptable and Unacceptable, or when the site is controversial. (Section 51.106(d))

Chapter 3

Major Policy and Implementation Questions Related to the Noise Regulation

As regulations are applied in the field, it is inevitable that questions will arise. It is, after all, very difficult to anticipate every situation when preparing a regulation. Sometimes the questions relate to specific and unique situations of limited interest to anyone but the office involved. Other questions, however, raise issues of more general concern. In this section we have brought together the most important and most relevant questions that have arisen since the noise regulation went into effect in August of 1979. We have used a question and answer format for your convenience.

The following are the topics included:

1. Noise projections for civil airports
2. Definition of infill for small towns
3. Areawide EIS waivers
4. Requirements for modernization and rehabilitation projects
5. Use of berms and barriers as attenuation measures
6. New and revised airport noise contours

Questions and Answers

1. How valid and useful are civil airport noise projections that show significant reductions in the amount of land exposed to high noise levels? Should we be suspicious?

Contours that show significant reductions in the area exposed to high noise levels may seem questionable, but, according to the Environmental Protection Agency, they may be quite accurate. The EPA does expect to see some significant reductions in the number of people exposed to high levels of aircraft noise over the next 15 years. In their report *Aviation Noise: The Next Twenty years*, EPA stated that they expected to see the number of people exposed to levels of 65 Ldn or greater to drop from a 1975 figure of 5,550,000 to about 2,650,000 in the year 2000. Much of this reduction would occur during the period 1980–1985 with more modest decreases thereafter. The reductions are expected to result from the Federal Aviation Administration's current noise certification requirements, even with up to 100% increases in aircraft operations. (Current certification requirements are for all new aircraft to achieve stage three noise levels and all older aircraft to achieve stage two levels by 1985. Progress has been good in meeting these requirements.)

In general then, you should not be surprised to see significant reductions in contour size if the following conditions are met:

• the decrease in size is no more than 50%;
• the increase in operations is no more than 100%; and
• FAR stage 3 aircraft, such as the B757 and B767, are included in the fleet mix, but not to the total exclusion of all other aircraft.

Assuming that the contours are otherwise technically correct, significantly smaller contours should be acceptable.

2. Many small towns aren't big enough for a project to meet the definition of infill contained in section 51.104 (b)(1)(ii). However, a project located in the heart of town can hardly be considered to be in a largely undeveloped area. Must an EIS be prepared?

Not necessarily. If the jurisdiction in which the project is located is not part of a standard metropolitan area, a project may be considered infill if it is within or contiguous to the already developed area and infrastructure (particularly water and sewer) is available and has the capacity to serve the project. It must also be clear that the project will not encourage the establishment of other incompatible land uses in the normally unacceptable noise zone.

If you believe a project meets these criteria, submit documentation to the Office of Environment and Energy for their review and determination.

3. What can we do to reduce the procedural burden when, for a variety of reasons, the Department expects to be considering a number of projects in an unacceptable noise zone? Most of the projects would probably qualify for an EIS waiver, but how can we avoid filling repetitive, individual requests?

While the number of cases where the Department would be seriously considering a number of projects exposed to unacceptable noise levels in the same jurisdiction is likely to be limited, there is an alternative to individual processing in those situations. The alternative is to issue an areawide waiver for the entire affected jurisdiction. Such a waiver can be useful when the unacceptable noise zone heavily impacts a substantially developed community with limited site alternatives. (In most cases we would expect that the noise source would be aircraft, but in very small towns it is possible that a heavily used rail line could create a large unacceptable noise zone.)

An areawide EIS waiver would, of course, have to have a more detailed environmental assessment than an individual project request, and there are other special processing steps.

But if you have a situation where you think the Department has a good reason to expect to process a number of projects within the unacceptable noise zone, there is an alternative to individual EIS waivers. Contact the Office of Environment and Energy for details on how to request the areawide waiver.

4. What exactly are the processing requirements and general policies for modernization and rehabilitation projects? Does secton 51.104 apply to them as well as to new construction? The noise regulation is a bit confusing on this.

Yes, the noise regulation is a bit confusing on this question. We have seen several instances where field offices have mistakenly applied the provisions of Section 51.104 to modernization and rehabilitation projects. We believe that this happens because section 51.104 is not as clearly titled as it might have been. It would be better if it read "special requirements for new construction" rather than simply "special requirements".

The only parts of the regulation that apply to modernization and rehabilitation projects are sections 51.101 (a)(5) and the definitions of normally unacceptable and unacceptable noise zones contained in the table in section 51.103. None of the other proessing or policy provisions of the table or of sections 51.102 and 51.104 apply. Therefore:

- modernization and rehabilitation projects are to be processed by the field offices regardless of the noise zone.
- EIS's are not required for modernization and rehabilitation projects unless mandated by other applicable environmental regulations.

You must however continue to encourage attenuation features in modernization and rehabilitation projects, in accordance with the general policy stated in section 51.101(a)(5).

5. We know that berms and barriers are the preferred type of noise attenuation because of the protection they provide for outdoor living areas, but we need some further guidance on when they are really the best choice.

While barriers can be an effective noise attenuation technique, they must, indeed, be used with caution and common sense because they can create more problems than they solve. Very high noise barriers can create significant aesthetic and financial problems relative to the noise benefit to be achieved. Barriers can block light, hinder natural ventilation, create an unpleasant sense of being walled in, and can be very unattractive. In addition, barriers do require continuing maintenance and can be very costly to build.

It is important to remember that the noise regulation says that "measures that reduce external noise at a site shall be used **wherever practicable**." Is it practicable to propose a 20 foot high barrier only 15 feet from the rear of a two-story building? Granted it would certainly protect the building from noise, but what about the blocked light, the reduced ventilation, the visual impact, and the cost? The purpose of a barrier is primarily to reduce the noise levels in those outdoor areas that people use. The secondary purpose is to reduce the need for structural attenuation. Therefore, the barrier should only be as high as is necessary to protect those areas. Structural attenuation should be required for the parts of the building not protected by the barrier. And if there aren't any outdoor areas where low noise levels are important, barriers shouldn't be required unless they would be more cost effective than building attenuation measures.

6. What should we be doing once we have processed new or revised aircraft noise contours and they have been approved for use?

The most important thing you can do once new or revised aircraft noise contours have been approved for use is to tell the people who are most likely to be affected by the change. If you have a newsletter that you regularly publish, that is one way to get the word out. At the very least you should specifically notify the affected jurisdictions and the builders/developers who are known to be active in the vicinity of the noise impacted areas. Make sure you notify builders and developers who have large scale projects that you have been processing in sections. Go back and check your files to find them. Even though you should have done an overall environmental review of the project at the time the first section was submitted, the approval of individual sections is dependent on the noise levels at the time that section is submitted.

Chapter 4

Noise Attenuation

Introducton

HUD's noise policy (24 CFR 51B) clearly requires that noise attenuation measures be provided when proposed projects are to be located in high noise areas. The requirements set out in Section 51.104(a) are designed to insure that interior levels do not exceed the 45 L_{dn} level established as a goal in Section 51.101(a)(9). Thus, in effect, if the exterior noise level is 65 L_{dn} to 70 L_{dn}, 25 db of noise attenuation must be provided; if the exterior noise level is between 70 and 75 L_{dn}, then 30 db of attenuation is required. Likewise, for projects proposed for areas where noise levels exceed 75 L_{dn}, sufficient attenuaton must be provided to bring interior levels down to 45 L_{dn} or below.

There are three basic ways to provide the noise attenuation required:

1. the use of barriers or berms
2. site design
3. acoustical construction

Of these, only the first two provide any improvement in the exterior environment. Because HUD considers a quiet exterior environment to be important, we prefer the use of those measures that reduce exterior levels as well as interior levels. The use of acoustical construction by itself is, therefore, the least preferred alternative since it only affects the interior levels. While we recognize that in many cases barriers or site design cannot provide all the attenuation necessary, you should combine them with acoustical construction whenever possible.

Your responsibility as a HUD staff member is to:

- make sure the project sponsor or developer is aware of the attenuation requirements for the project.
- make the sponsor aware of the options available

and

- review attenuation proposals to make sure they are adequate.

While it is not your responsibility to provide detailed design assistance to the sponsor or developer, you should know enough about the attenuation options to give him or her a basic understanding of what must be done. In many cases, you may be able to reassure the sponsor or developer that the necessary attenuation can be achieved through the use of common construction techniques or materials. Or you may be able to point out how a simple site design change can achieve the desired result without additional cost.

The following sections are designed to provide you with the information you will need to fulfill your responsibilities. Each attenuation approach is discussed both in terms of basic concepts and in terms of what to look for in reviewing attenuation proposals. The discussion does assume that you have a working knowledge of the *Noise Assessment Gujidelines*. If you have not worked with the *Guidelines* before or not recently you may want to go back and review them, particularly the section on calculating the effects of barriers.

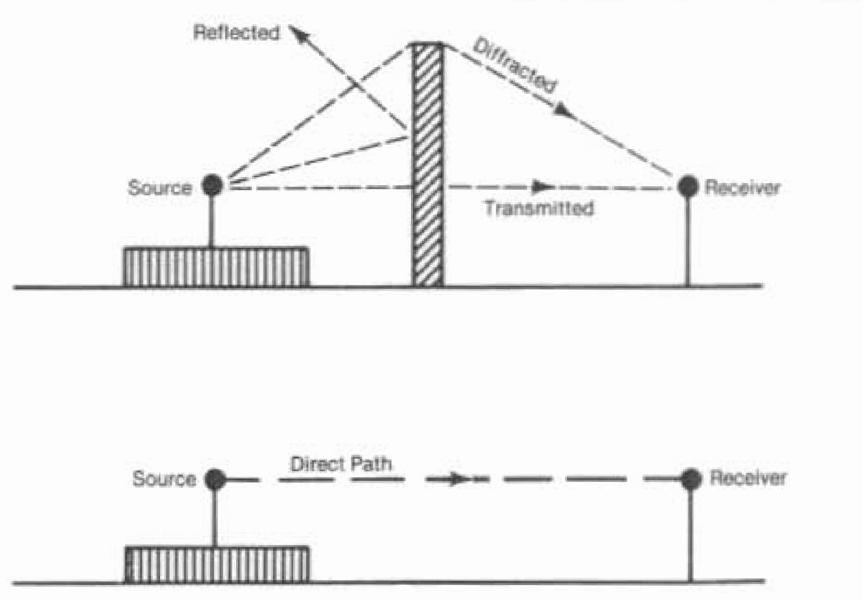
Barrier Noise Reduction Concepts

(The following, with some editing and with some additional graphics, is taken from the Federal Highway Administration's *Noise Barrier Design Handbook*.[1])

When no obstacles are present between [a source] and adjoining areas, sound travels by a **direct** path from the "sources"... to [the] "receivers"..., as shown in Figure 1. Introduction of a barrier between the source and receiver redistributes the sound energy into several [indirect] paths: a **diffracted** path, over the top of the barrier; a **transmitted** path, through the barrier; and a **reflected** path, directed away from the receiver. These paths are also illustrated in Figure 1.

[1] *Noise Barrier Design Handbook* US Department of Transportation, Federal Highway Administration, February 1976. (FHWA-RD-76-58).

Figure 1
Alteration of Noise Paths by a Barrier



Barrier Diffraction and Attenuation

Consider an infinitely long, infinitely massive noise barrier placed between a highway and the receiver. Figure 2 illustrates a cross-section through such a configuration. [In] this example, the only way that sound can reach the receiver is by bending over the top of the barrier; as shown in the figure. The bending of sound waves in this manner over an obstacle is known as diffraction. The area in which diffraction occurs behind the barrier is known as the "shadow zone." The straight path from the source over the top of the barrier forms the boundary of this zone.

All receivers located in the shadow zone will experience some sound attenuation; the amount of attenuation is directly related to the magnitude of the diffraction angle ϕ. As ϕ increases, the barrier attenuation increases. The angle ϕ will increase if the barrier height increases, or if the source or receiver are placed closer to the barrier. Clearly then the barrier attenuation is a function of the geometrical relationship between the source, receiver, and barrier. One way of relating these parameters to the barrier attenuation is to define the path-length difference as shown in Figure 3. This parameter is the difference in distance that the sound must travel in diffracting over the top of the barrier rather than passing directly through it.

In the preceding discussion it was assumed that the barrier was "infinite"; i.e., long enough to shield the receiver from all sound sources up and down the highway. For short barriers, the attenuation can be seriously limited by the sound from sections of highway beyond the barrier's ends, which are unshielded from the receiver, as shown in Figure 4. Similarly, when there are large gaps in the barrier (to permit access, for example), sound from the unshielded section of highway adjacent to the gap can greatly compromise barrier attenuation, especially for those receivers close to the opening.

Figure 2
Barrier Diffraction

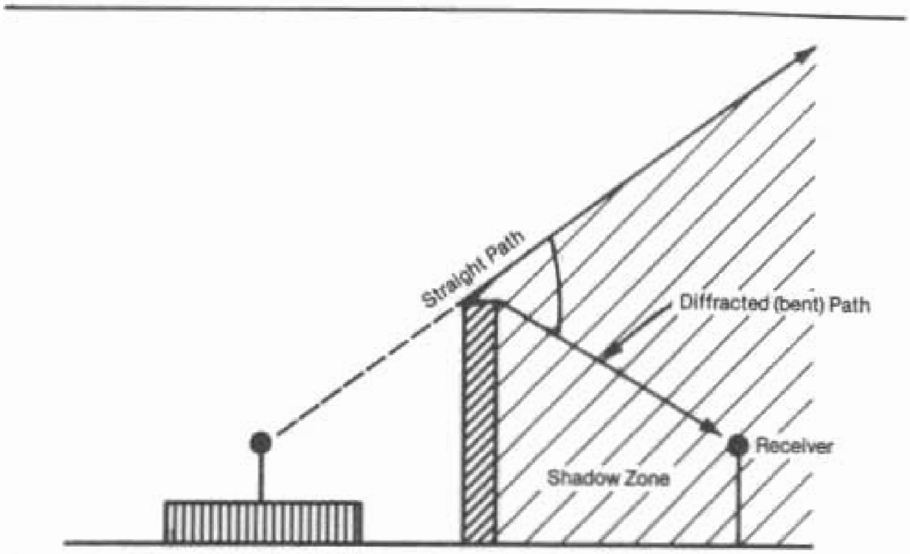


Figure 3
Path Length
Difference $\delta = A + B - d$

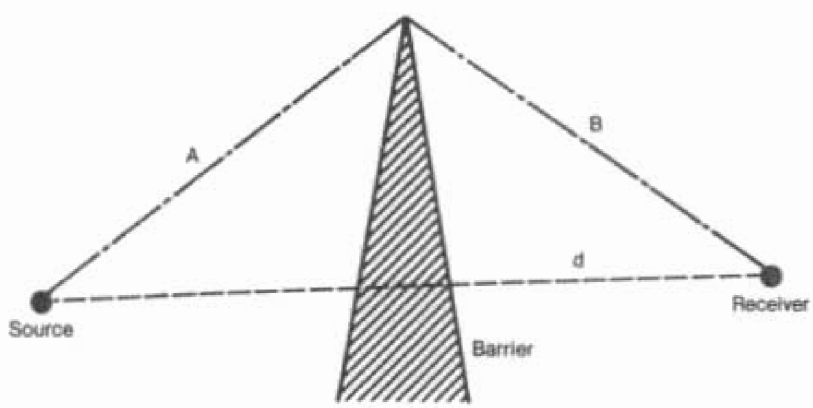
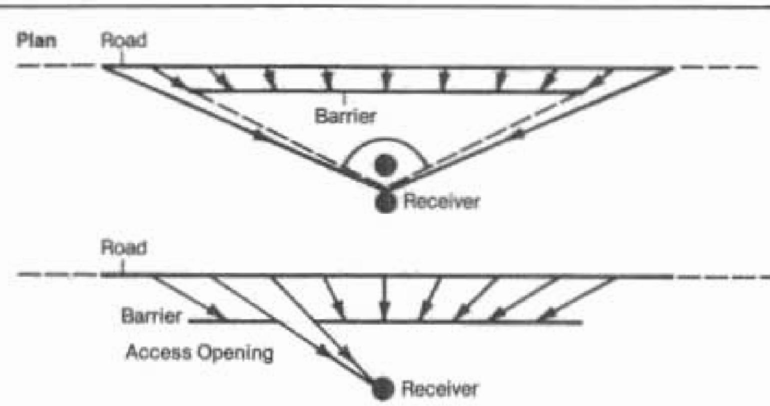


Figure 4
Short-circuit of Barrier Around Ends and Through Openings



Barrier Transmission

In addition to the sound that travels over the top of the barrier to reach the receiver, sound can travel through the barrier itself. The amount of sound "transmission" through the barrier depends upon factors relating to the barrier material (such as its weight and stiffness), the angle of incidence of the sound, and the frequency spectrum of the sound. One way of rating a material's ability to transmit noise is by the use of a quantity known as the transmission loss, TL. The TL is related to the ratio of the incident noise energy to the transmitted noise energy. Transmission loss values are normally expressed in decibels and represent the amount noise levels will be reduced when the sound waves pass through the material. The higher the TL value the less noise transmitted through the material. Typically, the TL value improves with increasing surface weight of the material.

The noise reduction provided by a barrier can be severely compromised if the TL value of the material permits too much noise to pass through the barrier. This is due to the fact that when attenuation is a function of two or more factors, the noise level at the measurement point is actually the combination of the reduced noise levels resulting from each attenuation factor. For example, with a typical barrier the noise levels are reduced by (1) sound waves being diffracted over the barrier and (2) sound waves passing through the barrier. The noise level at the receiver point is the combination of the attenuated levels resulting from each attenuation step. If the starting noise level is 65 db and the noise level is reduced 10 db when the sound waves pass through the barrier then the attenuated level reaching the receiver is 55 db. If the attenuation provided by the sound waves being diffracted over the barrier is also 10 db then the attenuated level reaching the receiver along that path is 55 db as well. Using the table in the *Noise Assessment Guidelines* to combine the two individual attenuated levels, one finds that the combined attenuated level is actually 58 db. Thus even though the attenuation value of each attenuation step was 10 db, the actual reduction for the receiver is only 7 db. It is, however, a function of the way noise levels combine that if the difference between levels is greater than 10 db it does not affect the levels. As a general rule, therefore, if the TL value is at least 10 dB above the attenuation value resulting from diffraction over the top of the barrier, the barrier noise reduction will not be significantly affected by transmission through the barrier (decreased by less than 0.5 dB). For many common materials used in barrier construction, such as concrete and masonry blocks, TL values are usually more than adequate. For less massive materials such as steel, aluminum and wood, TL values may not be adequate, particularly for those cases where large attenuations are required. (See Table 1 for a list of typical TL values.)

Even if a barrier material is massive enough to prevent significant sound transmission, the barrier noise reduction can be severely compromised if there are holes or openings in the barrier. For large openings, sound energy incident on the barrier will be directly transmitted through the opening to the receiver. When the opening is small an additional phenomenon occurs: upon striking the barrier wall the sound pressure will **increase**, resulting in an amplification of the transmitted sound to the receiver. Thus, the presence of openings or holes may seriously degrade the noise reduction provided by otherwise effective barriers.

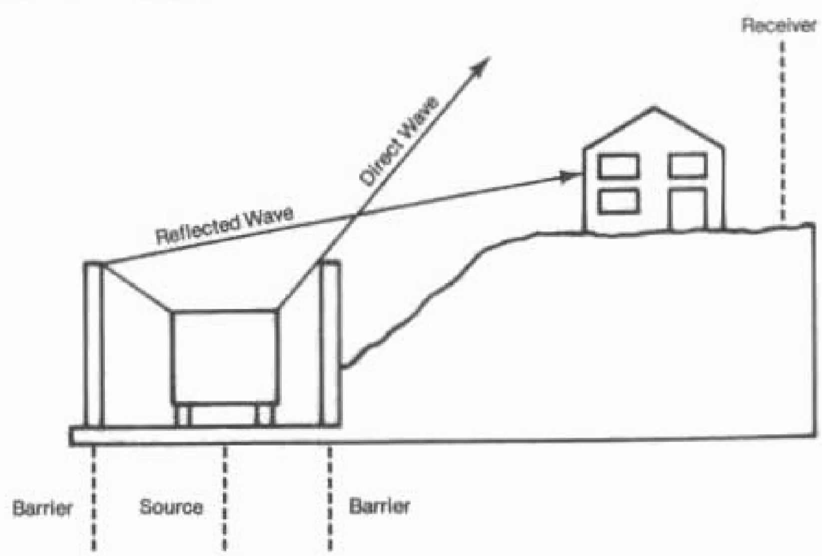
Barrier Reflections

As shown in Figure 1, sound energy can be reflected by a barrier wall. For the configuration shown in that figure, the reflected energy does not affect the receiver, but may affect receivers located to the left of the highway. However the increase in noise level for these receivers would be less than 3 dB, because this single reflection can at most double the sound energy. (Remember how you combine noise levels? The most you add is 3 db when levels are the same.)

The situation is entirely different, however, when a double barrier situation is involved (refer to Figure 5). In addition to the energy that reaches the receiver by diffraction over the top of the barrier, if the barrier walls are reflective, additional sound energy can reach the receiver by a reflection from the left wall as illustrated in the figure. The same principles apply when there is a vertical retaining wall opposite a noise barrier; similarly, in a deep vertical cut the opposite walls will create multiple reflections.

If the barrier walls are not perfectly reflecting but absorb some of the sound energy, the contributon of each reflection is decreased by an amount that depends upon the absorptive characteristics of the barrier. For very hard, reflective surfaces, the absorption characteristics are very poor. Although a serious degradation in barrier performance may result for the double barrier situation, use of materials with good absorption values will usually recover all of the lost noise reduction.

Figure 5
Reflections from an Opposing Barrier



It should be mentioned that the use of barrier walls with sloped sides (forming angles of grater than 10–15 degrees from the vertical) will also generally eliminate multiple reflections. Use of earth berms is particularly appropriate to accomplish this. Sloped barrier walls will require more material to achieve a desired height than a vertical wall, while berms will require greater right-of-way than a thin wall.

Ground Effects

Consider again the direct path of sound from the source to receiver as illustrated in Figure 1 in the absence of any obstacles. For sources and receivers located close to the ground, in addition to this direct path sound energy may reach the receiver by reflecting off the ground. When the terrain is relatively hard and flat, such a reflection will add to the noise from the direct path to increase the level at the receiver. However, when the ground is soft, there may be a phase reversal upon reflection such that the noise from the ground reflection path will destructively interfere with the noise from the direct path resulting in a significant reduction in noise levels at the receiver.

This reduction in level, known as ground-effect attenuation, is in excess of the 3 dB per doubling of distance propagation loss for a line source of noise and occurs only above soft absorptive ground (such as normal earth and most ground with vegetation). Over hard ground (such as concrete, stone and very hard-packed earth) these effects do not occur. These effects are most apparent for receivers on the ground floor, and decrease rapidly as receiver height above ground increases.

While ground absorption effects are not completely understood, it is generally believed that these effects account for the 4.5 dB per doubling of distance propagation loss observed over soft ground, as compared to the 3 dB propagation loss observed over hard ground. The implication with regard to barrier design is that placement of a barrier over soft ground between source and receiver will re-direct the sound over the top of the barrier, thus destroying the ground reflection and the additional 1.5 dB per doubling of distance attenuation. Thus, the barrier must be designed to provide more reduction than would otherwise be necessary, to compensate for the lost ground effects over absorptive ground.

Summary
(From: *Design Guide*, National Bureau of Standards[1])

In summary, the following can be said about noise barriers.

- If a barrier does not block the line-of-sight between the source and receiver, the barrier will provide little or no attenuation.
- If a barrier is constructed of a material with a surface weight density greater than 4 lb/ft^2 and there are no openings through the barrier, transmitted sound will usually be negligible.
- If there are openings totaling over 10 percent or more of the barrier area, barrier attenuation will be negligible.
- Diffracted sound is usually the most important aspect in estimating barrier attenuation.
- Reflected sound can be important for receivers on the source side of a barrier, but it normally is not a factor for receivers on the side opposite from the source. Hence reflected sound is usually not important to your building and site.
- Transmission of sound around the ends of the barrier can be critical if the barrier included angle is less than 170°.
- Barrier attenuations greater than an A-weighted sound level difference of 10 dB are difficult to obtain.
- For two or more barriers "in series," consider only the "dominant" barrier.
- Assume no attenuation for a receiver located beyond the end of a barrier.

Reviewing Barrier Proposals

An effective barrier is one which reduces the noise level behind the barrier to 65 L_{dn} or lower. If a barrier can reduce the exterior noise level to 65 L_{dn}, then standard construction techniques should be sufficient to insure an interior level of 45 L_{dn} or below. Therefore, if you determine that a proposed barrier is adequate to reduce the exterior noise level to 65 L_{dn} then no additional attenuation measures should be necessary.

[1] *Design Guide for Reducing Transportation Noise in and Around Buildings*, US Department of Commerce, National Bureau of Standards, April 1978. (Building Science Series 84)

There are four things to check when determining the adequacy of a proposed barrier:

1. Is it high enough?
2. Is it long enough?
3. Is it made of the right materials?
4. Is it properly constructed?

Is it High Enough?

In order for a barrier to be effective it must be at least high enough to break the line of sight between the source and the receiver. In the *Noise Assessment Guidelines* you will find the procedure for determining how much attenuation is provided by a barrier of a given height.

In general, barriers and berms are most effective for one and two story buildings because a relatively low barrier can often provide the attenuation needed. The height that might be required to provide attenuation for much taller buildings is often not feasible for either cost or aesthetic reasons. However, even if a barrier can not be made high enough to attenuate the upper floors of a multistory building, it may still be able to provide some protection for outdoor recreational areas. Before discarding the barrier idea check for this possibility.

If you find that the barrier as proposed is too short to be effective but the sponsor or developer tells you that he or she can not make the barrier any higher, there are some alternatives you can suggest. There are ways to get more attenuation out of each foot of overall height.

As a general rule, barriers work better the closer they are to the source. Figure 6 shows a barrier that does not block the line of sight at all when it is located next to the receiver, yet is quite tall enough when located next to the source. Thus, if the sponsor or developer can not make the barrier any taller, perhaps he or she can move it closer to the source.

Another way to get more attenuation without increasing overall barrier height is to bend the top of the barrier towards the source. Figure 7 shows a case where a barrier built perfectly straight provides 8 dB of attenuation. A barrier with the same overall height but with a 45 degree bend towards the source provides 9.5 dB of attenuation. Thus if the project sponsor or developer wants to keep the overall height of the barrier down, he or she can still increase the attenuation provided simply by bending the top.

Figure 6
Effect of Moving the Barrier Closer to the Source

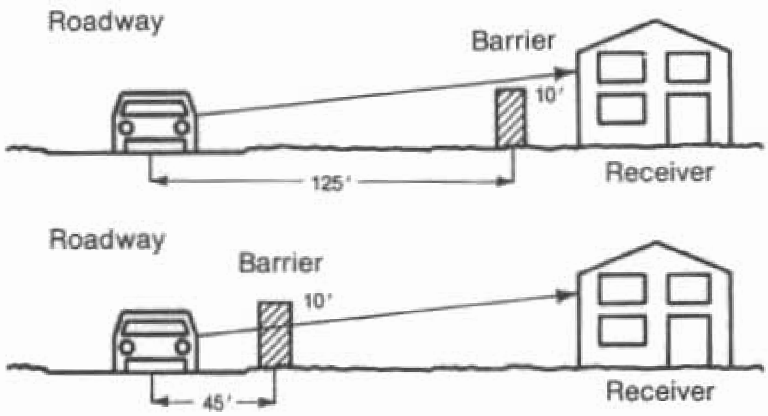
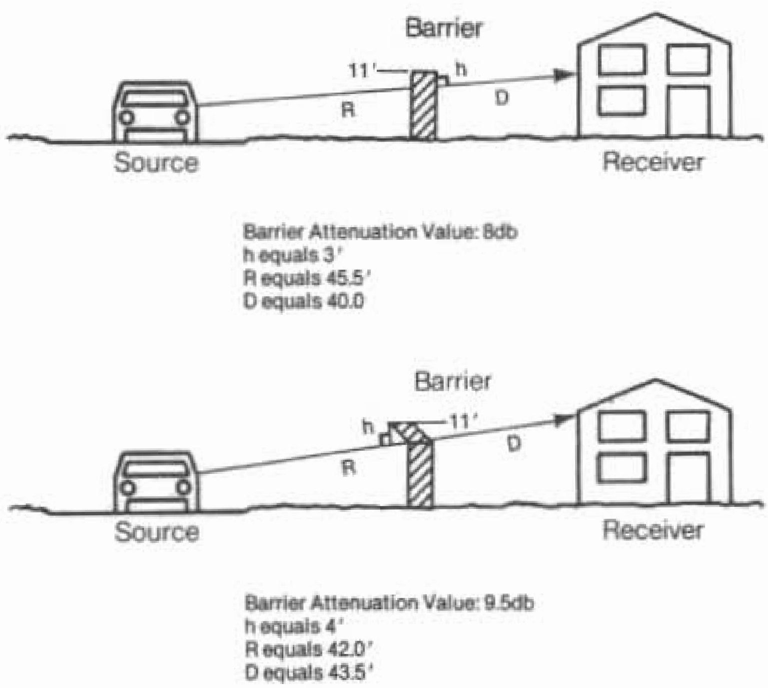


Figure 7
Effect of Bending the Top of the Barrier Towards the Source



Thus, if your review of a proposed barrier shows it to be too short, but it can not be made any higher, suggest that the barrier be moved closer to the source or that it be bent at the top, or both.

Is It Long Enough?

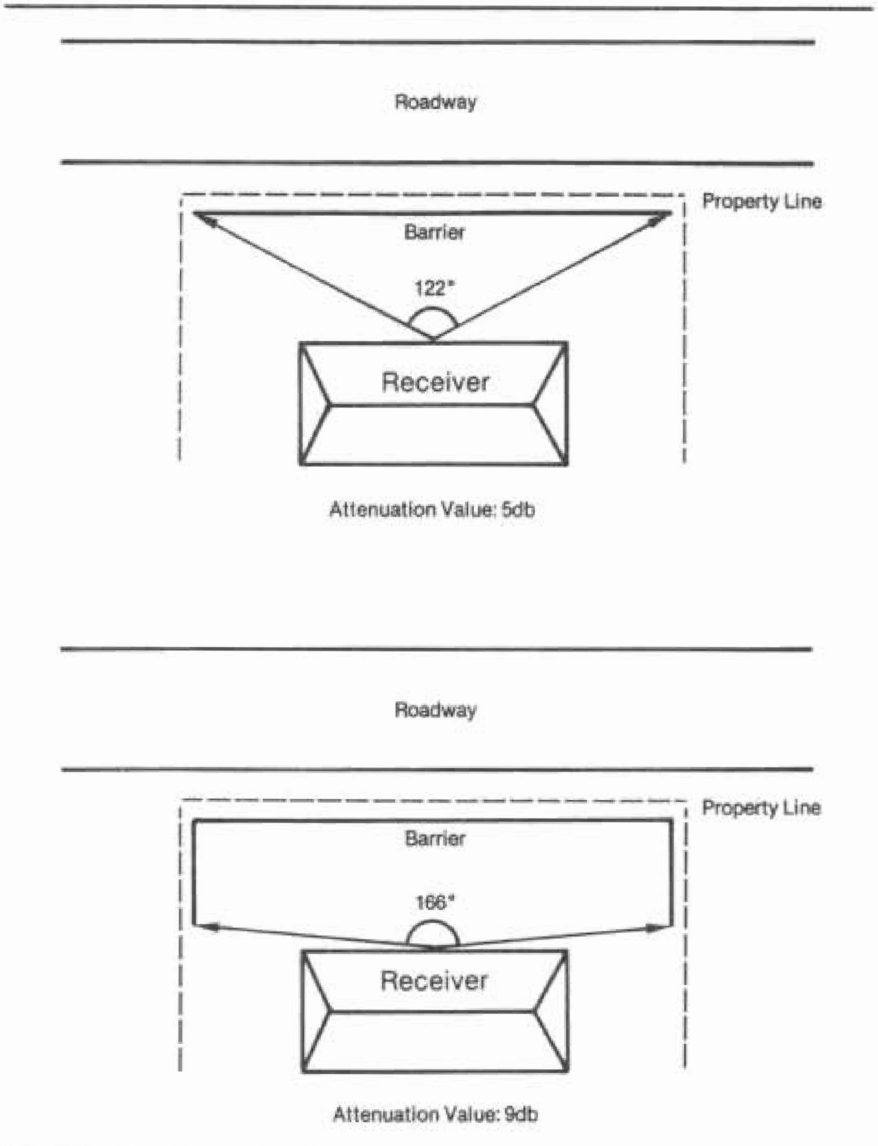
Once you have established how much attenuation the barrier provides due to its height, you must determine if the length of the barrier compromises that attenuation level. Again, *the Noise Assessment Guidelines* contain a procedure for calculating the effect of barrier length.

If you find that the barrier is too short but that there are limitations on how long it can be made, there are, as there were with barrier heights, some recommendations you can make on how to improve the effectiveness of the barrier.

Again, if you bend the edges of the barrier, this time towards the **receiver** not the source, you will increase the effectiveness of the barrier. Figure 8 shows how much a barrier's effectiveness can be improved by bending the edges.

You can also improve the effectiveness of the barrier by moving it closer to the receiver. Figure 9 shows how much a barrier's effectiveness can be increased by moving it closer to the receiver. Now obviously, this creates a conflict with what we said earlier about moving the barrier closer to the source. Clearly each case will require a different compromise. If height is not a limiting factor but length is, you might recommend to the project sponsor or developer that the barrier be moved closer to receiver and the height increased as necessary. If the reverse is true, you would want to recommend the opposite. If both height and length are limited, then the sponsor or developer must find that optimum point where the effeciveness of both the barrier height and the barrier length is as high as possible.

Figure 8
Effect of Bending the Edges of Barrier Towards Receiver
(Both Barriers have Potential Value of 10db)



Is It Made of The Right Materials?

Even if a barrier is high enough and long enough, its effectiveness can be severely reduced if it is made up of lightweight materials that easily transmit sound waves. In the preceding section on barrier concepts we talked about how if the transmission loss value for the barrier material was not at least 10 db higher than the attenuation value of the barrier based on length and height there would be a significant reduction in the effectiveness of the barrier.

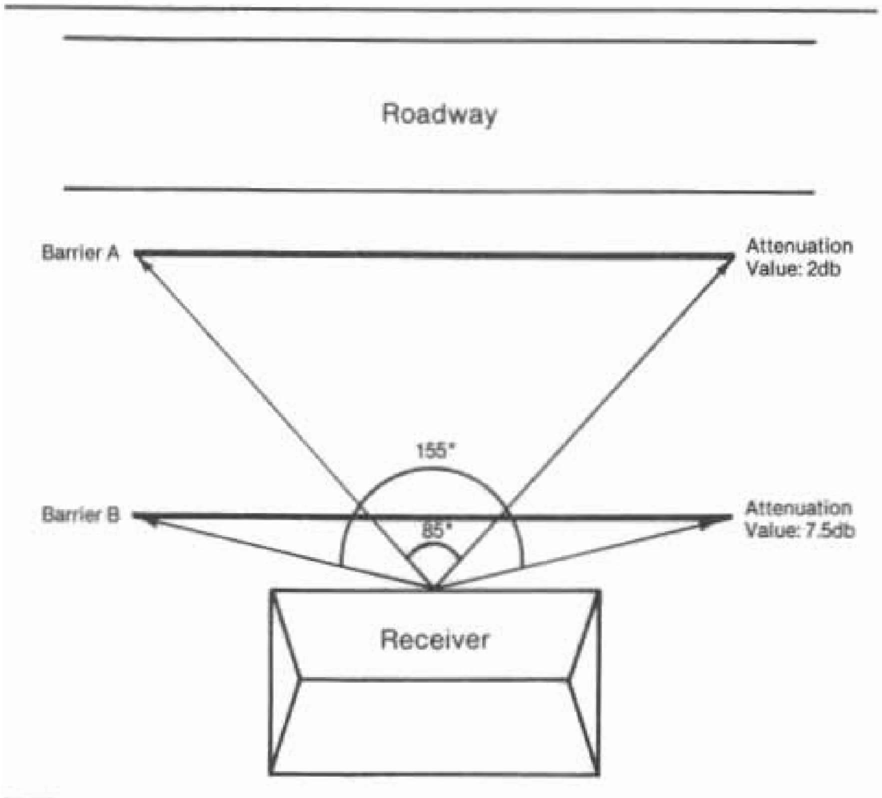
Therefore, once you have calculated the basic attenuation potential of the barrier, you must check to make sure the proper material is being used to build the barrier. Table 1 lists the transmission loss values for materials commonly used in barrier construction. Once you have found the transmission loss value for the material being used, go to Table 2. Read down the column with the transmission loss for the material at its top and across the line that has the attenuation potential for the barrier listed. Where the two intersect you will find the actual attenuation capability of the barrier.

If you find that the choice of material has severely reduced the effectiveness of the barrier, you should recommend that the sponsor or developer select another material.

Is It Properly Constructed?

Holes or openings can substantially reduce the effectiveness of a barrier. A barrier that has openings totaling 50% or more of its total area will provide no attenuation. A barrier that has openings totaling 10% of its total area has a maximum attenuation value of approximately 4db. That is 4db no matter how high, how long or how thick the barrier. So you can see that it is very important that the barrier is made of solid materials and that it is tightly constructed. In general the intended openings in a barrier should equal no more than 1% of total area and the construction specifications should require that all joints are tightly sealed.

Figure 9
Effect of Moving Barrier Closer to Receiver



A Final Note

One thing should have become clear to you as you have been reading this section, and that is that in order for you to adequately review a project sponsor or developer's proposed barrier you must be given fairly specific information about the exact dimensions of the proposed barrier, the type and thickness of the barrier material, and the exact design of the barrier including construction specifications. Without this information you will be unable to do any more than a cursory evaluation, an evaluation that could be far from accurate. Make sure you make it clear to the developer or sponsor what you need to have.

Table 1
Transmission Loss Value for Common Barrier Materials

Material	Thickness, (inches)	Transmission Loss, dBA (1)
Woods		
Fir	1/2	17
	1	20
	2	24
Pine	1/2	16
	1	19
	2	23
Redwood	1/2	16
	1	19
	2	23
Cedar	1/2	15
	1	18
	2	22
Plywood	1/2	20
	1	23
Particle Board	1/2	20
Metals		
Aluminum	1/16	23
	1/8	25
	1/4	27
Steel	24 ga	18
	20 ga	22
	16 ga	15
Lead	1/16	28
Concrete, Masonry, etc.		
Light Concrete	4	36
	6	39
Dense Concrete	4	40
Concrete Block	4	32
	6	36
Cinder Block (Hollow Core)	6	28
Brick	4	33
Granite	4	40
Composites		
Aluminum Faced Plywood	3/4	21-23
Aluminum Faced Particle Board	3/4	21-23
Plastic Lamina on Plywood	3/4	21-23
Plastic Lamina on Particle Board	3/4	21-23
Miscellaneous		
Glass (Safety Glass)	1/8	22
	1/4	26
Plexiglass (Shatterproof)		22-25
Masonite	1/2	20
Fiberglass/Resin	1/8	20
Stucco on Metal Lath	1	32
Polyester with Aggregate Surface	3	20-30

[1] A-weighted TL based on generalized truck spectrum. Source: *Noise Barrier Design Handbook*, FHWA

Table 2
Noise Reduction of a Barrier as a Function of Its Transmission Loss

Designed Attenuation, dB (from height) and length)	Tramission Loss, dB of Materials				
	10	15	20	25	30
5	3.8	4.6	4.9	5.0	5.0
6	4.5	5.5	5.8	6.0	6.0
7	5.2	6.4	6.8	6.9	7.0
8	5.9	7.2	7.7	7.9	8.0
9	6.5	8.0	8.7	8.9	9.0
10	7.0	8.8	9.6	9.9	10.0
11	7.5	9.5	10.5	10.8	11.0
12	7.9	10.2	11.4	11.8	11.9
13	8.2	10.9	12.2	12.7	12.9
14	8.5	11.5	13.0	13.7	13.9
15	8.8	12.0	13.8	14.6	14.9
16	9.0	12.5	14.5	15.5	15.8
17	9.2	12.9	15.2	16.7	16.8
18	9.4	13.2	15.9	17.2	17.7
19	9.5	13.5	16.5	18.0	18.7
20	9.6	13.8	17.0	18.8	19.6

Source: *Noise Barrier Design Handbook, FHWA*

Acoustical Site Planning Concepts

(This section, with some editing, is from *The Audible Landscape*, FHWA.[1])

The arrangement of buildings on a site can be used to minimize noise impacts. If incompatible land uses already exist, or if a noise sensitive activity is planned, acoustical site planning often provides a successful technique for noise impact reduction.

Many site planning techniques can be employed to shield a residential development from noise. These can include:

1. increasing the distance between the noise source and the receiver;
2. placing noise compatible land uses such as parking lots, maintenance facilities, and utility areas between the source and the receivers. Playgrounds and parks are not necessarily noise compatible activities.
3. locating barrier-type buildings parallel to the noise source or the highway; and
4. orienting the residences away from the noise.

The implementation of many of the above site planning techniques can be combined through the use of cluster and planned unit development techniques.

Distance

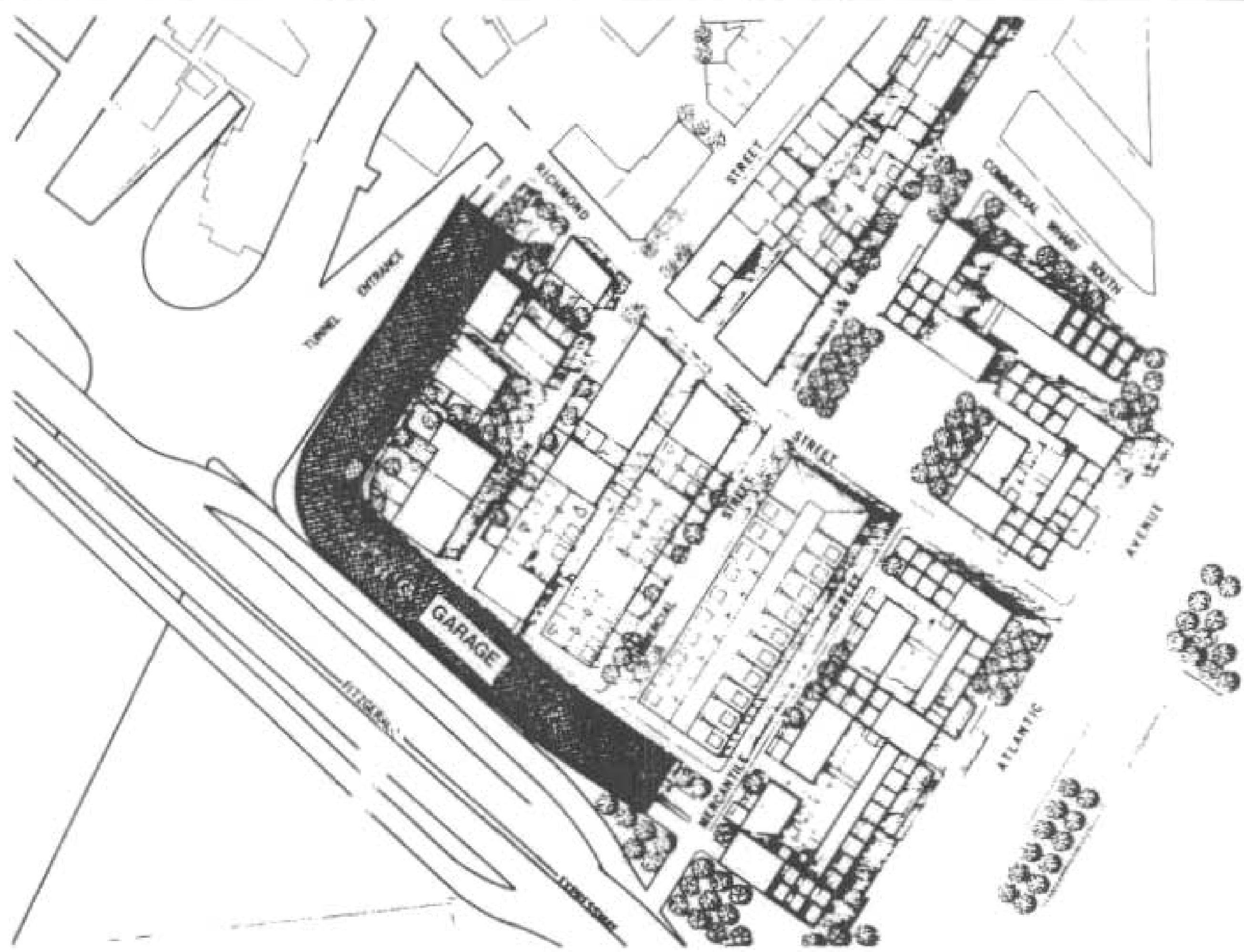
Noise can be effectively reduced by increasing the distance between a residential building and a highway. Distance itself reduces sound: doubling the distance from a noise source can reduce its intensity by as much as 3 dBA. In the case of highrise buildings, distance may be the only means, besides acoustical design and construction, of reducing noise impacts. This is because it is nearly impossible to provide physical shielding for the higher stories from adjacent noise.

Noise Compatible Land Uses as Buffers

Noise protection can be achieved by locating noise-compatible land uses between the highway and residential units. Whenever possible, compatible uses should be nearest the noise source. Figure 10 shows a proposed parking garage along two sides of a development in Boston. Both the

[1] *The Audible Landscape: A Manual for Highway Noise and Land Use*, US Department of Transportation, The Federal Highway Administration, November 1974. (GPO Stock Number: 5000-00079.)

Figure 10
Use of a Parking Garage to Shield a Residential Area



Fitzgerald Expressway and the entrance to the Callahan Tunnel which are shown on the site plan are major and noisy traffic routes. In addition to protecting the residential development from the noise and dirt of highway traffic, the parking garage provides needed facilities for the residents.

Buildings as Noise Shields

Additional noise protection can be achieved by arranging the site plan to use buildings as noise barriers. A long building, or a row of buildings parallel to a highway can shield other more distance structures or open areas from noise.

If the building being used as a barrier is sensitive to highway noise, the building itself must first be soundproofed. This technique was used in a housing project in England where a 3,900 foot long, 18 foot wide and 45-70 foot high wall (depending on the terrain) serves as both residence and a sound shield. The wall/building will contain 387 apartments in which the kitchens and bathrooms are placed towards the noise, and the bedrooms and living rooms face away from the highway. The wall facing the highway will be soundproofed and windows, when they exist, are sealed. Substantial noise reductions are expected.

Orientation

The orientation of buildings or activities on a site affects the impact of noise, and the building or activity area may be oriented in such a way as to reduce this impact.

Noise impacts can be severe for rooms facing the roadway since they are closest to the noise source. The noise impact may also be great for rooms perpendicular to the roadway because (a) the noise pattern can be more annoying in perpendicular rooms and (b) windows on perpendicular walls do not reduce noise as effectively as those on parallel walls because of the angle of the sound. Road noise can be more annoying in perpendicular rooms because it is more extreme when it suddenly comes in and out of earshot as the traffic passes around the side of the building, rather than rising and falling in a continuous sound, as it would if the room were parallel to passing vehicles.

Whether the noise impact is greater on the perpendicular or the parallel wall will depend on the specific individual conditions. Once the most severely impacted wall or walls are determined, noise impacts may be minimized by reducing or eliminating windows from these walls.

Buildings can also be oriented on a site in such a way as to exploit the site's natural features. With reference to noise, natural topography can be exploited and buildings placed in low noise pockets if they exist. If no natural noise pockets exist, it is possible to create them by excavating pockets for buildings and piling up earth mounds between them and the noise. Such a structure would obstruct the sound paths and reduce the noise impacts on the residences.

Cluster and Planned Unit Development

A cluster subdivision is one in which the densities prescribed by the zoning ordinance are adhered to but instead of applying to each individual parcel, they are aggregated over the entire site, and the land is developed as a single entity. A planned unit development, or P.U.D., is similar but changes in land use are included, such as apartments and commercial facilities in what would otherwise be a single-family district.

From Figure 11 it can be seen how the conventional grid subdivision affords no noise protection from the adjacent highway. The first row of houses bears the full impact of the noise. In contrast, the cluster and P.U.D. techniques enable open space and commercial uses respectively to serve as noise buffers. Examples of this are shown in Figures 12 and 13. A word of caution is necessary: in a cluster development, the required open space can be located near the highway to minimize noise to the residences. However, many recreation uses are noise sensitive, and when one takes advantage of the flexibility of cluster development to minimize noise, care must be taken not to use all of the available open space in

Figure 11
Conventional Grid Subdivision

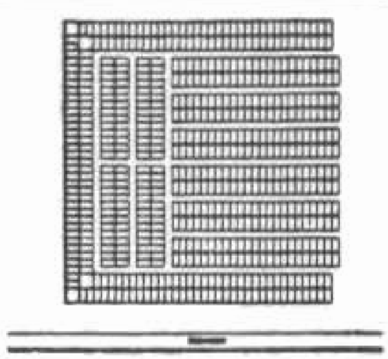
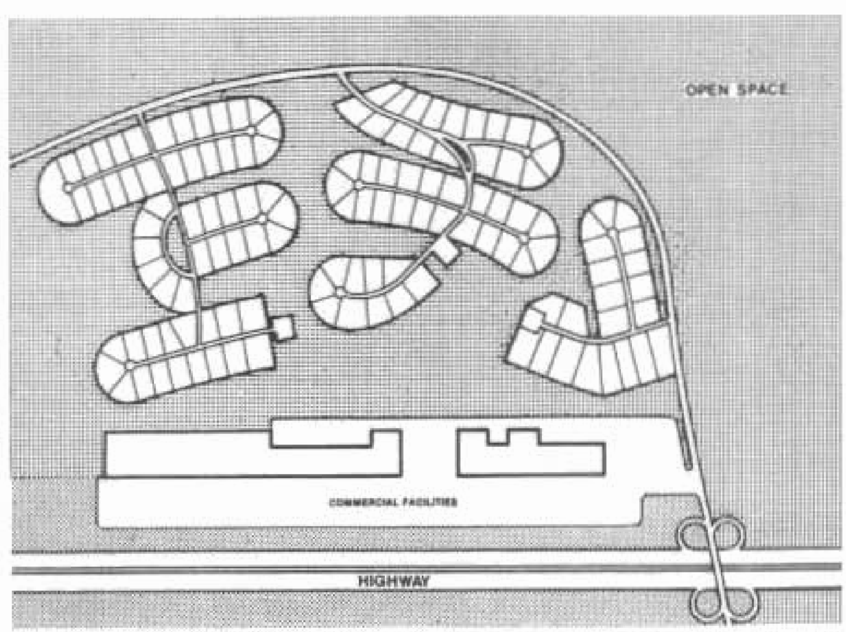


Figure 12
Placement of Noise Compatible Uses Near a Highway in a PUD



buffer strips, thus depriving the development of a significant open space area. Where high noise levels exist, a combination of buffer strips and other techniques (such as berms and acoustical sound proofing) can be employed.

The flexibility of the cluster and planned unit development techniques allows many of the above site planning techniques to be realized and effective noise reduction achieved.

Reviewing Site Plans

There are two main things to check when reviewing site plan changes to determine if the revised site plan provides adequate attenuation for the noise sensitive uses:

1. Is the separation between the source and the receiver great enough?
2. If noise-compatible buildings are being used as barriers for other buildings, are they adequate barriers, i.e., are they long enough and are they high enough? (And, if the buildings being used as barriers contain noise sensitive activities, have the buildings been properly soundproofed.)

In order to determine whether the proposed site plan changes will provide adequate separation between the source and the receiver, you simply go back to the *Noise Assessment Guidlines* procedures. You can use the *Guidelines* both to determine if the proposed separation distance is sufficient or to determine the necessary separation distance. You should at this point check to make sure that the uses being located in the "buffer zone" between the source and the receiver are indeed noise compatible uses. If parks or playgrounds are located in the buffer zone, make sure they are not the only ones associated with the project.

To determine whether the noise compatible buildings being proposed as barriers are adequate, you simply use the procedures outlined in the preceding section. Determine whether the building is high enough to properly break the line of sight between the receiver and the source. Then determine if the building is long enough. It is not necessary to check to make sure it is made of the proper materials or that it is properly constructed since the building will be inherently thick enough not to have any problems. Again, however, if the building being proposed as a barrier contains noise sensitive uses you must first verify that it is properly soundproofed. (See the next section for guidance on acoustical construction.) If the building is not properly soundproofed then it can not be used as a barrier for other buildings.

As you review the site plan check to see that the building locations will not aggravate noise problems. Figure 14 shows how building arrangement can make the noise problem worse.

Figure 13
Open Space Placed Near a Highway in a Cluster Development

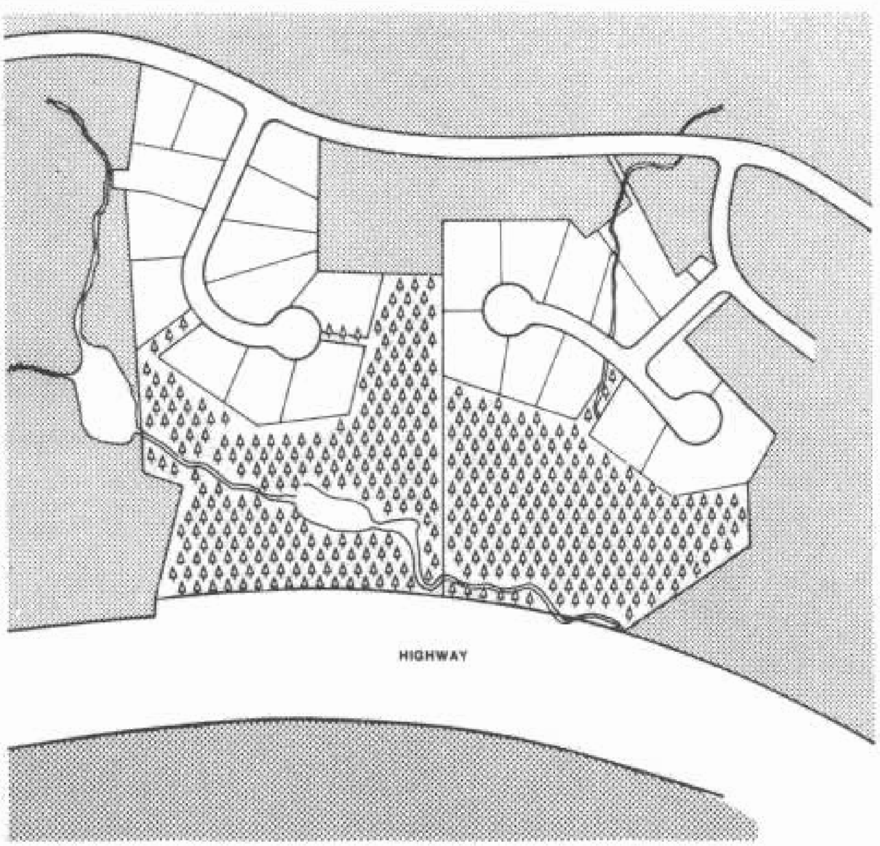
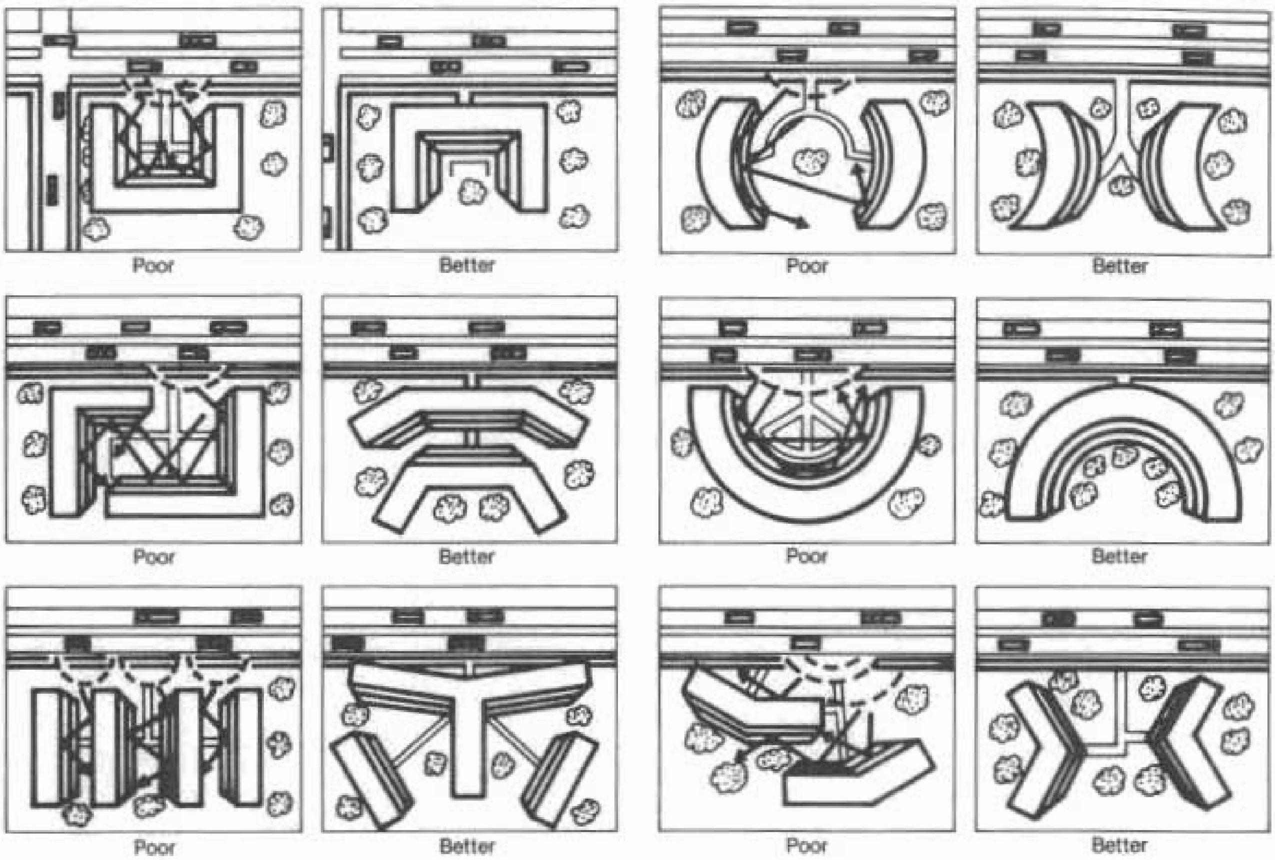


Figure 14
Orientation of Buildings on Sites



Acoustical Construction Concepts

(This section, with some editing is taken from the *Audible Landscape, FHWA.*[1])

Noise can be intercepted as it passes through the walls, floors, windows, ceilings, and doors of a building. Examples of noise reducing materials and construction techniques are described in the pages that follow.

To compare the insulation performance of alternative constructions, the Sound Transmission Class (STC) is used as a measure of a material's ability to reduce sound. Sound Transmission Class is equal to the number of decibels a sound is reduced as it passes through a material. Thus, a high STC rating indicates a good insulating material. It takes into account the influence of different frequencies on sound transmission, but essentially the STC is the difference between the sound levels on the side of the partition where the noise originates and the side where it is received. For example, if the external noise level is 85 dB and the desired internal level is 45 dB, a partition of 40 STC is required. The Sound Transmission Class rating is the official rating endorsed by the American Society of Testing and Measurement. It can be used as a guide in determining what type of construction is needed to reduce noise.

The use of the STC rating system for transportation noise is a subject of some debate. The STC rating was originally intended primarily for use with interior partitions and relates to the "subjective impressions of the sound insulation provided against the sounds of speech, radio, television, music, and similar sources of noise in offices and dwellings."[2] However, since it remains the only widely used noise reduction rating system for materials the STC system is very often used even with transportation noise. When STC ratings are used for transportation noise you should be aware that the STC ratings may be a few dB too high. For example, the STC rating for a standard frame 2 × 4 wall with exterior siding, and sheathing and interior sheetrock may be 37 dB.[3] If rated specifically for transportation noise the dB reduction rating might drop to 34 dB.[4] All this really means, however, is that you should use the STC ratings with a bit of caution and remain aware of the possible 2–3 dB overstating that you may get with the STC rating system. Throughout this text we will be talking in terms of STC ratings for materials and assemblies.

[1] *The Audible Landscape: A Manual for Highway Noise and Land Use*, US Department of Transportation, the Federal Highway Administration, November 1974. (GPO Stock #5000-00079).
[2] *Acoustical and Thermal Performance of Exterior Residential Walls, Doors, and Windows*, US Department of Commerce, National Bureau of Standards, November 1975. (NBS Building Science Series 77) page 21.
[3] Ibid., p. 29
[4] *Design Guide for Reducing Transportation Noise In and Around Buildings*, p. 137.

Walls

Walls provide building occupants with the most protection from exterior noise. Different wall materials and designs vary greatly in their sound insulating properties. Figure 15 provides a visual summary of some ways in which the acoustical properties can be improved:

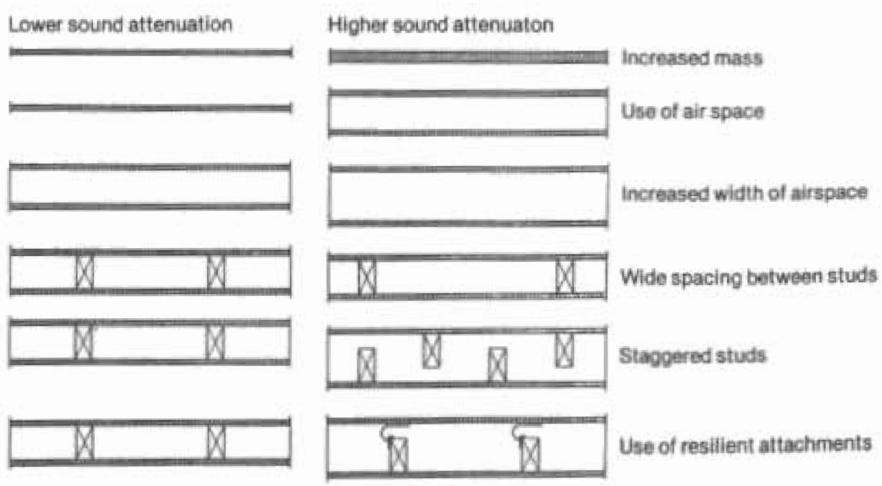
Increase the mass and stiffness of the wall. In general, the denser the wall material, the more it will reduce noise. Thus, concrete walls are better insulators than wood walls of equal thickness. Increasing the thickness of a wall is another way to increase mass and improve sound insulation. Doubling the thickness of a partition can result in as much as a 6 dB reduction in sound.[1] However, the costs of construction tend to limit the feasibility of large increases in wall mass.

The relative stiffness of the wall material can influence its sound attenuation value. Care must be taken to avoid wall constructions that can vibrate at audible frequencies and transmit exterior sounds.

[1] R. K. Cooke and P. Chrzanowski, "Transmission of Noise Through Walls and Floors," Cyril Harris, ed., Handbook of Noise Control, McGraw-Hill Book Company, Inc. (New York, 1957).

Figure 15
The Audible Landscape

Factors which influence sound attenuation of walls



Use cavity partitions. A cavity wall is composed of two or more layers separated by an airspace. The airspace makes the cavity wall a more effective sound insulator than a single wall of equal weight, leading to cost savings.

Increase the width of the airspace. A three inch airspace provides significant noise reduction, but increasing the spacing to six inches can reduce noise levels by an additional 5 dBA. Extremely wide airspaces are difficult to design.

Increase the spacing between studs. In a single stud wall, 24 inch stud spacing gives a 2-5 dB increase in STC over the common 16 inch spacing.[2]

Use staggered studs. Sound transmission can be reduced by attaching each stud to only one panel and alternating between the two panels.

[2]Leslie T. Doelle, Environmental Acoustics (New York, McGraw-Hill Book Company, 1972), pp. 232–233.

Use resilient materials to hold the studs and panels together. Nails severely reduce the wall's ability to reduce noise. Resilient layers such as fiber board and glass fiber board, resilient clips, and semi-resilient attachments are relatively inexpensive, simple to insert, and can raise the STC rating by 2-5 dB.[1]

Use dissimilar layers. If the layers are made of different materials and/or thickness, the sound reduction qualities of the wall are improved.[2]

Add acoustical blankets. Also known as isolation blankets, these can increase sound attenuation when placed in the airspace. Made from sound absorbing materials such as mineral or rock wool, fiberglass, hair felt or wood fibers, these can attenuate noise as much as 10 dB.[3] They are mainly effective in relatively lightweight construction.

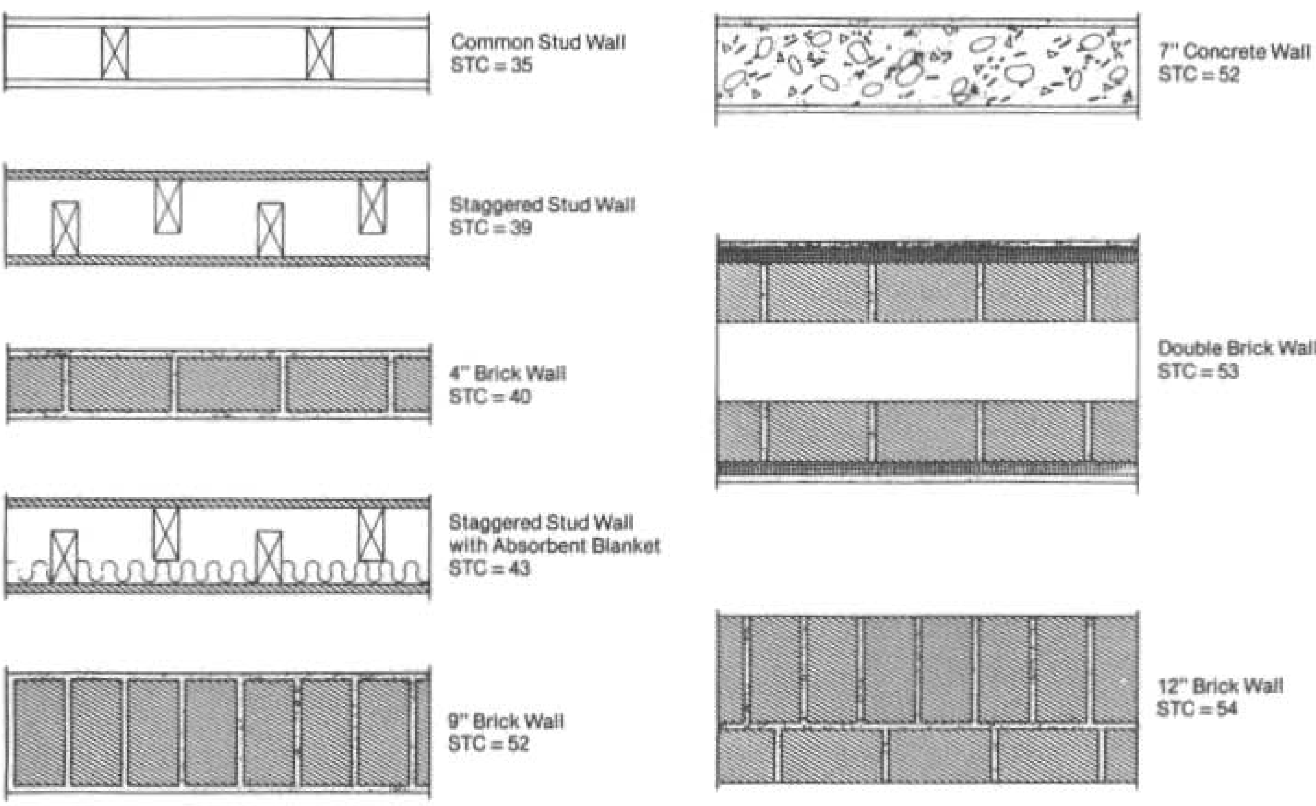
Seal cracks and edges. If the sound insulation of a high performance wall is ever to be realized, the wall must be well sealed at the perimeter. Small holes and cracks can be devastating to the insulation value of a wall. A one-inch square hole or a 1/16 inch crack 16 inches long will reduce a 50 STC wall to 40.[4]

Figure 16 shows a sample of wall types ranging from the lowest to the highest sound insulation values.

