BARGHAUSEN
A DIVISION OF CORE STATES GROUP

CORE STATES

06/11/2025

Preliminary Drainage Study

Phelan Tractor Supply Company
PROJ-2024-00098, DRNSTY-2025-00037

PREPARED BY

Barghausen Consulting Engineers
18215 72nd Avenue South,
Kent WA 98032
Phone: 425-251-6222
Email: hgrubb@barghausen.com

PREPARED FOR

Durban Development – Stephen Knudsen

CLIENT ADDRESS

106 Foster Avenue
Charlotte NC 28203
Phone : 704-319-8346
Contact : Stephen Knudsen
stephen.knudsen@durbandevelopment.com

SITE ADDRESS	PROJECT NO.	DATE	JURISDICTION
4351 Phelan Road Phelan CA APN 3066-251-09-0-000	23228	6/11/2025	San Bernardino County

TABLE OF CONTENTS

1.0 Project Description 3

1.1 Introduction 3

1.2 Existing Conditions 3

1.3 Proposed Conditions 4

1.4 Run-On 4

1.5 Flood Zone 5

1.6 Hydromodification 5

1.7 Detention 5

1.8 Water Quality 5

1.9 Groundwater 5

2.0 Calculation Methodology and Results 5

2.1 Runoff Volume Determination Method 5

2.2 Peak Flow Rate Determination Method 6

2.3 Design Capture Volume Determination Method 7

2.4 Detention Facility Design Method 7

2.5 Hydraulic Calculation Design Method 7

3.0 Conclusion 7

4.0 References 7

APPENDICES

APPENDIX A ALTA Survey, FEMA Flood Zone Overlay, DWR Best Available Map, HCOC Exemption Criteria and Map

APPENDIX B Existing, Proposed, and Run-On Conditions Maps

APPENDIX C Hydrology Calculations

APPENDIX D Water Quality Calculations

APPENDIX E Detention Facility Design

APPENDIX F Hydraulic Calculations

APPENDIX G Web Soil Survey Results and Geotechnical Report

1.0 PROJECT DESCRIPTION

1.1 Introduction

This preliminary drainage study has been prepared to analyze the hydrological effects of the proposed Tractor Supply Company store at 4351 Phelan Road, in San Bernardino County.

1.2 Existing Conditions

In the existing condition, the site is an approximately 4.81 acre parcel. The majority of the site (99%) is undeveloped; with the exception of approximately 2,300 of impervious cover. It is bounded by an undeveloped parcel to the west, a commercial development and undeveloped land to the east, residential properties to the south, and Phelan Road to the north. The pervious cover of the site consists of open brush of fair quality, with a handful of trees. Run-off travels generally from southwest to northeast with the highest point of elevation at the southwest corner. In the existing condition, the site also receives run-on from the parcels to the west and southwest. There is an existing masonry wall at the south parcel boundary which prevents run-on from the parcels to the south. Reference Appendix A for the site ALTA survey of existing conditions.

Run-off from the site ultimately sheet flows to Horse Canyon Creek, which is approximately 2,000 feet to the east. Horse Canyon Creek flows to the north, over the California Aqueduct, and gradually discharges to groundwater north of the aqueduct. Reference Figure 1 for the Vicinity Map.

Figure 1. Vicinity Map.

Soils at the proposed site fall into Hydrologic Soil Group A, consisting of sand and stratified gravelly sand to gravelly loamy sand. This soil exhibits excellent potential for infiltration. Please reference Appendix G for a Web Soil Survey summary of the on-site soils, and for the project-specific Geotechnical Report, dated December 12, 2023 and prepared by Partner Engineering and Science, for additional on-site soil information.

Infiltration testing was performed as part of the Geotechnical Report, at 4 locations throughout the site. A map of borings and infiltration tests is included as part of the Report in Appendix G. At the test site closest to the proposed infiltration facility location, the unfactored rate was found to be 15.09 inches per hour. The design infiltration rate was determined using the methods defined in Appendix C of the April 2016 Mojave River Watershed Technical Guidance Document for Water Quality Management Plans: Section VII – Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations, Orange County TGD Appendices, May 19, 2011. This methodology led to a safety of factor of 3.4, and a design infiltration rate of 4.4 inches per hour. Reference Appendix E. This result indicates that infiltration is likely to be feasible at the proposed site. However, prior to completion of a final infiltration facility design and issuance of permits, it will be necessary to perform additional testing at the exact location of the underground facility to confirm that the infiltrate rate is acceptable for infiltration as the preliminary results indicate.

1.3 Proposed Conditions

In the proposed condition, the size of the site will be reduced due to dedications to construct an extension of Riggins Road at the west side of the site, and an expansion of the Phelan Road right-of-way at the north side of the site. After dedications and easements for the widened right-of-way, the remaining disturbed area will consist of approximately 4.22 acres. In the developed condition, the site will be 69.6% impervious, to include an approximately 23,957 square foot Tractor Supply Company building, along with associated sidewalks and vehicle maneuvering areas. The 30.4% of the site to be pervious will be commercial landscaping emphasizing native, drought-tolerant plants. Run-off generated by the pervious area of the proposed site will be infiltrated in an underground chamber system. In the event of system failure, water will follow an overland release path to the Phelan Road right-of-way, matching the existing drainage pattern. As part of the Riggins Road extension at the west side of the site, curb and gutter will be constructed to route run-on from adjacent parcels to the Phelan Road right-of-way, aligning with the existing drainage pattern. Approximately 1.02 acres in the developed condition consist of self-treating landscaping. These areas are graded to route runoff to a cobble swale at the east boundary of the site and ultimately to the Phelan Road right-of-way. An additional 0.24 acres of perimeter landscaping along the west and north perimeters is infeasible to treat. However, as the pervious land cover is being improved from open brush to commercial landscaping with native plants, runoff discharge rate and volume from impervious areas will be decreased and rainfall will be largely mitigated in place. Reference Appendix A for a proposed condition BMP and DMA Exhibit.

1.4 Run-On

The proposed site will receive run-on generated by approximately 18.87 acres of terrain to the southwest, which consists mostly of open brush of fair quality. The discharge rate of the run-on generated by this area is shown the Run-On Exhibit in Appendix A. In the developed condition this run-on will be collected by the curb and gutter in the new Riggins Road right-of-way and conveyed to Phelan Road, then ultimately to Horse Canyon Creek.

1.5 Flood Zone

Per Flood Insurance Rate Map 06071C6450H, which bears an effective date of 08/28/2008, the proposed site is in Zone AO, an area without a base flood elevation with a depth of 1', and a velocity of 4 feet per second. The first floor of any new building will be required to be elevated a minimum of 1 foot above the known shallow flooding depth of 1 foot in compliance with FEMA/SBC regulations, with an elevation certificate required. Reference Appendix A for the relevant FEMA Firmette and the California Department of Water Resources Best Available Map.

1.6 Hydromodification

Horse Canyon Creek is labeled as exempt from hydromodification on the included San Bernardino County HCOC Exemption Criteria and Map. Thus, hydromodification is not a concern for this project. Reference Appendix A for the hydromodification exemption map.

1.7 Detention

The addition of impervious area associated with the development of this site would generate an increase in peak flow rates and adversely impact the downstream property owners. The proposed project is required to mitigate peak flow rates to meet the requirements of the Detention Basin Design Criteria For San Bernardino County. In the preliminary phase, the proposed facility was designed to have capacity to retain the difference between the 24-hour, 100-year event and 90% of the 24-hour, 25-year event.

1.8 Water Quality

The proposed project is a Regulated Project as defined in the April 2016 Mojave River Watershed Technical Guidance Document for Water Quality Management Plans, as it will replace more than 5,000 square feet of impervious surface. As such it will be required to retain, infiltrate, or treat the Design Capture Volume as calculated in the April 2016 Mojave River Watershed Technical Guidance Document for Water Quality Management Plans.

1.9 Groundwater

Groundwater levels are not a concern for the proposed site. Please refer to the Geotechnical Report in Appendix G for additional information.

2.0 CALCULATION METHODOLOGY AND RESULTS

2.1 Runoff Volume Determination Method

Runoff hydrographs were pre- and post-development conditions were generated using Section J of the August 1986 San Bernardino County Hydrology Manual, "Small Area Runoff Hydrograph Development". The design event used for the developed condition was the 100-year 24-hour storm as defined by the NOAA Atlas 14. The design event for the existing condition was the 25-year, 24-hour event as defined by the NOAA Atlas 14. Reference Appendix C for Hydrology Calculations and Hydrographs.

In the existing condition, there is one Drainage Area, for a total of 4.81 acres of cover. In the design 25-year, 24-hour event, this area was found to generate 22,334 cubic feet of runoff. For

detention facility design, 90% of this volume will be utilized in volume calculations. This figure is 20,101 cubic feet.

There are two Drainage Areas in the developed condition, for a total of 4.22 acres of cover. In the design 100-year, 24-hour event, these areas were found to generate 59,170 cubic feet of runoff.

2.2 Peak Flow Rate Determination Method

Post-development peak flow-rates for the proposed site were determined using Section D of the August 1986 San Bernardino County Hydrology Manual, "Rational Method". The Intensity – Duration Curves Calculation Sheet Figure D-3 was utilized along with NOAA Atlas 14 1-hour point rainfall values. Reference Appendix C for Hydrology Calculations.

Post-Development peak flow rates were calculated in accordance with the "San Bernardino County Hydrology Manual".

Pre-Development peak flow rates were calculated both in accordance with the San Bernardino County Hydrology Manual and the San Bernardino County Detention Basin Design Criteria. The Detention Basin Design Criteria has the following requirements.

a) 10-year peak flow rate was determined using 5-year rainfall.

b) 25-year peak flow rate was determined using 10-year rainfall.

c) 100-year peak flow rates were determined using 25-year rainfall and AMC-II.

Peak flow rate results are shown in Table 1.

Peak Flow Rates					
Existing Conditions			Proposed Conditions (DA#1)		
Q_2	1.75	cfs	Q_2	3.91	cfs
Q_{10}	4.92	cfs	Q_{10}	7.05	cfs
Q_{25}	7.08	cfs	Q_{25}	9.15	cfs
Q_{100}	10.72	cfs	Q_{100}	12.72	cfs
Existing Conditions (Detention Basin Design Criteria)			Proposed Conditions (DA#2)		
Q_2 Using 2-yr Event	1.75	cfs	Q_2	0.26	cfs
Q_{10} Using 5-yr Event	3.40	cfs	Q_{10}	1.00	cfs
Q_{25} Using 10-yr Event	4.92	cfs	Q_{25}	1.48	cfs
Q_{100} Using 25-Yr Event & AMC-II	5.71	cfs	Q_{100}	2.31	cfs
Run-On					
Q_2	1.47	cfs			
Q_{10}	3.29	cfs			
Q_{25}	6.31	cfs			
Q_{100}	11.47	cfs			

Table 1. Pre- and Post-Development Peak Flow Rates.

As expected, post-development peak flow rates were found to be higher than in the existing condition. However, in the final design the project will meet detention requirements by

detaining and infiltrating the volume of the 100-year, 24-hour storm and thus discharge off-site is not a concern.

2.3 Design Capture Volume Determination Method

The design capture volume (DCV) was calculated using the methodology in the April 2016 Mojave River Watershed Technical Guidance Document for Water Quality Management Plans.

The DCV was found to be 7,344 cubic feet. This DCV volume was significantly less than the volume required to be infiltrated by the proposed underground infiltration facility. Reference Appendix D for water quality calculations.

2.4 Detention Facility Design Method

The proposed facility to meet detention requirements will be an underground infiltration system consisting of ADS LandMax 5' diameter perforated storm drain. As described in Section 1.2, infiltration testing indicated that the proposed site meets requirements for infiltration and further testing will be required to confirm this finding prior to approval of a Final stormwater design.

Ultimately, a facility will be provided which retains and infiltrates the 100-year, 24-hour storm. A basin routing analysis will be provided with final design which the effect of infiltration during the design event.

For preliminary design, the proposed facility was required to retain the difference between the Proposed Conditions 100-year, 24-hour storm and 90% of the Existing Conditions 25-year, 24-hour storm. This volume is 39,099 cubic feet. Reference Appendix C for Hydrology Calculations used to generate this number, and Appendix E for the Detention Facility design which meets this required volume, with a capacity of 41,066 cubic feet. Peak flows for Detention Facility Design are provided in Section 2.2, but the facility in the final design will be sized to retain the 100-year, 24 hour storm so off-site discharges will be minor compared to the existing conditions.

2.5 Hydraulic Calculation Design Method

Full hydraulic design calculations will be included with the Final Drainage Study. For the preliminary drainage study, the pipe with the highest demand was sized using the Manning Equation. Reference Appendix F for results.

3.0 CONCLUSION

The proposed site will utilize an infiltration facility which can retain the difference between the 100-year, 24-hour storm and 90% of the 25-year, 24-hour storm. This will result in mitigated peak flows and will also provide for required water quality treatment. Reference the included Exhibits in Appendix B for flow lengths and for a Summary Table of Drainage Area data, to include upstream and downstream elevations, flow lengths, areas, land usages, soil types, percentages pervious, curve numbers and rainfall intensities. Run-on will be routed to the Phelan Road right-of-way, matching the existing drainage pattern.

4.0 REFERENCES

1. Mojave River Watershed Technical Guidance Document for Water Quality Management Plans, April 2016.

2. San Bernardino County Hydrology Manual, August 1986.

3. Detention Basin Design Criteria for San Bernardino County incl. September 1987 Memo.

APPENDIX A: ALTA Survey, FEMA Flood Zone Overlay, DWR Best Available Map, HCOC Exemption Criteria and Map

ALTA/NSPS TOPOGRAPHIC SURVEY

WEST 1/2 OF THE N/W 1/4 OF THE N/E 1/4 OF THE N/W 1/4
OF SECTION 24, T. 4 N., R. 7 W., S.B.B.&M.,
COUNTY SAN BERNARDINO, STATE OF CALIFORNIA,

COVER SHEET

SHEET 1 OF 3 NOVEMBER 2023

1 LEGAL DESCRIPTION

SCHEDULE "A"

FOR APN/PARCEL ID(S): 3066-251-09-0-000

THE LAND REFERRED TO HEREIN BELOW IS SITUATED IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA AND IS DESCRIBED AS FOLLOWS:

THE WEST HALF OF THE NORTHWEST QUARTER OF THE NORTHEAST QUARTER OF THE NORTHWEST QUARTER OF SECTION 24, TOWNSHIP 4 NORTH, RANGE 7 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE COUNTY SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO GOVERNMENT SURVEY.

EXCEPTING THEREFROM THAT PORTION AS CONVEYED TO THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JANUARY 27, 1986 AS INSTRUMENT NO. 1986-20823, OF OFFICIAL RECORDS.

EXCEPTING A 1/16TH OF ALL MINERALS, OIL, GAS AND OTHER HYDRO-CARBON SUBSTANCES IN SAID LAND, AS RESERVED IN THE DEED FROM MANLEY GOLDSBERRY, A WIDOWER, TO LESTER B. MC KINNEY AND ANNA E. MC KINNEY, HUSBAND AND WIFE, AS JOINT TENANTS, DATED DECEMBER 11, 1956, AND FILED FOR RECORD DECEMBER 21, 1956.

2 OWNER/TITLE INFORMATION

EFFECTIVE DATE: SEPTEMBER 25, 2023 AT 07:30 AM

THE FORM OF POLICY OR POLICIES OF TITLE INSURANCE CONTEMPLATED BY THIS REPORT IS: CLTA STANDARD COVERAGE POLICY 1990 (04-08-14)
ALTA LOAN POLICY 2021

1. THE ESTATE OR INTEREST IN THE LAND HEREINAFTER DESCRIBED OR REFERRED TO COVERED BY THIS REPORT IS: A FEE
2. TITLE TO SAID ESTATE OR INTEREST AT THE DATE HEREOF IS VESTED IN:

   SONG BOK SHIN, A SINGLE MAN, AS TO AN UNDIVIDED 25% INTEREST; KI SOO KIM, A SINGLE MAN, AS TO AN UNDIVIDED 12.5% INTEREST; JENNIFER J. NA, A SINGLE WOMAN, AS TO AN UNDIVIDED 20% INTEREST; MI SUK KIM, AN UNMARRIED WOMAN, AS TO AN UNDIVIDED 19.16% INTEREST; SANG KYU CHOE AND MYUNG JU SHIN, AS CO-TRUSTEES OF THE SANG MYUNG LIVING TRUST, U/A DATED MARCH 6, 2019, AS TO AN UNDIVIDED 12.5% INTEREST AND JASON KIM AND CHRISTINE SUE KIM, AS CO-TRUSTEES OF THE KIM FAMILY TRUST, U/A DATED APRIL 3, 2023, AS TO AN UNDIVIDED 10.84% INTEREST

3. THE LAND REFERRED TO IN THIS REPORT IS DESCRIBED AS FOLLOWS:
   SEE EXHIBIT "A" ATTACHED HERETO AND MADE A PART HEREOF

3 EXCEPTION ITEMS

AT THE DATE HEREOF, EXCEPTIONS TO COVERAGE IN ADDITION TO THE PRINTED EXCEPTIONS AND EXCLUSIONS IN SAID POLICY FORM WOULD BE AS FOLLOWS:

1. PROPERTY TAXES, WHICH ARE A LIEN NOT YET DUE AND PAYABLE, INCLUDING ANY ASSESSMENTS COLLECTED WITH TAXES TO BE LEVIED FOR THE FISCAL YEAR 2023-2024.

2. PROPERTY TAXES, INCLUDING ANY PERSONAL PROPERTY TAXES AND ANY ASSESSMENTS COLLECTED WITH TAXES, ARE PAID. FOR PRORATION PURPOSES THE AMOUNTS WERE:

   TAX IDENTIFICATION NO. : 3066-251-09-0-000
   FISCAL YEAR : 2022-2023
   1ST INSTALLMENT : $3,584.12
   2ND INSTALLMENT : $3,584.10
   EXEMPTION : NONE
   CODE AREA : 101-002

3. THE LIEN OF SUPPLEMENTAL OR ESCAPED ASSESSMENTS OF PROPERTY TAXES, IF ANY, MADE PURSUANT TO THE PROVISIONS OF CHAPTER 3.5 (COMMENCING WITH SECTION 75) OR PART 2, CHAPTER 3, ARTICLES 3 AND 4, RESPECTIVELY, OF THE REVENUE AND TAXATION CODE OF THE STATE OF CALIFORNIA AS A RESULT OF THE TRANSFER OF TITLE TO THE VESTEE NAMED IN SCHEDULE A OR AS A RESULT OF CHANGES IN OWNERSHIP OR NEW CONSTRUCTION OCCURRING PRIOR TO DATE OF POLICY.

4. WATER RIGHTS, CLAIMS OR TITLE TO WATER, WHETHER OR NOT DISCLOSED BY THE PUBLIC RECORDS.

5. EASEMENT(S) IN FAVOR OF THE PUBLIC OVER ANY EXISTING ROADS LYING WITHIN SAID LAND.

6. EASEMENT(S) FOR THE PURPOSE(S) SHOWN BELOW AND RIGHTS INCIDENTAL THERETO AS SET FORTH IN A DOCUMENT. PURPOSE:PIPELINES
   RECORDING DATE : AUGUST 25, 1928
   RECORDING NO : IN BOOK 397 PAGE 275, OFFICIAL
   RECORDS AFFECTS : A PORTION OF SAID LAND

7. EASEMENT(S) FOR THE PURPOSE(S) SHOWN BELOW AND RIGHTS INCIDENTAL THERETO, AS GRANTED IN A DOCUMENT:

   GRANTED TO : CONTINENTAL TELEPHONE COMPANY OF CALIFORNIA, A CALIFORNIA CORPORATION PURPOSE: PUBLIC UTILITIES AND INCIDENTAL PURPOSES
   RECORDING DATE : JANUARY 17, 1984
   RECORDING NO. : 84-011486, OFFICIAL
   RECORDS AFFECTS : A PORTION OF SAID LAND

8. AN ABSTRACT OF JUDGEMENT/ORDER AS DISCLOSED BY A RECORDED NOTICE:
   PLAINTIFF: SAMUEL LOVE
   DEFENDANT : CHRISTINE S KIM,
   ET AL COUNTY : SAN BERNARDINO
   COURT : DISTRICT COURT
   CASE NO. : 5;18-CV-01338-FMO-PLA
   NATURE OF ACTION: AS DESCRIBED HEREIN RECORDING DATE: AUGUST 5, 2020
   RECORDING NO. : 2020-0272986, OFFICIAL RECORDS

9. A STATE TAX LIEN FOR THE AMOUNT SHOWN AND ANY OTHER AMOUNTS DUE,

   STATE ID NO. : 21089603096
   FILED BY : STATE OF CALIFORNIA FRANCHISE
   TAX BOARD TAXPAYER: CHRISTINE KIM
   AMOUNT : $34,583.76 RECORDING DATE: APRIL 21, 2021
   RECORDING NO. : 2021-0183162, OFFICIAL RECORDS

10. PLEASE BE ADVISED THAT OUR SEARCH DID NOT DISCLOSE ANY OPEN DEEDS OF TRUST OF RECORD. IF YOU SHOULD HAVE KNOWLEDGE OF ANY OUTSTANDING OBLIGATION, PLEASE CONTACT THE TITLE DEPARTMENT IMMEDIATELY FOR FURTHER REVIEW PRIOR TO CLOSING.

11. ANY RIGHTS OF THE PARTIES IN POSSESSION OF A PORTION OF, OR ALL OF, SAID LAND, WHICH RIGHTS ARE NOT DISCLOSED BY THE PUBLIC RECORDS.

    THE COMPANY WILL REQUIRE, FOR REVIEW, A FULL AND COMPLETE COPY OF ANY UNRECORDED AGREEMENT, CONTRACT, LICENSE AND/OR LEASE, TOGETHER WITH ALL SUPPLEMENTS, ASSIGNMENTS AND AMENDMENTS THERETO, BEFORE ISSUING ANY POLICY OF TITLE INSURANCE WITHOUT EXCEPTING THIS ITEM FROM COVERAGE.

    THE COMPANY RESERVES THE RIGHT TO EXCEPT ADDITIONAL ITEMS AND/OR MAKE ADDITIONAL REQUIREMENTS AFTER REVIEWING SAID DOCUMENTS.

12. THE COMPANY WILL REQUIRE EITHER (A) A COMPLETE COPY OF THE TRUST AGREEMENT AND ANY AMENDMENTS THERETO CERTIFIED BY THE TRUSTEE(S) TO BE A TRUE AND COMPLETE COPY WITH RESPECT TO THE HEREINAFTER NAMED TRUST, OR (B) A CERTIFICATION, PURSUANT TO CALIFORNIA PROBATE CODE SECTION 18100.5, EXECUTED BY ALL OF THE CURRENT TRUSTEE(S) OF THE HEREINAFTER NAMED TRUST, A FORM OF WHICH IS ATTACHED.

    NAME OF TRUST : THE SANG MYUNG LIVING TRUST, U/A DATED MARCH 6, 2019
    AND THE KIM FAMILY TRUST, U/A DATED APRIL 3, 2023

3 EXCEPTION ITEMS

13. ANY INVALIDITY OR DEFECT IN THE TITLE OF THE VESTEES IN THE EVENT THAT THE TRUST REFERRED TO HEREIN IS INVALID OR FAILS TO GRANT SUFFICIENT POWERS TO THE TRUSTEE(S) OR IN THE EVENT THERE IS A LACK OF COMPLIANCE WITH THE TERMS AND PROVISIONS OF THE TRUST INSTRUMENT.

    IF TITLE IS TO BE INSURED IN THE TRUSTEE(S) OF A TRUST, (OR IF THEIR ACT IS TO BE INSURED), THIS COMPANY WILL REQUIRE A TRUST CERTIFICATION PURSUANT TO CALIFORNIA PROBATE CODE SECTION 18100.5.

    THE COMPANY RESERVES THE RIGHT TO ADD ADDITIONAL ITEMS OR MAKE FURTHER REQUIREMENTS AFTER REVIEW OF THE REQUESTED DOCUMENTATION.

14. IN ORDER TO COMPLETE THIS REPORT, THE COMPANY REQUIRES A STATEMENT OF INFORMATION TO BE COMPLETED BY THE FOLLOWING PARTY(IES),

    PARTY(IES): ALL PARTIES

    THE COMPANY RESERVES THE RIGHT TO ADD ADDITIONAL ITEMS OR MAKE FURTHER REQUIREMENTS AFTER REVIEW OF THE REQUESTED STATEMENT OF INFORMATION.

    NOTE:THE STATEMENT OF INFORMATION IS NECESSARY TO COMPLETE THE SEARCH AND EXAMINATION OF TITLE UNDER THIS ORDER. ANY TITLE SEARCH INCLUDES MATTERS THAT ARE INDEXED BY NAME ONLY, AND HAVING A COMPLETED STATEMENT OF INFORMATION ASSISTS THE COMPANY IN THE ELIMINATION OF CERTAIN MATTERS WHICH APPEAR TO INVOLVE THE PARTIES BUT IN FACT AFFECT ANOTHER PARTY WITH THE SAME OR SIMILAR NAME. BE ASSURED THAT THE STATEMENT OF INFORMATION IS ESSENTIAL AND WILL BE KEPT STRICTLY CONFIDENTIAL TO THIS

4 SURVEYOR CERTIFICATION

BASED ON CHICAGO TITLE COMPANY PRELIMINARY GUARANTEE NO. 122361152 DATED SEPTEMBER 25, 2023 AT 7:30AM,

TO;

TRACTOR SUPPLY COMPANY
DURBIN DEVELOPMENT COMPANY
CHICAGO TITLE COMPANY

THIS IS TO CERTIFY THAT THIS MAP OR PLAT AND THE SURVEY ON WHICH IT IS BASED WERE MADE IN ACCORDANCE WITH THE 2021 MINIMUM STANDARD DETAIL REQUIREMENTS FOR ALTA/NSPS LAND TITLE SURVEYS, JOINTLY ESTABLISHED AND ADOPTED BY ALTA AND NSPS, AND INCLUDES ITEMS 2, 3, 4, 7(A), 7(B)(1), 7(C), 8, 9, 11, 13, 16, 17, AND 20 OF TABLE A THEREOF. THE FIELDWORK WAS COMPLETED ON 10/20/2023.

DATE OF MAP: 10/28/2023

PROFESSIONAL LAND SURVEYOR
CHRISTOPHER D. JOHNSON
LS 7576
STATE OF CALIFORNIA

CHRISTOPHER D. JOHNSON
PLS 7576

5 FLOOD INFORMATION

BY GRAPHIC PLOTTING ONLY, THIS PROPERTY IS LOCATED IN ZONE "AO", "AREA WITHOUT A BASE FLOOD ELEVATION" WITH A DEPTH OF 1', VELOCITY OF 4 FEET PER SECOND, OF THE FLOOD INSURANCE RATE MAP, COMMUNITY PANEL NO. 06071C6450H, WHICH BEARS AN EFFECTIVE DATE OF 08/28/2008 AND IS LOCATED IN A SPECIAL FLOOD HAZARD AREA. NO FIELD SURVEYING WAS PERFORMED TO DETERMINE THIS ZONE AND AN ELEVATION CERTIFICATE MAY BE NEEDED TO VERIFY THIS DETERMINATION OR APPLY FOR A VARIANCE FROM THE FEDERAL EMERGENCY MANAGEMENT AGENCY.

ZONE "AO" - AREA DETERMINED TO BE OUTSIDE THE 500-YEAR FLOOD AND FROM 100-YEAR FLOOD.

6 CEMETERY

THERE IS NO VISIBLE EVIDENCE OF CEMETERIES ON THE SUBJECT PROPERTY AT THE TIME OF SURVEY.

7 STATEMENT OF ENCROACHMENTS

NO ENCROACHMENTS NOTED PER THIS SURVEY

8 ZONING INFORMATION

PER PROPERTY CONDITION REPORT "PERSONNEL AT THE MUNICIPAL ZONING OFFICE WERE CONSULTED, THE FILES AND WEBSITE WERE REVIEWED, AND/OR THE ZONING ORDINANCE WAS REVIEWED TO DETERMINE THE ZONING OF THE SUBJECT PROPERTY. ACCORDING TO THE INFORMATION PROVIDED, THE SUBJECT PROPERTY APPEARS TO BE LOCATED WITHIN A PHELAN/PINON HILLS GENERAL COMMERCIAL ZONE

PH/CG: PHELAN/PINON HILLS/GENERAL COMMERCIAL

11 SURVEYOR'S NOTES

1. PROPERTY HAS PHYSICAL ACCESS TO PHELAN ROAD FROM PROPERTY.
2. THIS SURVEY IS VALID ONLY IF THE DRAWING INCLUDES THE SEAL AND SIGNATURE OF THE SURVEYOR.
3. CERTIFICATION IS MADE TO THE ORIGINAL PURCHASER OF THE SURVEY. IT IS NOT TRANSFERABLE TO ADDITIONAL INSTITUTIONS OR SUBSEQUENT OWNERS.
4. SUBSURFACE AND ENVIRONMENTAL CONCERNS WERE NOT EXAMINED OR CONSIDERED AS A PART OF THIS SURVEY.
5. THE LOCATIONS OF UNDERGROUND UTILITIES AS SHOWN HEREON ARE BASED ON ABOVE GROUND STRUCTURES, SUBSURFACE LOCATION TOOLS, AND RECORD DRAWINGS PROVIDED TO THE SURVEYOR. LOCATIONS OF UNDERGROUND UTILITIES/ STRUCTURES MAY VARY FROM LOCATIONS SHOWN HEREON. NO EXCAVATIONS WERE MADE DURING THE PROCESS OF THIS SURVEY TO LOCATE UNDERGROUND UTILITIES/ STRUCTURES. DEPTHS UNKNOWN.
6. EVERY DOCUMENT OF RECORD REVIEWED AND CONSIDERED AS A PART OF THIS SURVEY IS NOTED ONLY THE DOCUMENTS NOTED HEREON WERE SUPPLIED TO THE SURVEYOR. THERE MAY EXIST OTHER DOCUMENTS OF RECORD WHICH WOULD AFFECT THIS PARCEL
7. DURING THE COURSE OF THE FIELD SURVEY THERE WAS NO OBSERVABLE EVIDENCE OF RECENT EARTH MOVING WORK OTHER THAN FIELD FARM TYPE PLOWING.
8. DURING THE COURSE OF THE FIELD SURVEY THERE WAS NO OBSERVABLE EVIDENCE OF BUILDING CONSTRUCTION OR BUILDING ADDITIONS WITHIN RECENT MONTHS.
9. DURING THE COURSE OF THE ALTA SURVEY THERE HAVE BEEN NO CHANGES IN THE STREET RIGHT-OF-WAY MADE AWARE TO THE SURVEYOR.
10. DURING THE COURSE OF THE FIELD SURVEY THERE WAS NO OBSERVABLE EVIDENCE OF SITE USE AS A SOLID WASTE DUMP SUMP OR SANITARY LANDFILL.
11. DURING THE COURSE OF THE FIELD SURVEY THERE WAS NO OBSERVABLE EVIDENCE OF A WETLANDS FIELD DELINEATION.
12. AT THE TIME OF THE INITIAL FIELD SURVEY, THERE WERE NO BUILDINGS ON THE SUBJECT PROPERTY.
13. PROFESSIONAL LIABILITY INSURANCE POLICY IN THE MINIMUM AMOUNT OF $ 1,000,000 TO BE IN EFFECT THROUGHOUT THE CONTRACT TERM.

12 PARKING INFORMATION

0 DEFINABLE STANDARD SPACES WITHIN LEASE LINE

0 DEFINABLE HANDICAP SPACES WITHIN LEASE LINE

0 CONFIRMABLE TOTAL PARKING SPACES WITHIN LEASE AREA

13 LAND AREA

PARCEL : 4.81 ACRES / 209,599 SQ FEET

TOTAL PARCEL : 4.81 ACRES / 209,599 SQ FEET

14 BUILDING AREA

VACANT LAND

15 BUILDING HEIGHT

VACANT LAND

19 UTILITY INFORMATION

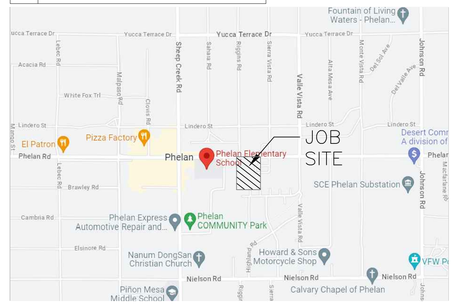
ON SITE UTILITIES ARE SHOWN PER PLANS PROVIDED BY CLIENT AND LOCATION OF OBSERVED EVIDENCE FOUND AT THE TIME OF THE SURVEY.

OFFSITE UTILITY COMPANIES:

ATTCAL	800-241-3624	COMNCA	925-232-3413
CTYSAL	831-758-7275	CWSSAL	831-767-3644
EXTSCA	615-554-4044	PACBEL	510-645-2929
PGESAL	661-205-9252	SALWTR	831-758-7150

△ = PLOTTED
○ = NON PLOTTABLE
□ = BLANKET
— = DOES NOT AFFECT

16 VICINITY MAP



ALTA SHEET INDEX

SHEET 1 TITLE SHEET
SHEET 2 BOUNDARY SHEET
SHEET 3 TOPO SHEET

Key to GLI Survey

1 LEGAL DESCRIPTION
2 OWNER TITLE INFORMATION
3 EXCEPTION 'B' ITEMS
4 SURVEYOR CERTIFICATION
5 FLOOD INFORMATION
6 CEMETERY
7 POSSIBLE ENCROACHMENTS
8 ZONING INFORMATION
9 LEGEND
10 BASIS OF BEARING
11 SURVEYOR'S NOTES
12 PARKING INFORMATION
13 LAND AREA
14 BUILDING AREA
15 BUILDING HEIGHT
16 VICINITY MAP
17 CLIENT INFORMATION BOX
18 PROJECT ADDRESS
19 UTILITY INFORMATION
20 BENCHMARK DESCRIPTION

17 BOUNDARY TOPO Survey

GEO LAND INC
SURVEYING • MAPPING • LEGAL DOCS
8854 GREENBACK LANE, SUITE 3
ORANGEVALE, CA, 95662.
916-871-4789
WWW.GEO-LANDINC.COM

Drwn By: AS/CJ	Date:
Surveyor Ref.No: LS 7576	Revision:
Aprvd By: CJ1	Date:
Field Date:	Revision:
Date:	Date:
	Revision:
	Date:
	Revision:

Prepared For:
DURBIN DEVELOPMENT COMPANY.

Client Ref. No: 1DDC01

18 PROJECT ADDRESS

4351 PHELAN ROAD,
PHELAN, CA

Project Name:
PHELAN TRACTOR SUPPLY COMPANY

GLI Project Number:
1DDC0101

ALTA-NSPS TOPOGRAPHIC SURVEY

WEST 1/2 OF THE N/W 1/4 OF THE N/E 1/4 OF THE N/W 1/4
OF SECTION 24, T. 4 N., R. 7 W., S.B.B.&M.,
COUNTY SAN BERNARDINO, STATE OF CALIFORNIA,

BOUNDARY SHEET

SHEET 2 OF 3 NOVEMBER 2023

GEO LAND INC
SURVEYING • MAPPING • LEGAL DOCS
8854 GREENBACK LANE, SUITE 3
ORANGEVALE, CA. 95662,
916-871-4789
WWW.GEO-LANDINC.COM

SCALE : 1" = 50'

0 50 100 150

10 BASIS OF BEARINGS

THE BEARING OF NORTH 89° 45' 06" EAST WAS TAKEN BETWEEN FOUND MONUMENTS AT THE NORTHWEST QUARTER CORNER AND THE NORTH QUARTER CORNER OF SECTION 24, T. 4 N., R. 7 W., SBB&M, AS SHOWN ON PARCEL MAP 655 FILED IN BOOK 6 OF PARCEL MAPS, PAGE 45, OFFICIAL RECORDS OF SAN BERNARDINO COUNTY.

REFERENCES

(1) 6 PM 45
(2) 201 MAPS 89
(3) 74 RS 61

LEGEND

- FOUND (FD.) SECTION CORNER
- FD. ¼ CORNER
- FD. CENTER SECTION
- FD. MONUMENT AS NOTED
- DIMENSION POINT
- BOUNDARY

ALTA SHEET INDEX

SHEET 1	TITLE SHEETS
SHEET 2	BOUNDARY SHEET
SHEET 3	TOPO SHEET

SURVEY SHEET INDEX NOTES:

REFER TO SHEET 1 FOR EXCEPTIONS
REFER TO SHEET 2 FOR BASIS OF BEARING
REFER TO SHEET 2 FOR BOUNDARY & EASEMENTS
REFER TO SHEET 3 FOR TOPOGRAPHIC INFORMATION

BENCHMARK 11
N/W ¼ SEC 24 FD 2" BC
1326.11'(1326.25')(2)
(1326.08')(3)
FD. 1" IP W/NAIL
AT ⅛ CORNER
332.01'
BASIS OF BEARINGS
N89°45'06"E(1) 2652.00'(2651.90')(1)(2653.29')(2)
1325.89'(1326.04')(2)
993.88'
N/W ¼ SEC 24
FD 2" BC
℄ SEC LINE
SEC 24
30.00'
30'
30.00'
52'
52'
52'
52'
N89°45'06"E 331.97'
INST. NO 1986-20823
(ORSB)
40'
10'
IRR
IRR
IRR
IRR
IRR
SHEEP CREEK ROAD
N00°33'20"W 2649.68'(N00°33'19"W 2649.61')(3)
1324.68'
STEVE H. CHO
4277 PHELAN ROAD
APN 3066-251-10
KIM FAMILY TRUST
APN 3066-251-09
4351 PHELAN ROAD
W ½ OF N/W ¼ OF N/E ¼ OF N/W ¼
SECTION 24, T.4 N., R.7 W.
AREA= 209,559.91 SQ.FT./4.81 ACRES
662.07'(662.20')(2)
632.07'
632.00'
S00°20'26"E 662.00'
HNY, LLC.
4359 PHELAN ROAD
APN 3066-251-08
N00°24'47"W 2648.89'(S00°25'00"E 2648.89')(2)
2648.28'(S00°25'00"E
1324.14'
6
POSSIBLE PIPELINE
EASEMENT
7
10' TELEPHONE EASEMENT
N00°16'35"W 695.75' (S00°16'56"E 695.94')(2)
661.81'
1323.61'
N00°16'35"W 2646.90'
VALLE VISTA ROAD
N89°44'25"E 331.17'
662.51'(662.24')(2)
993.14'
10.00'
FD. 1" IP
WASHER/NAIL
33.94'
(33.98')(2)
FD. 1" IP
W/ NAIL
APN 3066-251-14
TRACT 15454
255 MAPS 57
LOT A
LOT 4
LOT 3
N89°44'25"E 1324.07'
PALO VERDE COURT
SAGEBRUSH COURT
CONICERA COURT
194.07'
662.07'
661.81'
N/W ¼
SECTION 24
FD. 1" IP
W/NAIL
N89°44'16"E 1153.86'(N89°43'44"E 1154.08')(2)
FD. 1" IP
W/NAIL
Δ=90°00'51"
(90°00'40")(2)
L=251.41'
(251.36')(2)
R=160.03'
CH=N44°43'50"E
226.34'
189.87'(190.00')(2)
376.02'(376.00')(2)
408.10' (408.00')(2)
179.78'
(180.00')(2)
FD. 1" IP
W/NAIL
RIGGINS ROAD
SUNRISE BOULEVARD
SIERRA VISTA ROAD
SUNRISE COURT
FD. 1" IP
W/NAIL AT
⅛ CORNER
FD. 1" IP
REC 23227
AT ⅛ CORNER
1324.99'
1324.14'
1323.29'
1319.52'(1319.56'(3)
1319.57'
W ¼ SEC 24
FC 2" BC
FD. PK WASHER
SB CO AT ⅛ CORNER
N89°41'32"E 2639.09'
NIELSON ROAD
CTR ¼ SEC 24
FD PK WASHER
SB CO

ALTA-NSPS TOPOGRAPHIC SURVEY

WEST 1/2 OF THE N/W 1/4 OF THE N/E 1/4 OF THE N/W 1/4
OF SECTION 24, T. 4 N., R. 7 W., S.B.B.&M.,
COUNTY SAN BERNARDINO, STATE OF CALIFORNIA,

TOPO SHEET

SHEET 3 OF 3 NOVEMBER 2023

20 BENCHMARK DESCRIPTION

COUNTY OF SAN BERNARDINO BM STA HVC-11
ELEVATION = 4113.30 (NGVD29)
2" COUNTY BRASS DISK FLUSH WITH PAVEMENT AT
THE NORTHWEST QUARTER CORNER SECTION 24
T. 4 N., R. 7 W., SBB&M. AS SHOWN IN COUNTY FIELD
JOB LOG BOOK 10928, DATED SEPTEMBER 13, 2012 PAGE 5 OF 23.

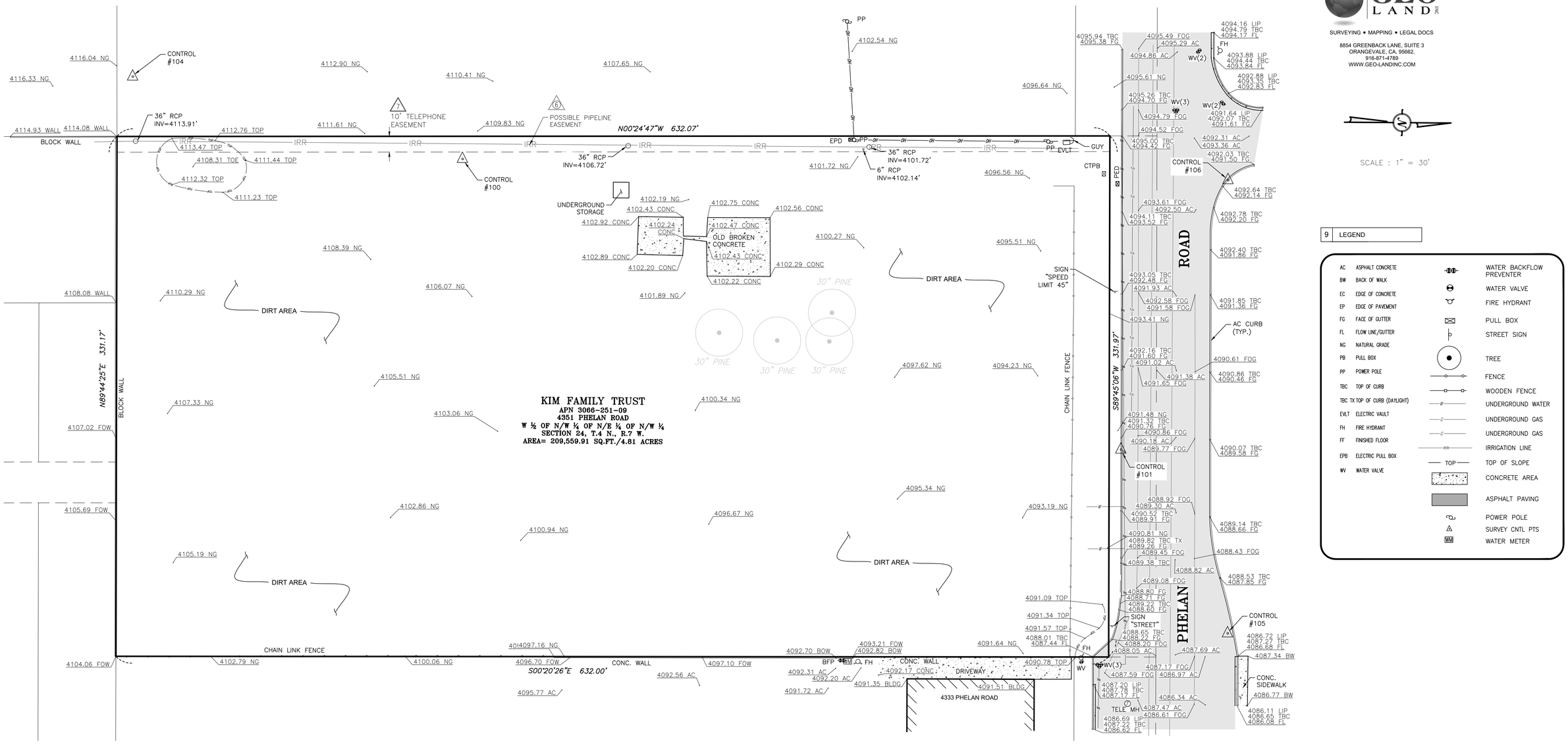
ALTA SHEET INDEX

SHEET 1 TITLE SHEETS
SHEET 2 BOUNDARY SHEET
SHEET 3 TOPO SHEET

SURVEY SHEET INDEX NOTES:

REFER TO SHEET 1 FOR EXCEPTIONS
REFER TO SHEET 2 FOR BASIS OF BEARING
REFER TO SHEET 2 FOR BOUNDARY & EASEMENTS
REFER TO SHEET 3 FOR TOPOGRAPHIC INFORMATION

GEO LAND INC
SURVEYING • MAPPING • LEGAL DOCS
8854 GREENBACK LANE, SUITE 3
ORANGEVALE, CA. 95662.
916-871-4789
WWW.GEO-LANDINC.COM



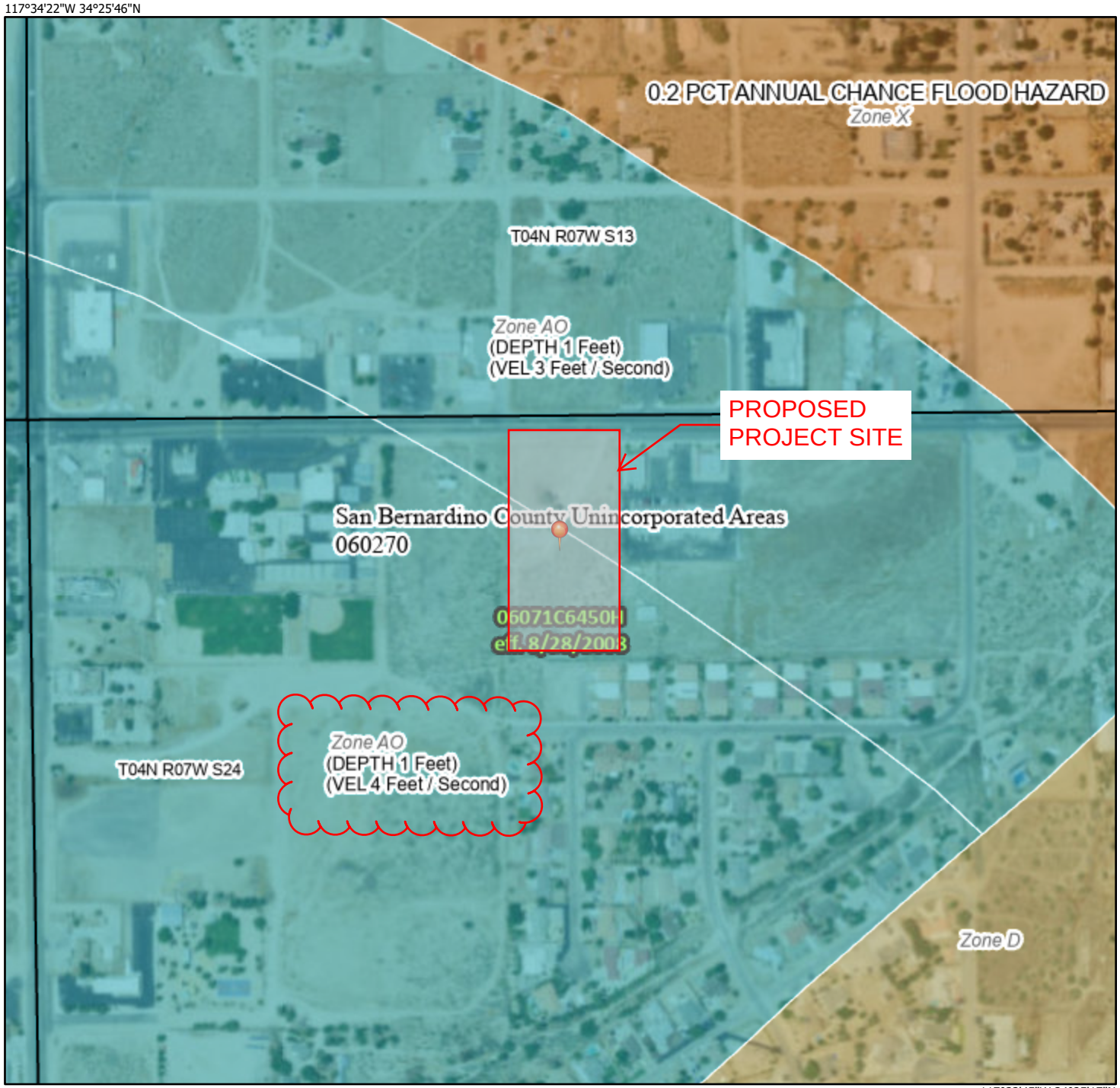
9 LEGEND

AC	ASPHALT CONCRETE		WATER BACKFLOW PREVENTER
BW	BACK OF WALK		WATER VALVE
EC	EDGE OF CONCRETE		FIRE HYDRANT
EP	EDGE OF PAVEMENT		PULL BOX
FG	FACE OF GUTTER		STREET SIGN
FL	FLOW LINE/GUTTER		TREE
NG	NATURAL GRADE		FENCE
PB	PULL BOX		WOODEN FENCE
PP	POWER POLE		UNDERGROUND WATER
TBC	TOP OF CURB		UNDERGROUND GAS
TBC TX	TOP OF CURB (DAYLIGHT)		UNDERGROUND GAS
EVLT	ELECTRIC VAULT		IRRIGATION LINE
FH	FIRE HYDRANT	TOP	TOP OF SLOPE
FF	FINISHED FLOOR		CONCRETE AREA
EPB	ELECTRIC PULL BOX		ASPHALT PAVING
WV	WATER VALVE		POWER POLE
			SURVEY CNTL PTS
		WM	WATER METER

SCALE : 1" = 30'

National Flood Hazard Layer FIRMette

FEMA



Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

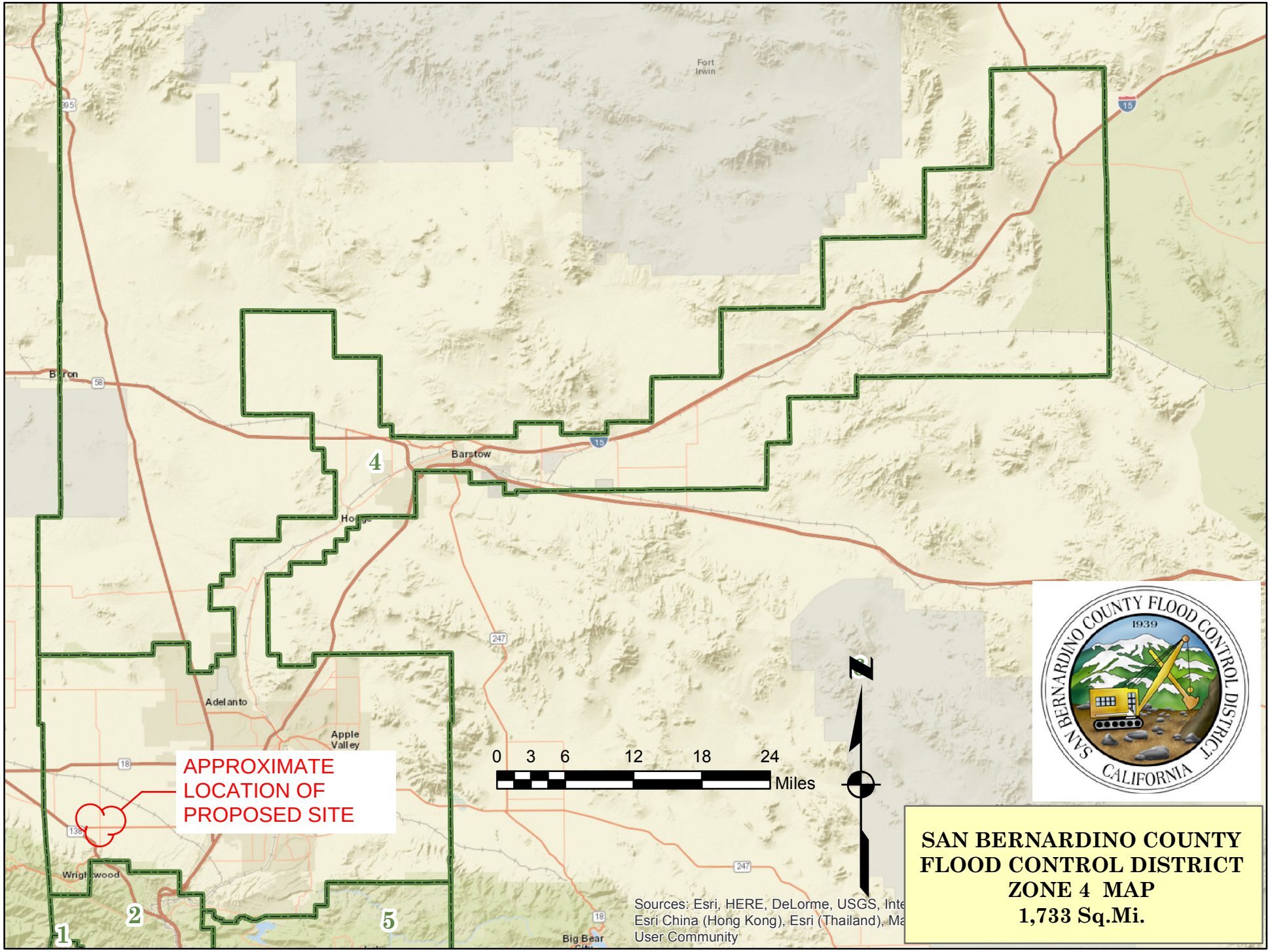
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

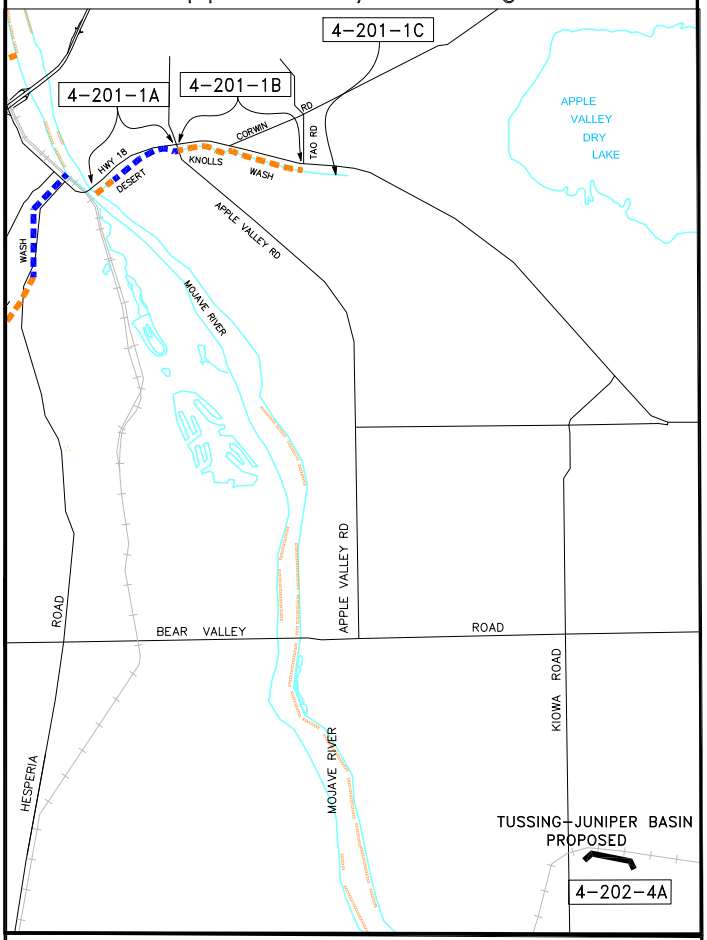
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/20/2023 at 12:34 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

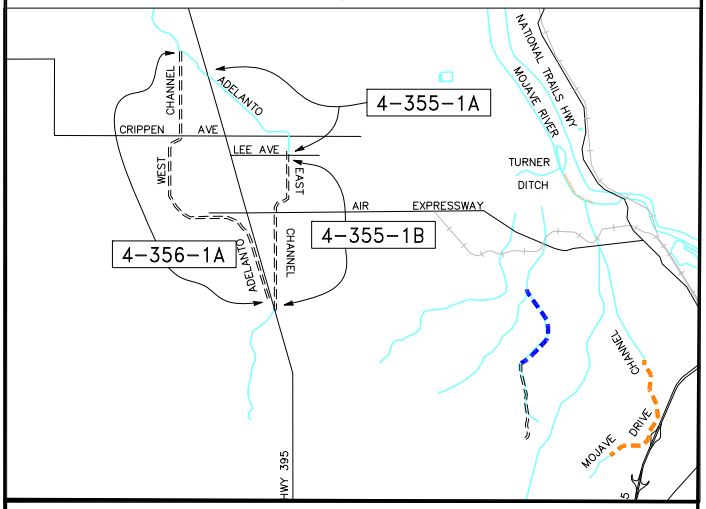
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.


Fort Irwin
Barstow
Adelanto
Apple Valley
Big Bear
4
1
2
5
APPROXIMATE LOCATION OF PROPOSED SITE
0 3 6 12 18 24
Miles
N
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT
1939
CALIFORNIA
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT
ZONE 4 MAP
1,733 Sq.Mi.

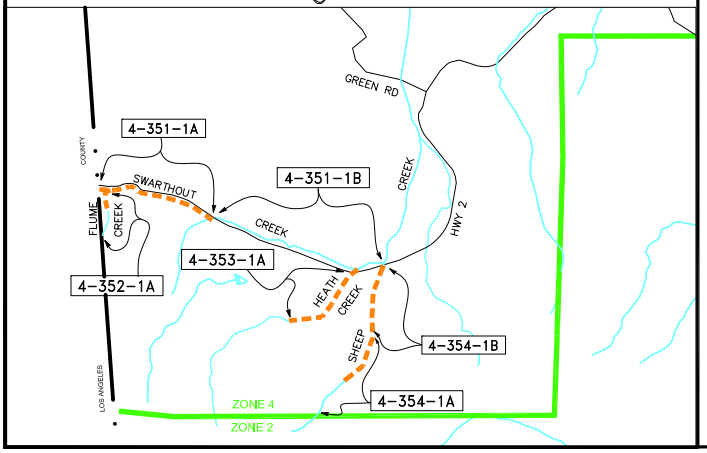
Apple Valley Drainage



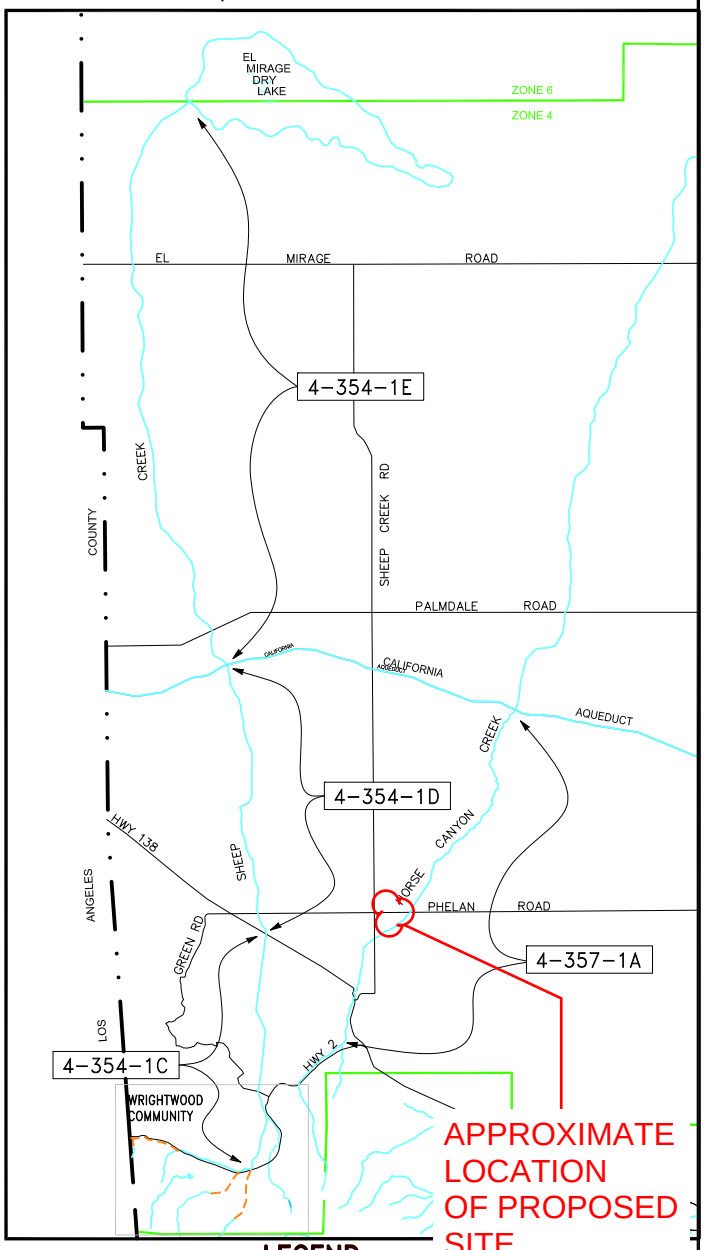
Adelanto West/East Channels



Wrightwood



Sheep Creek and Phelan



LEGEND

1-201-1D — F.C.D. SYSTEM NUMBER AND REACH

FLOOD CONTROL SYSTEM

ULTIMATE	INTERIM	
		CHANNEL
		STORM DRAIN
		LEVEE (xxx Existing Interim Revetment)
		BASIN OR DAM
		CHECKDAM
		MITIGATION/ENVIRONMENTAL

RELATED FACILITIES

- WATERCOURSE
- NON SYSTEM CHANNELS, STREET WATERWAYS OR STORM DRAINS, & CHANNELS IN RIVERSIDE CO.
- COUNTY BOUNDARY LINE

NOTE:

SYMBOLOGY TAKES PRECEDENCE OVER NAMING CONVENTION

S.B.C.F.C.D. SYSTEM INDEX

APPLE VALLEY, PHELAN, WRIGHTWOOD & EL MIRAGE SYSTEMS

4-200-00 thru 4-357-00

REV. DATE:	ACAD NO:	S.B.C.F.C.D. FILE NO.:
1-2023	SI4200	RM-D4-8

Figure F-1

PROPOSED SITE IS NORTH OF MAP BOUNDARY. SEE NEXT SHEET.