Remember that the effectiveness of best wall construction will be substantially reduced if you permit vents, mail slots or similar openings in the walls. If vents are permitted the ducts must be specially designed and insulated to make sure noise does not reach the inside. The best approach is simply to eliminate all such openings on impacted walls.

[1]Ibid, p. 172
[2]Ibid, p. 162
[3]Doelle, p. 20
[4]United States Gypsum, Sound Control Construction, Principles and Performance (Chicago, 1972), p. 66

Figure 16
Walls



Windows

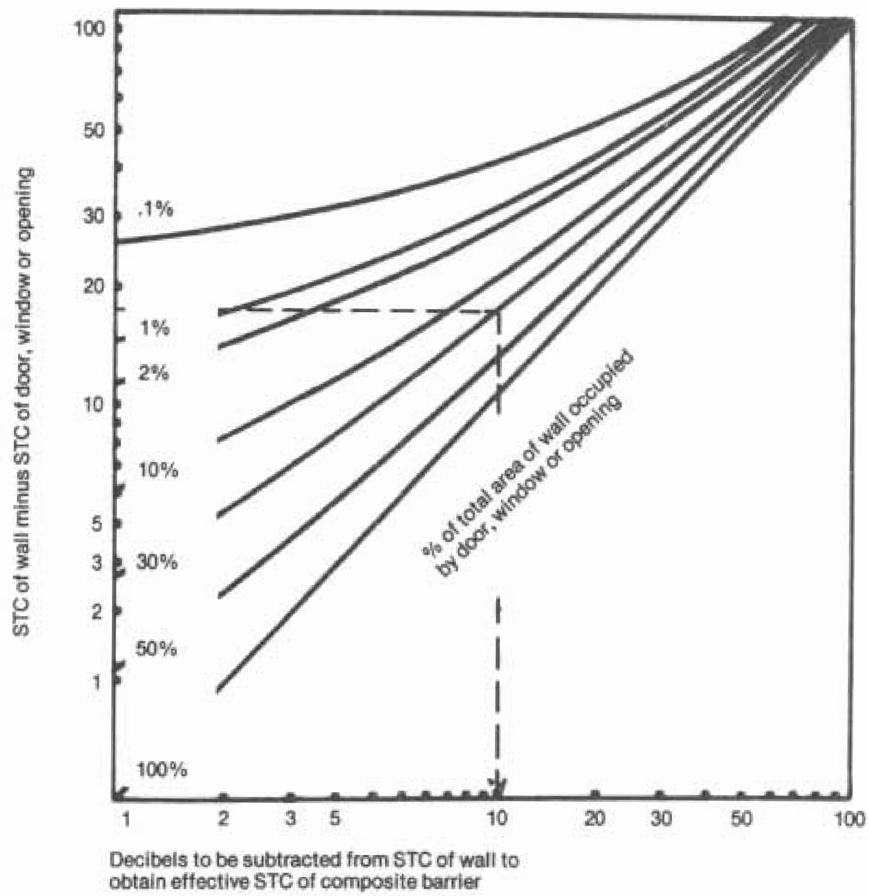
Sound enters a building through its acoustically weakest points, and windows are one of the weakest parts of a wall. An open or weak window will severely negate the effect of a very strong wall. Whenever windows are going to be a part of the building design, they should be given acoustical consideration. Figure 17 illustrates the effects of windows on the sound transmission of walls. For example, if a wall with an STC rating of 45 contains a window with an STC rating of 26 covering 30% of its area, the overall STC of the composite partition will be 35, a reduction of 10 dB.

The following is a discussion of techniques that can be used to reduce noise in a building by means of its windows. These techniques range from a blocking of the principal paths of noise entry to a blocking of the most indirect paths.

Close windows. The first step in reducing unwanted sound is to close and seal the windows. The greatest amount of sound insulation can be achieved if windows are permanently sealed. However, openable acoustical windows have been developed which are fairly effective in reducing sound.[1] Whether or not the sealing is permanent, keeping windows closed necessitates the installation of mechanical ventilation systems. If you are dealing with single family houses and some of the windows are facing away from all noise sources, a whole house fan may be better and cheaper than air conditioning. In multifamily housing or where all windows are exposed to the noise sources you will have to go with the air conditioning. If windows must be openable, special seals are available which allow windows to be opened.[2]

Reduce window size. The smaller the windows, the greater the transmission loss of the total partition of which the window is a part. Reducing the window size is a technique that is used because (a) it precludes the cost of expensive acoustical windows, and (b) it saves money by cutting down the use of glass. The problems with this technique are (a) it is not very effective in reducing noise; e.g., reducing the proportion of window to wall size from 50% to 20% reduces noise by only 3 decibels; and (b) many building codes require a minimum window to wall size ratio.

Figure 17
STC



Instructions on use of graph

1. Subtract the STC value of the door, window or opening from the STC value of the wall.
2. Enter the vertical axis of the graph at the point that matches the value from step 1.
3. Read across to the curve that represents the percentage of the total area of the wall that is taken up by the door, window, or opening.
4. Read down to the horizontal axis.
5. Subtract the value on the horizontal axis from the original STC value of the wall. The result is the composite STC value of the wall and the door, window or opening.

Increase glass thickness. If ordinary windows are insufficient in reducing noise impacts in spite of sealing techniques, then thicker glass can be installed. In addition, this glass can be laminated with a tough transparent plastic which is both noise and shatter resistant. Glass reduces noise by the mass principle; that is, the thicker the glass, the more noise resistant it will be. A 1/2-inch thick glass has a maximum STC rating of 35 dB compared to a 25 dB rating for ordinary 3/16 inch glass.

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[1] U.S. Department of Housing and Urban Development, A Study of Techniques to increase the Sound Insulation of Building Elements, Report No. WR 73-5, Washington, D.C., June 1973.

[2] Los Angeles Department of Airports, *Guide to the Soundproofing of Existing Homes Against Exterior Noise.* Report No. WRC 70-2, March 1970, pp. 9-11, 22-30. In this report, the function and performance of a number of operable seals are described.

However, glass thicknesses are only practical up to a certain point, when STC increases become too insignificant to justify the cost. For example, a 1/2 inch thick glass can have an STC of 35; increasing the thickness to 3/4 inch only raises the STC to 37. However, a double glass acoustical window consisting of two 3/16 inch thick panes separated by an airspace will have an STC of 51 and can cost less than either solid window.

In addition to thickness, proper sealing is crucial to the success of the window. To prevent sound leaks, single windows can be mounted in resilient material such as rubber, cork, or felt.

Install Double-Glazed Windows. Double-glazed windows are paired panes separated by an airspace or hung in a special frame. Generally, the performance of the double-glazed window may be increased with:

- increased airspace width
- increased glass thickness
- proper use of sealings
- slightly dissimilar thicknesses of the panes
- slightly non-parallel panes

In general the airspace between the panes should not be less than 2-4 inches if an STC above 40 is desired. If this is not possible, a heavy single-glazed window can be used. The use of slightly non-parallel panes is a technique employed when extremely high sound insulation is required, such as in control rooms of television studios.

The thickness of double-glazed panes may vary from 1/8 to 1/4 inch or more per pane. Although thickness is important, the factors which most determine the noise resistance of the window is the use of sealant and the width of the airspace.

As in the case of all windows, proper sealing is extremely important. To achieve an STC above 43, double-glazed windows should be sealed permanently. If the windows must be openable, there are available special frames and sealers for openable windows which allow a maximum STC of 43.[1]

Permanently sealed double-glazed windows often require an air pressure control system to maintain a constant air pressure and minimal moisture in the airspace. Without this system, the panes may deflect, and, in extremely severe cases, pop out of the frames.

[1]Ibid.

To further insure isolation of noise between double-glazed panes, the panes could be of different thicknesses, different weights, and slightly non-parallel to each other. This prevents acoustical coupling and resonance of sound waves.

Doors

Acoustically, doors are even weaker than windows, and more difficult to treat. Any door will reduce the insulation value of the surrounding wall. The common, hollow core wood door has an STC rating of 17 dB. Taking up about 20% of the wall, this door will reduce a 48 STC wall to 24 STC. To strengthen a door against noise, the hollow core door can be replaced by a heavier solid core wood door that is well sealed[1] and is relatively inexpensive. A solid core wood door with vinyl seal around the edges and carpeting on the floor will reduce the same 48 STC wall to only 33 dB.[2] An increased sound insulation value can be achieved if gasketed stops or drop bar threshold closers are installed at the bottom edge of the door. (See Figure 18)

The alternative solution to doors is to eliminate them whenever possible from the severely impacted walls and place them in more shielded walls.

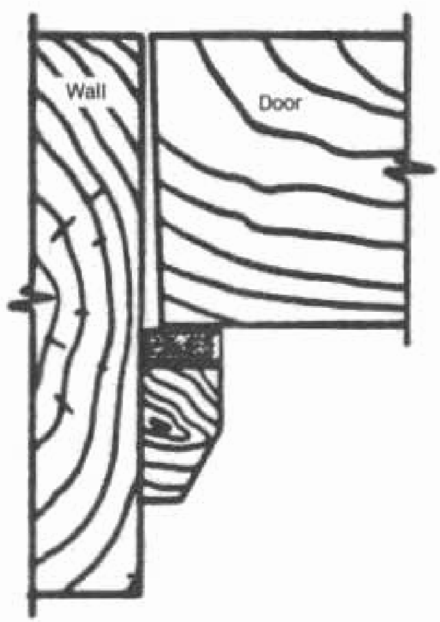
In any case no mail slots or similar openings should be allowed in exterior doors.

Roofs

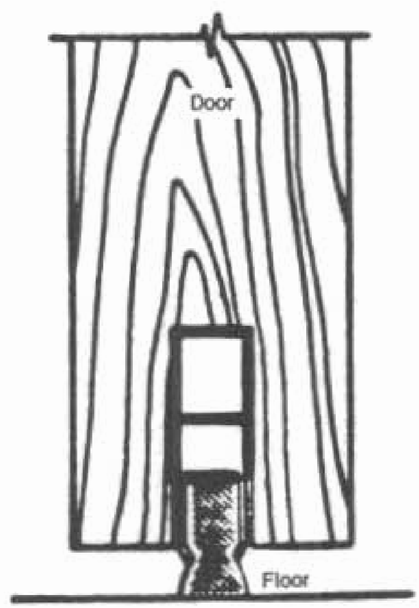
Acoustical treatment of roofs is not usually necessary unless the noise is extremely severe or the noise source is passing over the building. The ordinary plaster ceiling should provide adequate sound insulation except in extremely severe cases. An acoustically weak roof which is likely to require treatment is the beamed ceiling.[3] Beamed ceilings may be modified by the addition of a layer of fiberglass or some other noise resistent material. Suspended ceilings are the most effective noise reducers but they are also the most expensive.

[1]D.E. Bishop and P.W. Hirtle, "Notes on the Sound Transmission Loss of Residential-Type Windows and Doors," Journal of the Acoustical Society of America, 43:4 (1968).
[2]U.S. Gypsum, Sound Control... p. 100.
[3]Ibid p. 15.

Figure 18



Gasketed door stop



Drop bar threshold closer

Floors

In the case of highway noise, floors would only require acoustical treatment if the highway were passing under the building. In this case, flooring would have to provide protection against structural vibrations as well as airborne sound.

Two ways to insulate a floor from noise are to install a solid concrete slab at least 6 inches thick or install a floating floor. In general, the floating floor gives the greatest amount of sound and vibration insulation; however, it is extremely expensive. Basically, a floating floor consists of a wood or concrete slab placed over the structural slab, but separated by a resilient material. The resilient material isolates the surface slab from the structural slab and the surrounding walls.

What to Look for When Reviewing Plans

The number of possible combinations of the building materials that go into walls, ceilings, windows and doors, is, no doubt, considerably short of infinite. It is however still a very large number, large enough that it would be impossible to compile a list of all the possible combinations. Therefore, do not expect to find in this section, or anywhere else for that matter, a neat table showing the STC ratings for all the types of construction you may encounter. In fact, it is not really your responsibility to determine the precise STC ratings for the walls, ceilings, windows and doors in the projects you review. Your job is simply to review the attenuation levels claimed by the sponsor/developer and determine whether or not they are reasonable.

To enable you to perform the above described task, we have prepared a list of the most common types of construction for which we have STC ratings. By comparing the type of construction proposed to one of these "model" types you should be able to tell whether the claimed STC rating is reasonable. For example, the sponsor/developer submits a description of his building stating that a 2 × 6 stud wall with standard sheathing, insulation, wood siding, and 1/2" gypsum board achieves a STC rating of 48. You look at Table 3 and find that the closest "model" wall is a 2 × 4 stud wall with wood siding, sheathing, insulation, and 1/2" gypsum board. This wall has a STC rating of 39. An 9 dB difference is quite significant considering that the walls are really quite similar. You would probably want to go back to the developer/sponsor and ask for some supporting data that proves that the 2 × 6 wall he proposes will indeed provide 48 dB of noise attenuation.

In order to make it easier to review the attenuation levels provided by the proposed construction, we suggest that you ask the developer/sponsor to complete a form such as shown in Figure 19. Such a form will give you all the information you need in a properly organized format that will facilitate your review. You could fill in the first part and simply have the developer/sponsor fill out the second part and return it with the developer certification or other project documents.

As you will recall from the previous section, most walls provide pretty good attenuation by themselves. It is the presence of windows and doors and openings such as vents that reduces the attenuation capability of the wall. Thus, after you have determined whether the basic wall itself has a reasonable STC, you must review the impact of the windows and doors. You do this by using Figure 17. First you determine the difference between the STC ratings for the wall and the windows. You enter the vertical axis of Figure 17 with that number. You read across until you intersect the line that represents the percentage of the wall taken up by the windows. Then you read down to the horizontal axis where you wil find the value to be subtracted from the basic STC value of the wall. The resulting number is the combined STC value for the wall. If the wall also contains a door, repeat the same procedure, only start out with the modified STC rating for the wall. If the wall has doors only, then obviously you start with the basic wall STC rating. Finally you compare the number you have derived with that listed by the developer/sponsor. If they are fairly close, you need not pursue it further. If there is a substantial difference, you should ask for an explanation or documentation from the developer.

Once again, we caution you about borderline cases. If the attenuation required is 30 dB and the STC rating for the proposed construction is exactly 30 dB, you may want to ask the developer to provide even more attenuation. Remember that we discussed how the STC rating may overstate the actual attenuation provided by as much as 3 dB. If an additional 3 dB can be achieved at minimum cost, we would strongly urge that you seek it from the developer/sponsor.

Finally check to make sure the developer has provided some form of mechanical ventilation. If it's a single family house and a whole house fan is the means of ventilation being provided make sure that there are operable windows on walls which do not face the noise source(s) nor are perpendicular to the source(s). Otherwise the residents will have to open windows on the exposed wall, thus cancelling out much of the attenuation achieved.

Table 3
STC Ratings for Typical Building Components[1]

Building Component	Description	STC Rating
Frame Wall	a. 5/8" × 10" Redwood Siding b. 1/2" Insulation Board Sheathing c. 2 × 4 studs 16" o.c. d. Fiberglass Building Insulation e. 1/2" Gypsum Board attached directly to studs	39 dB
Stucco/Frame Wall	a. 7/8" Stucco b. No. 15 felt Building Paper and 1" Wire Mesh c. 2 × 4 Studs 16" o.c. d. Fiberglass Building Insulation e. 1/2" Gypsum Board attached directly to studs	46
Brick Veneer Wall	a. Face Brick b. 1/2" Airspace with metal ties c. 3/4" Insulation Board Sheathing d. 2 × 4 Studs 16" o.c. e. Fiberglass Building Insulation f. 1/2" Gypsum Board attached directly to studs	56
Masonry Wall	a. 1" Stucco b. 8" thick Hollow Concrete Block c. 1/2" Gypsum Board attached to furring strips	49 (estimated)
Windows	Wood double hung, closed but unlocked, single glazing	23
	Aluminum sliding, latched, single glazing	24
	Wood double hung, closed but unlocked, glazed with 7/16" insulating glass	22
	Aluminum single hung, closed, glazed with 7/16" insulating glass	25
	Wood, double hung, sealed, glazed with 7/16" insulating glass with single glazed storm sash-2 1/8" separation	35
	Aluminum sliding, closed, single glazed with single glazed storm sash, 1/8" separation	22
Exterior Doors	Wood, flush solid core, with brass weather stripping	27
	Wood, flush solid core, plastic weather stripping, aluminum storm door	34
	Wood, French door, brass weather stripping	26
	Steel, flush, with urethane foam core, with magnetic weather stripping	28
Roof	Shingle Roof with attic, 1/2" gypsum wall board ceiling framed independently of roof	43 (estimated)

[1]Except as noted, all STC ratings are from: *Acoustical and Thermal Performance of Exterior Residential Walls, Doors and Windows*, National Bureau of Standards.

Figure 19
Description of Noise Attenuation Measures
(Acoustical Construction)

Part I

Project Name ______________________________

Location ______________________________

Sponsor/Developer ______________________________

Noise Level (From NAG) ______________ Attenuation Required ______________

Primary Noise Source(s) ______________________________

Part II

1. For Walls (s) facing and parallel to the noise source(s) (or closest to parallel):
   a. Descripton of wall construction* ______________________________

      ____

   b. STC rating for wall (rated for no windows or doors): ______________

   c. Description of Windows: ______________________________

      ____

   d. STC rating for window type ______________________________

   e. Description of doors ______________________________

      ____

   f. STC rating for doors ______________________________

   g. Percentage of wall (per wall, per dwelling unit) composed of windows ______________ and doors ______________

   h. Combined STC rating for wall component ______________

2. For walls perpendicular to noise source(s):
   a. Description of wall construction* ______________________________

      ____

   b. STC rating for wall (rated for no windows or doors) ______________

   c. Description of windows ______________________________

      ____

   d. STC rating for windows ______________________________

   e. Description of doors ______________________________

      ____

f. STC rating for doors ______

g. Percentage of wall (per wall, per dwelling unit) composed of windows ______ and doors ______

h. Combined STC rating for wall component ______

3. Roofing component (if overhead attenuation is required due to aircraft noise):
   a. Description of roof construction ______

   ______

   b. STC rating (rated as if no skylights or other openings) ______

   c. Descripton of skylights or overhead windows ______

   ______

   d. STC rating for skylights or overhead windows ______

   e. Percentage of roof composed of skylights or windows (per dwelling unit) ______

   f. Percentage of roof composed of large uncapped openings such as chimneys ______

   g. Combined STC rating for roof component ______

4. Description of type of mechanical ventilation provided ______

   ______

Prepared by ______

Date: ______

*If walls contain vents or similar openings, attach a description of duct arrangement and insulation and a statement of how much the wall STC is reduced by the presence of the vent.

Figure 19
Description of Noise Attenuation Measures (Acoustical Construction)

Part I

Project Name PARADISE HOMES

Location ANYTOWN

Sponsor/Developer JOAN DOE + ASSOC. INC.

Noise Level (From NAG) 73 Attenuation Required 30db

Primary Noise Source(s) HIGHWAY

Part II

1. For Walls (s) facing and parallel to the noise source(s) (or closest to parallel):
   a. Descripton of wall construction* 3/8" FIR PLYWOOD SIDING, 2 X 4 STUDS 16" o.c. 3½" FIBERGLASS INSULATION
   b. STC rating for wall (rated for no windows or doors): 37
   c. Description of Windows: WOOD DOUBLE HUNG, INSULATING GLASS
   d. STC rating for window type 22
   e. Description of doors WOOD, FLUSH, SOLID CORE
   f. STC rating for doors 30
   g. Percentage of wall (per wall, per dwelling unit) composed of windows 10% and doors 5%
   h. Combined STC rating for wall component 30db
2. For walls perpendicular to noise source(s):
   a. Description of wall construction* SAME AS ABOVE
   b. STC rating for wall (rated for no windows or doors) 37
   c. Description of windows SAME AS ABOVE
   d. STC rating for windows 22
   e. Description of doors NO DOORS

f. STC rating for doors —

g. Percentage of wall (per wall, per dwelling unit) composed of windows 10 % and doors 0

h. Combined STC rating for wall component 30

3. Roofing component (if overhead attenuation is required due to aircraft noise):
   a. Description of roof construction N/A

   b. STC rating (rated as if no skylights or other openings)

   c. Descripton of skylights or overhead windows

   d. STC rating for skylights or overhead windows

   e. Percentage of roof composed of skylights or windows (per dwelling unit)

   f. Percentage of roof composed of large uncapped openings such as chimneys

   g. Combined STC rating for roof component

4. Description of type of mechanical ventilation provided CENTRAL AIR Conditioning

Prepared by

Date:

*If walls contain vents or similar openings, attach a description of duct arrangement and insulation and a statement of how much the wall STC is reduced by the presence of the vent.

SAMPLE

Quiz on Noise Attenuation

Questions

1. What are the three basic ways to provide noise attenuation?
2. What are the responsibilities of HUD personnel regarding noise attenuation?
3. When a barrier is introduced between a source and a receiver the sound energy is redistributed along 3 indirect paths. What are these three paths?
4. What is "Path Length Difference" and how does it affect the attenuation level provided by a barrier?
5. What are "Transmission Loss Values?"
6. How does the transmission loss value of barrier material affect the attenuation capability of the barrier?
7. As a general rule, what transmission loss values should you look for?
8. If you have more than one barrier between the source and the receiver is the amount of attenuation increased substantially?
9. What are the four things to check when reviewing a proposed barrier?
10. List 3 ways to make a barrier more effective without increasing its overall height.
11. List 3 ways to make a barrier more effective without increasing its overall length.
12. What is the maximum percentage of the total area of a barrier that can be made up of openings without a significant loss in barrier effectiveness?
13. List 3 site planning techniques that are used to shield residential developments.
14. When are parks and playgrounds not noise compatible uses that can be employed as buffers?
15. What are the two main things to look for when reviewing site plan changes?
16. What are some of the building orientations which can aggravate noise problems?
17. What is the Sound Transmission Class (STC) rating?
18. Which is better a high STC or a low STC rating?
19. What kinds of conditions were STC ratings originally developed for?
20. What should you do when using STC ratings in a transportation noise situation?
21. List 5 ways to improve the attenuation capability of a wall.
22. Windows are one of the acoustically weakest components in a wall. List 3 ways to reduce the negative effects of windows.
23. What is the best way to reduce the effect of doors?

Quiz on Noise Attenuation

Answers

1. a. barriers or berms
   b. site design
   c. acoustical construction
2. a. to make sure the project sponsor/developer is aware of the attenuation requirements
   b. provide sponsor/developer with an overview of available options
   c. review attenuation proposals to make sure they are adequate
3. a. A **diffracted** path over the top of the barrier
   b. A **transmitted** path through the barrier
   c. A **reflected** path away from the receiver
4. "Path Length Difference" is the difference in distance that sound must travel diffracting over the barrier rather than passing directly through it. Since sound energy decreases over distance, the greater the path length distance the greater the attenuation.
5. "Transmission Loss Values" represent the amount noise levels will be reduced when the sound waves pass through a barrier.
6. Since the attenuation provided by a barrier is a function of both the sound energy that goes over the top **and** the energy that goes through the barrier, if the transmission loss value is low then the effectiveness of the barrier will be greatly reduced.
7. If the transmission loss value of the barrier material is at least 10dB greater than the attenuation level provided by diffraction (i.e. barrier height) there shouldn't be any problem.
8. No. The combined effect of multiple barriers does not normally provide significantly greater attenuation than a single barrier. For design purposes, the general procedure is to assume the attenuation of the most effective barrier.
9. a. Is it high enough?
   b. Is it long enough?
   c. Is it made of the right material?
   d. Is it properly constructed?
10. a. move the barrier closer to the source
    b. bend the top of the barrier towards the source
    c. do both
11. a. move it closer to the receiver
    b. bend the ends toward the receiver
    c. do both
12. 1 percent
13. Any 3 of the below:
    a. increasing the distance between the source and the receiver
    b. placing noise compatible land uses between the source and the receiver
    c. locating barrier type buildings parallel to the source
    d. orienting residences away from the noise
14. when they are the only ones associated with the project
15. a. is the separation between the source and receiver great enough
    b. If a noise compatible building is being used as a barrier is it tall and long enough?
16. Building orientations which trap noise and cause it to reverberate off building walls. This would include shapes where a court is open to the source or where a series of buildings are arranged perpendicular to the source.
17. The STC rating is equal to the number of decibels a sound is reduced as it passes through a material.
18. A high STC rating is better.
19. The STC ratings were originally intended primarily for use with interior partitions and for noise such as speech, radios, television.
20. Recognize that the STC rating may overstate the effectiveness of the materials by 2–3db.
21. Any of the 9 below:
    a. increase the mass and stiffness of the wall
    b. use cavity partitions
    c. increase the width of the airspace
    d. increase the spacing between studs
    e. use staggered studs
    f. use resilient materials to hold the studs and finish materials together
    g. use of dissimilar layers (leaves)
    h. add acoustical blankets
    i. seal cracks and edges
22. Any of the 4 below:
    a. close the windows and provide mechanical ventilation
    b. reduce window size
    c. increase glass thickness
    d. install double glazed windows
23. Eliminate them from severely impacted walls

U.S. Department of Housing and Urban Development
Office of Community Planning and Development

Noise Notebook

Chapter 4
Supplement

Sound Transmission Class Guidance

Table of Contents

Sound Transmission Class Guidance

Introduction

The Noise Guidebook, pages 33-37, provides an elementary discussion of STC, provides some STC ratings for common building materials and limited exterior and interior wall construction configurations, and describes a method to determine composite STC value of a wall containing a window or door. This update provides for an understanding of STC and provides an expanded material and construction classification for both internal and external building materials and typical construction patterns.

The intent of this chapter is not to endorse anyone building manufacturer or product over another but to keep HUD Environmental staff and other interested persons advised on the STC values of current building materials and practices which can be applied to HUD supported housing activities. Additional subsections on specific types of building materials, construction techniques and STC values will be periodically added.

As stated in the Noise Guidebook, "STC is used as a measure of a material's ability to reduce sound," and effectively mitigate any adverse noise levels that could impede a person's use of a residential or commercial structure. The higher the STC value, the greater the sound attenuation and presumably the quieter the structure's interior. In addition to STC, another interior building measuring technique to evaluate sound impact or absorption between floors is the Impact Isolation Class (IIC). Both techniques will be fully discussed after a brief explanation of the following basic principals related to sound.

What Is Sound

Sound is indicated in two ways: frequency and intensity. Frequency, the high or low pitch of sound, is expressed as the number of vibrations or cycles per second. One vibration or cycle per second is a hertz (Hz). For example on a piano the middle C note has a frequency of 262 Hz and the total range of a piano has a frequency of 27 Hz to 4186 Hz, well within the 16 to 20,000 Hz range of the human ear. The sound created by the piano is heard by the human ear by air pressure created by vibration. The greater the pressure, the greater the loudness or intensity of the sound heard by the human ear. Loudness is expressed in decibels (dB). The decibel is one-tenth of a "Bel," a unit named for Alexander Graham Bell. Since the ear is more sensitive to sound in the middle range of frequencies, loudness (intensity) is determined at a frequency of 1,000 Hz. On the decibel scale, 0 dB indicates a level of sound at 1,000 Hz, a sound just barely audible to person with normal unimpaired hearing.

The A-weighted scale of a sound meter is designed to adjust the sensitivity of a sound meter to sounds of different frequencies that closely approximate how the human ear might respond to moderate sound levels in the 1,000 to 4,000 Hz range. The A-weighted sound level is used extensively for measuring community and transportation noises.

The Sound Transmission Class (STC), measured in decibels, is used to measure building material's ability to absorb sound. The STC can be used to measure sound absorption for both external building walls and internal walls in single and multifamily structures. The STC is measured by positioning a representative sample of the building material midway in an acoustical chamber, dividing the chamber in half or into two rooms. One section of the chamber contains the sound source and the other section the sound receiving equipment. The test procedure calls for a steady sound in the source room and measuring the sound level in both the source and receiving rooms. Differences in sound levels in the rooms determines the transmission loss characteristics of the material tested. For example, if a generated sound level of 80 dB is measured in the source room and 30 dB is measured in the adjacent receiving room, the tested material has a sound reduction intensity (STC) of 5OdB.

The Impact Isolation Class (IIC), measured in decibels, is the classification system used to determine sound *impact* from floor to ceiling in a structure. The IIC is not to be used to measure airborne sound penetration or absorption in walls. The IIC numerical rating efficiency increases with improved impact isolation performance of the floor and its component sub flooring and materials. The rating scale values are generally equivalent to the airborne sound transmission loss. The impact of steps or vibrations on a floor and the reverberation of that noise in the room below is dependent upon the type, density and thickness of the floor and ceiling material, its absorption material, and quality of construction. A separate section on common floor materials and construction patterns to illustrate both the STC and IIC ratings is included.

Sound Reduction In Structures

Four general techniques for controlling noise in single-family and multifamily structures are:

1. Elimination of the cause or source of the noise,
2. Employ materials which absorb sound rather than reflect noise,

3. Use sound barriers in building layout to prevent sound from being transmitted from one adjoining area into another, and
4. Use design considerations to mask or absorb the noise.

A description of each technique and its applicability follows.

1. ELIMINATION:
The elimination of a noise source may be impractical or impossible to achieve, whether emanating from within or outside the structure. Examples include the operation of mechanical equipment within the dwelling unit, excessive corridor noise, air conditioning/heating system, elevators, exhaust fans, and outdoor transportation sounds such as automotive traffic, aircraft overflights, and commercial or industrial activities. Some noise reduction could be achieved through sound reduction or absorption techniques, but total elimination of these sounds may be impossible.

2. ABSORPTION:
Sound absorption control is the reduction of sound emanating from a source within a room. The extent of control depends upon the efficiency of the room's surfaces in absorbing rather than reflecting sound waves. A surface, which could theoretically absorb 100% of the sound would have a sound absorption coefficient of 1.0. A surface absorbing 35% of the sound would have a coefficient of 0.35. The effectiveness of wall construction as a means of sound absorption is tested in a similar manner as that of STC. If a generated sound level of 80 dB is observed in one room and 30 dB is measured in an adjacent room, the reduction in sound absorption for the intervening wall is 50 dB. In choosing the type of construction material for interior walls to absorb sound transmission, porosity and density of the material should be considered. Resistance to sound transmission increases with unit weight and decreases with porosity. For example, unpainted, open textured concrete block exhibits improved resistance to sound passage after sealing the surface with plaster or paint. The sealing of the pores result in a reduction in the sound absorption of the block. In multifamily structures using concrete block partitions to separate public areas such as stairwells and corridors from adjacent living areas, sound transmission reduction is achieved through plastering or painting the surface of the residential unit or living area on the opposite side of the partition. The sound is absorbed by the concrete masonry's unpainted side and its transmission is prevented into the residential unit or living area by the plaster or paint on the other side.

However, all of the design elements that are employed to control sound can be nullified through poor or improper construction practices. Sound leakage will occur through any opening in a wall. An improperly fitted door or window is a prime source of sound leakage, as well as openings around ducts, pipes and electrical outlets which are improperly fitted or sealed.

3. SOUND BARRIERS:
Prudent building layout can be effective in controlling noise in single-family and multifamily housing. Sound waves can be prevented from being transmitted from one adjoining area to another. Closets, stairways and corridors can be used as buffers against airborne sound transmission between apartments or bedrooms. Concrete blocks or solid partitions can be employed to separate boiler rooms, air conditioning units, work areas or noisy public areas such as stairwells, corridors or lobbies from adjacent living areas. Partitions designed to absorb sound on one side and to retain sound absorption on the other can effectively block or reduce sound transmission into living areas intended for quiet use. The barrier should have a high sound absorption coefficient on one side and an equally high sound retention coefficient on the reverse side to effective. For example, unpainted porous concrete block would have a high sound absorption coefficient and a high noise retention coefficient on the reverse side if the porous surface in the living unit was effectively sealed by plaster or paint. Similarly, noise originators such as cloths washing machines, central heaters, and other noisy major appliances can be placed in a basement or utility rooms that are physically isolated from other living areas by walls or floors to absorb or block the emitted sounds.

4. DESIGN:
Design factors is the last major element to consider in controlling noise in single-family and multifamily structures. Design considerations offer the most infinite prospects for controlling noise due to the numerous types of building designs. For example, adjacent apartments can be arranged to have quiet areas (bedrooms or living rooms) abut and have noisy areas (kitchens and bathrooms) next to similar noisy areas. Apartment door openings into the same hallway can be staggered to reduce sound penetration into the unit directly across the hall. Since sound travels in a straight line, some of the sound from one doorway would be absorbed or diffused into the wall building material of the unit directly across the hall.

Windows should be placed as far away as possible from common walls. The closer the windows are to each other, the more sound will pass from one apartment to another. Medicine cabinets in opposite bathroom partitions should be offset. Cabinets placed back-to-back will transmit almost as much noise as an opening. Heating/cooling ducts are like speaking tubes, carrying noise from one room to another. Techniques should be employed to trap or splinter sound or have turns in the ducts to reduce noise transference.

Noise producing equipment should be kept as far as possible from living areas and especially the bedrooms. Flexible connectors should be used to couple mechanical equipment to pipes and ducts. Pipes and ducts should not be firmly connected to parts of a building that could serve as sounding boards but be supported by resilient connections to solid supports. Where pipes and ducts pass through walls and floors, they should be isolated by gaskets. The acoustical integrity of a building or a building section with an otherwise adequate STC rating can be significantly reduced by a small hole or crack in the exterior wall or any other path that allows sound to bypass the exterior or interior walls and flow into other areas of the structure.

Weather and Sound

Air will attenuate noise at high frequencies usually from 1,000 Hz upwards. Sound absorption by air changes with wind speed, temperature and humidity. For example, wind blowing at slower speeds near the ground surface than at higher elevations will produce a bending of the sound upwards, resulting in less noise at ground level. Temperature gradients have a similar effect because the velocity of sound increases with the higher temperatures. If the temperature is higher near the ground than in the upper layers (usually the case during the day), the sound waves higher above the ground will travel slower and the sound will be bent upwards resulting in quieter conditions at ground level. The reverse is true at night, the temperature is lower near the ground, sound will bend towards the ground, increasing noise at the ground level. Wind and temperature- gradient effects can also account for the occasional freak reception of sounds over long distances, especially train whistles. The sound has been bent upwards by a temperature or wind gradient and after traveling some way at high level is bent down again by a reverse gradient.

Weather conditions can produce substantial variations of as much as +- 10 dB. For example, fog causes an increase in the absorption in the air. A moderately dense fog, visibility 150 feet, gives extra attenuation of 1 to 3 dB per 300 feet, depending on frequency. Similarly, snow forms an absorbent layer on the ground, which affects ground reflection, thereby reducing the sound level.

Weather can also be a significant source of noise in a structure. Common irritants are wind and rain. Wind whistling around a building, into ventilation grilles, screens or past other external architectural or artistic features can result in disturbing noise. Similarly, the impact of rain on lightweight roofing, gutters or skylights can produce high internal noise levels.

STC Ratings for Wall, Floor and Window Materials and Assemblies

Appendix A illustrates sound transmission class ratings for wall, floor, window and door assemblies. The data used in this section is compiled from laboratory reports and various technical and trade literature publications received by this Office. Each item has an assigned STC rating, an accompanying sketch and a brief description of its composition or assembly. In addition, where possible, an Impact Isolation Class (IIC) rating has been assigned to floors to determine sound impact from floor to ceiling. Appendix A is a guide designed to aid HUD Housing and Environmental personal in determining STC values for most common housing construction practices and materials used in residential construction. The STC information can be used to supplement acoustical measurements by providing approximate interior noise levels for existing or proposed dwellings located in high noise areas by deducting the STC value from the exterior noise level. The data could also be used to advise HUD clients in determining and achieving compliance with the noise criteria stated in 24 CFR Part 51 B through the use of common construction materials and techniques to achieve noise attenuation for new construction and rehabilitation.

The appendix is divided into the following subsections:

1. WALLS
   - Exterior
   - Interior
2. FLOORS
   - Wood
   - Concrete
3. WINDOWS
4. DOORS
   - Exterior
   - Interior

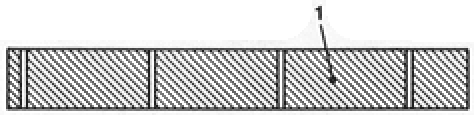
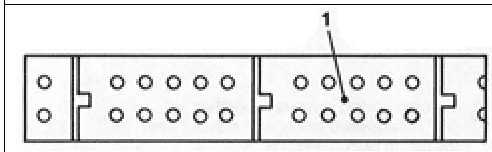
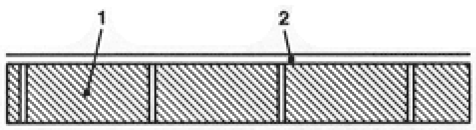
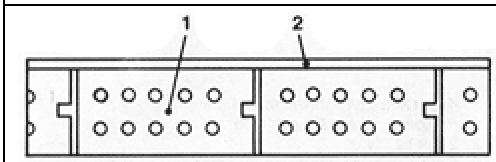
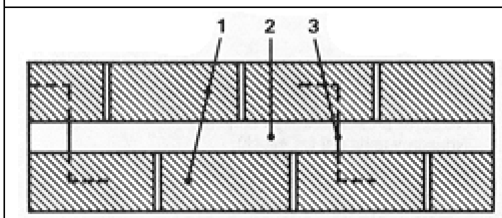
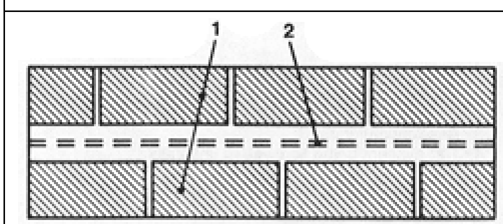
A bibliography of the reports, manufacturer's catalogs, technical papers, testing laboratories and other publications used in compiling this data is listed in the Appendix B.

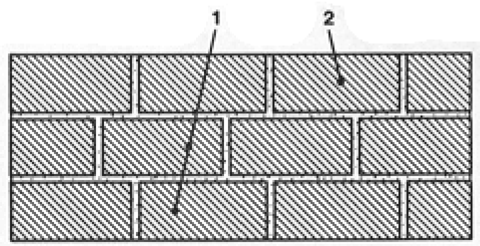
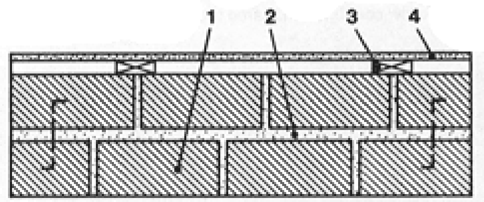
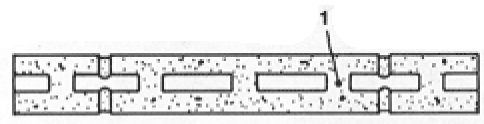
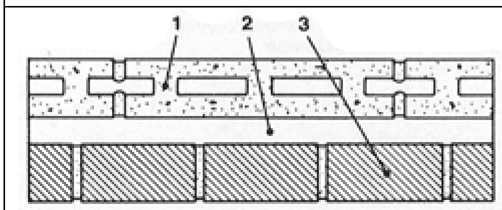
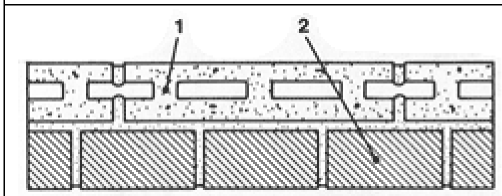
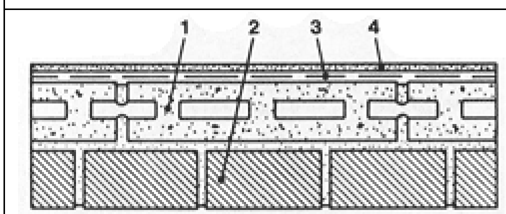
Appendix A STC Ratings

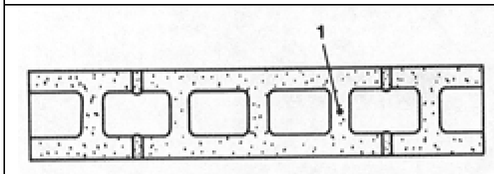
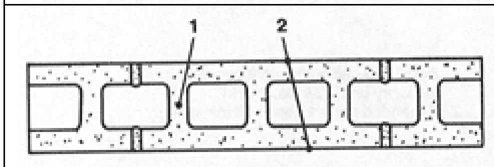
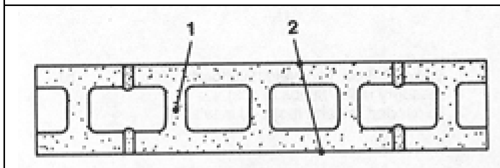
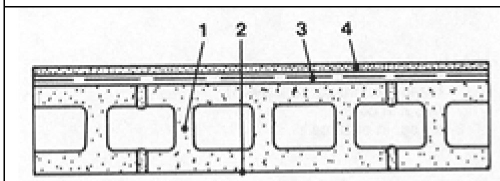
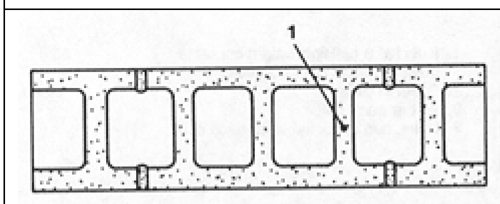
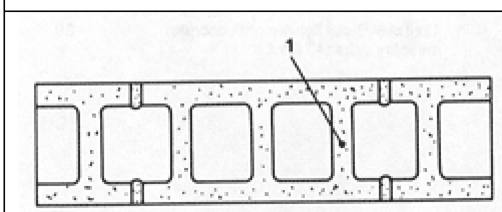
Appendix A

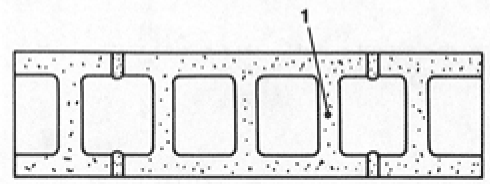
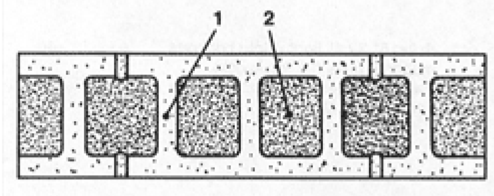
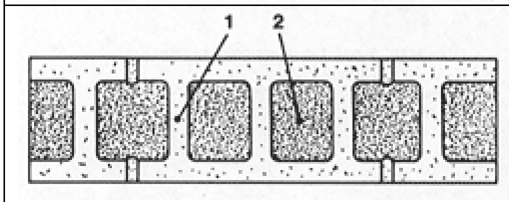
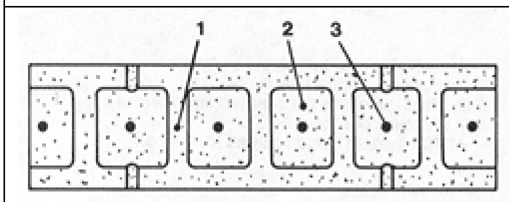
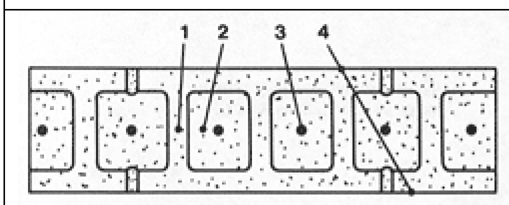
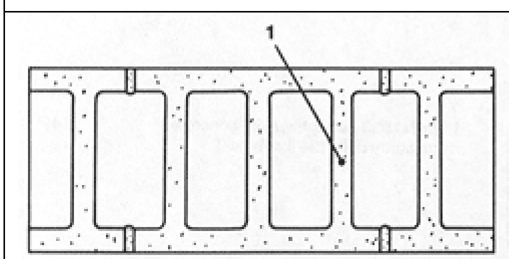
Walls: Exterior

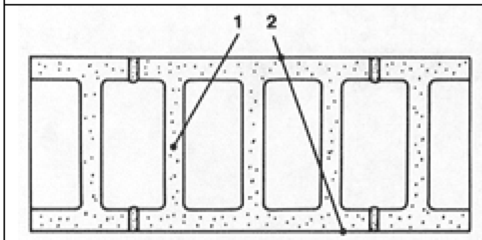
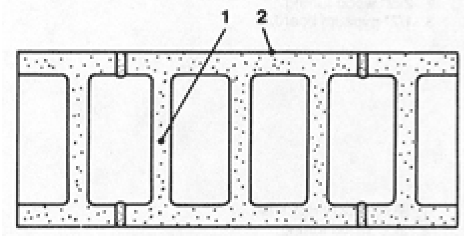
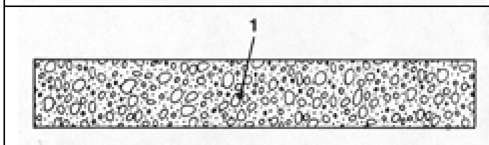
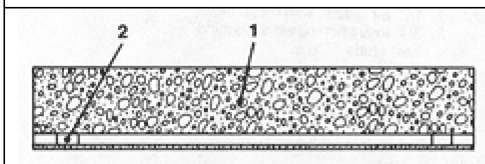
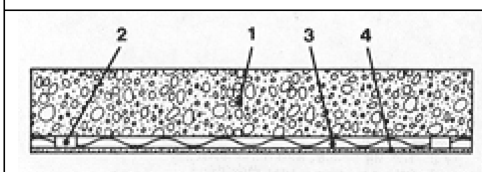
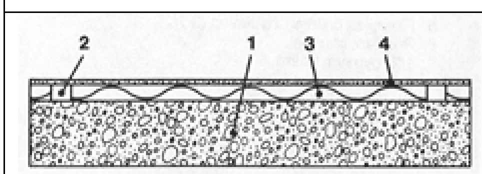
STC Ratings

Sketch	Brief Description	STC
	1. 4” face brick, mortared together.	45
	1. Hollow core brick, mortared together.	51
	1. Common brick, mortared together. 2. ½” gypsum/sand plaster.	50
	1. Hollow core brick, mortared together. 2. ½” gypsum/sand plaster.	53
	1. Face brick, mortared together. 2. 2” air space. 3. Metal ties.	50
	1. Brick, mortared together. 2. 2 ¼” cavity filled with concrete grout and #6 bars vertically 48”o.c. and #5 bars horizontally 30”o.c.	59

Sketch	Brief Description	STC
	1. Common brick, mortared together. 2. Face brick, mortared together.	59
	1. Common brick, mortared together. 2. ¾″ mortar-filled cavity with metal Z ties 24″o.c. in both directions. 3. 1x3″ furring strips 16″o.c. and nailed vertically into mortar joints 12″o.c. 4. ½″ gypsum board nailed 8″o.c. along edges and 12″o.c. in field.	53
	1. 4x8x16″ 3-cell lightweight concrete masonry units (17 lbs./block).	40
	1. 4x8x18″ 3-cell lightweight concrete masonry units (19 lbs./block). 2. 2″ air cavity. 3. Common brick, mortared together.	54
	1. 4x8x18″ 3-cell lightweight concrete masonry units (19 lbs./block). 2. Common brick, mortared together. (brick headers after every second course of block to tie the withes together).	51
	1. 4x8x18″ 3-cell lightweight concrete masonry units (19 lbs./block). 2. Common brick, mortared together. 3. Resilient channels. 4. ½″ gypsum board screwed to channels.	56

Sketch	Brief Description	STC
	1. 6x8x16" 3-cell lightweight concrete masonry units (21 lbs./block).	44
	1. 6x8x16" 3-cell lightweight concrete masonry units (21 lbs./block). 2. Paint both sides with primer-sealer coat and finish coat of latex.	46
	1. 6x8x18" 3-cell dense concrete masonry units (36 lbs./block). 2. Paint both sides with primer-sealer coat and finish coat of latex.	48
	1. 6x8x16" 3-cell lightweight concrete masonry units (21 lbs./block). 2. Paint, primer-sealer coat and finish coat of latex. 3. Resilient channels, 24"o.c. 4. ½" gypsum board screwed to channels.	53
	1. 8x8x16" 3-cell lightweight concrete masonry units (28 lbs./block).	45
	1. 8x8x18" 3-cell lightweight concrete masonry units (34 lbs./block).	49

Sketch	Brief Description	STC
	1. 8x8x18" 3-cell lightweight concrete masonry units (38 lbs./block).	49
	1. 8x8x18" 3-cell lightweight concrete masonry units (34 lbs./block). 2. Expanded mineral loose-fill insulation.	51
	1. 8x8x18" 3-cell lightweight concrete masonry units (38 lbs./block). 2. Expanded mineral loose-fill insulation.	51
	1. 8x8x18" 3-cell lightweight concrete masonry units (33 lbs./block). 2. Grout in cells. 3. #5 bar in each cell.	48
	1. 8x8x18" 3-cell lightweight concrete masonry units (33 lbs./block). 2. Grout in cells. 3. #5 bar each cell. 4. Paint two coats flat latex each side.	55
	1. 12x8x16" 3-cell lightweight concrete masonry units (43 lbs./block).	39

Sketch	Brief Description	STC
	1. 12x8x16. 3-cell lightweight concrete masonry units (43 lbs./block). 2. Paint both sides with 3 coats of latex block filler.	50
	1. 12x8x16” 3-cell lightweight concrete masonry units (43 lbs./block). 2. Paint one side only with 3 coats latex block filler.	51
	1. 6” cast concrete wall (71 psf).	57
	1. 6” cast concrete wall. 2. “Z” furring channels. 3. ½” gypsum board.	59
	1. 6” cast concrete wall. 2. “Z” furring channels. 3. 1”, 8-pcf rockwool. 4. ½” gypsum board.	62
	1. 6” cast concrete wall. 2. 2x2” wood furring. 3. 1 ½” 4-pcf rockwool. 4. ½” gypsum board.	63

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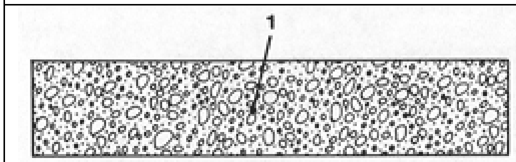
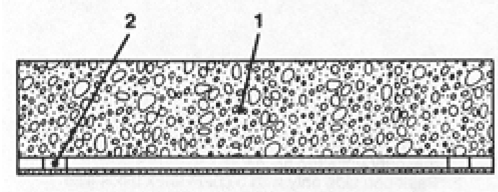
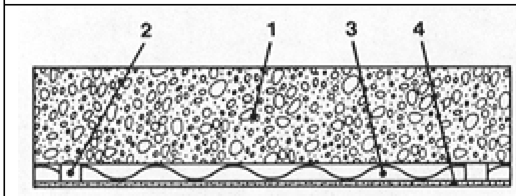
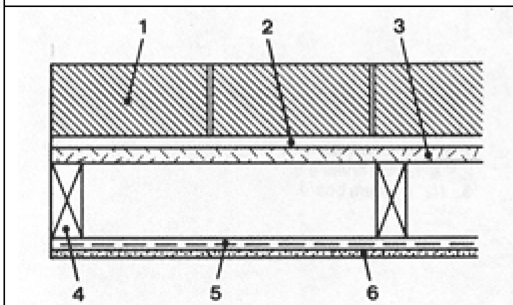
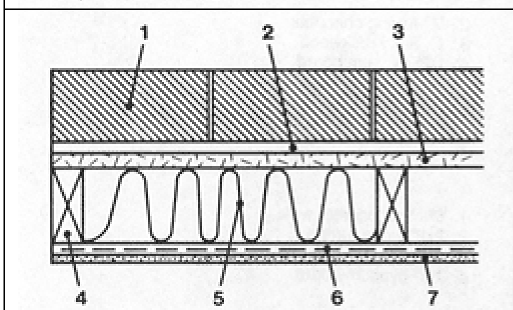
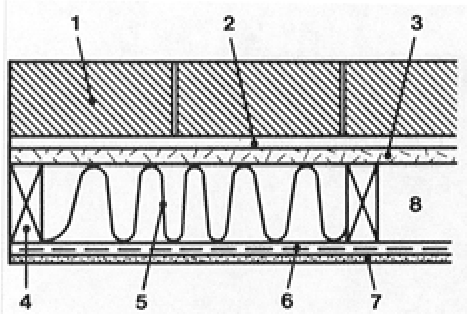
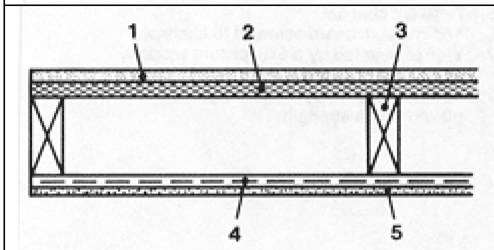
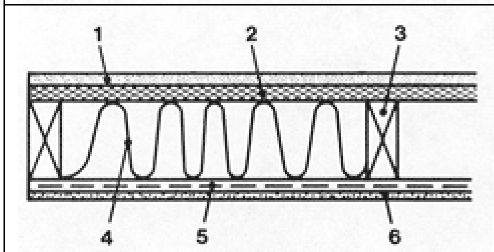
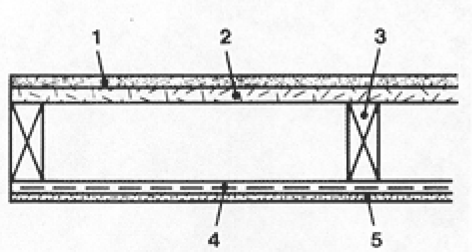
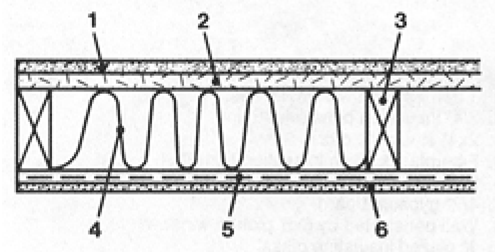
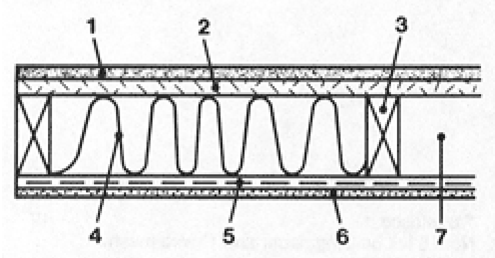
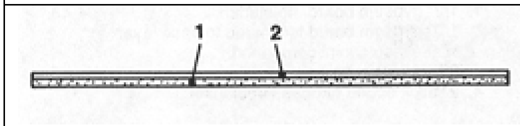
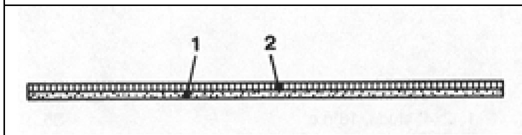
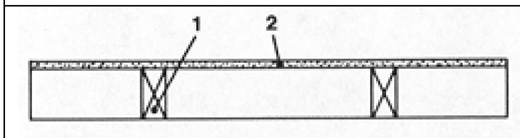
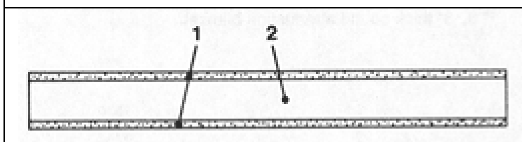
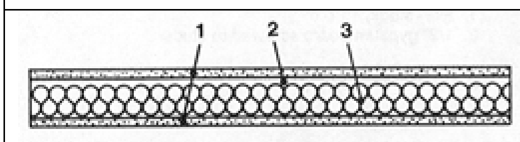
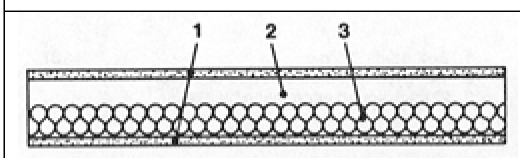
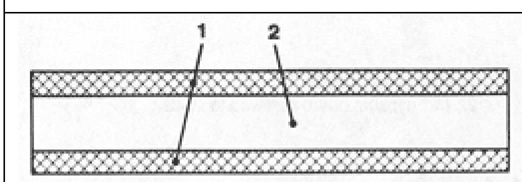
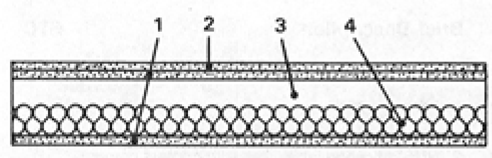
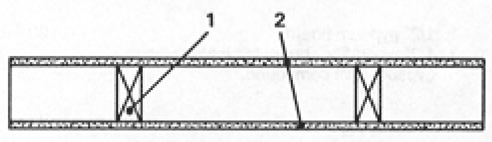
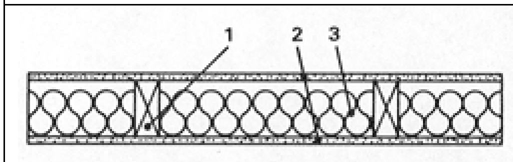
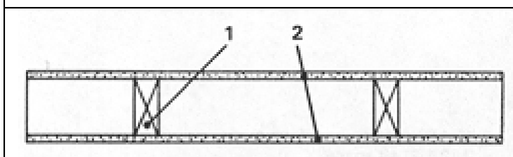
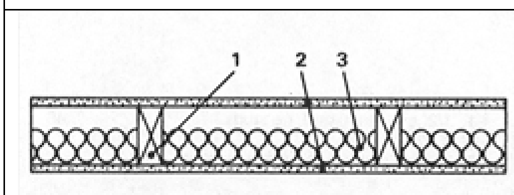
Sketch	Brief Description	STC
	1. 8” cast concrete wall (96.6 psf).	58
	1. 8” cast concrete wall. 2. 2x2” wood furring. 3. ½” gypsum board.	59
	1. 8” cast concrete wall. 2. 2x2” wood furring. 3. 1 ½”, 4 psf rockwall. 4. ½” gypsum board.	63
	1. Face brick. 2. ½” air space, with metal ties. 3. ¾” insulation board sheathing. 4. 2x4” studs 16”o.c. 5. Resilient channel. 6. ½” gypsum board.	54
	1. Face brick. 2. ½” air space, with metal ties. 3. ¾” insulation board sheathing. 4. 2x4” studs 16”o.c. 5. Fiberglas building insulation (3 ½”). 6. Resilient channel. 7. ½” gypsum board.	56

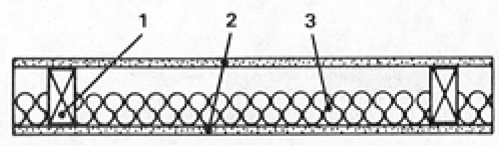
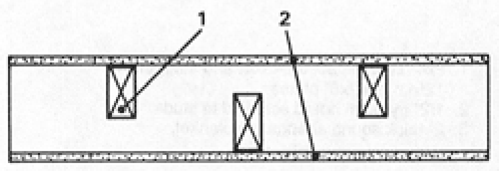
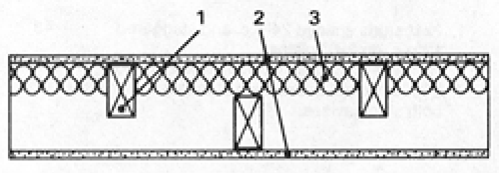
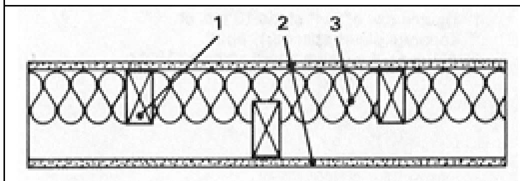
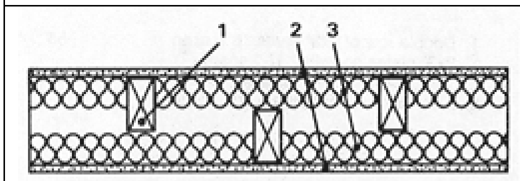
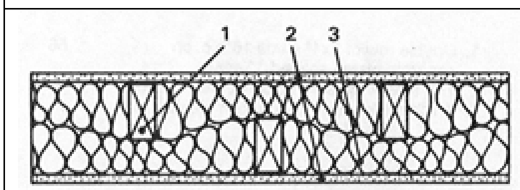
Sketch	Brief Description	STC
	1. Face brick (9x14’ wall). 2. ½” air space, with metal ties. 3. ¾” insulation board sheathing. 4. 2x4” studs 16”o.c. 5. Fiberglas building insulation (3 ½”). 6. Resilient channel. 7. ½” gypsum board. 8. Wall penetrated by 6x5' picture window 1” glazed insulating glass.	39
	1. 7/8” stucco. 2. No.15 felt building paper and 1” wire mesh. 3. 2x4” studs 16”o.c. 4. Resilient channel. 5. ½” gypsum board screwed to channel.	49
	1. 7/8” stucco. 2. No.15 felt building paper and 1” wire mesh. 3. 2x4” studs 16”o.c. 4. Fiberglas building insulation (3 ½”). 5. Resilient channel. 6. ½” gypsum board screwed to channel.	57
	1. 5/8 x 10” redwood siding. 2. ½” insulation board sheathing. 3. 2x4” wood studs 16”o.c. 4. Resilient channel. 5. ½” gypsum board screwed to channel.	43

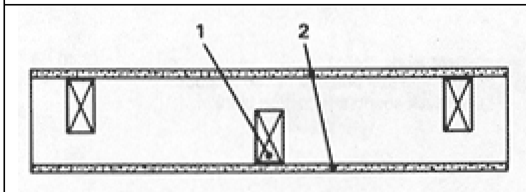
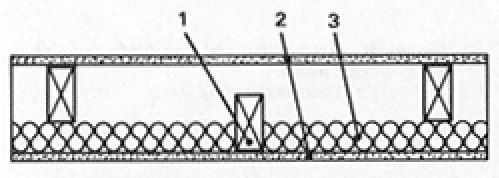
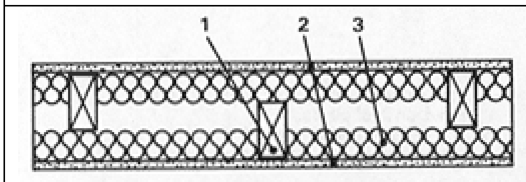
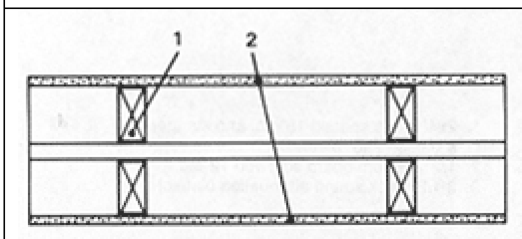
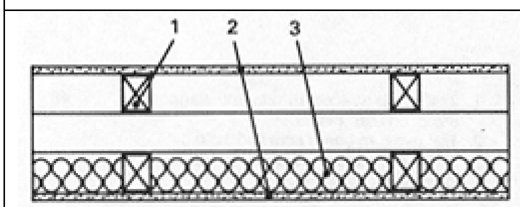
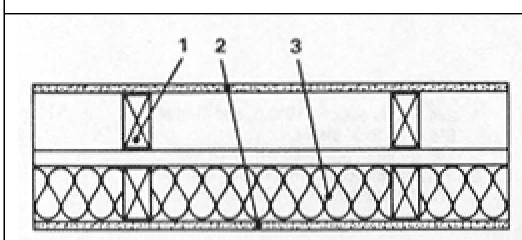
Sketch	Brief Description	STC
	1. 5/8x10” redwood siding. 2. ½” insulation board sheathing. 3. 2x4” wood studs 16”o.c. 4. Fiberglas building insulation (3 ½”). 5. Resilient channel. 6. ½” gypsum board screwed to channel.	47
	1. 5/8x10” redwood siding (9x14' wall). 2. ½” insulation board sheathing. 3. 2x4” wood studs 16.o.c. 4. Fiberglas building insulation (3 ½”). 5. Resilient channel. 6. ½” gypsum board screwed to channel. 7. a. Wall penetrated by a 6x5' picture window, 1” glazed insulating glass. b. Wall penetrated by a 6x5' 16 panel window, glazed single strength.	(a.38) (b.35)

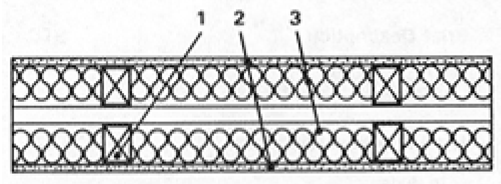
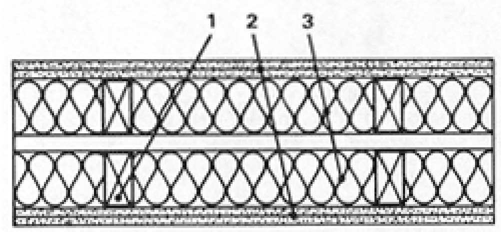
WALLS: Interior: Wooden Studs

Sketch	Brief Description	STC
	1. ½″ gypsum board. 2. 3/16″ plywood laminated with contact cement.	28
	1. ½″ gypsum board. 2. ½″ wood-fiber board laminated with gypsum joint compound.	30
	1. 2x4″ studs, 16″o.c. 2. 5/8″ gypsum board screwed to studs.	28
	1. ½″ gypsum board, no studs. 2. 2 ½″ air space.	30
	1. ½″ gypsum board, no studs. 2. 2 ½″ air space. 3. 2″ thick sound attenuation blanket.	44
	1. ½″ gypsum board, no studs. 2. 3 5/8″ air space. 3. 2″ thick sound attenuation blanket.	45
	1. 1 3/8″ thick wood-fiber board nailed to 2x4″ plates top and bottom and painted both sides. 2. 3 ½″ air cavity.	44

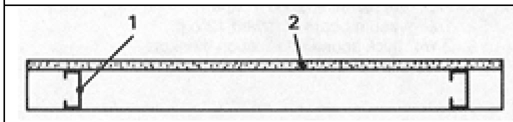
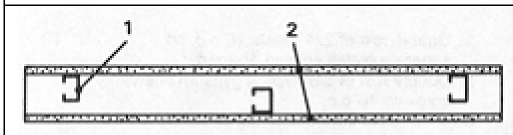
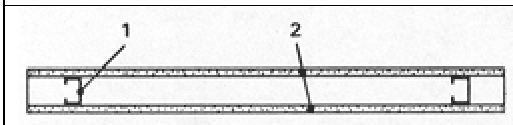
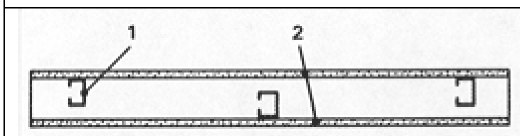
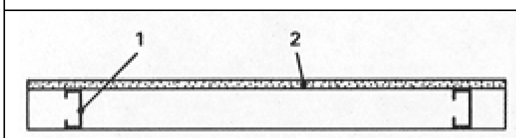
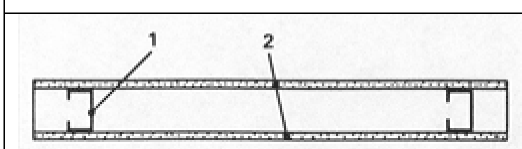
Sketch	Brief Description	STC
	1. ½" gypsum board, no studs. 2. ½" gypsum board laminated to base layer with gypsum joint compound. 3. 3 5/8" air cavity. 4. 2" thick sound attenuation blanket.	48
	1. 2x4" studs, 16"o.c. 2. 3/8" gypsum board nailed to studs.	35
	1. 2x4" studs, 16"o.c. 2. 3/8" gypsum board nailed to studs. 3. 3" thick sound attenuation blanket.	41
	1. 2x4" studs, 16"o.c. 2. ½" gypsum board screwed to studs.	34
	1. 2x4" studs, 16"o.c. 2. ½" gypsum board screwed to studs. 3. 2" thick sound attenuation blanket.	37
	1. 2x4" studs, 24"o.c. 2. ½" gypsum board screwed to studs.	36

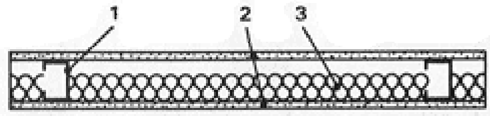
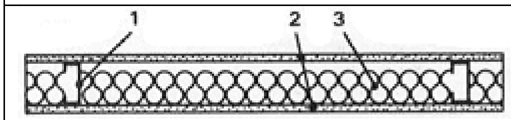
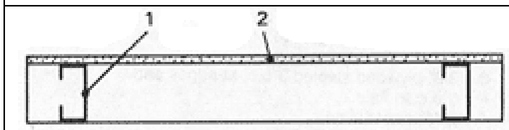
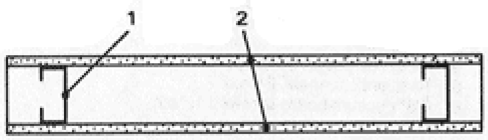
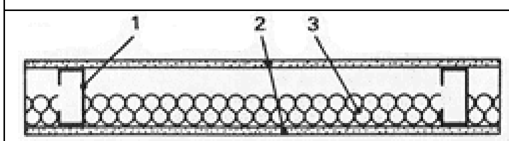
Sketch	Brief Description	STC
	1. 2x4"studs, 24"o.c. 2. ½" gypsum board screwed to studs. 3. 2" thick sound attenuation blanket.	40
	1. 2x4" studs spaced 16"o.c. and staggered 8"o.c. on 2x6" plates. 2. ½" gypsum board screwed 12"o.c.	39
	1. 2x4" studs spaced 16"o.c. and staggered 8"o.c. on 2x6" plates. 2. ½" gypsum board screwed 12"o.c. 3. 2 ¼" thick sound attenuation blanket.	48
	1. 2x4" studs spaced 16"o.c. and staggered 8"o.c. on 2x6" plates. 2. ½" gypsum board screwed 12"o.c. 3. 3 ½" thick sound attenuation blanket.	49
	1. 2x4" studs spaced 16"o.c. and staggered 8"o.c. on 2x6" plates. 2. ½" gypsum board screwed 12"o.c. 3. 2 ¼" thick sound attenuation blankets in both stud cavities.	49
	1. 2x4" studs spaced 16"o.c. and staggered 8"o.c. on 2x6" plates. 2. ½" gypsum board screwed 12"o.c. 3. 3 ½" thick sound attenuation blankets in both stud cavities.	51

Sketch	Brief Description	STC
	1. 2x4″ studs spaced 24″o.c. and staggered 12″o.c. on 2x6″ plates. 2. ½″ type X gypsum board screwed 12″o.c.	42
	1. 2x4″ studs spaced 24″o.c. and staggered 12″o.c. on 2x6″ plates. 2. ½″ gypsum board screwed to studs. 3. 2″ thick sound attenuation blanket.	46
	1. 2x4″ studs spaced 24″o.c. and staggered 12″o.c. on 2x6″ plates. 2. ½″ type X gypsum board screwed 12″o.c. 3. 2″ thick sound attenuation blankets in both stud cavities.	48
	1. Double row of 2x4″ studs 16″o.c. on separate plates spaced 1″ apart. 2. ½″ type X gypsum board screwed 12″o.c.	47
	1. Double row of 2x3″ studs 16″o.c. on 2x3″ plates spaced 2 ½″ apart. 2. ½″ gypsum board screwed 16″o.c. 3. 2 ¼″ thick sound attenuation blanket.	55
	1. Double row of 2x4″ studs 16″o.c. on separate plates spaced 1″ apart. 2. ½″ type X gypsum board screwed 12″o.c. 3. 3 ½″ thick sound attenuation blanket.	56

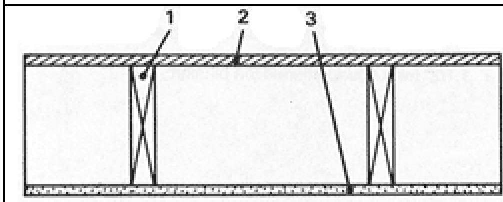
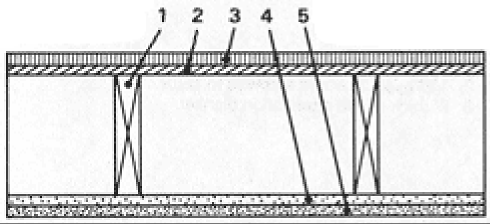
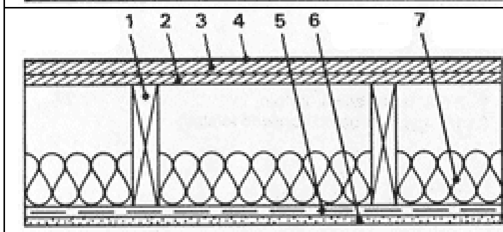
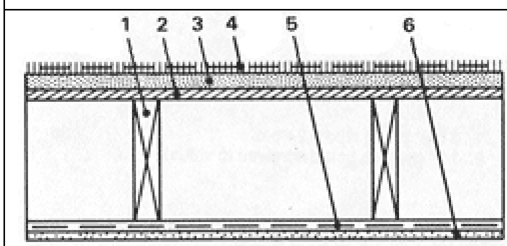
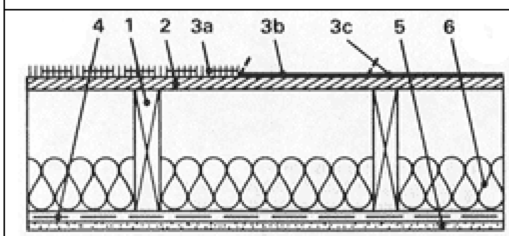
Sketch	Brief Description	STC
	1. Double row of 2x4″ studs 16″o.c. on separate plates spaced 1″ apart. 2. ½″ gypsum board screwed 12″o.c. 3. 2 ¼″ thick sound attenuation blankets in both stud cavities.	56
	1. Double row of 2x4″ studs 16.o.c. on separate plates spaced 1″ apart. 2. Double row of 5/8″ type X gypsum board screwed 16.o.c. 3. 3 ½″ thick sound attenuation blankets in both stud cavities.	63

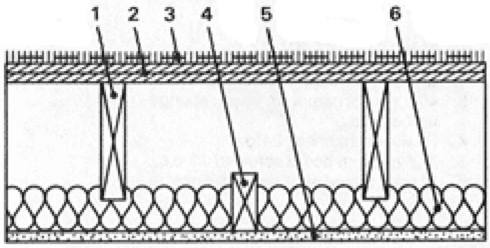
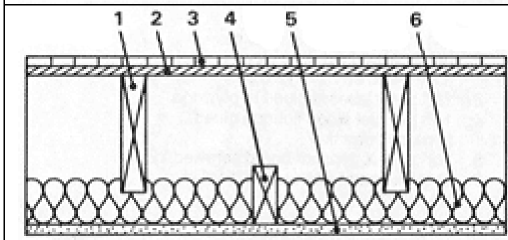
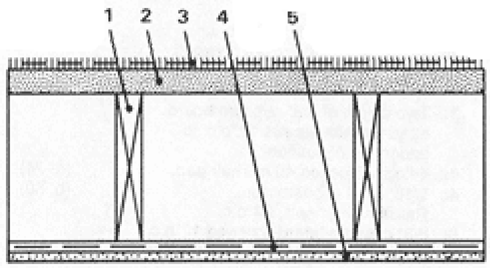
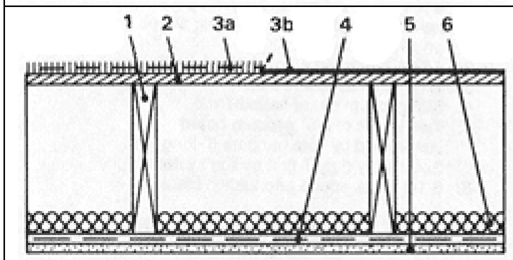
WALLS: Interior: Metal Studs

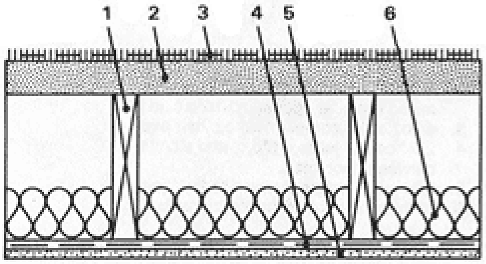
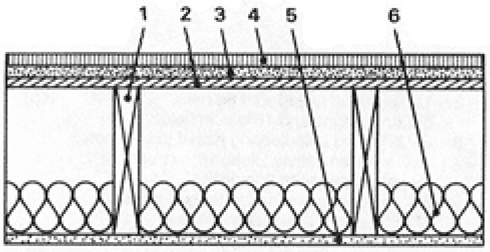
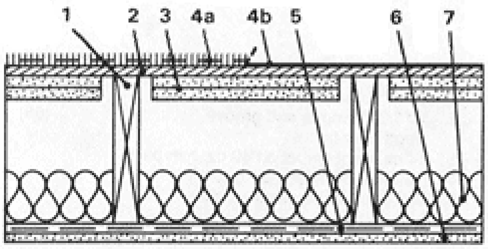
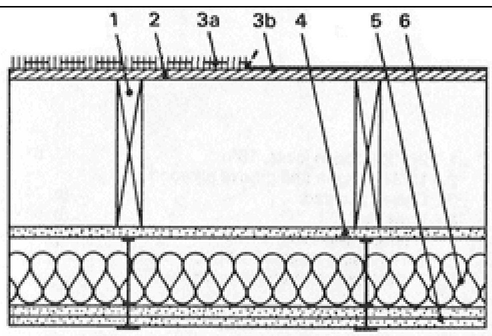
Sketch	Brief Description	STC
	1. 1 5/8” metal studs, 24”o.c. 2. 1/2. vinyl-faced gypsum board screwed to studs.	27
	1. 1 5/8” metal studs spaced 24”o.c. and staggered 12”o.c. on 2 ½” metal tracks. 2. 1/2” gypsum board screwed to studs.	34
	1. 1 5/8” metal studs, 24”o.c. 2. 5/8” gypsum board screwed 12”o.c. at edges and 24”o.c. in field.	37
	1. 1 5/8” metal studs spaced 24”o.c. and staggered 12”o.c. on 21/2” metal channels. 2. 5/8” gypsum board screwed to studs.	38
	1. 2 ½” metal studs, 24”o.c. 2. 1/2” vinyl-faced gypsum board screwed to studs.	27
	1. 2 1/2” metal studs, 24”o.c. 2. 5/8” gypsum board screwed to studs.	37

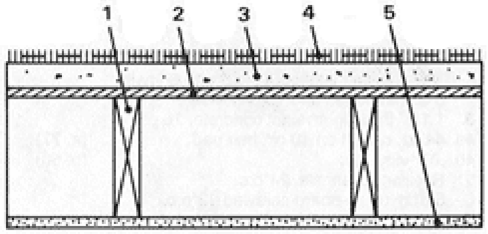
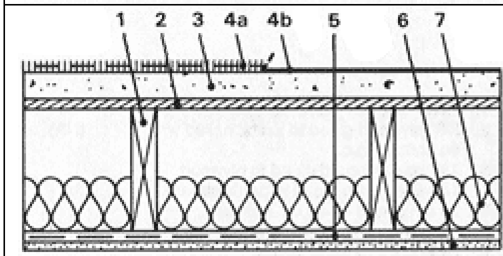
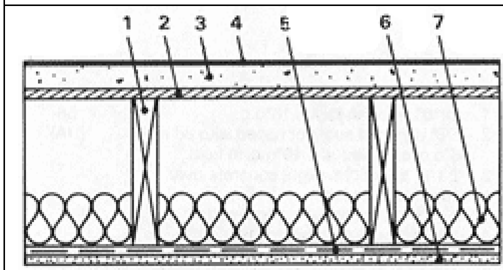
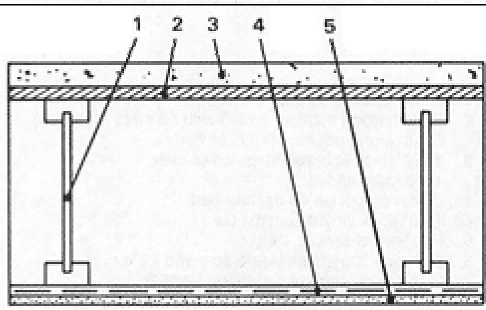
Sketch	Brief Description	STC
	1. 2 ½” metal studs, 24”o.c. 2. 5/8” gypsum board screwed 12”o.c. at edges and 24”o.c. in field. 3. 1 ½” thick sound attenuation blanket.	42
	1. 2 ½” metal studs, 24”o.c. 2. ½” gypsum board screwed to studs. 3. 2” thick sound attenuation blanket.	44
	1. 3 5/8” metal studs, 24”o.c. 2. 1/2. gypsum board screwed to studs.	27
	1. 3 5/8” metal studs, 24”o.c. 2. ½” gypsum board screwed to studs.	36
	1. 3 5/8” metal studs, 24”o.c. 2. ½” gypsum board screwed to studs. 3. 2” thick sound attenuation blanket.	44

Floors: Wood

Sketch	Brief Description	STC (IIC)
	1. 2x8″ wooden joists, 16″o.c. 2. 7/8″ tongue and groove nailed to joints. 3. 3/8″ gypsum nailed to joints.	NA (32)
	1. 2x8″ wooden joists, 16″o.c. 2. ½″ plywood nailed. 3. 25/32″ hardwood flooring. 4. 1/2″ gypsum nailed to joists. 5. Ceiling tire.	NA (37)
	1. 2x8″ wooden joists, 16″o.c. 2. 5/8″ tongue and groove plywood nailed with 8d nails 6″o.c. 3. 3/8″ plywood stapled 3″o.c. at edges and 6″o.c. in field. 4. .075″ sheet vinyl. 5. Resilient channels, 24″o.c. 6. 5/8″ gypsum board screwed 12″o.c. 7. 3″ thick sound attenuation blanket.	46 (44)
	1. 2x8″ wooden joists, 16″o.c. 2. 5/8″ plywood nailed with 8d nails. 3. ½″ nominal wood-fiber board glued to plywood. 4. 44 oz. carpet on 50 oz. pad. 5. Resilient channels, 24″o.c. 6. 5/8″ gypsum board screwed 12″o.c.	48 (65)
	1. 2x8″ wooden joists, 16″o.c. 2. 19/32″ tongue and groove plywood nailed with 8d nails 6″o.c. at edges and 10″o.c. in field. 3. a. 44 oz. carpet on 40 oz. hair pad. b. .075″ sheet vinyl. c. 1/16″ sheet vinyl. 4. Resilient channels, 24″o.c. 5. 5/8″ gypsum board screwed 12″o.c. 6. 3″ thick sound attenuation blanket.	48 (a. 69) (b. 45) (c.43)

<table>
<tr><th>Sketch</th><th>Brief Description</th><th>STC (IIC)</th></tr>
<tr><td></td><td>1. 2x8” wooden joists, 16”o.c.
2. 1 1/8” tongue and groove plywood nailed 6”o.c. at edges and 16”o.c. in field.
3. 44 oz. wool carpet on 40 oz. hair pad.
4. 2x4” ceiling joists, 16”o.c. and staggered between floor joists.
5. 5/8” gypsum board nailed to 2x4” joists.
6. 3” thick sound attenuation blanket.</td><td>53
(80)</td></tr>
<tr><td></td><td>1. 2x8” wooden joists, 16”o.c.
2. 1/2” plywood nailed with 8d nails 6”o.c. at edges and 16”o.c. in field.
3. 25/32” wood strip flooring nailed to sub floor.
4. 2x4” wooden ceiling joists, 16”o.c. and staggered between floor joists.
5. 5/8” gypsum board nailed to 2x4” joists.
6. 3” thick sound attenuation blanket.</td><td>54
(45)</td></tr>
<tr><td></td><td>1. 2x10” wooden joists, 16”o.c.
2. 1 11/32” tongue and groove wood-fiber board.
3. 44 oz. wool carpet on 40 oz. hair pad.
4. Resilient channels, 24”o.c.
5. 5/8” gypsum screwed 12”o.c.</td><td>49
(68)</td></tr>
<tr><td></td><td>1. 2x10” wooden joists, 16”o.c.
2. 19/32” tongue and groove plywood.
3.
a. Carpet and pad.
b. Vinyl tile.
4. Resilient channels, 24”o.c.
5. 5/8” gypsum screwed 12”o.c.
6. 1” thick sound attenuation blanket.</td><td>51
(a. 74)
(b.51)</td></tr>
</table>

Sketch	Brief Description	STC (IIC)
	1. 2x10″ wooden joists, 16″o.c. 2. 1 11/32″ tongue and groove wood-fiber board. 3. 40 oz. wool carpet on 80 oz. sponge rubber pad. 4. Resilient channels, 24″o.c. 5. 1/2″ gypsum board screwed 12″o.c. 6. 3″ thick sound attenuation blanket.	50 (72)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ plywood sub floor glued to joists, nailed with 8d nails 12″o.c. 3. ¼″ particleboard glued to plywood. 4. ½″ parquet wood flooring glued to particleboard. 5. ½″ type-X gypsum board screwed 12″o.c. 6. 3″ thick sound attenuation blanket.	43 (NA)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ tongue and groove plywood nailed with 8d nails 6″o.c. along edges and 10″o.c. in field. 3. Two layers of 5/8″ gypsum board attached with screws 12″o.c. to underside of sub floor. 4. a. 44 oz. carpet on 40 oz. hair pad. b. 1/16″ vinyl asbestos tile. 5. Resilient channels, 24″o.c. 6. 5/8″ gypsum board screwed 12″o.c. 7. 3 ½″ thick sound attenuation blanket.	56 (a. 74) (b.50)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ tongue and groove plywood nailed with 8d nails 6″o.c. along edges and 10″o.c. in field. 3. a. 44 oz. carpet on 40 oz. hair pad. b. 1/16″ vinyl asbestos tile. 4. 5/8″ gypsum board nailed 7″o.c. 5. Two layers of 5/8″ gypsum board suspended by wire hangers 5″ long in a 2x4' heavy-duty T grid ceiling system. 6. 3 ½″ thick sound attenuation blanket.	49 (a. 68) (b.47)

Sketch	Brief Description	STC (IIC)
	1. 2x8” wooden joists, 16”o.c. 2. 5/8” tongue and groove plywood nailed to joists with 8d nails 6”o.c. at edges and 10”o.c. in field. 3. 1 5/8” lightweight concrete over 4 mil. polyethylene film. 4. 44 oz. carpet on 40 oz. hair pad. 5. 5/8” gypsum board nailed to joists.	47 (66)
	1. 2x8” wooden joists, 16”o.c. 2. 5/8” tongue and groove plywood nailed to joists with 8d nails 6”o.c. at edges and 10”o.c. in field. 3. 1 5/8” thick lightweight concrete over 4 mil. polyethylene film. 4. a. 44 oz. carpet on 40 oz. hair pad. b. .075” sheet vinyl. 5. Resilient channels, 24”o.c. 6. 5/8” gypsum board screwed 12”o.c. 7. 3” thick sound attenuation blanket.	53 (a. 74) (b. 47)
	1. 2x10” wooden joists. 16”o.c. 2. 5/8” plywood nailed to joists. 3. 3. 1 ½” thick lightweight concrete, 13 psf. 4. Cushioned vinyl. 5. Resilient channels, 24”o.c. 6. 5/8” gypsum board screwed to channels. 7. 3 ½” thick sound attenuation blanket.	NA (51)
	1. Plywood web I-beams 12” deep and 24”o.c. 2. 3/4” plywood sub floor nailed with 6d nails 6”o.c. at edges and 10”o.c. in field. 3. 1 ½” thick lightweight concrete, 15 psf. 4. Resilient channels, 24”o.c. 5. 5/8” gypsum board screwed 12”o.c.	57 (NA)

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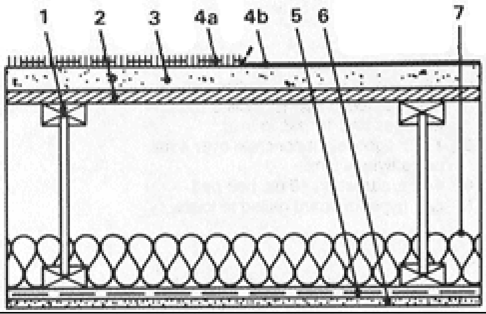
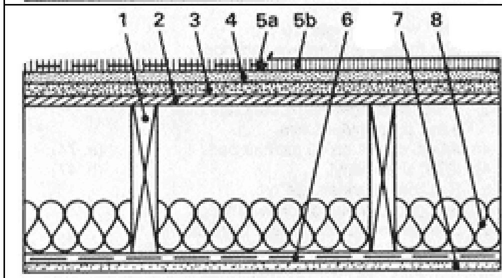
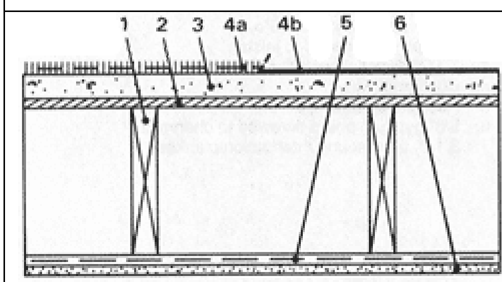
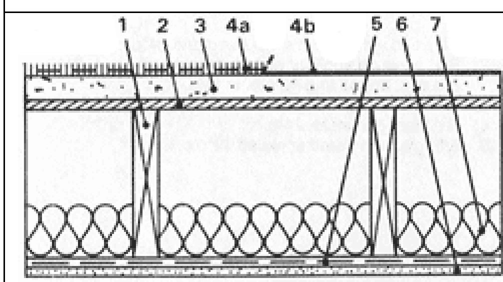
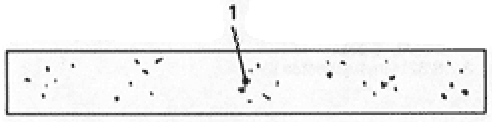
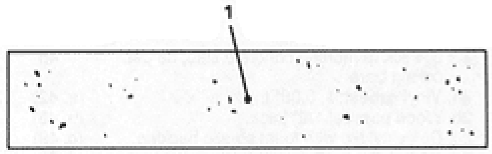
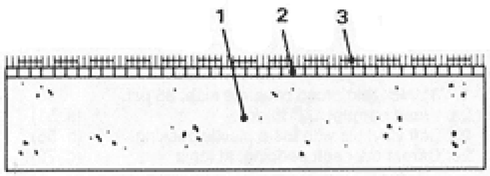
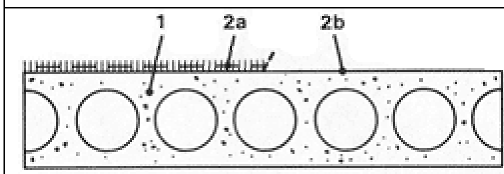
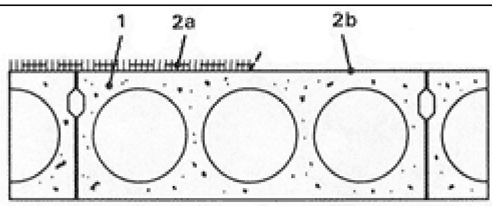
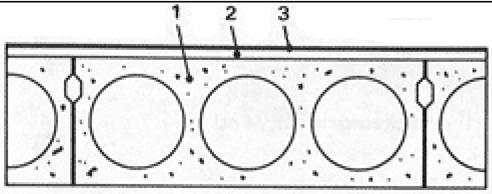
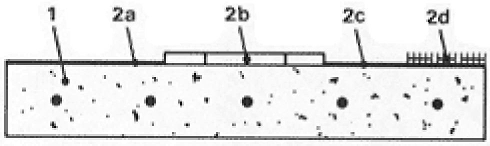
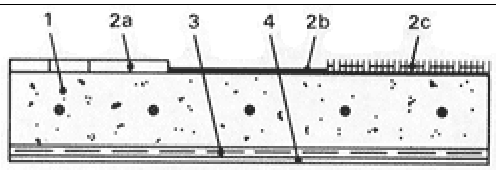
Sketch	Brief Description	STC (IIC)
	1. Plywood web I-beams 12" deep and 24"o.c. 2. 3/4" plywood sub floor nailed with 6d nails 6"o.c. at edges and 10"o.c. in field. 3. 1 1/2" thick lightweight concrete, 15 psf. 4. a. 44 oz. carpet on 40 oz. hair pad. b. .07" vinyl tile. 5. Resilient channels, 24.o.c. 6. 5/8" gypsum board screwed 12"o.c. 7. 3" thick sound attenuation blanket.	58 (a. 77) (b. 50)
	1. 2x10" wooden joists, 16"o.c. 2. 5/8" plywood glued to joists, nailed with 8d nails 12"o.c. 3. ¼" particleboard glued to plywood. 4. ½" fiberboard glued to particleboard. 5. a. 76 oz. carpet on 50 oz. hair pad. b. 1/2" parquet wood flooring. 6. Resilient channels, 24"o.c. 7. ½" type-X gypsum board screwed 12"o.c. 8. 3" thick sound attenuation blanket.	51 (NA)
	1. 2x10" wooden joists, 16"o.c. 2. 5/8" plywood sub floor nailed with 8d nails 6"o.c. along edges, 10"o.c. in field. 3. 1 1/2" thick lightweight concrete over 15 lb. asphalt felt. 4. a. 20 oz. carpet on 40 oz. hair pad. b. 1/16" thick vinyl-asbestos tile. 5. Resilient channels, 24"o.c. 6. ½" type-X gypsum board screwed 12"o.c.	56 (NA)
	1. 2x10" wooden joists, 16"o.c. 2. 5/8" plywood sub floor nailed with 8d nails 6"o.c. along edges, 10"o.c. in field. 3. 1 ½" thick lightweight concrete over 15 lb. asphalt felt. 4. a. 20 oz. carpet on 40 oz. hair pad. b. 1/16" thick vinyl-asbestos tile. 5. Resilient channels, 24"o.c. 6. 5/8" type-X gypsum board screwed 12"o.c. 7. 3 ½" thick sound attenuation blanket.	61 (NA)

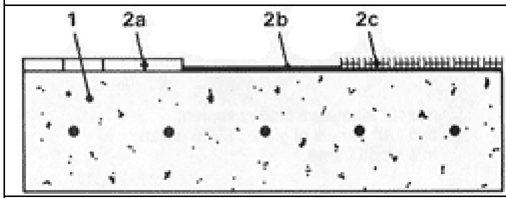
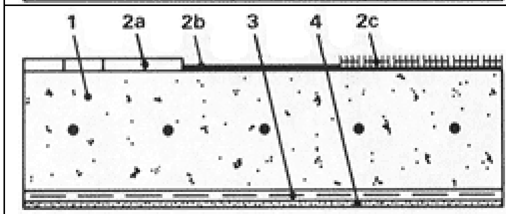
FLOORS: Concrete

Sketch	Brief Description	STC (IIC)
	1. 4″ thick concrete slab, 54 psf.	44 (25)
	1. 6″ thick concrete slab, 75 psf.	55 (34)
	1. 6″ thick concrete slab. 2. ½″ wood-fiber board glued to concrete. 3. 44 oz. carpet on 40 oz. hair pad.	NA (81)
	1. 6″ thick hollow-core concrete panel, 45 psf. 2. a. Carpet and pad. b. No floor covering.	48 (a. 69) (b. 23)
	1. 8″ thick hollow-core concrete panel, 57 psf. 2. a. 66 oz. carpet on 50 oz. hair pad. b. No floor covering.	50 (a. 74) (b. 28)

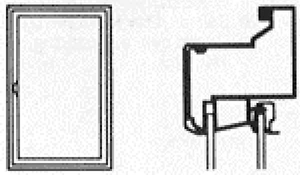
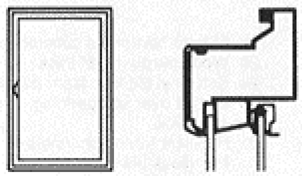
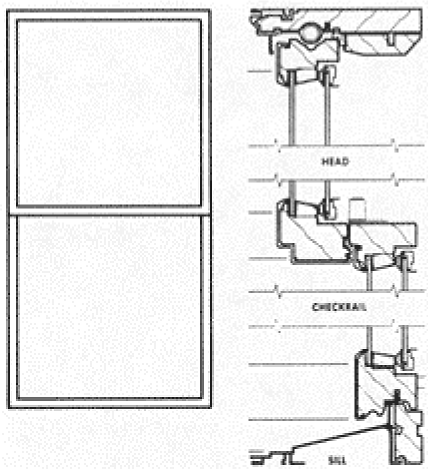
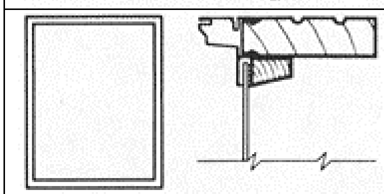
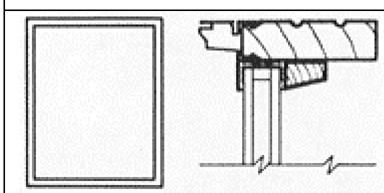
<table>
<tr><th>Sketch</th><th>Brief Description</th><th>STC
(IIC)</th></tr>
<tr><td></td><td>1. 8” thick hollow-core concrete panels, 57 psf.
2. 1/4” inorganic felt-supported underlayment board, .6 psf.
3. 3/32” vinyl-asbestos tile.</td><td>50
(51)</td></tr>
<tr><td></td><td>1. 3” thick reinforced concrete slab, 35 psf, ceiling bare.
2.
a. Vinyl asbestos, 0.08” thick.
b. Wood parquet 1/2” thick.
c. Soft vinyl tile with foam plastic backing.
d. Carpet over soft padding, at least ¼” thick.</td><td>45

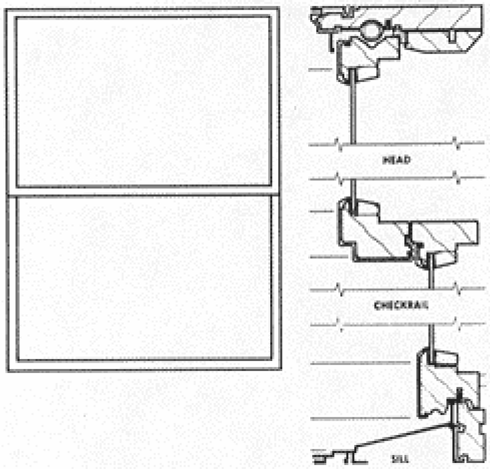
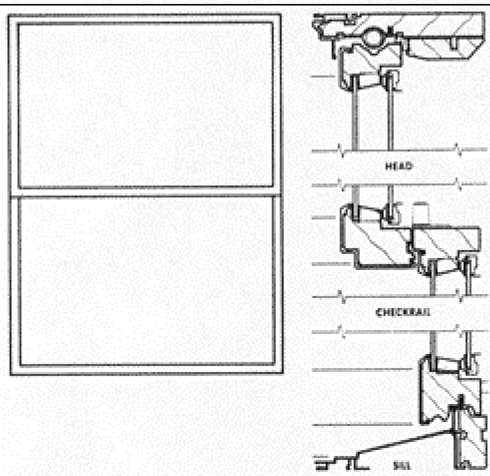
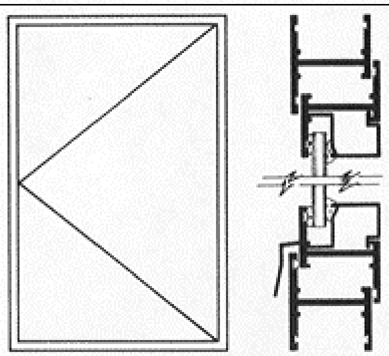
(a. 42)
(b.45)
(c. 49)
(d. 70)</td></tr>
<tr><td></td><td>1. 3” thick reinforced concrete slab, 35 psf.
2.
a. Wood parquet ½” thick.
b. Soft vinyl tile with foam plastic backing.
c. Carpet over soft padding, at least ¼” thick.
3. Resilient furring channels on ½” fiberglass blanket.
4. ½” gypsum board.</td><td>56

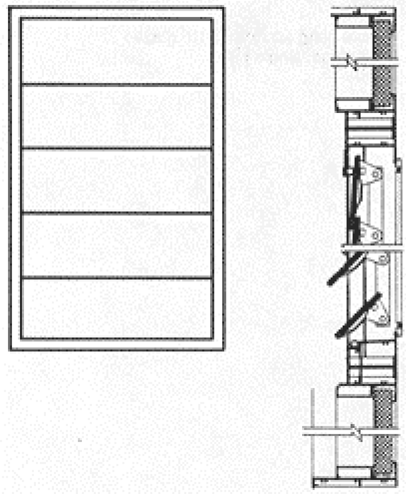
(a.51)
(b. 55)
(c. 70)</td></tr>
</table>

Sketch	Brief Description	STC (IIC)
	1. 5” thick reinforced concrete slab, 55 psf. ceiling bare. 2. a. Wood parquet ½” thick. b. Soft vinyl tile with foam plastic backing. c. Carpet over soft padding, at least ¼” thick.	51 (a. 46) (b. 50) (c. 70)
	1. 5” thick reinforced concrete slab, 55 psf. 2. a. Wood parquet ½” thick. b. Soft vinyl tile with foam plastic backing c. Carpet over soft padding, at least ¼” thick. 3. Resilient furring channels on ½” fiberglass blankets. 4. ½” gypsum board.	56 (a. 51) (b. 55) (c. 75)

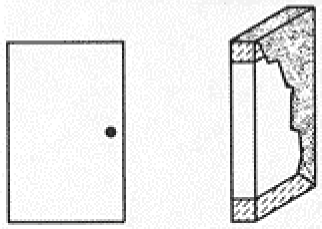
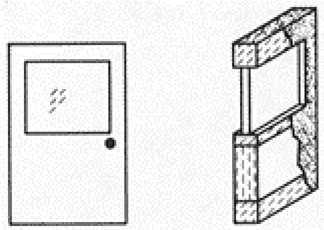
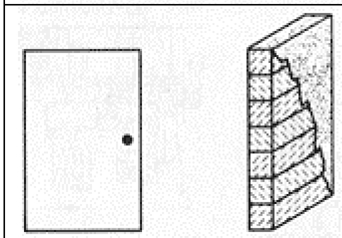
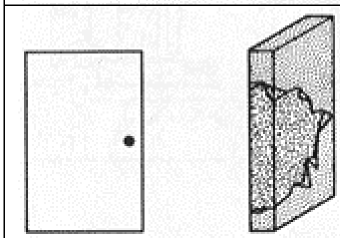
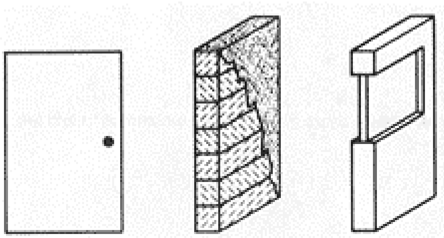
WINDOWS

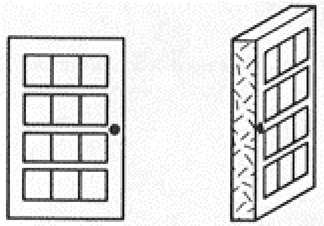
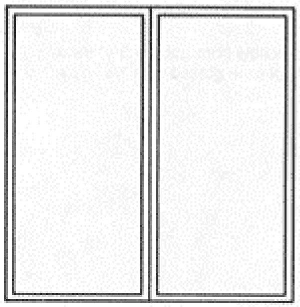
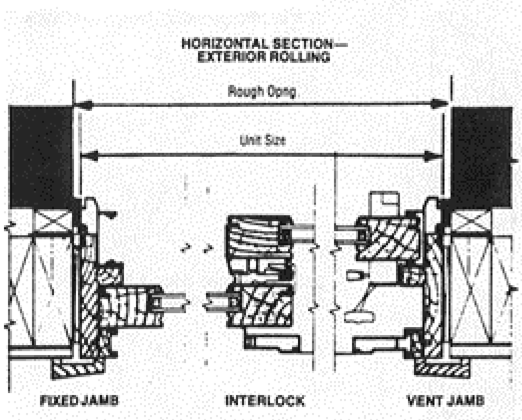
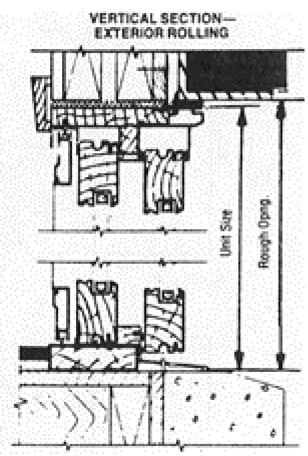
Sketch Front / Cross Section	Brief Description	STC
	30x48” aluminum clad casement, two 1/8” panels of glass, 13/16” apart in a wood frame.	29
	30x48” aluminum clad casement, one 3/32” panel and one 1/8” panel, 13/16” apart in a wood frame.	31
	32x24x24” aluminum double-hung windows (32” wide with 24” high upper sash and a 24” high lower sash), each sash has one 3/32” panel and one 1/8” panel, 13/16” apart in a wood frame.	29
	6x5' picture window glazed double strength, single panel.	29
	6x5' picture window plus storm sash, glazed double strength single panel, 3 ¾” separation between panels.	38

Sketch Front / Cross Section	Brief Description	STC
	3x5' double hung window, 7/16” glazed insulating glass, single panel.	26
	3x5' double hung window, 7/16” glazed insulating glass, single panel plus storm sash, glazed single strength, single sealed separation between panels: upper 1 ½”, lower 2 13/16”.	35
	3x4' awning window, glazed double strength, cranked shut.	24

Sketch Front / Cross Section	Brief Description	STC
	3x4' jalousie window, glazed ¼” glass, 4 ½” wide louvers with ½” in overlap, cranked tight shut.	20

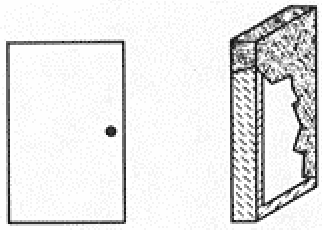
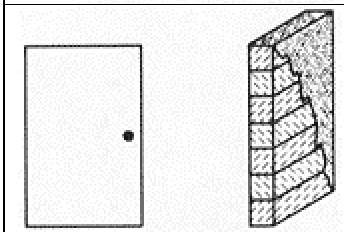
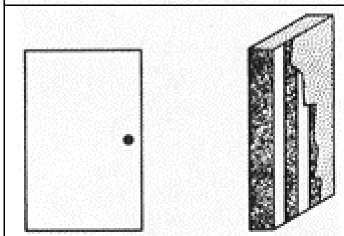
DOORS: Exterior

Sketch Front / Cross Section	Brief Description	STC
	3x7' hollow-core wood door, 1 ¾" thick.	20
	3x7' hollow-core door, 1 3/4" thick, 30% of area glazed with 1/8" glass.	19
	3x7' solid-core wood door, 1 ¾" thick.	27
	3x7' steel-faced door, 1 ¾" thick, rigid polyurethane core.	26
	3x7' solid-core wood door, 1 ¾" thick plus an aluminum storm door, glazed single strength.	34

Sketch Front / Cross Section	Brief Description	STC
	3x7' wood French door, 12 lights glazed single strength, mounted in frame, brass weather strip.	26
	6x6' sliding glass doors, ¾" insulating glass (2 pieces 1/8" tempered glass), one door opens, other is permanent in place.	28
 		

*All exterior doors are sealed with a weathering strip around the frame. Interior doors do not have a weather strip and are not flush to the floor to permit the installation of a carpet.

DOORS: Interior

Sketch Front / Cross Section	Brief Description	STC
	3x7' solid-core wood door, 1 ¾" thick, weight 1.5 lb/ft².	17
	3x7' solid-core wood door, 1 ¾" thick, weight 4.0 lb/ft².	20
	3x7' hollow-core steel door, 1 ¾" thick, weight 5.0 lb/ft².	17

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Appendix B References

Appendix B
General References

Books:
Acoustical and Thermal Performance of Exterior Residential Walls. Doors and Windows; NBS Building Science Series 77, U.S. Department of Commerce/National Bureau of Standards, 1975.

Acoustics Noise and Buildings; Parkin, Humphreys and Cowell; Faber and Faber; London; 1979.

Airborne Sound Transmission Loss, Characteristics of Wood Frame Construction; Fred F. Rudder, Jr.; USDA, Forest Service; General Technical Report FPL-43.

Handbook of Architectural Acoustics and Noise Control; Michael Retting; Tab Book; Blue Ridge Summit, Pa.; 1979.

Quieting: A Practical Guide to Noise Controls; U.S. Department of Commerce/National Bureau of Standards; NBS Handbook 119; 1976.

Institutions and Organizations:

Amerada Architectural Glass.
DeSco Windows.
Georgia-Pacific.
Industrial Acoustics Company.
National Concrete Masonry Association.
Office of Noise Control; California Department of Health Services.
Overly Manufacturing Company.
Paella Products.
Portland Cement Association.
U.S. Gypsum Company.

Testing Laboratories:

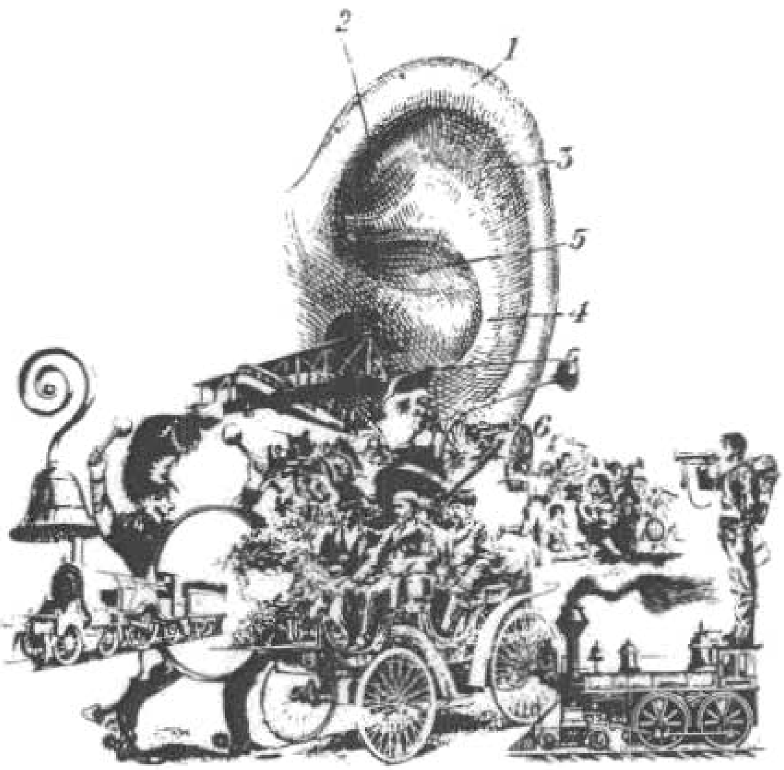
Cedar Knolls Acoustical Laboratories.
Geiger and Hamme.
Kaiser Gypsum.
Kodaras Acoustical.
National Institute of Standards and Technology.
National Research Council of Canada.
Riberbank Acoustical Laboratories.

Chapter 5

Noise Assessment Guidelines

U.S. Department of Housing and Urban Development
Office of Policy Development and Research

Noise Assessment Guidelines



Noise Assessment Guidelines

Foreword

In choosing among alternative sites for housing, potential noise problems are prominent among the issues that must be examined. These Noise Assessment Guidelines were developed to provide HUD field staff, interested builders, developers, and local officials with an easy-to-use method of evaluating noise problems with a minimum of time and effort.

We believe that this set of tools will simplify the process of balancing the goal of environmental protection with those of efficiency and reduced housing costs. We hope you will find them useful, and invite your comments.

Benjamin F. Bobo
Acting Assistant Secretary for
Policy Development and Research

Stephen J. Bollinger
Assistant Secretary for
Community Planning and
Development

Preface

The Department of Housing and Urban Development, in its efforts to provide decent housing and a suitable living environment, is concerned with noise as a major source of environmental pollution and has issued Subpart B on Noise Abatement and Control to Part 51 of Title 24 of the Code of Federal Regulations.

The policy established by Subpart B embodies HUD objectives to make the assessment of the suitability of the noise environment at a site: (1) easy to perform; (2) uniformly applicable to different noise sources; and (3) as consistent as possible with the assessment policies of other Federal departments and agencies. In furtherance of these objectives, the Office of Policy Development and Research has sponsored research to provide site analysis techniques. These *Noise Assessment Guidelines* do not constitute established policy of the Department but do provide a methodology whose use is encouraged by HUD as being consistent with its objectives. The *Guidelines* provide a means for assessing separately the noise produced by airport, highway, and railroad operations, as well as the means for aggregating their combined effect on the overall noise environment at a site.

This booklet has been prepared by Bolt Beranek and Newman Inc., under Contract No. H-2243R for the U.S. Department of Housing and Urban Development. It is a revision of an earlier edition published in August 1971. With the exception of changes made by the Department, the contractor is solely responsible for the accuracy and completeness of the data and information contained herein.

Contents

Introduction

These guidelines are presented as part of a continuing effort by the Department of Housing and Urban Development to provide decent housing and a suitable living environment for all Americans.

The procedures described here have been developed so that people without technical training will be able to assess the exposure of a housing site to present and future noise conditions. In this context, the site may hold only one small building, in which case the noise assessment is straightforward. Larger sites may hold larger buildings, or many buildings, and the noise level may be different at different parts of the site (or building). Assessments of the noise exposure should be made at representative locations around the site where significant noise is expected. These are designated as "Noise Assessment Locations," abbreviated NAL in the following text.

The only materials required are a map of the area, a ruler (straight edge), a protractor and a pencil. Worksheets and working figures are provided separately.

All of the information you need can be easily obtained – usually by telephone. For convenience, this information is listed at the beginning of each section under headings that indicate the most likely source. While you are obtaining this information, be sure to ask about any approved plans for future changes that may affect noise levels at the site – for example: land-use changes, changes in airport runway traffic, widening of roads, and so forth. In all evaluations, you should assess the condition that will have the most severe or most lasting effect on the use of the site.

Wherever possible, you should try to assess noise environments expected at least ten years in the future.

The degree of acceptability of the noise environment at a site is determined by the outdoor day-night average sound level (DNL) in decibels (dB). The assessment of site acceptability is presented first as an evaluation of the site's exposure to three major sources of noise – aircraft, roadways, and railways. These are then combined to assess the total noise at a site. Worksheets are provided at the back of these Guidelines to use in summarizing your evaluations.

The noise environment at a site will come under one of three categories:

Acceptable (DNL not exceeding 65 decibels) The noise exposure may be of some concern but common building constructions will make the indoor environment acceptable and the outdoor environment will be reasonably pleasant for recreation and play.

Normally Unacceptable (DNL above 65 but not exceeding 75 decibels) The noise exposure is significantly more severe; barriers may be necessary between the site and prominent noise sources to make the outdoor environment acceptable; special building constructions may be necessary to ensure that people indoors are sufficiently protected from outdoor noise.

Unacceptable (DNL above 75 decibels) The noise exposure at the site is so severe that the construction cost to make the indoor noise environment acceptable may be prohibitive and the outdoor environment would still be unacceptable.

When measuring the distance from the site to any noise source, measure from the source to the nearest points on the site where buildings having noise-sensitive uses are located. These points define the Noise Assessment Locations for the site. The relevant measurement location for buildings is a point 2 meters (6.5 feet) from the facade.

If at any point during the assessment the site's exposure to noise is found to be Unacceptable or Normally Unacceptable, every effort should be made to improve the condition, e.g., the location of the proposed dwellings can be changed or some shielding can be provided to block the noise from that source.

Where quiet outdoor space is desired at a site, distances should be measured from the important noise sources to the outdoor area in question and the combined noise exposure should be assessed.

Frequently, the locations of dwellings have not yet been specified at the time the noise assessment of a site is made. In these instances, distances used in the noise assessment should be measured as 2 meters less than the distance from the building setback line to the major sources of noise.

Combining Sound Levels in Decibels

The noise environment at a site is determined by combining the contributions of different noise sources. In these Guidelines, Workcharts are provided to estimate the contribution of aircraft, automobile, truck, and train noise to the total day-night average sound level (DNL) at a site. The DNL contributions from each source are expressed in decibels and entered on Worksheet A. The combined DNL from all the sources is the DNL for the site and is the value used to determine the acceptability of the noise environment.

Sound levels in decibels *are not combined by simple addition!* The following table shows how to combine sound levels:

Table

Difference in Sound Level	Add to Larger Level
0	3.0
1	2.5
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
9	0.5
10	0.4
12	0.3
14	0.2
16	0.1
greater than 16	0

Use the table by first finding the numerical difference in sound level between two levels being combined. Entering the table with this value, find the value to be added to the larger of the two levels, add this value to the larger level to determine the total. Where more than two levels are to be combined, use the same procedure to combine any two levels; then use this subtotal and combine it with any other level, and so on. Fractional numerical values may be interpolated from the table; however, the final result should be rounded to the nearest whole number.

Example 1: In performing a site evaluation, the separate DNL values for airports, road traffic, and railroads have been listed on Worksheet A as 56, 63, and 61 decibels. In order to complete the final evaluation of the site, these separate DNL values must be combined. The difference between 63 and 56 is 7; from the table you find that 0.8 should be added to 63, for a subtotal of 63.8. The difference between 63.8 and 61 is 2.8; from the table you interpolate that approximately 1.9 should be added to 63.8 for a total of 65.7 or 66 dB when rounded to whole numbers. This example shows how noise from different sources may be Acceptable, individually, at a site, but when combined, the total noise environment may exceed the Acceptable DNL limit of 65 decibels.

Aircraft

Necessary Information

To evaluate a site's exposure to aircraft noise, you will need to consider all airports (civil and military) within 15 miles of the site. The information required for this evaluation is listed below under headings that indicate the most likely source. Before beginning the evaluation, you should record the following information on Worksheet B:

From the FAA Area Office or the Military Agency in charge of the airport:

- Are current DNL or NEF (Noise Exposure Forecast) contours available? Noise contours are available for almost all military airports. These contours have been developed and published as part of the Air Installation Compatible Use Zone (AICUZ) program of the Department of Defense. The contours are published normally as part of an AICUZ report. Noise contours are also available for many civil airports. When available, they are superimposed on a map with an appropriately marked scale (see Figure 1, page 4).
- Any available information about approved plans for runway changes (extensions or new runways).

From the FAA Control Tower or Airport Operations (if DNL or NEF contours are *not* available):

- The number of nighttime jet operations (10 p.m. - 7 a.m.)
- The number of daytime jet operations (7 a.m. - 10 p.m.)
- The flight paths of the major runways.
- Any available information about expected changes in airport traffic, e.g., will the number of operations increase or decrease in the next 10 or 15 years.

In making your evaluation, use the data for the heaviest air traffic condition, whether present or future.

Evaluation of Site Exposure to Aircraft Noise

If current DNL (or NEF) contours are available (as in Figure 1 page 4), locate the site on the map by referring to the marked distance scale. If there are no other noise sources in the area, you do not need to do anything else. If there are other noise sources affecting the site, you will need to find the precise DNL value so you can combine it with the other sources. Obtain the DNL at the appropriate NAL on the site by interpolation between the contours on either side of the NAL. If NEF contours are used, estimate DNL by adding 35 decibels to the NEF values. Note that contours are usually provided in 5 decibel increments. (See Example 2 on page 4.) When supersonic aircraft operations are present, DNL contours are *required* for the assessment.

If DNL or NEF contours are *not* available, the DNL at a site may be estimated in several different ways:

- An FAA Handbook (Reference 1) can be used to estimate DNL contours for sites in general aviation airport vicinities. General aviation airports exclude commercial jet transports but may include business jets.
- A handbook available from EPA (Reference 2 at the back of this Guide) can be used to calculate DNL at individual points.
- A procedure for constructing approximate DNL contours for sites near commercial jet

Figure 1
Example of DNL Contours

Example 2: The illustration in Figure 1 at the top of page 4 shows the NAL's on a map that has DNL contours. We find that NAL number 1 lies between the 65 and 70 dB contours and that NAL number 2 lies outside the 65 dB contour.

We find the DNL at NAL number 1 by interpolation from the distances between the NAL and the 65 and 70 dB contours.

By scaling off the map, we find that the distance from the NAL, measured perpendicularly to the contours, is 800 feet to the 65 dB contour and 2400 feet to the 70 dB contour. The distance between the 65 and 70 dB contours is 2400 + 800 = 3200 feet. We find the DNL at the NAL number 1 to be 65 decibels plus 800/3200 x 5 decibels = 66.3 decibels.

Example 3: The illustration in Figure 2 at the bottom of page 5 shows an airport for which DNL or NEF contours are not available. The airport has 10 nighttime and 125 daytime jet operations.

To construct the approximate contours, we determine the effective number of operations as follows:

10 (nighttime) x 10 = 100

Add to this the actual number of daytime operations:

100 + 125 (daytime) = 225

To determine the distances A and B in relation to the runway (see Figure 3, page 5), enter the effective number of operations on the horizontal scales of the charts in Figure 3;

airports without supersonic aircraft is as follows:

Determine the "effective" number of jet operations at the airport by first multiplying the number of nighttime jet operations by 10.

Then add the number of daytime jet operations to obtain an effective total (see Example 3, page 4).

On a map of the area showing the principal runways, mark the location of the site and, using the diagram and charts of Figure 3 on page 5, construct approximate DNL contours of 65, 70, and 75 dB for the major runways and flight paths most likely to affect the site. (see Figure 2, page 5.)

Although a site may be Acceptable for exposure to aircraft noise; exposure to other sources of noise, when combined with the aircraft noise, may make the site Unacceptable. Therefore, if necessary, values of aircraft noise exposure less than 65 dB can be estimated from Table 2. Scale the shortest distance D^2 from the NAL to the flight path, as in Figure 2. Scale the distance D^1 from the 65 dB contour to the flight path. Divide D^2 by D^1 and enter this value into the following table to find the approximate DNL at the NAL.

Table 2

$\frac{D2}{D1}$	DNL dB
1.00	65
1.12	64
1.26	63
1.41	62
1.58	61
1.78	60
2.00	59
2.24	58
2.51	57
2.82	56
3.16	55

Figure 3
Charts for Estimating DNL for Aircraft Operations

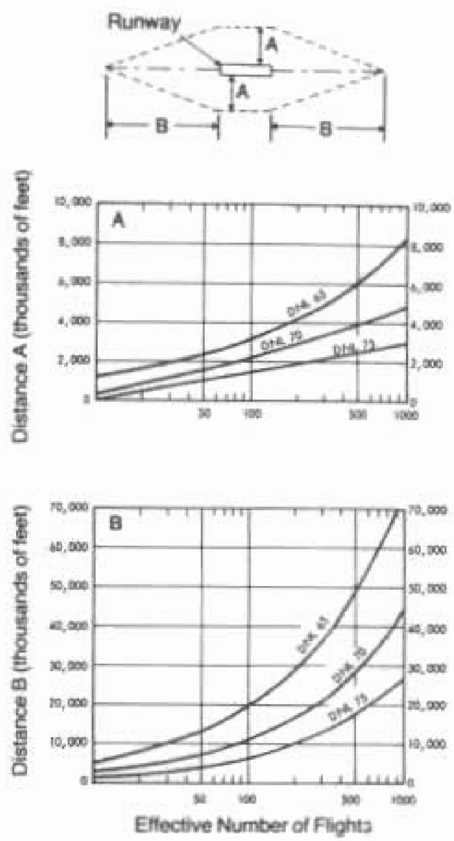
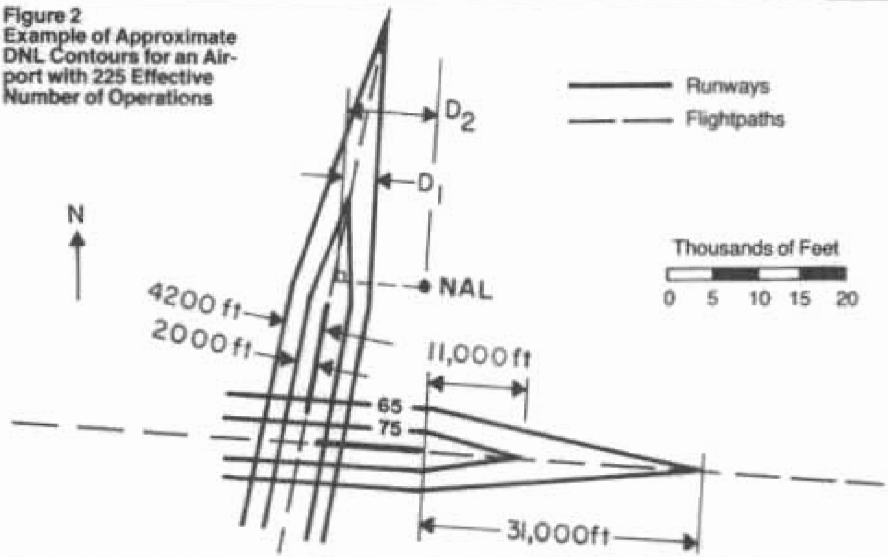


Figure 2
Example of Approximate DNL Contours for an Airport with 225 Effective Number of Operations



read up to the DNL curves; read across the chart to the left to obtain distances A and B from the vertical scales on the charts.

We find from Figure 3, for example, that for 225 effective operations, distance A is 4200 feet for the 65 dB contour and 2000 feet for the 75 dB contour. Distance B is 31,000 feet for the 65 dB contour and 11,000 feet for the 75 dB contour.

Example 4a: The NAL shown in Figure 2 is outside the 65 dB contour. The distance D^2 from the NAL to the flight path is 9700 feet. The distance D^1 from the 65 dB contour to the flight path, measured perpendicularly from the contour, is 3700 feet. The ratio D^2/D^1 is $9700/3700 = 2.62$. From Table 2 we find the DNL from the airport to be 56.6 dB. We do not know whether the site is Acceptable or not, however, since we must also assess the contribution of roadway and train noise to the total DNL at the site.

Example 4b: We observe that the perpendicular distance (D^2) from NAL number 2 (Figure 1) to the flight path is more than 3 times the distance (D^1) from the 65 dB contour to the flight path. From Table 2 we find that the contribution of the airport to the DNL at NAL number 2 is less than 55 decibels. We need not consider the airport further in accessing the noise environment at this site.

Roadways

Necessary Information

To evaluate a site's exposure to roadway noise, you will need to consider all roads that might contribute to the site's noise environment; roads farther away than 1000 feet normally may be ignored.

Before beginning the evaluation, determine if roadway noise predictions already exist for roads near the site. Also try to obtain all available information about approved plans for roadway changes (e.g., widening existing roads or building new roads) and about expected changes in road traffic (e.g., will the traffic on this road increase or decrease in the next 10 to 15 years).

If noise predictions have been made, they should be available from the City (County) Highway or Transportation Department. If not, record the following information on page 1 of Worksheet C:

- The distances from the NAL's for the site to the near edge of the nearest lane and the far edge of the farthest lane for each road.
- Distance to stop signs.
- Road gradient, if 2 percent or greater.
- Average speed.
- The total number of automobiles for both directions during an average 24-hour day. Traffic engineers refer to this as ADT, Average Daily Traffic (or sometimes AADT, meaning Annual Average Daily Traffic).
- The number of trucks during an average 24-hour day in each direction.

If possible, separate trucks into "heavy trucks" – those weighing more than 26,000 pounds with three or more axles – and "medium trucks" – those between 10,000 and 26,000 pounds. (Each medium truck is counted as equal to 10 automobiles.) Trucks under 10,000 pounds are counted as automobiles. Count buses capable of carrying more than 15 seated passengers as "heavy" trucks – others, as "medium" trucks. If it is not possible to separate the trucks into those that are heavy and those that are not, treat *all* trucks as though they are "heavy."

Note: If the road has a gradient of 2 percent of more, record the numbers for uphill and downhill traffic separately since these figures will be needed later; otherwise, simply record the total number of trucks. Most often you will have to assume that the uphill and downhill traffic are equally split.

- The fraction of ADT that occurs during nighttime (10 p.m. to 7 a.m.). If this is unknown, assume 0.15 for both trucks and autos.

Evauation of Site Exposure to Roadway Noise

Traffic surveys show that the amount of roadway noise depends on the percentage of trucks in the total traffic volume. To account for this effect, you must evaluate automobile and truck traffic separately and then combine the results.

The noise environment at each site due to traffic noise is determined by utilizing a series of Workcharts to define the contribution of automobiles and trucks from one or more roads at that site. Each noise source yields a separate DNL value.

Workchart 1 provides a graph for assessing a site with respect to the noise from automobiles, light and medium trucks; Workchart 2 provides a similar graph for assessment of heavy truck noise. These values are combined for each road affecting the noise environment at the site to obtain the total contribution of roadway noise. Remember, the noise from aircraft and railways must also be considered before determining the suitability of this site's noise environment.

Effective Distance

Before proceeding with these separate evaluations, however, determine the "effective distance" to each road from the dwelling or outdoor residential activity (the NAL's for the site) by averaging the distances to the nearest edge of the nearest lane and to the farthest edge of the farthest lane of traffic. (See Example 5, page 6, and Figure 4, page 7.)

Note: For roads with the same number of lanes in both directions, the effective distance is the distance to the center of the roadway (or median strip, if present).

Automobile Traffic

Workchart 1 was derived with the following assumptions:

- There is line-of-sight exposure from the site to the road; i.e., there is no barrier which effectively shields the site from the noise of the road.
- There is no stop sign within 600 feet of the site; traffic lights do not count because there is usually traffic moving on one street or the other.
- The average automobile traffic speed is 55 mph.
- The nighttime portion of ADT is 0.15.

If each road meets these four conditions, proceed to Workchart 1 for the evaluation. Enter the horizontal axis with the effective distance from the roadway to the NAL; draw a vertical line upward from this point. Enter the vertical axis with the effective automobile ADT; draw a horizontal line across from this point. (The "effective" automobile ADT is the sum of automobiles, light trucks, and 10 times the number of medium trucks in a 24-hour day.) Read the DNL value from Workchart 1 where the vertical and horizontal lines intersect. Record this value in column 16, Worksheet C.

But:

If any of the four conditions is different, make

Example 5: The site shown in Figure 4 is exposed to noise from three major roads: Road No. 1 has four lanes, each 12 feet wide, and a 30-foot wide median strip which accommodates a railroad track. Road No. 2 has four lanes, each 12 feet wide. Road No. 3 has six lanes, each 15 feet wide, and a median strip 30 feet wide.

The distance from NAL No. 1 to the near edge of Road No. 1 is 300 feet. The distance to the far edge of Road No. 1 is 300 feet, plus the number of lanes times the lane width, plus the width of the median strip. Thus, the distance to the farthest edge of the road is:

$300 + (4 \times 12) = 378$ ft

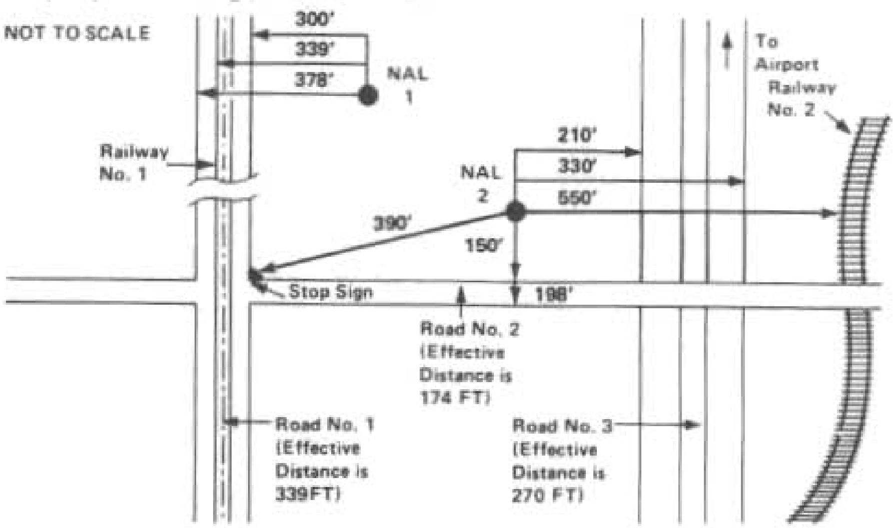
The effective distance is

$$\frac{378 + 300}{2} = 339 \text{ ft}$$

This is the value to be entered on line 1c of Worksheet C. The effective distances from the appropriate NAL's to Road No. 2 and Road No. 3 are found by the same method.

The distances shown in Figure 4 will be used for all roadway examples in this booklet.

Figure 4
Plan View of Site showing How Distance Should Be Measured from the Noise Assessment Location (NAL) of the Dwelling Nearest to the Source

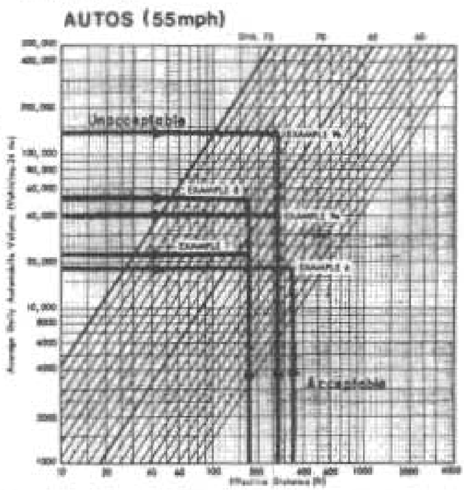


the necessary adjustments (on page 2, Worksheet C) listed below and *then* use Workchart 1 for the final evaluation.

First, a few general words about adjustments as they are applied in these Guidelines. Each Workchart has been derived for a baseline condition which is often found in practical cases. Where conditions differ from the baseline, they are accounted for by a series of one or more adjustment factors.

The adjustment factors are used as multipliers times the average number of vehicles operating during a 24-hour day. If more than one adjustment is required, it is not necessary that each be multiplied times the basic traffic flow separately; all adjustment factors are multiplied together, and them multiplied times the original traffic flow data. This will become clearer as you examine the Worksheets at the back of these Guidelines and work through the examples. After you have become familiar with the Guidelines, you will be able to work examples directly from the worksheets without referring back to the text. To simplify your work, all the adjustment factors are summarized at the back of these Guidelines.

Figure 5
Use of Workchart 1 To Evaluate Automobile Traffic Noise



Adjustments for Automobile Traffic

Stop-and-Go Traffic:
If there is a stop sign (not a traffic signal) within 600 feet of the NAL so that the flow of traffic is completely interrupted on the road under consideration, find the stop-and-go adjustment factor for automobiles from Table 3. Enter this value in column 9 on Worksheet C.

Table 3

Distance from NAL to Stop Sign In Feet	Automobile Stop-and-Go Adjustment Factor
0	0.10
100	0.25
200	0.40
300	0.55
400	0.70
500	0.85
600	1.00

Average Traffic Speed:
If the average automobile speed is other than 55 mph, enter the appropriate adjustment from Table 4 in column 10 of Worksheet C.