Ranchero Basin
Mojave River
Mojave River Forks Dam: COE [DSOD]
Horsethief Canyon
Cleghorn Canyon
Sawpit Canyon
Deep Creek
Grout Creek
Bear Creek
Sand Canyon Creek
Caion Creek Wash
Bailey Basin
Devil Basin #4
Devil Basin #7
Wiggins Basin #1
Sycamore Basin
Waterman Basin #1
Waterman Spreading Grounds
Twin Creek Spreading Grounds
Lytle Creek Wash
Day Creek Dam [DSOD]
Hillside Basin, COE
Rich Basin
San Antonio Dam
Demens Basin #2
San Antonio Basin #2
San Antonio Basin #5
San Sevaine Basin #5 [DSOD]
STATE HWY 210
Cucamonga Basin #6
San Antonio Basin #8
San Antonio Basin #9
College Heights Basin #1
College Heights Basin #4
Montclair Basin #1
Montclair Basin #2
Montclair Basin #4
Victoria Basin
Church Street Basin
8th Street Basin #1
Turner Basin #1
Banana Basin
Etiwanda Conservation Basin
Brooks Basin
Jurupa Basin [DSOD]
Wineville Basin
Ely Basin #2
Riverside Basin
Grove Avenue Basin
Lower Cucamonga Spdg Grnds
Cactus Basin #5
Cactus Basin #3b
Cactus Basin #2
Lytle Creek Gatehouse, COE
Linden Basin
Warm Creek Conservation Basin #4
Santa Ana River
Sand Canyon Basin
Dynamite Basin
Patton Basin
Cook Canyon Basin
Perris Hill Basin
Bledsoe Basin
City Creek Spreading Grounds
Seven Oaks Dam, COE [DSOD]
Seven Oaks Dam, COE
Plunge Creek Spreading Grounds
Mill Creek
Zanja Creek
Morey Arroyo
Wilson Creek Basin #3
Potato Creek Spreading Grounds
13th Street Basin
Oak Glen C
San Timoteo Sediment Basin #3
Mountain View Basin
San Timoteo Sediment Basin #13
San Timoteo Sediment Basin #14
Yucaipa Creek
Wildwood Basin #2
NF Dak Creek
Prado Dam
Cypress Channel
STATE HWY 71
STATE HWY 60
STATE 91
I 10 - I 15
I 215
STATE HWY 259
H01
H02
H02A
H02B
H03
H04
H05
H06
H07
H08
H09
H10
H11
H12
A
B
C
E
F
G
I
J
U
W
II
III
IV
V
VI
VII
VIII
IX
X
XIII

Legend

- Regional Board Boundary
- County Boundary

DrainageCourse

- <all other values>

Hydromodification

- EHM
- Low
- Medium
- High
- High (Default)

- Government Land
- State of California Land
- United States of America Land
- City Boundary
- Freeways
- Basins and Dams

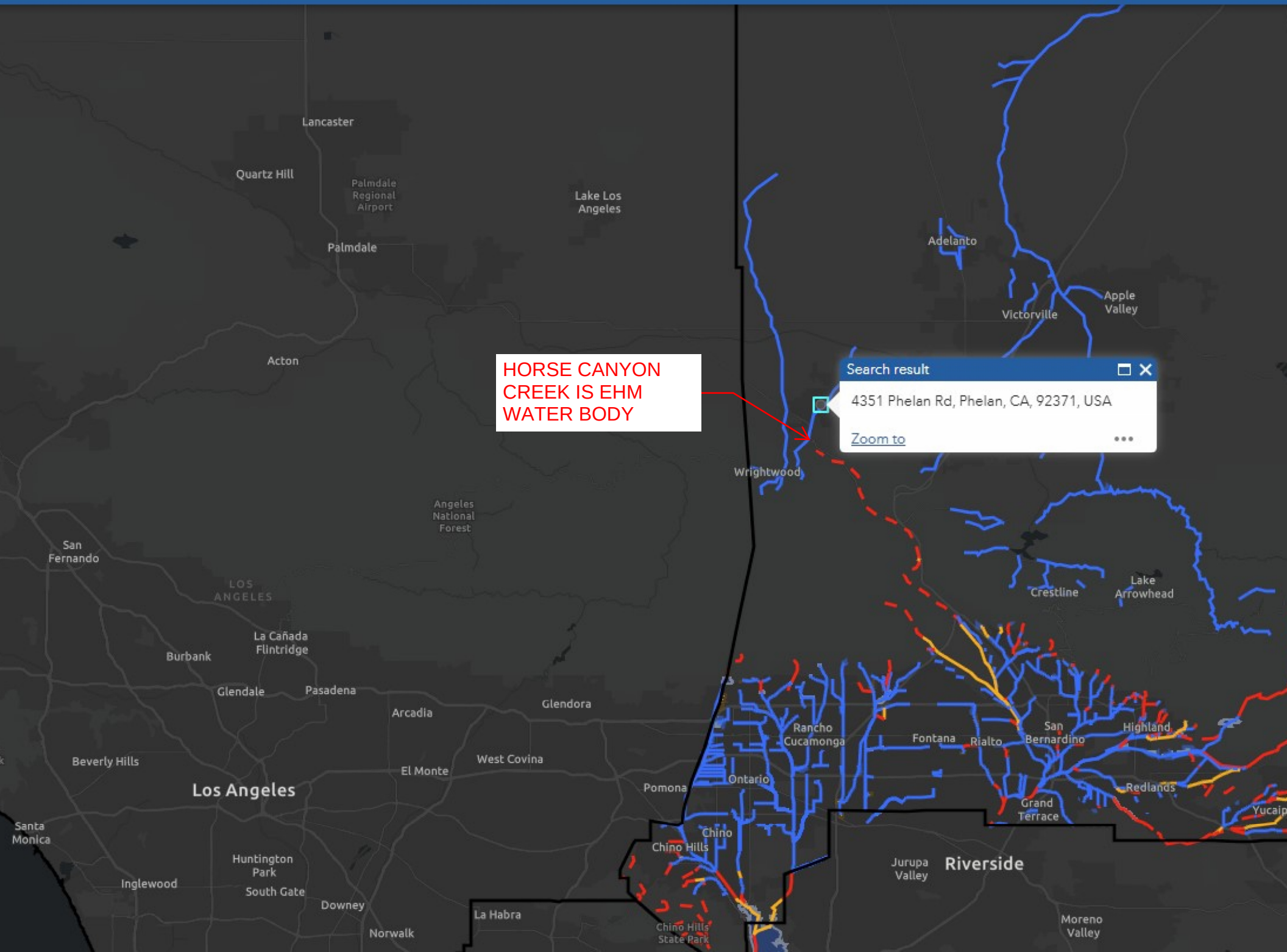
HCOC Exempt Areas

- None Exempt

HCOC Exempt

A, B, C, E, F, G, H01, H02, H02A, H02B, H03, H04, H05, H06, H07, H08, H09, H10, H11, H12, I, II, III, IV, V, VI, VII, VIII, IX, J, U, W, X, XIII

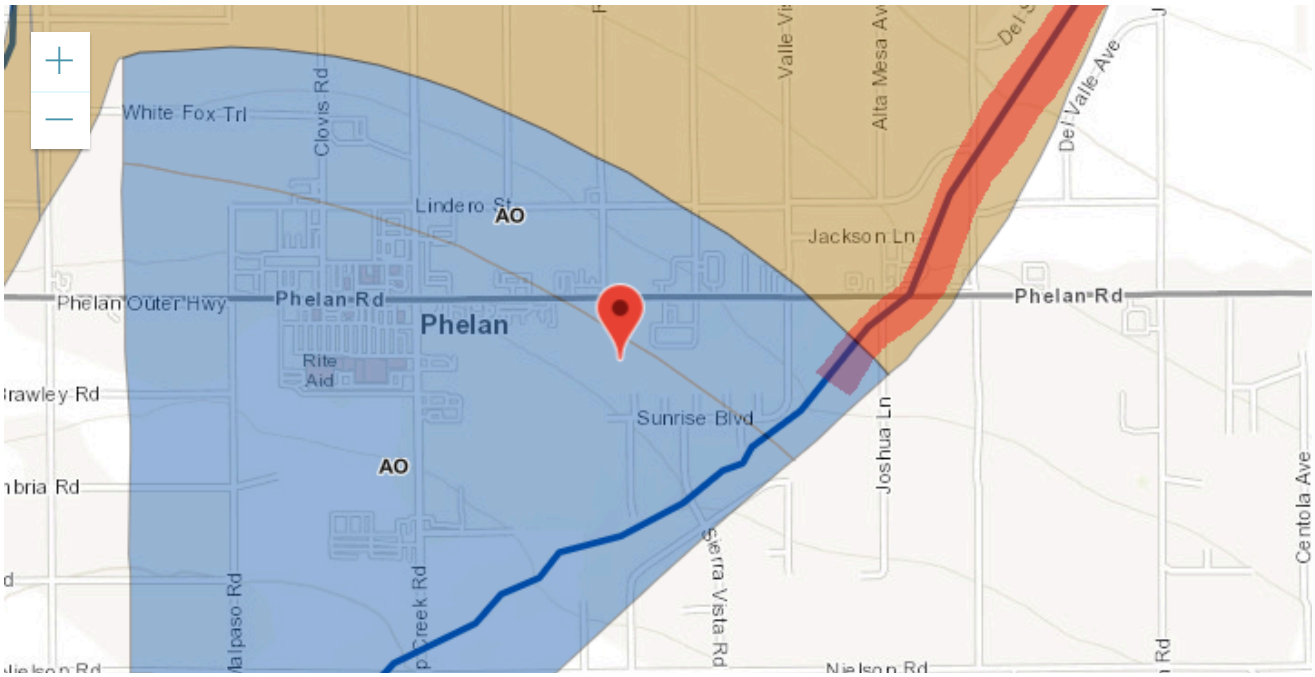
SNAPSHOT FROM SAN BERNARDINO COUNTY GIS TOOL



CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Floodplain Information

Latitude: 34.42541, Longitude: -117.56764

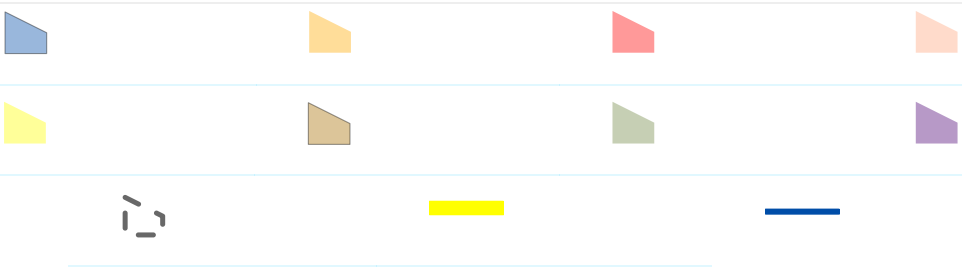


County: San Bernardino (34.42541, -117.56764)

Floodplain Layer	100-YR	200-YR	500-YR
FEMA Effective	AO ✓	N/A	Y ✓
DWR Awareness	N ✓	N/A	N/A
Regional/Special Studies	N ✓	N/A	N ✓
USACE Comp. Study	N ✓	N ✓	N ✓

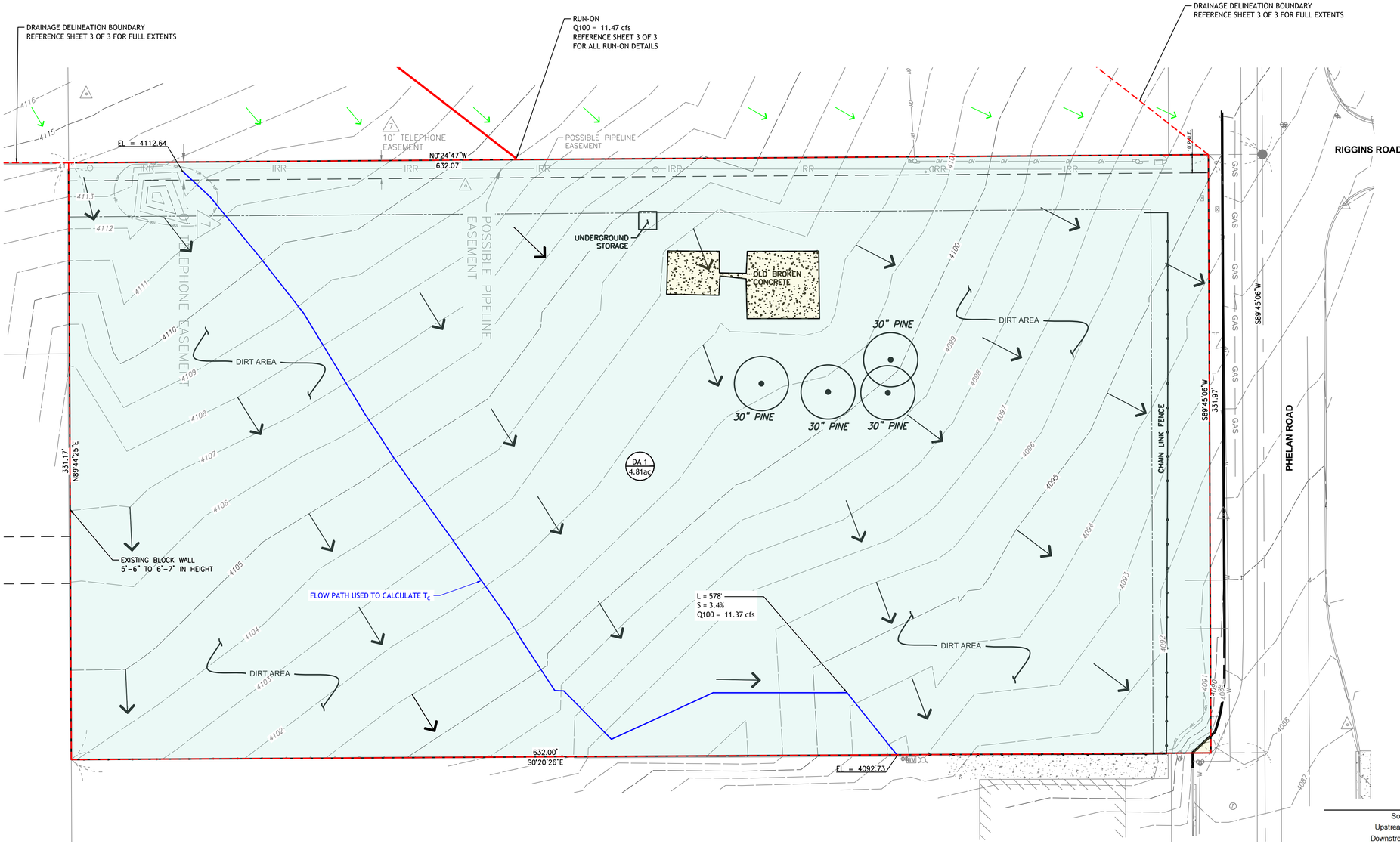
Y: The location is within the floodplain
N: The location is not within the floodplain
N/A: Data not available
✓ = Active Layer(s)

Floodplains are displayed using semi transparent colors. When viewing overlapping floodplains, the combination of multiple semi transparent colors will not match the legend colors. For accurate color representation, view floodplains individually.



APPENDIX B: Existing and Proposed Conditions Maps

TRACTOR SUPPLY COMPANY - PHELAN, CA
EXISTING CONDITIONS DMA EXHIBIT



0 15' 30' 60'
SCALE: 1"=30'

LEGEND

- DA BOUNDARY
- EXISTING IMPERVIOUS
- EXISTING PERVIOUS
- FLOW ARROW
- EXISTING CONTOURS
- PATH OF FLOW FOR RUN-ON FROM OFF-SITE

DA#1 (Existing)

Soil Type	Tujunga Sand (Hydrologic Soil Group A)			
Upstream Elevation	4114.06			
Downstream Elevation	4087.83			
Land Cover	Area (SF)	Percentage	Curve Number	Color
Impervious Cover	2333	1.1	98	
Open Brush - Fair Cover	207267	98.9	66	
Total	209600	100.0		
Total (ac)	4.81			
Rainfall Intensities (in/hr)				
2yr-18 minutes	0.94			
5yr-18 minutes	1.32			
10yr-18 minutes	1.67			
25yr-18 minutes	2.17			
100yr-18 minutes	3.01			
Peak Discharge Rate (100-yr)	10.72	cfs		

PRELIMINARY NOT FOR CONSTRUCTION

Title: EXISTING CONDITIONS DMA EXHIBIT
4351 PHELAN ROAD
PHELAN, CA

For: DURBAN DEVELOPMENT
106 FOSTER AVENUE, CHARLOTTE,
NORTH CAROLINA, 28203

LICENSED PROFESSIONAL ENGINEER
HAL P. CHUBB
87814
STATE OF CALIFORNIA
CIVIL
Not for Construction

Scale: Horizontal 1" = 30' Vertical N/A
Designed BB
Drawn BB
Checked MTL
Approved HPC
Date 6/11/25

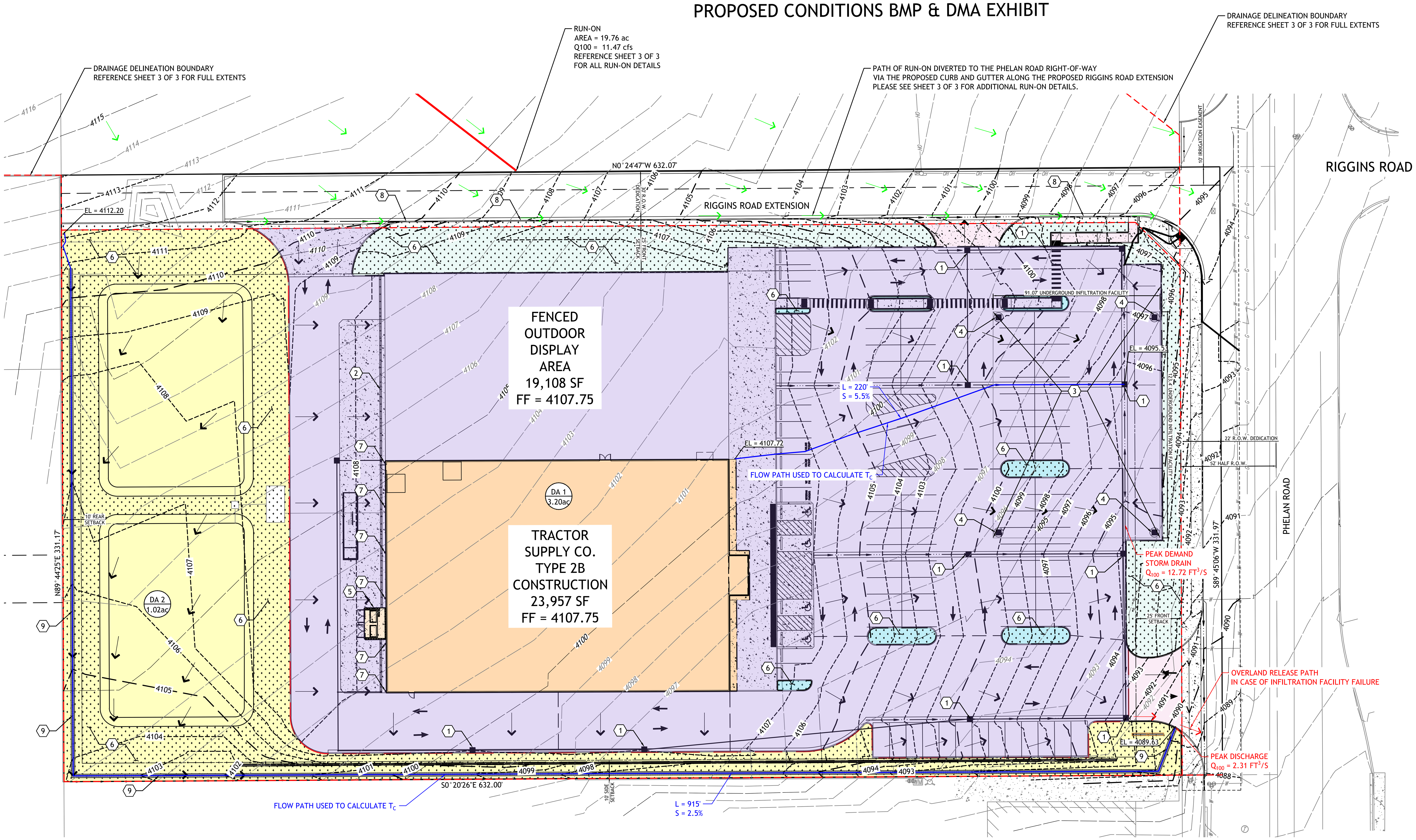
Barghausen Consulting Engineers, LLC.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222
barghausen.com

Job Number 23228
Sheet 1 OF 3

P:\23000s\23228\preliminary\storm\CAD\23228 Existing DMA.dwg 6/11/2025 4:23 PM BBLADES

TRACTOR SUPPLY COMPANY - PHELAN, CA

PROPOSED CONDITIONS BMP & DMA EXHIBIT



DA#1					
Soil Type	Tujunga Sand (Hydrologic Soil Group A)				
Upstream Elevation	4110.89				
Downstream Elevation	4092.12				
Land Cover	Area (SF)	Percentage	Curve Number	Treated By	Color
Impervious Cover	101174	72.5	98	BMP-01	
Buildings/Roofs	24617	17.6	98	BMP-01	
De Minimis Impervious	1929	1.4	98	De Minimis	
Commercial Landscape-Drains to Infiltration	1226	0.9	52	BMP-01	
Commercial Landscape-Self Treating	10649	7.6	52	Self-Treating	
Total	139595	100.0			
Total (ac)	3.20				
Rainfall Intensities (in/hr)					
2yr-5min	1.42				
10yr-5min	2.51				
25yr-5min	3.24				
100yr-5min	4.48				
Peak Discharge Rate (100-yr)	12.72	cfs			

DA#2					
Soil Type	Tujunga Sand (Hydrologic Soil Group A)				
Upstream Elevation	4112.2				
Downstream Elevation	4088.51				
Land Cover	Area (SF)	Percentage	Curve Number	Treated By	Color
Impervious Cover	480	1.1	98	De Minimis	
Commercial Landscaping	44068	98.9	52	Self-Treating	
Total	44548	100.0			
Total (ac)	1.02				
Rainfall Intensities (in/hr)					
2yr-16min	1.02				
10yr-16min	1.83				
25yr-16min	2.35				
100yr-16min	3.25				
Peak Discharge Rate (100-yr)	2.31	cfs			

CONSTRUCTION NOTES

1. PROPOSED PRECAST CATCH BASIN INLET. PROVIDE "ONLY RAIN IN THE DRAIN" LETTERING OR SIMILAR. (STRUCTURAL SOURCE CONTROL BMP S1).
2. PROPOSED TRENCH DRAIN DRAINING TO PROPOSED UNDERGROUND INFILTRATION.
3. BMP-01: PROPOSED UNDERGROUND INFILTRATION FACILITY CONSISTING OF ADS LANDMAX 5' DIAMETER PERFORATED HDPE PIPES.
4. PROPOSED ACCESS RISER.
5. PROPOSED TRASH ENCLOSURE BUILT TO COUNTY STANDARDS WITH ROOF (STRUCTURAL SOURCE CONTROL BMP S3.
6. PROPOSED ON-SITE LANDSCAPING AREA DESIGNED WITH EFFICIENT IRRIGATION (STRUCTURAL SOURCE CONTROL BMP S4). FINISH GRADE OF LANDSCAPED AREAS AT A MINIMUM OF 1-2 INCHES BELOW TOP OF CURB, SIDEWALK OR PAVEMENT (STRUCTURAL SOURCE CONTROL BMP S5).
7. DRAINAGE DOWNSPOUT FROM ROOF. RUNOFF COLLECTED BY TRENCH DRAIN AND CONVEYED TO INFILTRATION FACILITY.
8. PROPOSED CURB AND GUTTER IN RIGGINS ROAD EXTENSION TO TRANSPORT RUN-ON FROM PARCELS TO THE SOUTH TO PHELAN ROAD R.O.W., MAINTAINING EXISTING DRAINAGE PATTERN.
9. PROPOSED COBBLE SWALE TO TRANSPORT RUN-OFF FROM PROPOSED LANDSCAPED AREA OFF-SITE MATCHING THE EXISTING DRAINAGE PATTERN.

LEGEND

- BUILDING LINE
- EXISTING CURB TO REMAIN
- PROPOSED CURB
- PROPOSED LANDSCAPING
- PROPOSED CONCRETE
- PROPOSED ON-SITE FLOW DIRECTION
- PATH OF FLOW FOR RUN-ON FROM OFF-SITE
- PROPOSED OVERLAND FLOW DIRECTION (IN EVENT OF SYSTEM FAILURE)
- PROPOSED CONTOURS
- EXISTING CONTOURS
- DMA BOUNDARY
- DA BOUNDARY

Title: PROPOSED CONDITIONS DMA EXHIBIT
4351 PHELAN ROAD
PHELAN, CA

For: DURBAN DEVELOPMENT
106 FOSTER AVENUE, CHARLOTTE,
NORTH CAROLINA, 28203

HAL P. GUBB 87814 CIVIL STATE OF CALIFORNIA — Not for Construction

Scale: Horizontal 1" = 30' Vertical N/A

Designed BB | Drawn BB | Checked MTL | Approved HPG | Date 6/11/25

Barghausen Consulting Engineers, LLC.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222
barghausen.com

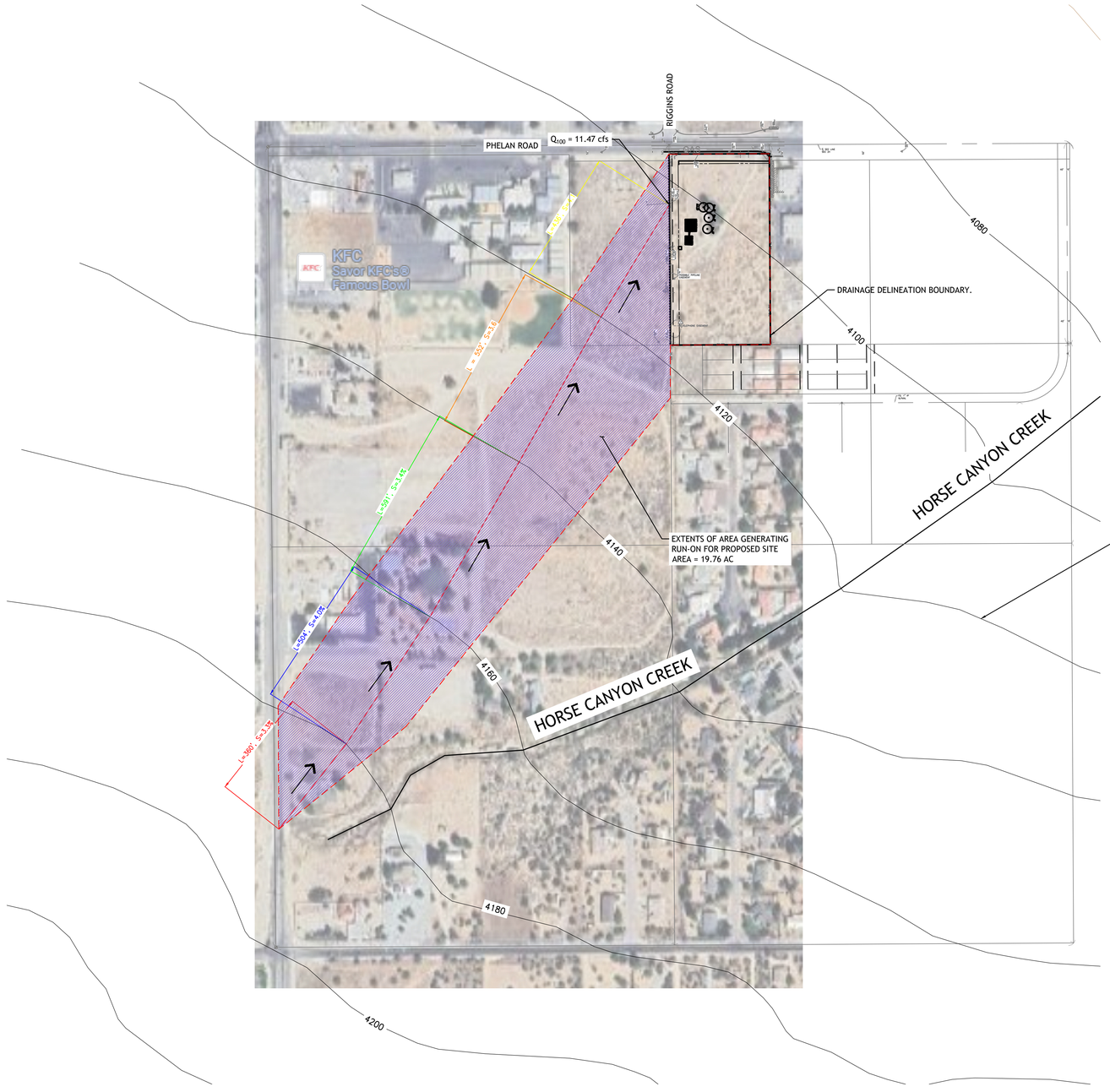
Job Number 23228

Sheet 2 OF 3

P:\23000s\23228\preliminary\storm\CAD\23228 Proposed DMA.dwg 6/11/2025 5:12 PM BBADES

PRELIMINARY NOT FOR CONSTRUCTION

TRACTOR SUPPLY COMPANY - PHELAN, CA
RUN-ON EXHIBIT



LEGEND

- FLOW ARROW
- EXISTING CONTOURS
- DRAINAGE DELINEATION BOUNDARY

N

0 100' 200' 400'

SCALE: 1"=200'

CONTOURS PER USGS MAP:
"PHELAN QUADRANGLE
CALIFORNIA - SAN BERNRADINO COUNTY
7.5-MINUTE SERIES"

Run-On Area			
Soil Type	Tujunga Sand (Hydrologic Soil Group A)		
Upstream Elevation	4190 (approx.)		
Downstream Elevation	4095 (approx)		
Land Cover (Assumed)	Area (SF)	Percentage	Curve Number
Impervious Cover	205365	25	98
Open Brush - Fair	616094	75	66
Total	821459		
Total (ac)	18.86		
Rainfall Intensities (in/hr)			
2yr-81 minutes	0.33		
5yr-81 minutes	0.465		
10yr-81 minutes	0.59		
25yr-81 minutes	0.76		
100yr-81 minutes	1.05		
Peak Discharge Rate (100-year)	11.47 cfs		

PRELIMINARY NOT FOR CONSTRUCTION

Title: RUN-ON EXHIBIT
4351 PHELAN ROAD
PHELAN, CA

For: DURBAN DEVELOPMENT
106 FOSTER AVENUE, CHARLOTTE,
NORTH CAROLINA, 28203

LICENSED PROFESSIONAL ENGINEER
HAL P. BLANKENSHIP
17814
Not for Construction
CIVIL
STATE OF CALIFORNIA

Scale: Horizontal 1" = 200' Vertical N/A

Designed BB
Drawn BB
Checked MTL
Approved HPG
Date 6/11/25

Barghausen Consulting Engineers, LLC.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222
barghausen.com

Job Number 23228

Sheet 3 OF 3

P:\23000s\23228\preliminary\storm\CAD\23228 Run-On Exhibit.dwg 6/11/2025 5:16 PM BBLADES

APPENDIX C: Hydrology Calculations

Existing Conditions

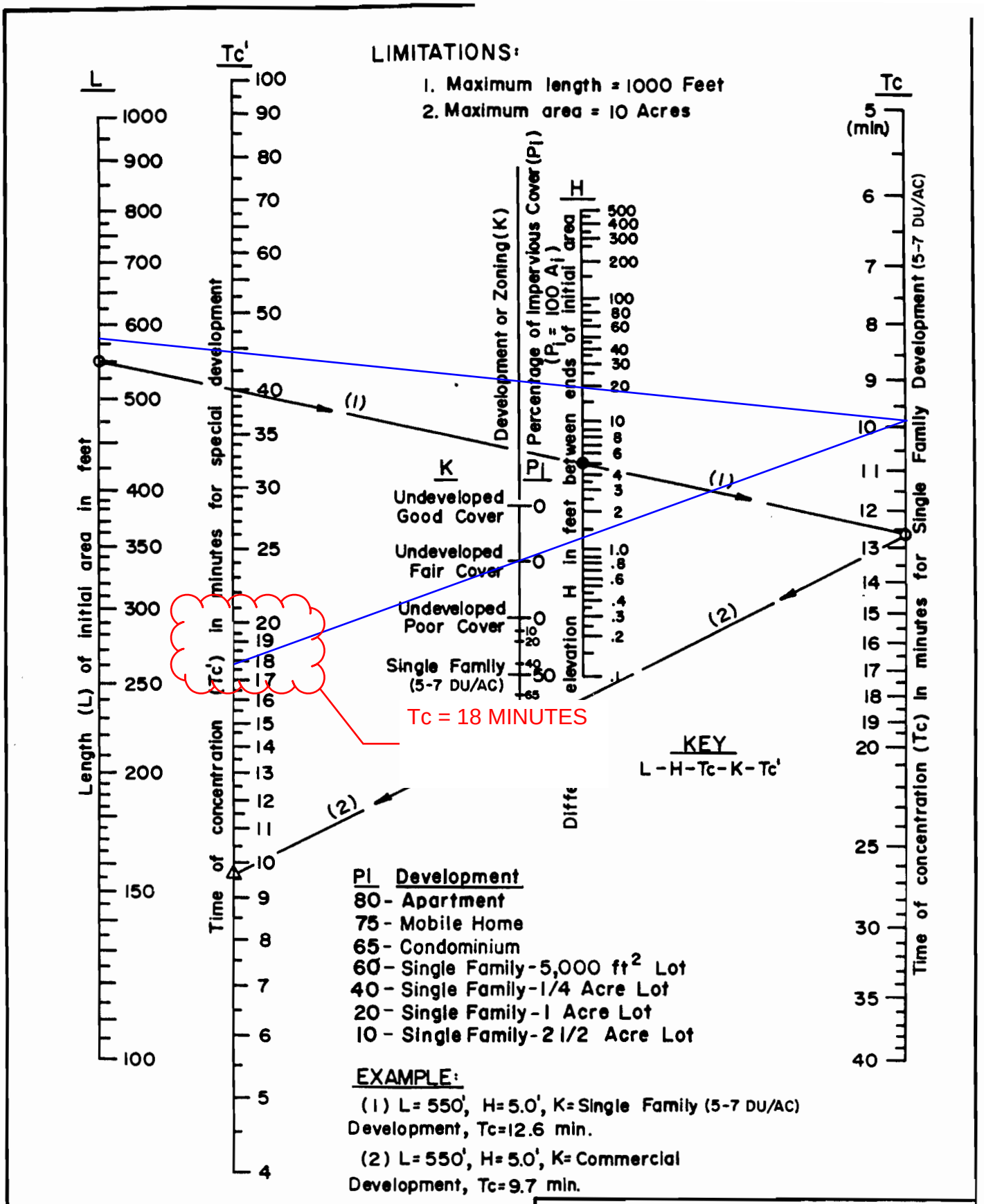
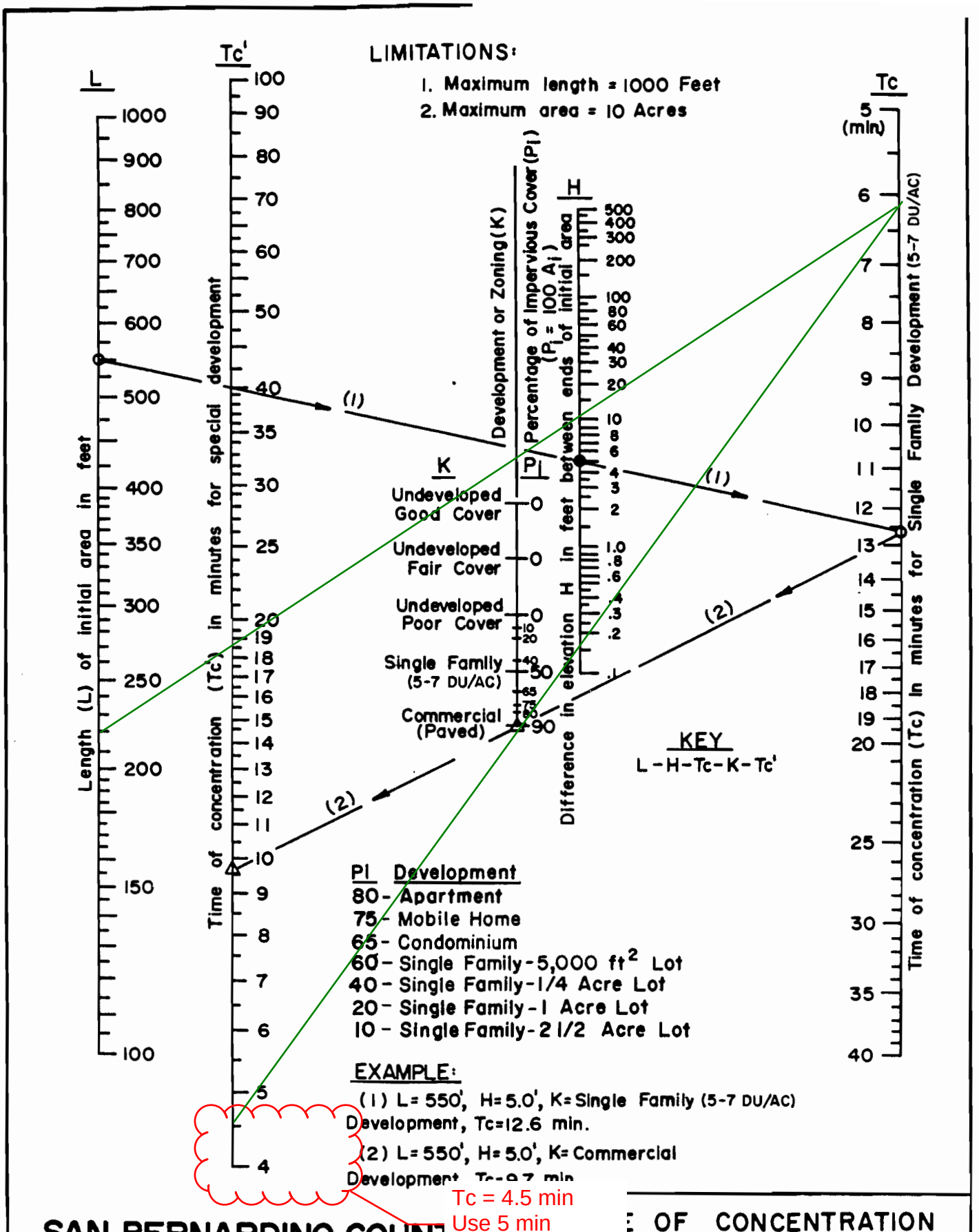