Table 4

Average Traffic Speed	Auto Speed Adjustment Factor
20 (mph)	0.13
25	0.21
30	0.30
35	0.40
40	0.53
45	0.67
50	0.83
55	1.00
60	1.19
65	1.40
70	1.62

Example 6: Road No. 1 meets the four conditions that allow for an immediate evaluation. In obtaining the information necessary for this evaluation, it was found that the automobile ADT is 18,000 vehicles (Line 5c of Worksheet C). On Workchart 1 we locate on the vertical scale the point representing 18,000 and on the horizontal scale the point representing 339 feet (see Figure 5). (Note that we must estimate the location of this point.) Using a straight-edge we draw lines to connect these two values and find that the NAL exposure to automobile noise from this road is a DNL of 58 dB, as read from the scale at the top of the graph.

Example 7: Road No. 2 has a stop sign at 390 feet from NAL No. 2. The automobile ADT is reported as being 32,500 vehicles (line 5c of Worksheet C). From Table 3 we interpolate between 300 and 400 feet to find the adjustment factor for stop-and-go traffic to be 0.69. The adjusted traffic ADT is

$0.69 \times 32{,}500 = 22{,}425$ vehicles per day

and with an effective distance of 174 feet from NAL No. 2, we find from Workchart 1 that the approximate value of DNL is 64 dB.

Example 8: Suppose that the stop sign on Road No. 2 were replaced by a traffic signal for which no stop-and-go adjustment is made and that the ADT increases to 75,000 vehicles. In addition, assume that the average speed is 45 mph instead of 55 mph. You adjust the new automobile ADT of 75,000 vehicles by the Auto Speed Adjustment Factor from Table 4

$0.67 \times 75{,}000 = 50{,}250$ vehicles

and at an effective distance of 174 feet find from Workchart 1 that the approximate value of DNL is 67 dB.

Nightime Adjustment.

DNL values are affected by the proportion of traffic volume that occurs during "daytime" (7 a.m. to 10 p.m.) and "nighttime" (10 p.m. to 7 a.m.). The graph on Workchart 1 assumes that 15 percent of the total ADT occurs during nighttime. If a different proportion of the traffic occurs at night, find the appropriate nighttime adjustment factor from Table 5. Record your answer in column 11 of Worksheet C.

Table 5

Nighttime Fraction of ADT	Nighttime Adjustment Factor
0	0.43
0.01	0.46
0.02	0.50
0.05	0.62
0.10	0.81
0.15	1.00
0.20	1.19
0.25	1.38
0.30	1.57
0.35	1.77
0.40	1.96
0.45	2.15
0.50	2.34

Once you have selected all the appropriate adjustment factors and entered them on page 2 of Worksheet C, multiply all the factors together, then multiply by the automobile ADT (column 12) for 24 hours, found on page 1 of Worksheet C. The resulting adjusted ADT should be entered in column 13. This is the ADT value to be used, in conjunction with the effective distance from the NAL to the road, to find the DNL value from Workchart 1. Enter this DNL value in column 14 of Worksheet C. Remember this is the DNL from automobile (as well as light and medium truck) noise; you must still find the DNL contribution from heavy truck noise in order to obtain the total DNL produced by the roadway you are assessing.

Attenuation of Noise by Barriers:

This adjustment reduces the noise produced by automobiles and trucks on the same road. Instructions for this adjustment appear after the noise assessment for truck traffic below.

Truck Traffic

Wherever possible, separate the average daily volume of trucks into heavy trucks (more than 26,000 pounds vehicle weight and three or more axles); medium trucks (less than 26,000 pounds but greater than 10,000 pounds), light trucks (counted as if they are automobiles). You should already have accounted for medium and light trucks in your automobile evaluation. Do not forget that buses that can carry more than 15 seated passengers are counted as heavy trucks. Heavy trucks (including buses) must be analyzed separately because they have quite different noise characteristics. If it is not possible to separate the trucks into those that are heavy and those that are not, treat *all* trucks as though they are "heavy."

Workchart 2, which is used to evaluate the site's exposure to heavy truck noise, was derived with the following assumptions:

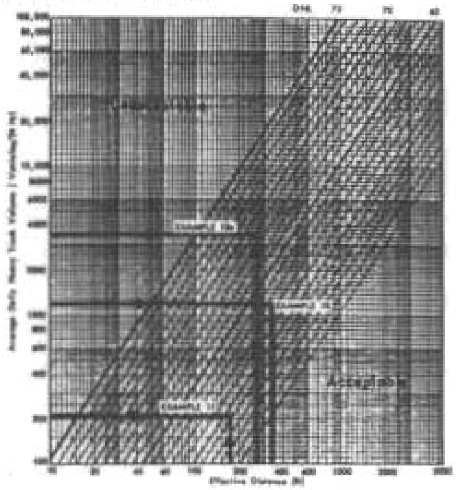
- There is line-of-sight exposure from the site to the road; i.e., there is no barrier which effectively shields the site from the road noise.
- The road gradient is less than 2 percent.
- There is no stop sign (traffic signals are permissible) within 600 feet of the site.
- The average truck traffic speed is 55 mph.
- The nighttime fraction of ADT is 0.15.

If the road meets these five conditions, proceed to Workchart 2 for an immediate evaluation of the site's exposure to heavy truck noise from that road.

But:
If any of the conditions is different, make the necessary adjustment(s) listed below and *then* use Workchart 2 for the evaluation.

Figure 6. Use of Workchart 2 to Evaluate Heavy Truck Noise

Heavy Trucks (55 mph)



Adjustments for Heavy Trucks

Road Gradient:

If there is a gradient of 2 percent or more, find the appropriate adjustment factor, for heavy trucks going uphill only, as shown in Table 6. List this factor in column 17 of Worksheet C.

Table 6

Percent of Gradient	Adjustment Factor
2	1.4
3	1.7
4	2.0
5	2.3
6 or more	2.5

Example 9a: Road No. 3 is a limited access highway with no stop signs and the average speed is 55 mph. Current traffic data indicate an automobile ADT of 40,000 vehicles of which 15 percent occurs during nighttime hours (10 p.m. to 7 a.m.). With an effective distance of 270 feet to NAL No. 2, Workchart 1 is used to show that the DNL for existing automobile traffic is between 63 and 64 dB. Round off to 64 dB.

Example 9b: However, traffic projections estimate that in 10 years the ADT will increase to 100,000 vehicles at an average speed of 55 mph and nighttime usage will increase to 25 percent. For future traffic, you must adjust the future ADT of 100,000 for the effect of increased nighttime use. From Table 5, you find an adjustment factor of 1.38. The adjusted ADT is

$1.38 \times 100{,}000 = 138{,}000$

and at an effective distance of 270 feet you find from Workchart 1 that the DNL will increase to 69 dB; therefore, provision for extra noise control measures should be explored. We will examine in Example 13 the effect of terrain as a shielding barrier that provides sound attenuation.

Example 10: Road No. 1 on Figure 4 meets the four conditions that allow for an immediate evaluation. The ADT for heavy truck flow is 1200 vehicles. Workchart 2 shows that the exposure to truck noise from this road at an effective distance of 339 feet is a DNL of 63 dB at NAL No. 1.

Average Traffic Speed:

Make this adjustment if the average speed differs from 55 mph. If the average truck speed differs with direction, treat the uphill and downhill traffic separately. Select the appropriate adjustment factors from Table 7 below, entering them in column 18 of Worksheet C.

Table 7

Average Traffic Speed MPH	Heavy Truck Speed Adjustment Factor
50 or less	0.81
55	1.00
60	1.17
65	1.38

Once you have found the speed adjustment factor, you can combine the uphill and downhill traffic. For uphill traffic, multiply the gradient factor times the speed adjustment factor times uphill traffic volume (truck ADT column 19) (assuming one half the total 24-hour average number of trucks unless specific information to the contrary exists), entering the product in column 20. Multiply the speed adjustment factor for downhill traffic times the downhill traffic volume (truck ADT/2 column 19). Add the values for uphill and downhill traffic, entering this sum in column 21. You may now complete the assessment of heavy truck noise without regard to uphill and downhill traffic separation.

Stop-and-Go Traffic:

If there is a stop sign (remember, not a traffic signal) within 600 feet of an NAL for the site on the road being assessed, find the adjustment factor determined according to Table 8. Enter it in Column 22 of Worksheet C.

Table 8

Heavy Truck Traffic Volume per Day	Heavy Truck Stop-and-Go Adjustment Factor
Less than 1200	1.8
1201 to 2400	2.0
2401 to 4800	2.3
4801 to 9600	2.8
9601 to 19,200	3.8
More than 19,200	4.5

Nighttime Adjustment

After all the above adjustments are made, do not forget to adjust for nighttime operations if they are not 15 percent of the total ADT, using the factors obtained from Table 5 just as for automobiles. Enter this value in column 23 of Worksheet C.

At this point, multiply the adjustment factors for nighttime and stop-and-go traffic times the heavy truck traffic volume in column 21 to find the adjusted heavy truck ADT, entering the product in column 24. Use this value and the effective distance from the NAL to the road to find the truck DNL from Workchart 2, entering your answer in column 25 of Worksheet C. If no shielding barriers are to be considered, combine the DNL from heavy trucks with the DNL from automobiles (column 14). The result is the DNL from the road being assessed and should be entered on Worksheet C.

But:

If a shielding barrier is to be considered for the site, make the analysis described below separately for automobiles and then for heavy trucks *before* combining the DNL values. This step is necessary since barriers are far more effective for automobiles than for heavy trucks. Once you have found the amount of attenuation provided by the barrier for automobiles, enter it in column 15. Find the value of barrier attenuation for heavy trucks and enter it in column 25. Subtract these attenuation values from the DNL values obtained previously (columns 14 and 24), entering the reduced DNL values in columns 16 and 27. Combine the automobile and heavy truck DNL values, reduced by the attenuation provided by the barrier, to find the final DNL produced by the roadway at the site.

Remember to combine the contributions to DNL of *all* roads that affect the noise environment at each NAL for the site to obtain the total DNL from all roadways. Enter this DNL on both Worksheet C and the summary Worksheet A.

Attenuation of Noise by Barriers

Noise barriers are useful for shielding sensitive locations from ground level noise sources. For example, a barrier may be the best way to deal with housing sites at which the noise exposure is not acceptable because of nearby roadway traffic.

A barrier may be formed by the road profile, by a solid wall or embankment, by a continuous row of noise-compatible buildings, or by the terrain itself. To be an *effective* shield, however, the barrier must block all residential levels from line of sight to the road; it must not have any gaps that would allow noise to leak through.

Some Preliminary Matters:

In evaluating noise barrier performance, you will be working with different kinds of "distances" between the sound source, the observer, and the barrier.

Actual Distance – the existing distance that would be measured using a tape measure with no corrections or adjustments. This may mean one of two things, *depending on the application;* either the:

- *slant distance* – the actual distance,

Example 11: Road No. 2 has a stop sign at 390 feet from NAL No. 2. There is also a road gradient of 4 percent. No heavy trucks are allowed on this road, but a schedule shows an average of 12 large buses pass along the road per hour between 7 a.m. and 10 p.m., although no buses are scheduled during the remaining nighttime period. The buses are equally divided in each direction along the road. (Remember large buses, those that carry over 15 seated passengers, count as heavy trucks.)
We find the ADT for the "heavy trucks" (the buses in this case) by multiplying the average number of vehicles per hour by the number of hours between 7 a.m. and 10 p.m. That is, 12 x 15 = 180, or 90 vehicles in each direction. We find from Table 6 that the gradient adjustment factor for uphill traffic is 2.0. We find the truck volume adjusted for gradient is

uphill:	*90 x 2.0 = 180*
downhill:	*= 90*
total (column 21)	*= 270 vehicles*

From Table 8, we find the adjustment factor for stop-and-go traffic to be 1.8.

We also remember that we have no buses in the nighttime period and find the factor in Table 5 on page 8 for zero nighttime operations to be 0.43.

Our final adjusted ADT is (column 24)

1.8 x 0.43 x 270 = 209 Vehicles

From Workchart 2, with an effective distance of 174 feet, we find a DNL of 59 dB.

Example 12a: Road No. 3 is a depressed highway and the profile shields all residential levels of the housing from line of sight to the traffic. The average truck speed is 50 mph. The ADT for heavy trucks is 4400 vehicles. We adjust for average speed (from Table 7)

4400 x 0.81 = 3564

and find from Workchart 2 that, with an effective distance of 270 feet, the DNL from truck noise would be 69 dB if no barrier existed. We proceed to analyze the barrier attenuation.

measured along the line of sight between two points; or the

- *map distance* – the actual distance, measured on a horizontal plane, between the two points, as on a map or on the project plan.

For an observer high in an apartment tower, the slant distance to the road may be much longer than the map distance.

Barrier effectiveness is expressed in terms of noise attenuation in decibels (dB), determined with the aid of Workchart 6. This numerical value is subtracted from the previously calculated DNL in order to find the resultant DNL at the Noise Assessment Location.

Note: A noise barrier can be considered as a means of protecting a site from noise even if it cannot wrap around the site to shield from view practically all of the source of noise at every sensitive location on the site. It must be recognized, however, that such a barrier is much less effective than an ideal barrier. (See Workchart 7 and Step 6 below.)

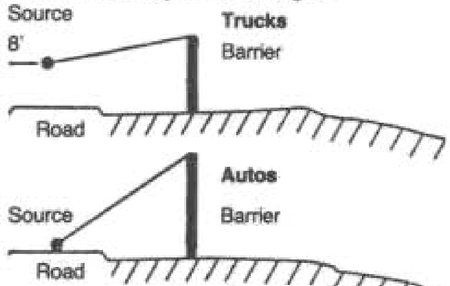
Barriers of reasonable height cannot be expected to protect housing more than a few stories above ground level. Barriers will generally protect the ground and the first two or three floors, but not the higher floors. If there are to be frequently occupied balconies on the upper levels, one solution is to move the building farther from the noise source and face the sensitive areas away from the noise.

Steps to Evaluate a Barrier

1. For the observer's position, use the mid-height of the highest residential level. For the source position, use the following heights (see Figure 7):

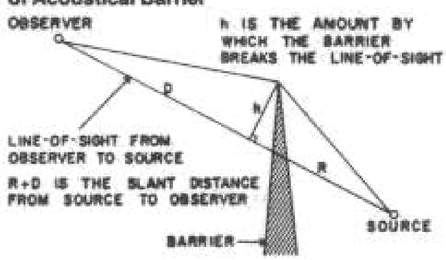
- autos, medium trucks, railway cars – the road or railway surface height
- heavy trucks – 8 feet above the road surface
- diesel locomotives or trains using horns or whistles at grade crossings – 15 feet above the rails.

Figure 7.
Source Heights to Be Used in Roadway Barrier Designs



Get accurate values for the following quantities: h, the shortest distance from the barrier top to the line of sight from source to observer; R and D, the slant distances along the line of sight from the barrier to the source and observer, respectively (see Figure 8).

Figure 8.
Generalized Geometry of Acoustical Barrier



Specifically, R and D are the two segments into which h breaks the line of sight. Note that h is *not* the height of the barrier above the ground but the distance from the barrier top to the line of sight.

2. Enter at the top of Workchart 6 with the value of h on the left-hand scale; move right to intersect the curve corresponding to R (or D, whichever is *smaller*).

3. Move down to intersect the curve corresponding to the value of D/R (or R/D, whichever is *smaller)*.

4. Move right to intersect the vertical scale in order to find the barrier shielding value A in decibels.

5. Interruption of the line of sight with a barrier between the noise source and an observer reduces the amount of sound attenuation provided by the ground. Find the amount of this loss B from the table on Workchart 6 by entering the table with the value of D/R. Find the barrier attenuation value S corresponding to an ideal barrier that completely hides the noise source from view by subtracting B from the value of A obtained in Step 4.

6. If the barrier exists along only a part of the road so that unshielded sections of the road would be visible from the site, the barrier is less effective than an ideal barrier. On a plan view of the site, locate the two ends of the barrier and draw lines from these points to the Noise Assessment Location. Use a protractor to measure the angle formed at the NAL by the two lines. Enter the horizontal scale of Workchart 7 with the values of this angle; read up to the curve having the value of S determined from Step 5 (interpolating if necessary); read left across to the vertical scale labeled "actual barrier performance" to find the value of FS to use for the actual barrier in question.

7. Subtract the barrier attenuation value S (or FS if adjusted for finite barrier length according to Workchart 7) from the value of DNL previously determined to reevaluate the site with the noise barrier in place.

Example 12b: (Refer to Figure 9.) Six stories are planned for the housing where the site has an elevation of 130 feet. The effective elevation for the highest story is found by multiplying the number of stories by 10 feet, adding the site elevation, and subtracting 5 feet.

(6 × 10) + 130 - 5 = 185 feet

The barrier, which in this case is formed by the road profile, has no "height" other than the elevation of the natural terrain above the noise sources traveling on the roadway. The important dimensions are indicated in Figure 9.

Some people with a technical background will be able to fit the geometric diagram to the site situation readily, working from the project drawings and a scratch sheet.

But if you are *not* confident of your geometry, Workchart 5 gets you the values of R, D, and h from the map distances and elevations of the site. We illustrate that procedure in this example.

First, enter the elevations of the source (S), the observer (O), and the top of the barrier (H), as well as the map distances from the barrier to the source (R') and observer (D'), at the top right of Workchart 5. Then, follow the steps on that Workchart to derive the values of h, R, and D that are needed in using Workchart 6.

Entering Workchart 6 at the upper left with the value of h (5.5 feet), we move horizontally

Figure 9.
Detail of Site Showing Measurements Necessary for a Barrier Adjustment

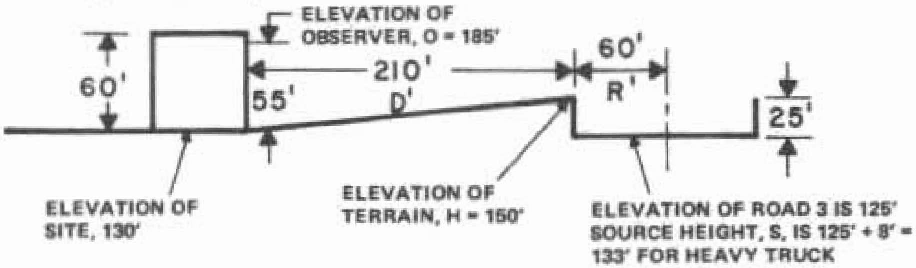
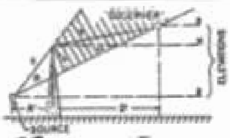


Figure 10.
Use of Workchart 5 to Determine Barrier Dimensions in Example 12b

Workchart 5
Noise Barrier
To find R, D and h from Site Elevations and Distances

Enter the values for:
H = 150 R' = 60
S = 133 D' = 210
O = 185



Fill out the following worksheet (all quantities are in feet):

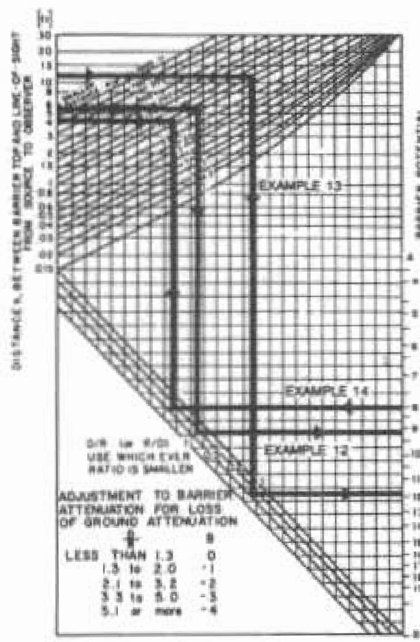
1. Elevation of barrier top minus elevation of source	[H 150]	−	[S 133]	=	[1 17]	
2. Elevation of observer minus elevation of source	[O 185]	−	[S 133]	=	[2 52]	
3. Map distance between source and observer (R' + D')					[3 270]	
4. Map distance between barrier and source (R')					[4 60]	
5. Line 2 divided by line 3	[2 52]	÷	[3 270]	=	[5 0.19]	
6. Square the quantity on line 5 (i.e., multiply it by itself); always positive	[5 0.19]	×	[5 0.19]	=	[6 0.04]	
7. 40% of line 6	[0.4]	×	[6 0.04]	=	[7 0.016]	
8. One minus line 7	[1.0]	−	[7 0.016]	=	[8 0.984]	
9. Line 5 times line 4 (will be negative if line 2 is negative)	[5 0.19]	×	[4 60]	=	[9 11.4]	
10. Line 1 minus line 9	[1 17]	−	[9 11.4]	=	[10 5.6]	
11. Line 10 times line 8	[10 5.6]	×	[8 0.984]	=	[11 5.5]	= h
12. Line 5 times line 10	[5 0.19]	×	[10 5.6]	=	[12 1.06]	
13. Line 4 divided by line 8	[4 60]	÷	[8 0.984]	=	[13 61]	
14. Line 13 plus line 12	[13 61]	+	[12 1.06]	=	[14 62]	= R
15. Line 3 minus line 4	[3 270]	−	[4 60]	=	[15 210]	
16. Line 15 divided by line 8	[15 210]	÷	[8 0.984]	=	[16 213]	
17. Line 16 minus line 12	[16 213]	−	[12 1.06]	=	[17 212]	= D

(Note: the value on line 2 may be negative, in which case so will the values on lines 5, 9, and 12; line 1 may also be negative. Remember, then, in lines 12, 14, and 17, that adding a negative number is the same as subtracting: x + (−y) = x − y. And subtracting a negative number is like adding: x − (−y) = x + y.)

Round off R and D to nearest integer; h to one decimal place.

Figure 11.
Use of Workchart 6 to Evaluate Barrier in Examples 12b, 13 and 14

Noise Barrier   Workchart 6



to the right until we meet the value of R or D, whichever is smaller: in this example, R = 62 feet. From that point we drop vertically downward until we meet the value of R/D or D/R, whichever is smaller: in this case, R/D = 0.29. From that point, move horizontally to the right to find the value for A = 9 dB. Entering the table for determining loss of ground attenuation effect due to the barrier with a value for D/R of 3.5, the reduction in attenuation (B) is found to be 3 dB. Substracting 3 dB from 9 dB provides a net attenuation of 6 dB. With 6 dB of attenuation, the original DNL of 69 dB (Example 12a) is reduced to 63 dB.

Example 13: An alternative approach, which is somewhat more direct, is illustrated here for the noise of automobiles on Road No. 3.

A preliminary step is to make an accurately scaled sketch of the general geometry introduced on page 8. It must include the positions of the source (this time at the road surface), the observer, and the top of the barrier; and will show the distances h, R, and D. Such a sketch is shown superimposed on the profile of the road and its neighborhood in Figure 12.

If we carefully scale the dimensions directly from this sketch, we find the following values for h, R, and D:

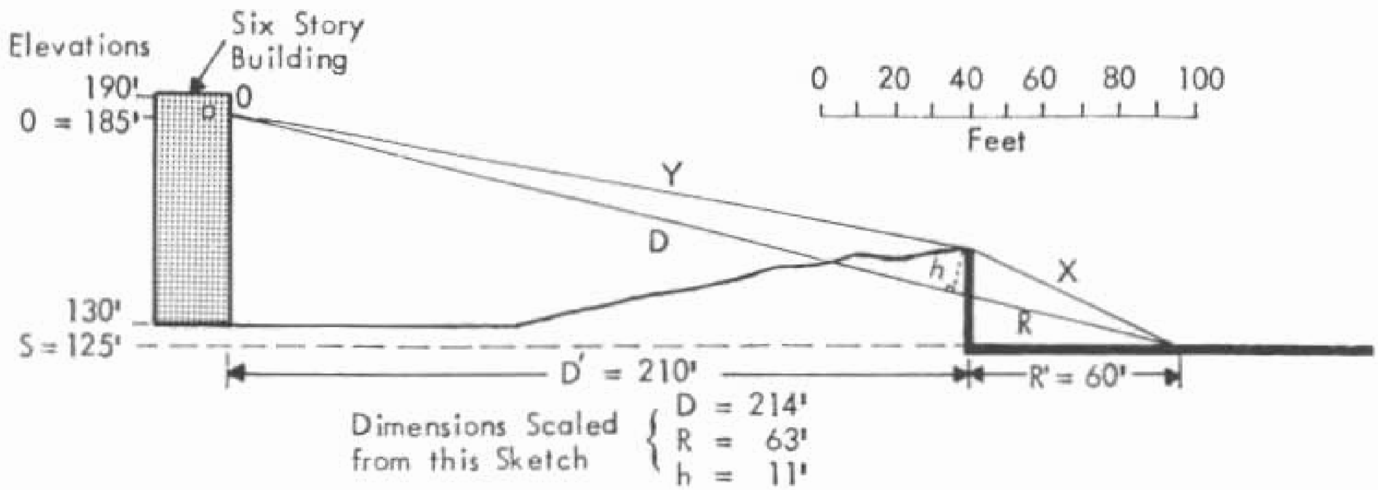
R=63 feet

R/D=0.3

D=214 feet
h=11 feet

The barrier attenuation is found, by entering Workchart 6 with these values, to be A=12 dB. It is larger than that found for trucks because the noise source is lower and is, therefore, better shielded by the barrier. The loss from ground attenuation is again B=3 dB for a net attenuation of 12 - 3 = 9 dB. In Example 9b, we found that the DNL

Figure 12.
Sketch Showing Dimensions for Example 13



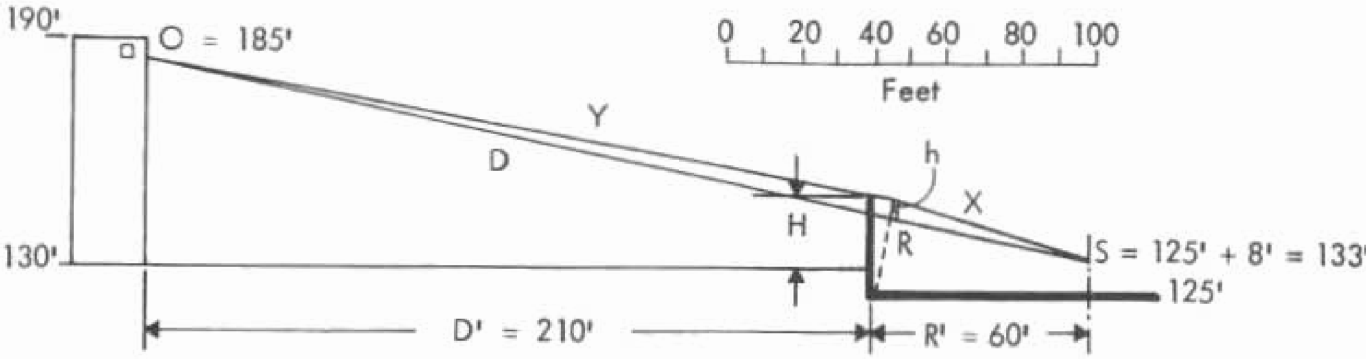
for the projected traffic volume of 100,000 vehicles per day was 69 dB if no consideration was given the shielding provided by the terrain. Subtracting the 9 dB attenuation from 69, we find the partial DNL for automobiles is 60 dB.

In order to find the combined truck and automobile noise for Road No. 3, we combine the 63 dB of truck noise with the 60 dB of automobile noise using Table 1. We find that 1.8 should be added to 63 dB, for a combined DNL of 64.8 dB, or 65 dB when rounded to the nearest whole number.

Example 14: Where no natural barrier exists, Workchart 6 can be used in reverse to estimate the height of a barrier needed to obtain a required attenuation. In example 9b we found that, without any attenuation from terrain or a barrier, the automobile traffic produced a DNL of 69 dB, and in Example 12a the heavy truck traffic produced a DNL of 69 dB. When combined, the total DNL is 72 dB. Suppose the terrain were not rising between NAL and Road No. 3, as shown in Figure 12, but instead was level between the NAL and the edge of the road, as shown in Figure 13. We want to find out how high a wall, infinite in length, would be required at the edge of the road to reduce the combined truck and automobile noise to less than 65 dB. We have found in the previous examples that a barrier of a given height will provide more attenuation for automobiles than it will for trucks. As a first step in our analysis, we will find the height of a wall that will reduce the truck noise to just below 65 dB, say 64 dB, and then find out whether the additional attenuation it provides for automobile noise will be sufficient to reduce the combined truck and automobile noise to less than 65 dB. We begin by finding the height of wall that will provide 5 dB attenuation for truck noise.

We estimate that the ratio of R/D is about the same as R'/D', the ratio of horizontal distance in Figure 13, which is equal to 0.29. Before entering Workchart 6, we find from the loss of ground attenuation table that for D/R = 3.4 we will lose 3 dB attenuation from an ideal barrier. In order to have a net attenua-

Figure 13.
Sketch Showing Dimensions for Example 14



tion of 5 dB, we must have an ideal barrier that provides 5 + 3 = 8 dB attenuation.

Entering Workchart 6 on the right side scale A at 8 decibels, we move across to the diagonal lines, finding 0.29 by interpolating between the lines marked at 0.2 and 0.5. Moving directly up to a point midway between the R lines of 50 and 70, we find our estimated R of approximately 60. Moving across to the left we find that the line of sight between the observer and the truck source height must be broken by a value of h equal to 4.5 feet.

We can determine the height of the wall H in several ways. By drawing h=4.5 feet to scale on Figure 13, we can scale the total wall height H to be approximately 20 feet. Those who feel comfortable with geometry can calculate H by using the similar triangle relationships in Figure 13 to determine that H is 19.1 feet.

Now we must find how much a wall 19 feet high will attenuate automobile noise, remembering that the source height for automobiles is at the road surface elevation of 125 feet. By scaling the drawing, or by geometry, we determine that the line of sight between the observer position and the automobile source is broken by a value of h that is approximately 13 feet. Entering Workchart 6 at 13 feet we find, for R=60 feet and R/D=0.29, that the potential barrier attenuation is 12dB. We must reduce this by 3 dB for loss of ground attenuation to find the actual shielding of automobile noise to be 9 dB. The original 69 dB of automobile noise is reduced to 69 - 9 = 60 dB.

Finally, we combine the heavy truck noise, attenuated by the wall to 69 - 5 = 64 dB, with the automobile noise reduced to 60 dB, to find a combined DNL of 65.5 dB, or 66 dB when rounded upward. Remember, however, that this is for an infinite wall. Further adjustments would have to be made once the actual length was known.

Railways

Necessary Information

To evaluate a site's exposure to railway noise, you will need to consider all rapid transit lines and railroads within 3000 feet of the site (except totally covered subways). The information required for this evaluation is listed below under headings that indicate the most likely source.

Before beginning the evaluation, you should record the following information on Worksheet D:

From the area map and/or the (County) Engineer:

- The distance from the appropriate NAL on the site to the center of the railway track carrying most of the traffic.

From the Supervisor of Customer Relations for the railway:

- The number of diesel trains and the number of electrified trains in both directions during an average 24-hour day.
- The fraction of trains that operate during nighttime (10 p.m. - 7 a.m.) If this is unknown, assume 0.15.
- The average number of diesel locomotives per train. If this is unknown, assume 2.
- The average number of railway cars per diesel train and per electrified train. If this is unknown, assume 50 for diesel trains and 8 for electrified trains.
- The average train speed. If this is unknown, assume 30 mph.
- Is the track made from welded or bolted rails?

From the Engineering Department of the railway:

- Is the site near a grade crossing that requires prolonged use of the train's horn or whistle? If so, where are the whistle posts located? (Whistle posts are signposts which tell the engineer to start blowing the horn or whistle. Every grade crossing has whistle posts and they are listed on the railroad's "track charts." If traffic on the track is one-way, there will be only one whistle post. The grade crossing itself is the other "whistle post."

Electrified rapid transit and commuter trains that do not use diesel engines should be treated the same as railway cars.

Note: Buildings closer than 100 feet to a railroad track are often subject to excessive vibration transmitted through the ground. Construction at such sites is discouraged.

Evaluation of Site Exposure to Railway Noise

Railway noise is produced by the combination of diesel engine noise and railway car noise. These Guidelines provide for the separate evaluation of diesel locomotives and railroad cars, and then the combination of the two, in order to obtain the DNL from trains. When rapid transit or electrified trains that do *not* use diesel engines are the only trains passing near a site go directly to the second part of the evaluation since these trains are treated in the same manner as railway cars.

Diesel Locomotives

Workchart 3 was derived with the following assumptions:

- A clear line of sight exists between the railway track and the Noise Assessment Location.
- There are two diesel locomotives per train.
- The average train speed is 30 mph.
- Nighttime operations are 0.15 of the 24-hour total.
- The site is not near a grade crossing requiring prolonged use of the train's horn or whistle.

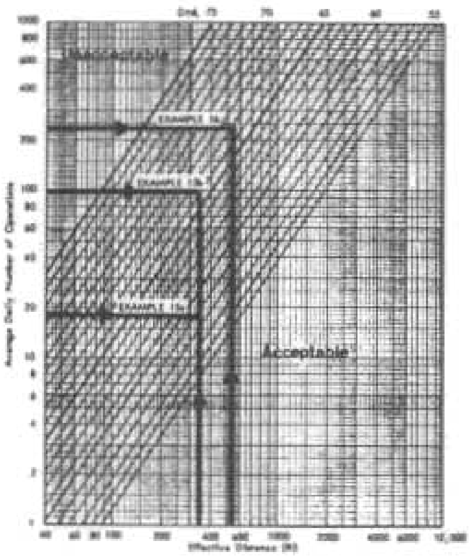
If the situation meets these conditions, proceed to Workchart 3 for an immediate evaluation of diesel locomotive noise.

But:

If any of the conditions is different, make the necessary adjustments listed below and *then* use Workchart 3 for the evaluation.

Figure 14.
Use of Workchart 3 to Evaluate Diesel Locomotive Noise

Railroads – Diesel Locomotives



Adjustments for Diesel Locomotives

Number of Locomotives:

If the average number of diesel locomotives per train is not 2, divide the average number by 2. Enter this value in column 9 of Worksheet D.

Example 15a: The distance from NAL number 1 to Railway Number 1 is 339 feet. Two percent of the 35 daily operations occur at night; there is clear line of sight between the tracks and the NAL, and no horns or whistles are used. No information is available on train size or speed, therefore we will assume 2 engines per train and a speed of 30 mph.

Since the percentage of nighttime operations is different from 15 percent, we must adjust the actual number of daily operations, multiplying by 0.50 according to Table 5.

0.50 x 35 = 17.5 = 18

Entering Workchart 3 with 18 daily operations and a distance of 339 feet, we find that the contribution of diesel engine noise is a DNL of 59 dB (see Figure 14).

In order to find the total contribution of the trains to the total DNL, we must also find the noise level produced by the train's cars. Entering Workchart 4 (see Figure 15) with 18 daily operations and a distance of 339 feet, we find the DNL is below 50 on the chart, or more than 10 decibels lower than the noise level produced by the engines. Based on the chart for decibel addition, the combination of the noise from the engines and the cars adds less than 0.5 decibels to the DNL value for the engines alone, 59 dB.

Example 15b: Suppose that a forecast of train operations for Railway 1 indicates that there will still be 35 trains per day, but now 50 percent of the operations will occur at night, the average train will have 4 engines and 75 cars, and the average speed will be 50 mph.

We first find the contribution to DNL made by diesel locomotives by using the following adjustment factors:

- number of engines adjustment: 2
- speed adjustment: 0.60
- day/night adjustment: 2.34

We multiply these adjustments together with the number of trains:

2 X 0.60 X 2.34 X 35 = 98

Entering Workchart 3 (see Figure 14) with 98 daily operations and a distance of 339

Average Train Speed:

If the average train speed is different from 30 mph, find the appropriate adjustment factor from Table 9 and list in column 10 of Worksheet D.

Table 9

Average Speed (mph)	Speed Adjustment Factor
10	3.00
20	1.50
30	1.00
40	0.75
50	0.60
60	0.50
70	0.43

Horns or Whistles:

If the NAL is perpendicular to any point on the track between the whistle posts for the grade crossing, enter the number 10 in column 11, Worksheet D.

Nighttime Adjustment:

Remember to adjust for nightime operations, if different from 0.15 of the total, by selecting the appropriate adjustment factor from Table 5 on page 8. Enter in column 12, Worksheet D.

Multiply the adjustment factors together, times the number of diesel trains per day (you have listed this number previously on line 2a, page 1, of Worksheet D, and should enter this number again in column 13) to obtain the adjusted number of trains per day. Enter the adjusted number of diesel trains per day in column 14. Use this value, in conjunction with the distance from the NAL to the track (line 1, page 1, of Worksheet D), to find from Workchart 3 the DNL produced by diesel locomotives. List in column 15 of Worksheet D.

Railway Cars and Rapid Transit Systems

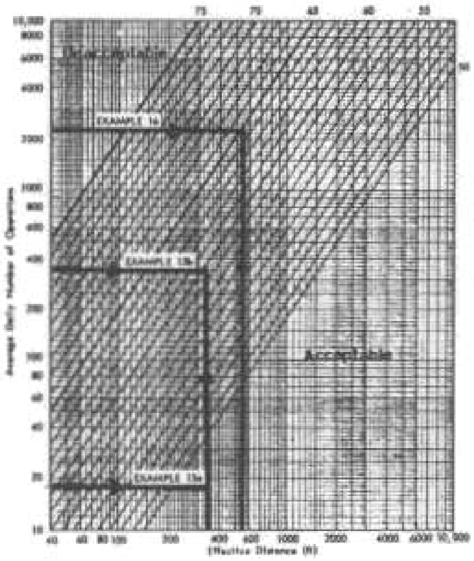
Workchart 4 was derived with the following assumptions:

- A clear line of sight exists between the railway and the NAL.
- There are 50 cars per train.
- The average train speed is 30 mph.
- Nighttime operations are 0.15 of the 24-hour total.
- Rails are welded together.

If the situation meets these conditions, proceed to Workchart 4 for an immediate evaluation of railway car noise. Again, if any of the conditions is different, make the necessary adjustments listed below and then use Workchart 4 for the evaluation.

Figure 15.
Use of Workchart 4 to Evaluate Railway Car Noise

Railroads – Cars and Rapid Transit



Adjustments for Railway Cars and Rapid Transit Trains

Number of Cars:

Divide the average number of cars by 50 and enter this number in column 18 of Workchart D.

Average Speed:

Make this adjustment, if the average speed is not 30 mph, by selecting the appropriate value from Table 10, entering it in column 19 of Worksheet D.

Table 10

Average Speed (mph)	Speed Adjustment Factor
10	0.11
20	0.44
30	1.00
40	1.78
50	2.78
60	4.00
70	5.44
80	7.11
90	9.00
100	11.11

Bolted Rails:

Enter the number 4 in column 20 of Worksheet D.

Nighttime Adjustment:

Enter the appropriate adjustment factor from Table 5 in column 21 of Worksheet D.

feet, we find that the site has an engine noise contribution to DNL of 66 dB.

We next obtain the adjustment factors for the noise produced by the cars:

- number of cars adjustment: 1.50
- speed adjustment: 2.78
- day/night adjustment: 2.34

Multiplying the adjustment factors times the average daily number of trains:

1.5 X 2.78 X 2.34 X 35 = 342

Entering Workchart 4 (see Figure 15) with 342 operations and a distance of 339 feet, we find the contribution of the cars to the DNL is 60 dB. Using Table 1 for combining levels, we find that the 6 dB difference between engine noise at 66 and car noise at 60 gives a combined DNL of 67 dB for these trains.

Example 16: The distance from NAL number 2 to Railroad Number 2 is 550 feet; there are 100 operations per day, of which 30 percent occur at night. A clear line of sight exists between the site and the railroad, and no horns or whistles are used nearby. An average train on this track uses 4 engines, has 100 cars, the average speed is 40 miles per hour, and the track has bolted, not welded, rails.

We first find the adjustment factors for the diesel engines:

- number of engines adjustment: 2
- speed adjustment: 0.75
- day/night adjustment: 1.57

Multiplying the adjustments together, times the number of trains:

2 X 0.75 X 1.57 X 100 = 236

Entering Workchart 3 (see Figure 14) with 236 operations at a distance of 550 feet, we find the DNL contribution from engine noise to be 67 dB.

Next we find the adjustment factors for the railroad cars:

- number of cars adjustment: 2
- speed adjustment: 1.78
- bolted track adjustment: 4
- day/night adjustment: 1.57

Multiplying the adjustments together, times the number of trains:

2 X 1.78 X 4 X 1.57 X 100 = 2236

Entering Workchart 4 (see Figure 15) with

(Continued next page)

Figure 16.
Sketch Showing Dimensions for Example 16

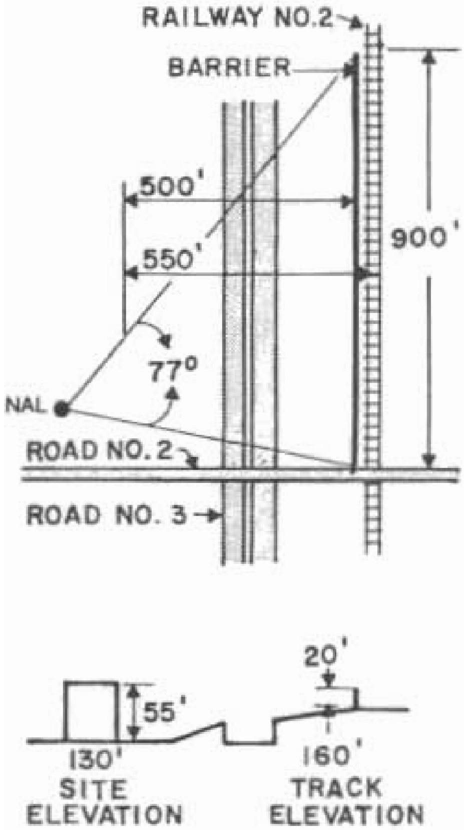


Figure 17.
Use of Workchart 6 in Example 16

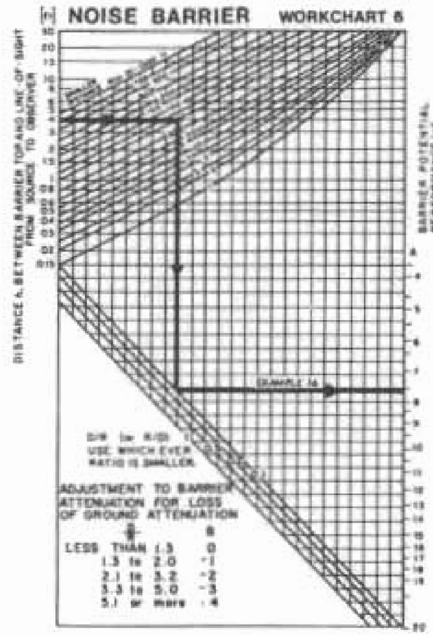
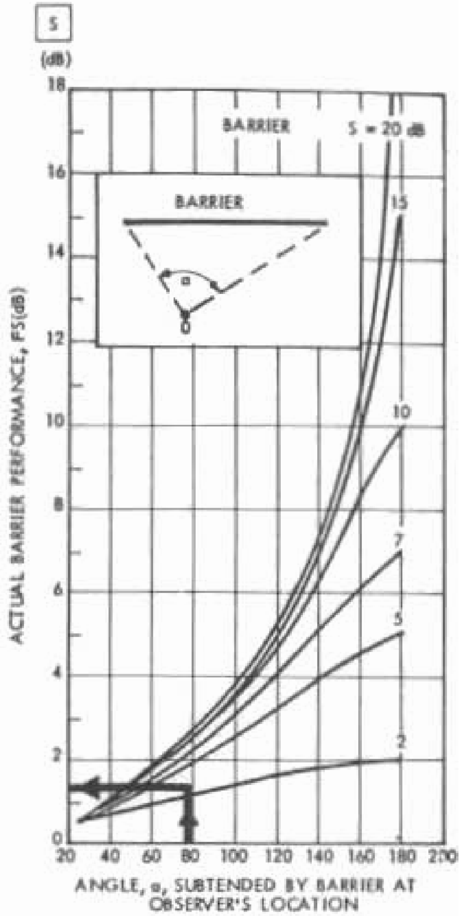


Figure 18.
Use of Workchart 7 in Example 16



2236 operations at a distance of 550 feet, we find the DNL contribution from the railroad cars to be 65 dB. Combining the engine sound levels with the car sound levels we find the total DNL from the trains to be 69 dB.

It would be possible to erect a 20-foot noise barrier, running parallel to the track at a distance of 50 feet; it could start at Road Number 2 and run 900 feet north toward the airport, as shown in Figure 16. Both the railroad track and the ground level at the barrier location are at an elevation of 160 feet. Thus, we have the following values with which to calculate the potential reduction in engine noise (using Workchart 5). (Because the distances involved are so unequal, this situation does not lend itself to direct scaling of the distances.)

H = 180 feet (20' above the ground)

S = 175 feet (15' above the track, see page 19)

0 = 285 feet (from Example 11 in the section on roadway noise)

R' = 50 feet

D' = 500 feet

We find from Worksheet 5 that the values of R and D are no different (within the accuracy of the calculation) from R' and D', a situation that will always occur when the differences in elevation are so much smaller than the distances from the site to the noise source. The value of h is 4 feet; R/D = 0.1

We can now use these numbers to enter Workchart 6 to find the *potential* barrier performance (that is, the barrier adjustment factor that would apply in the case of an infinitely long barrier). Entering Workchart 6 at h = 4 feet, with R/D = 0.1, we find the basic attenuation of the barrier to be 7.5 dB. However, with D/R = 10, we find from the table of loss-of-ground-effect attenuation that we must subtract 4 dB from the 7.5, or a net effect of 3.5 dB. However, the situation is even worse, since the barrier is finite in length.

To find the actual attenuation for this *finite* barrier, we must first find the angle subtended by the barrier to the NAL. Referring to Figure 16, we draw lines from the NAL each end of the barrier. With

References

1. D.E. Bishop, A.P. Hays, "Handbook for Developing Noise Exposure Contours for General Aviation Airports," FAA-AS-75-1, December 1975 (NTIS No. AD-A023429).

2. D.E. Bishop, et al., "Calculation of Day-Night Levels Resulting From Civil Aircraft Operations," BBN Report 3157 for Environmental Protection Agency, March 1976 (NTIS No. PB 266 165).

3. B.A. Kugler, D.E. Commins, W.J. Galloway, "Highway Noise – A Design Guide for Prediction and Control," NCHRP Report 174, Transportation Research Board, National Research Council, 1976.

4. T.J. Schultz, W.J. Galloway, "Noise Assessment Guidelines – Technical Background," Office of Policy Development and Research, U.S. Department of Housing and Urban Development," 1980.

5. M.A. Simpson, "Noise Barrier Design Handbook," FHWA-RD-76-58, Federal Highway Administration, February 1976 (NTIS No. PB 266 378).

a protractor we measure the angle between the two lines to be 77 degrees. Locate the curve on Workchart 7 corresponding to the potential barrier attenuation of 3.5 dB; it lies midway between the two lowest curves (see Figure 18). The point on this curve corresponding to a subtended angle of 77 degrees indicates that the actual barrier performance would be only 1.5 dB. With only 1.5 dB of attenuation, the barrier is clearly not cost-effective. In order to achieve a usable attenuation from the barrier, it would have to be extended beyond the other side of Road Number 2 to obtain a larger subtended angle. This extension, however, would still not be cost-effective unless the height of the barrier were increased substantially.

Summary of Adjustment Factors

Combination of Sound Levels

Table 1

Difference in Sound Level	Add to Larger Level
0	3.0
1	2.5
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
9	0.5
10	0.4
12	0.3
14	0.2
16	0.1
greater than 16	0.

Aircraft

Table 2 DNL Outside 65 dB Contour

D1 = distance from 65 dB contour to flight path
D2 = distance from site to flight path

D2 / D1	DNL dB
1.0	65
1.12	64
1.26	63
1.41	62
1.58	61
1.78	60
2.00	59
2.24	58
2.51	57
2.82	56
3.16	55

Automobile Traffic

Table 3 Stop-and-go

Distance from Site to Stop Sign feet	Automobile Stop-and-go Adjustment Factor
0	0.10
100	0.25
200	0.40
300	0.55
400	0.70
500	0.85
600	1.00

Table 4 Average Traffic Speed

Average Traffic Speed	Adjustment Factor
20 (mph)	0.13
25	0.21
30	0.30
35	0.40
40	0.53
45	0.67
50	0.83
55	1.00
60	1.19
65	1.40
70	1.62

Table 5 Nighttime (applies to all sources)

Nighttime Fraction of ADT	Nighttime Adjustment Factor
0	0.43
0.01	0.46
0.02	0.50
0.05	0.62
0.10	0.81
0.15	1.00
0.20	1.19
0.25	1.38
0.30	1.57
0.35	1.78
0.40	1.96
0.45	2.15
0.50	2.34

Medium Trucks

(less than 26,000 pounds, greater than 10,000 pounds)

Multiply adjusted automobile traffic by 10.

Heavy Trucks

Table 6 Road Gradient

Percent of Adjustment Gradient Factor	
2	1.4
3	1.7
4	2.0
5	2.2
6 or more	2.5

Table 7 Average Speed

Average Traffic Speed (mph)	Truck Speed Adjustment Factor
50 or less	0.81
55	1.00
60	1.17
65	1.38

Table 8 Stop-and-go

Heavy Truck Traffic Volume per Day	Heavy Truck Stop-and-Go Adjustment Factor
Less than 1200	1.8
1201 to 2400	2.0
2401 to 4800	2.3
4801 to 9600	2.8
9601 to 19,200	3.8
More than 19,200	4.5

Railroads - Diesel Engines

Number of Engines per Train
The number of engines divided by 2.

Table 9 Average Train Speed

Average Speed (mph)	Speed Adjustment Factor
10	3.00
20	1.50
30	1.00
40	0.75
50	0.60
60	0.50
70	0.43

Whistles or horns
Multiply number of trains by 10.

Railroads - Cars and Rapid Transit

Numbers of cars.
Number of cars per train divided by 50.

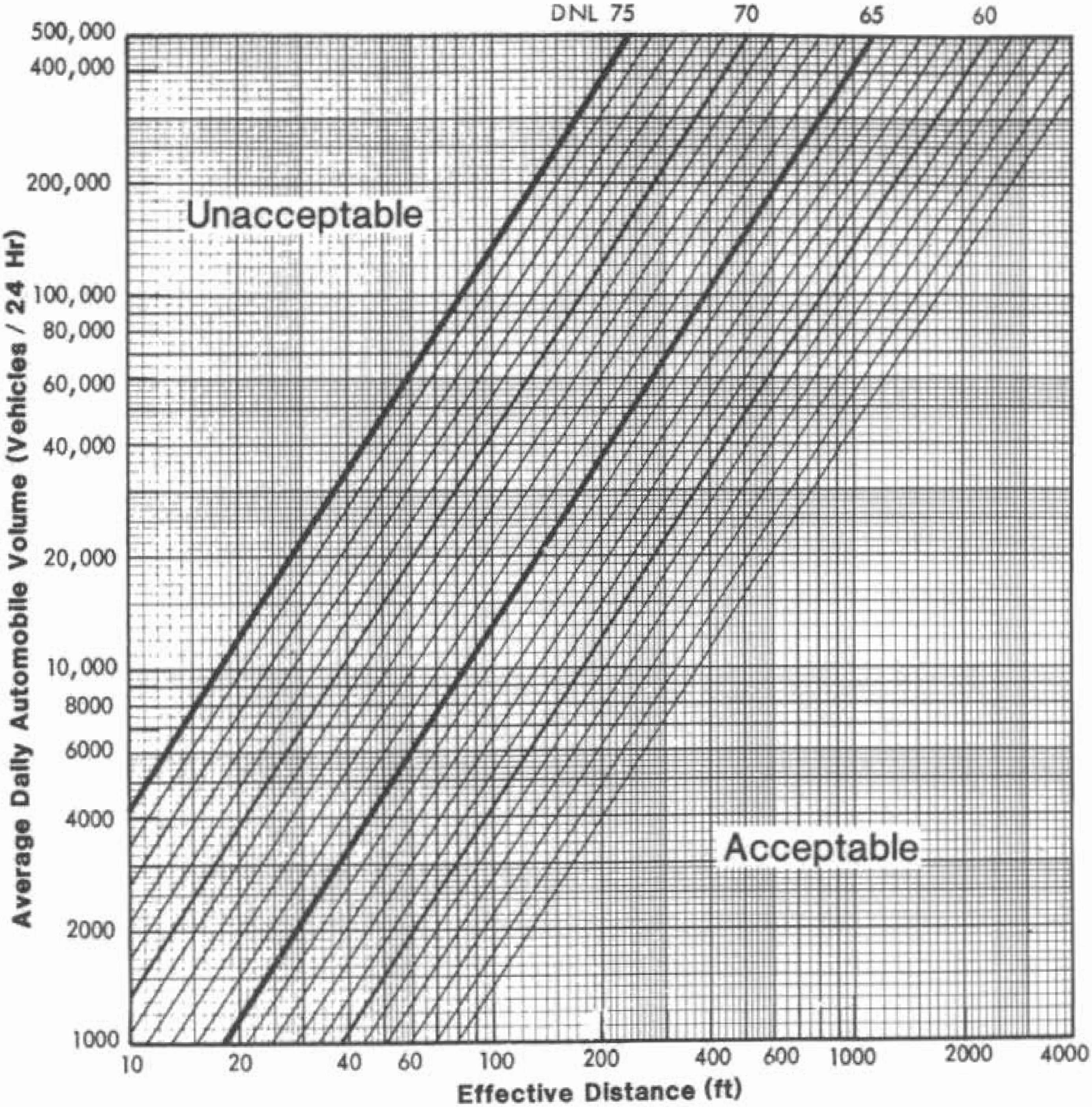
Table 10 Average Train Speed

Average Speed (mph)	Speed Adjustment Factor
10	0.11
20	0.44
30	1.00
40	1.78
50	2.78
60	4.00
70	5.44
80	7.11
90	9.00
100	11.11

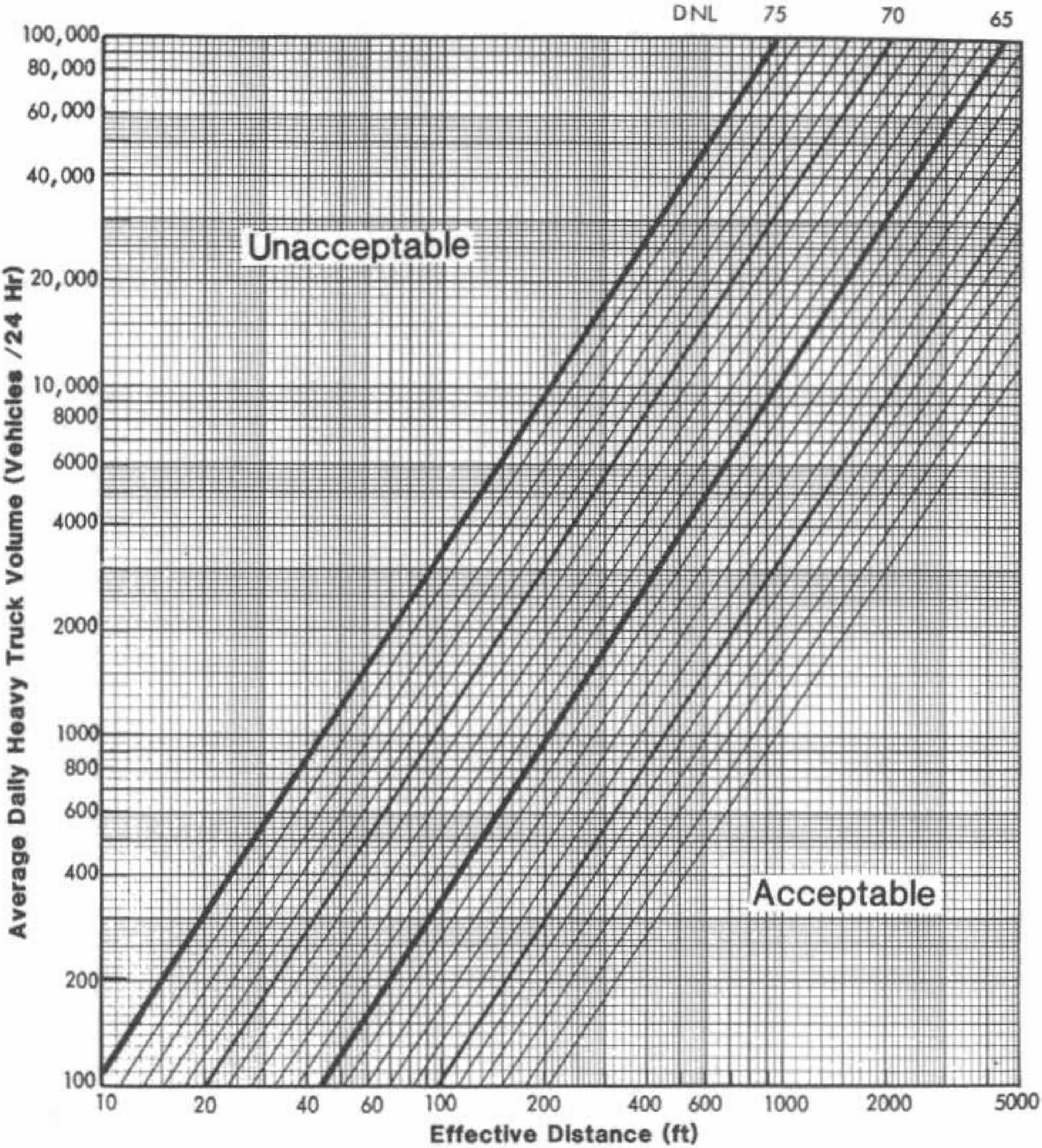
Bolted Rails
Multiply number of trains by 4.

Whistles or Horns
Multiply number of trains by 100.

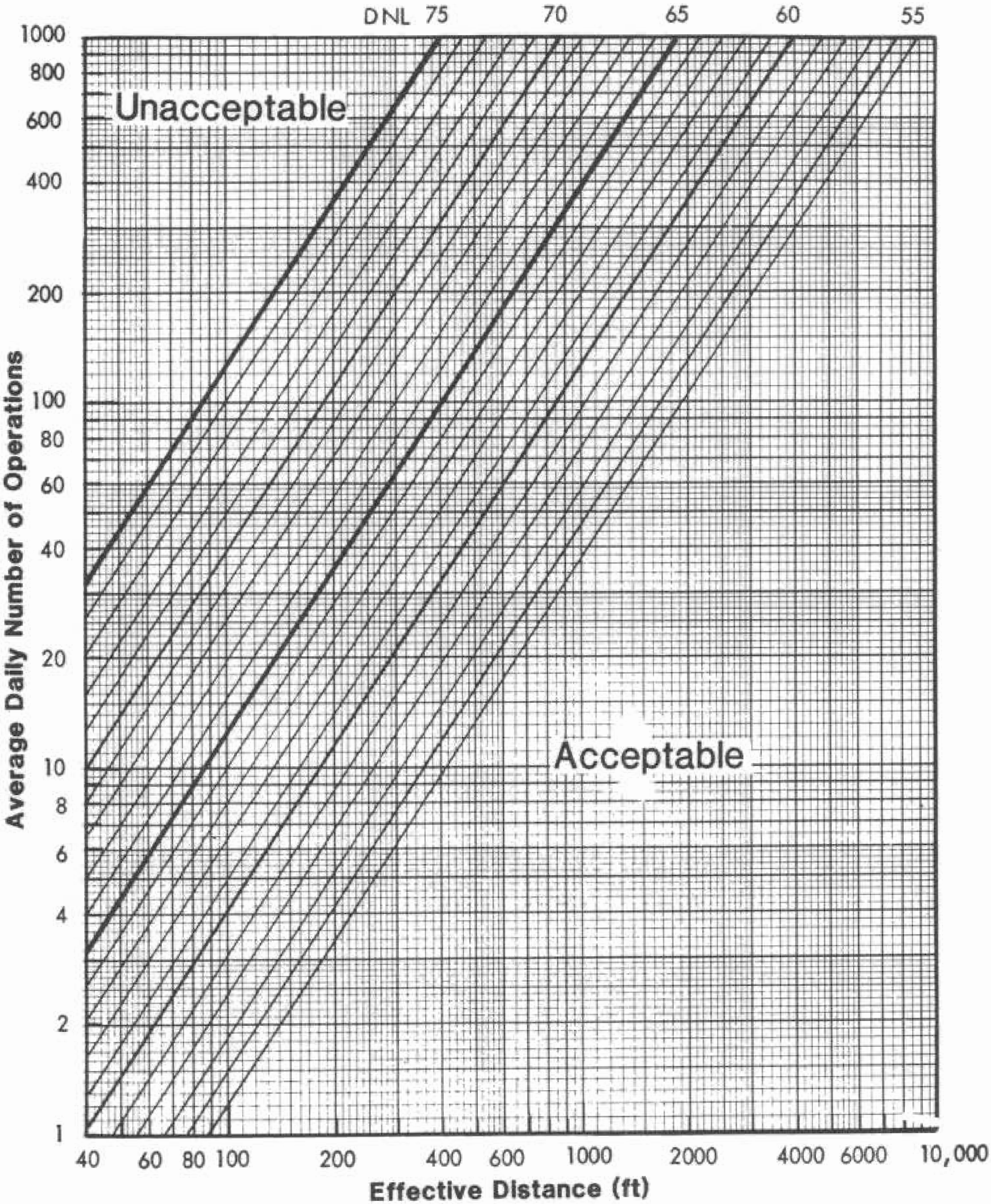
Workchart 1
Autos (55 mph)



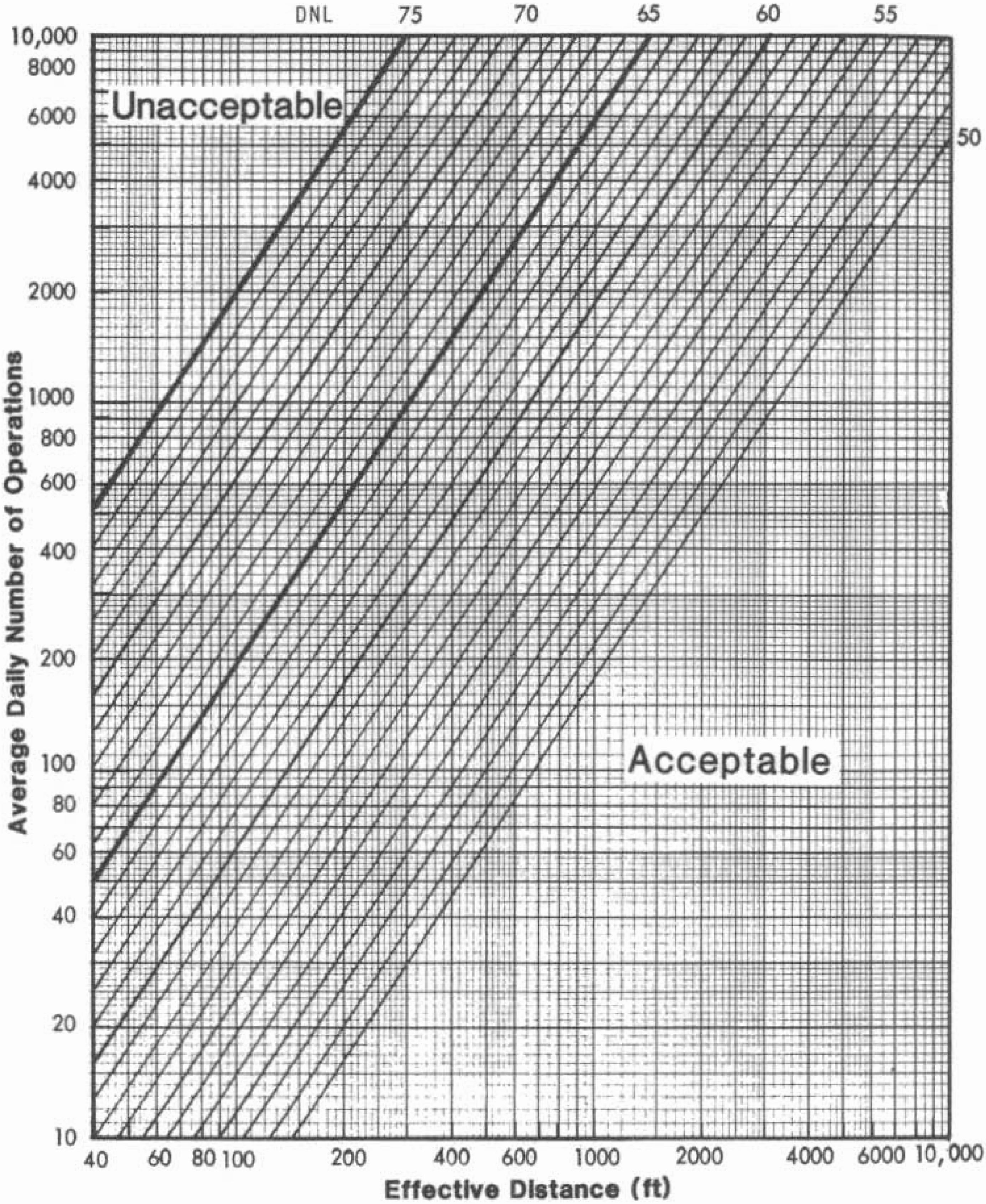
Workchart 2
Heavy Trucks (55 mph)



Workchart 3
Railroads - Diesel Locomotives



Workchart 4
Railroads - Cars and Rapid Transit



782 of 900

Workchart 5
Noise Barrier

To find R, D and h from Site Elevations and Distances

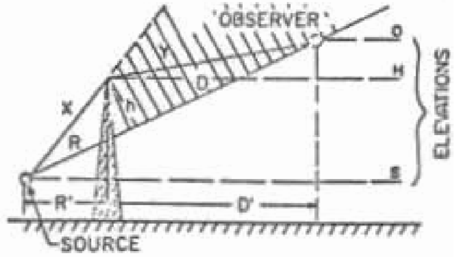
Fill out the following worksheet (all quantities are in feet):

Enter the values for:

H= ______________ R'= ______________

S= ______________ D'= ______________

O= ______________

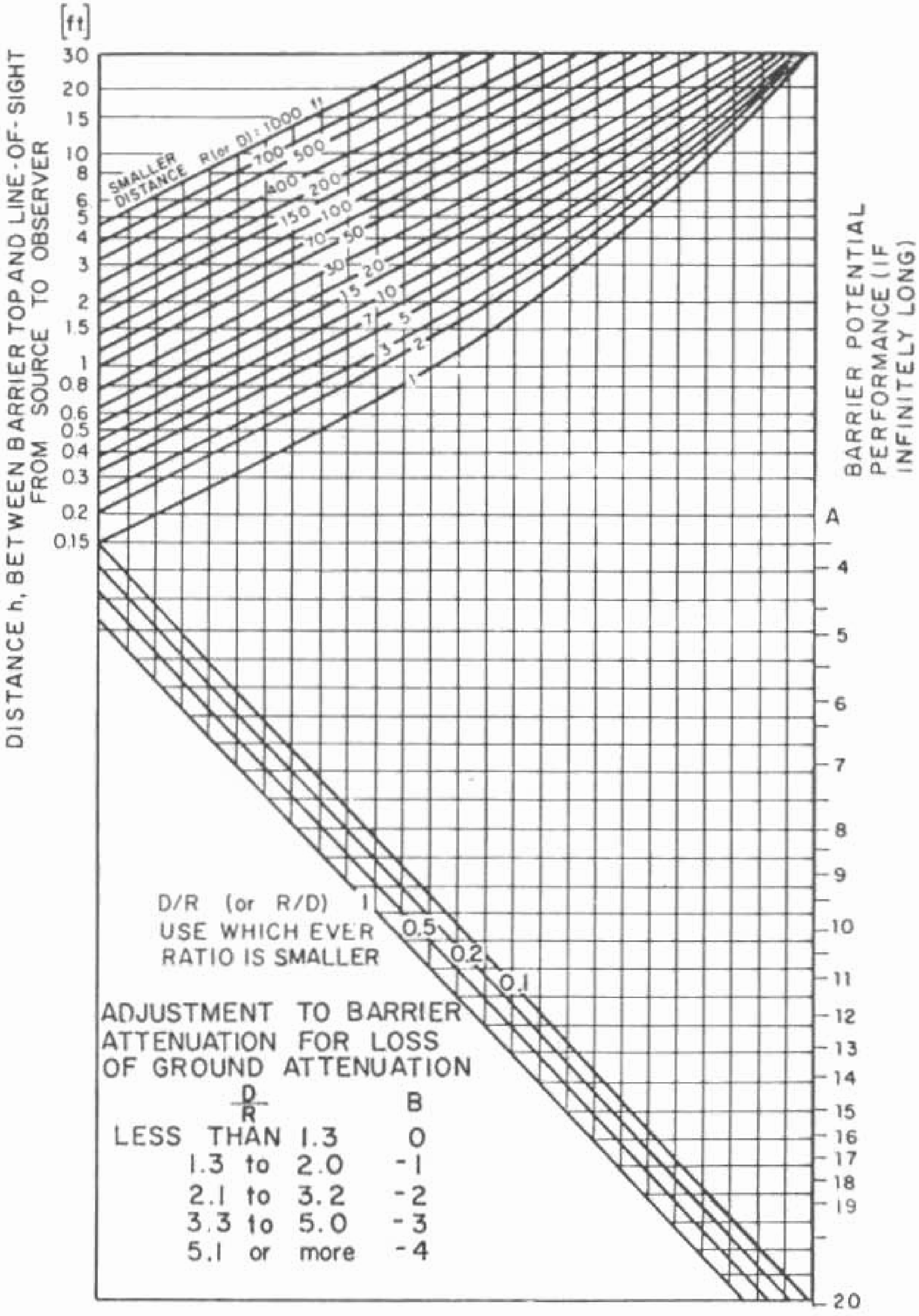


1. Elevation of barrier top minus elevation of source	[H]	−	[S]	=	[1]	
2. Elevation of observer minus elevation of source	[O]	−	[S]	=	[2]	
3. Map distance between source and observer (R' + D')					[3]	
4. Map distance between barrier and source (R')					[4]	
5. Line 2 divided by line 3	[2]	÷	[3]	=	[5]	
6. Square the quantity on line 5 (i.e., multiply it by itself); always positive	[5]	×	[5]	=	[6]	
7. 40% of line 6	[0.4]	×	[6]	=	[7]	
8. One minus line 7	[1.0]	−	[7]	=	[8]	
9. Line 5 times line 4 (will be negative if line 2 is negative)	[5]	×	[4]	=	[9]	
10. Line 1 minus line 9	[1]	−	[9]	=	[10]	
11. Line 10 times line 8	[10]	×	[8]	=	[11]	= h
12. Line 5 times line 10	[5]	×	[10]	=	[12]	
13. Line 4 divided by line 8	[4]	÷	[8]	=	[13]	
14. Line 13 plus line 12	[13]	+	[12]	=	[14]	= R
15. Line 3 minus line 4	[3]	−	[4]	=	[15]	
16. Line 15 divided by line 8	[15]	÷	[8]	=	[16]	
17. Line 16 minus line 12	[16]	−	[12]	=	[17]	= D

[**Note:** the value on line 2 may be negative, in which case so will the values on lines 5,9, and 12; line 1 may also be negative. Remember, then, in lines 10, 14, and 17, that adding a negative number is the same as subtracting: $x+(-y)=x-y$. And subtracting a negative number is like adding: $x-(-y)=x+y$.

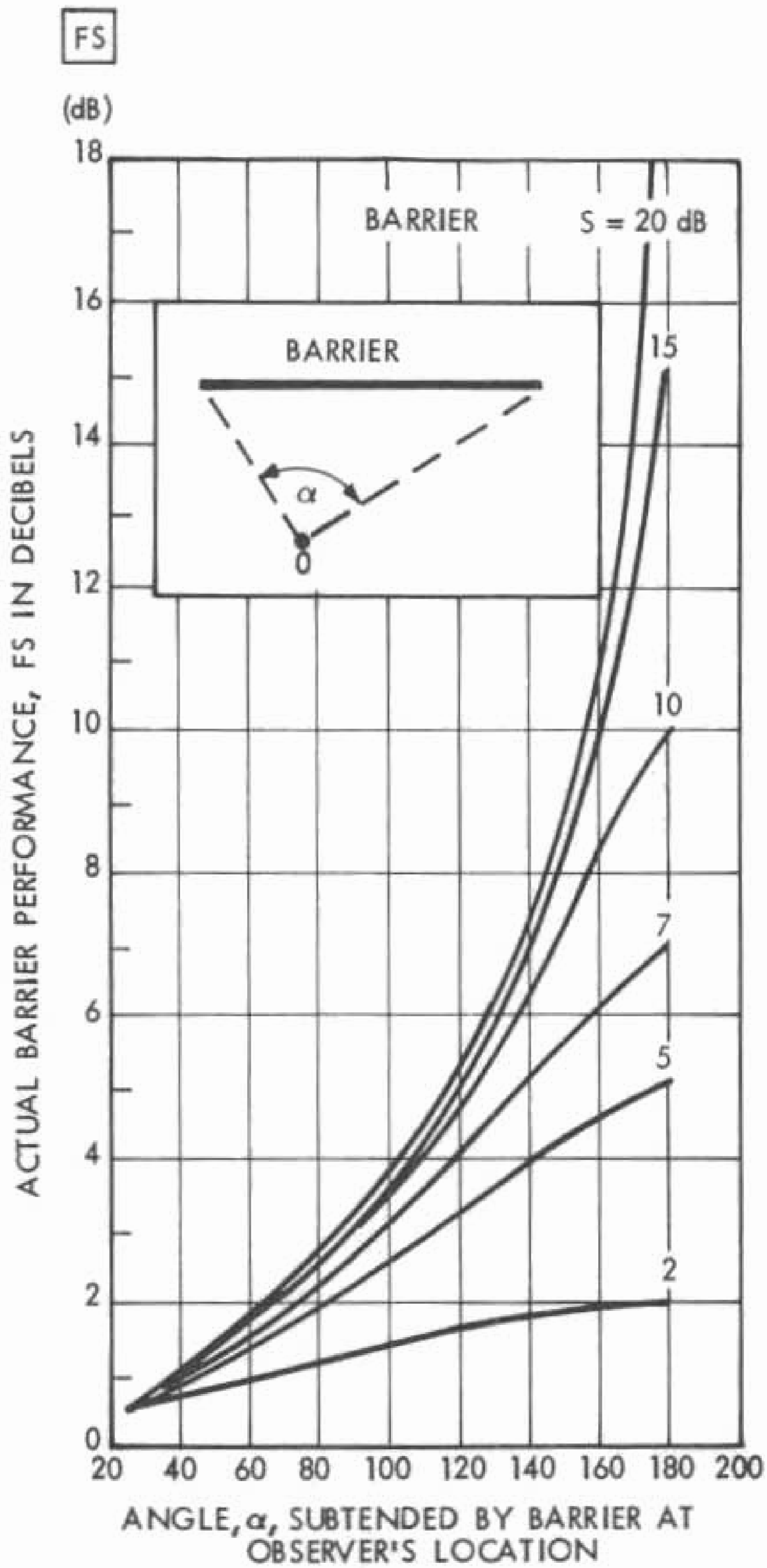
Round off R and D to nearest integer, h to one decimal place.

Workchart 6
Noise Barrier



D/R	B
LESS THAN 1.3	0
1.3 to 2.0	-1
2.1 to 3.2	-2
3.3 to 5.0	-3
5.1 or more	-4

Workchart 7



Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

Worksheet A
Site Evaluation

Noise Assessment Guidelines

Site Location

Program

Project Name

Locality

File Number

Sponsor's Name | Phone

Street Address | City, State

	Acceptability Category	DNL	Predicted for Operations in Year
1. Roadway Noise			
2. Aircraft Noise			
3. Railway Noise			

Value of DNL for all noise sources: (see page 3 for combination procedure) ______

Final Site Evaluation (circle one)

Acceptable

Normally Unacceptable

Unacceptable

Signature ______________________ Date ______________

Clip this worksheet to the top of a package containing Worksheets B-E and Workcharts 1-7 that are used in the site evaluations

Worksheet B
Aircraft Noise

List all airports within 15 miles of the site:

1. ______________________________

2. ______________________________

3. ______________________________

Necessary Information:	Airport 1	Airport 2	Airport 3
1. Are DNL, NEF or CNR contours available? (yes/no)	______	______	______
2. Any supersonic aircraft operations? (yes/no)	______	______	______
3. Estimating approximate contours from Figure 3:			
a. number of nighttime jet operations	______	______	______
b. number of daytime jet operations	______	______	______
c. effective number of operations (10 times a + b)	______	______	______
d. distance A for 65 dB	______	______	______
70dB	______	______	______
75 dB	______	______	______
e. distance B for 65 dB	______	______	______
70 dB	______	______	______
75 dB	______	______	______
4. Estimating DNL from Table 2:			
a. distance from 65 dB contour to flight path, D^1	______	______	______
b. distance from NAL to flight path, D^2	______	______	______
c. D^2 divided by D^1	______	______	______
d. DNL	______	______	______
5. Operations projected for what year?	______	______	______
6. Total DNL from all airports		______	

Signed ______________________________ Date ______________

Worksheet C
Roadway Noise

Page 1

Noise Assessment Guidelines

List all major roads within 1000 feet of the site:

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

Necessary Information	Road 1	Road 2	Road 3	Road 4
1. Distance in feet from the NAL to the edge of the road				
a. nearest lane				
b. farthest lane				
c. average (effective distance)				
2. Distance to stop sign				
3. Road gradient in percent				
4. Average speed in mph				
a. Automobiles				
b. heavy trucks - uphill				
c. heavy trucks - downhill				
5. 24 hour average number of automobiles and medium trucks in both directions (ADT)				
a. automobiles				
b. medium trucks				
c. effective ADT (a + (10xb))				
6. 24 hour average number of heavy trucks				
a. uphill				
b. downhill				
c. total				
7. Fraction of nighttime traffic (10 p.m. to 7 a.m.)				
8. Traffic projected for what year?				

Worksheet C
Roadway Noise

Page 2

Noise Assessment Guidelines

Adjustments for Automobile Traffic

	9 Stop and-go Table 3		10 Average Speed Table 4		11 Night-Time Table 5		12 Auto ADT (line 5c)		13 Adjusted Auto ADT	14 DNL (Workchart 1)		15 Barrier Attenuation		16 Partial DNL
Road No. 1		X		X		X		=			–		=	
Road No. 2		X		X		x		=			–		=	
Road No. 3		X		X		X		=			–		=	
Road No. 4		X		X		X		=			–		=	

Adjustments for Heavy Truck Traffic

	17 Gradient Table 6		18 Average Speed Table 7		19 Truck $\frac{ADT}{2}$		20	21		22 Stop and-go Table 8		23 Night-Time Table 5		24 Adjusted Truck ADT	25 DNL (Work-chart 2)		26 Barrier Attn.		27 Partial DNL
Uphill		X		X		=														
Road No. 1								Add		X		X		=			–		=	
Downhill				X		=														
Uphill		X		X		=														
Road No. 2								Add		X		X		=			–		=	
Downhill				X		=														
Uphill		X		X		=														
Road No. 3								Add		X		X		=			–		=	
Downhill				X		=														
Uphill		X		X		=														
Road No. 4								Add		X		X		=			–		=	
Downhill				X		=														

Combined Automobile & Heavy Truck DNL

Road No. 1 ________ Road No. 2 ________ Road No. 3 ________ Road No. 4 ________ Total DNL for All Roads ____________

Signature ______________________________ Date ______________

Worksheet D
Railway Noise

Page 1

Noise Assessment Guidelines

List All Railways within 3000 feet of the site:

1. ______________________________

2. ______________________________

3. ______________________________

Necessary Information:	**Railway No. 1**	**Railway No. 2**	**Railway No. 3**
1. Distance in feet from the NAL to the railway track:	______	______	______
2. Number of trains in 24 hours:			
a. diesel	______	______	______
b. electrified	______	______	______
3. Fraction of operations occuring at night (10 p.m. – 7 a.m.):	______	______	______
4. Number of diesel locomotives per train:	______	______	______
5. Number of rail cars per train:			
a. diesel trains	______	______	______
b. electrified trains	______	______	______
6. Average train speed:	______	______	______
7. Is track welded or bolted?	______	______	______
8. Are whistles or horns required for grade crossings?	______	______	______

Worksheet D
Railway Noise

Page 2

Noise Assessment Guidelines

Adjustments for Diesel Locomotives

	9 No. of Locomotives / 2		10 Average Speed Table 9		11 Horns (enter 10)		12 Night-time Table 5		13 No. of Trains (line 2a)		14 Adj. No. of Opns.	15 DNL Workchart 3		16 Barrier Attn.		17 Partial DNL
Railway No. 1	______	X	______	X	______	X	______	X	______	=	______	______	–	______	=	______
Railway No. 2	______	X	______	X	______	X	______	X	______	=	______	______	–	______	=	______
Railway No. 3	______	X	______	X	______	X	______	X	______	=	______	______	–	______	=	______

Adjustments for Railway Cars or Rapid Transit Trains

	18 Number of cars / 50		19 Average Speed Table 10		20 Bolted Rails (enter 4)		21 Night-time Table 5		22 No. of Trains (Line 2a or 2b)		23 Adj. No. of Opns.	24 DNL Work-chart 4		25 Barrier Attn.		26 Partial DNL
Railway No. 1	______	X	______	X	______	X	______	X	______	=	______	______	–	______	=	______
Railway No. 2	______	X	______	X	______	X	______	X	______	=	______	______	–	______	=	______
Railway No. 3	______	X	______	X	______	X	______	X	______	=	______	______	–	______	=	______

Combined Locomotive and Railway Car DNL

Railway No. 1 ______ Railway No. 2 ______ Railway No. 3 ______ Total DNL for all Railways ______

Signature ______________________ Date ______________

Chapter 6

A Workbook for the Noise Assessment Guidelines

Introduction

The following problems were prepared to give you the opportunity to practice the calculations and procedures described in the *Noise Assessment Guidelines*. Because it is so rarely used, we have not included any problems dealing with the aircraft noise procedure.

We have not reproduced the charts or tables from the *Guidelines* so you will need to have it at hand to do the problems.

Noise Assessment Guidelines Workbook

Problems

Problems 1 Through 7: Combining Sound Levels in Decibels

Calculate the Combined Sound Level for the Following Sets of Individual Levels:

1. 67 LDN
   61 LDN
   ______ Combined Level

2. 63 LDN
   63 LDN
   ______ Combined Level

3. 51 LDN
   68 LDN
   ______ Combined Level

4. 62 LDN
   65 LDN
   ______ Combined Level

5. 67 LDN
   72 LDN
   ______ Combined Level

6. 59 LDN
   63 LDN
   71 LDN
   ______ Combined Level

7. 73 LDN
   72 LDN
   61 LDN
   67 LDN
   ______ Combined Level

Problems 8 and 9: Calculating Effective Distance

Calculate the Effective Distances for the Following Roads:

8. Distance in Feet from NAL to:

Near Edge of Nearest Lane	22 Feet
Far Edge of Farthest Lane	76 Feet
Effective Distance	______

9. Distance in Feet from NAL to:

Near Edge of Nearest Lane	60 Feet
Far Edge of Farthest Lane	84 Feet
Effective Distance	______

Problems 10 Through 15: Adjustment Factors

List The Adjustment Factors Necessary for Each of the Following Situations and the Numerical Value for Each Adjustment Factor.

10. A Roadway Where the Road Gradient Is 1%, the Average Speed for Both Autos and Trucks Is 30 MPH and the Fraction of Nighttime Traffic Is 10%.

    Adjustment Factors Needed: ______

    Value of Adjustment Factors: ______

11. A Roadway Where There Is A Stop Sign 400 Feet from the NAL. The Gradient Is 1%, the Average Speed for Autos Is 45 MPH (There Are No Trucks) and the Fraction of Nighttime Traffic Is 15%.

    Adjustment Factors Needed: ______

    Value of Adjustment Factors: ______

12. A Roadway Where the Road Gradient Is 2%, the Average Speed for Autos Is 50 MPH and for Trucks (Both Uphill and Downhill) Is 50 MPH and the Fraction of Nighttime Traffic Is 10%.

    Adjustment Factors Needed: ____

    Value of Adjustment Factors: ____

13. A Railroad Where the Fraction of Operations Occurring at Night Is 30%, the Average Train Speed Is 40 MPH, the Track Is Bolted and There Are No Whistle Or Horns Required for Grade Crossings.

    Adjustment Factors Needed: ____

    Value of Adjustment Factors: ____

14. A Railroad Where the Fraction of Operations Occurring at Night Is 5%, the Average Train Speed Is 10 MPH, the Tracks Are Welded and There Are No Whistles Or Horns Required for Grade Crossing.

    Adjustment Factors Needed: ____

    Value of Adjustment Factors: ____

15. A Railroad Where the Fraction of Operations Occurring at Night Is 20%, the Average Train Speed Is 30 MPH, the Track Is Bolted and No Whistles or Horns Are Required for Grade Crossings.

    Adjustment Factors Needed: ____

    Value of Adjustment Factors: ____

Problems 16 Through 21: Some Basic Problems

Calculate the Combined Noise Levels for Each of the Following Situations:

16. A Roadway Where the distance in Feet from the NAL to the Near Edge of the Nearest Lane Is 310 Feet, the Distance to the Far Edge of the Farthest Lane Is 358 Feet. There Is A Stop Sign 400 Feet from the NAL. The Gradient Is 1%. The Average Number of Automobiles Is 17,000, the 24 Hour Average Number of Medium Trucks Is 1,500, the 24 Hour Average Number of Heavy Trucks Is 400 Total. The Fraction of Nighttime Traffic Is 20%.

    The Combined Noise Level for This Roadway Is ______________________.

17. A Site Exposed to Noise from Two Roads. For Roadway Number 1 the Distance in Feet from the NAL to the Near Edge of the Nearest Lane Is 125 Feet, the Distance to the Far Edge of the Farthest Lane Is 233 Feet. There Is A Stop Sign 250 Feet from the NAL. The Gradient Is 3%. The Average Speed for Both Autos and Trucks Is 30 MPH.

    The 24 Hour Average Number of Autos Is 22,000, the 24 Hour Average Number of Medium Trucks Is 2,000. The 24 Hour Average Number of Heavy Trucks Is 950 Total. The Fraction of Nighttime Traffic Is 10%.

    For Roadway Number 2, the Distance to the Near Edge of the Nearest Lane Is 45 Feet, the Distance to the Far Edge of the Farthest Lane Is 93 Feet. There Is A Stop Sign 100 Feet from the NAL and the Gradient Is 1%. The Average Speed for Both Autos and Heavy Trucks Is 30 MPH. The 24 Hour Average Number of Automobiles Is 14,000, for Medium Trucks 700, and for Heavy Trucks 600 Total. The Fraction of Nighttime Traffic Is 20%.

    The Combined Noise Level for This Site Is ______________________

18. A Site Exposed to Noise from Two Railroads. For Railroad 1, the Distance in Feet from the NAL to the Railway Track Is 150 Feet. There Are 35 Diesel Trains Every 24 Hours, No Electrified Trains. The Fraction of Operations Occurring at Night Is 25%. There Are 3 Diesel Locomotives Per Train and 70 Cars Per Train. The Average Speed Is 30 MPH and the Track Is Bolted. No Whistles Or Horns Are Used.

    For Railroad 2, the Distance in Feet from the NAL to the Railway Track Is 310 Feet. There Are 20 Diesel and 2 Electrified Trains Each 24 Hours. The Fraction of Operations Occurring at Night Is 15%. There Are 2 Locomotives Per Diesel Train and 45 Cars for Each Diesel Train and 15 Cars Per Electrified Train. The Average Train Speed Is 40 MPH and the Track Is Bolted. No Horns Or Whistles Are Used.

    The Combined Noise Level for This Site Is ______________________.

19. A Site Exposed to Noise from Two Railroads. For Railroad 1, the Distance in Feet from the NAL to the Railway Track Is 75 Feet. There Are 34 Diesel Trains Every 24 Hours, No Electrified Trains. Twenty Percent of the Operations Occur at Night. There Are 5 Locomotives Per Train and 75 Cars Per Train. The Average Train Speed Is 35 MPH and the Track Is Welded. No Horns Or Whistles.

    For Railway 2, the Distance in Feet from the NAL to the Railway Track Is 120 Feet. There Are 12 Diesel Trains in 24 Hours, No Electrified Trains. Twenty-Five Percent of the Operations Occur at Night. There Are 4 Locomotives Per Train and 40 Cars Per Train. The Average Train Speed Is 20 MPH and the Track Is Bolted. No Horns Or Whistles Are Used.

    The Combined Noise Level for This Site Is ______________________

20. A Site Exposed to Noise from Three Roads. For Road 1, the Distance in Feet from the NAL to the Near Edge of the Nearest Lane Is 100 Feet, to the Far Edge of the Farthest Lane, 208 Feet. There Is No Stop Sign and the Gradient Is 1%. The Average Speed for Autos Is 55 MPH. (There Are No Trucks Allowed On This Road.) The 24 Hour Average Number of Autos Is 40,000. The Fraction of Nighttime Traffic Is 15%.

    For Road 2, the Distance from the NAL to the Near Edge of the Nearest Lane Is 45 Feet, to the Far Edge of the Farthest Lane 75 Feet. There Is A Stop Sign 175 Feet from the NAL and the Road Gradient Is 4%. The average Speed for Both Autos and Trucks Is 40 MPH. The 24 Hour Average Number of Autos Is 15,000, for Medium Trucks 900 and for Heavy Trucks 320 Total. The Fraction of Nighttime Traffic Is 20%.

    For Road 3, the Distance from the NAL to the Near Edge of the Nearest Lane Is 52 Feet, to the Far Edge of the Farthest Lane 92 Feet. There Is A Stop Sign 400 Feet from the NAL and the Gradient Is 1%. The Average Speed for Both Autos and Trucks Is 25 MPH. The 24 Hour Average Number of Autos Is 5,000, for Medium Trucks 1,050 and for Heavy Trucks 175 Total. The Fraction of Nighttime Traffic Is 20%.

    The Combined Noise Level for This Site Is ______________________.

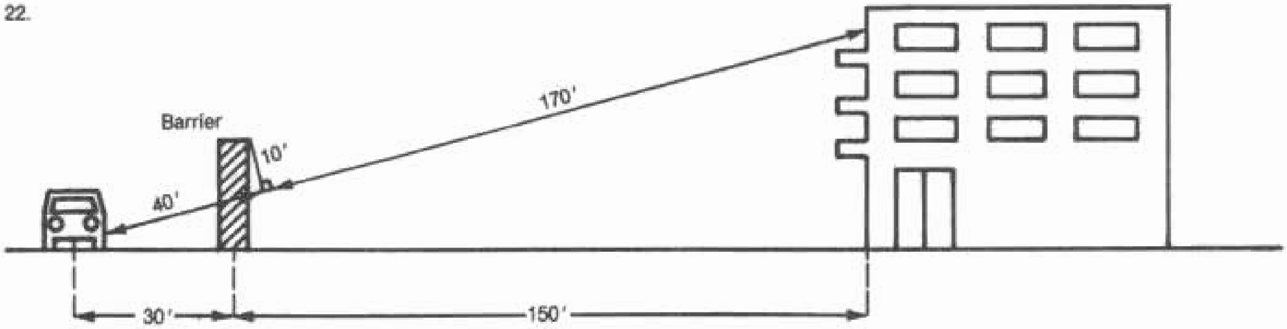
21. A Site Exposed to Noise from A Railroad. The Distance from the NAL to the Railroad Is 110 Feet. There Are 30 Diesel Trains Every 24 Hours, No Electrified Trains. Twenty Percent of the Operations Occur at Night. There Are 3 Locomotives Per Train and 50 Cars Per Train. The Average Train Speed Is 30 MPH, the Track Is Bolted and There Is A Grade Crossing Where Horns and Whistles Are Used 100 Feet from the NAL.

The Combined Noise Level at This Site Is ________________.

Problems 22 Through 24: Barriers - Identifying the Values for H, R, R′, D and D′

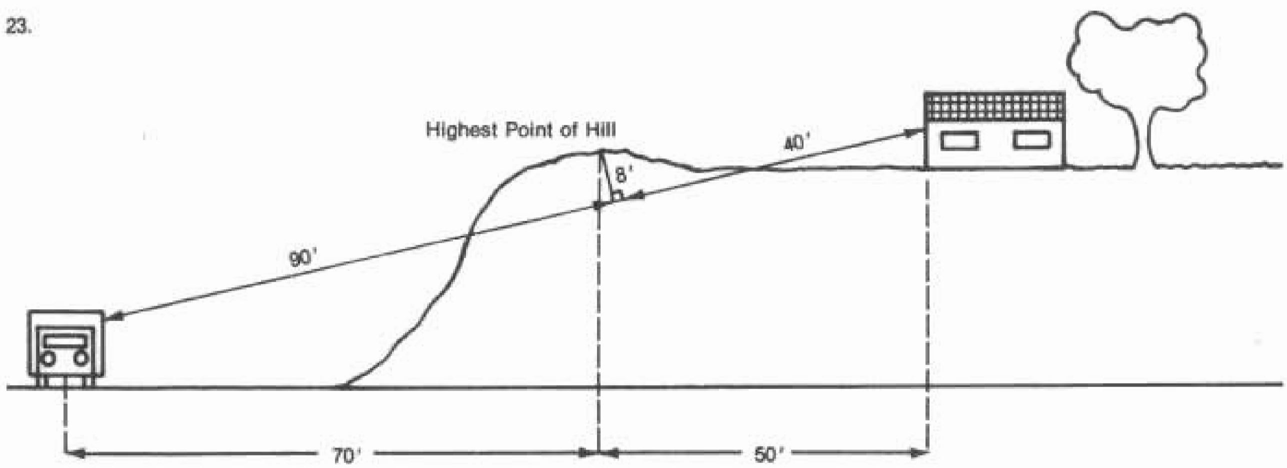
Identify the Values for H, R, R′, D and D′ for Each of the Following Barriers:

22.



H = ________, R = ________, R′ = ________ D = ________ and D′ = ________

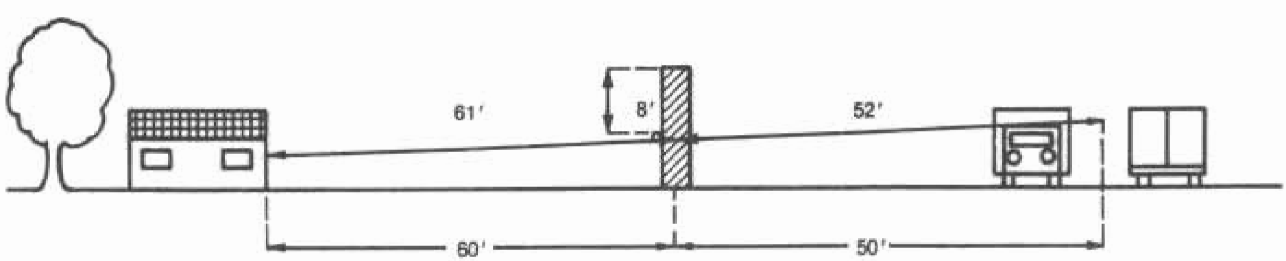
23.



H = ________, R = ________, R′ = ________, D = ________ and D′ = ________

Barrier	40′	10′	170′	90′	70′
Highest Point of Hill	30′	150′		8′	50′
				40′	

24.



H = ________, R = ________, R′ ________, D = ________ and D′ ________

Problems 25 Through 27: Barrier Calculations Using Workcharts 6 and 7.

Using Workcharts 6 and 7 Only, Calculate the Noise Attenuation Provided by the Barriers Illustrated in Problems 22 Through 24. Additional Data on the Angles Subtended by the Ends of the Barriers and the NAL for Each Location Is Provided.

25. Calculate the Noise Attenuation Provided by the Barrier Described in Problem 22. The Angle Subtended by the Ends of the Barrier and the NAL Is 150 Degrees.

    The Noise Attenuation Provided Is ______________________ Decibels.

26. Calculate the Noise Attenuation Provided by the Barrier Described in Problem 23. The Angle Subtended by the Ends of the Barrier and the NAL Is 90 Degrees.

    The Noise Attenuation Provided Is ______________________ Decibels.

27. Calculate the Noise Attenuation Provided by the Barrier Described in Problem 24. The Angle Subtended by the Ends of the Barrier and the NAL Is 130 Degrees.

    The Noise Attenuation Provided Is ______________________ Decibels.

Problems 28 Through 30: Barrier Calculations Using Workcharts 5, 6 and 7

Calculate the Attenuation Provided By the Barriers in the Following Situations. Use Workcharts 5, 6 and 7.

28. A Two Story Building Is Exposed to Noise Levels of 68 LDN from Automobiles. The Barrier Is 15 Feet High and Is Located 40 Feet from the Source and 20 Feet from the Building. The Source, Barrier, and Building Are All On Level Ground. The Angle Subtended by the Ends of the Barrier and the Noise Assessment Location Is 110 Degrees.

    The Noise Attenuation Provided by This Barrier Is ______________ Decibels.

    Is This Sufficient? ______________________

29. A Three Story Building Is Exposed to A Noise Level of 72 LDN from Diesel Locomotives and 60 LDN from Railroad Cars. The Barrier Is 12 Feet High and Is Located 40 Feet from the Source and 85 Feet from the Building. The Barrier and the Building Are on the Same Level, But the Track Is Depressed 25 Feet. The Angle Subtended by the Ends Of the Barrier and the NAL Is 120 Degrees.

    The Noise Attenuation Provided by This Barrier Is ______________ Decibels.

    Is This Sufficient? ______________________

30. A Three Story Building Is Exposed to Noise Levels of 67 LDN from Automobiles and 71 LDN from Trucks. The Barrier Is 16 Feet High and Is Located 36 Feet from the Source and 56 Feet from the Building. The Source, the Barrier and the Building Are All At the Same Level. The Angle Subtended by the Barrier Ends and the NAL Is 130 Degrees.

    The Noise Attenuation Provided by This Barrier Is ______________ Decibels.

    Is This Sufficient? ______________________

Noise Assessment Guidelines Workbook
Answers

Problem

1. 68 LDN (67–61 = 6, Add 1dB (From Table) to 67 = 68 LDN)
2. 66 LDN (63–63 = 0, Add 3dB (From Table) to 63 = 66 LDN)
3. 69 LDN (69–51 = 0, Add 0dB to 69 = 69 LDN)
4. 67 LDN (65–62 = 3, Add 1.8dB to 65, Round Off to Nearest Whole Number, 66.8 = 67 LDN)
5. 73 LDN (72–65 = 5, Add 1.2 = 73.2 = 73 LDN)
6. 72 LDN (63–59 = 4, Add 1.5 = 64.5, 71–64.5 = 6.5
Interpolate From Table: 6 = 1.0, 7 = .8
6.5 = .9) 71 + .9 = 71.9 = 72 LDN)

7. 76 LDN (67–61 = 6, Add 1.0 = 68, 72–68 = 4, Add 1.5 = 73.5,
73.5–73 = .5, Interpolate From Table,
Add 2.75 = 76.25 = 76 LDN)

8. 49 Feet (76 + 22 = 98 − 2 = 49)
9. 72 Feet (84 + 60 = 144 − 2 = 72)

10. Adjustment Factors Needed: Speed and Night-Time Percentage

    Value of Factors: Speed = Autos .30
    Trucks .81
    Nighttime
    Percentage .81

    Note—You Must Have Different Speed Adjustments for Autos and Trucks.

11. Adjustment Factors Needed: Speed and Stop and Go Traffic
    Value of Factors: Speed .67
    Stop and Go .70

12. Adjustment Factors Needed: Gradient, Speed and Nighttime Percentage

    Value of Factors: Gradient 1.4
    Speed = Autos .30
    Trucks .81
    Nighttime
    Percentage .81

13. Adjustment Factors Needed: Nighttime Percentage, Speed, Bolted Track

    Value of Factors: Nighttime
    Percentage 1.57
    Speed = Engines .75
    Cars 1.78
    Bolted Track 4

    Note—You Must Have Different Speed Adjustments for Engines and Cars.

14. Adjustment Factors Needed: Nighttime Percentage and Speed

    Value of Factors: Nighttime
    Percentage .62
    Speed = Engines 3.0
    Cars .11

15. Adjustment Factors Needed: Nighttime Percentage and Bolted Track

    Value of Factors: Nighttime
    Percentage 1.19
    Bolted Track 4

16. Combined Noise Level = 62 LDN (If Your Answer Is Plus or Minus 1dB Its OK – Between Rounding Off and the Large Scale on the Nomographs, That's Close Enough)

Worksheet C **Page 1** Noise Assessment Guidelines
Roadway Noise

List all major roads within 1000 ft of the site:

1. ______
2. ______
3. ______
4. ______

Necessary Information	Road 1	Road 2	Road 3	Road 4
1. Distance in feet from the NAL to the edge of the road				
a. nearest lane	310			
b. farthest lane	358			
c. average (effective distance)	334			
2. Distance to stop sign	400			
3. Road gradient in percent	1%			
4. Average speed in mph				
a. Automobiles	40			
b. heavy trucks - uphill	40			
c. heavy trucks - downhill	40			
5. 24 hour average number of automobiles and medium trucks in both directions (ADT)				
a. automobiles	17000			
b. medium trucks	1500			
c. effective ADT (a + (10xb))	32000			
6. 24 hour average number of heavy trucks				
a. uphill	200			
b. downhill	200			
c. total	400			
7. Fraction of nighttime traffic (10:00 p.m. to 7 a.m.)	20%			
8. Traffic projected for what year?	—			

Worksheet C **Page 2** Noise Assessment Guidelines
Roadway Noise

Adjustments for Automobile Traffic

	9 Stop and-go Table 3	10 Average Speed Table 4	11 Night Time Table 5	12 Auto ADT (line 5c)	13 Adjusted Auto ADT	14 DNL (Workchart 1)	15 Barrier Attenuation	16 Partial DNL
Road No. 1	.70 x	.53 x	1.19 x	32000 =	14128	67 -	0 =	67
Road No. 2	x	x	x	=		-	=	
Road No. 3	x	x	x	=		-	=	
Road No. 4	x	x	x	=		-	=	

Adjustments for Heavy Truck Traffic

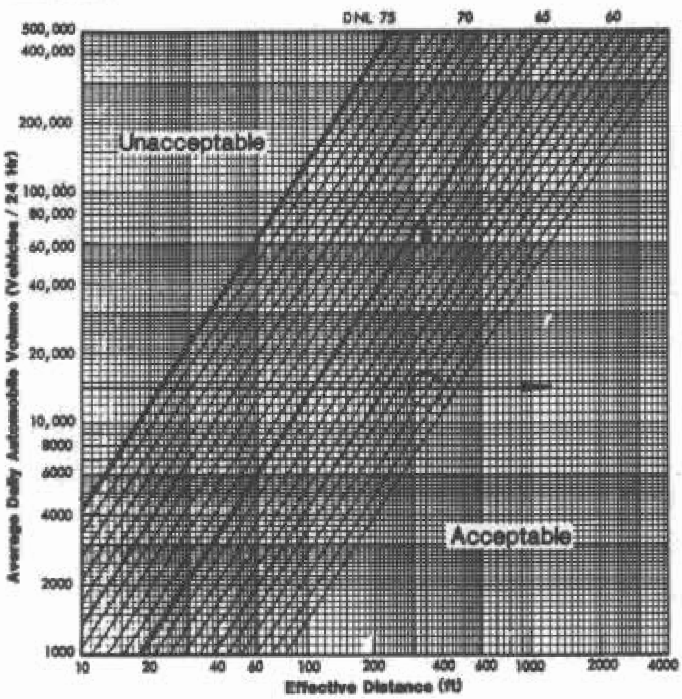
		17 Gradient Table 6	18 Average Speed Table 7	19 Truck ADT 6	20	21	22 Stop and-go Table 9	23 Night Time Table 5	24 Adjusted Truck ADT	25 DNL (Work chart 2)	26 Barrier Adj.	27 Partial DNL
Road No. 1	Uphill	— x	.81 x	200 =	162							
					Add	324 x	1.8 x	1.19 =	694	60 -	0 =	60
	Downhill		.81 x	200 =	162							
Road No. 2	Uphill	x	x	=								
					Add	x	x	=		-	=	
	Downhill		x	=								
Road No. 3	Uphill	x	x	=								
					Add	x	x	=		-	=	
	Downhill		x	=								
Road No. 4	Uphill	x	x	=								
					Add	x	x	=		-	=	
	Downhill		x	=								

Combined Automobile & Heavy Truck DNL

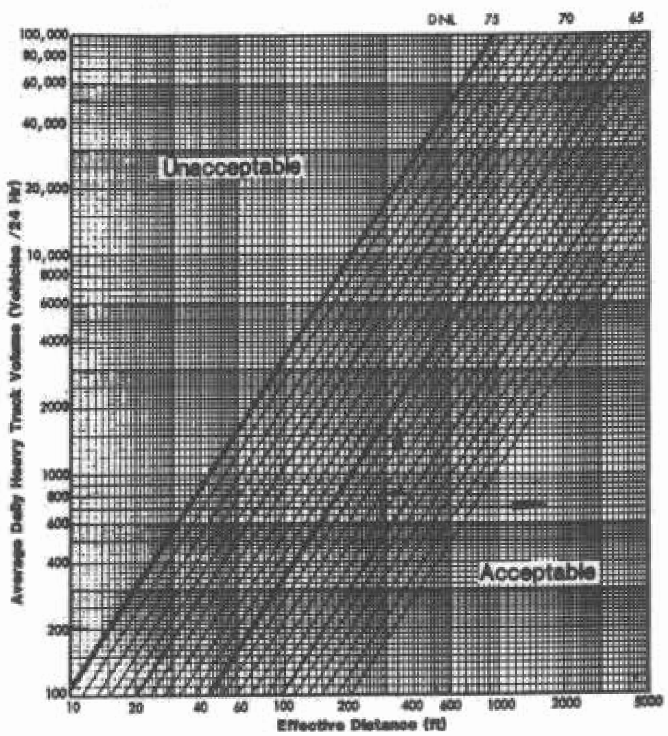
Road No. 1 62 Road No. 2 ______ Road No. 3 ______ Road No. 4 ______ Total DNL for All Roads 62

Signature ______ Date ______

Workchart 1
Autos (55 mph)



Workchart 2
Heavy Trucks (55 mph)



17. Combined Noise Level = 74 LDN (+ OR – 1 dB)

Worksheet C Page 1 Noise Assessment Guidelines
Roadway Noise

List all major roads within 1000 ft of the site:

1. ______
2. ______
3. ______
4. ______

Necessary Information	Road 1	Road 2	Road 3	Road 4
1. Distance in feet from the NAL to the edge of the road				
a. nearest lane	125	45		
b. farthest lane	233	93		
c. average (effective distance)	179	69		
2. Distance to stop sign	250	100		
3. Road gradient in percent	3%	1%		
4. Average speed in mph				
a. Automobiles	30	30		
b. heavy trucks - uphill	30	30		
c. heavy trucks - downhill	30	30		
5. 24 hour average number of automobiles and medium trucks in both directions (ADT)				
a. automobiles	22000	14000		
b. medium trucks	2000	700		
c. effective ADT (a + (10xb))	42000	21000		
6. 24 hour average number of heavy trucks				
a. uphill	475	300		
b. downhill	475	300		
c. total	950	600		
7. Fraction of nighttime traffic (10:00 p.m. to 7 a.m.)	10%	20%		
8. Traffic projected for what year?	–	–		

Worksheet C Page 2 Noise Assessment Guidelines
Roadway Noise

Adjustments for Automobile Traffic

	8 Stop and go Table 3	10 Average Speed Table 4	11 Night Time Table 5	12 Auto ADT (line 5c)	13 Adjusted Auto ADT	14 DNL (Workchart 1)	15 Barrier Attenuation	16 Partial DNL
Road No. 1	.48 ×	.30 ×	.81 ×	42000 =	4899	57 –	0 =	57
Road No. 2	.25 ×	.30 ×	1.19 ×	21000 =	1874	59 –	0 =	59
Road No. 3	×	×	×	=		–	=	
Road No. 4	×	×	×	=		–	=	

Adjustments for Heavy Truck Traffic

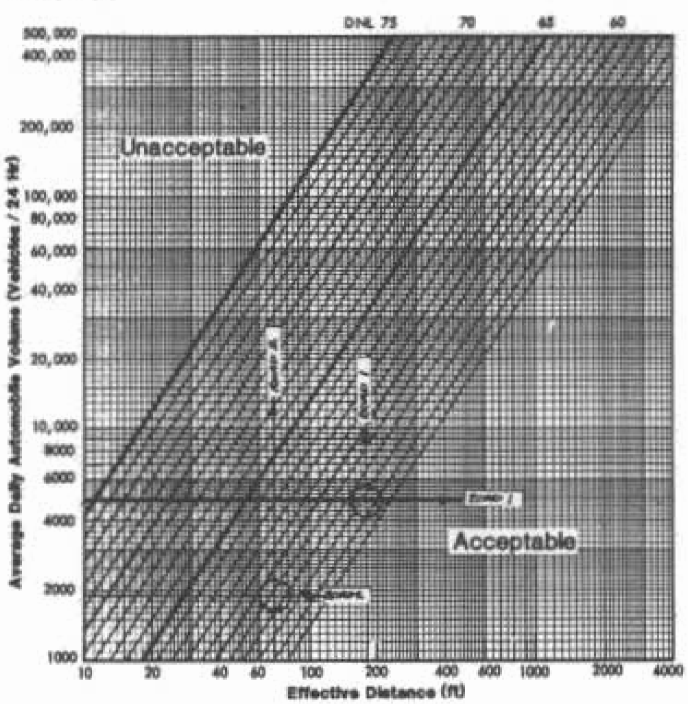
		17 Gradient Table 6	18 Average Speed Table 7	19 Truck ADT	20	21	22 Stop and go Table 8	23 Night Time Table 9	24 Adjusted Truck ADT	25 DNL (Workchart 2)	26 Barrier Atten.	27 Partial DNL
Road No. 1	Uphill	1.7 ×	.81 ×	475 =	654							
						Add 1039 ×	1.8 ×	.81 =	1515	68 –	0 =	68
	Downhill		.81 ×	475 =	385							
Road No. 2	Uphill	– ×	.81 ×	300 =	243							
						Add 486 ×	1.8 ×	1.19 =	1041	72 –	0 =	72
	Downhill		.81 ×	300 =	243							
Road No. 3	Uphill	×	×	=								
						Add	×	×	=	–	=	
	Downhill		×	=								
Road No. 4	Uphill	×	×	=								
						Add	×	×	=	–	=	
	Downhill		×	=								

Combined Automobile & Heavy Truck DNL

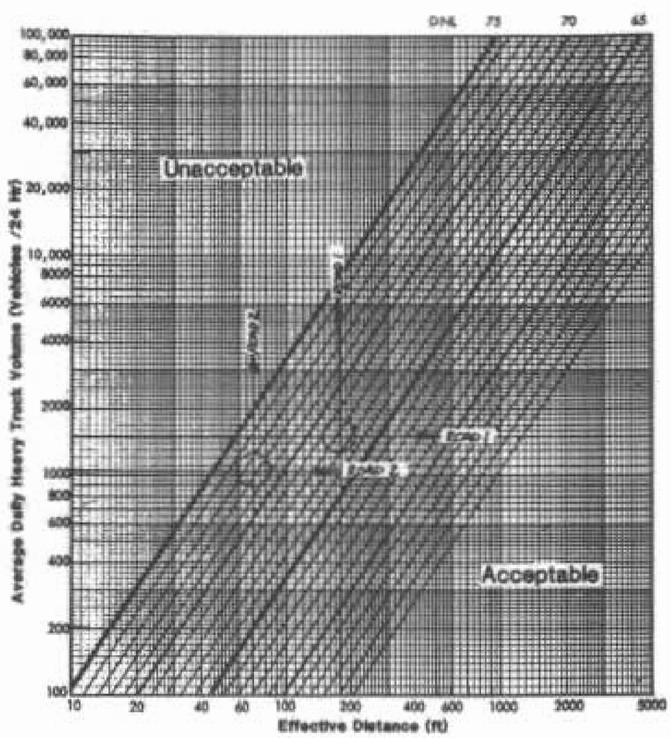
Road No. 1 68 Road No. 2 72 Road No. 3 ____ Road No. 4 ____ Total DNL for All Roads 74

Signature ______ Date ______

Workchart 1
Autos (55 mph)



Workchart 2
Heavy Trucks (55 mph)



18. Combined Noise Level = 71 LDN

Note—In Order to Complete Column 18 for Railway #2 You Must Find the Average Number of Cars Per Train. Multiply the Number of Diesel Trains Times the Number of Cars Per Train (20 × 45 = 900). Multiply the Number of Electrified Trains Times the Number of Cars Per Train (2 × 15 = 30). Add the Two Totals Together and Divide By the Total Number of Trains (900 + 30 = 930 − 22 = 42).

Worksheet D
Railway Noise

Page 2

Noise Assessment Guidelines

Adjustments for Diesel Locomotives

	9 No. of Locomotives / 2	10 Average Speed Table 8	11 Horns (enter 10)	12 Night-time Table 6	13 No. of Trains (line 3a)	14 Adj. No. of Opns.	15 DNL Workchart 3	16 Barrier Attn.	17 Partial DNL
Railway No. 1	1.6	1.0	—	1.38	35	72	70	0	72
Railway No. 2	1	.75	—	1.0	20	15	58	0	58
Railway No. 3									

Adjustments for Railway Cars or Rapid Transit Trains

	18 Number of cars / 50	19 Average Speed Table 10	20 Bolted Rails (enter 4)	21 Night-time Table 5	22 No. of Trains (Line 3a or 3b)	23 Adj. No. of Opns.	24 DNL Workchart 4	25 Barrier Attn.	26 Partial DNL
Railway No. 1	1.4	1.0	4	1.38	35	270	64	0	64
Railway No. 2	.84	1.78	4	1.38	22	182	57	0	67
Railway No. 3									

Combined Locomotive and Railway Car DNL

Railway No. 1 71 Railway No. 2 61 Railway No. 3 71 Total DNL for all Railways

Signature ____________________ Date ____________

19. Combined Noise Level = 76 LDN

Worksheet D
Railway Noise

Page 2

Noise Assessment Guidelines

Adjustments for Diesel Locomotives

	9 No. of Locomotives / 2	10 Average Speed Table 8	11 Horns (enter 10)	12 Night-time Table 6	13 No. of Trains (line 3a)	14 Adj. No. of Opns.	15 DNL Workchart 3	16 Barrier Attn.	17 Partial DNL
Railway No. 1	2.5	.88	—	1.19	34	89	75	0	75
Railway No. 2	2	1.50	—	1.38	12	50	70	0	70
Railway No. 3									

Adjustments for Railway Cars or Rapid Transit Trains

	18 Number of cars / 50	19 Average Speed Table 10	20 Bolted Rails (enter 4)	21 Night-time Table 5	22 No. of Trains (Line 3a or 3b)	23 Adj. No. of Opns.	24 DNL Workchart 4	25 Barrier Attn.	26 Partial DNL
Railway No. 1	1.5	1.39	—	1.19	34	.84	63	0	63
Railway No. 2	.80	.44	4	1.38	12	23	55	0	55
Railway No. 3									

Combined Locomotive and Railway Car DNL

Railway No. 1 75 Railway No. 2 70 Railway No. 3 ____ Total DNL for all Railways 76

Signature ____________________ Date ____________

20. Combined Noise Level = 75 LDN

Worksheet C
Roadway Noise — Page 1 — Noise Assessment Guidelines

List all major roads within 1000 ft of the site:

1. ______
2. ______
3. ______
4. ______

Necessary Information	Road 1	Road 2	Road 3	Road 4
1. Distance in feet from the NAL to the edge of the road				
a. nearest lane	100	45	52	
b. farthest lane	208	75	92	
c. average (effective distance)	154	60	72	
2. Distance to stop sign	–	175	400	
3. Road gradient in percent	1%	4%	1%	
4. Average speed in mph				
a. Automobiles	55	40	25	
b. heavy trucks - uphill	55	40	25	
c. heavy trucks - downhill	55	40	25	
5. 24 hour average number of automobiles and medium trucks in both directions (ADT)				
a. automobiles	40000	15800	5000	
b. medium trucks	–	900	1050	
c. effective ADT (a + (10xb))	40000	24800	15500	
6. 24 hour average number of heavy trucks				
a. uphill	–	160	87	
b. downhill	–	160	88	
c. total	–	320	175	
7. Fraction of nighttime traffic (10:00 p.m. to 7 a.m.)	15%	20%	20%	
8. Traffic projected for what year?	–	–	–	

Worksheet C
Roadway Noise — Page 2 — Noise Assessment Guidelines

Adjustments for Automobile Traffic

	9 Stop and go Table 3	10 Average Speed Table 4	11 Night Time Table 5	12 Auto ADT (line 5c)	13 Adjusted Auto ADT	14 DNL (Workchart 1)	15 Barrier Attenuation	16 Partial DNL
Road No. 1	0	x 1.0	x 1.0	x 40000	= 40000	67	– 0	= 67
Road No. 2	.36	x .58	x 1.19	x 24000	= 5450	65	– 0	= 65
Road No. 3	.70	x .21	x 1.19	x 15500	= 2711	60	– 0	= 60
Road No. 4		x	x	x	=		–	=

Adjustments for Heavy Truck Traffic

		17 Gradient Table 6	18 Average Speed Table 7	19 Truck ADT	20	21	22 Stop and-go Table 8	23 Night-Time Table 5	24 Adjusted Truck ADT	25 DNL (Work. chart 2)	26 Barrier Atn.	27 Partial DNL
Road No. 1	Uphill	–	x –	x –	= –							
	Road No. 1					Adj –	x –	x –	= –	–	– –	= –
	Downhill		–	x –	= –							
Road No. 2	Uphill	2.0	x .81	x 160	= 259							
	Road No. 2					Adj 389	x 1.8	x 1.19	= 833	72	– 0	= 72
	Downhill		.81	x 160	= 130							
Road No. 3	Uphill	1.0	x .81	x 87	= 70							
	Road No. 3					Adj 141	x 1.8	x 1.19	= 303	67	– 0	= 67
	Downhill		.81	x 88	= 71							
Road No. 4	Uphill		x	x	=							
	Road No. 4					Adj	x	x	=		–	=
	Downhill			x	=							

Combined Automobile & Heavy Truck DNL

Road No. 1 67 Road No. 2 73 Road No. 3 68 Road No. 4 ______ Total DNL for All Roads 75

Signature ______ Date ______

21. Combined Noise Level = 81 LDN

To Solve This Problem You Must Add Some More Lines to the Workchart for Engines Because the Workchart as Set up Does Not Go High Enough. There Are A Variety of Ways to Do This But One of the Easiest Is to Take A Piece of Blank Paper (A 3 × 5 Card Does Very Well) Place the Edge of the Paper Along Either the Top Or Bottom Edge of the Workchart and Mark Where the LDN Lines Fall Along the Edge of the Blank Paper. Then Once You Have Drawn Your Distance and Operations Lines on the Work Chart, You Take Your Paper with the Line Markings and Lay It along the Line for Adjusted Operations with the Mark Farthest to the Right Lined up with the 75 LDN Line. Now Just Count over until You Reach the Intersection of the Operations and Distance Lines.

Worksheet D
Railway Noise

Page 2

Noise Assessment Guidelines

Adjustments for Diesel Locomotives

	9 No. of Locomotives / 2	10 Average Speed Table 6	11 Horns (enter 10)	12 Night-time Table 5	13 No. of Trains (line 3a)	14 Adj. No. of Opns.	15 DNL Workchart 3	16 Barrier Atn.	17 Partial DNL
Railway No. 1	1.5 x	1.0 x	10 x	1.19 x	30 =	535	81 −	0 =	81
Railway No. 2	x	x	x	x	=		−	=	
Railway No. 3	x	x	x	x	=		−	=	

Adjustments for Railway Cars or Rapid Transit Trains

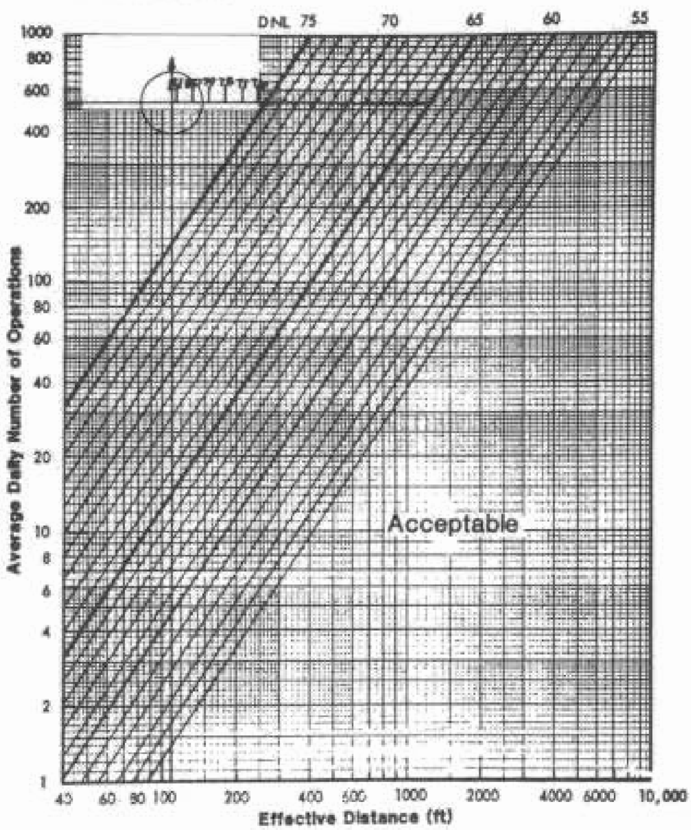
	18 Number of cars / 50	19 Average Speed Table 10	20 Bolted Rails (enter 4)	21 Night-time Table 5	22 No. of Trains (Line 3a or 3b)	23 Adj. No. of Opns.	24 DNL Workchart 4	25 Barrier Atn.	26 Partial DNL
Railway No. 1	1.0 x	1.0 x	4 x	1.19 x	30 x	143	63 −	0 =	63
Railway No. 2	x	x	x	x	x		−	=	
Railway No. 3	x	x	x	x	x		−	=	

Combined Locomotive and Railway Car DNL

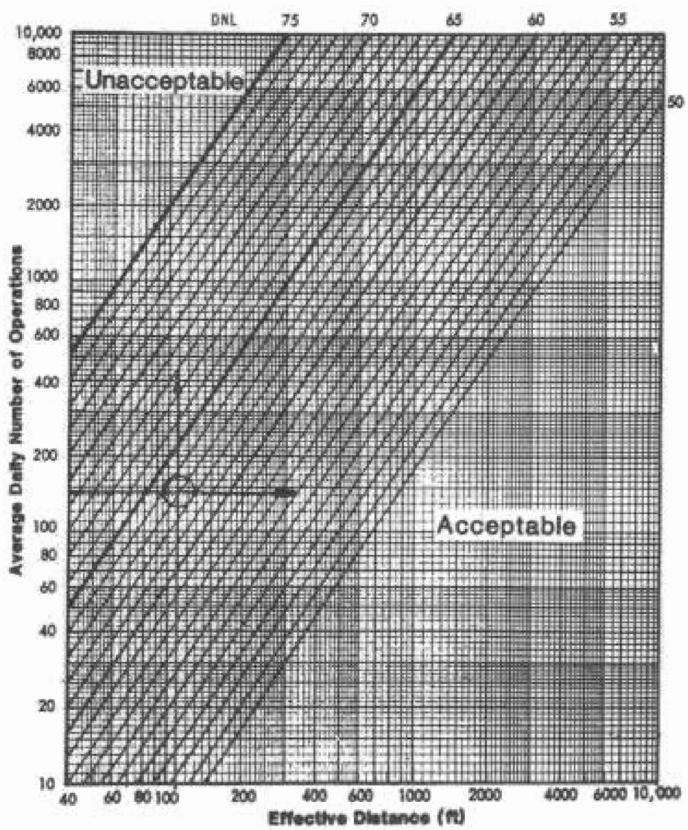
Railway No. 1 81 Railway No. 2 ______ Railway No. 3 ______ Total DNL for all Railways 81

Signature ______________________ Date ______________

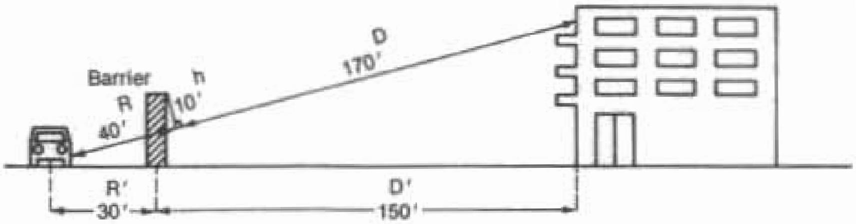
Workchart 3
Railroads - Diesel Locomotives



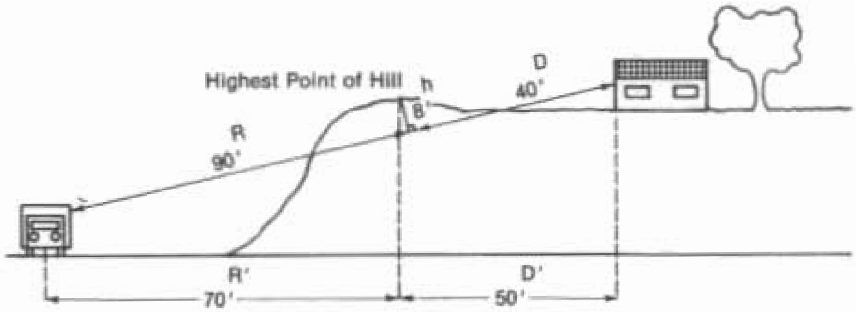
Workchart 4
Railroads - Cars and Rapid Transit



22. H = 10 Feet, R = 40 Feet, R' = 30 Feet, D = 170 Feet, D' = 150 Feet

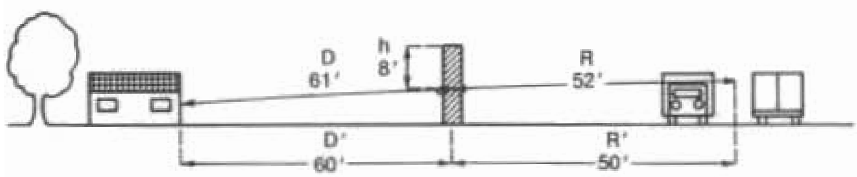


23. H = 8 Feet, R = 90 Feet, R' = 70 Feet, D = 40 Feet, D' = 50 Feet



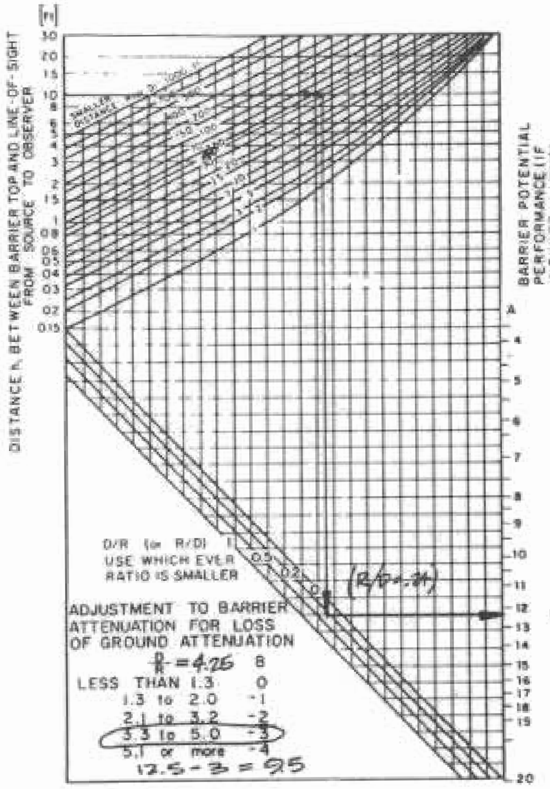
Note—The Line of Sight Line Starts Above the Road Level Because of the Trucks.

24. H = 8 Feet, R = 52 Feet, R' = 50 Feet, D = 61 Feet, D' = 60 Feet

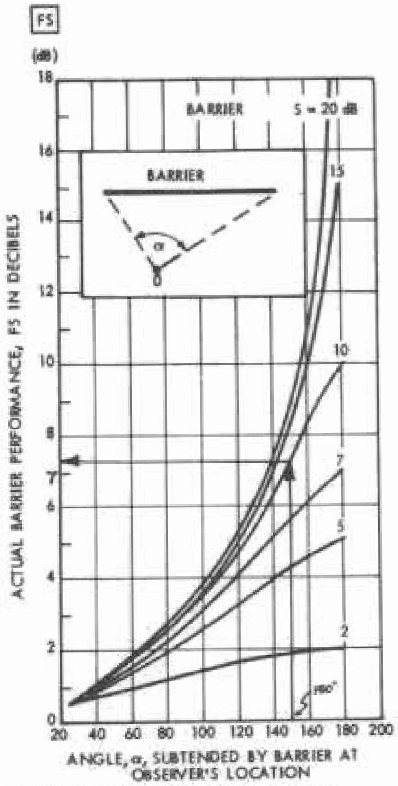


25. The Noise Attenuation Provided Is 7 Decibels

Workchart 6
Noise Barrier



Workchart 7

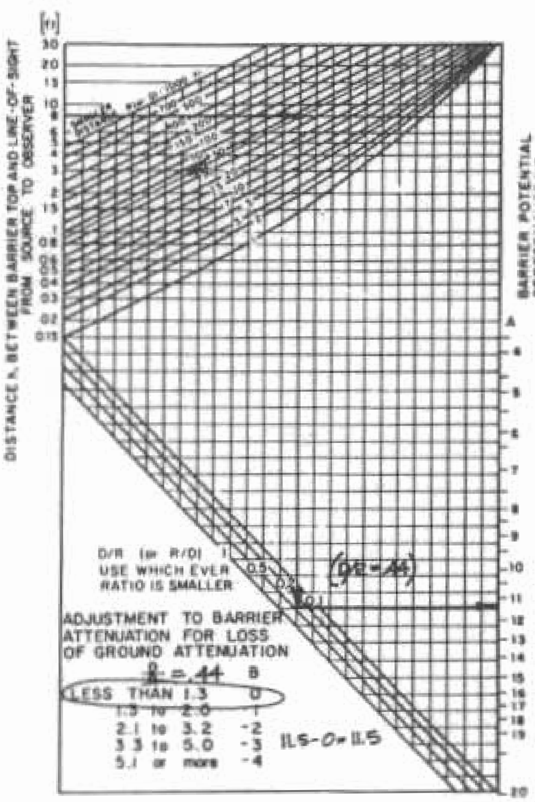


Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

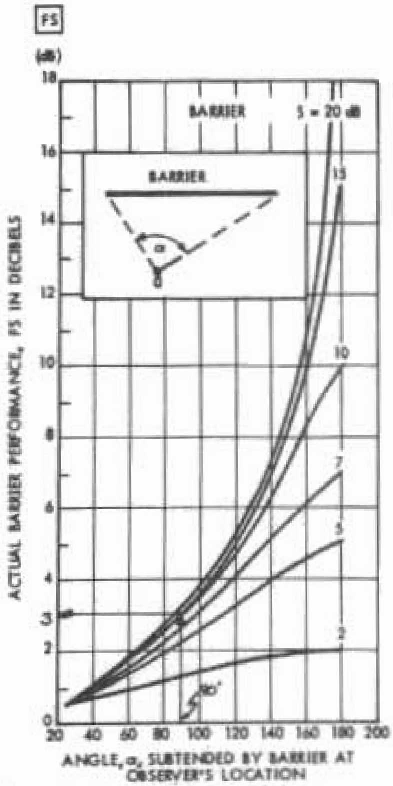
26. The Noise Attenuation Provided Is 3 Decibels

Note—When the Curves ARe So Close Together Don't Worry About Extrapolating. In This Case You Couldn't Anyway, the 15 dB and 10 dB Curves Have Merged.

Workchart 8
Noise Barrier



Workchart 7

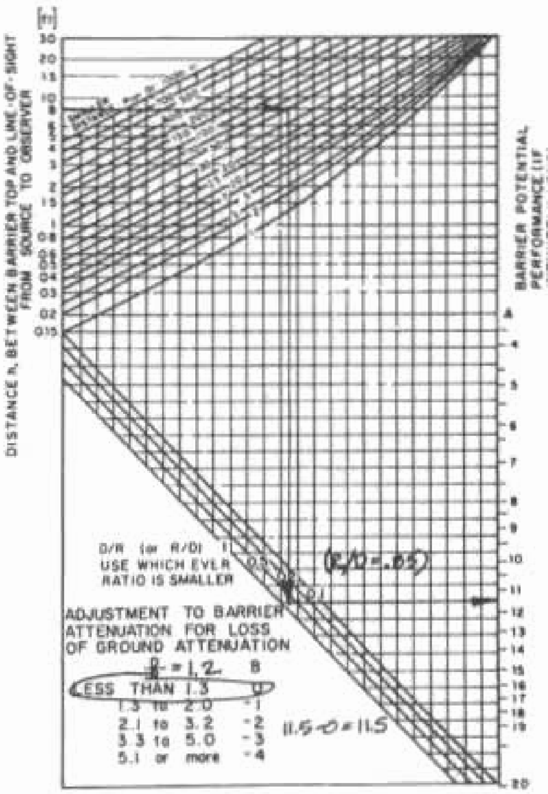


Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

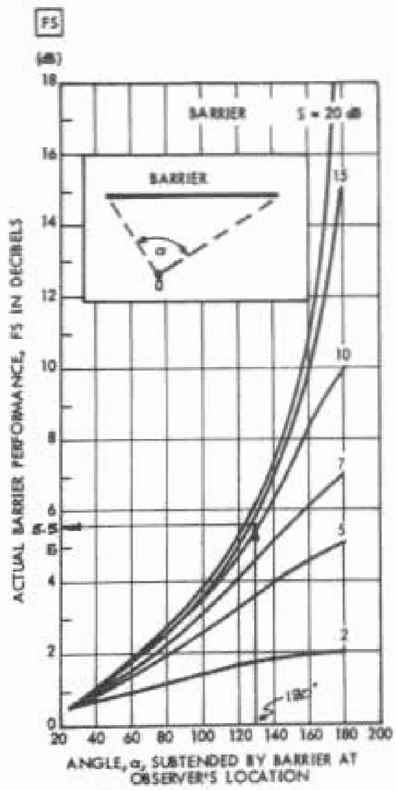
27. The Noise Attenuation Provided Is 6 Decibels (5.5 Rounded Up)

Note—Again You Have Problems With Extrapolating—Don't Worry About Being Too Precise.

Workchart 6
Noise Barrier



Workchart 7



Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

28. The Noise Attenuation Provided by This Barrier Is 4 dB. This Is Sufficient

Note—Don't Forget That the Height of the observor Is 5′ Less Than the Total Height of the Building and the Height of the Building Is 10 Feet Times the Number of Stories. And Did You Remember to Make the Adjustment for Ground Attenuation Loss.