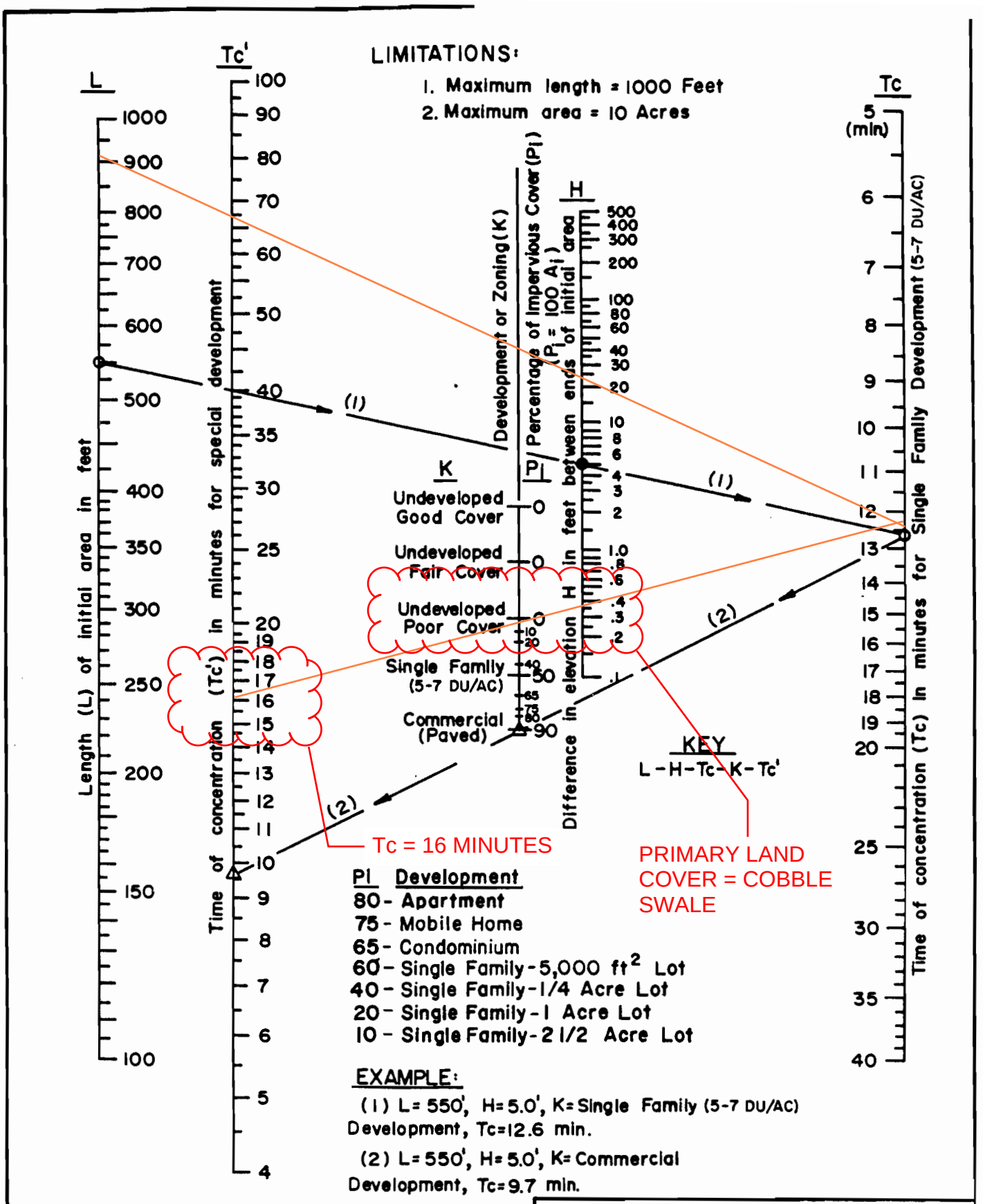
Figure D-1



SAN BERNARDINO COUNT : OF CONCENTRATION NOMOGRAPH

HYDROLOGY MANUAL | FOR INITIAL SUBAREA

Figure D-1

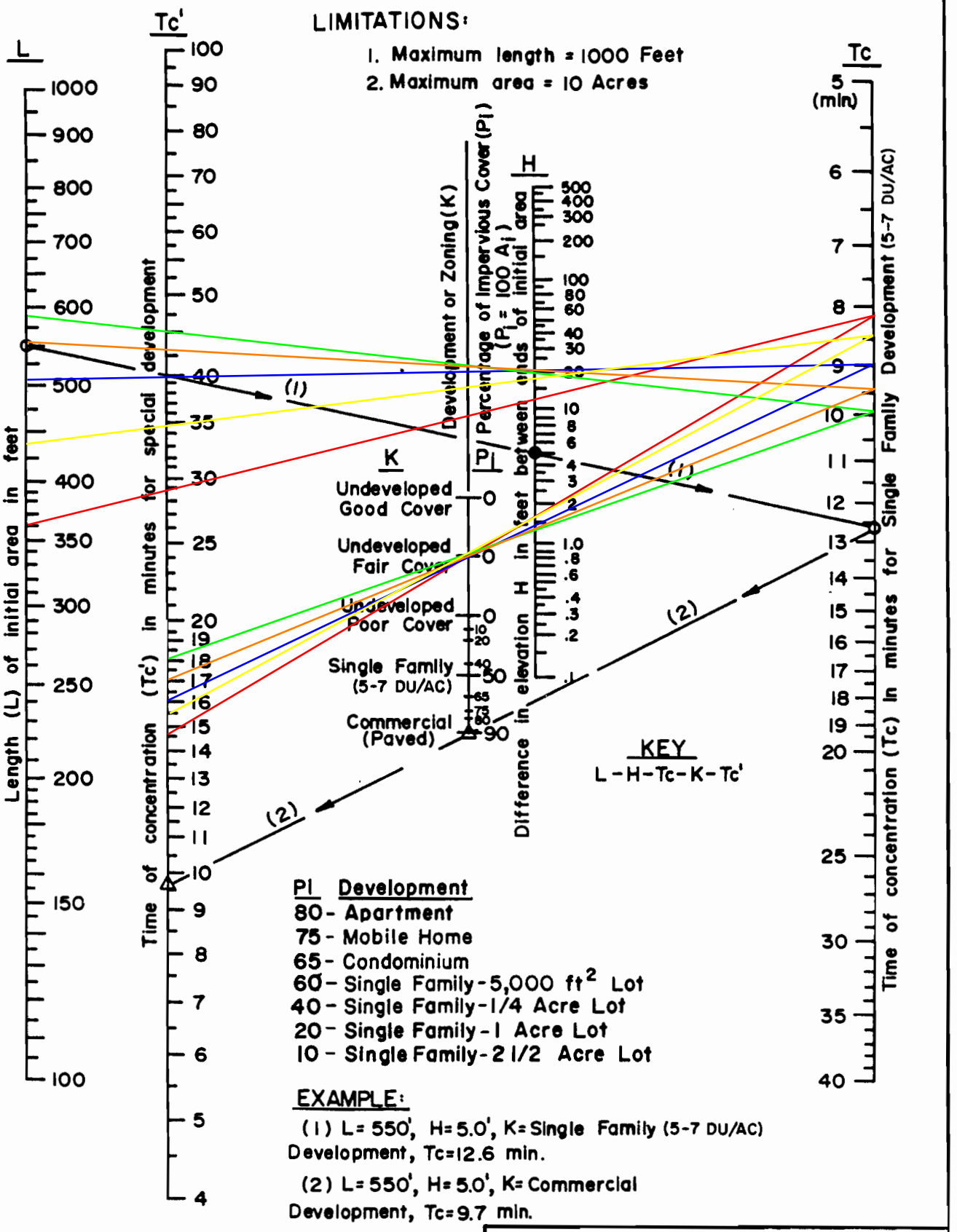


SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

Total Tc = 81 minutes



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

NOAA Atlas 14, Volume 6, Version 2
Location name: Phelan, California, USA*
Latitude: 34.4254°, Longitude: -117.5676°
Elevation: 4105 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

USED TO DETERMINE FLOW RATES FOR DA#1 (Tc = 5 MIN)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.996** (0.828-1.21)	**1.42** (1.18-1.73)	**2.00** (1.66-2.46)	**2.51** (2.05-3.11)	**3.24** (2.57-4.14)	**3.84** (2.98-5.00)	**4.48** (3.38-5.98)	**5.16** (3.79-7.09)	**6.12** (4.32-8.78)	**6.91** (4.70-10.3)
10-min	**0.714** (0.594-0.870)	**1.02** (0.840-1.24)	**1.44** (1.19-1.76)	**1.80** (1.48-2.23)	**2.33** (1.84-2.97)	**2.75** (2.13-3.59)	**3.20** (2.42-4.28)	**3.70** (2.71-5.08)	**4.39** (3.09-6.29)	**4.96** (3.37-7.36)
15-min	**0.576** (0.480-0.704)	**0.820** (0.680-1.00)	**1.16** (0.956-1.42)	**1.45** (1.19-1.79)	**1.88** (1.48-2.39)	**2.22** (1.72-2.89)	**2.58** (1.95-3.46)	**2.98** (2.19-4.10)	**3.54** (2.49-5.08)	**3.99** (2.72-5.93)
30-min	**0.414** (0.344-0.504)	**0.588** (0.486-0.718)	**0.832** (0.686-1.02)	**1.04** (0.852-1.29)	**1.34** (1.06-1.72)	**1.59** (1.23-2.07)	**1.85** (1.40-2.48)	**2.14** (1.57-2.94)	**2.54** (1.79-3.64)	**2.86** (1.95-4.25)
60-min	**0.285** (0.236-0.348)	**0.405** (0.335-0.495)	**0.574** (0.473-0.702)	**0.718** (0.587-0.886)	**0.927** (0.733-1.18)	**1.10** (0.849-1.43)	**1.28** (0.966-1.71)	**1.47** (1.08-2.02)	**1.75** (1.23-2.51)	**1.97** (1.34-2.93)
2-hr	**0.210** (0.174-0.256)	**0.288** (0.238-0.351)	**0.395** (0.326-0.484)	**0.487** (0.399-0.602)	**0.619** (0.490-0.791)	**0.726** (0.562-0.947)	**0.839** (0.634-1.12)	**0.959** (0.704-1.32)	**1.13** (0.795-1.62)	**1.26** (0.860-1.88)
3-hr	**0.174** (0.144-0.212)	**0.235** (0.194-0.287)	**0.319** (0.263-0.391)	**0.391** (0.320-0.483)	**0.493** (0.390-0.630)	**0.576** (0.446-0.751)	**0.663** (0.501-0.886)	**0.756** (0.555-1.04)	**0.886** (0.624-1.27)	**0.989** (0.673-1.47)
6-hr	**0.125** (0.103-0.152)	**0.167** (0.138-0.204)	**0.225** (0.186-0.276)	**0.275** (0.224-0.339)	**0.344** (0.272-0.439)	**0.399** (0.309-0.521)	**0.457** (0.346-0.611)	**0.519** (0.381-0.714)	**0.605** (0.426-0.868)	**0.673** (0.458-1.00)
12-hr	**0.082** (0.068-0.100)	**0.114** (0.094-0.139)	**0.157** (0.129-0.192)	**0.192** (0.157-0.237)	**0.242** (0.191-0.309)	**0.281** (0.218-0.367)	**0.321** (0.243-0.430)	**0.364** (0.267-0.500)	**0.422** (0.297-0.606)	**0.468** (0.318-0.695)
24-hr	**0.054** (0.047-0.062)	**0.077** (0.069-0.089)	**0.109** (0.097-0.127)	**0.136** (0.119-0.158)	**0.172** (0.146-0.207)	**0.201** (0.166-0.247)	**0.230** (0.186-0.290)	**0.261** (0.205-0.338)	**0.303** (0.229-0.409)	**0.336** (0.245-0.470)
2-day	**0.031** (0.028-0.036)	**0.046** (0.041-0.053)	**0.066** (0.058-0.076)	**0.082** (0.072-0.096)	**0.105** (0.089-0.126)	**0.122** (0.102-0.151)	**0.141** (0.114-0.178)	**0.160** (0.126-0.208)	**0.187** (0.141-0.253)	**0.208** (0.152-0.291)
3-day	**0.022** (0.020-0.026)	**0.033** (0.029-0.038)	**0.048** (0.042-0.055)	**0.060** (0.052-0.070)	**0.077** (0.065-0.093)	**0.090** (0.075-0.111)	**0.104** (0.084-0.131)	**0.119** (0.093-0.154)	**0.139** (0.105-0.188)	**0.156** (0.114-0.218)
4-day	**0.018** (0.016-0.021)	**0.026** (0.023-0.031)	**0.038** (0.034-0.044)	**0.048** (0.042-0.056)	**0.062** (0.053-0.075)	**0.073** (0.061-0.090)	**0.085** (0.069-0.107)	**0.097** (0.076-0.126)	**0.114** (0.086-0.155)	**0.128** (0.093-0.179)
7-day	**0.011** (0.010-0.013)	**0.017** (0.015-0.019)	**0.024** (0.021-0.028)	**0.031** (0.027-0.036)	**0.040** (0.034-0.049)	**0.048** (0.040-0.059)	**0.056** (0.045-0.071)	**0.065** (0.051-0.084)	**0.077** (0.058-0.104)	**0.087** (0.063-0.121)
10-day	**0.008** (0.007-0.009)	**0.012** (0.010-0.014)	**0.018** (0.016-0.020)	**0.023** (0.020-0.027)	**0.030** (0.025-0.036)	**0.036** (0.030-0.044)	**0.042** (0.034-0.053)	**0.049** (0.038-0.063)	**0.058** (0.044-0.079)	**0.066** (0.048-0.093)
20-day	**0.004** (0.004-0.005)	**0.007** (0.006-0.008)	**0.010** (0.009-0.012)	**0.014** (0.012-0.016)	**0.018** (0.015-0.022)	**0.022** (0.018-0.027)	**0.026** (0.021-0.033)	**0.031** (0.024-0.040)	**0.037** (0.028-0.051)	**0.043** (0.031-0.060)
30-day	**0.003** (0.003-0.004)	**0.005** (0.004-0.006)	**0.008** (0.007-0.009)	**0.010** (0.009-0.012)	**0.014** (0.012-0.017)	**0.017** (0.014-0.021)	**0.021** (0.017-0.026)	**0.025** (0.019-0.032)	**0.030** (0.023-0.041)	**0.034** (0.025-0.048)
45-day	**0.002** (0.002-0.003)	**0.004** (0.003-0.005)	**0.006** (0.005-0.007)	**0.008** (0.007-0.009)	**0.011** (0.009-0.013)	**0.014** (0.011-0.017)	**0.016** (0.013-0.021)	**0.019** (0.015-0.025)	**0.024** (0.018-0.032)	**0.027** (0.020-0.039)
60-day	**0.002** (0.002-0.002)	**0.003** (0.003-0.004)	**0.005** (0.004-0.006)	**0.006** (0.006-0.008)	**0.009** (0.007-0.011)	**0.011** (0.009-0.014)	**0.013** (0.011-0.017)	**0.016** (0.012-0.021)	**0.019** (0.015-0.026)	**0.023** (0.016-0.032)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

EXISTING PERVIOUS LAND COVER (AMC III)

PROPOSED LAND COVER (AMC III)

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Figure ADD-1
Antecedent Moisture Condition (AMC)

5-day Rainfall - NOAA Atlas 14
(50% of Total Rainfall Prior to Peak)*

*1/2 (11-day - 1-day) =
1/2 (([10-day] + (1/10 ([20-day] - [10-day]))) - [1-day])

5 0 5 10 15
Miles

N
W E
S

Growing Season
- AMC I
- AMC II
- AMC III

APPROXIMATE LOCATION OF SITE. AMC III

STATE HWY 127
I-15
US HWY 395
I-40
STATE HWY 247
STATE HWY 62

Death Valley
Ridgecrest
Boron
Barstow
Adelanto
George AFB
George AFB
Victorville
Apple Valley
Mountain View Acres
Hesperia
Wrightwood
Crestline
Lake Arrowhead
Running Springs
Big Bear City
Big Bear Lake
Twentynine Palms
Yucca Valley
Joshua Tree
Morongo Valley
Claremont
Needles
Parker Dam
Big River

TABLE C.1. CURVE NUMBER RELATIONSHIPS

CN for AMC Condition II	Corresponding CN for AMC Condition I	Corresponding CN for AMC Condition III
100	100	100
95	87	99
90	78	98
85	70	97
80	63	94
75	57	91
70	51	87
65	45	83
60	40	79
55	35	75
50	31	70
45	27	65
40	23	60
35	19	55
30	15	50
25	12	45
20	9	39
15	7	33
10	4	26
5	2	17
0	0	0

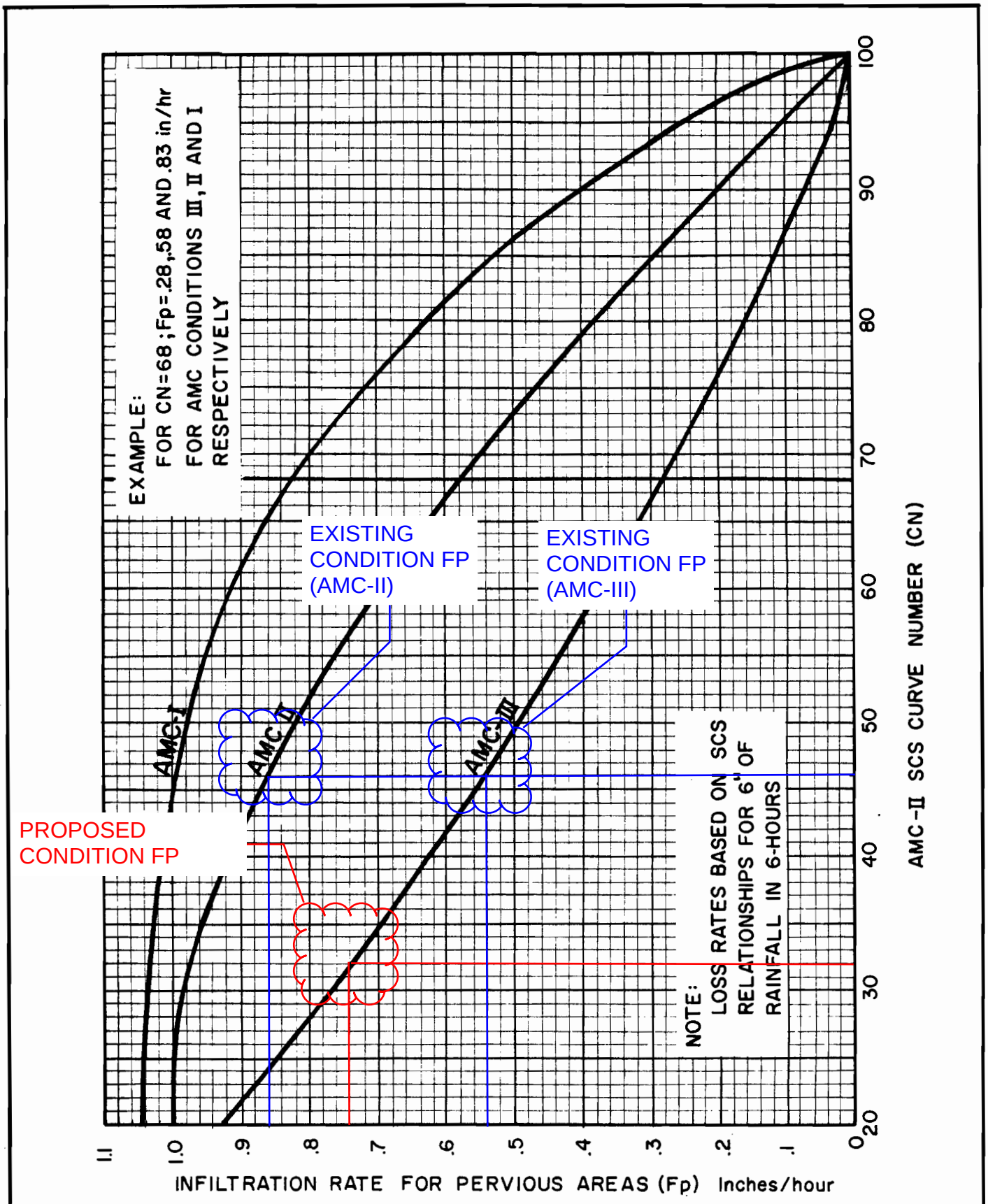
EXISTING PERVIOUS LAND COVER (INTERPOLATE TO 66)

PROPOSED PERVIOUS LAND COVER (INTERPOLATE TO 52)

C.6. ESTIMATION OF LOSS RATES

In estimating loss rates for design hydrology, a watershed curve number (CN) is determined for each soil-cover complex within the watershed using Figure C-3. The working range of CN values is between 0 and 98, where a low CN indicates low runoff potential (high infiltration), and a high CN indicates high runoff potential (low infiltration). Selection of a CN takes into account the major factors affecting loss rates on pervious surfaces including the hydrologic soil group, cover type and quality, and antecedent moisture condition (AMC).

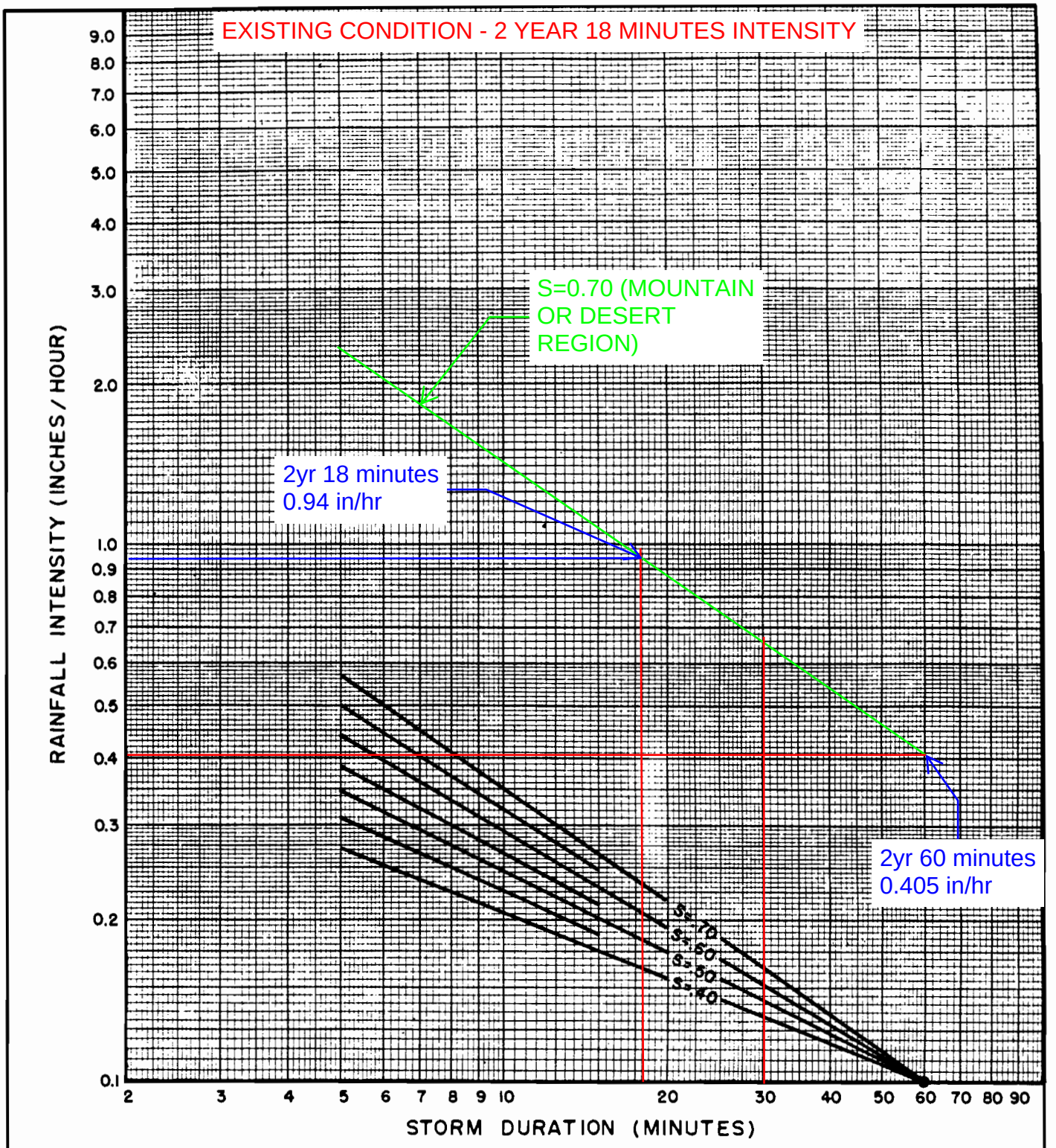
Also included in the CN selection are the effects of "initial abstraction" (Ia) which represents the combined effects of other effective rainfall losses including depression storage, vegetation interception, evaporation, and transpiration, among other factors.



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6



DESIGN STORM FREQUENCY = 2 YEARS

ONE HOUR POINT RAINFALL = 0.405 INCHES

LOG-LOG SLOPE = 0.70

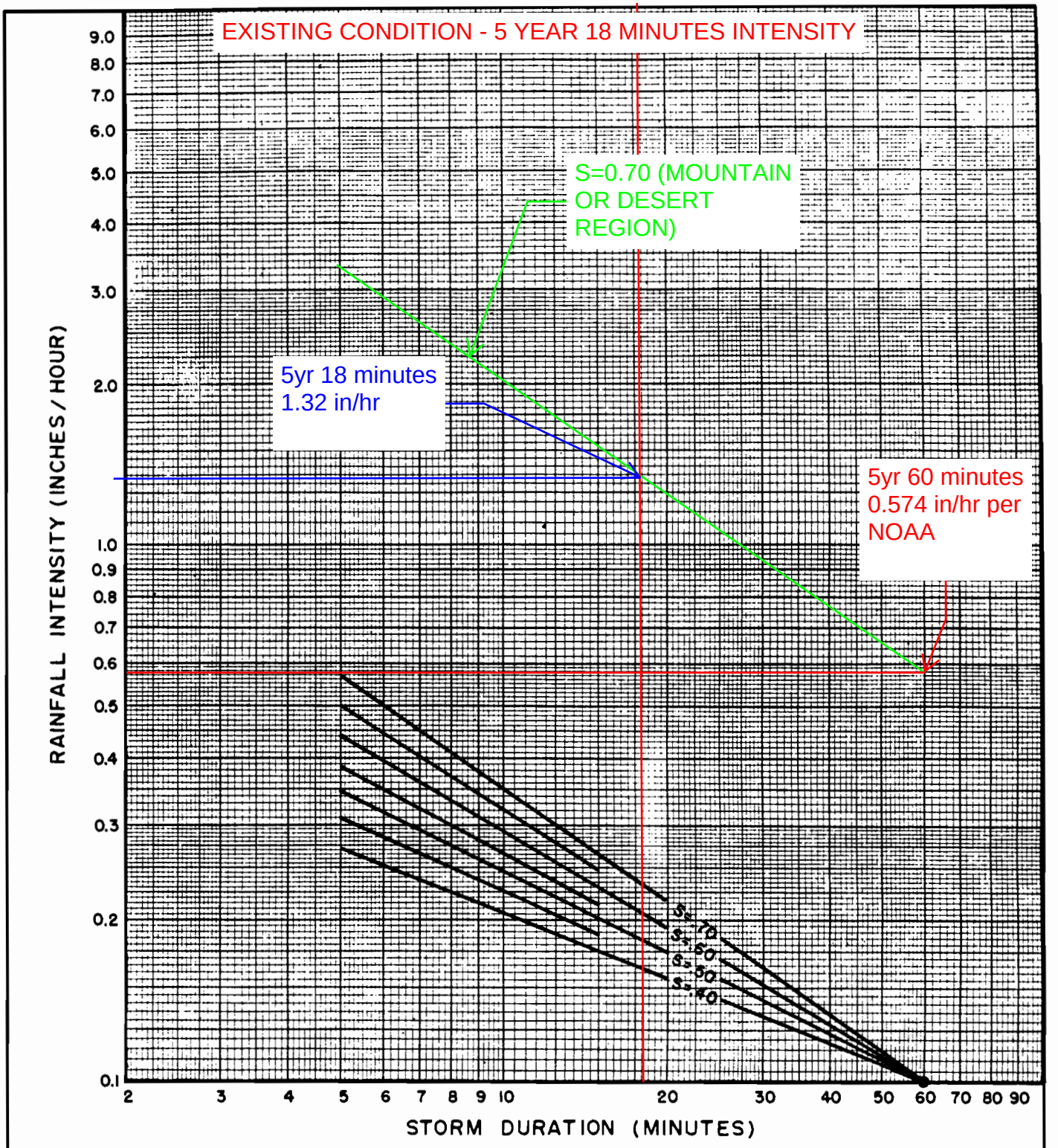
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 5 YEARS

ONE HOUR POINT RAINFALL = 0.574 INCHES

LOG-LOG SLOPE = 0.70

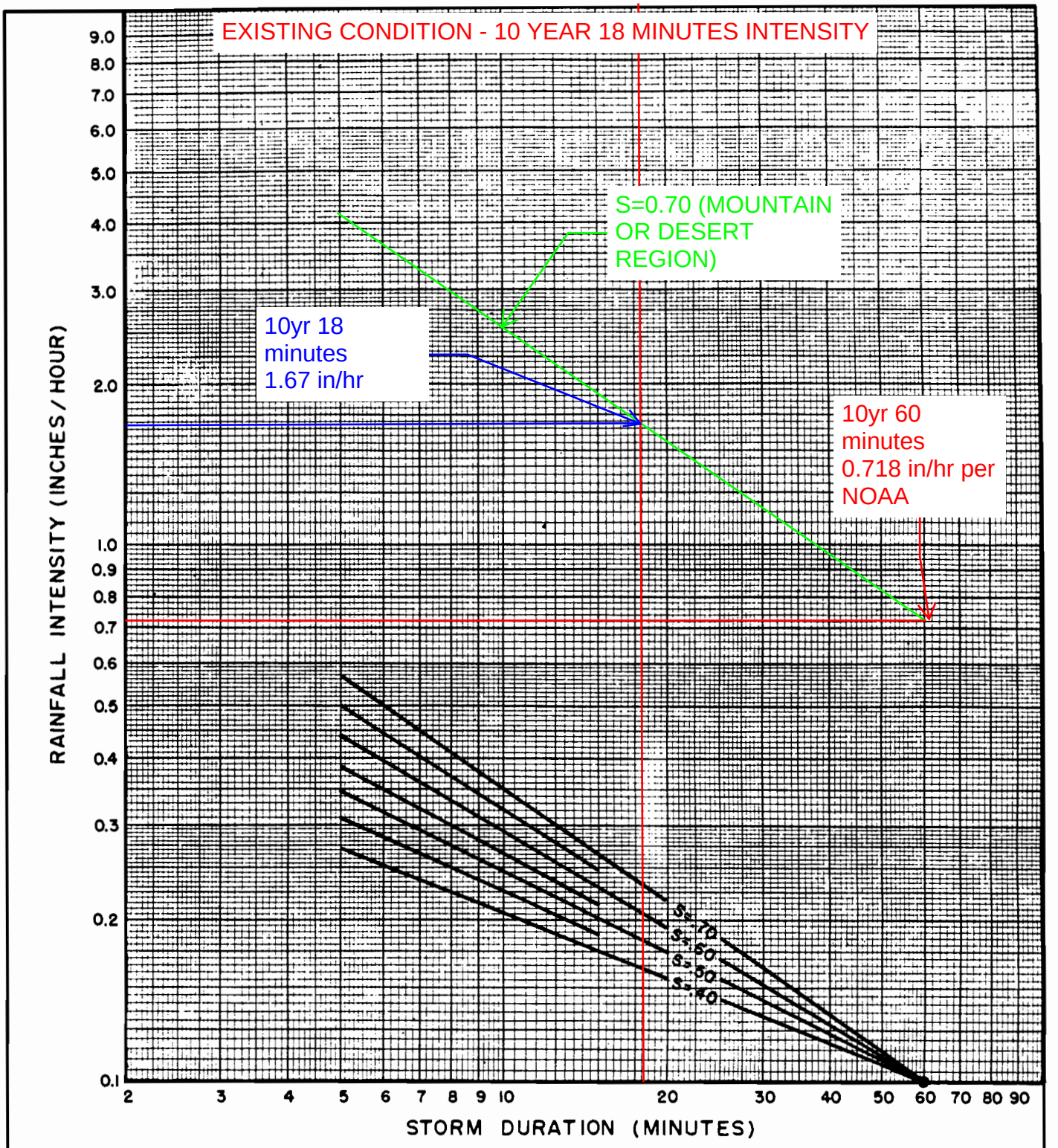
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 10 YEARS