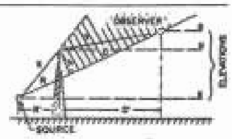
Workchart 5
Noise Barrier

To find R, D and h from Site Elevations and Distances

Enter the values for:

H= 15 R'= 40
S= 0 D'= 20
O= 15

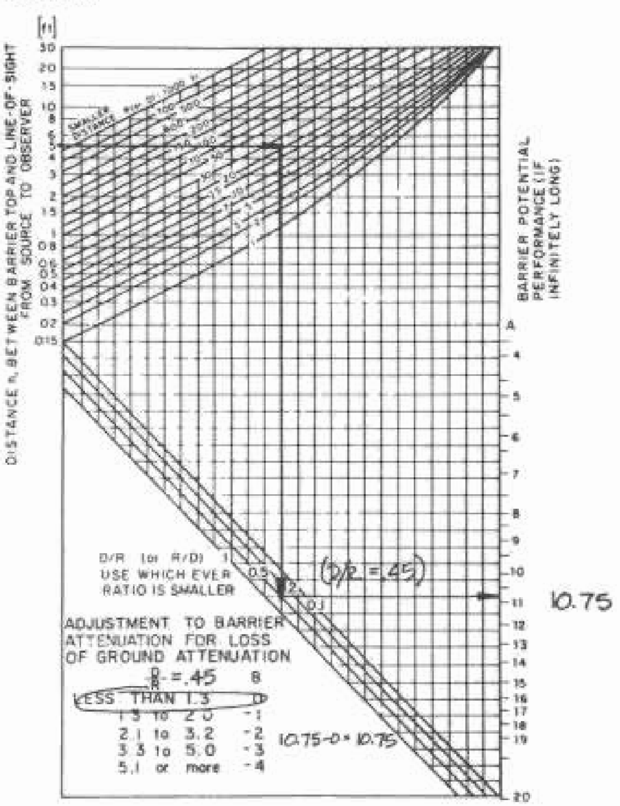
Fill out the following worksheet (all quantities are in feet):



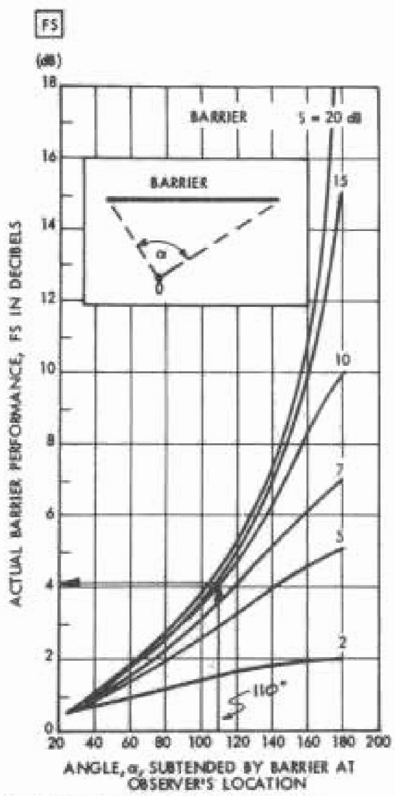
1. Elevation of barrier top minus elevation of source	[H 15]	−	[S 0]	=	[1 15]		
2. Elevation of observer minus elevation of source	[O 15]	−	[S 0]	=	[2 15]		
3. Map distance between source and observer (R′ + D′)					[3 60]		
4. Map distance between barrier and source (R′)					[4 40]		
5. Line 2 divided by line 3	[2 15]	÷	[3 60]	=	[5 .25]		
6. Square the quantity on line 5 (i.e., multiply it by itself); always positive	[5 .25]	×	[5 .25]	=	[6 .0625]		
7. 40% of line 6	[0.4]	×	[6 .0625]	=	[7 .025]		
8. One minus line 7	[1.0]	−	[7 .025]	=	[8 .975]		
9. Line 5 times line 4 (will be negative if line 2 is negative)	[5 .25]	×	[4 40]	=	[9 10]		
10. Line 1 minus line 9	[1 15]	−	[9 10]	=	[10 5]		
11. Line 10 times line 8	[10 5]	×	[8 .975]	=	[11 4.9]	=	h
12. Line 5 times line 10	[5 .25]	×	[10 5]	=	[12 1.25]		
13. Line 4 divided by line 8	[4 40]	÷	[8 .975]	=	[13 41]		
14. Line 13 plus line 12	[13 41]	+	[12 1.25]	=	[14 42]	=	R
15. Line 3 minus line 4	[3 60]	−	[4 40]	=	[15 20]		
16. Line 15 divided by line 8	[15 20]	÷	[8 .975]	=	[16 20.5]		
17. Line 16 minus line 12	[16 20.5]	−	[12 1.25]	=	[17 19]	=	D

[Note: the values on line 2 may be negative, in which case so will the values on lines 5, 6, and 12; line 1 may also be negative. Remember, then, in lines 10, 14, and 17, that adding a negative number is the same as subtracting: $x + (-y) = x - y$. And subtracting a negative number is like adding: $x - (-y) = x + y$.] Round off R and D to nearest integer, h to one decimal place.

Workchart 6
Noise Barrier



Workchart 7



Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

29. The Noise Attenuation Provided by This Barrier Is Approximately 5 dB for Both the Engines and the Railroad Cars.

This Is Not Sufficient.

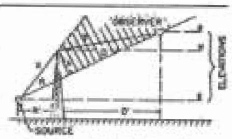
Note—You Were Supposed to Calculate Attenuation for Diesel Engines and Cars Separately Because the Source Heights Are Different. The Value of S for the Engines Should Have Been −10 and the Value of S for the Railroad Cars Should Have Been −25.

Workchart 5
Noise Barrier
To find R, D and h from Site Elevations and Distances

Enter the values for:

H= 12 R'= 40
S= −10 D'= 85
O= 25

Fill out the following worksheet (all quantities are in feet):

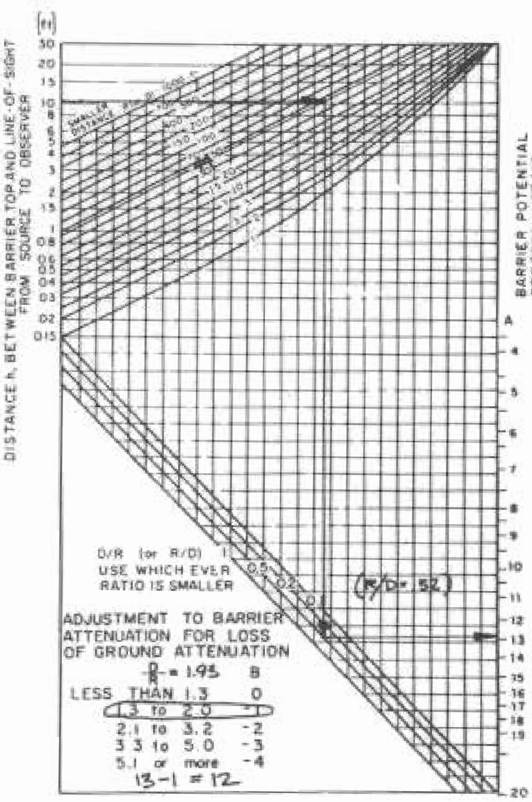


1. Elevation of barrier top minus elevation of source	[H 12] − [S −10] = [1 22]	
2. Elevation of observer minus elevation of source	[O 25] − [S −10] = [2 35]	
3. Map distance between source and observer (R' + D')	[3 125]	
4. Map distance between barrier and source (R')	[4 40]	
5. Line 2 divided by line 3	[2 35] ÷ [3 125] = [5 .28]	
6. Square the quantity on line 5 (i.e., multiply it by itself); always positive	[5 .28] × [5 .28] = [6 .08]	
7. 40% of line 6	[0.4] × [6 .08] = [7 .03]	
8. One minus line 7	[1.0] − [7 .03] = [8 .97]	
9. Line 5 times line 4 (will be negative if line 2 is negative)	[5 .28] × [4 40] = [9 11.2]	
10. Line 1 minus line 9	[1 22] − [9 11.2] = [10 10.8]	
11. Line 10 times line 8	[10 10.8] × [8 .97] = [11 10.5]	= h
12. Line 5 times line 10	[5 .28] × [10 10.8] = [12 3]	
13. Line 4 divided by line 8	[4 40] ÷ [8 .97] = [13 41]	
14. Line 13 plus line 12	[13 41] + [12 3] = [14 44]	= R
15. Line 3 minus line 4	[3 125] − [4 40] = [15 85]	
16. Line 15 divided by line 8	[15 85] ÷ [8 .97] = [16 88]	
17. Line 16 minus line 12	[16 88] − [12 3] = [17 85]	= D

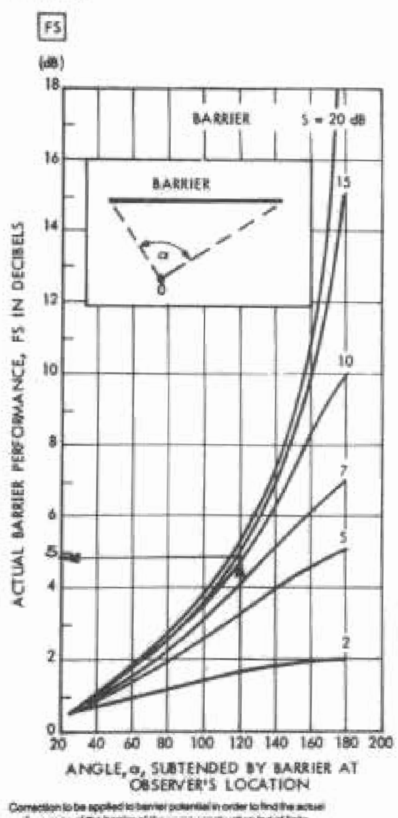
[Note: the value on line 2 may be negative, in which case so will the values on lines 5, 9, and 12; line 1 may also be negative. Remember, then, in lines 10, 14, and 17, that adding a negative number is the same as subtracting: x + (−y) = x − y. And subtracting a negative number is like adding: x − (−y) = x + y.]

Round off R and D to nearest integer, h to one decimal place

Workchart 6
Noise Barrier



Workchart 7



Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

Workchart 5
Noise Barrier

To find R, D and h from Site Elevations and Distances

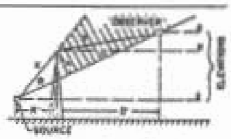
Enter the values for:

H = 12 R' = 40

S = −25 D' = 85

O = 25

Fill out the following worksheet (all quantities are in feet):

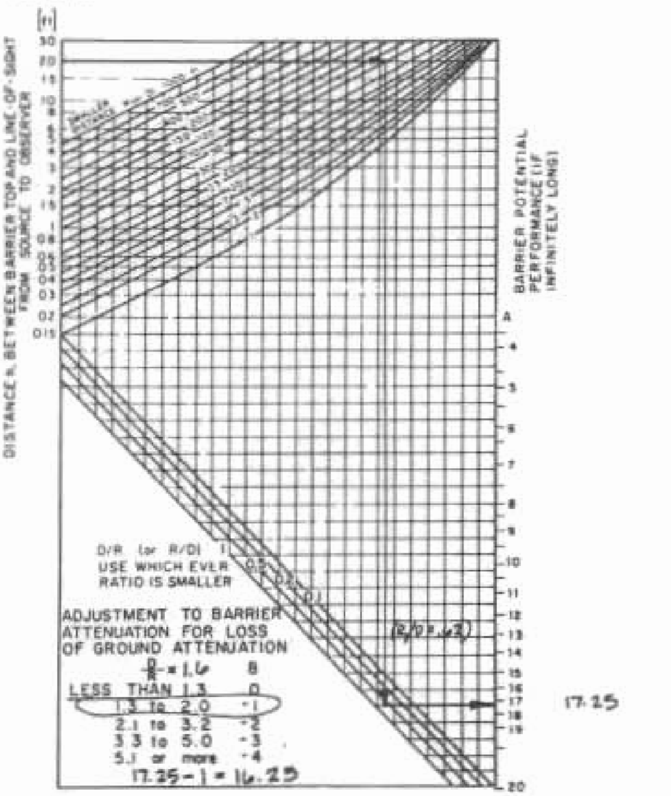


1. Elevation of barrier top minus elevation of source	[H 12]	−	[S −25]	=	[1 37]	
2. Elevation of observer minus elevation of source	[O 25]	−	[S −25]	=	[2 50]	
3. Map distance between source and observer (R' + D')					[3 125]	
4. Map distance between barrier and source (R')					[4 40]	
5. Line 2 divided by line 3	[2 50]	÷	[3 125]	=	[5 .4]	
6. Square the quantity on line 5 (i.e., multiply it by itself); always positive	[5 .4]	×	[5 .4]	=	[6 .16]	
7. 40% of line 6	[0.4]	×	[6 .16]	=	[7 .06]	
8. One minus line 7	[1.0]	−	[7 .06]	=	[8 .94]	
9. Line 5 times line 4 (will be negative if line 2 is negative)	[5 .4]	×	[4 40]	=	[9 16]	
10. Line 1 minus line 9	[1 37]	−	[9 16]	=	[10 21]	
11. Line 10 times line 8	[10 21]	×	[8 .94]	=	[11 19.7]	= h
12. Line 5 times line 10	[5 .4]	×	[10 21]	=	[12 8.4]	
13. Line 4 divided by line 8	[4 40]	÷	[8 .94]	=	[13 42.6]	
14. Line 13 plus line 12	[13 42.6]	+	[12 8.4]	=	[14 51]	= R
15. Line 3 minus line 4	[3 125]	−	[4 40]	=	[15 85]	
16. Line 15 divided by line 8	[15 85]	÷	[8 .94]	=	[16 90.4]	
17. Line 16 minus line 12	[16 90.4]	−	[12 8.4]	=	[17 82]	= D

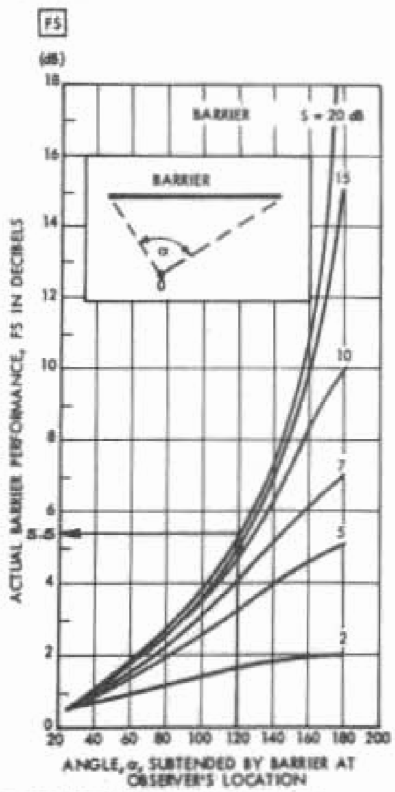
Note: the value on line 2 may be negative, in which case so will the values on lines 5, 6, and 12. line 1 may also be negative. Remember, then, in lines 10, 14, and 17, that adding a negative number is the same as subtracting … And subtracting a negative number is like adding …

Round off R and D to nearest integer, h to one decimal place.

Workchart 6
Noise Barrier



Workchart 7



Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

30. The Noise Attenuation Provided by This Barrier Is 3 dB for Trucks and 5 dB for Autos. The Combined Level Resulting Is 69 LDN.

This Is Not Sufficient

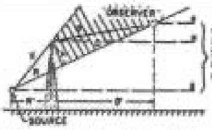
Note—You Must Calculate the Barrier Effect Separately for Autos and Trucks Because the Source Height is Different. Then Recombine levels.

Workchart 5
Noise Barrier
To find R, D and h from Site Elevations and Distances

Enter the values for:

H = 16 R' = 36
S = 0 D' = 56
O = 25

Fill out the following worksheet (all quantities are in feet):

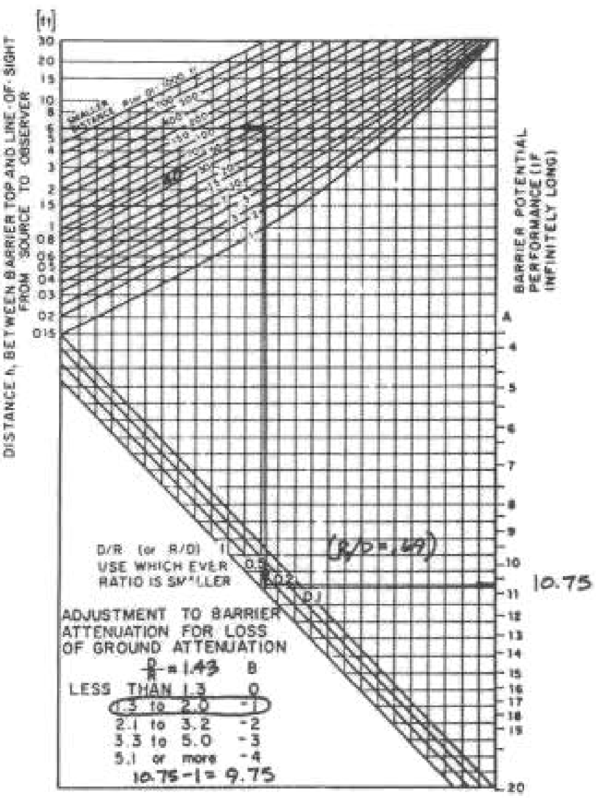


1. Elevation of barrier top minus elevation of source	[H 16]	−	[S 0]	=	[1 16]		
2. Elevation of observer minus elevation of source	[O 25]	−	[S 0]	=	[2 25]		
3. Map distance between source and observer (R' + D')					[3 92]		
4. Map distance between barrier and source (R')					[4 36]		
5. Line 2 divided by line 3	[2 25]	÷	[3 92]	=	[5 .27]		
6. Square the quantity on line 5 (i.e., multiply it by itself); always positive	[5 .27]	×	[5 .27]	=	[6 .07]		
7. 40% of line 6	[0.4]	×	[6 .07]	=	[7 .03]		
8. One minus line 7	[1.0]	−	[7 .03]	=	[8 .97]		
9. Line 5 times line 4 (will be negative if line 2 is negative)	[5 .27]	×	[4 36]	=	[9 9.7]		
10. Line 1 minus line 9	[1 16]	−	[9 9.7]	=	[10 6.3]		
11. Line 10 times line 8	[10 6.3]	×	[8 .97]	=	[11 6.1]	=	h
12. Line 5 times line 10	[5 .27]	×	[10 6.1]	=	[12 1.7]		
13. Line 4 divided by line 8	[4 36]	÷	[8 .97]	=	[13 37]		
14. Line 13 plus line 12	[13 37]	+	[12 1.7]	=	[14 39]	=	R
15. Line 3 minus line 4	[3 92]	−	[4 36]	=	[15 56]		
16. Line 15 divided by line 8	[15 56]	÷	[8 .97]	=	[16 58]		
17. Line 16 minus line 12	[16 58]	−	[12 1.7]	=	[17 56]	=	D

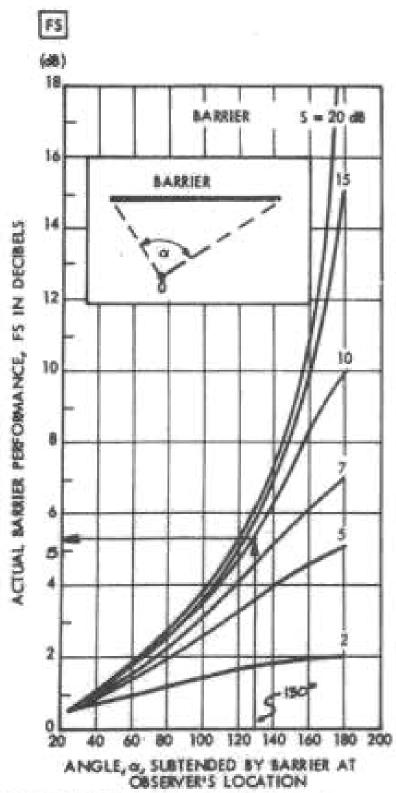
[Note: the value on line 2 may be negative, in which case so will the values on lines 5,9, and 12; line 1 may also be negative. Remember, then, in lines 10, 14, and 17, that adding a negative number is the same as subtracting: x+(-y)=x-y. And subtracting a negative number is like adding: X-(-y)=x+y.]

Round off R and D to nearest integer, h to one decimal place.

Workchart 6
Noise Barrier



Workchart 7



Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

Workchart 5
Noise Barrier

To find R, D and h from Site Elevations and Distances

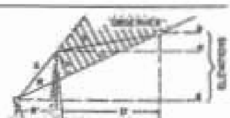
Fill out the following worksheet (all quantities are in feet)

Enter the values for:

H = 16   R' = 36

S = 8   D' = 56

O = 25

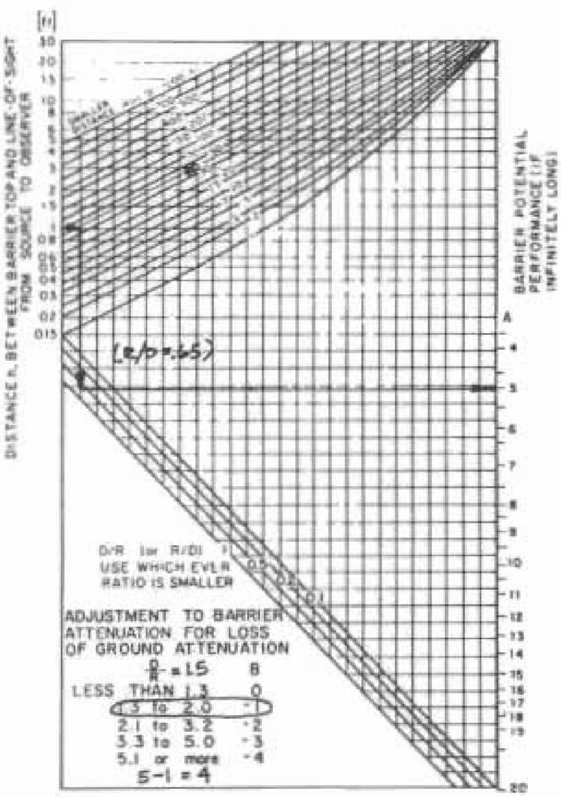


1. Elevation of barrier top minus elevation of source	[H 16] − [S 8]	= [1 8]	
2. Elevation of observer minus elevation of source	[O 25] − [S 8]	= [2 17]	
3. Map distance between source and observer (R' + D')		[3 92]	
4. Map distance between barrier and source (R')		[4 36]	
5. Line 2 divided by line 3	[2 17] ÷ [3 92]	= [5 .2]	
6. Square the quantity on line 5 (i.e., multiply it by itself); always positive	[5 .2] × [5 .2]	= [6 .04]	
7. 40% of line 6	[.4] × [6 .04]	= [7 .02]	
8. One minus line 7	[1.0] − [7 .02]	= [8 .98]	
9. Line 5 times line 4 (will be negative if line 2 is negative)	[5 .2] × [4 36]	= [9 7]	
10. Line 1 minus line 9	[1 8] − [9 7]	= [10 1]	
11. Line 10 times line 8	[10 1] × [8 .98]	= [11 .98]	= h
12. Line 5 times line 10	[5 .2] × [10 1]	= [12 .2]	
13. Line 4 divided by line 8	[4 36] ÷ [8 .98]	= [13 37]	
14. Line 13 plus line 12	[13 37] + [12 .2]	= [14 37]	= R
15. Line 3 minus line 4	[3 92] − [4 36]	= [15 56]	
16. Line 15 divided by line 8	[15 56] ÷ [8 .98]	= [16 57]	
17. Line 16 minus line 12	[16 57] − [12 .2]	= [17 57]	= D

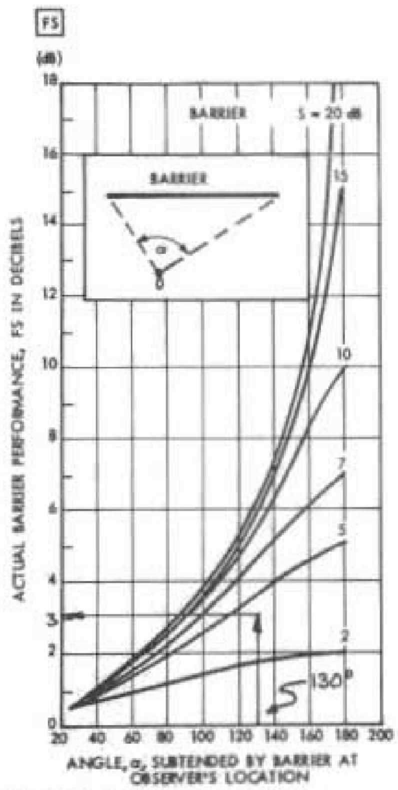
Note: the value on line 2 may be negative, in which case so will the values on lines 5, 9, and 12; line 1 may also be negative. Remember, then, in lines 10, 14, and 17, that adding a negative number is the same as subtracting: x + (−y) = x − y. And subtracting a negative number is like adding: x − (−y) = x + y.

Round off R and D to nearest integer, h to one decimal place.

Workchart 6
Noise Barrier



Workchart 7



Correction to be applied to barrier potential in order to find the actual performance of the barrier of the same construction but of finite length.

Chapter 7

The Use of Noise Measurements

Noise Calculations Are Best For HUD Use

There are two ways to determine noise levels for a site under review: the noise can be calculated or it can be measured. While one's first reaction might well be that it would obviously be better to go out and actually measure the noise levels at the site, calculated noise levels are really much better for implementing HUD's noise policy.

Calculated noise levels are developed using mathematical models that contain a variety of assumptions about the process of noise propagation as well as data on sound levels generated by typical sources (i.e. aircraft engines, automobile tires etc.). The model can be a complex computer model or it can be a simple desktop model such as the procedures in the *Noise Assessment Guidelines*. The models can also employ a variety of noise descriptors. (See chapter 1 for a discussion of noise descriptors.) Most noise studies done for the Federal Highway Administration, for example, use either the L_{10} or the L_{eq} noise descriptor. Many aircraft noise studies use the NEF or CNEL descriptor. All of these descriptors are compatible with the L_{dn} noise descriptor system that is preferred by HUD and the HUD noise regulation contains instructions for converting all of them into L_{dn}. (sections 51.106(a)(1) and (2))

Whether produced by a sophisticated computer model or by the desktop *Noise Assessment Guidelines*, calculated noise levels are more useful for HUD needs than measured levels for two significant reasons: The first is that with noise measurements you have no good way to take into account future changes in the future noise environment. The houses we help build today are going to be around for a long time and it is very important that we determine, to the extent we can, the noise environment that will exist throughout the life of the buildings. While there are clearly limitations on how far into the future we can reasonably project traffic levels for roads, railroads and airports, we can at least look 5 to 10 years ahead. The HUD noise regulation (24 CFR 51B) requires that "to the extent possible, noise exposure shall be projected to be representative of conditions that are expected to exist at a time at least 10 years beyond the date of the project or action under review." It is very easy to make these projections if you use the *Noise Assessment Guidelines* or a computer model to determine noise levels.

The second reason why we prefer that you calculate noise levels is that through the calculation process you can use monthly or yearly data to determine traffic levels. Thus you come up with a more typical picture of conditions. With noise measurements there is always the possibility that the day or even days chosen for measurements will not be typical and that the measurements may over or understate the problem. While the conscientious measurer will try to account for any unusual conditions, it isn't always possible. So long as cost considerations limit the number of days that measurements can be taken there will always be the problem of unrepresentative data. With calculations this isn't a problem. The computer model that generates contours for airports, for example, uses an entire years data to develop the average day. Certainly the results are more likely to be representative than the results that would be derived from just a few days measurements.

When Noise Measurements Are Useful

While it is the preferred procedure to calculate noise levels, there are a few situations where the noise models might not be accurate and it might be better to rely on measurements. One instance would be when there is insufficient or inadequate traffic data. Another case might be where you have a unique physical situation that is not accounted for in whatever mathematical model is available.

Obtaining good traffic data can be difficult. You may only be able to get gross data that simply lists total vehicles without making any distinctions between trucks and automobiles. Or you may not be able to get any reliable data on the percentage of traffic between 10 pm and 7 am. While the *Noise Assessment Guidelines* do contain some assumptions that you can use when you don't have all the data you need, there may be instances when you just don't think those assumptions would accurately portray the problem.

By the same token, there are certain physical situations that mathematical models such as the *Noise Assessment Guidelines* couldn't anticipate and therefore do not reflect in their formulas. For example, the *Guidelines* say that you don't have to calculate the noise levels for underground transit lines. Well what if the line is underground but there are large air vents that reach from the belowground tunnels to the surface? A great deal of noise can reach the surface through these vents but the *Noise Assessment Guidelines* don't have any way to take it into account. You couldn't treat it as if the subway line were aboveground because it isn't really and at least some of the noise is blocked. This would be a case where a noise measurement would probably be the best way to determine the noise levels. By the same token, the guidelines do not really take into account the sometimes significant amounts of reflected noise that can occur at urban sites surrounded by tall buildings, i.e. the canyon effect.

When Not to Use Measurements

One thing noise measurements should not be used for is to confirm or refute calculated noise levels, especially computer generated aircraft contours. Our experience with both the *Noise Assessment Guidelines* and with computer noise models is that both are quite accurate if done properly. If you are convinced that the calculations were done correctly, and if you believe that the data used were good, you should strongly discourage anyone who wants to take measurements because they think that measurements are inherently more accurate than calculations. Comparing measured noise levels to calculated levels is like comparing apples and oranges. The calculated noise levels should include projected traffic levels, the measured ones will not. The calculated levels will be based on daily traffic counts derived by averaging months of data, the measured levels will, at best, reflect just a few days. (This is particularly true for aircraft noise contours. The day-to-day operations of an airport can vary significantly depending upon weather conditions and any one or two days worth of measurements are very likely to show different levels from those generated by a computer model employing a year of data to derive an average day.)

If you have determined that noise measurements are appropriate, you must make sure that they are done properly, otherwise the data will be useless. There are four elements to proper measurements: 1) where the measurements are taken; 2) when they are taken; 3) the type of equipment used; and 4) the actual measurement procedure.

Where measurements should be taken: The locations for noise measurements should be selected using the same criteria you would use to select a Noise Assessment Location for a *Noise Assessment Guidelines* calculation. The *Noise Assessment Guidelines* recommend that "assessments of the noise exposure should be made at representative locations around the site where significant noise is expected." Further, the *Guidelines* state that when selecting these locations you should consider those buildings containing noise sensitive uses which are closest to the predominant noise sources. Where quiet outdoor space is desired at a site, you should also select points in the outdoor area in question. Specifically, the "relevant measurement location for buildings is a point 2 meters (6.5 feet) from the facade." If there are no buildings yet the measurement point should be 2 meters from the closest point setback requirements would allow a building facade.

When measurements should be taken: Because measurements are only going to be taken for a few days at best, special care should be taken to make sure that the days selected are representative of average traffic levels. For highways, avoid both Monday and Friday, particularly before or after a holiday. In fact holiday periods, such as the Christmas/New Years season, should be avoided entirely. Highway traffic, or rather more importantly, truck traffic is likely to be down during these periods and noise levels may be significantly lower than normal. On the other hand, holiday periods are often peak travel periods for airlines and measurements taken around airports then would show unusually high noise levels.

Whoever is taking the measurements should also check to make sure that there aren't any special circumstances that might affect traffic levels. For example road construction or repair work might divert additonal traffic onto the road being measured, or divert traffic away. In both cases the noise levels measured would not be representative.

And finally, noise measurements should not be taken during extreme weather conditions both because of the possible effects on traffic levels but also because the weather conditions can exaggerate the actual noise levels.

Ideally, noise measurements should be taken over several days spread over at least a few months. But given that time and money will normally preclude this, at least make sure the one or two days you can get are as close to typical as possible.

What equipment to use: There are many sound level meters on the market which are suitable for taking noise measurements for transportation sources. They need only to meet the requirements of American National Standard Specification for Type 1 Sound Level Meters: S1.4-1971. Type 1 sound level meters are "precision" meters and provide the most accurate measurements. They are also, of course, the most expensive. Fast time-averaging and A frequency weighting are to be used. The sound level meter with the A-weighting is progressively less sensitive to sound with frequencies below 1,000 hertz, somewhat as is the ear. With fast time averaging the sound level meter responds particularly to recent sounds almost as quickly as does the ear in judging the loudness of a sound. Fast time averaging has a time constant of about 1/8 second.

While a sound level measuring system that averages decibel readouts on a short term basis such as for every minute or every hour is acceptable, it would be far better if a system that actually provides a 24 hour integrated L_{dn} readout were used. Such a system eliminates the need for calculating the L_{dn} value, an area where many inexperienced consultants go astray. These systems are more expensive however, and the consultant who doesn't do much noise work is unlikely to have one.

Measurement procedures: Detailed procedures for making sound level measurements are spelled out in the American National Standards Institute's Standard Methods ANSI S1.2-1962(R1976) *American National Standard Method for the Physical Measurement of Sound* and ANSI S1.13-1971(R1976) *American National Standard Methods for the Measurement of Sound Pressure Levels.*

Some of the basic procedures that should be followed are:

1. Measurements should normally be made over a continuous 24 hour period. If this is not possible, measurements may be made over a period of days but still must cover the entire 24 hour period. The selection of the days becomes even more critical so that they are as similar as possible. Sampling is not acceptable.
2. The sound level meter must be calibrated before each use.
3. The sound level meter should be provided with a wind screen.
4. Care should be taken to insure that there are no temporary obstructions, such as parked trucks, between the meter and the source.

The Noise Study

The noise study prepared to describe the measurement results should contain at least the following:

1. A map showing where the measurements were taken
2. A vicinity map showing the site and the major noise sources
3. A chart indicating the date, the time, and weather conditions when measurements were taken at each measurement location
4. The type of microphone used
5. Any variations from ANSI procedures
6. The results of the measurements in L_{dn} for each measurement location
7. Any unusual conditions that existed during the measurement period—i.e. construction activity, major traffic tieup, etc.
8. If an integrating sound level meter was not used, the calculations used to derive the L_{dn} value.

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Noise and Its Effects

By Dr. Alice H. Suter, Conference Consultant, Administrative Conference of the United States, November 1991

This report was prepared for the consideration of the Administrative Conference of the United States. The views expressed are those of the author and do not necessarily reflect those of the members of the Conference or its committees except where formal recommendations of the Conference are cited.

Table of Contents

I. Introduction

This report presents an overview of noise and its effects on people. Special emphasis is placed on developments over the past decade, both in terms of noise conditions and noise effects research. By doing so, this report should illustrate some of the reasons for concern about noise problems, which persist after the closing of EPA's Office of Noise Abatement and Control (ONAC).

Noise has a significant impact on the quality of life, and in that sense, it is a health problem in accordance with the World Health Organization's (WHO) definition of health. WHO's definition of health includes total physical and mental well-being, as well as the absence of disease. Along these lines, a 1971 WHO working group stated: "Noise must be recognized as a major threat to human well-being." (Suess, 1973)

The effects of noise are seldom catastrophic, and are often only transitory, but adverse effects can be cumulative with prolonged or repeated exposure. Although it often causes discomfort and sometimes pain, noise does not cause ears to bleed and noise-induced hearing loss usually takes years to develop. Noise-induced hearing loss can indeed impair the quality of life, through a reduction in the ability to hear important sounds and to communicate with family and friends. Some of the other effects of noise, such as sleep disruption, the masking of speech and television, and the inability to enjoy one's property or leisure time also impair the quality of life. In addition, noise can interfere with the teaching and learning process, disrupt the performance of certain tasks, and increase the incidence of antisocial behavior. There is also some evidence that it can adversely affect general health and well-being in the same manner as chronic stress. These effects will be discussed in more detail in the paragraphs below.

II. ONAC'S Activities in Noise Effects Research and Criteria

In response to the mandates of Section 5 of the Noise Control Act of 1972, ONAC published Public Health and welfare Criteria for Noise (EPA, 1973a) and Information on Levels of Environmental Noise Requisite to Protect Public Health and welfare with an Adequate Margin of Safety (EPA, 1974a), popularly known as the "Levels Document" for obvious reasons). Also in 1973,ONAC sponsored an international conference in Yugoslavia on the effects of noise, from which voluminous proceedings there published (EPA, 1973b). All of these documents there widely distributed and, although somewhat dated, are still read and referenced today. Because a considerable amount of research in this area has been conducted over the past 2 decades, these documents would benefit from revision.

In these documents ONAC established dose-response relationships for noise and its effects, and identified safe levels of noise to prevent hearing loss and activity interference. The agency also established the day-night average noise level as a universal descriptor to be used in assessing the impact of community noise.

Section 14 of the Act directs ONAC to conduct or finance research on noise effects, including investigations of the psychological and physiological effects of noise on humans and the effects of noise on animals. Approximately 35 technical reports resulted from these efforts, as well as contractor reports and numerous articles in scientific journals.

Some of the more noteworthy examples of EPA's research program there:

- Projects involving the cardiovascular effects of noise at the University of Miami, Johns Hopkins University and the Massachusetts Institute of Technology (Peterson, et al., 1978, 1981, 1983; Hattis and Richardson,1980; Turkkan et al, 1983).
- A longitudinal study of noise exposure and hearing threshold levels in children conducted by the Fels Institute (Roche et al., 1977).
- An interagency agreement with the U.S. Air Force to study the effects of noise on hearing (e.g., Guignard, 1973; Johnson, 1973; Schori and McGatha, 1978; Suter, 1978).
- A study identifying the sound levels of speech communication in various environments (Pearsons, et al., 1977).
- Two studies at Northeastern University comparing methods for predicting the loudness and acceptability of noise (Scharf et al., 1977; Scharf and Hellman, 1979).

Although much useful information was derived from these programs, some of them there irreparably damaged by the abrupt termination of funding from ONAC that occurred in 1981 and 1982. For one example, the Johns Hopkins study of cardiovascular effects of noise on primates was terminated after testing on only one subject had been completed. For another, the longitudinal data from the Fels Institute is now of little value after a hiatus of more than a decade.

III. Physical Properties and Measurement of Sound

A. Physical Properties

Noise is often defined as unwanted sound. To gain a satisfactory understanding of the effects of noise, it would be useful to look briefly at the physical properties of sound.

Sound is the result of pressure changes in a medium (usually air), caused by vibration or turbulence. The amplitude of these pressure changes is stated in terms of sound level, and the rapidity with which these changes occur is the sound's frequency. Sound level is measured in decibels (abbreviated dB), and sound frequency is stated in terms of cycles per second, or nowadays, Hertz (abbreviated Hz). Sound level in decibels is a logarithmic rather than a linear measure of the change in pressure with respect to a reference pressure level. A small increase in decibels can represent a large increase in sound energy. Technically, an increase of 3 dB represents a doubling of sound energy, and an increase of 10 dB represents a tenfold increase. The ear, however, perceives a 10-dB increase as doubling of loudness.

Another important aspect is the duration of the sound, and the way it is distributed in time. Continuous sounds have little or no variation in time, varying sounds have differing maximum levels over a period of time, intermittent sounds are interspersed with quiet periods, and impulsive sounds are characterized by relatively high sound levels and very short durations.

The effects of noise are determined mainly by the duration and level of the noise, but they are also influenced by the frequency. Long-lasting, high-level sounds are the most damaging to hearing and generally the most annoying. High-frequency sounds tend to be more hazardous to hearing and more annoying than low-frequency sounds. The way sounds are distributed in time is also important, in that intermittent sounds appear to be somewhat less damaging to hearing than continuous sounds because of the ear's ability to regenerate during the intervening quiet periods. However, intermittent and impulsive sounds tend to be more annoying because of their unpredictability.

B. Instrumentation

The instrument for measuring noise is the basic sound level meter or a number of its derivatives, including noise dose meters (usually called dosimeters), integrating sound level meters, graphic level recorders, and community noise analyzers. Improvements in all of these instruments have taken place during the last decade. This is especially true of the computerized dosimeters and integrating meters, which can measure, compute, store, and display comprehensive data on the noise field (Earshen, 1986). These instruments are now able to measure over very wide dynamic ranges and to measure impulsive sounds with a high degree of accuracy.

C. Measurement and Descriptors

Most sound level meters and dosimeters use built-in frequency filters or "weighting networks " in the measurement process. By far the most frequently used filter is the A weighting network, which discriminates against low-frequency and very high-frequency sounds. A weighting approximates the equal-loudness response of the ear at moderate sound levels, and correlates well with both hearing damage and annoyance from noise. A weighting will be assumed throughout this report unless otherwise specified.

Composite measures of noise, such as the equivalent continuous sound level (Leq) and the day-night average sound level (DNL) incorporate A weighting, (The mathematical notation for DNL is Ldn.) these levels constitute sound energy averages over given periods of time, the DNL incorporates a 10-dB nighttime penalty from 10:00 pm to 7:00 am, meaning that events occurring during that time are counted as 10 dB higher than they really are. A variant of the DNL that is used in California (and Europe) is the community noise equivalent level (CNEL), which incorporates a 5-dB penalty for evening noise events, as well as the 10-dB nighttime penalty (California Code of Regulations, 1990).

For more than a decade, both the DNL and the simple Leq have been used extensively for assessing the impact of aircraft/airport noise. Recently, however, communities have expressed dissatisfaction with these metrics when used to regulate noise (Wesler, 1990). Metrics that employ averaging fail to describe the disturbance arising from single events, especially low-flying aircraft, unexpected or newly occurring flights, or flights occurring in areas where solitude is at a premium. The sound exposure level (SEL), an event's sound level normalized to one second, is gaining popularity as a supplement to the DNL and the Leq for characterizing single events.

IV. Noise in America

A. Population Trends

The U.S. population has increased an average of 25 million with each census since 1950. According to the World Almanac (1991), the population in 1980 was 226 million and approximately 250 million in 1990. This reflects an increase of nearly 11 percent over the decade, or slightly more than 1 percent per year. Presently, 77 percent of the U.S. population lives in the nation's 283 designated metropolitan areas, and the rate of growth in these areas is twice that of nonmetropolitan areas (Bryant, 1991).

Not surprisingly, EPA research indicates that noise levels in communities is directly related to the population density (EPA, 1974b).[1] Because the noise in urban areas generally exceeds that of suburban and rural areas, it is not unreasonable to assume that noise in the U.S. is increasing at least in proportion to the increase in urbanization and more rapidly than the growth of the general population. In addition, noise sources appear to be multiplying at a faster pace than the population.

B. Noise Sources

Figure 1, from EPA's simplified version of the Levels Document, Protective Noise Levels, shows the range of sound levels for some common noise sources (EPA, 1978). Most leading noise sources will fall into the following categories: road traffic, aircraft, railroads, construction, industry, noise in buildings, and consumer products.

1. Road traffic noise

In its Levels Document (1974), EPA estimated that road traffic noise was the leading source of community noise. EPA's contractors found that to be true in 1981 (EPA, 1981), and there is little reason to believe otherwise today.

Truck transportation, as a convenient and economical means of moving raw materials and consumer goods from place to place, is growing at a faster pace than the general population. For example, a total[2] of 33.6 million trucks there registered in the U.S. in 1980. That number grew to 45.5 million in 1989, an increase of about 35 percent (American Trucking Assoc., 1991).

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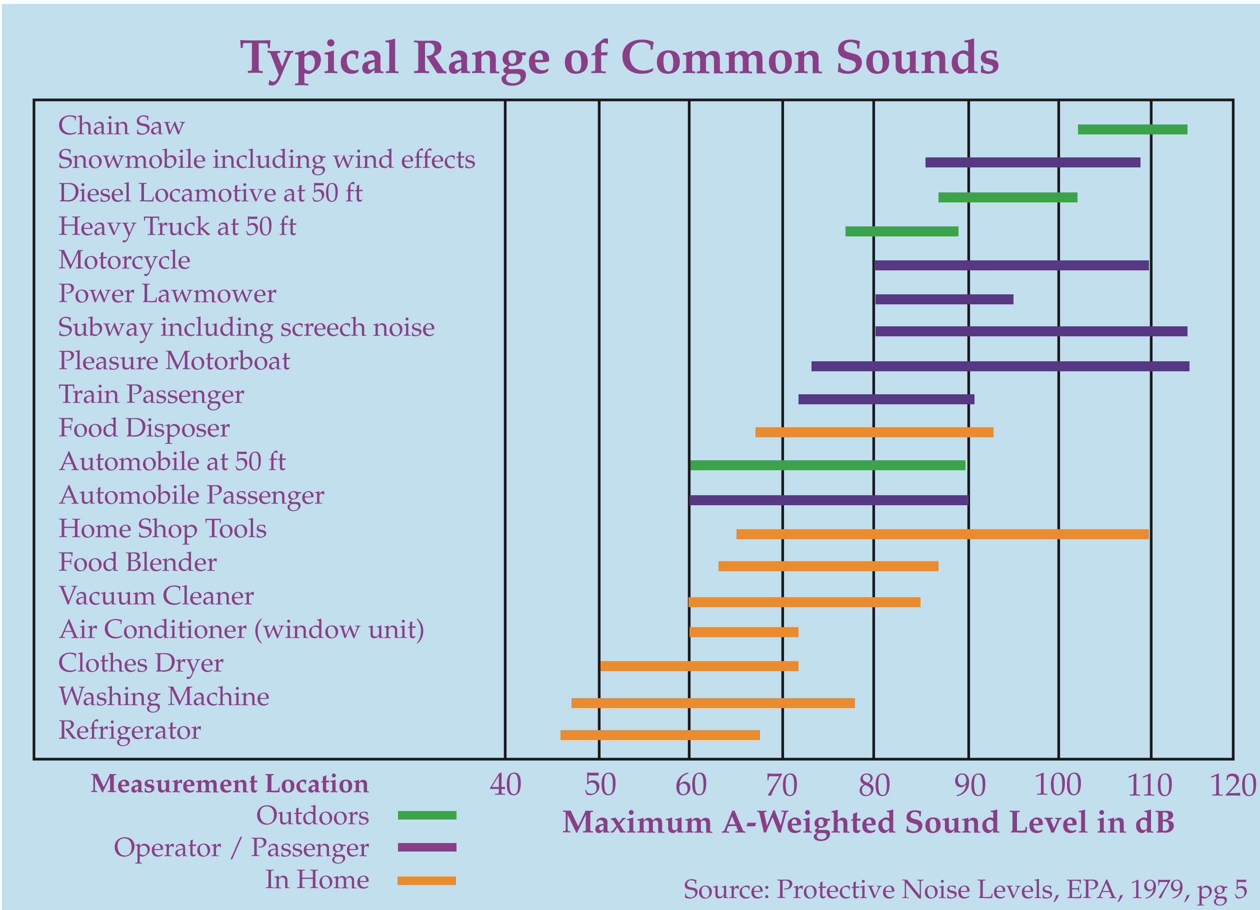
[1] The day-night average sound level appears to be proportional to the log of population density in people per square mile (EPA.1974b).

[2] The total number of trucks registered includes personal-use as well as commercial trucks of all weight classes.

Noise from the motors and exhaust systems of large trucks provides the major portion of highway noise impact, and provides a potential noise hazard to the driver as well.[3] In addition, noise from the interaction of tires with the roadway is generated by trucks, buses, and private autos.

In the city, the main sources of traffic noise are the motors and exhaust systems of autos, smaller trucks, buses, and motorcycles. This type of noise can be augmented by narrow streets and tall buildings, which produce a "canyon" in which traffic noise reverberates.

Typical Range of Common Sounds



2. Aircraft noise

Air traffic also appears to be increasing more rapidly than the U.S. population. In 1980, U.S. scheduled airlines flew approximately 255.2 billion passenger miles and 5.7 billion cargo (ton) miles. By 1990, these figures there 457.9 billion and 10.6 billion, respectively (Air Transport Assoc., 1991a). This represents an increase of 79 percent in passenger mileage, and 86 percent in air height mileage. Air cargo traffic has grown particularly rapidly in the last five years, and will probably continue that trend over the next decade.

By 1989, the quieter "Stage III" airplanes comprised nearly 40 percent of the domestic fleet (Air Transport Assoc, 1991b). By the year 2004, all of the noisier Stage II aircraft must be phased out

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[3] According to Reinhart (1991) the most common complaint about truck noise is related to problems caused by tampering with the mufflers of trucks using compression brakes. About 5 percent of the heavy trucks surveyed by Reinhart and his colleagues had no functioning muffler, despite the existence of antitampering laws.

(Airport Noise and Capacity Act, 1990). This requirement should promote a quieter environment around airports, but the growth of air transportation and the pressing need for airport expansion threatens to offset the benefits of the quieter aircraft.

Nowadays, the problem of low-flying military aircraft has added a new dimension to community annoyance, as the nation seeks to improve its "nap-of-the-earth" warfare capabilities. In addition, the issue of aircraft operations over national parks, wilderness areas, and other areas previously unaffected by aircraft noise has claimed national attention over recent years (Fidell, 1990; Cantoni, 1991; Weiner, 1990; Mouat, 1990).

3. Noise from railroads

The noise from locomotive engines, horns and whistles, and switching and shunting operations in rail yards can impact neighboring communities and railroad workers. For example, rail car retarders can produce a high-frequency, high-level screech that can reach peak levels of 120 dB at a distance of 100 feet (EPA, 1974), which translates to levels as high as 138 or 140 dB at the railroad worker's ear.

Unlike truck and air transportation, however, rail transportation does not appear to be increasing. According to the Association of American Railroads, the railroad industry loaded 22.1 million freight cars in 1988, down slightly from 22.6 million in 1980 (AAR, 1991).

4. Construction noise

The noise from construction of highways, city streets, and buildings is a major contributor to the urban scene. Construction noise sources include pneumatic hammers, air compressors, bull dozers, loaders, dump trucks (and their back-up signals), and pavement breakers. The construction industry has done very well over recent years with a value-added GNP of $97.9 billion in 1977, increasing to $247.7 billion in 1989 (Dept. of Commerce, 1991), an increase of about 153 percent. The number of workers employed in construction grew from 4.3 million in 1980 to about 5.2 million in 1990, an increase of nearly 21 percent (BLS, 1991a).

5. Noise in industry

Although industrial noise is one of the less prevalent community noise problems, neighbors of noisy manufacturing plants can be disturbed by sources such as fans, motors, and compressors mounted on the outside of buildings. Interior noise can also be transmitted to the community through open windows and doors, and even through building walls. These interior noise sources have significant impacts on industrial workers, among whom noise-induced hearing loss is unfortunately common.

The size of the U.S. manufacturing industry has not grown significantly over the last decade. Although the industrial. GNP increased from $673.9 billion in 1980 to $969.6 billion in 1990 (in terms of constant dollars) (BLS, 1991b), the workforce has declined from slightly more than 20 million to about 19 million during that period (BLS, 1991c). Consequently, industrially-generated community noise is probably no greater than it was in 1980.

From the worker's perspective the industrial noise problem is still very serious. The Occupational Safety and Health Administration has cut back on the enforcement of occupational noise standards and has allowed the substitution of hearing protection devices in lieu of engineering controls in many cases (OSHA, 1986). However, it is difficult to know whether noise levels in industry are increasing or decreasing because no comprehensive survey has been performed since the 1976 survey performed by Bolt Beranek and Newman Inc. (BBN, 1976).

6. Noise in buildings

Apartment dwellers are often annoyed by noise in their homes, especially when the building is not well designed and constructed. In this case, internal building noise from plumbing, boilers, generators, air conditioners, and fans, can be audible and annoying. Improperly insulated walls and ceilings can reveal the sound of amplified music, voices, footfalls, and noisy activities from neighboring units. External noise from emergency vehicles, traffic, refuse collection, and other city noises can be a problem for urban residents, especially when windows are open or insufficiently glazed.

Wetherill (1987) reports that although the lack of soundproofing is the most frequent environmental complaint of apartment dwellers, the knowledge to solve these problems is not being applied. In fact, the quality of construction is steadily declining, and the noise problems are getting worse (Wetherill, 1991).

7. Noise from consumer products

Certain household equipment, such as vacuum cleaners and some kitchen appliances, have been and continue to be noisemakers, although their contribution to the daily noise dose is usually not very large. Added to this list would be yard maintenance equipment, such as lawn mowers and snow blowers, which can, at least, cause disharmony with one's neighbors, and pother shop tools, which can be hazardous to hearing if used for sufficient periods of time.

One example of a fairly new product is the gasoline-pothered leaf blower, with average A-weighted sound levels at the operator's position of 103.6 dB, and maximum levels of 110-ll2 dB (Clark, 1991). In an extensive review of nonoccupational noise exposures, Davis et al. (1985) report that the manufacturers of household devices have been reluctant to release sound level information. Consequently, it could be difficult to assess the magnitude of the problem and the extent to which noise levels are increasing or decreasing.

Residents of suburban and rural areas are sometimes disturbed by recreational noise sources, such as off-road vehicles, high-pothered motor boats, and snowmobiles. Some of these sources, such as snowmobiles, are not as noisy as they there more than a decade ago, due to attention to the problem by the manufacturers and their trade associations. Others are no less noisy, and possibly more so because noise seems to be generic to the sport. Example would be motorcycle and car racing, and events like "tractor pulls."

In fact, the allure of noisy recreational activities seems to be considerably greater now than it was a decade or so ago. The technology of sound reproduction has advancer to the point where loudspeakers can faithfully reproduce music and other sounds at levels well above 120 dB. Sporting events use giant digital "applause meters" to measure and display enthusiasm for the more popular team. The extreme in car stereo technology is now the "boom car", with sound levels exceeding 140 dB.[4] Activities like aerobic exercising and ice skating, as well as disco dancing, are accompanied by amplified music played at high sound levels. After summarizing the results of 16 studies of discotheques and rock concerts Clark (1991) reported the geometric mean of the measured sound levels as 103.4 dB. The trend in noise levels for these kinds of activities is definitely upward.

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[4] The International Auto Sound Challenge Association sponsors contests and gives the most points to contestants whom speakers produce the highest sound pressure levels, up to 140 dB. However, levels above that merit no more than 140 points.

One of the most serious sources of recreational noise is sport shooting, where peak sound pressure levels at the ear can range from about 144 dB up to more than 170 dB[5] (Odess, 1972). In his analysis of this literature, Clark (1991) cites estimates of the number of people responding positively to questions about hunting or target shooting. These estimates range from 14 percent of the general population in Scandinavia and the U.K. (Axelsson et al., 1981; Davis et al., 1985) to nearly 50 percent in the Canadian workforce (Chung et al., 1981), which Clark found to be consistent with estimates from U.S. industry. In a population of rural schoolchildren, 45 out of 47 boys and 2 out of 21 girls reported having used guns (Kramer and Wood, 1982).

A subcategory of consumer product noise that deserves mention is noisy toys. A few toys, such as firecrackers, snappers, and cap pistols have been part of the adventurous child's experience for generations. The general assumption is that these toys do not pose a hazard when used occasionally and located at a sufficient distance from the ear[6]. Nowadays, there is a large variety of noisy toys, thanks to the availability of improved technology. Many of them mimic adult noisemakers, such as amplified toy guitars, child-shed vacuum cleaners, and miniature pother saws. Some of these toys generate quite high levels of sound. For example, a baby's squeeze toy (Fay, 1991) and the battery operated siren of a toy police car have both been measured at 110 dB[7].

In a recent report on noisy toys, Leroux and Laroche (1991) cite studies showing A-weighted noise levels for a toy motor at 107 dB and a child's rattle at 99-100 dB (LNE, 1973). Current Canadian legislation limits the sound output of toys to "one hundred decibels measured at the distance that the product ordinarily would be from the ear of the child using it..." (Act, 1969), but Leroux and Laroche propose that this limit be lowered to an A-weighted level of 75 dB.

C. Numbers of People Exposed to Noise

The fact that people are variously exposed to noise is not surprising. Considering that decibels are measured on a logarithmic scale, however, the magnitude of these variations can be enormous. For example, the average noise level outside an urban apartment can be 1,000 times more intense than in a rural residential neighborhood. Fortunately, this difference will be perceived more like an eight-fold rather than a thousand-fold increase. Figure 2, from EPA's document Protective Noise Levels, shows examples of outdoor day-night average sound levels measured at various locations (EPA, 1978).

In 1974, EPA estimated that nearly 100 million Americans lived in areas where the daily average noise levels exceeded its identified safe DNL of 55 dB (EPA, 1974a). Figure 3, from EPA's Levels

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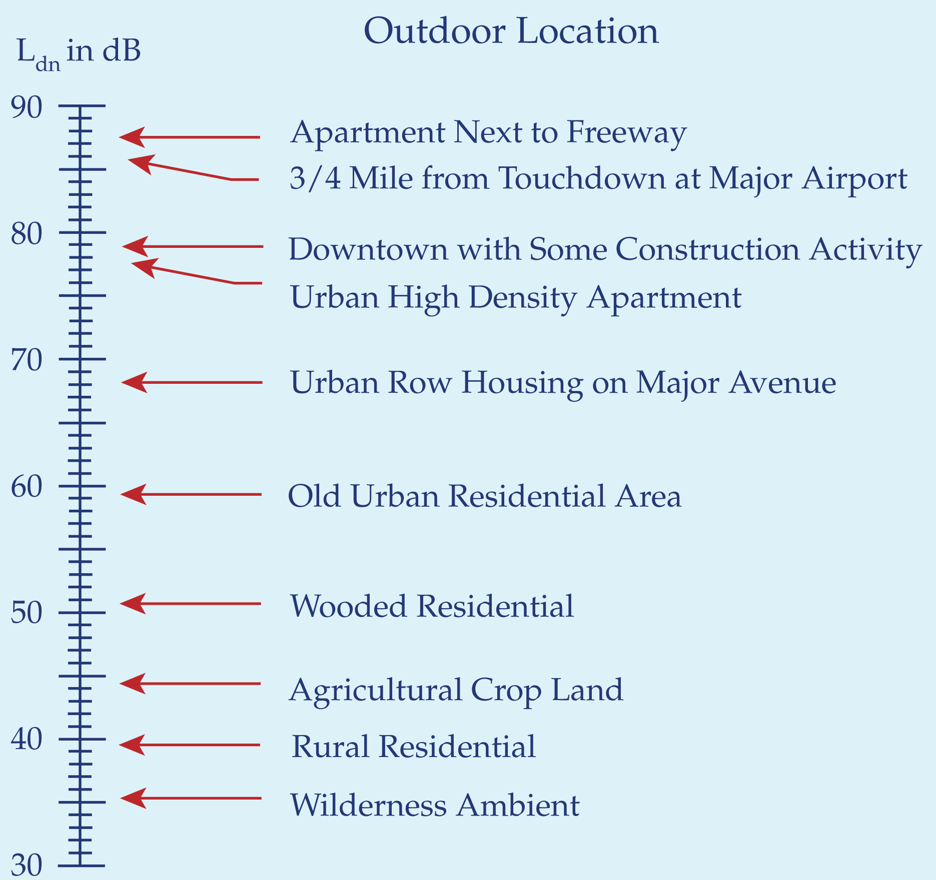
5 A-weighted level. of these weapons would measure somewhat lower, with levels for .22 caliber rifles at about 132-139 dB and shotguns at 150-165 dB. (See Clark, 1991)

6 Certain European studies, however, have reported as many as 1 percent to 3.7 percent of teenage children suffer hearing losses caused by impulsive noise from toys (Gjaevenes, 1967; Moe, 1966). Noise from cap guns, for example, can exceed peak sound pressure levels of 140 dB (Gjaevenes, 1966; Hodge and McCommons, 1966; Marshall and Brandt, 1973; all as cited by Leroux and Laroche,
1991).

7 New York audiologist Thomas Fay has measured the noise levels of a variety of children's toys. In doing so he places the sound level meter's microphone quite close to the noise source (from 2 inches to 1/2 inch away), based on his observations of the children at play. (Personal communication, April 1991).

Document, shows the residential noise environment of the U.S. population as a function of the exterior DNL, with separate curves for the freeway and aircraft increments.

Examples of Outdoor Day-Night Average Sound Levels in dB Measured at Various Locations



Examples of Outdoor Day-Night Average Sound Levels in dB Measured at Various Locations

Source: Protective Noise Levels (EPA, 1979, pg 8)

A few years later EPA contracted with the consulting firm Bolt Beranek and Newman (BBN) to develop more detailed estimates. The resulting report, Noise in America, includes a breakdown according to noise exposure source (EPA, 1981). Table I gives the estimated number of Americans exposed to traffic; aircraft, construction, rail, and industrial noise for various DNLs from 55 dB to 80 dB. The authors note that there will be some overlap among populations exposed to different sources, so the numbers across categories are not additive. The far right column represents the total estimated number of people exposed to the combined sources. Although the authors do not give an estimate for the number of people exposed above Ldn 55 dB, another authority puts it at 138 million at that time (Eldred, 1990).

These estimates do not represent the results of a national survey. Instead, the authors used data and models available to EPA and BBN at the time. Because of this, some categories of noise exposure are likely to be more accurate than others. They did, however, represent the best available estimates at the time, and because no efforts have been made to update them, they are the best estimates available today.

D. Summary: Noise in America

It is safe to assume that noise in communities is increasing. Noise levels are directly related to population density, and the urban population is increasing at twice the pace of the nonurban population. In addition, the last decade has seen rapid growth in air transportation, trucking, and the construction industries, indicating that noise levels from these sources has most likely increased. The fact that some of these sources have been and continue to be quieted (especially new generations of trucks and aircraft) should mitigate this increase, but the extent of this mitigation will remain unknown until some sort of national survey is performed. Noise from construction continues to be a problem, and it appears that noise inside buildings as well as noise from recreational activities and consumer products is on the rise. Estimates of the number of people exposed to noise at various levels are now somewhat outdated.

Residential Noise Environment of the National Population As a Function of Exterior Day-Night Average Sound Level

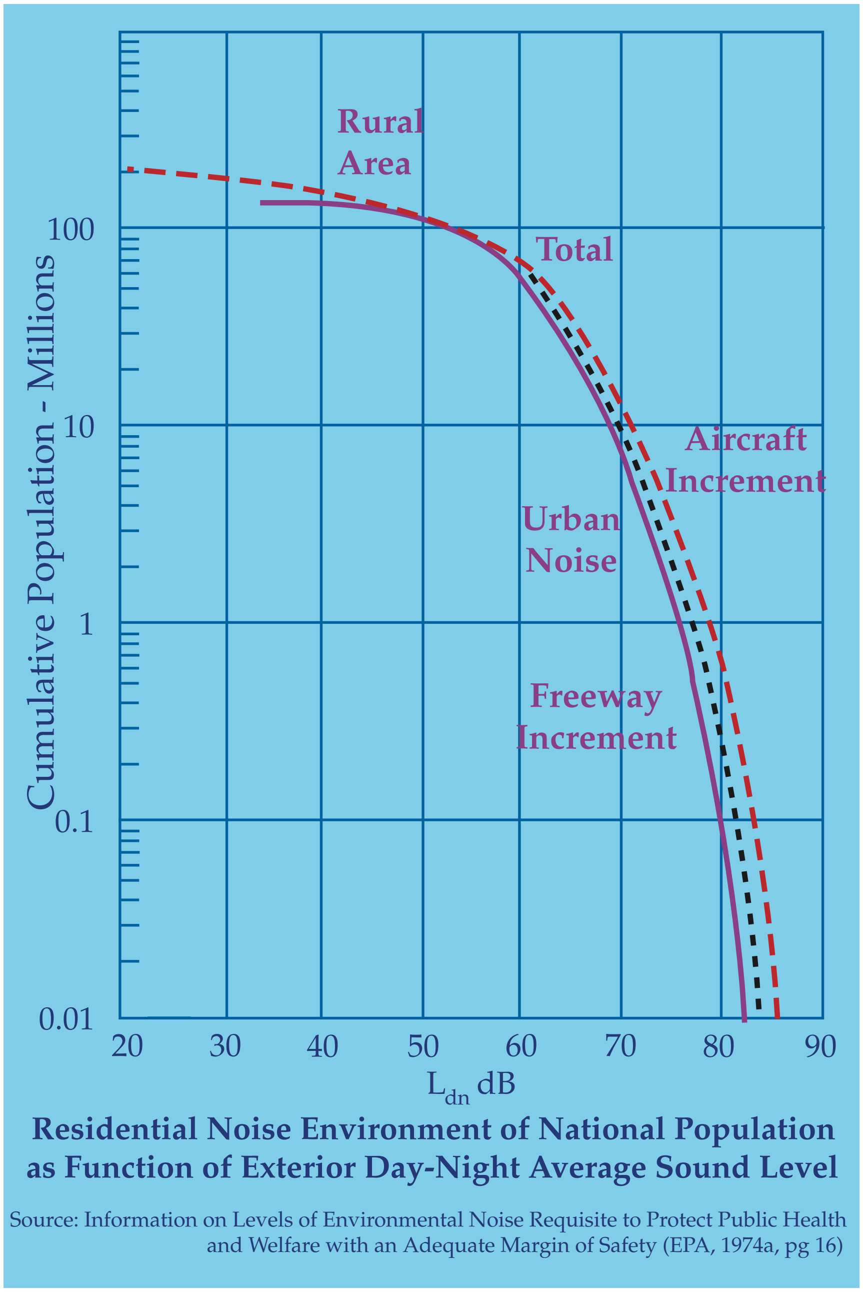


Table 1: Summary of U.S. Population Exposed to Various Day-Night Average Sound Levels (or higher) From Noise Sources in the Community.
(1) From Noise in America (EPA, 1981, pp. 10 and 15)

Estimated Number (in Millions) of People in Each Noise Category

DNL (dB)	Traffic	Aircraft	Construction	Rail	Industrial	Total
>80	0.1	0.1	—	—	—	0.2
>75	1.1	0.3	0.1	—	—	1.5
>70	5.7	1.3	0.6	0.8	—	8.1
>65	19.3	4.7	2.1	2.5	0.3	27.8
>60	46.6	11.5	7.7	3.5	1.9	63.6
>55	96.8	24.5	27.5	6.0	6.9	92.4*

(1) DNL values are yearly averages, outdoors
(2) Note that there is some overlap among populations exposed to different noise sources. For example, some of the 96.8 million people exposed to Ldn 55 dB and above from traffic noise are also exposed to aircraft noise.
(3) Construction estimates include both residential and nonresidential exposure.

*Distribution of total exposed to all sources starts at Ldn 58 dB since the analysis involves combining distributions exposed to 55 dB and above.

V. Effects of Noise

A. Noise-Induced Hearing Loss

Hearing loss is one of the most obvious and easily quantified effects of excessive exposure to noise. Its progression, however, is insidious, in that it usually develops slowly over a long period of time, and the impairment can reach the handicapping stage before an individual is aware of what has happened. While the losses are temporary at first, they become permanent after continued exposure, and there is no medical treatment to counteract the effect. When combined with presbycusis, hearing loss naturally occurring with the aging process, the result is a premature impairment that grows inexorably with age.

According to the U.S. Public Health Service (PHS, 1991), some 10 million of the estimated 21 million Americans with hearing impairments owe their losses to noise exposure (as cited in Carney, 1991). The study goes on to say that it is unclear whether the incidence of hearing impairment has risen in recent years because the necessary studies have not been conducted.

1. Extent of noise-induced hearing loss from environmental sources

Although the major cause of noise-induced hearing loss is occupational, substantial damage can be caused by nonoccupational sources. In addition to the frequently-blamed sources of loud music and shooting, noise-induced hearing loss has been noted in the children of farm families, presumably from the frequent use of tractors (e.g., Broste et al., 1979); general aviation pilots because of the high noise levels emitted by piston aircraft (Anon., 1982); and users of earlier generations of cordless telephones because of the placement of the ring mechanism in the earpiece (Orchik et al., 1985 and 1987).

The prevailing notion among parents is that the hearing threshold levels of children are worse than they used to be because of exposure to loud music. Actually, a recent national survey of 38,000 school children found better hearing threshold levels than 30 years ago, but blames the discrepancies on the sampling methods used in the earlier study and the conversion from an older to a nether zero reference level (Lundeen, 1991). There is, however, evidence that the hearing of some young people is being affected by noisy leisure time activities (Axelsson et al., 1987).