ONE HOUR POINT RAINFALL = 0.718 INCHES

LOG-LOG SLOPE = 0.70

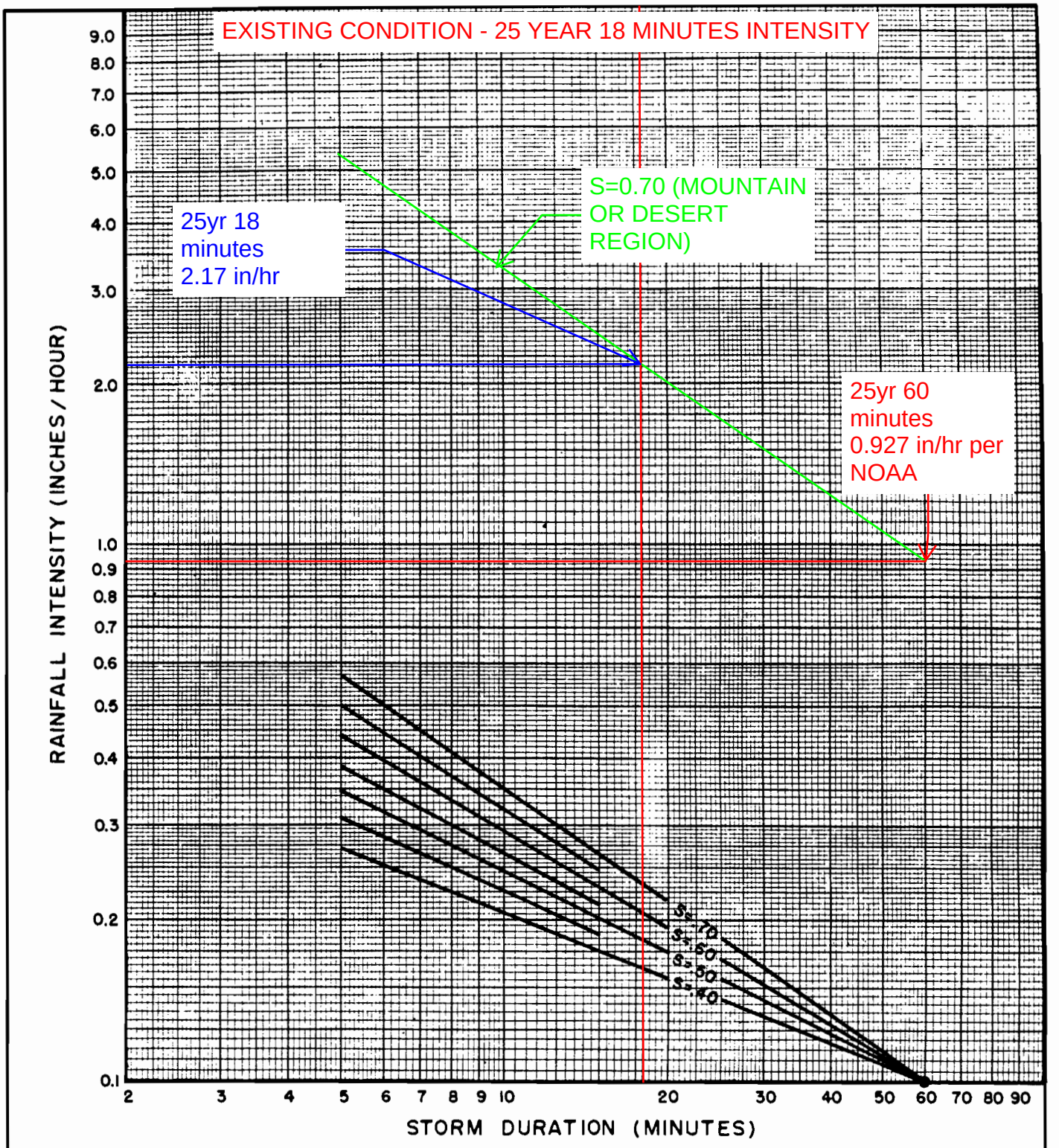
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 25 YEARS

ONE HOUR POINT RAINFALL = 0.927 INCHES

LOG-LOG SLOPE = 0.70

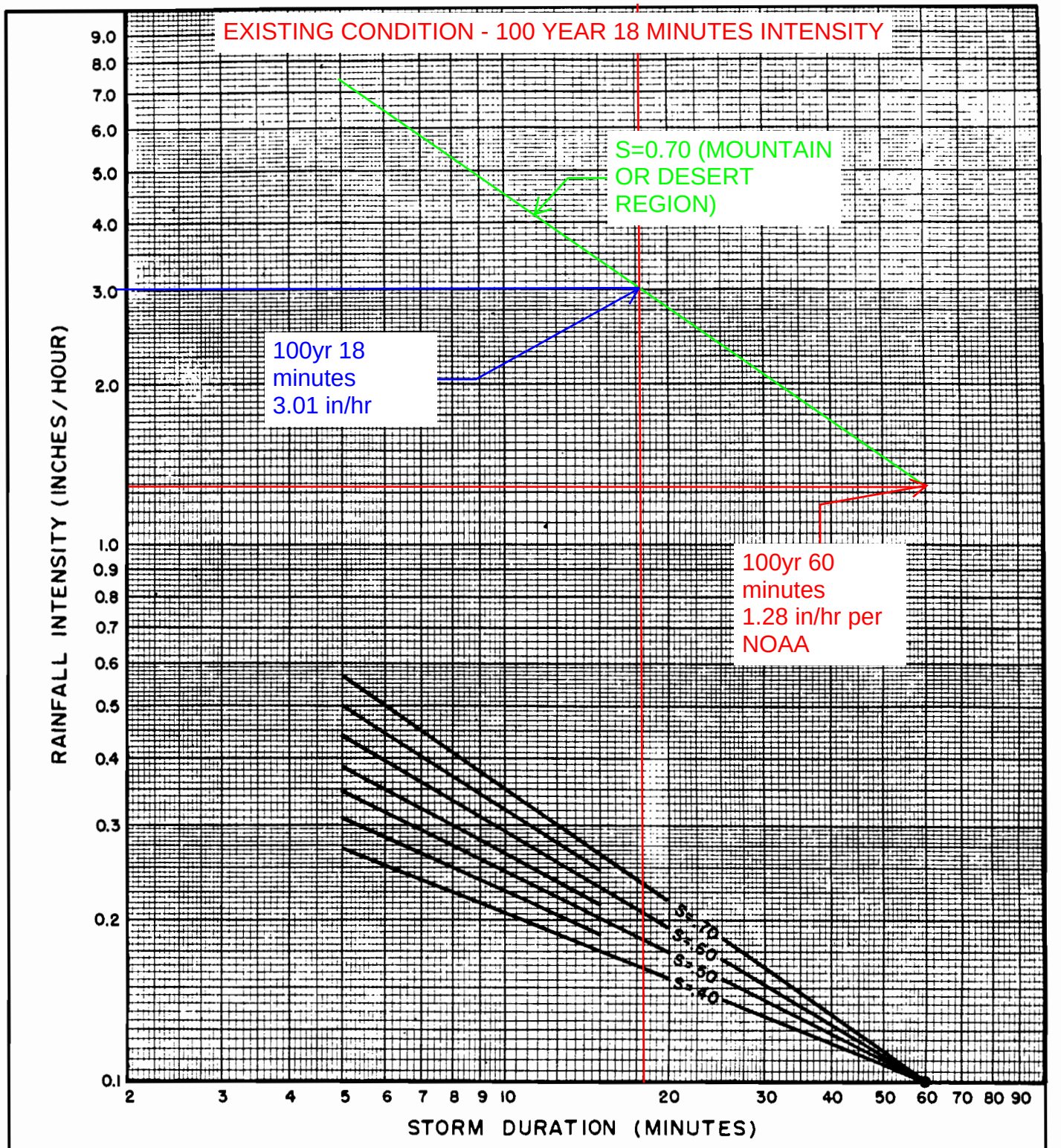
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 100 YEARS

ONE HOUR POINT RAINFALL = 1.28 INCHES

LOG-LOG SLOPE = 0.70

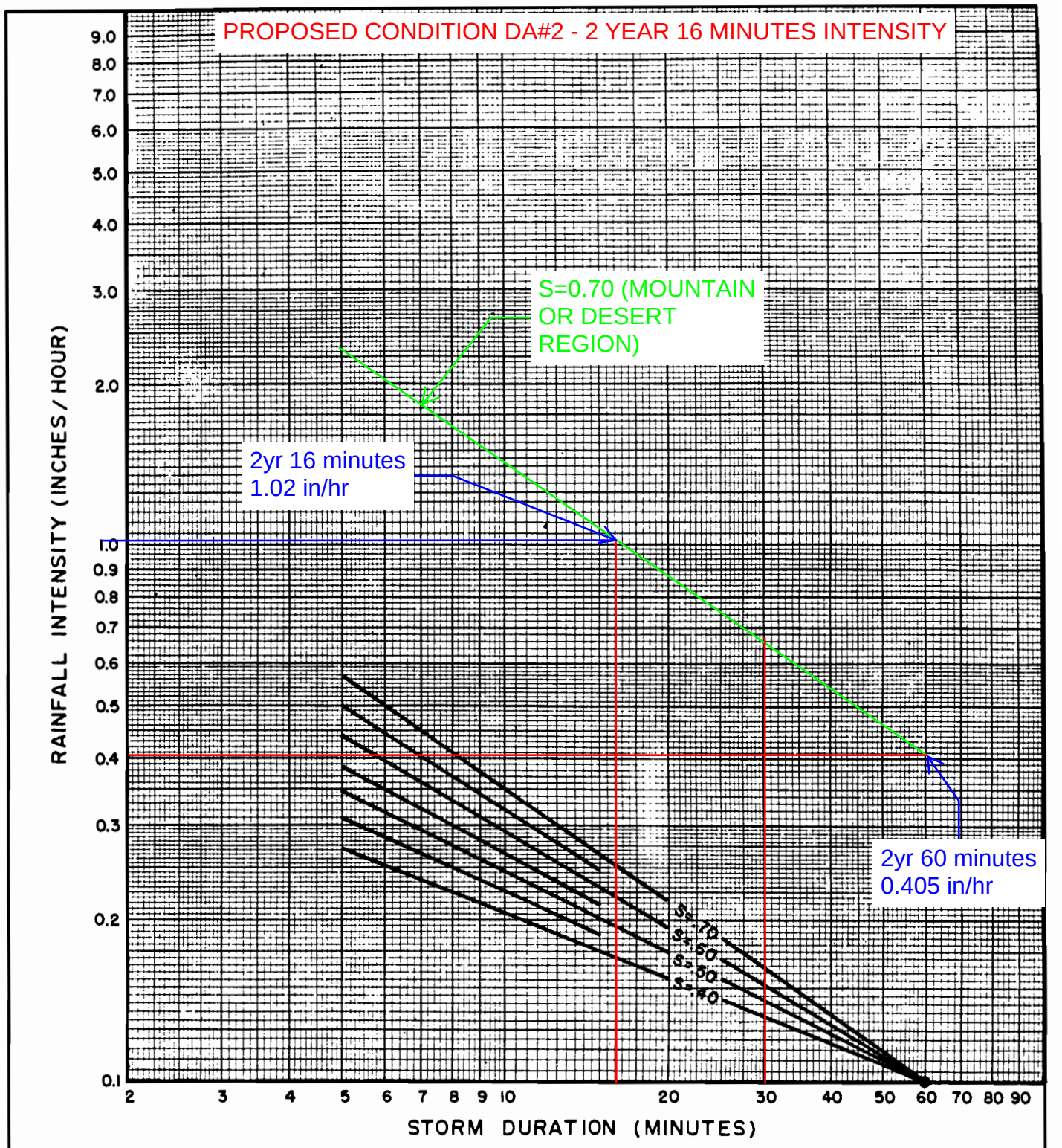
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 2 YEARS

ONE HOUR POINT RAINFALL = 0.405 INCHES

LOG-LOG SLOPE = 0.70

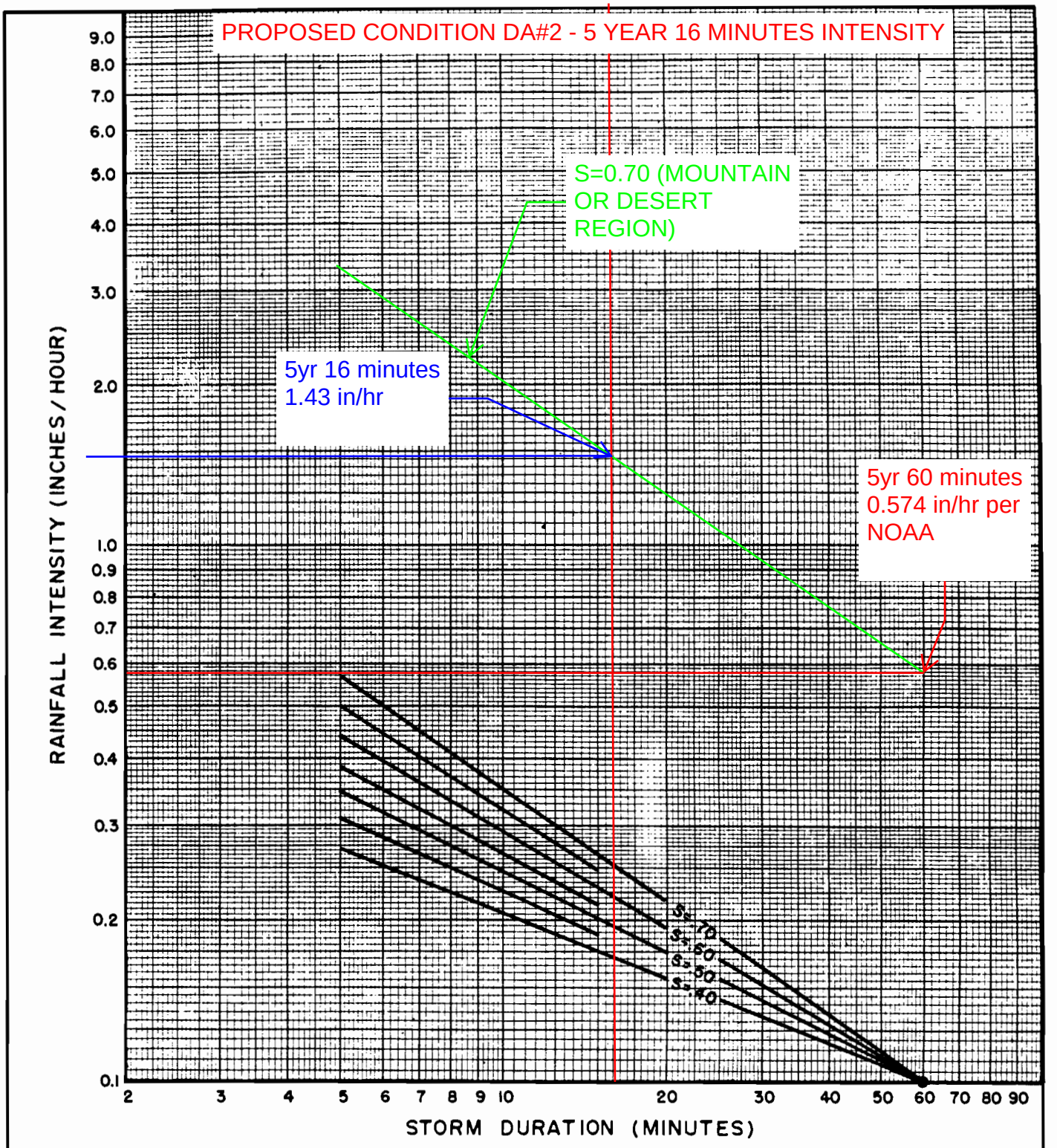
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 5 YEARS

ONE HOUR POINT RAINFALL = 0.574 INCHES

LOG-LOG SLOPE = 0.70

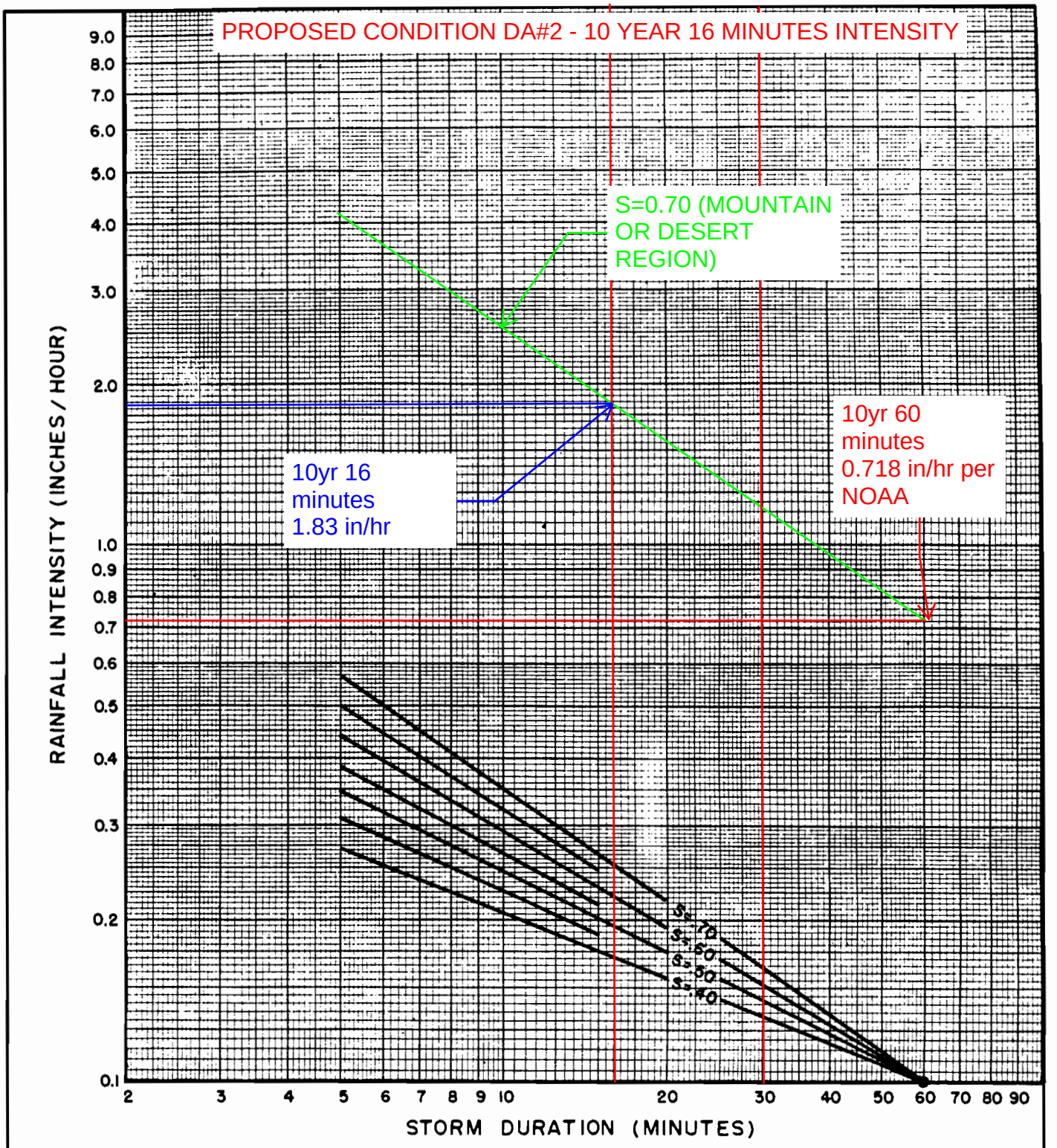
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 10 YEARS

ONE HOUR POINT RAINFALL = 0.718 INCHES

LOG-LOG SLOPE = 0.70

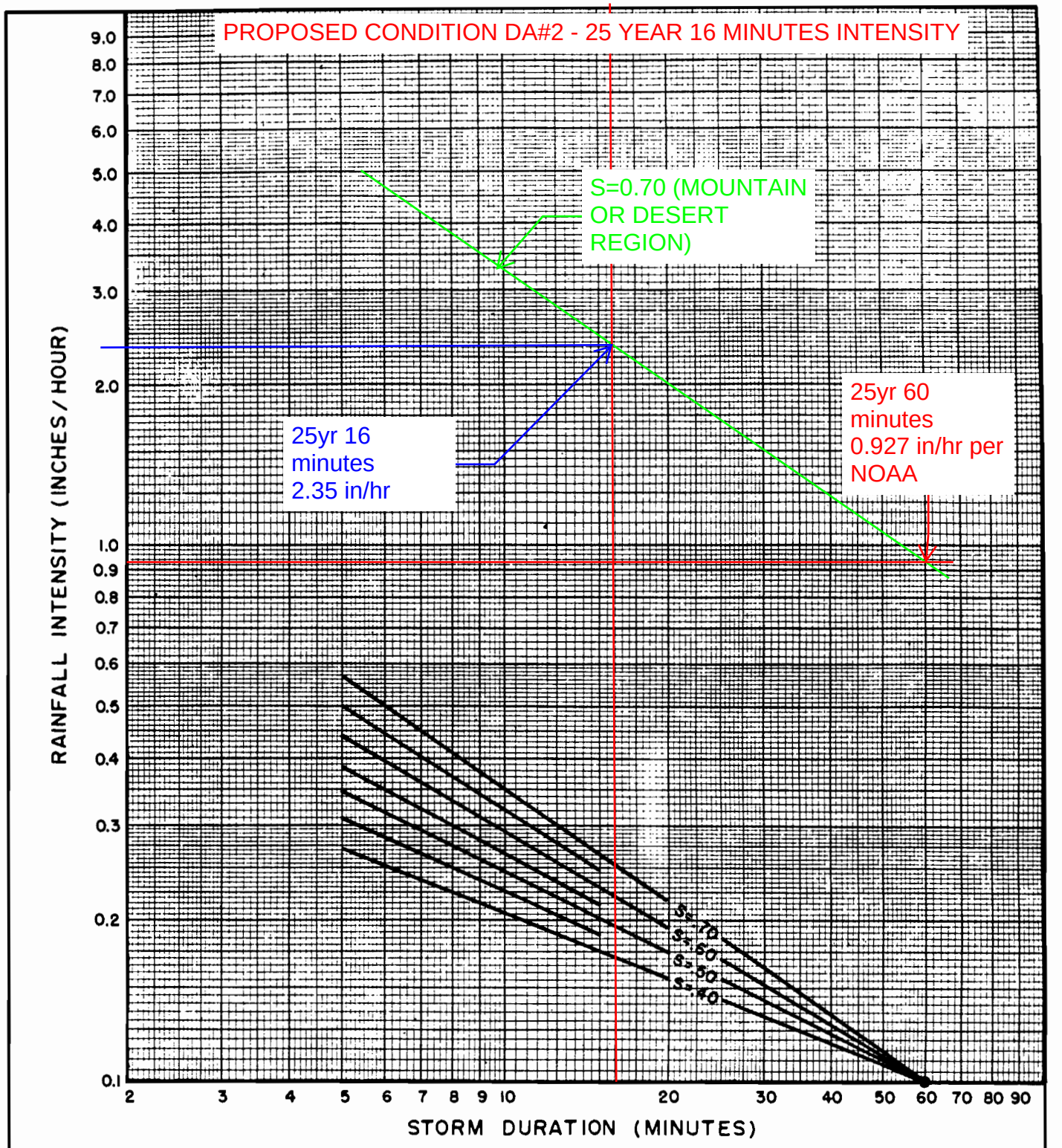
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 25 YEARS

ONE HOUR POINT RAINFALL = 0.927 INCHES

LOG-LOG SLOPE = 0.70

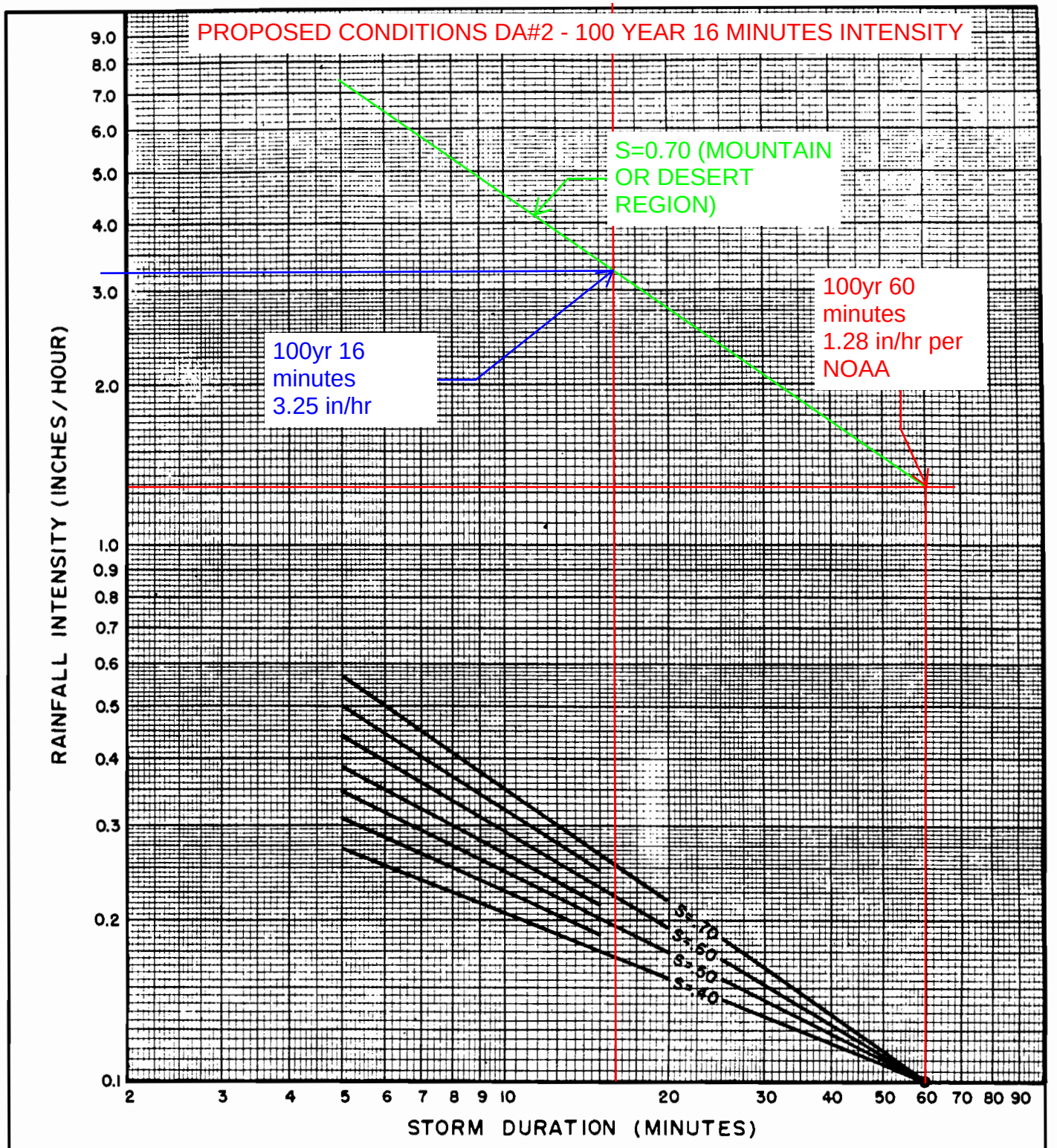
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 100 YEARS

ONE HOUR POINT RAINFALL = 1.28 INCHES

LOG-LOG SLOPE = 0.70

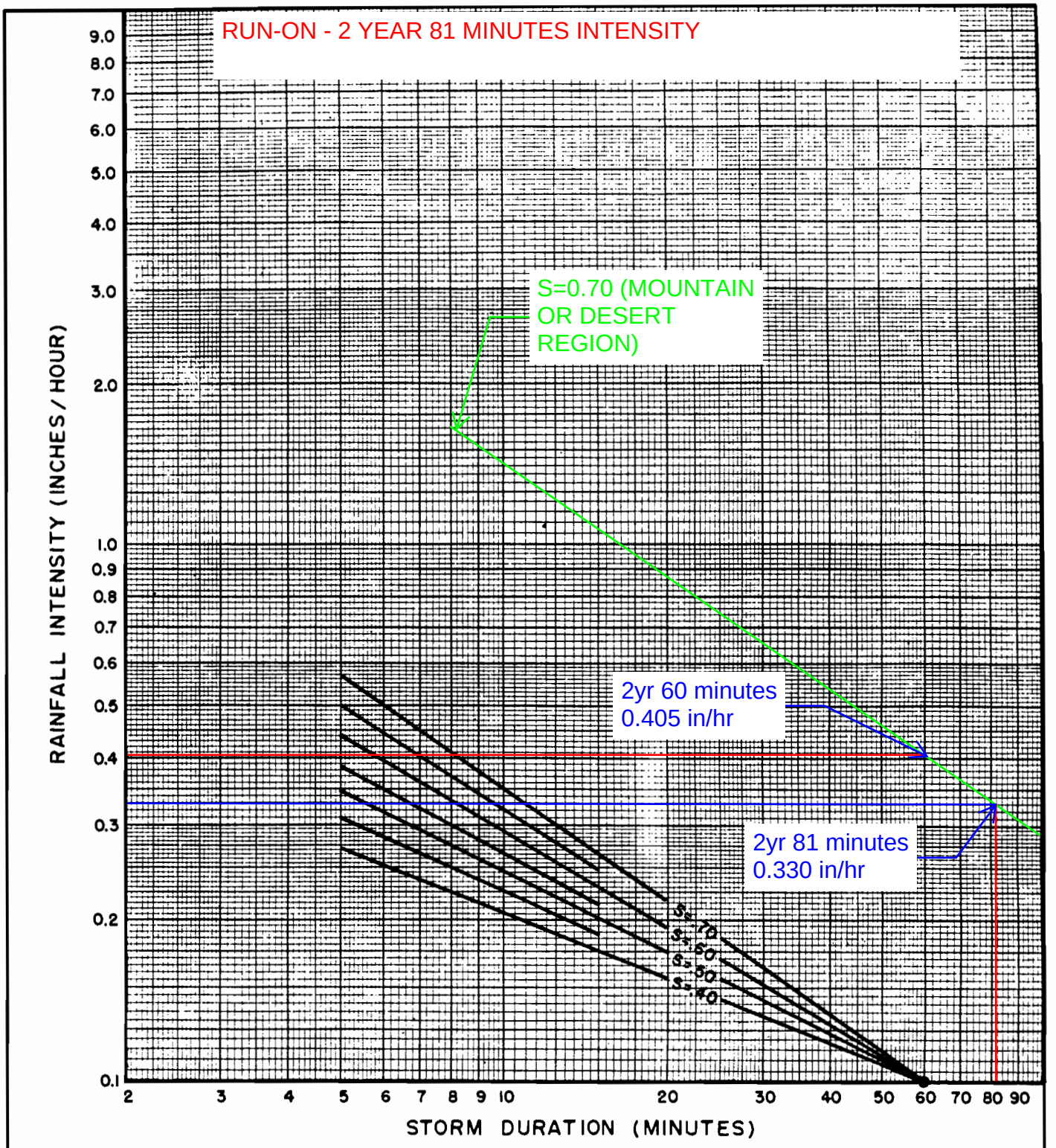
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 2 YEARS

ONE HOUR POINT RAINFALL = 0.405 INCHES

LOG-LOG SLOPE = 0.70

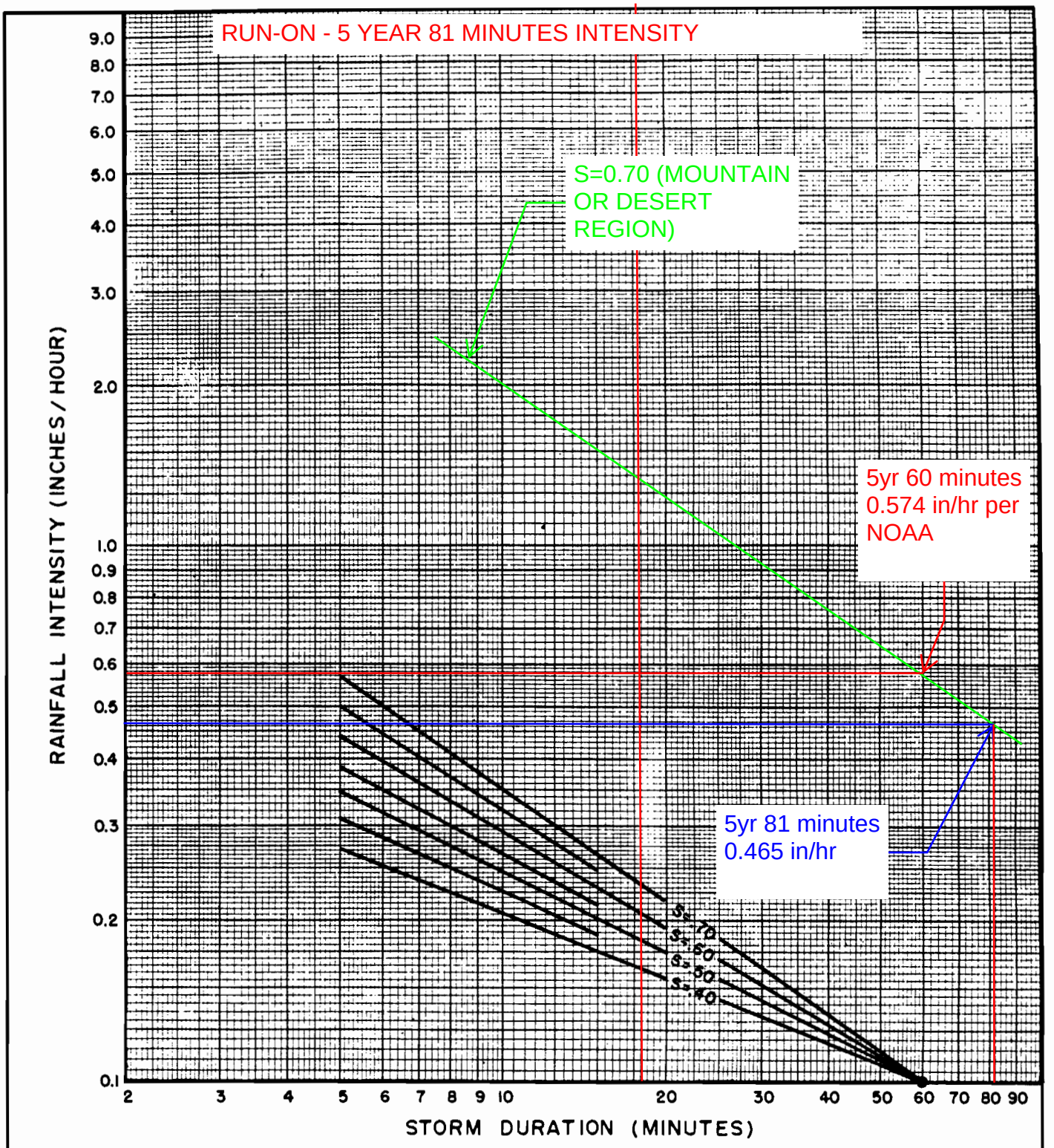
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 5 YEARS

ONE HOUR POINT RAINFALL = 0.574 INCHES

LOG-LOG SLOPE = 0.70

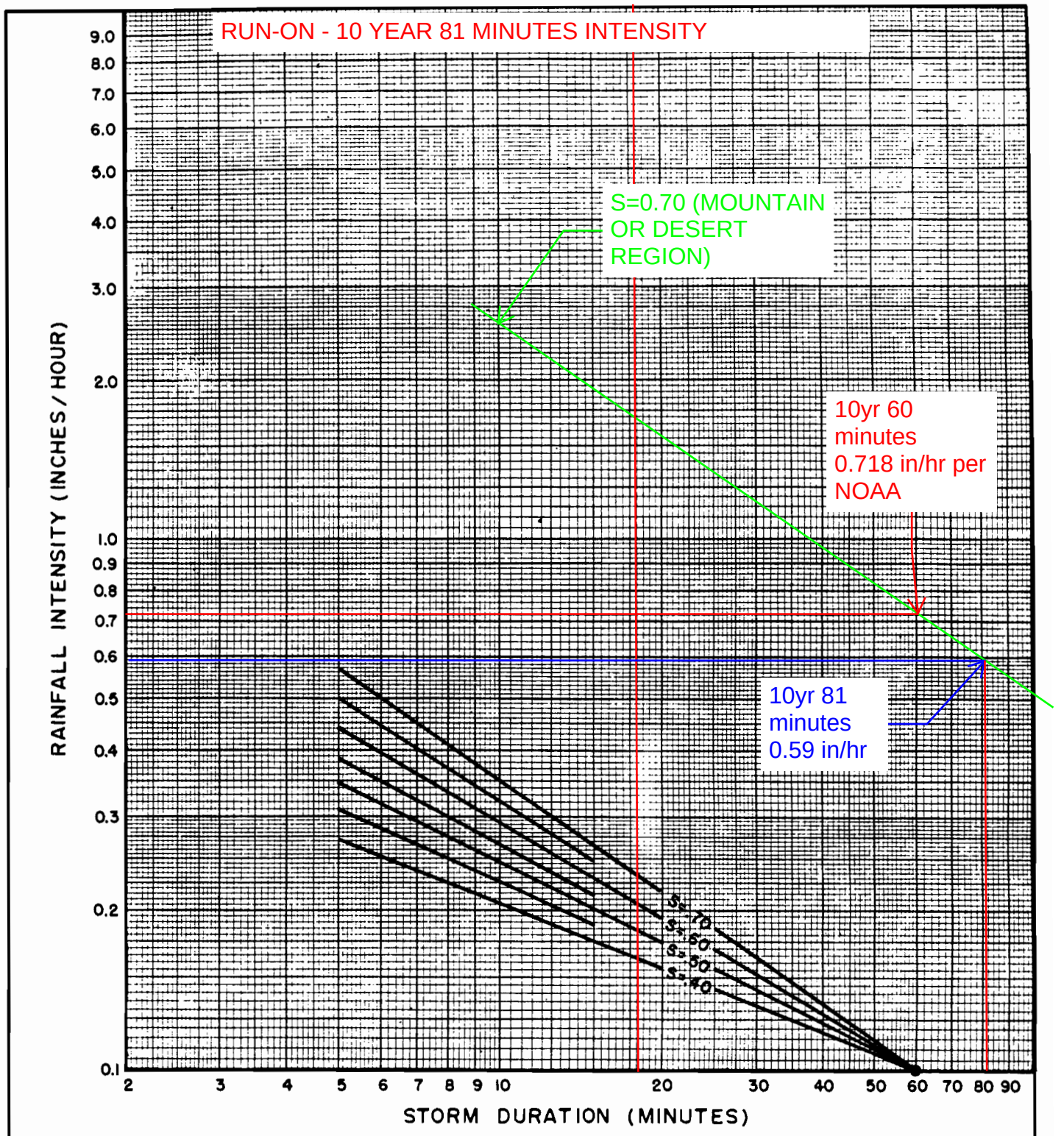
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 10 YEARS

ONE HOUR POINT RAINFALL = 0.718 INCHES

LOG-LOG SLOPE = 0.70

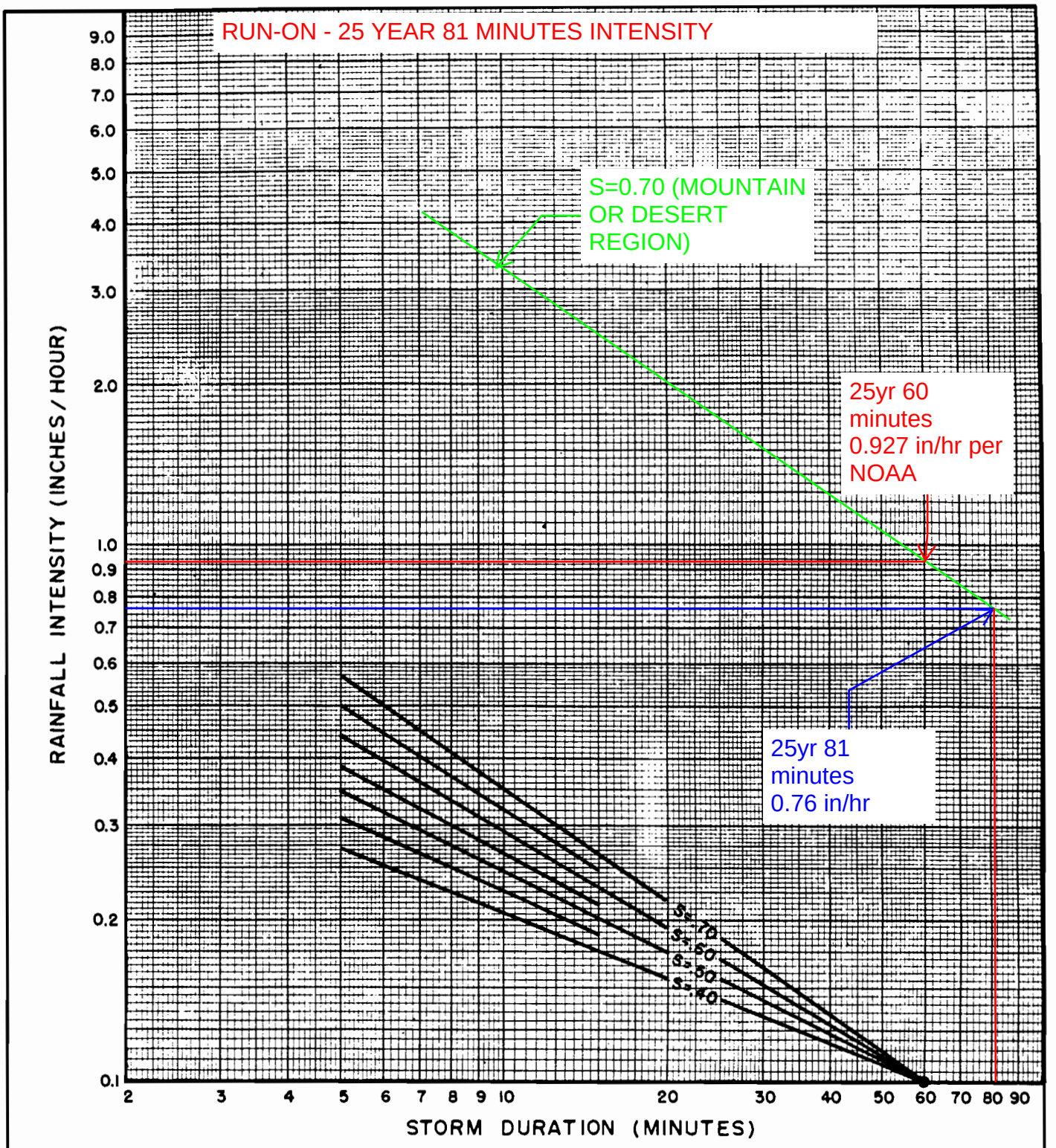
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 25 YEARS

ONE HOUR POINT RAINFALL = 0.927 INCHES

LOG-LOG SLOPE = 0.70

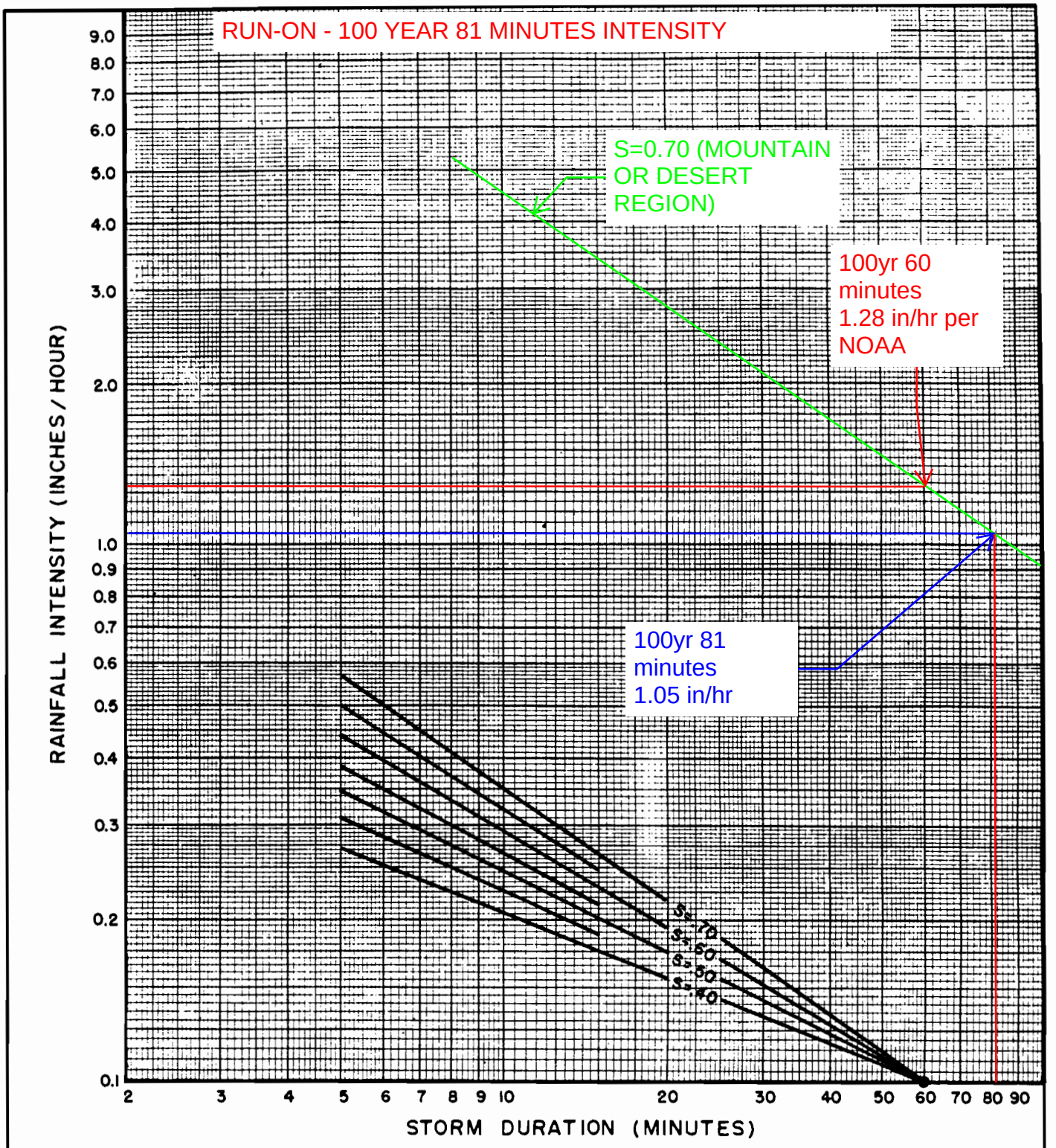
PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



DESIGN STORM FREQUENCY = 100 YEARS

ONE HOUR POINT RAINFALL = 1.28 INCHES

LOG-LOG SLOPE = 0.70

PROJECT LOCATION = PHELAN

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3

Peak Flow Rate Calculations- Tractor Supply Company Phelan

$$Q = 0.9 \times (I - Fm) \times A$$

Existing Conditions

Area, A	4.81	ac
Intensities, I		
Tc	18	minutes
2yr-18 minutes	0.94	in/hr
5yr-18 minutes	1.32	in/hr
10yr-18 minutes	1.67	in/hr
25yr-18 minutes	2.17	in/hr
100yr-18 minutes	3.01	in/hr

Catchment Maximum Loss Rate, F_M

Pervious Area Fraction, A_p	0.99	
Impervious Area Fraction A_i	0.01	
F_p	0.54	in/hr
F_m	0.53	in/hr
F_p AMC II	0.86	in/hr
F_M AMC II	0.85	

Peak Flow Rates, $Q_\#$

Q_2 Using 2-yr Event	1.75	cfs
Q_{10} Using 10-yr Event	4.92	cfs
Q_{25} Using 25-yr Event	7.08	cfs
Q_{100} Using 100-Yr Event	10.72	cfs

Peak Flow Rates per Detention Basin Design Criteria, $Q_\#$

(Per 1987 Memo Modifying Input Parameter provided in Hydrology Manual)

Q_2 Using 2-yr Event	1.75	cfs
Q_{10} Using 5-yr Event	3.40	cfs
Q_{25} Using 10-yr Event	4.92	cfs
Q_{100} Using 25-Yr Event & **AMC-II**	5.71	cfs

Proposed Conditions - DA#1 (Tributary to Underground Infiltration)

Area, A	3.20	ac
Intensities, I		
Tc	5	minutes
2yr-5min	1.42	in/hr
10yr-5min	2.51	in/hr

25yr-5min	3.24	in/hr
100yr-5min	4.48	in/hr

Catchment Maximum Loss Rate, F_M

Pervious Area Fraction, A_p	0.085	
Impervious Area Fraction A_i	0.915	
F_p	0.74	in/hr
F_m	0.06	in/hr

Peak Flow Rates, $Q_\#$

Q_2	3.91	cfs
Q_{10}	7.05	cfs
Q_{25}	9.15	cfs
Q_{100}	12.72	cfs

Proposed Conditions - DA#2 (South and East Landscaped Areas)

Area, A	1.02	ac
Intensities, I		
Tc	16	minutes
2yr-16min	1.02	in/hr
10yr-16min	1.83	in/hr
25yr-16min	2.35	in/hr
100yr-16min	3.25	in/hr

Catchment Maximum Loss Rate, F_M

Pervious Area Fraction, A_p	0.989	
Impervious Area Fraction A_i	0.011	
F_p	0.74	in/hr
F_m	0.73	in/hr

Peak Flow Rates, $Q_\#$

Q_2	0.26	cfs
Q_{10}	1.00	cfs
Q_{25}	1.48	cfs
Q_{100}	2.31	cfs

Peak Flow Rate Calculations- Tractor Supply Company Phelan - Run-On Area

$$Q = 0.9 \times (I - Fm) \times A$$

Existing Conditions

Area, A	19.76	ac
Intensities, I		
Tc	81	minutes
2yr-81 minutes	0.33	in/hr
5yr-81 minutes	0.465	in/hr
10yr-81 minutes	0.59	in/hr
25yr-81 minutes	0.76	in/hr
100yr-81 minutes	1.05	in/hr

Catchment Maximum Loss Rate, F_M

Pervious Area Fraction, A_p	0.75	
Impervious Area Fraction A_i	0.25	
F_p	0.54	in/hr
F_m	0.41	in/hr

Peak Flow Rates, $Q_\#$

Q_2 Using 2-yr Event	1.47	cfs
Q_{10} Using 10-yr Event	3.29	cfs
Q_{25} Using 25-yr Event	6.31	cfs
Q_{100} Using 100-Yr Event	11.47	cfs

NOAA Atlas 14, Volume 6, Version 2
Location name: Phelan, California, USA*
Latitude: 34.4254°, Longitude: -117.5676°
Elevation: 4105 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

USED TO DEVELOP EXISTING CONDITION HYDROGRAPH

USED TO DEVELOP PROPOSED CONDITION HYDROGRAPHS

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.083 (0.069-0.101)	0.118 (0.098-0.144)	0.167 (0.138-0.205)	0.209 (0.171-0.259)	0.270 (0.214-0.345)	0.320 (0.248-0.417)	0.373 (0.282-0.498)	0.430 (0.316-0.591)	0.510 (0.360-0.732)	0.576 (0.392-0.855)
10-min	0.119 (0.099-0.145)	0.170 (0.140-0.207)	0.240 (0.198-0.294)	0.300 (0.246-0.371)	0.388 (0.307-0.495)	0.459 (0.355-0.598)	0.534 (0.404-0.714)	0.616 (0.452-0.847)	0.732 (0.515-1.05)	0.826 (0.562-1.23)
15-min	0.144 (0.120-0.176)	0.205 (0.170-0.250)	0.290 (0.239-0.355)	0.363 (0.297-0.448)	0.469 (0.371-0.598)	0.555 (0.430-0.723)	0.646 (0.488-0.864)	0.745 (0.547-1.02)	0.885 (0.623-1.27)	0.998 (0.679-1.48)
30-min	0.207 (0.172-0.252)	0.294 (0.243-0.359)	0.416 (0.343-0.509)	0.521 (0.426-0.643)	0.672 (0.532-0.858)	0.796 (0.616-1.04)	0.927 (0.701-1.24)	1.07 (0.785-1.47)	1.27 (0.894-1.82)	1.43 (0.974-2.13)
60-min	0.285 (0.236-0.348)	0.405 (0.335-0.495)	0.574 (0.473-0.702)	0.718 (0.587-0.886)	0.927 (0.733-1.18)	1.10 (0.849-1.43)	1.28 (0.966-1.71)	1.47 (1.08-2.02)	1.75 (1.23-2.51)	1.97 (1.34-2.93)
2-hr	0.420 (0.348-0.512)	0.576 (0.476-0.703)	0.791 (0.653-0.969)	0.975 (0.798-1.20)	1.24 (0.980-1.58)	1.45 (1.12-1.89)	1.68 (1.27-2.24)	1.92 (1.41-2.64)	2.26 (1.59-3.24)	2.53 (1.72-3.75)
3-hr	0.523 (0.433-0.637)	0.707 (0.585-0.863)	0.960 (0.792-1.18)	1.18 (0.962-1.45)	1.48 (1.17-1.89)	1.73 (1.34-2.26)	1.99 (1.51-2.66)	2.27 (1.67-3.12)	2.66 (1.88-3.82)	2.97 (2.02-4.41)
6-hr	0.750 (0.621-0.914)	1.00 (0.832-1.23)	1.35 (1.12-1.66)	1.65 (1.35-2.03)	2.06 (1.63-2.63)	2.39 (1.86-3.12)	2.74 (2.07-3.66)	3.11 (2.28-4.28)	3.63 (2.55-5.20)	4.04 (2.74-5.99)
12-hr	0.997 (0.826-1.22)	1.38 (1.14-1.68)	1.90 (1.56-2.32)	2.32 (1.90-2.87)	2.92 (2.31-3.73)	3.39 (2.63-4.42)	3.88 (2.93-5.18)	4.39 (3.22-6.04)	5.09 (3.59-7.30)	5.65 (3.84-8.38)
24-hr	1.30 (1.15-1.49)	1.87 (1.66-2.16)	2.64 (2.33-3.05)	3.27 (2.86-3.81)	4.14 (3.51-4.99)	4.83 (4.01-5.94)	5.53 (4.48-6.97)	6.27 (4.94-8.12)	7.29 (5.51-9.84)	8.08 (5.90-11.3)
2-day	1.53 (1.35-1.76)	2.23 (1.97-2.57)	3.17 (2.80-3.67)	3.96 (3.47-4.61)	5.05 (4.28-6.08)	5.90 (4.90-7.26)	6.79 (5.50-8.56)	7.72 (6.08-10.0)	9.01 (6.81-12.2)	10.0 (7.32-14.0)
3-day	1.65 (1.46-1.90)	2.42 (2.14-2.79)	3.47 (3.06-4.01)	4.34 (3.80-5.06)	5.56 (4.72-6.70)	6.53 (5.42-8.03)	7.53 (6.10-9.49)	8.59 (6.77-11.1)	10.1 (7.61-13.6)	11.2 (8.21-15.7)
4-day	1.75 (1.55-2.02)	2.58 (2.29-2.98)	3.72 (3.29-4.30)	4.68 (4.10-5.45)	6.02 (5.10-7.25)	7.08 (5.88-8.71)	8.20 (6.64-10.3)	9.38 (7.39-12.1)	11.0 (8.34-14.9)	12.3 (9.02-17.2)
7-day	1.93 (1.71-2.22)	2.86 (2.53-3.30)	4.17 (3.68-4.82)	5.29 (4.63-6.16)	6.88 (5.83-8.29)	8.16 (6.77-10.0)	9.51 (7.70-12.0)	11.0 (8.63-14.2)	13.0 (9.83-17.6)	14.6 (10.7-20.5)
10-day	1.99 (1.76-2.29)	2.96 (2.62-3.42)	4.36 (3.85-5.04)	5.56 (4.87-6.48)	7.30 (6.19-8.79)	8.71 (7.23-10.7)	10.2 (8.27-12.9)	11.8 (9.32-15.3)	14.1 (10.7-19.1)	16.0 (11.7-22.4)
20-day	2.30 (2.04-2.65)	3.49 (3.09-4.02)	5.21 (4.60-6.03)	6.73 (5.90-7.85)	8.98 (7.61-10.8)	10.9 (9.00-13.3)	12.9 (10.4-16.2)	15.1 (11.9-19.5)	18.2 (13.8-24.6)	20.8 (15.2-29.1)
30-day	2.67 (2.37-3.07)	4.04 (3.58-4.66)	6.07 (5.36-7.02)	7.88 (6.90-9.19)	10.6 (8.98-12.8)	12.9 (10.7-15.8)	15.3 (12.4-19.3)	18.0 (14.2-23.3)	21.9 (16.6-29.6)	25.2 (18.4-35.2)
45-day	3.15 (2.79-3.62)	4.73 (4.19-5.46)	7.09 (6.26-8.20)	9.22 (8.07-10.7)	12.4 (10.5-15.0)	15.2 (12.6-18.7)	18.2 (14.7-22.9)	21.4 (16.9-27.7)	26.2 (19.8-35.4)	30.1 (22.0-42.1)
60-day	3.51 (3.11-4.04)	5.20 (4.60-5.99)	7.75 (6.84-8.96)	10.1 (8.82-11.7)	13.6 (11.5-16.4)	16.6 (13.8-20.4)	19.9 (16.1-25.1)	23.5 (18.5-30.4)	28.8 (21.7-38.8)	33.1 (24.2-46.3)

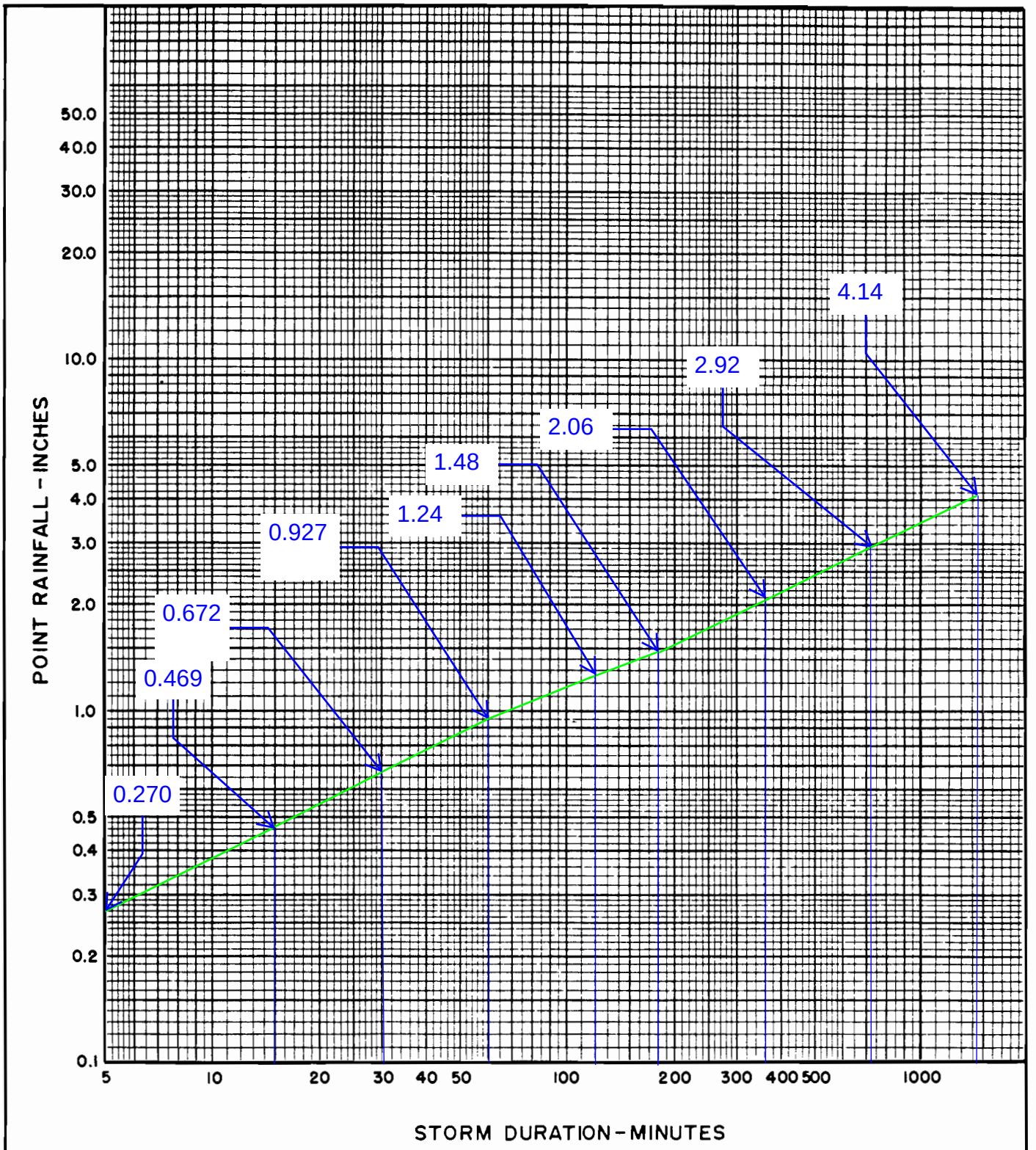
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



PROJECT LOCATION PHELAN CA

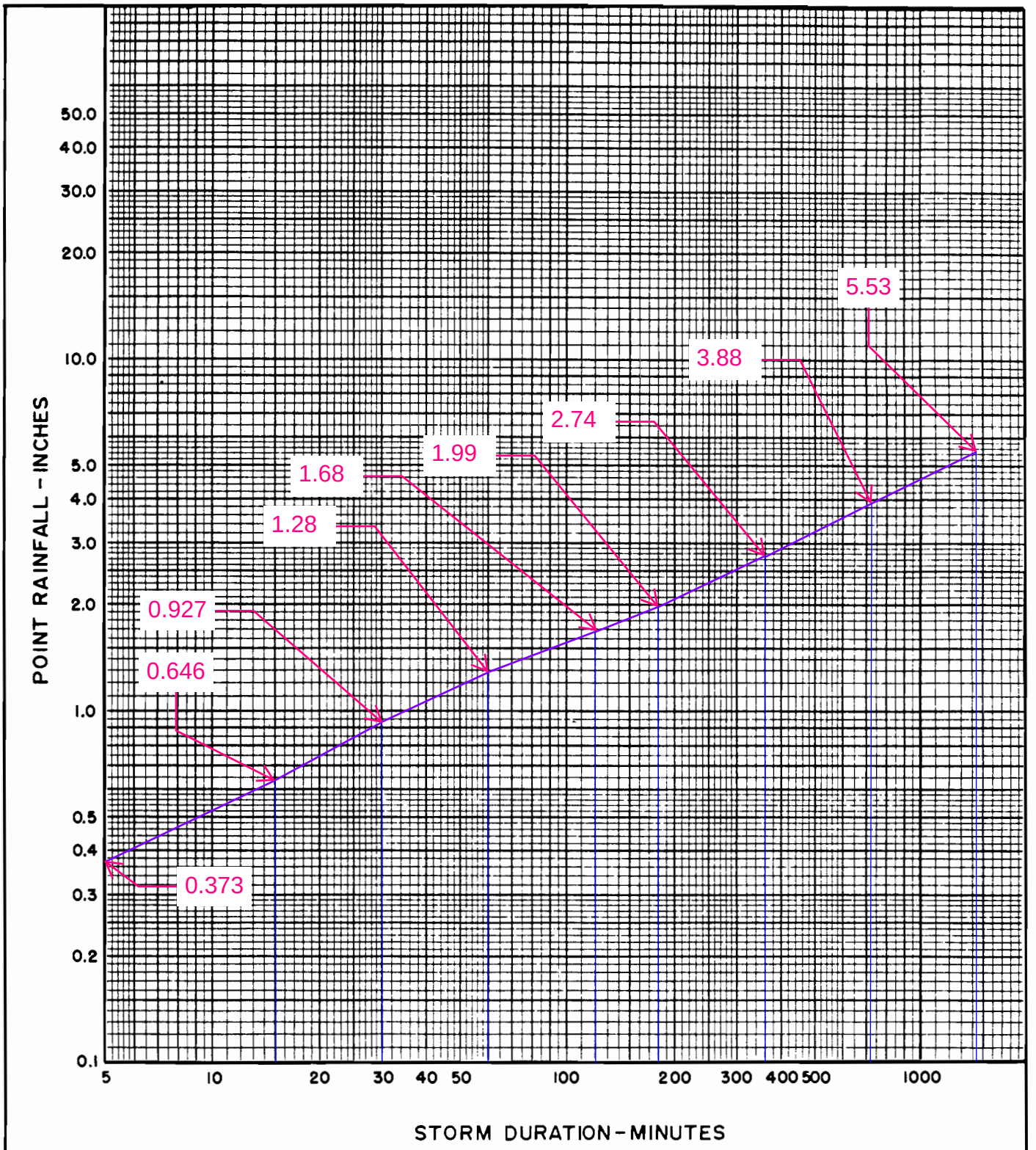
NOTES USED TO DEVELOP 25-YR, 24 HOUR STORM HYDROGRAPHS

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

AREA - AVERAGED MASS RAINFALL PLOTTING SHEET

FIGURE E-8



PROJECT LOCATION PHELAN CA

NOTES USED TO DEVELOP 100-YR, 24 HOUR STORM HYDROGRAPHS

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

AREA - AVERAGED MASS RAINFALL PLOTTING SHEET

FIGURE E-8

Small Area Runoff Hydrograph for Tractor Supply Phelan Existing Conditions

25-Year, 24-Hour Storm

Catchment Maximum Loss Rate, F_M		
Pervious Area Fraction, A_p	0.99	
Impervious Area Fraction A_i	0.01	
F_p	0.54	in/hr
F_m	0.53	in/hr