Loud music in particular appears to be the cause of hearing impairment and tinnitus in rock musicians. Such luminaries as Pete Townshend and Ted Nugent[8] have acquired substantial hearing losses and are now campaigning for hearing conservation (Murphy, 1989). Some studies point to a hearing hazard for attendees as well (see in Clark, 1991; Clark and Bohne, 1986; Danenberg et al.,1987).

As mentioned above, probably the greatest nonoccupational hazard to hearing comes from sport shooting. Clark (1991) cites studies of industrial workers by Chung et al. (1981), Johnson and Riffle (1982), and Prosser et al. (1988), showing significantly greater hearing losses among sport-shooters than among their nonshooting counterparts. These losses are almost always characterized by worse hearing in the left ear than the right.

The contribution from nonoccupational sources is called "sociocusis" (a contraction of "socio-acusis"). Evidence from primitive societies suggests that the absence of sociocusis explains the large differences in hearing threshold level between these populations and those of the "civilized" nations (Rosen, 1962). Sociocusis, occupational hearing loss, and presbycusis contribute in various

2. The handicap of noise-induced hearing loss

Vowel sounds tend to be low in frequency and high in sound energy, while the consonants are much higher in frequency and have considerably less amplitude. It also happens that consonants provide the primary intelligibility to speech. Because noise damages the ear's ability to perceive high-frequency sounds much earlier and more severely than the low-frequency sounds, individuals with noise-induced hearing loss are at a particular disadvantage in understanding speech.

Individuals with early noise-induced hearing loss often think that other people no longer speak dearly. They soon begin to notice that they have difficulty understanding speech when there is noise in the background, and in groups of people, and that it is hard to identify which person is talking. As the hearing loss progresses, these individuals avoid social occasions and situations where they must listen at a distance, like church and theater. The eventual result can be loneliness and isolation.

3. The study of noise-induced hearing loss

Noise damages the delicate sensory cells of the inner ear, the cochlea. This process can be studied in the laboratory by inducing temporary shifts in hearing threshold level in humans. Over recent years the preferred method of investigation is to produce temporary and permanent threshold shifts in animals, and to study the resulting physiological and anatomical changes in the cochlea, as well as shifts in hearing threshold level. The laboratory allows for strict control of noise level and

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[8] According to Nugent, who has worn an earplug in his right ear since 1967: "My left ear is there just to balance my face, because it doesn't work at all." (Murphy 1989) proportion to an individual's total hearing impairment. While the contribution of each source may be less than significant, the combination of all three can be enough to produce a handicapping condition. As longevity in the U.S. population increases, the toll of noise-induced hearing loss will become increasingly evident (Carney, 1991).

duration, but the durations are usually relatively short because of the time and expense involved. Also there is some controversy over the extent to which the results can be generalized to humans.

Much of the recent laboratory effort in noise research has focused on the structural and functional basis of noise-induced hearing loss, which has been greatly aided by the electron microscope. Investigators have identified the sensory cell's stereocilia and the rootlets which anchor them as the auditory system's most vulnerable components with respect to noise exposure (Libermnan, 1990).

Field studies of noise-exposed workers avoid the problems of species generalization, and the exposure durations can be over many decades. They are usually cross-sectional studies, however, meaning that the current hearing threshold levels are related to noise exposures that have been experienced over many years. Although the current noise measurements may be valid, their validity over prior years usually has to be assumed without benefit of precise data.

4. Risk of hearing impairment from continuous noise

The methods and results of the major field studies of continuous noise exposure conducted in the late 1960s and early 1970s remain unchallenged. Examples are the studies of Burns and Robinson (1970), Baughn (1973), Passchier-Vermeer (1968), and the U.S. National Institute for Occupational Safety and Health (NIOSH, 1973). Data from these studies have been used by various organizations to estimate the risk of hearing impairment over a working lifetime of exposure to noise. These types of studies have also been used by the EPA to estimate the hazard of nonoccupational noise (Guignard, 1973; Johnson, 1973; EPA, 1973a). The data cited above of Burns and Robinson, Baughn, and Passchier-Vermeer went into EPA's identification of a yearly average exposure level of 70 dB as the safe level, which could be experienced over a lifetime (EPA, 1974a)[9].

A new international standard (ISO, 1989), which is based mainly on the data of Passchier-Vermeer and Burns and Robinson, contains formulas for assessing the risk of noise-induced hearing impairment and handicap: using either a highly screened (for non-occupational hearing loss) or an unscreened population as a control group. The data and analyses found in these major studies have not been seriously challenged, and remain in use today.

5. Varying and intermittent noise

There has been some debate over the best rule for combining noise level and duration to assess the damaging effects of noise, especially varying and intermittent noise. This relationship is often called the doubling rate, or nowadays, the exchange rate. The EPA, as well as most other federal agencies (and most European countries, the United Kingdom, some Canadian provinces) use the equal-energy rule, which incorporates a 3-dB exchange rate. OSHA uses the 5-dB exchange rate, and the U.S. Air Force, uses 4 dB. None of these rules makes any provisions for the temporal order of sounds, although the 5-dB exchange rate supposedly represents a simplification of criteria that take a certain number of intermittencies into account.[10]

Investigations of the relationship between noise level and duration have been conducted over recent years using laboratory animals. The results have confirmed the validity of the equal energy (3-dB) rule for single exposures to continuous noise (Bohne and Pearse, 1982; Ward and Turner, 1982),

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[9] The 70-dB 24-hour average sound level can be interpreted as a 75-dB 8-hour average sound level plus an average sound level during the other 16 hours of less than 60 dB (see EPA's Levels Document, p.29, footnote d).

[10] The 5-dB rule does not necessarily provide for intermittencies because it allows uninterrupted exposures to continuous noise at high levels. See Suter 1983.

or when the exposures are broken up into 8-hour, or even 1-hour "workdays", 5 days per week, so long as the sound energy is equivalent (Ward, 1983). There is, however, some benefit to intermittent quiet periods (Ward and Turner, 1982), during which the ear can recover from small, temporary hearing losses. For this reason EPA has adjusted its identified safe level upward by 5 dB[11] since most environmental noise exposures are intermittent in nature. EPA's use of the equal-energy rule and the 5-dB adjustment have not been seriously challenged.

6. Impulse noise

The effects of impulse noise have been studied extensively over recent years, but there is less agreement on this topic than there is for continuous and intermittent noise. Although there was consensus favoring the 3-dB rule at a 1981 international meeting in England (von Gierke et al., 1981), actual dose-response relationships are still elusive. The effects of impulse noise do not always follow the 3-dB rule, in that temporal pattern, waveform, and rise time can affect the growth of hearing loss, despite constancy of sound energy (Henderson and Hamernik, 1986).

Frequency also has some bearing on the damage caused by impulse noise, in that low-frequency impulses produce significantly less damage than sounds in the mid-to-high-frequency range (Price, 1983). The ear appears to be most susceptible to impulses with peaks around 4,000 Hz (Price, 1989). Also, there may be a critical level, above which the ear is considerably more at risk because of a change in the response mechanism. On the basis of his research, Price (1981) has suggested a critical level of 145 dB, with a standard deviation of 8 dB.

7. Susceptibility

Evidence from field studies indicates that men incur more hearing loss than women from comparable noise exposures (Burns and Robinson, 1970; Berger et al., 1978; Royster et al., 1980), and that Caucasians appear to be more susceptible than Blacks to noise-induced hearing loss (Royster et al., 1980). Other factors, such as age, preexposure hearing threshold level, general health, and use of alcohol, have not yet proved to be reliable predictors of susceptibility (Ward, 1986), although

8. Interactions with other agents

Noise can interact with drugs and industrial agents to produce additive or even synergistic effects on hearing. As expected, the higher the levels of noise and the greater the dose of the other agent, the greater will be the resulting hearing loss. The ototoxic properties of certain drugs, most notably the aminoglycoside antibiotics (the "mycin" drugs), are heightened by exposure to noise. Numerous studies of kanamycin plus noise exposure have revealed additive and some synergistic results (Humes, 1984). High doses of salicylates (aspirin) accompanied by noise exposure can produce temporary hearing losses (McFadden and Plattsmier, 1983), but permanent losses do not seem to occur. Cisplatin, used in cancer chemotherapy, is known to be toxic to the auditory system, and has been shown to interact significantly with none exposure (Boettcher et al., 1989).

A variety of industrial agents, which can be potent neurotoxins, have been shown to be capable of producing hearing loss (Fechter, 1989). These agents include heavy melds, such as lead and mercury, organic solvents, such as toluene, xylene, and carbon disulfide, and an asphyxiant, carbon monoxide.

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[11] The identified safe level of 70 dB reflects the incorporation of the 5-dB adjustment there is some indication that the use of tobacco may increase susceptibility to noise-induced hearing loss (Barone, et al., 1987; Stark, et al., 1988)

9. Hearing protectors

As its first (and only) labeling regulation, EPA promulgated a regulation for labeling the attenuation of hearing protection devices (EPA, 1979). The standard required manufacturers to subject their hearing protectors to specific laboratory tests, and to publish a "Noise Reduction Rating" (NRA) on the product's package. The NRA was subsequently adopted by OSHA in its hearing conservation amendment, which required employers to use it in assessing the adequacy of hearing protectors for given noise environments (OSHA, 1981 and 1983). Recent research shows that the NRA greatly overestimates the noise reduction to be achieved by these devices in actual field use.[12] These kinds of findings have led to the formation of a new ANSI working group to investigate alternatives to the current NRA (Berger et al. 1990), and the recommendation that EPA revise its existing labeling regulation (Berger, 1991; Stewart, 1991).

10. Summary: Noise-induced hearing loss

Noise-induced hearing loss is probably the most well-defined of the effects of noise. Predictions of hearing loss from various levels of continuous and varying noise have been extensively researched and are no longer controversial. Some discussion still remains on the extent to which intermittencies ameliorate the adverse effects on hearing and the exact nature of dose-response relationships from impulse noise. It appears that some members of the population are somewhat more susceptible to noise-induced hearing loss than others, and there is a growing body of evidence that certain drugs and chemicals can enhance the auditory hazard from noise.

Although the incidence of noise-induced hearing loss from industrial populations is more extensively documented, there is growing evidence of hearing loss from leisure time activities, especially from sport shooting, but also from loud music, noisy toys, and other manifestations of our "civilized" society. Because of the increase in exposure to recreational noise, the hazard from these sources needs to be more thoroughly evaluated. Finally, the recent evidence that hearing protective devices do not perform in actual use the way laboratory tests would imply, lends support to the need for reevaluating current methods of assessing hearing protector attenuation.

B. Interference With Communication

Noise can mask important sounds and disrupt communication between individuals in a variety of settings. This process can cause anything from a slight irritation to a serious safety hazard involving an accident or even a fatality because of the failure to hear the warning sounds of imminent danger. Such warning sounds can include the approach of a rapidly moving motor vehicle, or the sound of malfunctioning machinery. For example, Aviation Safety (Anon., 1982), states that hundreds of accident reports have many "say again" exchanges between pilots and controllers, although neither side reports anything wrong with the radios.

Noise can disrupt face-to-face and telephone conversation, and the enjoyment of radio and television in the home. It can also disrupt effective communication between teachers and pupils in schools, and can cause fatigue and vocal strain in those who need to communicate in spite of the noise. Interference with communication has proved to be one of the most important components of noise-related annoyance (EPA, 1974a).

In its Levels Document, EPA determined that a yearly average day-night sound level of 45 dB would permit adequate speech communication in the home, and a DNL of 55 dB would permit

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[12] In a summary of 10 studies, Berger (1983) shows that most hearing protectors in the field provide only one-third to one-half the attenuation that they do in the laboratory.

normal communication outdoors at a distance of about 3 meters.[13] These levels also apply to hospitals and educational facilities. Higher average noise levels would be satisfactory for certain nonresidential spaces, such as commercial and industrial facilities, and inside transportation, depending on the degree to which speech communication is critical. Research over the last 20 years has expanded and refined EPA's criteria development in this area, but has not generated any major changes.

1. Prediction of speech interference

Methods of predicting the amount of speech that can be communicated in various noise backgrounds have been available for decades. Probably the most popular and respected method is the articulation index (AI) (French and Steinberg, 1947), which requires the measurement or estimation of the spectrum level of both speech and noise in 20 contiguous bands. Over the past 2 decades investigators have suggested adjustments to the AI for l13-octave bands, reverberation time, various vocal efforts, etc., and more recently for various degrees of hearing impairment (Humes, et al., 1986 and 1987).

The speech interference level (SIL) (Beranek, 1954) provides a quick method for estimating the distance at which communication can occur for different levels of vocal effort. The current method involves measuring octave-band sound pressure levels at 500, 1,000, 2,000, and 4,000 Hz and referring to a chart to determine the die potential communication distance. The basic chart has been expanded to include such parameters as a broader range of voice levels and provisions for room reverberation (Webster, 1983). Additions to both the AI and the SIL have been proposed by Lazarus (1990), who offers modifications and extensions to account for strain on the part of both talker and listener, and the wearing of hearing protectors.

Another popular method to predict speech communication in a variety of conditions, the speech transmission index (STI), has been developed by a Netherlands research group (Houtgast, 1980; Houtgast and Steeneken, 1983). The STI takes into account room volume and reverberation time, in addition to speech and none levels, and distance between talker and listener. A more recent outgrowth, the rapid speech transmission index (RASTI), represents a simplified version of the STI intended for field use, and is available in an instrument conforming to an international standard (IEC, 1987).

Finally the sound level meter's A-weighting network can be successfully used to predict speech interference levels. It is easy to use, available on virtually all sound level meters, and effective when the noise spectra are not complex.

2. Criteria for speech and warning signals

In addition to the classic work of Beranek and his colleagues (Beranek et al., 1971), Beranek has recently refined the traditional curves to account for the annoyance due to low-frequency "rumble" (Beranek, 1989). New criteria for determining acceptable background levels of noise in rooms are also offered by Lazarus (1986a, 1986b, 1987, and 1990). Lazarus includes in his criteria a variety of parameters such as: type of room, type of communication, communication distance, vocal effort, quality of speech intelligibility, AI, communication strain, listener's hearing sensitivity, and the use of hearing protectors.

Guidelines for audible warning signals have been developed by Patterson (1982). These guidelines, which there originally created for civil aircraft, there later adapted to helicopters and even station-

[13] These levels represent EPA's identification of safe levels of environmental noise to protect the public health and welfare against all adverse effects of noise with the exception of hearing loss.

ary workplaces like hospitals (Patterson, 1985; Rood et al., 1985). Another set of guidelines for acoustic warning signals has been developed by Lazarus and Hoge (1986), and are based on the compatibility of signal type with various desired or undesired situations.

Although criteria have not yet been developed for speech recognition involving nonnative listeners, experiments by Florentine (1985) and Nabelek (1983) indicate that these individuals need more favorable listening conditions (less background noise and reverberation) than their native- language counterparts. These findings have implications for air traffic control systems.

3. The effect of hearing protectors on speech and warning signal perception

Hearing protectors attenuate both noise and the desired signal by equal amounts in a given frequency band, reducing both to levels where the ear is less likely to distort. This process often improves speech recognition when the level of background noise exceeds 80 to 90 dB. However, because hearing protectors usually provide considerably more attenuation in the high frequencies than in the low frequencies, listeners who have high-frequency hearing losses are at a disadvantage. Many speech sounds and some warning signals will be attenuated beyond the range of audibility. This is especially true of individuals whose losses exceed an average of 30 dB at the audiometric frequencies 2000, 3000, and 4000 Hz (Lindeman, 1976). A potential solution for this problem lies in some newly developed hearing protectors with flat attenuation across the frequency spectrum (Allen and Berger, 1990; Killion et. al., 1988). One type of these protectors has already become popular with orchestral musicians (Killion et al., 1988) and even some rock musicians (Cohen, 1990).

Individuals tend to speak more softly when they wear hearing protectors, and consequently, speech communication is degraded when both talker and listener wear these devices (Hoermann et al,, 1984), Hearing protectors also interfere with the localization of sounds in space, and this is especially true of the ability to localize sounds in the vertical plane while wearing ear muffs (Noble, 1981). Both ear plugs and ear muffs cause these types of problems, but it appears that they are more pronounced with ear muffs (Howell and Martin, 1975; Abel et al., 1982). These findings can have serious implications for safety in some circumstances.

4. Scholastic performance

Noise can disrupt communication in the classroom to the extent that the instructional method used in schools close to airports is sometimes nicknamed " jet pause" teaching. Cohen and Weinstein (1981) have reviewed several studies, which, after controlling for socioeconomic factors, indicate that the academic performance of children in quiet schools is better than that of children in noisy schools.

For example, elementary school children on the side of a school facing train tracks. performed more poorly on a reading achievement test than children in classrooms on the quiet side of the school (Bronzaft and McCarthy,:1975).[14] Cohen and Weinstein also discuss research showing that skills, such as auditory discrimination and reading achievement can be adversely affected when children live in noisy circumstances, even though their schools may be no noisier than average. These latter studies indicate that interference with communication in the classroom is not the only

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[14] Bronzaft reported that in 1978 the city of New York reduced the noise of the elevated train and installed acoustical insulation in the affected classrooms, providing a total reduction in the A-weighted noise level of 6 to 8 dB (Bronzaft, 1981). By 1981, there was essentially no difference. in reading achievement between students on the two sides of the school for the classroom studied.

process at work here. Possible additional explanations include adverse effects on children's information processing strategies and their feelings of personal control[15] (Cohen and Weinstein, 1981).

5. Summary: Interference with communication

Interference with speech communication and other sounds is one of the most salient components of noise-induced annoyance. The resulting disruption can constitute anything from an annoyance to a serious safety hazard, depending on the circumstance.

Research over the past 2 decades has expanded and refined methods for predicting communication interference, but has not produced any major changes. Numerous adjustments have been suggested for the AI, the SIL has been modified and refined, and a new predictive method, the STI has been added. Criteria for determining acceptable background levels in rooms have also been expanded and refined, and progress has been made on the development of effective acoustic warning signals.

It is now clear that hearing protection devices can interfere with the perception of speech and warning signals, especially when the listener is hearing impaired, both talker and listener wear the devices, and when wearers attempt to locate a signal's source.

Noise can interfere with the educational process, and the result has been dubbed "jet-pause teaching" around some of the nation's noisier airports, but railroad and traffic noise can also produce scholastic decrements.

C. Effects of Noise on Sleep

Noise is one of the most common forms of sleep disturbance, and sleep disturbance is a critical component of noise-related annoyance. A study used by EPA in preparing the Levels Document showed that sleep interference was the most frequently cited activity disrupted by surface vehicle noise (BBN, 1971). Aircraft none can also cause sleep disruption, especially in recent years with the escalation of nighttime operations by the air cargo industry. When sleep disruption becomes chronic, its adverse effects on health and well-being are well-known.

1. Assessing sleep disturbance

Noise can cause the sleeper to awaken repeatedly and to report poor sleep quality the next day, but noise can also produce reactions of which the individual is unaware. These reactions include changes from heavier to lighter stages of sleep, reductions in "rapid eye movement" (REM) sleep, increases in body movements during the night, changes in cardiovascular responses, and mood changes and performance decrements the next day. The accuracy and efficiency with which these effects are measured has been greatly assisted by the use of contemporary computers. The most popular measurement tool nowadays is electro-encephalography, but other methods, such as electrocardiography, electromyography, and electrooculography are also used, as well as clinical observation, self-assessment surveys, and accelerometry to measure the motion of the bed frame.

As a result of many years of research on the effects of noise on sleep, it is clear that intermittent and impulsive noise is more disturbing than continuous noise of equivalent energy, and that meaningful sounds are more likely to produce sleep disruption than sounds with neutral content. Also, older people are more likely to have their sleep disturbed by noise than younger people. In fact, children appear to be about 10 dB less sensitive to noise-induced sleep disruption than adults (Eberhardt, 1990). Sleep disturbance from noise tends to be greater in the early hours of the morn-

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[15] See also the discussion of noise, performance, and behavior in sections D.4, and D.5. below.

ing, when individuals spend more time in lighter sleep stages, and this is particularly true of the elderly.

2. Criteria for sleep interference

In the Levels Document EPA identified an indoor DNL of 45 dB, which translates to a nighttime average sound level of 35 dB, as necessary to protect against sleep interference. However, consensus on the levels of noise that can be tolerated without sleep disruption is incomplete at this time. In an attempt to develop a quantitative model for predicting noise-induced sleep interference, Pearsons et al., (1989) reviewed and analyzed 21 studies. However, the authors there unable to derive dose-response relationships from these studies because of large discrepancies between studies conducted in the laboratory and those conducted in the field.

In a recent review of the noise and sleep research, Griefahn (1990) recommends that the nighttime average sound level be kept below 45 dB in the sleeper's quarters. She cites research by Eberhardt (1987 and 1990; Eberhardt et al., 1987;) and Vallet et al., (1976 and 1990) showing self- reported adverse effects from continual road traffic when the average sound level is 40 dB and physiological responses at an average level of 37 dB. For intermittent road traffic noise, maximum recommended levels for single events (as opposed to average levels) range from 45 to 68 dB, depending on the investigation (Griefahn, 1990). Vallet et al. (1990), recommend maximum outside levels of 65 dB, which, of course, relies on some attenuation by the residence. Griefahn also points out that higher maximum levels can be tolerated if the ambient noise level is not very low, and that the difference between single events and the ambient level should not exceed 8 to 10 dB.

3. After-effects and habituation

Numerous recent investigations have revealed after-effects due to noisy nights. Ohrstrom (1983) found mood changes on the day following nights when the average sound level was as low as 35 dB. Adverse effects on performance, such as increased reaction time, have also been measured (Jurriens et al., 1983), and it appears that older peoples' next day performance is more adversely affected by noise than that of younger people (Griefahn and Gros, 1983).

Although people often believe they get used to nighttime noise, physiological tests point to the contrary. Studies have shown that while the subjective response improves with time, cardiovascular responses remain unchanged (Muzet, 1983). Vallet et al. (1990) conclude that habituation is not complete, even after 5 years of exposure to noise.

4. Summary: Effects of noise on sleep

Noise-induced sleep interference is one of the critical components of community annoyance. It can produce short-term adverse effects, such as mood changes and decrements in task performance the next day, with the possibility of more serious effects on health and well-being if it continues over long periods.

EPA's identified indoor DNL of 45 dB has not been seriously challenged over the past decade, but consensus in this area is lacking. One problem is that different experimenters tend to use a variety of descriptors (DNL, Leq, and maximum single-event levels) and a variety of methods for evaluating the effects (EEG, EKG, self-report, etc.). Perhaps one reason for the lack of clear-cut criteria is that this a complex area to research, requiring considerable time and expense. Another is, of course, a need for more field studies in this area.

D. Effects on Performance and Behavior

EPA did not use the literature on the effects of noise on performance and behavior in the identification of its levels of noise to protect against activity interference. One reason may have been that much of the information at that time related to the occupational setting rather than the general environment. Another may have been the complexity of the topic and the difficulty involved in identifying a single noise level that could apply to a great variety of tasks and conditions. Although these difficulties still pertain, much research has been generated in this area over recent years.[16]

Noise can cause adverse effects on task performance and behavior at work, and in nonoccupational and social settings. These effects are the subject of some controversy, however, since they do not always occur as predicted. Sometimes noise actually improves performance, and sometimes there are no measurable differences between performance in noisy and quiet conditions. The presence and degree of effects depends on a variety of intervening variables.

1. Sensory and motor effects

Experiments on the effects of noise on vision have produced conflicting results, with the suggestion of some effects on visual discrimination (Cohen, 1977). There is evidence, however, that high levels of noise can produce shifts in visual field (Parker, et al., 1976, 1978). High levels of noise can affect vestibular function, especially when the presentation to the two ears is asymmetrical, (or the level of attenuation is greater in one ear) (Harris, 1968). Impulsive or other sudden loud sounds can produce a startle response that does not completely habituate with repeated, predictable exposures (May and Rice, 1971).

2. Noise variables

Sound level is one of the most important parameters when predicting performance effects. The level of noise necessary to produce adverse effects is greatly dependent upon the type of task. Simple tasks remain unaffected at noise levels as high as 115 dB or above, while more complex tasks are disrupted at much lower levels. Until fairly recently, the level of beginning effects was thought to be around 95 dB for most conditions, but a summary of recent research (Jones, 1990) points to effects at much lower levels. Effects on serial reaction tasks have been noted for continuous noise with C-weighted noise levels of 90 dB (Jones, 1983) and for intermittent noise with C-weighted levels of around 80 dB (Lahtela et al., 1986).

Frequency and temporal characteristics also play a part. High-frequency sound is more disruptive titan low-frequency sound, and intermittent noise can affect performance more adversely titan continuous noise of equivalent energy. Aperiodic intermittencies are more likely to produce adverse effects than regular ones, and impulse noise may be even more disruptive. Again the effects are variable, depending upon task complexity and other factors.

Much of the important research in the effects of noise on performance conducted over the last decade has focused on the effects of irrelevant speech.[17] The adverse effects of irrelevant speech appear to be fairly independent of sound level, at least in the 55-95 dB range, and therefore, are not mitigated simply by attenuating them by 10 dB or so (Jones, 1990). It also appears that irrelevant speech affects processes involving memory (e.g., reasoning, mental arithmetic, and problem solving)

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[16] For a comprehensive review of the effects of noise on job performance, see Suter, 1989.

[17] The initial work was performed by Salame and Baddeley (1982, 1983, and 1987), and has been summarized by Jones (1990) at a recent conference in Stockholm.

rather than attention. With respect to reading tasks, however, meaningful speech is more disruptive than meaningless speech (Jones, 1990). These findings have significance for many modern work and school environments, where information processing and exchange is so important, especially those of the "open plan" variety.

3. Task variables

Task complexity has been identified in numerous experiments as a crucial determinant of the effects of noise on performance. Noise exposure usually leaves simple routine tasks unaffected, and can even improve performance of monotonous tasks, presumably by elevating one's level of arousal (Broadbent, 1971). Some tasks, such as tracking and jobs requiring intellectual function, can be momentarily disrupted without decrements in overall performance (Broadbent, 1979). But if the noise level is sufficiently high or if the task becomes more complex, noise will have an adverse effect. When two or more tasks must be performed simultaneously in a noisy environment, performance on the primary task usually remains unaffected, while performance on the subsidiary task deteriorates (Hockey and Hamilton, 1970; Davies and Jones, 1975; Finkleman and Glass, 1970).

4. After-effects

It seems that noise can have even greater effects after than during exposure. The most common after-effect appearing in the experimental literature is a reduced tolerance for frustration, manifested in a series of experiments as a reduction in willingness to persist in trying to solve insoluble puzzles (Glass and Singer, 1972; Percival and Loeb, 1980). This research also indicates that predictability of the noise signal greatly reduces its adverse after-effects (Glass and Singer, 1972). One study found that the type of noise also influenced the after-effect. Aircraft noise modified to produce sudden onsets and offsets resulted in a lower tolerance for frustration after the exposure than white noise that ad been similarly modified (Percival and Loeb, 1980).

5. Effects of noise on social behavior

There is an extensive literature concerning the effect of noise on social behavior, and just a few examples of this research will be discussed here. Singer et al. (1990) point out that noise has been used as a noxious stimulus in a variety of investigations because it produces the same biological and psychological effects as other stressors. In fact, they observe that the effects of noise combined with perceived control have been frequently demonstrated, and these investigations have also been extended to many other situations where the presence of control reliably moderates the effects of stress.[18]

In a frequently-cited laboratory study, Matthews and Cannon (1975) found that fewer subjects there willing to help someone who had "accidentally" dropped materials when background noise levels there 85 dB than when they there 65 dB. In a subsequent field study, the same results there demonstrated in a background of lawn mother noise, and this time the addition of a cast on the "victim's" arm enhanced helping behavior under quiet conditions, but failed to do so during the noise episodes (Matthews and Cannon, 1975). In another such experiment, Sauser et al. (1978) found that subjects recommended lower salaries for fictitious employees when exposed to A-weighted levels of office noise at 70 to 80 dB than in quiet. Broadbent (1979 and 1983) cites additional evidence suggesting that subjects will give each other increased amounts of shock and noise when they themselves are exposed to noise, and also cites evidence that noise increases anxiety levels (Broadbent, 1983).

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[18] Singer et al. (1990) cite the research of Langer and Rodin on the effects of patient control in a nursing home situation.

As mentioned above, the presence of control, or even perceived control, is one of the most important predictors of adverse behavioral effects. Subjects who perceive that they have control over the noise show significantly greater tolerance for frustration than subjects without control, even if the control is never exercised (Glass and Singer, 1972). In a recent experiment, Singer and his colleagues found that subjects who there told that they had control of an A-weighted, 103-dB noise stimulus showed significantly greater persistence on a difficult task than subjects who had no control or subjects that had control for only part of the experiment (Singer et al., 1990). This finding occurred despite the fact that the subjects with only partial control reported feelings of control no different from those with full control. To the extent that these findings can be generalized to populations living in noisy areas, this kind of research may have significant sociological implications.

6. Summary: Effects on performance and behavior

Noise can adversely affect task performance in a variety of circumstances. In the past, research in this area has focused mainly on the occupational setting, where noise levels must be sufficiently high and the task sufficiently complex for performance decrements to occur. Recent research implicates more moderate noise levels, especially when speech is the disruptive noise stimulus. Some research indicates that noise can also produce disruptive after-effects, commonly manifested as a reduced tolerance for frustration, and it appears that the presence and timing of control over the noise are critical to the prediction of after-effects. Even moderate noise levels can increase anxiety, decrease the incidence of helping behavior, and increase the risk of hostile behavior in experimental subjects. These effects may, to some extent, help explain the “dehumanization” of today’s urban environment.

E. Extra-Auditory Health Effects

Noise has been implicated in the development or exacerbation of a variety of health problems, ranging from hypertension to psychosis. Some of these findings are based on carefully controlled laboratory or field research, but many others are the products of studies that have been severely criticized by the research community. In either case, obtaining valid data can be very difficult because of the myriad of intervening variables that must be controlled, such as age, selection bias, preexisting health conditions, diet, smoking habits, alcohol consumption, socioeconomic status, exposure to other agents, and environmental and social stressors. Additional difficulties lie in the interpretation of the findings, especially those involving acute effects. For example, if noise raises blood pressure on a temporary basis, will prolonged exposure produce permanent changes? In cases where these effects are permanent but slight, what are the long-term implications? These types of questions and problems have caused this particular area of noise research and criteria development to be very controversial.

1. Theoretical basis

Noise is considered a nonspecific biological stressor, eliciting a response that prepares the body . for action, sometimes referred to as the “fight or flight” response. The physiological mechanism thought to be responsible for this reaction is the stimulation by noise (via the auditory system) of the brain’s reticular activating system (Cohen, 1977). Neural impulses spread from the reticular system to the higher cortex and throughout the central nervous system. Noise can, therefore, influence perceptual, motor, and cognitive behavior, and also trigger glandular, cardiovascular, and gastrointestinal changes by means of the autonomic nervous system. Evidence of these effects, however, is not easy to. come by. Despite decades of research and probably hundreds of studies, relatively little can be said with much confidence.

2. Effects on blood pressure

Probably the most attention has been directed toward cardiovascular effects, especially potential elevations in blood pressure. Many studies of the stressful effects of noise have been conducted on rodents and other laboratory animals. the advantage of these studies is that they offer a greater degree of control and it is possible to have longer exposures than with human subjects. The disadvantages are that there is difficulty generalizing to humans, especially with the smaller animals, the expense involved when larger animals are used, and the prevailing public sentiment against animal experimentation.

EPA sponsored one of the most notable animal studies of noise exposure, in which Peterson and his colleagues performed five sets of experiments on the cardiovascular effects of noise on monkeys (Peterson et al., 1978, 1981, and 1983). The stimulus consisted of A-weighted levels of workplace noise at 85 to 90 dB, and the exposures there as long as 9 months. The results showed significant elevations of both systolic and diastolic blood pressure the fact that these changes persisted long after exposure cessation argues for a chronic effect, at least in this case. Unfortunately, an attempt to replicate this experiment with another primate model was discontinued for lack of funding after only two subjects had been exposed (Turkkan, et al., 1983). Relatively few animal experiments have been conducted in this area over recent years.

With respect to laboratory investigations involving human subjects, Rehm (1983) cites six studies showing increases in blood pressure, but questions whether these effects would be permanent. In an attempt to identify more susceptible populations, Michalak et al. (1990) investigated the effects of low-flying aircraft on elderly subjects. Using recorded aircraft sounds, they found significant increases in both systolic and diastolic blood pressure after exposure to the two types of noise, with significantly greater response to the rapid-onset flyover noise. Whether or not these increases would become permanent with protracted exposure is not known.

Field studies of noise and blood pressure among workers or community residents are becoming increasingly popular, but the results are not always consistent. Rehm (1983) has reviewed 14 field studies, mostly of occupational noise exposure, and reports that the majority showed significant increases in either systolic or diastolic blood pressure, or both. Van Dijk et al. (1983), however, reports that six other studies of exposure to occupational noise found no significant differences between exposed and nonexposed groups.

Knipschild and Oudshoom (1977) avoided some of the pitfalls characteristic of epidemiological studies by examining a population near the Amsterdam airport before and after an increase in exposure to aircraft noise, and comparing it to a nonexposed population nearby. The dependent variable was the purchase of certain prescription drugs: tranquilizers, sleeping pills, antacids, and cardiovascular drugs. The investigators found that the use of these drugs in the nonnoise area was essentially stable, whereas the use of most types of these drugs in the area newly impacted by noise increased steadily over the years investigated. This increase was especially noticeable for antihypertensive drugs.

In a more recent review, van Dijk (1990) analyzed 12 cross-sectional studies, with half of them showing a positive relation between noise exposure and blood pressure, and the others no significant effects. Van Dijk criticizes these kinds of investigations for the following kinds of weaknesses: inadequate description of noise and blood pressure measurements; absence or inadequate control of intervening variables; use of hearing loss as a determinant of exposure magnitude; use of hearing. protectors; and questionable interpretation of the results. Part of the problem may be that the investigators often come from only one discipline, when, in fact, a multi-disciplinary team is needed.

Thompson and Fidell (1990) recommend the use of prospective or case-control models, rather than the more convenient cross-sectioned study, and they stress the importance of adequate sample size. They maintain that because any changes in blood pressure resulting from community noise are likely to be small, careful controls, large sample sizes, and at least 5 years of exposure to noise would be nerved to identify significant effects.

3. Effects on blood chemistry

Blood chemistry is also of interest in studies of wire exposure and the cardiovascular system. In the review cited above, Rehm (1983) reports on a series of experiments, both laboratory and field, which show increased levels of the catecholamines epinephrine and norepinephrine. Among them are the series of experiments by Ising and his colleagues (1981a, 1981b, 1981c), showing a connection between noise exposure and magnesium metabolism and humans and animals. According to Rehm, this finding suggests a possible mechanism for cardiovascular effects in that a chronic magnesium imbalance can lead to increased intracellular levels of calcium (in the heart, for instance), which, in turn, can cause vasoconstriction and increases the sensitization for catecholamines.

A large epidemiological study, the Caerphilly and Speedwell Heart Disease Study in England, holds some promise for investigating the effects of road traffic noise (Babisch and Gallacher, 1990). This study of heart disease and a variety of environmental factors uses both the cross-sectional and prospective approaches, and should continue for more than 10 years. The investigators have performed detailed noise exposure measurements. Sample sizes of more than 2000 men have been drawn from both the Caerphilly and Speedwell communities, and controls for age, socio-economic factors, family history, body weight, smoking habits, alcohol, and physical activity have been instituted. Initial results (from the cross-sectional study) indicate significant noise related elevations of serum cholesterol and glucose levels, and plasma viscosity, with an absence of significance for blood pressure or any of the other cardiovascular risk factors. The authors point out that all of the effects there slight, but even small increases, should they prove to be real, would be relevant to the public health.

4. Interactions

Several investigators have suggested that aversion to noise may be more highly correlated with health problems than the noise itself. For example, a study by Rehm (1983) found a significant correlation between noise annoyance and cardiovascular disorders. Her data also suggest that those with existing health problems are more annoyed by environmental factors, such as noise. Similarly, Rovekamp (1983) found that subjects who described themselves as sensitive to noise showed significantly greater noise-induced increases in peripheral vasoconstriction than their “normal” counterparts. Finally, a recent study . of road traffic and aircraft noise failed to show a significant increase in blood pressure resulting from noise, but did show a correlation between the presence of noise and subjective health complaints (Pulles et al.,1990). Differences in effects between noise and non-noise groups there dependent upon the subjects’ perceived control over the noise, but independent of noise level.

5. Other adverse effects

Adverse health effects from noise exposure other than cardiovascular effects are even more difficult to isolate. Several studies have investigated the effects of noise on fetal development, with inconclusive results. Some have shown an indication of reduced birth weight or an increase in premature births, but the effects are usually slight, and (except in one case, McDonald et al., 1988), not statistically significant (Rehm and Jansen, 1978; Knipschild et al.., 1981).

The effects of noise on documented mental health disorders are likewise inconclusive. Rehm (1990) cites a series of studies showing increased numbers of psychoneurotic and psychosomatic complaints due to noise exposure, but whether or not these complaints lead to chronic disfunction or illness is not obvious.

6. Summary: Extra-auditory effects

As a biological stressor, noise can influence the entire physiological system. Most effects appear to be transitory, but with continued exposure some effects have been shown to be chronic in laboratory animals. Probably the strongest evidence lies in the cardiovascular effects. However, many studies show adverse effects, while many others show no significant differences between experimental and control populations.

Undoubtedly because of the lack of consistent evidence in thin area, EPA could not use data on extra-auditory health effects in its identification of safe levels of environmental noise. Instead, this subject was relegated to a brief discussion in an appendix in the Levels Document. Although considerable attention was devoted to this topic at the international conference in Yugoslavia, and some coverage was given in the 1973 Criteria Document, the evidence was far from sufficient and much too complex to enable the formulation of dose-response relationships. Later, EPA did fund some promising research in this area (Hattis and Richardson, 1980; Peterson et al., 1978, 1981, 1983; Turkkan, 1983), some of which has clearly demonstrated adverse cardiovascular effects at noise levels typical of occupational settings.

In the interim, there has been considerable European research activity in this area, but nearly 20 years later, criteria are still lacking. What is available, however, should give public policymakers as well as noise producers some reason for concern, especially in situations where those impacted by the noise have no control over or perceive they have no control over their exposures.

F. Annoyance

Annoyance is the measured outcome of a community's response to survey questions on various environmental and other factors, such as noise exposure. Although annoyance in individuals is sometimes measured in the laboratory, field evaluations of community annoyance are most useful for predicting the consequences of planned actions involving highways, airports, road traffic, railroads, or other noise sources. Factors directly affecting annoyance from noise include interference with communication and sleep disturbance, which have been discussed in earlier sections. Other less direct effects are disruption of one's peace of mind, the enjoyment of one's property, and the enjoyment of solitude. The consequences of noise-induced annoyance are privately felt dissatisfaction, publicly expressed complaints to authorities, and potential adverse health effects, as suggested above.

"Annoyance" has been the term used to describe the community's collective feelings about noise ever since the early noise surveys in the 1950s and 1960s, although some have suggested that this term tends to minimize the impact. While "aversion" or "distress" might be more appropriate descriptors, their use would make comparisons to previous research difficult. It should be clear, however, that annoyance can connote more than a slight irritation; it can mean a significant degradation in the quality of life. This represents a degradation of health in accordance with the WHO's definition of health, meaning total physical and mental well-being, as well as the absence of disease.

1. Predicting annoyance for public policy purposes

To facilitate the development of criteria and public policy, Schultz (1978) summarized and analyzed a large number of studies of community annoyance from aircraft, road traffic, and railroad noise. As part of this effort, Schultz made several simplifying assumptions, among them that the percentage of the population determined to be "highly annoyed" would be the only parameter plotted as a function of day-night average sound level. The resulting curve portrays annoyance as independent of noise source, and it has been dubbed the Schultz curve.

Recently, Fidell et al. (1991) reanalyzed the original data used by Schultz, adding new data from it community noise surveys. The resulting function shows slightly greater annoyance in the range between DNLS of 51 dB and 72 dB, and slightly less annoyance above about a DNL of 76 dB than the original curve. In general, the two curves are fairly close, indicating that the new studies have not drastically altered the prediction of community annoyance, at least when reactions to various noise sources are plotted together. When annoyance from various noise sources is analyzed separately, however, the new data are quite revealing, as will be discussed below.

Although it has been used internationally in the formation of noise policy, the Schultz curve has been the subject of much debate (Kryter, 1982a, 1982b; Griffiths, 1983). For example, Griffiths (1983) criticizes Schultz for treating attitudinal data categorically (highly annoyed or otherwise) rather than scaling it, for failing to analyze the distribution of annoyance, for assuming a fixed threshold for noise-related annoyance, and for choosing such an extreme criterion as highly annoyed. Perhaps because of these reasons, as well as a number of others, researchers and policymakers are beginning to examine alternatives to the Schultz curve for predicting community annoyance from noise.

2. Metrics

The metrics most commonly used to describe the relationship between noise and community annoyance are the equivalent continuous sound level, and the day-night average sound level (DNL), composite ratings based on the A-weighted sound level. The DNL is used almost exclusively for airport planning in the U.S., but this practice has recently been called into question. For example, the importance of communication and relaxation in the evening hours has been recognized (in California and occasionally in Europe) by the use of the community noise equivalent level (CNEL), a metric that includes a 5-dB penalty for noises occurring between 7:00 and 10:00 pm as well as the 10-dB nighttime penalty (California Code of Regulations, 1990). In a study of the communities surrounding two French airports, residents expressed the greatest annoyance during the hours between 7:00 and 11:00 pm (Francois, 1977).

Some authorities are considering the use of the sound exposure level (SEL) for evaluating the effects of single events, such as aircraft flyovers (EPA/FAA, 1990). The importance of other parameters are also being considered, such as rise time (or onset time) as an indicator of the annoyance from low-flying military aircraft (Harris, 1989). Officials from the U.S. Forest Service report that their agency has begun to use an aircraft detectability criterion to site recreational facilities (Harrison et al., 1990).

3. Criteria

Community annoyance resulting from noise-induced activity interference was one of the most important considerations in EPA's identification of an outdoor DNL of 55 dB as the "safe" level of environmental noise (EPA, 1974a). Some years later, a Federal Inter-Agency Committee on Urban

Noise (FICUN) developed guidelines for considering noise in land-use planning and control (DOT, 1980).[19]

In its noise zone classification table, “minimal” exposures to noise there defined as DNLS below 55 dB, and between DNLS of 55 and 65 dB, the exposures there labeled “moderate.” However, all of these exposures there considered “acceptable” according to land-use planning standards specified by the Department of Housing and Urban Development (HUD). No research was cited to support these conclusions. In a footnote, FICUN stated the following:

HUD, DOT and EPA recognize Ldn = 55 dB as a goal for outdoors in residential areas in protecting the public health and welfare with an adequate margin of safety (Reference: EPA “Levels” Document.) However, it is not a regulatory goal. It is a level defined by a negotiated scientific consensus without concern for economic and technological feasibility or the needs and desires of any particular community.

The Department of Transportation’s Federal Aviation Administration (FAA) has adopted a DNL of 65 as the point above which residential land-use becomes “normally unacceptable.” Below this level, the FAA does not require airport authorities to draw noise contours or discuss the impact of airport noise on the surrounding communities for purposes of compatibility planning or to receive grants under the Part 150 program.[20] Thus, public policy decisions, at least on the federal level, have not considered the annoyance of individuals living in the DNL 55-65 dB range.

Recent research confirms the findings of earlier investigations relied upon by the EPA, that annoyance is often generated at day-night average sound levels well below 65 dB (Fidell et al., 1985; Fidell et al., 1991; Hall et al., 1981). Figures 4 and 5 from Fidell et al. (1991) portray the responses from surveys of two mid-sized airports in California: Burbank Airport and the Orange County Airport. The percentage of respondents highly annoyed is depicted as a function of DNL, and compared to the Schultz curve. Both studies show significantly greater numbers of people highly annoyed than would have been predicted by the Schultz curve. For example, at 60 dB, as many as 70 percent of the Burbank population described themselves as highly annoyed and some 40 percent near the Orange County Airport.

Presumably because of this kind of evidence, another interagency task force has convened to discuss the extent to which day-night average sound levels below 65 dB should be taken into account in assessing the impact of aircraft/airport noise, and to examine the possible need for a single-event metric to supplement the DNL (EPA/FAA, 1990).[21]

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[19] FICUN was an ad-hoc interagency panel composed of representatives from EPA, FAA, HUD, the Department of Defense, and the Veterans Administration. In 1990 another such group, the Federal Interagency Committee on Noise (FICON) has been activated (focussing mainly on aircraft noise), but a report has not been published to date.

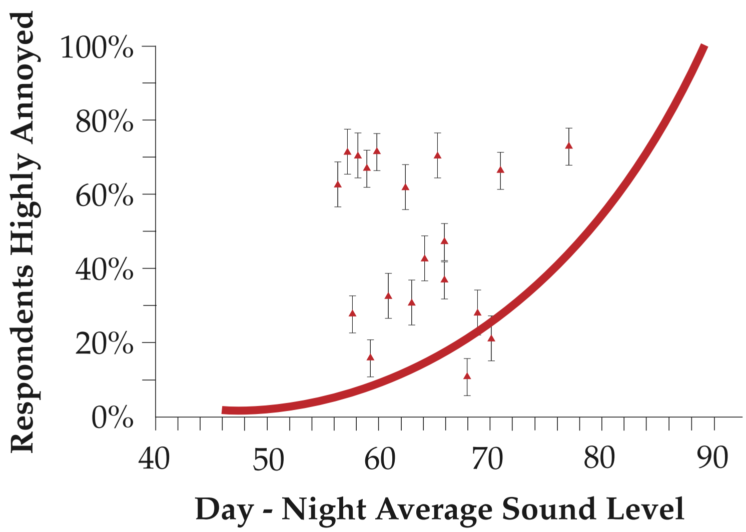
[20] Part 150 studies are conducted at airports where the noise generated by airport construction or expansion is potentially incompatible with the surrounding community. These studies must follow the procedure set out by Federal Aviation Regulations (FAR) Part 150.

[21] The U.S. EPA and FAA put together an intragency agreement to examine the extent to which single event analyses and information beyond the Ldn = 65 contour provide useful additions to current methods of evaluating potential airport noise impacts. Under this agreement, a contractor would identify eight existing airports and perform a quantitative analysis using existing data. No new annoyance data would be developed.

4. Sources

The sources of noise producing community annoyance are primarily aircraft, road traffic, and railroad noise, although noise from industry, construction, and within buildings can also be problematical. The leading offenders are usually aircraft and road traffic noise, although the hierarchy depends upon many factors, such as urbanization, numbers of noise events, and proximity to the sources. Recent research indicates that, despite equivalent noise levels, some sources of community noise are more annoying than others, providing further indication that the Schultz curve cannot be valid for all circumstances.

Treating annoyance from all sources with one predictive curve provokes the hoards of oversimplification. De Jong (1990a) reports that an analysis of Dutch studies carried out over the previous 15 years showed that aircraft and highway noise produced considerably more annoyance than equivalent levels of train, tramway, and urban road noise (Miedema, 1988). The divergence was particularly pronounced at high noise levels. The fact that aircraft generate more annoyance than surface transportation is portrayed dramatically in the analysis described above by Fidell et al. (1991), where annoyance related to mid-sized airports appears substantially greater than that predicted by the Schultz curve, while annoyance from urban sources, such as trains, trams, and street traffic, is considerably less than that predicted by the Schultz curve.[22] Figures 6 and 7, also from Fidell et al. (1991), depict data from British and Swedish railroad studies, showing somewhat less annoyance from these sources in relation to the Schultz curve.



Relationship of data from Burbank Airport Study to 1978 synthesis (Schultz) curve, showing percentage of respondents highly annoyed as a function of day-night average sound level. (After Fidell et al. 1991)

[22] See also Fidell et al. (1985), Hall et al. (1981), and de Jong (1990).

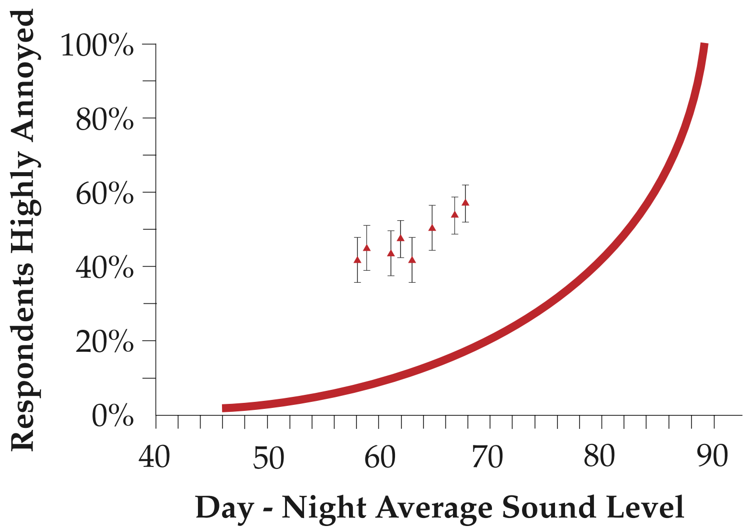


Figure 5
Relationship of data from Orange Country Airport Study to 1978 synthesis (Schultz) curve, showing percentage of respondents highly annoyed as a function of day-night average sound level. (After Fidell et al., 1991).

The explanation for these source-related differences is not necessarily that aircraft noise is inherently more annoying than surface transportation noise. It may be related to differences in people's criteria for responding to various noise sources (de Jong, 1990b; Green and Fidell, 1991). Or it may be caused by differences in sensitivity which are actually biologically based.[23] Green and Fidell (1991) point out that this evidence does not discredit the predictive validity of the DNL, but suggest that communities adopt a more sensitive criterion when evaluating the impact of aircraft noise.[24]

Impulse noise also appears to be more annoying than continuous noise of equivalent energy, and various penalties have been proposed ranging from 0 dB at relatively high ambient noise levels of about 67 dB, to 10 dB at ambient levels as low as 35 dB (Rice, 1983). Vos and Smoorenburg (1983) have recommended a formula for computing the impulse noise penalty, taking into account the type of noise source, the signal level, and the ambient noise level.

As de Jong points out (1990b), most people are exposed to some combination of noise sources, posing a very complex predictive problem. Several models for predicting noise annoyance from complex sources have been proposed, but most fail to solve the difficult theoretical problems involved (de Jong cites Berglund et al., 1981, and Miedema, 1985). Among the groups working on these models are the Institute for Sound and Vibration Research in England, and the Netherlands' Organization for Applied Scientific Research, TNO.

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[23] De Jong (1990b) cites the work of Di Nisi et al. (1987) and Ising, et al.(1981b) to support this theory.

[24] Green and Fidell found a difference of 5.2 dB bettheen the noise levels at which the same percentage of people are highly annoyed by aircraft noise versus noise from surface transportation.

5. Nonacoustics variables

Although it is dear that community annoyance is positively correlated with noise exposure level, other variables also appear to be important, such as ambient noise level, time of day and year, location, and socioeconomic status. None of these other variables, however, is as powerful as the attitude of the residents surveyed. This is a good example of the fact that the human being is not a black box, where the effect is a simple consequence of the input. In a recent analysis of 280 social surveys, Fields (1990) examined 17 hypotheses as they relate to community annoyance from noise. Besides noise exposure level, the only variables Fields identified as strongly correlated with noise annoyance there the attitudinal hypotheses: (1) fear that the noise source might be a danger to the neighborhood, (2) belief that the noise is preventable, (3) awareness that non-noise problems are associated with the noise source, (4) stated sensitivity to noise, and (5) belief that the economic activity represented by the source is not important for the community.

6. Habituation

The evidence is fairly dear that so long as the stimulus remains the same, noise annoyance does not subside over time (e.g., Fields, 1990). Griffiths (1983) cites studies showing no habituation for highway noise 4 months to 2 years after the opening of new routes. De long (1990) found that annoyance in a previously surveyed community increased by 10 percent with no change in noise levels. He suggests that this increase could represent a shift of internal criteria due to increased publicity and other factors, or perhaps an increase in physiological sensitization.

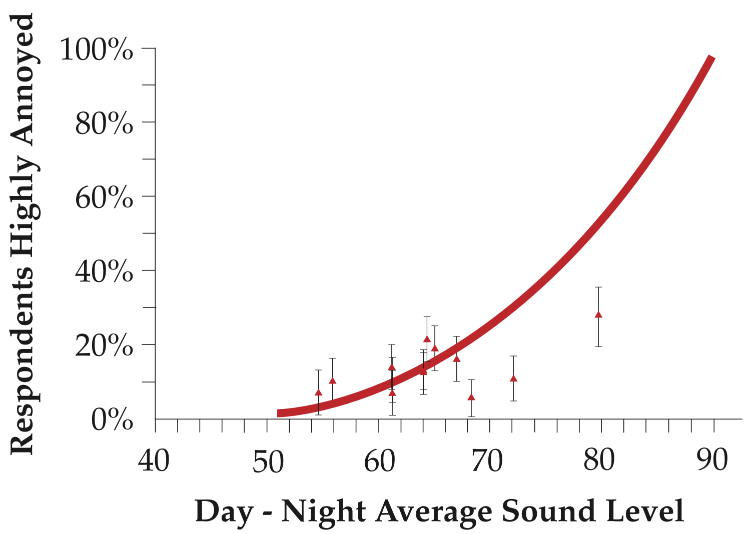

Figure 7 - Relationship of data from Swedish Railroad Study to 1978 synthesis (Schulz) curve, showing percentage of respondents highly annoyed as a function of day-night average sound level. After Fidell et al, 1991).

There has been very little study of the effects of noise-related annoyance on general health, although this would appear to be a fertile field. The study mentioned in section E.4, above by Rehm (1983) suggests a relationship between annoyance and cardiovascular disorders. Likewise, another study indicates a connection between noise and subjective health complaints (Pulles, et al., 1990). De Jong (1990a) refers to the recent use in Germany of the concept of "substantial annoyance" as a predictor of possible health damage.[25] He recommends the development of an integrated theory of noise effects "to uncover the relationships among medical, physiological, behavioral, and ecological effects of environmental noise. " (de Jong, 1990a, p.520)

8. Summary: Annoyance

Annoyance can be viewed as the expression of negative feelings resulting from interference with activities, as well as disruption of one's peace of mind and the enjoyment of one's environment. Although this reaction can run the gamut of mild irritation to extreme distress, only responses categorized as "highly annoyed" (and greater) have been used to measure the impact of noise on communities. The most respected and widely used criterion to assess community annoyance in the U.S. has been the Schultz curve, although this criterion has been the subject of heated debate. Several recent studies indicate that the Schultz curve underestimates annoyance due to aircraft noise and overestimates annoyance from the noise of urban traffic and trains, leading to the conclusion that annoyance from these categories should be assessed separately. In addition, there has been growing interest in supplementing the traditional DNL with a descriptor for single events.

EPA's Levels Document identified the outdoor level to protect against activity interference as a day-night average sound level of 55 dB. This identification was not to be construed as a standard or regulation,[26] but as information to aid states, localities, and the general public. Later, an interagency task force identified average levels between 55 and 65 dB as "acceptable" for purposes of land-use planning. The DNL 65-dB criterion, which has been applied particularly to airport noise assessments, is now being reconsidered by another interagency task force.

There is evidence that impulse noise is more annoying than continuous noise of equivalent energy, and various correction factors have been proposed to account for the difference. In addition, most people are exposed to a combination of noise sources, and models for predicting the resulting annoyance are in the formative stages.

The most important variables other than noise exposure level relate to people's attitudes about the noise, such as fear of possible danger, stated sensitivity, and the belief that the noise is preventable. Finally, it appears that noise-related annoyance does not subside over time.

VI. Conclusions

Noise has a significant impact on the quality of American life. There is no evidence that the impact has diminished in the years since ONAC was abolished. Rather, it appears that the impact is at least as great, and most probably greater, than it was 10 years ago, due to population growth, especially in urban areas, and the proliferation of certain noise sources.

A considerable amount of noise effects research has been conducted over the last decade, much of it taking place in the European nations where governmental concern about noise is greater than it is in the U.S. at this time. These studies have expanded the knowledge base and filled certain gaps. Many of them suggest important interrelationships between the various noise effects that remain largely unexplored. For example, perceived control over noise appears to decrease its adverse effects on the subsequent performance of certain tasks. The concept of control also has a bearing on annoyance from noise, as do several other nonacoustic factors. Annoyance appears to be related to

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[25] De Jong cites Jansen (1986).

[26] See Foreword, Levels Document (EPA, 1974a).

extra-auditory health effects, and chronic sleep interference, which is a component of annoyance, can have adverse effects on health and well-being.

All of these effects are, to a varying degree, stress related. Nowadays there is increasing evidence in the medical literature on the relationship between stress and illness, one which is often exacerbated by lack of control.

Cumulatively, this evidence suggests the potential for a unifying hypothesis that may well explain some of the health effects that have been observed in connection to noise exposure, but have usually been dismissed because of the absence or insufficiency of direct cause and effect relationships. Such a hypothesis, however, can only be validated by a new interdisciplinary approach, one which takes a broader and somewhat different perspective than is currently employed. This approach could very well provide the key to understanding a great deal more about the general impact of noise on society, and the extra-auditory effects in particular.

GUIDELINES FOR CONSIDERING NOISE IN LAND USE PLANNING AND CONTROL

June 1980

Federal Interagency Committee on Urban Noise

FEDERAL
INTERAGENCY COMMITTEE
ON URBAN NOISE

To all local government officials and others interested in noise/land use concerns:

In his Environmental Message to Congress in August, 1979, President Carter announced a new Urban Noise Initiative to reduce urban noise. The Federal Interagency Committee on Urban Noise was thereby established to coordinate various programs, including an interagency program designed "to encourage noise sensitive development, such as housing, to be located away from major noise sources." As a first step in that program, the Committee is pleased to make available this document which presents a broad consolidation of Federal guidance on the incorporation of noise considerations in local development planning and site review operations. We hope that it will facilitate improved communication among all levels of government on noise compatible land use and that you will find it useful in addressing noise/land use concerns in your community.

Douglas Costle
Administrator
U.S. Environmental Protection Agency

Neil Goldschmidt
Secretary
U.S. Department of Transportation

Moon Landrieu
Secretary
U.S. Department of Housing
and Urban Development

Robert B. Pirie, Jr.
Assistant Secretary of Defense
(Manpower, Reserve Affairs & Logistics)
U.S. Department of Defense

Max Cleland
Administrator
Veterans Administration

TABLES

CONTENTS

APPENDICES

Section 1 presents consolidated Federal agency land use compatibility guidelines. Section 2 overviews techniques by which the guidelines can be implemented. Section 3 briefly overviews the major Federal agency noise control policies and programs. The Appendices contain brief descriptions of environmental noise descriptors and annotated bibliographies of selected Federal documents.

Section 1. LAND USE COMPATIBILITY GUIDELINES

This section contains two tables. Table 1 classifies noise levels into a set of noise zones according to the most commonly used environmental noise descriptors. Noise zones are identified in order of increasing noise level by the letters "A" through "D". The descriptors are discussed in Appendix A. The Day-Night Average Sound Level (DNL)[1] descriptor can be used for all noise sources. The Equivalent Sound Level (L_{eq}) is included because some highway noise data can be expected to be in terms of an equivalent sound level for the highway "design hour" — see Table 1 for description of when L_{eq} (design hour) is equivalent to DNL for planning purposes. The L_{eq} descriptor itself is not unique to highways and can be applied to any noise source. The Noise Exposure Forecast (NEF) descriptor is used for aircraft noise only and is being superceded by DNL. The Community Noise Equivalent Level (CNEL) descriptor (for the state of California) uses values similar to DNL. Older descriptors unique to airport noise environments, such as the Composite Noise Rating (CNR), may be encountered. For general comparison purposes L_{dn} 65 = NEF 30 = CNR 100, L_{dn} 75 = NEF 40 = CNR 115.

Table 2 contains suggested land use compatibility guidelines. The table arrays land uses[2] on the left with the noise zones of Table 1 across the top. Land use compatibility is expressed as being "compatible", "incompatible" and "compatible with restrictions." The system as presented in the table is comprised of two digit categories identifying land use activity in the most generalized way (e.g. "10 Residential"). Within some of the two-digit categories here are sub-categories identifying activity in greater detail. Compatibility as expressed in this table represents a consolidation of existing Federal agency guidelines. This table serves as a point of departure in making several kinds of determinations, including whether various land uses should be allowed at particular sites based upon the noise levels at those sites. Detailed planning should be based on the procedures and specific general planning guidance found in appropriate Federal agency documents (Appendix B) as well as the needs, desires and site characteristics of the particular community. Another input to the

[1]Day-Night Average Sound Level is abbreviated as DNL and symbolized mathematically as L_{dn} (e.g., L_{dn} 65, L_{dn} 75, etc.).

[2]Land uses are here categorized according to the standard land use activity categories found in the *Standard Land Use Coding Manual*, Housing and Home Finance Agency (now Department of Housing and Urban Development) and Bureau of Public Roads (now Department of Transportation/Federal Highway Administration), 1965.

planning process is the statement of public health and welfare goals in EPA's "Levels" Document. The levels can be used by individual communities to incorporate public health and welfare goals into the planning process. These levels do not *in themselves,* however, form the sole basis for appropriate land use actions because they do not consider cost, feasibility, the noise levels from any particular source, or the development needs of the community and do include an adequate margin of safety. They should be considered by all communities in their planning, including those who now enjoy quiet and wish to preserve it, as well as those which are relatively noisy and wish to mitigate the problem.

TABLE 1. NOISE ZONE CLASSIFICATION

Noise Zone	Noise Exposure Class	Noise Descriptor: DNL[1] Day-Night Average Sound Level	Noise Descriptor: L_{eq}(hour)[3] Equivalent Sound Level	Noise Descriptor: NEF[4] Noise Exposure Forecast	HUD Noise Standards
A	Minimal Exposure	Not Exceeding 55	Not Exceeding 55	Not Exceeding 20	"Acceptable"
B	Moderate Exposure	Above 55[2] But Not Exceeding 65	Above 55 But Not Exceeding 65	Above 25 But Not Exceeding 30	
C-1	Significant Exposure	Above 65 Not Exceeding 70	Above 65 Not Exceeding 70	Above 30 But Not Exceeding 35	"Normally Unacceptable"[5]
C-2		Above 70 But Not Exceeding 75	Above 70 But Not Exceeding 75	Above 35 But Not Exceeding 40	
D-1	Severe Exposure	Above 75 But Not Exceeding 80	Above 40 But Not Exceeding 80	Not Exceeding 45	"Unacceptable"
D-2		Above 80 But Not Exceeding 85	Above 80 But Not Exceeding 85	Above 45 But Not Exceeding 50	
D-3		Above 85	Above 85	Above 50	

[1]CNEL — Community Noise Equivalent Level (California only) uses the same values.

[2]HUD, DOT and EPA recognize L_{dn} = 55 dB as a goal for outdoors in residential areas in protecting the public health and welfare with an adequate margin of safety (Reference: EPA "Levels" Document.) However, it is not a *regulatory* goal. It is a level defined by a negotiated scientific consensus without concern for economic and technological feasibility or the needs and desires of any particular community.

[3]The Federal Highway Administration (FHWA) noise policy uses this descriptor as an alternative to L_{10} (noise level exceeded ten percent of the time) in connection with its policy for highway noise mitigation. The L_{eq} (design hour) is equivalent to DNL for planning purposes under the following conditions: 1) heavy trucks equal ten percent of total traffic flow in vehicles per 24 hours; 2) traffic between 10 p.m. and 7 a.m. does not exceed fifteen percent of the average daily traffic flow in vehicles per 24 hours. Under these conditions DNL equals L_{10} - 3 decibels.

[4]For use in airport environs only; is now being superceded by DNL.

[5]The HUD Noise Regulation allows a certain amount of flexibility for non-acoustic benefits in zone C-1. Attenuation requirements can be waived for projects meeting special requirements.

TABLE 2. SUGGESTED LAND USE COMPATIBILITY GUIDELINES

Land Use		Noise Zones/DNL Levels in L_{dn}						
SLUCM No.	Name	A 0-55	B 55-65	C-1 65-70	C-2 70-75	D-1 75-80	D-2 80-85	D-3 85+
10	**Residential**							
11	Household units.							
11.11	Single units — detached	Y	Y*	25[1]	30[1]	N	N	N
11.12	Single units — semidetached	Y	Y*	25[1]	30[1]	N	N	N
11.13	Single units — attached row	Y	Y*	25[1]	30[1]	N	N	N
11.21	Two units — side-by-side	Y	Y*	25[1]	30[1]	N	N	N
11.22	Two Units — one above the other	Y	Y*	25[1]	30[1]	N	N	N
11.31	Apartments — walk up	Y	Y*	25[1]	30[1]	N	N	N
11.32	Apartments — elevator	Y	Y*	25[1]	30[1]	N	N	N
12	Group quarters	Y	Y*	25[1]	30[1]	N	N	N
13	Residential hotels	Y	Y*	25[1]	30[1]	N	N	N
14	Mobile home parks or courts	Y	Y*	N	N	N	N	N
15	Transient lodgings	Y	Y*	25[1]	30[1]	35[1]	N	N
16	Other residential	Y	Y*	25[1]	30[1]	N	N	N
20	**Manufacturing**							
21	Food and kindred products — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
22	Textile mill products — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
23	Apparel and other finished products made from — fabrics, leather, and similar materials — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
24	Lumber and wood products (except furniture) — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
25	Furniture and fixtures — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
26	Paper and allied products — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
27	Printing, publishing, and allied industries	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
28	Chemicals and allied products — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
29	Petroleum refining and related industries	Y	Y	Y	Y[2]	Y[3]	Y[4]	N

*The designation of these uses as "compatible" in this zone reflects individual Federal agencies' consideration of general cost and feasibility factors as well as past community experiences and program objectives. Localities, when evaluating the application of these guidelines to specific situations, may have different concerns or goals to consider. For an indication of possible community reaction in residential environments at various levels of cumulative noise, Table D-1 in Appendix D should be consulted.

NOTES FOR TABLE 2

1. a) Although local conditions may require residential use, it is discouraged in C-1 and strongly discouraged in C-2. The absence of viable alternative development options should be determined and an evaluation indicating that a demonstrated community need for residential use would not be met if development were prohibited in these zones should be conducted prior to approvals.

   b) Where the community determines that residential uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB (Zone C-1) and 30 dB (Zone C-2) should be incorporated into building codes and be considered in individual approvals. Normal construction can be expected to provide a NLR of 20 dB, thus the reduction requirements are often stated as 5, 10 or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. Additional consideration should be given to modifying NLR levels based on peak noise levels.

   c) NLR criteria will not eliminate outdoor noise problems. However, building location and site planning, design and use of berms and barriers can help mitigate outdoor noise exposure particularly from ground level sources. *Measures that reduce noise at a site should be used wherever practical in preference to measures which only protect interior spaces.*

2. Measures to achieve NLR of 25 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

3. Measures to achieve NLR of 30 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

4. Measures to achieve NLR of 35 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

KEY TO TABLE 2

SLUCM	Standard Land Use Coding Manual
Y (Yes)	Land Use and related structures compatible without restrictions.
N (No)	Land Use and related structures are not compatible and should be prohibited.
NLR (Noise Level Reduction)	Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
Y^x (Yes with restrictions)	Land Use and related structures generally compatible; see notes 2 through 4.
25, 30, or 35	Land Use and related structures generally compatible; measures to achieve NLR of 25, 30 or 35 must be incorporated into design and construction of structure.
25*, 30* or 35*	Land Use generally compatible with NLR; however, measures to achieve an overall do not necessarily solve noise difficulties and additional evaluation is warranted.