Low Loss Rate, F*		
P_{24}	4.14	in
CN (Pervious Area) (AMC III)	66	
S (Pervious Area)	5.15	
Initial Abstraction (Pervious Area)	1.03	
CN (Impervious Area)	98	
S (Impervious Area)	0	
Initial Abstraction (Impervious Area)	0	
Y_pervious	0.28	
Y_impervious)	1.00	
Y	0.29	
Catchment Low Loss Fraction Y_bar	0.71	
Fm	**0.53**	in/hr
Y_bar	**0.71**	
Area	**4.81**	acres
Tc	**18**	minutes

Peak Rainfall Unit Number (18 minutes periods)	**Mass Rainfall (Inches)**	**Unit Rainfall (Inches)**	**Unit Loss (Inches)**	**Net Rainfall (Inches)**	**Effective Rainfall (Inches/Hr.)**	**Discharge (Q) (cfs)**
1	0.55	0.55	0.16	0.39	1.30	5.61
2	0.74	0.19	0.13	0.06	0.18	0.79
3	0.90	0.16	0.11	0.05	0.15	0.67
4	1.05	0.15	0.11	0.04	0.14	0.63
5	1.12	0.07	0.05	0.02	0.07	0.29
6	1.20	0.08	0.06	0.02	0.08	0.33

7	1.28	0.09	0.06	0.03	0.09	0.38
8	1.35	0.07	0.05	0.02	0.07	0.29
9	1.42	0.06	0.05	0.02	0.06	0.27
10	1.48	0.06	0.05	0.02	0.06	0.27
11	1.54	0.06	0.04	0.02	0.06	0.24
12	1.60	0.06	0.04	0.02	0.06	0.24
13	1.65	0.06	0.04	0.02	0.06	0.24
14	1.71	0.06	0.04	0.02	0.06	0.24
15	1.77	0.06	0.04	0.02	0.06	0.24
16	1.83	0.06	0.04	0.02	0.06	0.24
17	1.89	0.06	0.04	0.02	0.06	0.24
18	1.94	0.06	0.04	0.02	0.06	0.24
19	2.00	0.06	0.04	0.02	0.06	0.24
20	2.06	0.06	0.04	0.02	0.06	0.24
21	2.10	0.04	0.03	0.01	0.04	0.18
22	2.15	0.04	0.03	0.01	0.04	0.18
23	2.19	0.04	0.03	0.01	0.04	0.18
24	2.23	0.04	0.03	0.01	0.04	0.18
25	2.28	0.04	0.03	0.01	0.04	0.18
26	2.32	0.04	0.03	0.01	0.04	0.18
27	2.36	0.04	0.03	0.01	0.04	0.18
28	2.40	0.04	0.03	0.01	0.04	0.18
29	2.45	0.04	0.03	0.01	0.04	0.18
30	2.49	0.04	0.03	0.01	0.04	0.18
31	2.53	0.04	0.03	0.01	0.04	0.18
32	2.58	0.04	0.03	0.01	0.04	0.18
33	2.62	0.04	0.03	0.01	0.04	0.18
34	2.66	0.04	0.03	0.01	0.04	0.18
35	2.71	0.04	0.03	0.01	0.04	0.18
36	2.75	0.04	0.03	0.01	0.04	0.18
37	2.79	0.04	0.03	0.01	0.04	0.18
38	2.83	0.04	0.03	0.01	0.04	0.18
39	2.88	0.04	0.03	0.01	0.04	0.18
40	2.92	0.04	0.03	0.01	0.04	0.18
41	2.95	0.03	0.02	0.01	0.03	0.13
42	2.98	0.03	0.02	0.01	0.03	0.13
43	3.01	0.03	0.02	0.01	0.03	0.13
44	3.04	0.03	0.02	0.01	0.03	0.13
45	3.07	0.03	0.02	0.01	0.03	0.13
46	3.10	0.03	0.02	0.01	0.03	0.13
47	3.13	0.03	0.02	0.01	0.03	0.13
48	3.16	0.03	0.02	0.01	0.03	0.13
49	3.19	0.03	0.02	0.01	0.03	0.13
50	3.23	0.03	0.02	0.01	0.03	0.13

51	3.26	0.03	0.02	0.01	0.03	0.13
52	3.29	0.03	0.02	0.01	0.03	0.13
53	3.32	0.03	0.02	0.01	0.03	0.13
54	3.35	0.03	0.02	0.01	0.03	0.13
55	3.38	0.03	0.02	0.01	0.03	0.13
56	3.41	0.03	0.02	0.01	0.03	0.13
57	3.44	0.03	0.02	0.01	0.03	0.13
58	3.47	0.03	0.02	0.01	0.03	0.13
59	3.50	0.03	0.02	0.01	0.03	0.13
60	3.53	0.03	0.02	0.01	0.03	0.13
61	3.56	0.03	0.02	0.01	0.03	0.13
62	3.59	0.03	0.02	0.01	0.03	0.13
63	3.62	0.03	0.02	0.01	0.03	0.13
64	3.65	0.03	0.02	0.01	0.03	0.13
65	3.68	0.03	0.02	0.01	0.03	0.13
66	3.71	0.03	0.02	0.01	0.03	0.13
67	3.74	0.03	0.02	0.01	0.03	0.13
68	3.77	0.03	0.02	0.01	0.03	0.13
69	3.80	0.03	0.02	0.01	0.03	0.13
70	3.84	0.03	0.02	0.01	0.03	0.13
71	3.87	0.03	0.02	0.01	0.03	0.13
72	3.90	0.03	0.02	0.01	0.03	0.13
73	3.93	0.03	0.02	0.01	0.03	0.13
74	3.96	0.03	0.02	0.01	0.03	0.13
75	3.99	0.03	0.02	0.01	0.03	0.13
76	4.02	0.03	0.02	0.01	0.03	0.13
77	4.05	0.03	0.02	0.01	0.03	0.13
78	4.08	0.03	0.02	0.01	0.03	0.13
79	4.11	0.03	0.02	0.01	0.03	0.13
80	4.14	0.03	0.02	0.01	0.03	0.13

Runoff Hydrograph

Time Period	Q
1	0.13
2	0.13
3	0.13
4	0.13
5	0.13
6	0.13
7	0.13
8	0.13
9	0.13
10	0.13
11	0.13

12	0.13
13	0.13
14	0.13
15	0.13
16	0.13
17	0.13
18	0.13
19	0.13
20	0.13
21	0.13
22	0.13
23	0.13
24	0.13
25	0.13
26	0.13
27	0.13
28	0.18
29	0.18
30	0.18
31	0.18
32	0.18
33	0.18
34	0.18
35	0.18
36	0.18
37	0.18
38	0.18
39	0.18
40	0.18
41	0.24
42	0.24
43	0.24
44	0.24
45	0.24
46	0.24
47	0.24
48	0.27
49	0.29
50	0.38
51	0.38
52	0.54
53	1.15
54	5.33
55	0.46

56	0.38
57	0.27
58	0.24
59	0.24
60	0.24
61	0.18
62	0.18
63	0.18
64	0.18
65	0.18
66	0.18
67	0.18
68	0.13
69	0.13
70	0.13
71	0.13
72	0.13
73	0.13
74	0.13
75	0.13
76	0.13
77	0.13
78	0.13
79	0.13
80	0.13

Hydrograph Report

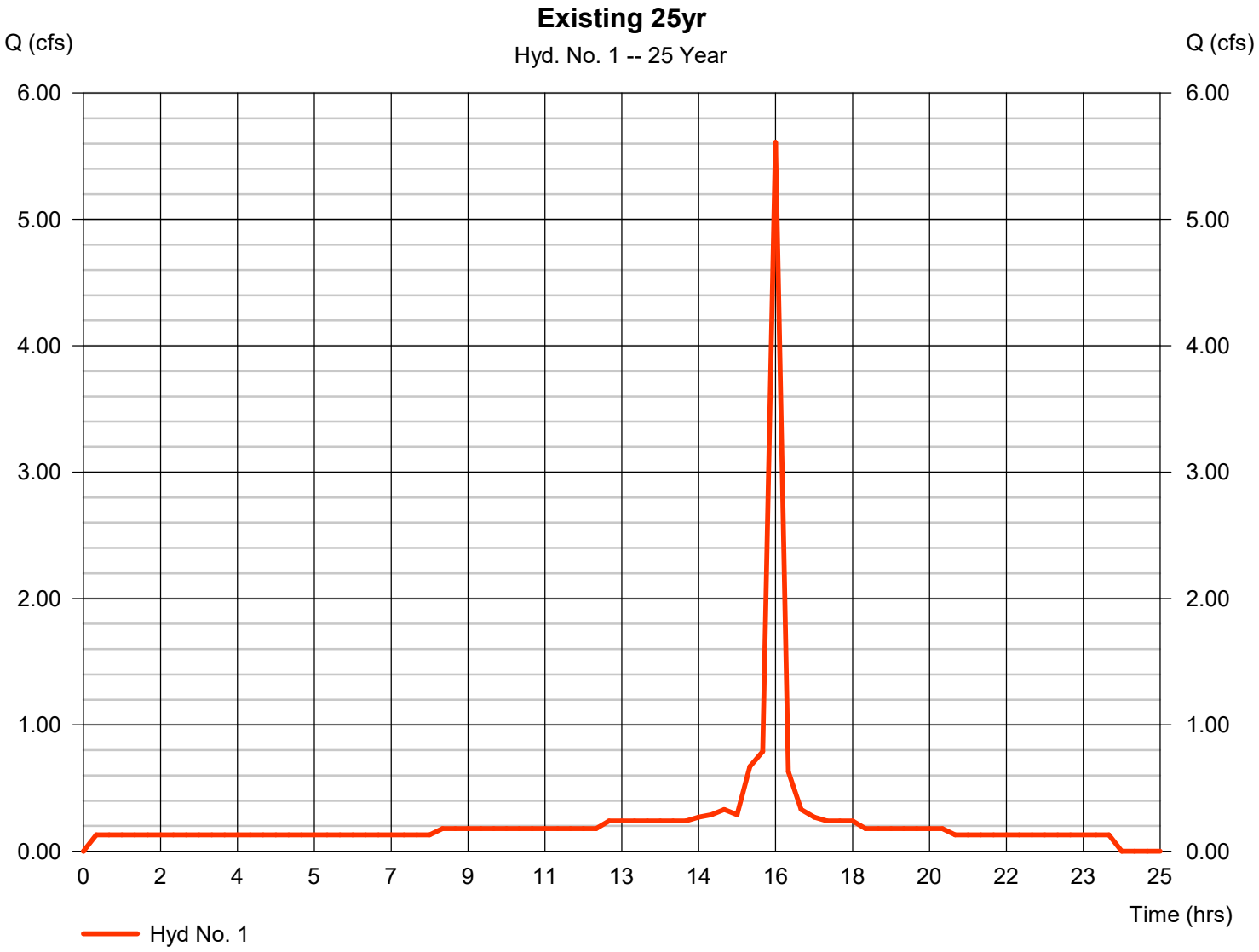
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025 Wednesday, 06 / 11 / 2025

Hyd. No. 1

Existing 25yr

Hydrograph type	= Manual	Peak discharge	= 5.610 cfs
Storm frequency	= 25 yrs	Time to peak	= 16.20 hrs
Time interval	= 18 min	Hyd. volume	= 22,334 cuft

90% of Hydrograph Volume = 20,101 cuft



Small Area Runoff Hydrograph for Tractor Supply Phelan Proposed Area Tributary To Underground Infiltration System (DA#1)

100-Year, 24-Hour Storm

Catchment Maximum Loss Rate, F_M		
Pervious Area Fraction, A_p	0.085	
Impervious Area Fraction A_i	0.915	
F_p	0.74	in/hr
F_m	0.06	in/hr

Low Loss Rate, F*		
P_{24}	5.53	in
CN (Pervious Area) (AMC III)	52	
S (Pervious Area)	9.23	
Initial Abstraction (Pervious Area)	1.85	
CN (Impervious Area)	98	
S (Impervious Area)	0	
Initial Abstraction (Impervious Area)	0	
Y_pervious	0.19	
Y_impervious)	1.00	
Y	0.93	
Catchment Low Loss Fraction Y_bar	0.07	
Fm	**0.06**	in/hr
Y_bar	**0.07**	
Area	**3.20**	acres
Tc	**5**	minutes

Peak Rainfall Unit Number (5 minutes periods)	**Mass Rainfall (Inches)**	**Unit Rainfall (Inches)**	**Unit Loss (Inches)**	**Net Rainfall (Inches)**	**Effective Rainfall (Inches/Hr.)**	**Discharge (Q) (cfs)**
1	0.373	0.373	0.005	0.368	4.413	12.710
2	0.534	0.161	0.005	0.156	1.869	5.390
3	0.646	0.112	0.005	0.107	1.281	3.690
4	0.740	0.094	0.005	0.089	1.065	3.070
5	0.840	0.100	0.005	0.095	1.137	3.280

6	0.927	0.087	0.005	0.082	0.981	2.840
7	0.986	0.059	0.004	0.055	0.657	1.900
8	1.045	0.059	0.004	0.055	0.657	1.900
9	1.104	0.059	0.004	0.055	0.657	1.900
10	1.162	0.059	0.004	0.055	0.657	1.900
11	1.221	0.059	0.004	0.055	0.657	1.900
12	1.280	0.059	0.004	0.055	0.657	1.900
13	1.313	0.033	0.002	0.031	0.372	1.080
14	1.347	0.033	0.002	0.031	0.372	1.080
15	1.380	0.033	0.002	0.031	0.372	1.080
16	1.413	0.033	0.002	0.031	0.372	1.080
17	1.447	0.033	0.002	0.031	0.372	1.080
18	1.480	0.033	0.002	0.031	0.372	1.080
19	1.513	0.033	0.002	0.031	0.372	1.080
20	1.547	0.033	0.002	0.031	0.372	1.080
21	1.580	0.033	0.002	0.031	0.372	1.080
22	1.613	0.033	0.002	0.031	0.372	1.080
23	1.647	0.033	0.002	0.031	0.372	1.080
24	1.680	0.033	0.002	0.031	0.372	1.080
25	1.706	0.026	0.002	0.024	0.289	0.840
26	1.732	0.026	0.002	0.024	0.289	0.840
27	1.758	0.026	0.002	0.024	0.289	0.840
28	1.783	0.026	0.002	0.024	0.289	0.840
29	1.809	0.026	0.002	0.024	0.289	0.840
30	1.835	0.026	0.002	0.024	0.289	0.840
31	1.861	0.026	0.002	0.024	0.289	0.840
32	1.887	0.026	0.002	0.024	0.289	0.840
33	1.913	0.026	0.002	0.024	0.289	0.840
34	1.938	0.026	0.002	0.024	0.289	0.840
35	1.964	0.026	0.002	0.024	0.289	0.840
36	1.990	0.026	0.002	0.024	0.289	0.840
37	2.011	0.021	0.001	0.019	0.233	0.680
38	2.032	0.021	0.001	0.019	0.233	0.680
39	2.053	0.021	0.001	0.019	0.233	0.680
40	2.073	0.021	0.001	0.019	0.233	0.680
41	2.094	0.021	0.001	0.019	0.233	0.680
42	2.115	0.021	0.001	0.019	0.233	0.680
43	2.136	0.021	0.001	0.019	0.233	0.680
44	2.157	0.021	0.001	0.019	0.233	0.680
45	2.178	0.021	0.001	0.019	0.233	0.680
46	2.198	0.021	0.001	0.019	0.233	0.680
47	2.219	0.021	0.001	0.019	0.233	0.680
48	2.240	0.021	0.001	0.019	0.233	0.680
49	2.261	0.021	0.001	0.019	0.233	0.680

50	2.282	0.021	0.001	0.019	0.233	0.680
51	2.303	0.021	0.001	0.019	0.233	0.680
52	2.323	0.021	0.001	0.019	0.233	0.680
53	2.344	0.021	0.001	0.019	0.233	0.680
54	2.365	0.021	0.001	0.019	0.233	0.680
55	2.386	0.021	0.001	0.019	0.233	0.680
56	2.407	0.021	0.001	0.019	0.233	0.680
57	2.428	0.021	0.001	0.019	0.233	0.680
58	2.448	0.021	0.001	0.019	0.233	0.680
59	2.469	0.021	0.001	0.019	0.233	0.680
60	2.490	0.021	0.001	0.019	0.233	0.680
61	2.511	0.021	0.001	0.019	0.233	0.680
62	2.532	0.021	0.001	0.019	0.233	0.680
63	2.553	0.021	0.001	0.019	0.233	0.680
64	2.573	0.021	0.001	0.019	0.233	0.680
65	2.594	0.021	0.001	0.019	0.233	0.680
66	2.615	0.021	0.001	0.019	0.233	0.680
67	2.636	0.021	0.001	0.019	0.233	0.680
68	2.657	0.021	0.001	0.019	0.233	0.680
69	2.678	0.021	0.001	0.019	0.233	0.680
70	2.698	0.021	0.001	0.019	0.233	0.680
71	2.719	0.021	0.001	0.019	0.233	0.680
72	2.740	0.021	0.001	0.019	0.233	0.680
73	2.756	0.016	0.001	0.015	0.177	0.520
74	2.772	0.016	0.001	0.015	0.177	0.520
75	2.788	0.016	0.001	0.015	0.177	0.520
76	2.803	0.016	0.001	0.015	0.177	0.520
77	2.819	0.016	0.001	0.015	0.177	0.520
78	2.835	0.016	0.001	0.015	0.177	0.520
79	2.851	0.016	0.001	0.015	0.177	0.520
80	2.867	0.016	0.001	0.015	0.177	0.520
81	2.883	0.016	0.001	0.015	0.177	0.520
82	2.898	0.016	0.001	0.015	0.177	0.520
83	2.914	0.016	0.001	0.015	0.177	0.520
84	2.930	0.016	0.001	0.015	0.177	0.520
85	2.946	0.016	0.001	0.015	0.177	0.520
86	2.962	0.016	0.001	0.015	0.177	0.520
87	2.978	0.016	0.001	0.015	0.177	0.520
88	2.993	0.016	0.001	0.015	0.177	0.520
89	3.009	0.016	0.001	0.015	0.177	0.520
90	3.025	0.016	0.001	0.015	0.177	0.520
91	3.041	0.016	0.001	0.015	0.177	0.520
92	3.057	0.016	0.001	0.015	0.177	0.520
93	3.073	0.016	0.001	0.015	0.177	0.520

94	3.088	0.016	0.001	0.015	0.177	0.520
95	3.104	0.016	0.001	0.015	0.177	0.520
96	3.120	0.016	0.001	0.015	0.177	0.520
97	3.136	0.016	0.001	0.015	0.177	0.520
98	3.152	0.016	0.001	0.015	0.177	0.520
99	3.168	0.016	0.001	0.015	0.177	0.520
100	3.183	0.016	0.001	0.015	0.177	0.520
101	3.199	0.016	0.001	0.015	0.177	0.520
102	3.215	0.016	0.001	0.015	0.177	0.520
103	3.231	0.016	0.001	0.015	0.177	0.520
104	3.247	0.016	0.001	0.015	0.177	0.520
105	3.262	0.016	0.001	0.015	0.177	0.520
106	3.278	0.016	0.001	0.015	0.177	0.520
107	3.294	0.016	0.001	0.015	0.177	0.520
108	3.310	0.016	0.001	0.015	0.177	0.520
109	3.326	0.016	0.001	0.015	0.177	0.520
110	3.342	0.016	0.001	0.015	0.177	0.520
111	3.357	0.016	0.001	0.015	0.177	0.520
112	3.373	0.016	0.001	0.015	0.177	0.520
113	3.389	0.016	0.001	0.015	0.177	0.520
114	3.405	0.016	0.001	0.015	0.177	0.520
115	3.421	0.016	0.001	0.015	0.177	0.520
116	3.437	0.016	0.001	0.015	0.177	0.520
117	3.452	0.016	0.001	0.015	0.177	0.520
118	3.468	0.016	0.001	0.015	0.177	0.520
119	3.484	0.016	0.001	0.015	0.177	0.520
120	3.500	0.016	0.001	0.015	0.177	0.520
121	3.516	0.016	0.001	0.015	0.177	0.520
122	3.532	0.016	0.001	0.015	0.177	0.520
123	3.547	0.016	0.001	0.015	0.177	0.520
124	3.563	0.016	0.001	0.015	0.177	0.520
125	3.579	0.016	0.001	0.015	0.177	0.520
126	3.595	0.016	0.001	0.015	0.177	0.520
127	3.611	0.016	0.001	0.015	0.177	0.520
128	3.627	0.016	0.001	0.015	0.177	0.520
129	3.642	0.016	0.001	0.015	0.177	0.520
130	3.658	0.016	0.001	0.015	0.177	0.520
131	3.674	0.016	0.001	0.015	0.177	0.520
132	3.690	0.016	0.001	0.015	0.177	0.520
133	3.706	0.016	0.001	0.015	0.177	0.520
134	3.722	0.016	0.001	0.015	0.177	0.520
135	3.737	0.016	0.001	0.015	0.177	0.520
136	3.753	0.016	0.001	0.015	0.177	0.520
137	3.769	0.016	0.001	0.015	0.177	0.520

138	3.785	0.016	0.001	0.015	0.177	0.520
139	3.801	0.016	0.001	0.015	0.177	0.520
140	3.817	0.016	0.001	0.015	0.177	0.520
141	3.832	0.016	0.001	0.015	0.177	0.520
142	3.848	0.016	0.001	0.015	0.177	0.520
143	3.864	0.016	0.001	0.015	0.177	0.520
144	3.880	0.016	0.001	0.015	0.177	0.520
145	3.891	0.011	0.001	0.011	0.128	0.370
146	3.903	0.011	0.001	0.011	0.128	0.370
147	3.914	0.011	0.001	0.011	0.128	0.370
148	3.926	0.011	0.001	0.011	0.128	0.370
149	3.937	0.011	0.001	0.011	0.128	0.370
150	3.949	0.011	0.001	0.011	0.128	0.370
151	3.960	0.011	0.001	0.011	0.128	0.370
152	3.972	0.011	0.001	0.011	0.128	0.370
153	3.983	0.011	0.001	0.011	0.128	0.370
154	3.995	0.011	0.001	0.011	0.128	0.370
155	4.006	0.011	0.001	0.011	0.128	0.370
156	4.018	0.011	0.001	0.011	0.128	0.370
157	4.029	0.011	0.001	0.011	0.128	0.370
158	4.040	0.011	0.001	0.011	0.128	0.370
159	4.052	0.011	0.001	0.011	0.128	0.370
160	4.063	0.011	0.001	0.011	0.128	0.370
161	4.075	0.011	0.001	0.011	0.128	0.370
162	4.086	0.011	0.001	0.011	0.128	0.370
163	4.098	0.011	0.001	0.011	0.128	0.370
164	4.109	0.011	0.001	0.011	0.128	0.370
165	4.121	0.011	0.001	0.011	0.128	0.370
166	4.132	0.011	0.001	0.011	0.128	0.370
167	4.144	0.011	0.001	0.011	0.128	0.370
168	4.155	0.011	0.001	0.011	0.128	0.370
169	4.166	0.011	0.001	0.011	0.128	0.370
170	4.178	0.011	0.001	0.011	0.128	0.370
171	4.189	0.011	0.001	0.011	0.128	0.370
172	4.201	0.011	0.001	0.011	0.128	0.370
173	4.212	0.011	0.001	0.011	0.128	0.370
174	4.224	0.011	0.001	0.011	0.128	0.370
175	4.235	0.011	0.001	0.011	0.128	0.370
176	4.247	0.011	0.001	0.011	0.128	0.370
177	4.258	0.011	0.001	0.011	0.128	0.370
178	4.270	0.011	0.001	0.011	0.128	0.370
179	4.281	0.011	0.001	0.011	0.128	0.370
180	4.293	0.011	0.001	0.011	0.128	0.370
181	4.304	0.011	0.001	0.011	0.128	0.370

182	4.315	0.011	0.001	0.011	0.128	0.370
183	4.327	0.011	0.001	0.011	0.128	0.370
184	4.338	0.011	0.001	0.011	0.128	0.370
185	4.350	0.011	0.001	0.011	0.128	0.370
186	4.361	0.011	0.001	0.011	0.128	0.370
187	4.373	0.011	0.001	0.011	0.128	0.370
188	4.384	0.011	0.001	0.011	0.128	0.370
189	4.396	0.011	0.001	0.011	0.128	0.370
190	4.407	0.011	0.001	0.011	0.128	0.370
191	4.419	0.011	0.001	0.011	0.128	0.370
192	4.430	0.011	0.001	0.011	0.128	0.370
193	4.441	0.011	0.001	0.011	0.128	0.370
194	4.453	0.011	0.001	0.011	0.128	0.370
195	4.464	0.011	0.001	0.011	0.128	0.370
196	4.476	0.011	0.001	0.011	0.128	0.370
197	4.487	0.011	0.001	0.011	0.128	0.370
198	4.499	0.011	0.001	0.011	0.128	0.370
199	4.510	0.011	0.001	0.011	0.128	0.370
200	4.522	0.011	0.001	0.011	0.128	0.370
201	4.533	0.011	0.001	0.011	0.128	0.370
202	4.545	0.011	0.001	0.011	0.128	0.370
203	4.556	0.011	0.001	0.011	0.128	0.370
204	4.568	0.011	0.001	0.011	0.128	0.370
205	4.579	0.011	0.001	0.011	0.128	0.370
206	4.590	0.011	0.001	0.011	0.128	0.370
207	4.602	0.011	0.001	0.011	0.128	0.370
208	4.613	0.011	0.001	0.011	0.128	0.370
209	4.625	0.011	0.001	0.011	0.128	0.370
210	4.636	0.011	0.001	0.011	0.128	0.370
211	4.648	0.011	0.001	0.011	0.128	0.370
212	4.659	0.011	0.001	0.011	0.128	0.370
213	4.671	0.011	0.001	0.011	0.128	0.370
214	4.682	0.011	0.001	0.011	0.128	0.370
215	4.694	0.011	0.001	0.011	0.128	0.370
216	4.705	0.011	0.001	0.011	0.128	0.370
217	4.716	0.011	0.001	0.011	0.128	0.370
218	4.728	0.011	0.001	0.011	0.128	0.370
219	4.739	0.011	0.001	0.011	0.128	0.370
220	4.751	0.011	0.001	0.011	0.128	0.370
221	4.762	0.011	0.001	0.011	0.128	0.370
222	4.774	0.011	0.001	0.011	0.128	0.370
223	4.785	0.011	0.001	0.011	0.128	0.370
224	4.797	0.011	0.001	0.011	0.128	0.370
225	4.808	0.011	0.001	0.011	0.128	0.370

226	4.820	0.011	0.001	0.011	0.128	0.370
227	4.831	0.011	0.001	0.011	0.128	0.370
228	4.843	0.011	0.001	0.011	0.128	0.370
229	4.854	0.011	0.001	0.011	0.128	0.370
230	4.865	0.011	0.001	0.011	0.128	0.370
231	4.877	0.011	0.001	0.011	0.128	0.370
232	4.888	0.011	0.001	0.011	0.128	0.370
233	4.900	0.011	0.001	0.011	0.128	0.370
234	4.911	0.011	0.001	0.011	0.128	0.370
235	4.923	0.011	0.001	0.011	0.128	0.370
236	4.934	0.011	0.001	0.011	0.128	0.370
237	4.946	0.011	0.001	0.011	0.128	0.370
238	4.957	0.011	0.001	0.011	0.128	0.370
239	4.969	0.011	0.001	0.011	0.128	0.370
240	4.980	0.011	0.001	0.011	0.128	0.370
241	4.991	0.011	0.001	0.011	0.128	0.370
242	5.003	0.011	0.001	0.011	0.128	0.370
243	5.014	0.011	0.001	0.011	0.128	0.370
244	5.026	0.011	0.001	0.011	0.128	0.370
245	5.037	0.011	0.001	0.011	0.128	0.370
246	5.049	0.011	0.001	0.011	0.128	0.370
247	5.060	0.011	0.001	0.011	0.128	0.370
248	5.072	0.011	0.001	0.011	0.128	0.370
249	5.083	0.011	0.001	0.011	0.128	0.370
250	5.095	0.011	0.001	0.011	0.128	0.370
251	5.106	0.011	0.001	0.011	0.128	0.370
252	5.118	0.011	0.001	0.011	0.128	0.370
253	5.129	0.011	0.001	0.011	0.128	0.370
254	5.140	0.011	0.001	0.011	0.128	0.370
255	5.152	0.011	0.001	0.011	0.128	0.370
256	5.163	0.011	0.001	0.011	0.128	0.370
257	5.175	0.011	0.001	0.011	0.128	0.370
258	5.186	0.011	0.001	0.011	0.128	0.370
259	5.198	0.011	0.001	0.011	0.128	0.370
260	5.209	0.011	0.001	0.011	0.128	0.370
261	5.221	0.011	0.001	0.011	0.128	0.370
262	5.232	0.011	0.001	0.011	0.128	0.370
263	5.244	0.011	0.001	0.011	0.128	0.370
264	5.255	0.011	0.001	0.011	0.128	0.370
265	5.266	0.011	0.001	0.011	0.128	0.370
266	5.278	0.011	0.001	0.011	0.128	0.370
267	5.289	0.011	0.001	0.011	0.128	0.370
268	5.301	0.011	0.001	0.011	0.128	0.370
269	5.312	0.011	0.001	0.011	0.128	0.370

270	5.324	0.011	0.001	0.011	0.128	0.370
271	5.335	0.011	0.001	0.011	0.128	0.370
272	5.347	0.011	0.001	0.011	0.128	0.370
273	5.358	0.011	0.001	0.011	0.128	0.370
274	5.370	0.011	0.001	0.011	0.128	0.370
275	5.381	0.011	0.001	0.011	0.128	0.370
276	5.393	0.011	0.001	0.011	0.128	0.370
277	5.404	0.011	0.001	0.011	0.128	0.370
278	5.415	0.011	0.001	0.011	0.128	0.370
279	5.427	0.011	0.001	0.011	0.128	0.370
280	5.438	0.011	0.001	0.011	0.128	0.370
281	5.450	0.011	0.001	0.011	0.128	0.370
282	5.461	0.011	0.001	0.011	0.128	0.370
283	5.473	0.011	0.001	0.011	0.128	0.370
284	5.484	0.011	0.001	0.011	0.128	0.370
285	5.496	0.011	0.001	0.011	0.128	0.370
286	5.507	0.011	0.001	0.011	0.128	0.370
287	5.519	0.011	0.001	0.011	0.128	0.370
288	5.530	0.011	0.001	0.011	0.128	0.370

Runoff Hydrograph

Time Period	Q (cfs)
1	0.37
2	0.37
3	0.37
4	0.37
5	0.37
6	0.37
7	0.37
8	0.37
9	0.37
10	0.37
11	0.37
12	0.37
13	0.37
14	0.37
15	0.37
16	0.37
17	0.37
18	0.37
19	0.37
20	0.37
21	0.37
22	0.37

23	0.37
24	0.37
25	0.37
26	0.37
27	0.37
28	0.37
29	0.37
30	0.37
31	0.37
32	0.37
33	0.37
34	0.37
35	0.37
36	0.37
37	0.37
38	0.37
39	0.37
40	0.37
41	0.37
42	0.37
43	0.37
44	0.37
45	0.37
46	0.37
47	0.37
48	0.37
49	0.37
50	0.37
51	0.37
52	0.37
53	0.37
54	0.37
55	0.37
56	0.37
57	0.37
58	0.37
59	0.37
60	0.37
61	0.37
62	0.37
63	0.37
64	0.37
65	0.37
66	0.37

67	0.37
68	0.37
69	0.37
70	0.37
71	0.37
72	0.37
73	0.37
74	0.37
75	0.37
76	0.37
77	0.37
78	0.37
79	0.37
80	0.37
81	0.37
82	0.37
83	0.37
84	0.37
85	0.37
86	0.37
87	0.37
88	0.37
89	0.37
90	0.37
91	0.37
92	0.37
93	0.37
94	0.37
95	0.37
96	0.37
97	0.52
98	0.52
99	0.52
100	0.52
101	0.52
102	0.52
103	0.52
104	0.52
105	0.52
106	0.52
107	0.52
108	0.52
109	0.52
110	0.52

111	0.52
112	0.52
113	0.52
114	0.52
115	0.52
116	0.52
117	0.52
118	0.52
119	0.52
120	0.52
121	0.52
122	0.52
123	0.52
124	0.52
125	0.52
126	0.52
127	0.52
128	0.52
129	0.52
130	0.52
131	0.52
132	0.52
133	0.52
134	0.52
135	0.52
136	0.52
137	0.52
138	0.52
139	0.52
140	0.52
141	0.52
142	0.52
143	0.52
144	0.52
145	0.68
146	0.68
147	0.68
148	0.68
149	0.68
150	0.68
151	0.68
152	0.68
153	0.68
154	0.68

155	0.68
156	0.68
157	0.68
158	0.68
159	0.68
160	0.68
161	0.68
162	0.68
163	0.68
164	0.68
165	0.68
166	0.68
167	0.68
168	0.68
169	0.84
170	0.84
171	0.84
172	0.84
173	0.84
174	0.84
175	0.84
176	0.84
177	1.08
178	1.08
179	1.08
180	1.08
181	1.08
182	1.08
183	1.08
184	1.08
185	1.90
186	1.90
187	1.90
188	1.90
189	2.84
190	3.29
191	3.71
192	5.40
193	12.75
194	3.08
195	1.90
196	1.90
197	1.08
198	1.08