TABLE 2. SUGGESTED LAND USE COMPATIBILITY GUIDELINES (continued)

Land Use		Noise Zones/DNL Levels in L_{dn}						
SLUCM No.	Name	A 0-55	B 55-65	C-1 65-70	C-2 70-75	D-1 75-80	D-2 80-85	D-3 85+
30	**Manufacturing (cont'd)**							
31	Rubber and misc. plastic products — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
32	Stone, clay and glass products — manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
33	Primary metal industries	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
34	Fabricated metal products — manufacturing.	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
35	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks — manufacturing	Y	Y	Y	25	30	N	N
39	Miscellaneous manufacturing	Y	Y	Y	Y[2]	Y[3]	Y[4]	
40	**Transportation, communication and utilities**							
41	Railroad, rapid rail transit and street railway transportation	Y	Y	Y	Y[2]	Y[3]	Y[4]	Y
42	Motor vehicle transportation	Y	Y	Y	Y[2]	Y[3]	Y[4]	Y
43	Aircraft transportation	Y	Y	Y	Y[2]	Y[3]	Y[4]	Y
44	Marine craft transportation	Y	Y	Y	Y[2]	Y[3]	Y[4]	Y
45	Highway and street right-of-way	Y	Y	Y	Y[2]	Y[3]	Y[4]	Y
46	Automobile parking	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
47	Communication	Y	Y	Y	25[5]	30[5]	N	N
48	Utilities	Y	Y	Y	Y[2]	Y[3]	Y[4]	Y
49	Other transportation, communication and utilities	Y	Y	Y	25[5]	30[5]	N	N
50	**Trade**							
51	Wholesale trade	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
52	Retail trade — building materials, hardware and farm equipment	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
53	Retail trade — general merchandise	Y	Y	Y	25	30	N	N
54	Retail trade — food	Y	Y	Y	25	30	N	N
55	Retail trade — automotive, marine craft, aircraft and accessories	Y	Y	Y	25	30	N	N
56	Retail trade — apparel and accessories	Y	Y	Y	25	30	N	N
57	Retail trade — furniture, home furnishings and equipment	Y	Y	Y	25	30	N	N
58	Retail trade — eating and drinking establishments	Y	Y	Y	25	30	N	N
59	Other retail trade	Y	Y	Y	25	30	N	N

NOTES FOR TABLE 2

2. Measures to achieve NLR of 25 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

3. Measures to achieve NLR of 30 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

4. Measures to achieve NLR of 35 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

5. If noise sensitive use indicated NLR; if not use is compatible.

KEY TO TABLE 2

SLUCM	Standard Land Use Coding Manual
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NLR (Noise Level Reduction)	Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
Y^X (Yes with restrictions)	Land Use and related structures generally compatible; see notes 2 through 4.
25, 30, or 35	Land Use and related structures generally compatible; measures to achieve NLR of 25, 30 or 35 must be incorporated into design and construction of structure.
25*, 30* or 35*	Land Use generally compatible with NLR; however, measures to achieve an overall noise reduction do not necessarily solve noise difficulties and additional evaluation is warranted.

TABLE 2. SUGGESTED LAND USE COMPATIBILITY GUIDELINES (continued)

Land Use		Noise Zones/DNL Levels in L_{dn}						
SLUCM No.	**Name**	**A 0-55**	**B 55-65**	**C-1 65-70**	**C-2 70-75**	**D-1 75-80**	**D-2 80-85**	**D-3 85+**
60	**Services**							
61	Finance, insurance and real estate services	Y	Y	Y	25	30	N	N
62	Personal services	Y	Y	Y	25	30	N	N
62.4	Cemeteries	Y	Y	Y	Y^{2}	Y^{3}	$Y^{4,11}$	$Y^{6,11}$
63	Business services	Y	Y	Y	25	30	N	N
64	Repair services	Y	Y	Y	Y^{2}	Y^{3}	Y^{4}	N
65	Professional services	Y	Y	Y	25	30	N	N
65.1	Hospitals, nursing homes	Y	Y*	25*	30*	N	N	N
65.1	Other medical facilities	Y	Y	Y	25	30	N	N
66	Contract construction services	Y	Y	Y	25	30	N	N
67	Governmental services	Y	Y*	Y*	25*	30*	N	N
68	Educational services	Y	Y*	25*	30*	N	N	N
69	Miscellaneous services	Y	Y	Y	25	30	N	N
70	**Cultural, entertainment and recreational**							
71	Cultural activities (including churches)	Y	Y*	25*	30*	N	N	N
71.2	Nature exhibits	Y	Y*	Y*	N	N	N	N
72	Public assembly	Y	Y	Y	N	N	N	N
72.1	Auditoriums, concert halls	Y	Y	25	30	N	N	N
72.11	Outdoor music shells, amphitheaters	Y	Y*	N	N	N	N	N
72.2	Outdoor sports arenas, spectator sports	Y	Y	Y^{7}	Y^{7}	N	N	N
73	Amusements	Y	Y	Y	Y	N	N	N
74	Recreational activities (incl. golf courses, riding stables, water recreation)	Y	Y*	Y*	25*	30*	N	N
75	Resorts and group camps	Y	Y*	Y*	Y*	N	N	N
76	Parks	Y	Y*	Y*	Y*	N	N	N
79	Other cultural, entertainment and recreation	Y	Y*	Y*	Y*	N	N	N
80	**Resource production and extraction**							
81	Agriculture (except livestock)	Y	Y	Y^{8}	Y^{9}	Y^{10}	$Y^{10,11}$	$Y^{10,11}$
81.5 to 81.7	Livestock farming and animal breeding	Y	Y	Y^{8}	Y^{9}	N	N	N
82	Agricultural related activities	Y	Y	Y^{8}	Y^{9}	Y^{10}	$Y^{10,11}$	$Y^{10,11}$
83	Forestry activities and related services	Y	Y	Y^{8}	Y^{9}	Y^{10}	$Y^{10,11}$	$Y^{10,11}$
84	Fishing activities and related services	Y	Y	Y	Y	Y	Y	Y
85	Mining activities and related services	Y	Y	Y	Y	Y	Y	Y
89	Other resource production and extraction	Y	Y	Y	Y	Y	Y	Y

***The designation of these uses as "compatible" in this zone reflects individual Federal agencies' consideration of cost and feasibility factors as well as program objectives. Localities, when evaluating the application of these guidelines to specific situations, may have different concerns or goals to consider. For an indication of possible community reaction in residential environments at various levels of cumulative noise, Table D-1 in Appendix D should be consulted.**

NOTES FOR TABLE 2

2. Measures to achieve NLR of 25 must be incorporated into the design and construction of portions of these buildings where the public is received, office ares. noise sensitive areas or where the normal noise level is low.

3. Measures to achieve NLR of 30 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

4. Measures to achieve NLR of 35 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

6. No buildings.

7. Land use compatible provided special sound reinforcement systems are installed.

8. Residential buildings require a NLR of 25.

9. Residential buildings require a NLR of 30.

10. Residential buildings not permitted.

1 Land use not recommended, but if community decides use is necessary, hearing protection devices should be worn by personnel.

KEY TO TABLE 2

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Y^X (Yes with restrictions)	Land Use and related structures generally compatible; see notes 2 through 4.
25, 30, or 35	Land Use and related structures generally compatible; measures to achieve NLR of 25, 30 or 35 must be incorporated into design and construction of structure.
25*, 30* or 35*	Land Use generally compatible with NLR; however, measures to achieve an overall noise reduction do not necessarily solve noise difficulties and additional evaluation is warranted.

Section 2. TECHNIQUES FOR DEALING WITH NOISE IN LAND USE PLANNING

There are many techniques that local governments can use to reduce the effect of noise on surrounding land uses. These techniques range from simply increasing public awareness of existing noise levels to the very drastic, but admittedly very effective step of public purchase of severely exposed land uses. The following table outlines some of these techniques. The table is not intended to be exhaustive. Rather it is presented simply to illustrate the range of techniques available to reduce the effect of noise on land uses.

The techniques are arrayed in order of increasing stringency and general effectiveness. The effectiveness of any given technique is, however, very much a function of the specific noise situation and the way in which the technique is applied. It should also be understood that often the most effective approach will be a *combination* of techniques such as enacting both zoning and building code requirements.

The table includes, for each technique, a brief general summary of current experience with the techniques. The column entitled "situation where most applicable" includes indications of inherent limitations to given techniques. The "comments" column is intended to provide general insights on how the techniques work.

TABLE 3. TECHNIQUES FOR DEALING WITH NOISE IN LAND USE PLANNING

TECHNIQUE	SITUATION WHERE MOST APPLICABLE	COMMENTS
	Anywhere	Can be an important factor in determining the marketability of homes and other land uses. Can have a direct effect on developers and builders. Use in combination with other actions.
b. Prior Notice of Noise Levels to Renters and Purchasers	Anywhere	Can be required by local ordinance. Enables renters and purchasers to choose environment with full information. May reduce or eliminate subsequent complaints or damage claims.
II. Coordination		
a. OMB Circular A-95 Process	Anywhere Federal and Federally assisted projects are proposed	Allows identification of noise problems in the review and comment of Federal and Federally assisted plans, programs and projects. Indirect control.
b. Environmental Assessment Process	Anywhere Environmental Impact Analyses are required.	Indirect Control. Increase awareness of noise. May discourage inappropriate projects. Mechanism to propose mitigation measures.
III. Providing Advisory Services		
a. Architectural or Planning Review	Where there is appropriate staff or funding.	Site-specific analysis for each case.
b. Design Assistance	Where there is appropriate staff or funding.	Allows inclusion of noise mitigation measures such as building attenuation, siting modification, berms, and barriers, etc.
c. Information Libraries	Anywhere	Passive advisory service.

Continued on following page

TABLE 3. TECHNIQUES FOR DEALING WITH NOISE IN LAND USE PLANNING (continued)

TECHNIQUE	SITUATION WHERE MOST APPLICABLE	COMMENTS
	Where comprehensive planning process is established particularly where controls (zoning) must implement plan.	Works best when noise is considered a basic suitability factor along with others such as slope, soils conditions, etc. Should be addressed in all types of plans. May require enabling legislation.
V. Incorporating Noise Issues Into Environmental Management Programs	Where programs such as Areawide Waste Management, Air Quality, Coastal Zone Management, Prime and Unique Agricultural Lands and Floodplains and Wetlands are established.	These programs influence land use policy.
VI. Development Codes and Policies		
a. Subdivision Regulations and/or site plan approvals. Require Noise Reduction Considerations in site design (site orientation, buffers, barriers, etc.)	Where portions of development projects fall within noise exposure areas.	May not be applicable for airborne aircraft. May require enabling legislation.
b. Building codes. Require sound insulation, isolation, absorption in building construction	Where interior noise exposure can be reduced to acceptable levels and buildings should otherwise be prohibited.	Noise Level Reduction (NLR) up to 35 dB (15 dB above normal construction). Outdoor environment not protected. May require enabling legislation to use noise zones for building code restrictions. Difficult to apply retroactively. Local opposition to increased building costs possible Related to energy conservation. Requirements might also be incorporated into health and/or occupancy codes.

Continued on following page

TABLE 3. TECHNIQUES FOR DEALING WITH NOISE IN LAND USE PLANNING (continued)

TECHNIQUE	SITUATION WHERE MOST APPLICABLE	COMMENTS
VI. Development Codes and Policies — *continued*		
c. Special Permits and/or Special Planning Districts	Anywhere a permit granting system exists or can be started.	Site-specific analysis would be required for each case. May require enabling legislation.
d. Special Use Designations	Anywhere unique or special land characteristics exist (cultural or historic, scenic, wetlands, floodplains, prime agricultural lands, water supply sources).	Such areas may be noise exposed and those designations will normally assure noise compatibility. May require legislation.
e. Official Map	Anywhere streets exist or are planned.	Planned major streets should avoid noise sensitive areas and should encourage development in areas not exposed to noise.
f. Capital Improvements	Anywhere	Governmental constructed utilities, streets, and facilities should be sited to encourage compatible use and be in themselves compatible.
VII. Land Use Controls		
a. Zoning —		
1. For compatible land uses	Anywhere	Should be based on a comprehensive plan. May require enabling legislation to use noise as a criterion. Not retroactive and can be removed upon short notice. Most effective for undeveloped areas.
2. To require buffer areas	Where noise source is at ground level.	Easy to implement in low density areas. Not effective for airborne aircraft. May require enabling legislation.
3. To require berms or barriers	Where noise source is at ground level.	Effective but care is needed to insure that it is aesthetically desirable. May require enabling legislation.

Continued on following page

TABLE 3. TECHNIQUES FOR DEALING WITH NOISE IN LAND USE PLANNING (continued)

TECHNIQUE	SITUATION WHERE MOST APPLICABLE	COMMENTS
VII. Land Use Controls — *continued*		
4. To allow cluster or planned unit development	For medium and large developments	Significant potential benefits. Builders can incorporate buffer areas without reducing number of units. May require enabling legislation.
VIII. Purchase Real Property Interests		
a. Fee Purchase		
1. For compatibility	Where noise levels are extreme	Attempts to contain worst noise effects within the right-of-way or site. May require enabling legislation.
2. For public use	Where public use is compatible and needed in that location.	Limited by need for compatible public uses.
b. Fee purchase and resale with development restrictions	Where other measures are impractical	Public authority may be reluctant. Local government may object to controls. Business may object to government becoming developer. Dependent on demand feasibility for compatible use. May require enabling legislation.
c. Easement (development rights) purchase	Where other measures are impractical	May be more practical than Fee Simple purchase. May require enabling legislation.
d. Agricultural Land Preservation District	Where land is suitable.	Requires appropriate legislation. Minimum site size of 50 acres is typical and usually allows a single farm residence. Presents possible bird strike hazards.
IX. Property Tax Incentives (open space, agricultural, etc.)	Where tax pressures exist on owners of undeveloped land.	Requires enabling legislation. Easy in many cases to implement. Cannot prevent incompatible development but can allow economically productive compatible land use.

Section 3. FEDERAL AGENCY PROGRAMS AND POLICIES

The purpose of this section is to briefly overview the noise policies and programs relating to land use of the following agencies:

- Department of Defense (DOD)
- Department of Housing and Urban Development (HUD)
- Environmental Protection Agency (EPA)
- Department of Transportation/Federal Aviation Administration (DOT/FAA)
- Department of Transportation/Federal Highway Administration (DOT/FHWA)
- Veterans Administration (VA)

The Federal noise policies and programs discussed in this section all share the common goal of protecting the public health and welfare with regard to noise. Most policies also state additional goals in recognition that noise is a specific constraint on particular agency missions. DOD, for example, states as a primary goal of its noise policy, the continuance of operational integrity at its airfields.

All of the policies address in varying degrees (and some not exclusively), transportation noise problems, particularly those of highways and airport systems. The policies concentrate on these noise sources not only because their noise problems are among the most pervasive, but because Federal agencies have assisted by providing billions of dollars for their construction and maintenance. Most, however, are actually owned and operated by local and State governments.

The major differences among the policies center upon the noise levels specified and the types of noise measures used or required. There are *four different types of noise levels* used in these policies:

- mitigation levels (e.g., FHWA design levels);
- levels required to protect the public health and welfare (e.g., EPA "levels" document);
- general planning (land use) levels (e.g., DOD);
- levels required for Federal assistance (e.g., HUD, VA) (these are similar to the general planning levels).

As Table 4 shows, a specific purpose is associated with each type of level. *Misuse of a particular type in any situation can produce erroneous results.*

Primarily because of differences in statutory authority, the noise policies differ in the kinds of noise actions and techniques emphasized. The FAA and EPA regulations, for example, stress source and operational controls for aircraft and highway vehicles while the FHWA policy, in the main, stresses noise mitigation (e.g., placement of noise barriers) at noise sensitive locations along highways. HUD and VA, on the other hand, require, in certain cases, that the receiver (e.g., residential development) be provided noise attenuation as a condition for mortgage insurance or assistance.

A brief overview of individual agency noise policies follows.

TABLE 4. FEDERAL AGENCY POLICY AND PROGRAM SUMMARY

AGENCY		1. DEPARTMENT OF DEFENSE (DOD)	2. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)	3. ENVIRONMENTAL PROTECTION AGENCY (EPA)	4. DOT/FEDERAL AVIATION ADMINISTRATION (FAA)	5. DOT/FEDERAL HIGHWAY ADMINISTRATION (FHWA)	6. VETERAN'S ADMINISTRATION (VA)
Type of Program or Policy		Air Installations Compatible Use Zones (AICUZ) Program	HUD Noise Regulations	Health & Welfare Guidance	Aviation Noise Abatement Policy	Highway Noise Policy	VA Noise Policy
Key Documents		DOD Instruction 4165.57 (1977) Installation AICUZ Studies	24 CRF Part 51 Subpart B; Noise Assessment Guidelines (1980)	EPA "Levels" Document (1974)	DOT/FAA Aviation Noise Abatement Policy (1976) Advisory Circular: 150/5050-6 (1977)	FHPM 7-7-3 (1976)	Section VIII Appraisal of residential properties near Airports (1969)
Noise Levels	Title of Levels	Levels used as "reasonable" guidance to communities in planning	Levels which determine whether proposed sites are eligible for HUD insurance or assistance	Levels which are required to protect the public health and welfare with an adequate margin of safety	Levels used as "starting points" in determining noise/land use relationships	Design Noise Levels	Levels determining whether proposed sites are eligible for VA assistance
	Purpose of Levels	Guidance to communities for planning. Reflects cost, feasibility, past community experience, general program objectives and consideration of health and welfare goals.	See above. Levels can be used as general planning levels. Reflects cost, feasibility, general program objectives and consideration of health and welfare goals.	These levels identify in scientific terms the threshold of effect. While the levels have relevance for planning, they do not in themselves form the sole basis for appropriate land use actions because they do *not* consider cost, feasibility or the development needs of the community. The user should make such tradeoffs.	Guidance to communities for planning. Reflects safety, cost, feasibility, general program objectives and consideration of health and welfare goals.	These levels are used in determining where noise mitigation on a particular highway project is warranted. They do reflect cost and feasibility considerations. They are not appropriate land use criteria. Location Specific.	See above. Reflects cost, feasibility general program objectives and consideration of health and welfare goals.
	Source to which applied	Military Airfields	All sources	All sources	Civil Airports	Highways only	Airports only
	Noise Descriptors Used	DNL	DNL	DNL	DNL, & SEL (California only)	L_{eq} or L_{10} for design hour	Various (including DNL)

Department of Defense (DOD)

Department of Defense policy for noise compatible land use guidance is called the Air Installation Compatible Use Zone (AICUZ). Each military service has an AICUZ program to investigate, describe, and study noise exposure and land use at all DOD air installations. AICUZ studies for each installation are prepared and given to the public and local, regional, state, and other federal agencies for use in their land use planning/control and intergovernmental programs and processes. Each study contains noise contours, accident potential zones, existing and future land use compatibilities and incompatibilities, land use planning/control recommendations.

Department of Defense Policy:

- Requires that all reasonable, economical, and practical measures will be taken to reduce and/or control the generation of noise from flying.
- Is to work toward achieving compatibility between air installations and neighboring civilian communities by means of a compatible land use planning and control process conducted by the local community.
- Requires working with local governments, local planning commissions, special purpose districts, regional planning agencies, state agencies, and state legislatures as well as other federal agencies.
- Includes technical assistance to local, regional, and state agencies to assist them in developing their land use planning and regulatory processes, to explain an AICUZ study and its implications, and generally to work toward compatible planning and development in the vicinity of military airfields.

Department of Housing and Urban Development (HUD)

The major purpose of the Department of Housing and Urban Development's (HUD) noise regulations (24 CFR Part 51 Subpart B) is to insure that activities assisted or insured by the Department achieve the goal of a suitable living environment. HUD also supports other agencies efforts in noise control.

The regulations generally apply to all HUD actions and provide minimum national standards to protect citizens against excessive noise in their communities and places of residence. The basic policy is that HUD assistance for construction of new noise sensitive uses is prohibited generally for projects with Unacceptable noise exposures and is discouraged for projects with Normally Unacceptable noise exposure. Unacceptable noise exposure is defined as a noise level above 75 dB (Day-night average sound level (DNL) in decibels). A Normally Unacceptable level is one above 65 dB but not exceeding 75 dB. These noise levels are to be based on noise from all sources, highway, railroad and aircraft.

Attenuation measures are normally required before projects in the Normally Unacceptable zone can be approved. Attenuation measures that reduce the external noise at a site are preferred, whenever practicable, over measures which only provide attenuation for interior spaces. HUD's noise regulations also apply to modernization and rehabilitation. For major or substantial rehabilitation projects in the Normally Unacceptable and Unacceptable noise zones HUD actively will seek to have noise attenuation features incorporated into the project. In the Unacceptable noise zones, HUD will strongly encourage conversion of noise exposed sites to more compatible land uses.

HUD also requires that Comprehensive Planning Assistance grantees give adequate consideration to noise as an integral part of the urban environment with particular emphasis being placed on the importance of compatible land use planning in relation to airports, highways and other sources of high noise. Recipients of community development block grants under Title I of the Housing and Community Development Act of 1974 must also take into consideration the noise criteria and standards in the environmental assessment process.

Environmental Protection Agency (EPA)

The EPA's Noise program is designed to provide leadership to the national noise abatement effort. The key statutory mandates under which EPA operates are the Noise Control Act of 1972 (PL92-574) and the Quiet Communities Act of 1978 (95-609).

Until recently, EPA's Program has concentrated its efforts in setting noise source emission standards for various products, including transportation vehicles, construction equipment and consumer products. EPA also proposes aircraft/airport regulations to the FAA following a special procedure specified in the Noise Control Act of 1972.

Key to these efforts have been EPA reports defining scientifically the relationships between noise level and human response. The EPA "Levels" Document established threshold levels of impact which, if met, would protect the public "with an adequate margin of safety". As noted in Table 4, while these levels have relevance for planning, they, in themselves, are *not* necessarily appropriate land use planning criteria because they do not consider cost, feasibility, or the development needs of the community.

The emphasis of EPA's program today is on assisting cities, States and others to develop and carry out effective noise programs through various approaches, including noise and land use. In addition to a new grants program under the Quiet Communities Act, EPA has initiated such technical assistance programs as The Quiet Communities Program (QCP) and Each Community Helps Others (ECHO). The QCP is a program focusing EPA guidance and fiscal resources on target communities to achieve total community involvement and action. The ECHO program provides technical assistance to local communities on specific noise problems consulting services from officials of communities who have successfully overcome similar problems. Various other programs emphasizing provision of information on noise to various publics are also being developed and carried out.

Department of Transportation/Federal Aviation Administration (DOT/FAA)

The Federal Aviation Administration's noise program is guided by the 1976 Aviation Noise Abatement Policy and the Aviation Safety and Noise Abatement Act of 1979. The policy defines the responsibilities of the FAA, airport proprietors and users, and land use planning and control authorities in achieving and maintaining airport noise compatibility. The FAA uses two major approaches to implement this policy. The first is aimed at reducing the noise of the individual aircraft. This includes a program to retrofit engines or equipment on noisy aircraft or to replace them with newer, quieter aircraft. It also includes the development of operational procedures which can reduce the aircraft's noise impacts.

The other major approach to noise compatibility is through planning and development activities at airports under the Airport and Airway Development Act of 1970 (as amended). Airport Noise Control and Land Use Compatibility (ANCLUC) planning studies integrate the master planning study activities, the environmental considerations, and the airport-land use compatibility planning activities at an airport. The objective is to achieve maximum noise and environmental compatibility within the constraints of safety, service, and economic viability. The plan may contain operational controls as well as physical improvements for the airport. It will also recommend, based upon a comprehensive study effort, land uses and strategies for land use control for areas around the airport impacted by noise. FAA's advisory circular, Airport-Land Use Compatibility Planning (AC 150/5050-6), serves as the basic guidance for the land use compatibility portion of an ANCLUC study.

The Aviation Safety and Noise Abatement Act of 1979 strengthens the FAA's noise policy by providing assistance to airport operators to prepare and carry out noise compatibility programs and providing incentives for replacing noisy aircraft with new technology aircraft. In compliance with this Act, the FAA will develop and promulgate an amendment to Part 150 of the Federal Aviation Regulations which will standardize airport noise abatement plans and provide for their review, specify standard noise metrics for use in airport noise assessments, and identify compatible land uses.

Department of Transportation/Federal Highway Administration (DOT/FHWA)

As a result of the Federal Aid Highway Act of 1970[1], the Federal Highway Administration (FHWA) is concerned with traffic and construction noise associated with Federal aid highways. Since 1972, FHWA has had a noise policy applicable to new highway construction. The focus of the policy is to elevate the consideration of noise exposure in Federal-Aid highway location and design decisions by requiring substantive study of future noise exposure in conjunction with standards featuring highway design noise levels. (These levels have a very specific purpose which is explained in Table 4. Since 1976, FHWA's policy has also provided for noise mitigation on existing Federal aid highways. The principal noise mitigation measure has been placement of barriers at noise sensitive locations.

FHWA also recognizes and supports other approaches to highway noise control. Although in the source control area FHWA's authority is limited to implementing interstate motor carrier noise standards issued by EPA, it supports legislation to reduce the noise levels of motor vehicles. In the land use area its authority (like that of the other Federal agencies discussed here) is limited to providing information and guidance.[2]

The FHWA noise policy applies to the Federal Highway program which (unique among the policies discussed here) is a state administrated program receiving Federal assistance. The noise policy is actually carried out as part of the overall environmental assessment process required by the National Environmental Policy Act. For each new highway, FHWA

[1]Act amended in 1973 and 1976.

[2]FHWA's key document in this area is *The Audible Landscape* (1974).

requires that state highway agencies furnish localities information on noise and land use. Furthermore, FHWA will normally not approve funds for barrier construction for areas which have become sensitive after May 24, 1976, unless localities have instituted land use controls over the remaining undeveloped lands adjacent to the highways.

Veterans Administration (VA)

The Veterans Administration (VA) policy for consideration of noise and land use planning is contained in separate statements. One statement is for the VA's Loan Guaranty Program and the other is for both the Department of Medicine and Surgery (DM&S) and the Department of Memorial Affairs (DMA).

The VA Loan Guaranty noise policy governs VA decisions as to whether residential sites in airport environs are "acceptable" for loan guaranty programs to eligible veterans and active duty personnel.

The VA Loan Guaranty noise policy features a set of three noise zones. In the case of new construction, all new developments located in the two higher zones generally are not eligible for VA assistance. There is flexibility in that if a local officer recommends acceptance, the VA Central Office will consider the case in light of geographic factors and proposed attenuation features,[1] as well as marketability. In the middle zone, it, therefore, may be possible to develop properties which will be acceptable for VA loans.

In all cases (existing as well as proposed properties) for sites located in the two higher zones, VA requires that a statement from each veteran purchaser be obtained indicating awareness that (a) the property being purchased is located in an area adjacent to an airport, and (b) the aircraft noise factor may affect normal liveability, value and saleability of the property.

The VA's Loan Guaranty Service conducts its business with veteran purchasers, lenders, builders and other sellers who are interested in VA's guaranty of the loan to an individual veteran purchaser. The Loan Guaranty Service rarely has any direct interaction with local authorities.

The policy for land acquisition and maintenance adhered to by DM&S and DMA considers noise in the environmental planning of all acquisition and construction programs. All new VA Medical Centers, domiciliaries, and other medical facilities are compatible or have been designed with noise attenuation features allowing them to be compatible with zones as defined in Table 2. All new VA National Cemetery Construction has generally been limited to Noise Zones A & B as described on Table 2 because of the nature of outdoor services. Guidelines for planning state facilities which are eligible for grant funds from DM&S or DMA programs are slightly relaxed leaving latitude to local conditions in planning requirements.

[1]Such as soundproofing, year round air conditioning and other treatment.

Appendix A

EXPLANATION OF ENVIRONMENTAL NOISE DESCRIPTORS

This appendix discusses various descriptors that Federal agencies have used to assess environmental noise. These descriptors can be categorized as to whether they are applicable to 1) all sources or 2) airport only.

1) *Applicable to all sources*

A. *Day Night Average Sound Level (DNL; scientific notation L_{dn})*

Day-Night average sound level[1], abbreviated as DNL and symbolized as L_{dn}, is the 24 hour average sound level, in decibels, for the period from midnight to midnight, obtained after addition of 10 decibels to sound levels in the night from midnight to 7 a.m. and from 10 p.m. to midnight. DNL is a measureable quantity and can be measured directly at a specific location, using portable monitoring equipment[2]. (When it is measured it is not necessary that the measurement begin at midnight.)

B. *Equivalent sound level (L_{eq})*

L_{eq} is the average sound level[1], in decibels, for any time period under consideration. If averaged over a 24 hour period, the only difference between it and DNL would be the 10 decibel night time weighting used in DNL.

In connection with its highway noise standards featuring design noise levels, FHWA uses an L_{eq} for the highway "design hour" as an alternative to the L_{10} descriptor. (The design hour is normally the 30th highest traffic volume occurring during the year.) Noise levels are predicted for the design year, which is normally 20 years from construction of the highway, and the noisiest hour of the day (usually the design hour). As indicated in Table II-1, under typical conditions the L_{eq} (design hour) approximately equals DNL.

[1]Average sound level — the level, in decibels, of the mean-square A-weighted sound pressure during a stated time period, with reference to the square of the standard reference sound pressure of 20 micropascals.

[2]It is important to note that L_{dn} contours derived from the use of noise prediction models do *not* necessarily reflect precise noise levels at specific locations. Typically, computer based airport noise prediction models forecast yearly average values for L_{dn}.

C. *L_{10}*

While this descriptor applies to any noise source, FHWA is the only Federal agency using it (as an alternative to L_{eq}). L_{10} is defined as the sound level that is exceeded 10 percent of the time for the period under consideration, which, in the case of FHWA, is the design hour. DNL under typical conditions approximately equals L_{10} - 3 decibels.

D. *Community Noise Equivalent Level (CNEL)*

The CNEL, developed for the State of California, is almost identical to the DNL, except that it introduces an intermediate weighting for the early evening hours between 7:00 p.m. and 10:00 p.m. in addition to the weighting for the nighttime hours (10:00 p.m. to 7:00 a.m.). CNEL, like DNL, is a measurable quantity and can be measured directly. DNL is approximately equal to CNEL in almost all situations.

2) *Measures applying to airport sources only*

A. *Noise Exposure Forecast (NEF)*

The NEF was developed in 1967 as a refinement of the composite noise rating (CNR). It takes into account the factors considered by the CNR plus the additional exposure factors of the duration of aircraft flyovers and of discrete (pure) tones such as turbine "whine". The NEF cannot be directly measured and requires a computer for noise contour development. DNL approximately equals NEF + 35.

REFERENCES FOR APPENDIX A

1. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety; Environmental Protection Agency;* Report No. 550/9-74-004; March 1974 (document for sale by U.S. Government Printing Office, Stock No. 055-000-00120-1, $2.10).
   This document gives the technical basis for the L_{dn} and L_{eq} noise descriptors.
2. *Federal-Aid Highway Program Manual 7-7-3,* Federal Highway Administration, May 14, 1976, Washington, D.C.
   This document describes FHWA's design noise levels which are expressed in L_{eq} and L_{10}.
3. *The Adopted Noise Regulations for California Airports,* Title 4, Register 70, No. 48-11-28-70, Subchapter 6, Noise Standards (distributed by Documents Section, State of California, P.O. Box 20191, Sacramento, California 95820).
   Describes CNEL.
4. *Noise Exposure Forecast: Evolution, Evaluation, Extensions, and Land Use Interpretations;* W.J. Galloway and D.E. Bishop; Bolt, Beranek, and Newman, Inc.; Report No. FAA-No.-70-9; August 1970 (available through the National Technical Information Service, Springfield, Virginia 22151, No. AD 717-131, $5.25).

5. *Procedures for Developing Noise Exposure Forecast Areas for Aircraft Flight Operations;* D.E. Bishop and R.D. Horonjeff; Bolt, Beranek and Newman, Inc.; Report No. DS-67-10; August 1967 (available through the National Technical Information Service, Springfield, Virginia 22151, No. AD 660-706, $5.25).

These documents are basic references for the Noise Exposure Forecast.

6. *Land Use Planning Relating to Aircraft Noise;* W.J. Galloway and A.C. Pietrasanta; Bolt, Beranek, and Newman, Inc.; Technical Report No. 821; October 1964 (available through the National Technical Information Service, Springfield, Virginia 22151, No. AD-615-015, $5.25).

This document describes the CNR methodology (which is no longer in general use).

Appendix B

ANNOTATED BIBLIOGRAPHY OF FEDERAL DOCUMENTS RELATED TO NOISE AND LAND USE ACTIVITIES

The purpose of this bibliography is to provide aid to all persons involved in noise and land use planning and decision making, including planners, elected officials, facility and land managers, the private development community and the general public.

This bibliography discusses only Federal agency publications which are relevant to noise and land use activities. A much more extensive list would result were Federal publications included which cover other noise subject areas of interest to State and local agencies (e.g., highway noise mitigation, construction noise, aircraft source regulation, etc.).

The bibliography is organized into two parts. The first part covers Federal noise regulations, guidance tools and manuals and special studies. The second part discusses relevant Congressional statutes.

Noise/Land Use Bibliography — Part I

DEPARTMENT OF DEFENSE (DOD)

1. "Air Installations Compatible Use Zones," Department of Defense Instruction 4165.57, 8 November 1977.

   This regulation sets forth the broad requirements for the Air Installations Compatible Use Zones (AICUZ) program while leaving implementation to individual military services.

2. "Intergovernmental Coordination of Defense Land and Facility Plans and Projects, Department of Defense Directive 4165.61, 16 December 1976.

   This directive gives DOD's intergovernmental coordination policy.

3. "Planning in the Noise Environment," Air Force Manual 19-10, TM-5-803-2 (Army), and NAVFAC P-970 (Navy), 15 June 1978.

   This is a noise description, reduction and planning handbook; includes noise and land use guidelines.

4. *"USAF Air Installation Compatible Use Zone (AICUZ) Policy,"* June 1979.

   This document contains the U.S. Air Force AICUZ policy.

5. USAF Air Installation Compatible Use Zone (AICUZ) Handbook (Environmental Planning Bulletin 10) 2 Volumes, June 1979.

   This contains the procedures and guidelines for preparing AICUZ studies.

6. "Interagency/Intergovernmental Coordination of Land, Facility and Environmental Plans, and Programs." Air Force Regulation 19-9, 1980.

   This is the USAF's AICUZ and interagency/intergovernmental coordination policy.

7. "Air Force Handbook for Installation Coordination with Civilian Agencies: (Interim Environmental Planning Bulletin 14), two volumes, January 1978.

   This contains USAF's procedures for intergovernmental coordination at the local, regional and State levels.

8. "Air Force Handbook for Federal Agency Coordination" (Interim Environmental Planning Bulletin 15), January 1978.

   This contains procedures for Federal agency coordination; includes Federal agency directory.

9. "Intergovernmental Coordination of Department of the Navy Land Facility Plans, Projects, and Program," OPNAVINST 11010.35, 1979, U.S. Navy.

   This contains Navy intergovernmental coordination policy and procedures.

10. "Air Installation Compatible Use Zone Program (AICUZ)," OPNAVINST 11010.36, 1979, U.S. Navy.

    This contains Navy policy, procedures and guidelines for carrying out the AICUZ program at Navy and Marine Corps installations.

11 "Air Force Directory of State Environmental Planning Agencies," October 1977.

   Lists approximately 1300 State agencies.

12. "Air Installation Compatible Use Zone Studies," U.S. Air Force and U.S. Navy.

    These studies are published for each air installation.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

1. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety,* Environmental Protection Agency, Washington, D.C. (EPA 550/9-74-004), March 1974.

   This document is a scientific statement of threshold protective levels of noise without consideration of cost or feasibility or the needs of the community in any specific condition.

2. *Public Health and Welfare Criteria for Noise,* Report No. 550/9-73-002, Environmental Protection Agency, Washington, D.C., July 1973.

   This document contains published descriptive data on the effects of noise which might be expected from various levels and exposure situations.

3. *Model Community Noise Control Ordinance.* Environmental Protection Agency, September 1975.

   This model is intended as a basic tool for use by communities of various sizes in the development of noise control ordinances, (which can include land use provisions) tailored to their specific local conditions and goals.

4. *State and Municipal Noise Control Activities, 1973-74.* Environmental Protection Agency, Washington, D.C., January 1976.

   This report presents an assessment of the status of State and local noise control efforts and is intended as a reference guide for public administrators.

5. *Federal Noise Program Report Series: Volume I, Department of Defense: Air Installations Compatible Use Zones (AICUZ) Program,* Environmental Protection Agency, Washington, D.C., April 1977. (EPA 550/9-77-353).

   This report describes the features and problems of DOD's AICUZ program.

6. *Federal Noise Program Report Series: Volume II, Department of Housing and Urban Development: Noise Abatement and Control Policy,* Environmental Protection Agency, Washington, D.C., April 1977.

   This report discusses the features and problems associated with HUD's Noise Policy.

7. *Federal Noise Program Report Series: Volume III, Department of Transportation, Federal Highway Administration: Noise Policy and Related Environmental Procedures,* Environmental Protection Agency, Washington, D.C., July 1977. (EPA 550/9-77-357).

   This report describes the features and problems associated with FHWA's noise policy and related environmental procedures.

8. *Calculation of Day-Night Levels L_{dn} Resulting from Civil Aircraft Operations.* Environmental Protection Agency, Washington, D.C., January 1977.

   This report gives manual techniques for predicting aircraft noise levels in the environs of specific airports.

GENERAL SERVICES ADMINISTRATION (GSA)

1. *Compatible Land Uses at Federal Airfields.* Federal Management Circular 75-2: General Services Administration, 1975.

   This circular prescribes the Executive Branch's general policy with respect to achieving compatible land uses on either public or privately owned property at or in the vicinity of Federal airfields.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

1. *"Environmental Criteria and Standards, Noise Abatement and Control, 24 CFR, Part 51, Subpart B,"* U.S. Department of Housing and Urban Development, July 12, 1979.

   This is the basic noise policy with quantitative noise standards and implementation procedures.

2. *Noise Assessment Guidelines.* W.J. Galloway and T.J. Schultz, Bolt, Beranek and Newman, Inc., prepared for the U.S. Department of Housing and Urban Development, 1980.

   These are guidelines for use in implementing the HUD noise regulation. They provide a tool for persons without acoustical training to perform preliminary estimates of the noise exposure at a site in relation to the HUD standards.

3. *HUD Noise Assessment Guidelines Technical Background.* W.J. Galloway and T.J. Schultz, Bolt, Beranek and Newman, Inc., prepared for the U.S. Department of Housing and Urban Development, 1980.

   This report discusses the need for noise abatement, the various techniques for measuring and describing noise and human responses to it. It gives technical background information for the development of site noise assessment techniques.

4. *Aircraft Noise Impact, Planning Guidelines for Local Agencies.* R. Dale Beland, Wilsey and Ham, Inc., prepared for the U.S. Department of Housing and Urban Development, 1972.

   This manual, based upon information developed in joint HUD-DOT studies and other case studies of aircraft noise abatement, provides a tool for local planners, local governments and others in developing a comprehensive aircraft abatement program through land use planning. GPO order number 2308-00214, NTIS order number PB213-020. Some of the technical data is a bit dated, but in general, still very useful.

5. Metropolitan Aircraft Noise Abatement Policy Studies, U.S. Department of Housing and Urban Development, 1971.
   a. MANAPS — O'Hare International Airport, Chicago, Ill., 1971.
   b. MANAPS — Cape Kennedy Regional Airport, East Central Florida Planning Council, 1971.
   c. MANAPS — J.F. Kennedy International Airport, N.Y., Tri-state Transportation Commission, 1971.
   d. MANAPS — Bradley International Airport, Windsor Locks, Conn., Capitol Regional Planning Agency, 1971.

6. *Noise in Urban and Suburban Areas: Results of Field Studies.* Bolt, Beranek and Newman, prepared for the U.S. Department of Housing and Urban Development, 1967. National Technical Information Service order number PB210-849.

   This study identifies significant noise sources, other than aircraft, known to create disturbances within the home. It analyzes the results of a social survey made to determine community responses to traffic noise.

DEPARTMENT OF TRANSPORTATION/Federal Aviation Administration (DOT/FAA)

"Aviation Noise Abatement Policy," DOT/FAA, November 1976.

This discusses actions the Administrator of FAA and Secretary of DOT believe should be taken to reduce aviation noise impact on the people who live in areas surrounding airports. It defines the roles and responsibilities of airport operators, aircraft operators, affected communities and the FAA for noise compatibility.

2. *Airport-Land Use Compatibility Planning,* FAA Advisory Circular 150/5050-6, 1977.

   This is FAA's guidance for compatible land use planning in the vicinity of both new and existing airports. It provides ideas and techniques for planning as well as guidance which may be used in developing noise control plans as encouraged by the DOT/FAA Noise Abatement Policy of 1976.

3. *Airport Noise Control and Land Use Compatibility (ANCLUC) Planning under the Planning Grant Program,* FAA Order 5900.4, 1977.

   This document provides programming and planning guidance for ANCLUC planning.

4. *Noise Control Plans,* FAA Order 1050.11, 1977.

   This document provides FAA policy and procedures for airport noise control plans.

5. *Citizen Participation in Airport Planning,* FAA Advisory Circular 150/5050-4, 1975.

   This circular provides guidances for citizen involvement in airport planning.

6. *Policies and Procedures for Considering Environmental Impacts,* FAA Order 1050.1C, 1979.

   This order covers FAA procedures for environmental assessments for all FAA project actions.

7. *Airport Environmental Handbook,* FAA Order 5050.4, 1980.

   This order covers procedures for airport actions.

8. *Impact of Noise on People,* Federal Aviation Administration, Washington, D.C., 1977.

   This document summarizes known information concerning public health and welfare effects and reactions.

9. *Five Year Environmental Plan 1978-1982,* Federal Aviation Administration.

10. *Airport Development Aid Program Handbook,* FAA Order 5100.36, 1979.

11. *Certified Airplane Noise Levels,* FAA Advisory Circular 36-1B, December 1977.

    This circular provides noise level data for airplanes certified under FAR Part 36 since its publication on November 18, 1969.

12. *Estimated Airplane Noise Levels in A-Weighted Decibels,* AC 36-3A, June 11, 1980.

    This circular provides listings of both certificated and uncertificated aircraft noise levels in A-weighted decibels, both ranked in descending order and listed by aircraft manufacturer. These values are intended to provide a consistent basis for comparison of noise levels of major aircraft models rather than of individual aircraft. Ranking of aircraft noise levels that occur under uniform Federal Aviation Regulation Part 36 certification conditions provides the best information currently available on the relative noisiness of civil aircraft over a wide variety of conditions.

13. *Integrated Noise Model, Version 1, January 1978.* Federal Aviation Administration.

    This report discusses the model and its uses.

14. *FAA INM Basic User's Guide, Version 2, 1979.* Federal Aviation Administration.

    This report contains the procedures for use of the Integrated Noise Model. (INM)

15. *INM Installation Manual, 1978.* Federal Aviation Administration.

    This report contains instructions for installing the INM program.

16. *Report to Congress, Study, Feasibility, Practicability and Cost of Soundproofing of Hospitals, and Public Health Facilities Near Airports.* Federal Aviation Administration, July 1977.

    This study, required by Section 26(3), Appendix B of the Airport and Airway Development Act Amendments of 1976 (P.C. 94-353), concludes that soundproofing of schools, hospitals, and public health facilities located near airports is a feasible and practicable means for alleviating aircraft noise impact.

17. *Planning for the Airport and its Environs: The Sea-Tac Success Story.* Federal Aviation Administration, Washington, D.C., April 1978.

    This is a case study of airport planning in the environs of Sea-Tac Airport, Washington. It constitutes guidance for other communities upset with airport noise incompatibility problems.

18. *Community Involvement Manual,* FAA-EE-79-06, 1979.

    This report gives additional guidance for conducting citizen participation activities.

19. *Developing Noise Exposure Contours for Federal Aviation Airports.* DOT-FA-75WA-3710, NTIS No. ADA 023429. December 1975.

    This report presents a "desk top" method for developing noise contours for airports other than air carrier airports.

DEPARTMENT OF TRANSPORTATION/Federal Highway Administration (DOT/FHWA)

"A Statement of National Highway Transportation Policy," page 21, paragraph 2, Federal Highway Administration, December 1976, Washington, D.C.

This document sets forth FHWA's policy on highway traffic noise. Noise control mitigation, land use and source control are discussed.

"Federal-Aid Highway Program Manual 7-7-3," Federal Highway Administration, Washington, D.C., May 14, 1976.

This document contains FHWA's noise standards for highways and requirements for Federal participation in highway noise mitigation.

3. *"The Audible Landscape: A Manual for Highway Noise and Land Use,"* Federal Highway Administration, Washington, D.C., November 1974, (Reprinted — August 1976).

   This document discusses various land use control techniques which communities can use in highway environs.

4. *Determination of Reference Energy Mean Emission Levels,* FHWA-OEP/HEV-78-1. Reagan, Jerry A., prepared for the Federal Highway Administration, Washington, D.C., July 1978.

   This report provides guidance for measurement of noise emission levels of motor vehicles and for using this measured data to compute reference energy mean emission levels.

5. *Highway Noise Barrier Selection, Design and Construction Experiences, Implementation Package 76-8,* Federal Highway Administration, Region 10. Snow, C.H., prepared for U.S. Department of Transportation, FHWA, Offices of Research and Development, Office of Engineering, Office of Environmental Policy, Washington, D.C., October 1976.

6. *Insulation of Buildings Against Highway Noise.* Davy, Bruce A. and Skale, Steven R., Wyle Research. Prepared for U.S. Department of Transportation, Federal Highway Administration, Office of Development, FHWA-TS-77-202. Washington, D.C., 1977.

   This manual provides highway engineers tools to assess the noise insulation requirements of buildings, to determine the effectiveness of existing buildings in insulation of interior space against highway traffic noise, and to evaluate the effectiveness of proposed modifications.

7. *A Guide to Visual Quality in Noise Barrier Design, Implementation Package 77-12.* Blum, Randolph F., The Organization for Environmental Growth, Inc., Prepared for the U.S. Department of Transportation, Office of Research and Development. Washington, D.C., July 1978.

   This report deals with the esthetic considerations of noise barrier design.

8. *Background Report on Outdoor-Indoor Noise Reduction Calculation Procedures Employing the Exterior Wall Noise Rating (EWNR) Method.* Mange, Gary E.; Skale, Steven R.; and Sutherland, Louis C., Wyle Research. Prepared for the U.S. Department of Transportation, Federal Highway Administration, Office of Development, Report No. FHWA-TS-77-220, Washington, D.C., March 1978.

This is a background report on the procedures for evaluating outdoor-indoor noise reduction of structure in terms of the single number metric Exterior Wall Noise Rating (EWNR).

9. *Fundamentals and Abatement of Highway Traffic Noise.* Anderson, G.S.; Miller, L.N.; and Shadley, Fr. R., Bolt, Beranek and Newman, Inc. Prepared for U.S. Department of Transportation, FHWA, PB-222-703/1. Washington, D.C., June 1973.

10. *FHWA Highway Traffic Noise Prediction Model.* Barry, T. and J. Reagan, FHWA-RD-77-108, Federal Highway Administration, Washington, D.C., December 1978.

This draft report describes FHWA traffic noise model. A predicted sound level can be calculated through a series of manual adjustments to the reference energy mean emission level.

VETERANS ADMINISTRATION (VA)

1. Veterans Administration, *"Section VIII Appraisal of Residential Properties Near Airports, 1969.*

This contains the VA noise policy.

Noise/Land Use Bibliography — Part II

KEY CONGRESSIONAL STATUTES RELEVANT TO NOISE AND LAND USE

- Aviation Safety and Noise Abatement Act of 1979.

  This Act directs the Secretary of Transportation to take specific actions with respect to airport noise reduction.

- Quiet Communities Act of 1978.

  This Act directs the Environmental Protection Agency to assist States and Communities in carrying out their own noise control programs through the administration of a nation-wide Quiet Communities Program.

- Federal Aid Highway Act of 1970, and 1973 and 1976 amendments.

  This series of legislation contains provisions directing the Federal Highway Administration to take specific actions with respect to highway noise, including the development and carrying out of noise standards for new highway construction and providing funding for noise mitigation on existing highways.

- Airport and Airways Development Act of 1970 and 1976 amendments.

  This legislation provides the Federal Aviation Administration's Grants Programs for airport planning and development including noise compatibility planning and sharing in the costs of certain airport noise abatement measures and activities.

- Noise Control Act of 1972.

  This Act requires all Federal agencies to carry out their programs in a manner so as to promote an environment free from noise that jeopardizes the health and welfare of the American public, and directs the Environmental Protection Agency to undertake certain noise abatement activities, including setting noise standards and furnishing technical assistance to State and local governments.

- National Environmental Policy Act of 1969.

  This Act requires that for all proposed Federal actions significantly affecting the quality of the environment, Federal agencies should prepare an environmental impact statement concerning the proposed action.

- Federal Aviation Act of 1968 and 1972 amendments.

  This law constitutes the basic authority for Federal regulation of Aircraft noise.

- The Department of Housing and Urban Development Act of 1965.

  This law provides that the Department of Housing and Urban Development may make such rules as may be necessary to carry out its duties and sets forth, as a matter of national purpose, the sound development of the Nation's communities.

Appendix C

ANNOTATED BIBLIOGRAPHY OF FEDERAL MANUALS AND OTHER DOCUMENTS RELATED TO NOISE ATTENUATION IN BUILDINGS

DEPARTMENT OF COMMERCE/National Bureau of Standards (DOC/NBS)

1. *Quieting: A Practical Guide to Noise Control.* Berendt, Raymond D., Corliss, Edith L.R. and Ojalvo, Morris, S., U.S. Department of Commerce, July 1976.

   This guide offers to the general lay reader practical solutions to various noise problems including recommendations for techniques for quiet in existing homes as well as for choosing a quiet home or apartment.

2. *Design Guide for Reducing Transportation Noise in and Around Buildings.* Pallett, David S., Wehrli, R., Kilmer, Roger D., and Quindry, Thomas L., U.S. Department of Commerce/National Bureau of Standards, April, 1978.

   This design guide presents a unified procedure for the selection of noise criteria in and around buildings, for the prediction of exterior and interior noise levels arising as a consequence of transportation systems operations, and for the evaluation of the adequacy of building designs with regard to environmental noise. Noise criteria levels are suggested in terms of equivalent sound levels (L_{eq}). Simplified predictive methods enable the estimation of noise levels from highways, railways, and aircraft. The sound isolation provided by the building shell is estimated by means of a new single-figure rating system. Finally, the manual suggests design manipulations which may make possible the improvement of the acoustic conditions in and around buildings.

3. *Acoustical and Thermal Performance of Exterior Residential Walls, Doors and Windows.* Sabine, H.J., Lacher, M.B., Flynn, D.R., and Quindry, T.L., U.S. Department of Commerce, November 1975.

   This manual is intended to assist in achieving improved design when both noise and energy conservation are to be considered. It describes the results of laboratory tests (109 acoustical, 48 thermal) conducted on typical residential exterior wall constructions and compares them with literature data on similar constructions.

4. *Noise Criteria of Buildings: A Critical Review.* Yaniv, Simone I. and Flynn, D.R., U.S. Department of Commerce, January, 1978.

   This report reviews existing criteria that could be applied to rating the noise environment in dwellings, and to rating noise isolation from outside to inside a dwelling. It concludes that the central problem is to select appropriate criteria for rating the interior noise environment. Once this is done, criteria for noise isolation can be derived directly and these in turn can be used to derive performance requirements for building elements, such as partitions and exterior walls.

DEPARTMENT OF DEFENSE (DOD)

1. *"Air Installation Compatible Use Zone Studies,"* U.S. Air Force and U.S. Navy.

   A standard appendix in each study gives recommendations for design and construction techniques for primarily residential construction to achieve various levels of noise reduction corresponding to the land use guidance contained in the main document.

2. *"Planning in the Noise Environment,"* Air Force Manual 19-10, TM-5-803-2 (Army), and NAVFAC P-970 Navy), 15 June 1978.

   This manual is a tool for installation planners to assist them in developing acceptable noise environments on military installations; contains some information on building acoustics.

3. TM-5-805-15, *U.S. Army Technical Manual on Architectural Acoustics.*

   This manual contains design information to provide occupant with satisfactory acoustical conditions within and protection from noise that may be injurious to health or welfare. Provides recommended techniques for reducing unwanted sounds.

4. *Facility Acoustic Parameters Catalog.* Naval Environmental Support Service (AESO 330-76-02), January 1977.

   This provides a fundamental knowledge of architectural acoustics. Provides techniques for determination of Sound Transmission Class (STC) and composite transmission loss and for relating noise reduction to STC. Provides absorption and transmission loss data.

5. *Noise Reduction Technology Catalog.* Naval Environmental Support Service, AESO Report 330-70-01, January 1977.

   This report provides a fundamental acquaintance with the properties of noise and various techniques applicable to noise control. Provides absorption and transmission loss data for common building materials.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

1. *A Guide to Airborne, Impact, and Structure Borne Noise-control in Multi-family Dwellings.* Berendt, Raymond D., Winzer, George E., and Burroughs, prepared for U.S. Department of Housing and Urban Development, September 1961. NTIS order number PB210-849.

   This Guide incorporates a broad range of criteria appropriate for isolating airborne, impact, and structure-borne noise associated with residential construction. Sound classifications represented in the most common types of building construction are identified.

DEPARTMENT OF TRANSPORTATION/Federal Aviation Administration (DOT/FAA)

"The Feasibility, Practicability and Cost of the Soundproofing of Schools, Hospitals, and Public Health Facilities Near Airports," Federal Aviation Administration, 1977.

This study, required by Section 26(3), Appendix B of the Airport and Airway Development Act Amendments of 1976 (P.C. 94-353), concludes that soundproofing of schools, hospitals, and public health facilities near airports is a feasible and practicable means for alleviating aircraft noise impact.

DEPARTMENT OF TRANSPORTATION/Federal Highway Administration (DOT/FHWA)

1. *Insulation of Buildings Against Highway Noise.* Davy, Bruce A. and Skale, Steven R., Wyle Research, prepared for U.S. Department of Transportation, Federal Highway Administration, Office of Development, FHWA-TS-77-202. Washington, D.C., 1977.

   This manual provides highway engineers with the necessary tools to assess the noise insulation requirements of buildings, to determine the effectiveness of existing buildings in insulating interior space against highway traffic noise, and to evaluate the effectiveness of proposed modifications.

2. *Background Report on Outdoor-Indoor Noise Reduction Calculation Procedures Employing the Exterior Wall Noise Rating (EWNR) Method.* Mange, Gary E.; Skale, Steven R.; and Sutherland, Louis C., Wyle Research. Prepared for U.S. Department of Transportation, Federal Highway Administration, Office of Development, Report No. FHWA-TS-77-220, Washington, D.C., March 1978.

   This is a background report on the procedure for evaluating outdoor-indoor noise reduction of structure in terms of the single number metric Exterior Wall Noise Rating (EWNR), first reviews the basis of previous single number ratings emphasizing the Sound Transmission Class (STC). It is shown that the latter was initially designed to try to account for the relative loudness of interior noises in typical residences as heard by adjoining neighbors on the other side of a common party wall.

In a similar, but quite independent manner, the EWNR metric was developed so that the A-weighted indoor noise level, due to highway noise sources outdoors, could be roughly estimated directly from the value of EWNR and the A-weighted outdoor noise level. The basis for this is defined, first in terms of the basic theory for noise reduction from outdoors to indoors at one frequency. The result is then summed over all frequencies to give the overall effective noise reduction. The EWNR single number rating replaces this complex summation and, as shown by recently conducted field tests, provides a valid method with an accuracy of about ± 3 dB for predicting levels inside buildings due to outdoor transportation noise sources.

This background report also briefly reviews the basis for the tables of EWNR values and tables of various EWNR adjustment factors used to evaluate the composite noise reduction of A-weighted noise levels for a wide range of practical residential structural assemblies which may include walls, windows, doors, roofs, and ceilings.

3. *Guide to the Soundproofing of Existing Homes Against Exterior Noise.* Wyle Research, prepared for city of Los Angeles Department of Airports (1970). Reprinted with permission by Federal Highway Administration, Office of Development, 1977.

   This manual is for the designer in selecting and conceptualizing various methods of soundproofing existing homes. This guide presents the various successful methods used in a 1970 pilot project to increase the noise reduction capabilities of existing houses for the Los Angeles Department of Airports. Three categories of modification from minor to extensive are covered. The guide also provides a basic understanding of the elements of noise control and the systematic method of soundproofing houses. This guide expands the repertory of methods and techniques of reducing the impact of highway traffic noise on its neighbors.

DEPARTMENT OF AGRICULTURE (DOA)

1. Jones, R.E., "Effects; of Flankling and Test Environment on Lab Field Correlation of Airborne Sound Insulation," *Journal of the Acoustical Society of America,* 57(5), 1975, 1138-1149.

2. Jones, R.E., "Field Sound Insulation Evaluation for Two Auxiliary Walls," USDA Forest Service Research Paper No. FPL-244, Forest Products Laboratory, Madison, WI, 1975.

3. Jones, R.E., "How to Accurately Predict the Sound Insulation of Partitions," *Sound and Vibration* 10(6), pp. 14-25, 1976: Errata *Sound and Vibration* 10(11), 1976, p. 15.

4. Jones, R.E., "Insulation Evaluation of Load Bearing Sandwich Panels for Housing," Forest Products Laboratory, Madison, WI., 1975 NTIS No. PB 244-152/AS.

5. Jones, R.E., "Laboratory-Field Correlation for Airborne Sound Transmission Through Party Walls," USDA Forest Service Research paper No. FPL-240, Forest Products Laboratory, Madison, WI., 1975.

DEPARTMENT OF AGRICULTURE (continued)

6. Jones, R.E., "Sound Insulation Evaluation of Several Single-Row-of-Wood Stud Party Walls Under Laboratory and Field Conditions, USDA Forest Service Research paper No. FPL-241, Forest Products Laboratory, Madison, WI., 1975.

7. Jones, R.E., "Sound Insulation of High Performance Wood Frame Party Partitions Under Laboratory and Field Conditions," USDA Forest Service Research paper No. FPL-309, Forest Products Laboratory, Madison, WI., April 1978.

Appendix D

EFFECTS OF NOISE ON PEOPLE

Environmental noise affects health and welfare in many ways. Table D-1 describes some aspects of the effect of noise on people in residential areas to varying levels of cumulative exposure. As stated in the main portion of this document, it can be used as an important input to the local land use decision making process. For a further discussion of the effects of noise consult the bibliography on the following page.

TABLE D-1. EFFECTS OF NOISE ON PEOPLE
(Residential Land Uses Only)

Effects[1] / Day-Night Average Sound Level in Decibels	Hearing Loss	Speech Interference		Annoyance[2]	Average Community Reaction[4]	General Community Attitude Towards Area
		Indoor	Outdoor			
	Qualitative Description	% Sentence Intelligibility	Distance in Meters for 95% Sentence Intelligibility	% of Population Highly Annoyed[3]		
75 and above	May Begin to Occur	98%	0.5	37%	Very Severe	Noise is likely to be the most important of all adverse aspects of the community environment.
70	Will Not Likely Occur	99%	0.9	25%	Severe	Noise is one of the most important adverse aspects of the community environment.
65	Will Not Occur	100%	1.5	15%	Significant	Noise is one of the important adverse aspects of the community environment.
60	Will Not Occur	100%	2.0	9%	Moderate to Slight	Noise may be considered an adverse aspect of the community environment.
55 and below	Will Not Occur	100%	3.5	4%		Noise considered no more important than various other environmental factors.

1. "Speech Interference" data are drawn from the following tables in EPA's "Levels Document": Table 3, Fig. D-1, Fig. D-2, Fig. D-3. All other data from National Academy of Science 1977 report "Guidelines for Preparing Environmental Impact Statements on Noise, Report of Working Group 69 on Evaluation of Environmental Impact of Noise."
2. Depends on attitudes and other factors.
3. The percentages of people reporting annoyance to lesser extents are higher in each case. An unknown small percentage of people will report being "highly annoyed" even in the quietest surroundings. One reason is the difficulty all people have in integrating annoyance over a very long time.
4. Attitudes or other non-acoustic factors can modify this. Noise at low levels can still be an important problem, particularly when it intrudes into a quiet environment.

NOTE: Research implicates noise as a factor producing stress-related health effects such as heart disease, high-blood pressure and stroke, ulcers and other digestive disorders. The relationships between noise and these effects, however, have not as yet been quantified.

HEALTH EFFECTS BIBLIOGRAPHY

1. *Noise Abatement: Policy Alternatives for Transportation, Report to the EPA.* National Academy of Sciences, Washington, D.C., 1977, p. 63.

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8. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety,* (EPA 550/9-74-004), Mar. 1974.

9. *Some Considerations in Choosing an Occupational Noise Exposure Regulation,* prepared for the U.S. Environmental Protection Agency by MIT Center for Policy Alternatives, (EPA 550/9-76-007), pp. 2-40, 2-41, and 118.

10. *Report to the President and Congress on Noise,* Report of the Administrator of EPA in compliance with Title IV of the Public Law 91-6004: The Clean Air Act Amendments of 1970 (Washington, D.C.; U.S. EPA, Feb., 1972), pp. 1-42.

11 Cohen, Alexander, "Effects of Noise on Psychological State", *Proceedings of the Conference on Noise As a Public Health Hazard,* ASHA, No. 4, Feb. 1969, p. 84.

12. Tanaka, Y., and T. Arayama, in *Practica: Oto-Phino-Laryngo-Logica,* 31, (1969), p. 269.

13. Scibetta, J.J., and M.G. Rosen, in *American Journal Obstet. & Gynec.,* 33 (1969), p. 830.

14. Statement by A. Stanley Weltman in Public Hearing on Physiological and Psychological Effects on Noise, Boston (Oct. 23-9, 1971), p. 123.

15. Ando, Y., and H. Hattori, "Effects of Noise on Human Placental Lacotgen (NPL), Levels in Maternal Plasma", *British Journal of Obstetrics and Gynec.*, 84 (Feb. 1977), p. 115.

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17. Cohen, S., D.C. Glass and J.E. Singer, "Apartment Noise, Auditory Discrimination, and Reading Ability in Children", *Journal of Exp. and Social Psychology*, 9, No. 5, (1973), pp. 407-422.

18. The Superintendent of Schools of Inglewood, CA, before Congressional Subcommittee, in *The Social Impact of Noise*, EPA report, (Dec. 1971), p. 20.

19. *Public Health and Welfare Criteria for Noise*, (EPA 550/9-73-002), 1973, pp. 8-20, 6-7

20. Miller, "Effects of Noise on People," *Journal of the Acoustical Society of America*, 56, No. 3, (Sept. 1974), pp. 757. 743.

21. Federal Railroad Administration, Advanced Notice of Proposed Rulemaking, "Protection of Railroad Maintenance-of-Ways-and-Structure Employees", *Federal Register*, Vol. 40, No. 76, April 18, 1975, pp. 17265-6.

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Appendix E

FEDERAL AGENCY POINTS OF CONTACTS FOR ADDITIONAL INFORMATION

DEPARTMENT OF DEFENSE (DoD)

1. Office of the Secretary of Defense
   A. Deputy Assistant Secretary of Defense
   (Energy, Environment and Safety)
   Pentagon, Room 3E784
   Washington, D.C. 20301 — (202) 695-0221
   B. Deputy Assistant Secretary of Defense
   (Installations and Housing)
   Pentagon, Room 3E760
   Washington, D.C. 20301 — (202) 695-7804
2. United States Army
   A. U.S. Army Environmental Hygiene Agency
   Bioacoustics Division
   Aberdeen Proving Ground, Maryland 21010
   B. Headquarters, Department of the Army
   DAEN-Z-CE
   Washington, D.C. 21010
   C. Headquarters, Department of the Army
   DAEN-MPE-I
   Washington, D.C. 20314
   D. Commander/Director
   CERL
   P.O. Box 4005
   Champaign, Illinois 61820

DEPARTMENT OF DEFENSE (DoD) (continued)

3. United States Navy

   A. General:

      Office of Chief of Naval Operations (OP-04E)
      Department of the Navy
      Washington, D.C. 20350 (202) 325-0090

   B. Specific for Individual Installations
      Commanding Officer of Installation involved

4. United States Air Force

   A. General:

      Environmental Division (AF/LEEV)
      Directorate of Engineering and Services
      Headquarters U.S. Air Force
      Washington, D.C. 20330

   B. General — Standard Federal Regions I-IV:

      Environmental Planning Division (AFRCE/ROV)
      USAF Regional Civil Engineer/Eastern Region
      526 Title Building
      Atlanta, GA 30303

   C. General — Standard Federal Regions V-VIII:

      Environmental Planning Division (AFRCE/ROV)
      USAF Regional Civil Engineer/Central Region
      Main Tower Building
      1200 Main Street
      Dallas, TX 75202

   D. General — Standard Federal Regions IX-X:

      Environmental Planning Division
      USAF Regional Civil Engineer/Western Region
      630 Sansome Street
      San Francisco, CA 94111

   E. Specific for Individual Installations:

      Environmental Planning Section (DEEV)
      Base Civil Engineer

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

A General:

Director
Environmental Planning Division
Office of Environmental Quality
451 7th Street, S.W.
Washington, D.C. 20410 — (202) 755-8909

B Specific for Individual Projects:

Environmental Clearance Officers in HUD Regional and Area Offices

ENVIRONMENTAL PROTECTION AGENCY (EPA)

A. Headquarters

Office of Noise Abatement and Control
Washington, D.C. 20460 — (703) 557-7634

B. Regions

Region I
JFK Building
Boston, MA 02203 — (617) 223-5708

Region II
26 Federal Building
New York, NY 10007 — (212) 264-2110

Region III
Curtis Building
6th & Walnut Streets
Philadelphia, PA 19106 — (215) 597-9118

Region IV
345 Courtland St., N.E.
Atlanta, GA 30308 — (404) 881-4861

Region V
230 South Dearborn St.
Chicago, IL 60604 — (312) 353-2202

Region VI
First International Bldg.
1201 Elm Street
Dallas, TX 75270 — (214) 767-7242

Region VII
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ENVIRONMENTAL PROTECTION AGENCY (EPA) (continued)

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1860 Lincoln Street
Denver, CO (303) 837-2221

Region IX
215 Freemont Street
San Francisco, CA 94105 (415) 556-4606

Region X
1200 Sixth Avenue
Seattle, WA 98101 (206) 442-1253

DEPARTMENT OF TRANSPORTATION/Federal Aviation Administration (DOT/FAA)

Headquarters

A. Office of Environment and Energy (AEE-100)
800 Independence Ave., S.W.
Washington, D.C. 20591 (202) 755-9468

B. Ofice of Airport Planning and Programming (APP-600)
800 Independence Ave., S.W.
Washington, D.C. 20591 (202) 426-3263

DEPARTMENT OF TRANSPORTATION/Federal Highway Administration (DOT/FHWA)

A Headquarters
Office of Environmental Policy
400 Seventh Street
Washington, D.C. 20590 (202) 426-0351

B. Regions

Regions I
Leo W. O'Brien Federal Building
Room 709
Clinton Avenue and North Pearly Street (518) 472-6476
Albany, NY 12207 FTS 562-6476

Region III
George H. Fallon Federal Office Building
31 Hopkins Plaza
Room 1633 (301) 962-2361
Baltimore, MD 21201 FTS 922-2361

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VETERANS ADMINISTRATION (VA)

A Headquarters 810 Vermont Ave., N.W. Washington, D.C. 20460	(202) 389-2249

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