199	1.08
200	1.08
201	0.84
202	0.84
203	0.84
204	0.84
205	0.68
206	0.68
207	0.68
208	0.68
209	0.68
210	0.68
211	0.68
212	0.68
213	0.68
214	0.68
215	0.68
216	0.68
217	0.52
218	0.52
219	0.52
220	0.52
221	0.52
222	0.52
223	0.52
224	0.52
225	0.52
226	0.52
227	0.52
228	0.52
229	0.52
230	0.52
231	0.52
232	0.52
233	0.52
234	0.52
235	0.52
236	0.52
237	0.52
238	0.52
239	0.52
240	0.52
241	0.37
242	0.37

243	0.37
244	0.37
245	0.37
246	0.37
247	0.37
248	0.37
249	0.37
250	0.37
251	0.37
252	0.37
253	0.37
254	0.37
255	0.37
256	0.37
257	0.37
258	0.37
259	0.37
260	0.37
261	0.37
262	0.37
263	0.37
264	0.37
265	0.37
266	0.37
267	0.37
268	0.37
269	0.37
270	0.37
271	0.37
272	0.37
273	0.37
274	0.37
275	0.37
276	0.37
277	0.37
278	0.37
279	0.37
280	0.37
281	0.37
282	0.37
283	0.37
284	0.37
285	0.37
286	0.37

287	0.37
288	0.37

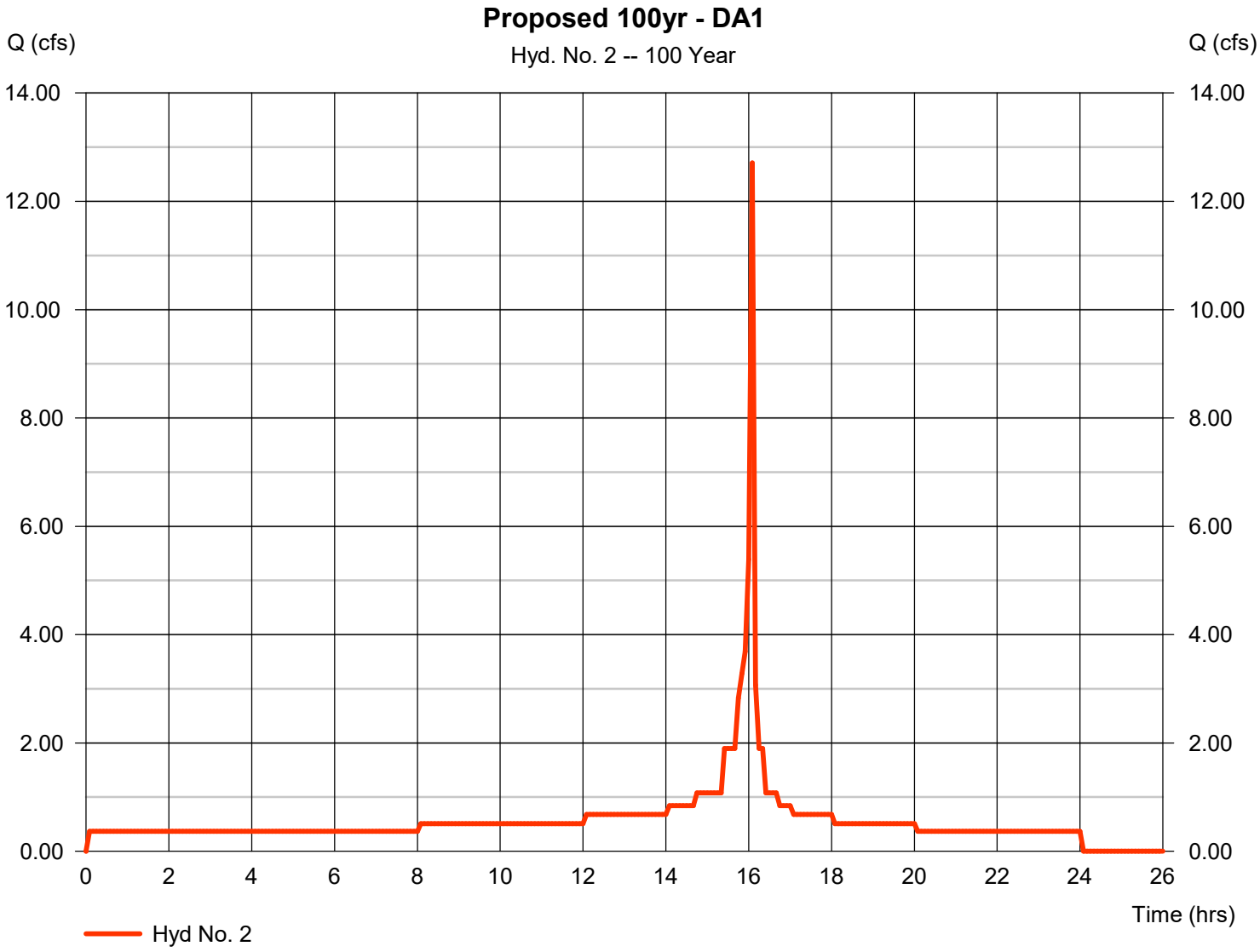
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025 Wednesday, 06 / 11 / 2025

Hyd. No. 2

Proposed 100yr - DA1

Hydrograph type	= Manual	Peak discharge	= 12.71 cfs
Storm frequency	= 100 yrs	Time to peak	= 16.08 hrs
Time interval	= 5 min	Hyd. volume	= 53,967 cuft



Small Area Runoff Hydrograph for Tractor Supply Phelan Proposed Conditions - DA#2

100-Year, 24 Hour Storm

Catchment Maximum Loss Rate, F_M		
Pervious Area Fraction, A_p	0.989	
Impervious Area Fraction A_i	0.011	
F_p	0.74	in/hr
F_m	0.73	in/hr

Low Loss Rate, F*		
P_{24}	5.53	in
CN (Pervious Area) (AMC III)	52	
S (Pervious Area)	9.23	
Initial Abstraction (Pervious Area)	1.85	
CN (Impervious Area)	98	
S (Impervious Area)	0	
Initial Abstraction (Impervious Area)	0	
Y_pervious	0.19	
Y_impervious	1.00	
Y	0.20	
Catchment Low Loss Fraction Y_bar	0.80	
Fm	**0.73**	in/hr
Y_bar	**0.80**	
Area	**1.02**	acres
Tc	**16**	minutes

Peak Rainfall Unit Number (16 minutes periods)	**Mass Rainfall (Inches)**	**Unit Rainfall (Inches)**	**Unit Loss (Inches)**	**Net Rainfall (Inches)**	**Effective Rainfall (Inches/Hr.)**	**Discharge (Q) (cfs)**
1	0.650	0.650	0.195	0.455	1.706	1.570
2	0.950	0.300	0.195	0.105	0.393	0.370
3	1.150	0.200	0.160	0.040	0.149	0.140
4	1.310	0.160	0.128	0.032	0.119	0.110
5	1.450	0.140	0.112	0.028	0.104	0.100
6	1.550	0.100	0.080	0.020	0.075	0.070

7	1.620	0.070	0.056	0.014	0.052	0.050
8	1.720	0.100	0.080	0.020	0.075	0.070
9	1.790	0.070	0.056	0.014	0.052	0.050
10	1.860	0.070	0.056	0.014	0.052	0.050
11	1.930	0.070	0.056	0.014	0.052	0.050
12	2.000	0.070	0.056	0.014	0.052	0.050
13	2.068	0.068	0.055	0.014	0.051	0.050
14	2.137	0.068	0.055	0.014	0.051	0.050
15	2.205	0.068	0.055	0.014	0.051	0.050
16	2.273	0.068	0.055	0.014	0.051	0.050
17	2.342	0.068	0.055	0.014	0.051	0.050
18	2.410	0.068	0.055	0.014	0.051	0.050
19	2.478	0.068	0.055	0.014	0.051	0.050
20	2.547	0.068	0.055	0.014	0.051	0.050
21	2.615	0.068	0.055	0.014	0.051	0.050
22	2.683	0.068	0.055	0.014	0.051	0.050
23	2.752	0.068	0.055	0.014	0.051	0.050
24	2.820	0.068	0.055	0.014	0.051	0.050
25	2.873	0.053	0.042	0.010	0.039	0.040
26	2.925	0.053	0.042	0.010	0.039	0.040
27	2.978	0.053	0.042	0.010	0.039	0.040
28	3.030	0.053	0.042	0.010	0.039	0.040
29	3.083	0.053	0.042	0.010	0.039	0.040
30	3.135	0.053	0.042	0.010	0.039	0.040
31	3.188	0.053	0.042	0.010	0.039	0.040
32	3.240	0.053	0.042	0.010	0.039	0.040
33	3.293	0.053	0.042	0.010	0.039	0.040
34	3.345	0.053	0.042	0.010	0.039	0.040
35	3.398	0.053	0.042	0.010	0.039	0.040
36	3.450	0.052	0.042	0.010	0.039	0.040
37	3.498	0.048	0.038	0.010	0.036	0.040
38	3.546	0.048	0.038	0.010	0.036	0.040
39	3.593	0.048	0.038	0.010	0.036	0.040
40	3.641	0.048	0.038	0.010	0.036	0.040
41	3.689	0.048	0.038	0.010	0.036	0.040
42	3.737	0.048	0.038	0.010	0.036	0.040
43	3.784	0.048	0.038	0.010	0.036	0.040
44	3.832	0.048	0.038	0.010	0.036	0.040
45	3.880	0.048	0.038	0.010	0.036	0.040
46	3.917	0.037	0.029	0.007	0.027	0.030
47	3.953	0.037	0.029	0.007	0.027	0.030
48	3.990	0.037	0.029	0.007	0.027	0.030
49	4.027	0.037	0.029	0.007	0.027	0.030
50	4.063	0.037	0.029	0.007	0.027	0.030

51	4.100	0.037	0.029	0.007	0.027	0.030
52	4.137	0.037	0.029	0.007	0.027	0.030
53	4.173	0.037	0.029	0.007	0.027	0.030
54	4.210	0.037	0.029	0.007	0.027	0.030
55	4.247	0.037	0.029	0.007	0.027	0.030
56	4.283	0.037	0.029	0.007	0.027	0.030
57	4.320	0.037	0.029	0.007	0.027	0.030
58	4.357	0.037	0.029	0.007	0.027	0.030
59	4.393	0.037	0.029	0.007	0.027	0.030
60	4.430	0.037	0.029	0.007	0.027	0.030
61	4.467	0.037	0.029	0.007	0.027	0.030
62	4.503	0.037	0.029	0.007	0.027	0.030
63	4.540	0.037	0.029	0.007	0.027	0.030
64	4.577	0.037	0.029	0.007	0.027	0.030
65	4.613	0.037	0.029	0.007	0.027	0.030
66	4.650	0.037	0.029	0.007	0.027	0.030
67	4.687	0.037	0.029	0.007	0.027	0.030
68	4.723	0.037	0.029	0.007	0.027	0.030
69	4.760	0.037	0.029	0.007	0.027	0.030
70	4.797	0.037	0.029	0.007	0.027	0.030
71	4.833	0.037	0.029	0.007	0.027	0.030
72	4.870	0.037	0.029	0.007	0.027	0.030
73	4.907	0.037	0.029	0.007	0.027	0.030
74	4.943	0.037	0.029	0.007	0.027	0.030
75	4.980	0.037	0.029	0.007	0.027	0.030
76	5.017	0.037	0.029	0.007	0.027	0.030
77	5.053	0.037	0.029	0.007	0.027	0.030
78	5.090	0.037	0.029	0.007	0.027	0.030
79	5.127	0.037	0.029	0.007	0.027	0.030
80	5.163	0.037	0.029	0.007	0.027	0.030
81	5.200	0.037	0.029	0.007	0.027	0.030
82	5.237	0.037	0.029	0.007	0.027	0.030
83	5.273	0.037	0.029	0.007	0.027	0.030
84	5.310	0.037	0.029	0.007	0.027	0.030
85	5.347	0.037	0.029	0.007	0.027	0.030
86	5.383	0.037	0.029	0.007	0.027	0.030
87	5.420	0.037	0.029	0.007	0.027	0.030
88	5.457	0.037	0.029	0.007	0.027	0.030
89	5.493	0.037	0.029	0.007	0.027	0.030
90	5.530	0.037	0.029	0.007	0.027	0.030

Runoff Hydrograph

Time Period	Q (cfs)
1	0.030

2	0.030
3	0.030
4	0.030
5	0.030
6	0.030
7	0.030
8	0.030
9	0.030
10	0.030
11	0.030
12	0.030
13	0.030
14	0.030
15	0.030
16	0.030
17	0.030
18	0.030
19	0.030
20	0.030
21	0.030
22	0.030
23	0.030
24	0.030
25	0.030
26	0.030
27	0.030
28	0.030
29	0.030
30	0.030
31	0.040
32	0.040
33	0.040
34	0.040
35	0.040
36	0.040
37	0.040
38	0.040
39	0.040
40	0.040
41	0.040
42	0.040
43	0.040
44	0.040
45	0.050

46	0.050
47	0.050
48	0.050
49	0.050
50	0.050
51	0.050
52	0.050
53	0.050
54	0.050
55	0.050
56	0.070
57	0.070
58	0.100
59	0.140
60	0.360
61	1.560
62	0.110
63	0.050
64	0.050
65	0.050
66	0.050
67	0.050
68	0.050
69	0.040
70	0.040
71	0.040
72	0.040
73	0.040
74	0.040
75	0.040
76	0.030
77	0.030
78	0.030
79	0.030
80	0.030
81	0.030
82	0.030
83	0.030
84	0.030
85	0.030
86	0.030
87	0.030
88	0.030
89	0.030

90	0.030

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

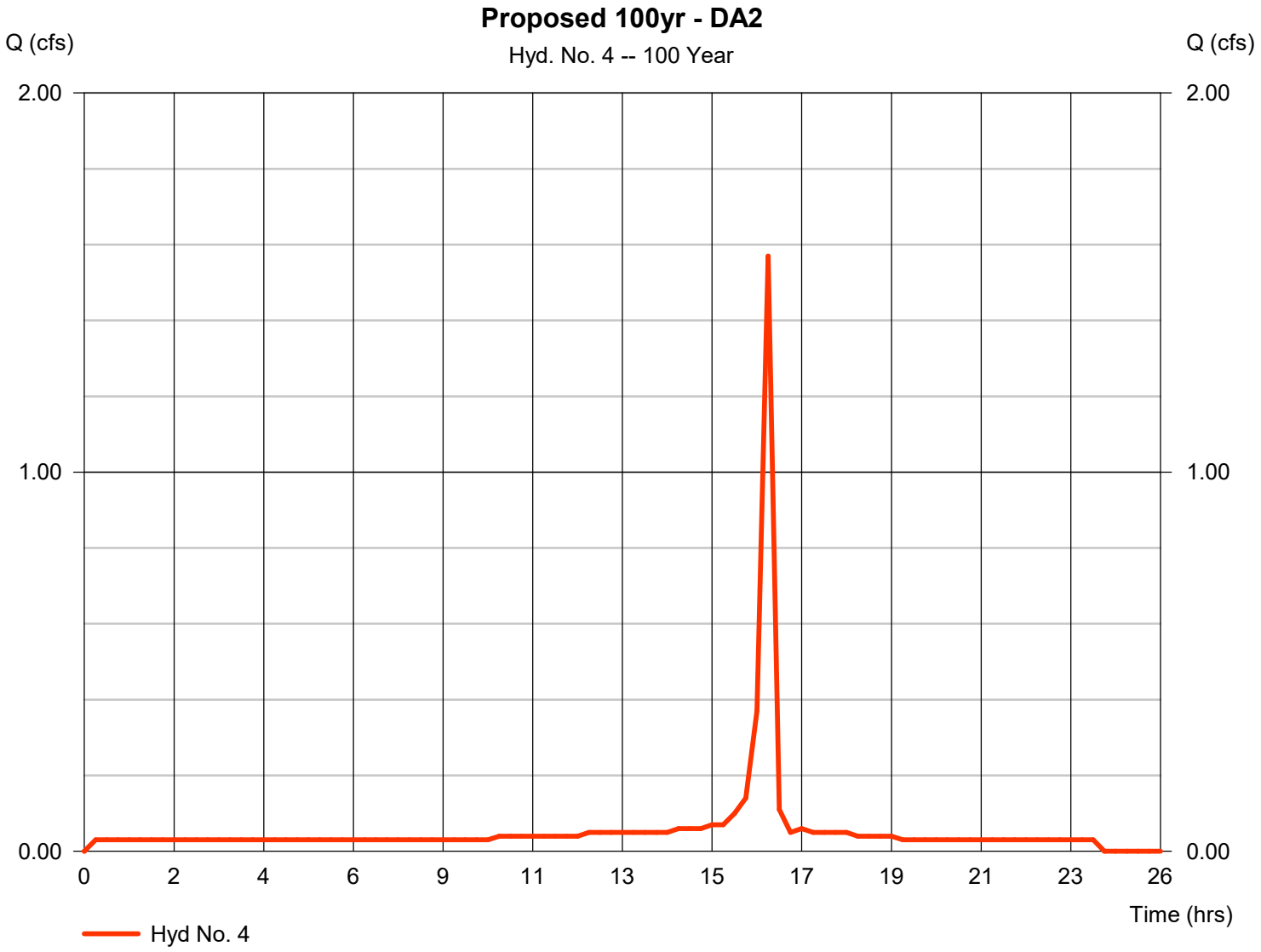
Wednesday, 06 / 11 / 2025

Hyd. No. 4

Proposed 100yr - DA2

Hydrograph type	=	Manual	Peak discharge	=	1.570 cfs
Storm frequency	=	100 yrs	Time to peak	=	16.27 hrs
Time interval	=	16 min	Hyd. volume	=	5,203 cuft

100-Year 24-Hour Volume = 53,967 + 5,203 = 59,170 cubic feet
90% of 25-Year, 24-Hour Volume of Existing Condition = 20,101 cubic feet
Volume to be Retained = 39,069 cubic feet



APPENDIX D: Water Quality Calculations

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)		
[1] Project area DA 1 (ft^2): 183,664	[2] Imperviousness after applying preventative site design practices (Imp%): 0.695	[3] Runoff Coefficient (Rc): _0.488 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
[4] Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.405 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
[5] Compute P_6, Mean 6-hr Precipitation (inches): 0.501 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Desert = 1.2371)*		
[6] Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*		24-hrs ☐ 48-hrs ☒
[7] Compute design capture volume, DCV (ft^3): 7,344 *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*		

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.083 (0.069-0.101)	0.118 (0.098-0.144)	0.167 (0.138-0.205)	0.209 (0.171-0.259)	0.270 (0.214-0.345)	0.320 (0.248-0.417)	0.373 (0.282-0.498)	0.430 (0.316-0.591)	0.510 (0.360-0.732)	0.576 (0.392-0.855)
10-min	0.119 (0.099-0.145)	0.170 (0.140-0.207)	0.240 (0.198-0.294)	0.300 (0.246-0.371)	0.388 (0.307-0.495)	0.459 (0.355-0.598)	0.534 (0.404-0.714)	0.616 (0.452-0.847)	0.732 (0.515-1.05)	0.826 (0.562-1.23)
15-min	0.144 (0.120-0.176)	0.205 (0.170-0.250)	0.290 (0.239-0.355)	0.363 (0.297-0.448)	0.469 (0.371-0.598)	0.555 (0.430-0.723)	0.646 (0.488-0.864)	0.745 (0.547-1.02)	0.885 (0.623-1.27)	0.998 (0.679-1.48)
30-min	0.207 (0.172-0.252)	0.294 (0.243-0.359)	0.416 (0.343-0.509)	0.521 (0.426-0.643)	0.672 (0.532-0.858)	0.796 (0.616-1.04)	0.927 (0.701-1.24)	1.07 (0.785-1.47)	1.27 (0.894-1.82)	1.43 (0.974-2.13)
60-min	0.285 (0.236-0.348)	0.405 (0.335-0.495)	0.574 (0.473-0.702)	0.718 (0.587-0.886)	0.927 (0.733-1.18)	1.10 (0.849-1.43)	1.28 (0.966-1.71)	1.47 (1.08-2.02)	1.75 (1.23-2.51)	1.97 (1.34-2.93)
2-hr	0.420 (0.348-0.512)	0.576 (0.476-0.703)	0.791 (0.653-0.969)	0.975 (0.798-1.20)	1.24 (0.980-1.58)	1.45 (1.12-1.89)	1.68 (1.27-2.24)	1.92 (1.41-2.64)	2.26 (1.59-3.24)	2.53 (1.72-3.75)
3-hr	0.523 (0.433-0.637)	0.707 (0.585-0.863)	0.960 (0.792-1.18)	1.18 (0.962-1.45)	1.48 (1.17-1.89)	1.73 (1.34-2.26)	1.99 (1.51-2.66)	2.27 (1.67-3.12)	2.66 (1.88-3.82)	2.97 (2.02-4.41)
6-hr	0.750	1.00	1.35	1.65	2.06	2.39	2.74	3.11	3.63	4.04

APPENDIX E: Detention Facility Design

Worksheet H: Factor of Safety and Design Infiltration Rate and Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	2	0.50
		Predominant soil texture	0.25	1	0.25
		Site soil variability	0.25	2	0.50
		Depth to groundwater / impervious layer	0.25	1	0.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1.50
B	Design	Tributary area size	0.25	2	0.5
		Level of pretreatment/ expected sediment loads	0.25	3	0.75
		Redundancy	0.25	3	0.75
		Compaction during construction	0.25	1	0.25
		Design Safety Factor, $S_B = \Sigma p$			2.25
Combined Safety Factor, $S_{TOT} = S_A \times S_B$					3.4
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)					15.09
Design Infiltration Rate, in/hr, $K_{DESIGN} = S_{TOT} \times K_M$					4.4

Supporting Data

Briefly describe infiltration test and provide reference to test forms:

Shallow percolation test was performed per the County of San Bernardino TECHNICAL GUIDANCE DOCUMENT APPENDICES, APPENDIX VII, INFILTRATION RATE EVALUATION PROTOCOL AND FACTOR OF SAFETY RECOMMENDATIONS, dated May 19, 2011. Upon completion of testing the percolation rate measured in the field was converted into an infiltration rate using the Porchet method. Reference Geotechnical Report for all additional information.

Note: The minimum combined adjustment factor shall not be less than 2.0 and the maximum combined adjustment factor shall not exceed 9.0.

PROJECT INFORMATION	
ENGINEERED PRODUCT MANAGER	
ADS SALES REP	
PROJECT NO.	

Advanced Drainage Systems, Inc.

PHELAN TSC

PHELAN, CA

ADS RETENTION/DETENTION PIPE SYSTEM SPECIFICATION

SCOPE

THIS SPECIFICATION DESCRIBES ADS RETENTION/DETENTION PIPE SYSTEMS FOR USE IN NON-PRESSURE GRAVITY-FLOW STORM WATER COLLECTION SYSTEMS UTILIZING A CONTINUOUS OUTFALL STRUCTURE.

PIPE REQUIREMENTS

ADS RETENTION/DETENTION SYSTEMS MAY UTILIZE ANY OF THE VARIOUS PIPE PRODUCTS BELOW:

- N-12® STIB PIPE (PER AASHTO) SHALL MEET AASHTO M 294, TYPE S OR ASTM F2306
- N-12® STIB PIPE (PER ASTM F2648) SHALL MEET ASTM F2648
- N-12® MEGA GREEN™ STIB SHALL MEET ASTM F2648

ALL PRODUCTS SHALL HAVE A SMOOTH INTERIOR AND ANNULAR EXTERIOR CORRUGATIONS. ALL STIB PIPE PRODUCTS ARE AVAILABLE AS PERFORATED OR NON-PERFORATED. WTIB PIPE PRODUCTS ARE ONLY AVAILABLE AS NON-PERFORATED. PRODUCT-SPECIFIC PIPE SPECIFICATIONS ARE AVAILABLE IN THE DRAINAGE HANDBOOK SECTION 1 "SPECIFICATIONS".

JOINT PERFORMANCE

PLAIN END / SOIL-TIGHT (STIB):
STIB PIPE SHALL BE JOINED USING A BELL AND SPIGOT JOINT. THE BELL AND SPIGOT JOINT SHALL MEET THE SOIL-TIGHT REQUIREMENTS OF ASTM F2306 AND GASKETS SHALL MEET THE REQUIREMENTS OF ASTM F477.

PLAIN END PIPE AND FITTINGS CONNECTIONS SHALL BE JOINED WITH COUPLING BANDS COVERING AT LEAST TWO FULL CORRUGATIONS ON EACH END OF THE PIPE. GASKETED SOIL-TIGHT COUPLING BAND CONNECTIONS SHALL INCORPORATE A CLOSED-CELL SYNTHETIC EXPANDED RUBBER GASKET MEETING THE REQUIREMENTS OF ASTM D1056 GRADE 2A2. GASKETS, WHEN APPLICABLE, SHALL BE INSTALLED BY THE PIPE MANUFACTURER.

FITTINGS

FITTINGS SHALL CONFORM TO ASTM F2306 AND MEET JOINT PERFORMANCE INDICATED ABOVE FOR FITTINGS CONNECTIONS. CUSTOM FITTINGS ARE AVAILABLE AND MAY REQUIRE SPECIAL INSTALLATION CRITERION.

INSTALLATION

INSTALLATION SHALL BE IN ACCORDANCE WITH ASTM D2321 AND ADS RECOMMENDED INSTALLATION GUIDELINES, WITH THE EXCEPTION THAT MINIMUM COVER IN NON-TRAFFIC AREAS FOR 12-60 INCH (300-1500 mm) DIAMETERS SHALL BE 1 FT (0.3 m). MINIMUM COVER IN TRAFFICKED AREAS FOR 12-36 INCH (300-900 mm) DIAMETERS SHALL BE 1 FT (0.3 m) AND FOR 42-60 INCH (1050-1500 mm) DIAMETERS, THE MINIMUM COVER SHALL BE 2 FT (0.6 m). BACKFILL SHALL CONSIST OF CLASS I (COMPACTED) OR CLASS II (MINIMUM 95% SPD) MATERIAL, WITH THE EXCEPTION THAT 60 INCH (1500 mm) SYSTEMS SHALL USE CLASS I MATERIAL ONLY. MINIMUM COVER HEIGHTS DO NOT ACCOUNT FOR PIPE BUOYANCY. REFER TO ADS TECHNICAL NOTE 5.05 "PIPE FLOTATION" FOR BUOYANCY DESIGN CONSIDERATIONS. MAXIMUM COVER OVER SYSTEM USING STANDARD BACKFILL IS 8 FT (2.4 m); CONTACT A REPRESENTATIVE WHEN MAXIMUM FILL HEIGHT MAY BE EXCEEDED. ADDITIONAL INSTALLATION REQUIREMENTS ARE PROVIDED IN THE DRAINAGE HANDBOOK SECTION 6 "RETENTION/DETENTION".

ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

NOTES:

1) ALL ELEVATIONS, DIMENSIONS AND LOCATIONS OF RISERS, INLETS AND OUTLETS, SHALL BE VERIFIED BY THE ENGINEER PRIOR TO RELEASING FOR FABRICATION.

2) IN SITUATIONS WHERE A FINE-GRAINED BACKFILL MATERIAL IS USED ADJACENT TO THE PIPE SYSTEM, AND ESPECIALLY INVOLVING GROUND WATER CONDITIONS, CONSIDERATION SHOULD BE GIVEN TO THE USE OF GASKETED PIPE JOINTS. AT THE VERY LEAST THE PIPE JOINTS SHOULD BE WRAPPED IN A SUITABLE, NON-WOVEN GEOTEXTILE FABRIC TO PREVENT INFILTRATION OF FINES INTO THE PIPE SYSTEM.

3) CONSIDERATION FOR CONSTRUCTION EQUIPMENT LOADS MUST BE TAKEN INTO ACCOUNT.

4) ALL PIPE DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCES.

5) ALL RISERS TO BE FIELD EXTENDED OR TRIMMED TO FINAL GRADE.

THE UNDERSIGNED HERBY APPROVES THE ATTACHED PAGES.

CUSTOMER DATE

VOLUME RETAINED
BY FACILITY

User Inputs

Project Name:	Phelan TSC
State:	California
City:	PHELAN
Engineer::	undefined undefined
Measurement Type:	Imperial
Product:	HDPE N-12
Nominal diameter:	60
Required volume:	41000 cubic ft.
Available length:	130 ft.
Available width:	100 ft.
Stone Above:	6 in.
Stone Below:	9 in.
Stone Porosity:	30%

Results

Installed Storage Volume:	41066.19 cubic ft.
System length:	123.40 ft.
System width:	91.07 ft.
Number Of Rows:	12
Approx. Bed Size Required:	11238.06 square ft.

System Components

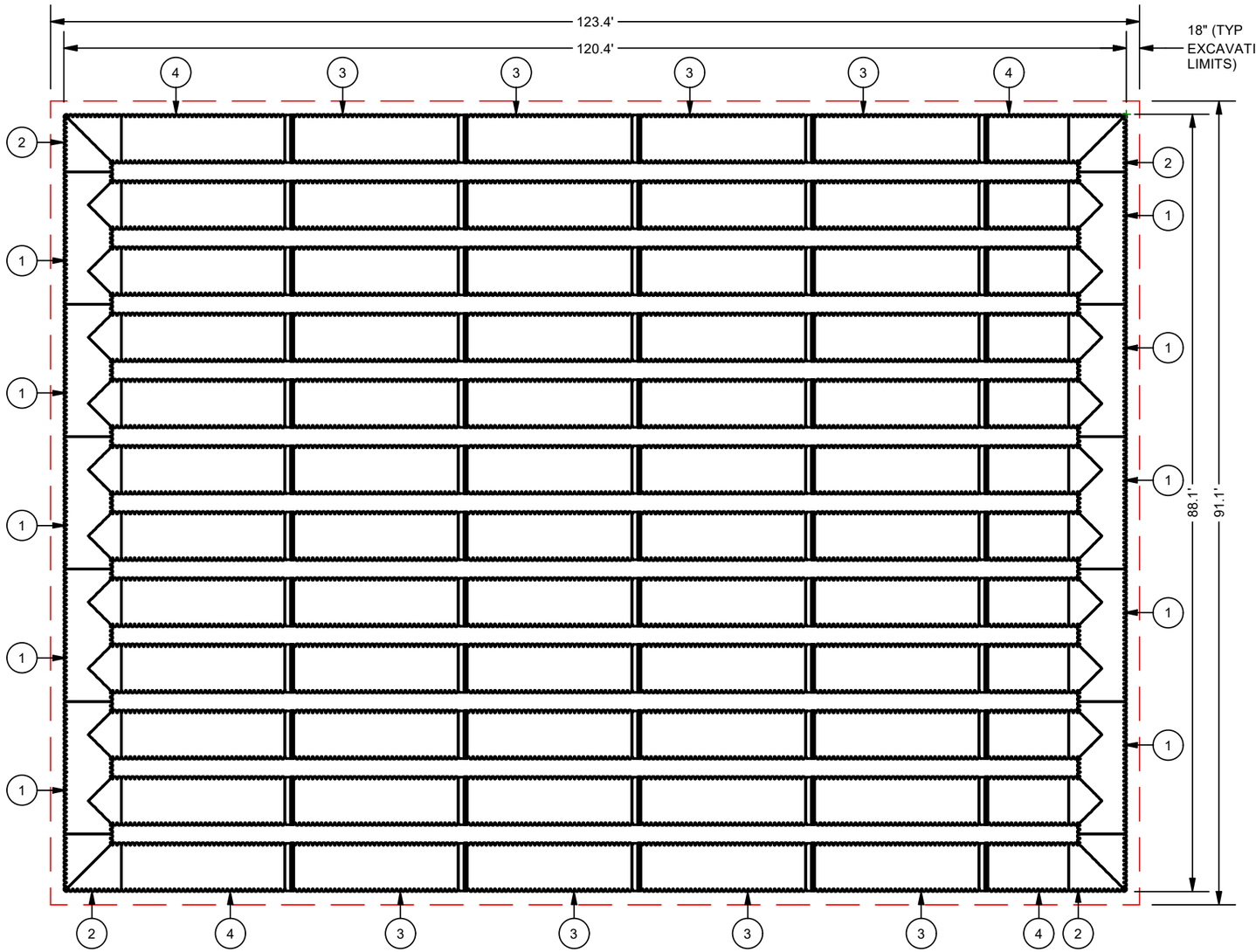
Amount Of Stone Required:	1490.66 cubic yards
Volume of excavation (Bottom of system to top of system):	2822.00 cubic yards

100-Year 24-Hour Volume = 53,967 + 5,203 = 59,170 cubic feet
90% of 25-Year, 24-Hour Volume of Existing Condition = 20,101 cubic feet
Volume to be Retained = 39,069 cubic feet

ITEM	QTY	ALT. QTY	PART #	DESCRIPTION	STAN.	VENDOR	NOTE
1	10		6052AN	60".DOUBLE MANIFOLD TEE	STAN	ADS	SEE DETAIL
2	4		6098AN	60".MANIFOLD 90 DEG BEND	STAN	ADS	SEE DETAIL
3	48 STICKS	945 LF	60610020IB	60".N12 HWY.WTIB.PERF.20'	STAN	ADS	AS SHOWN
4	18 STICKS	345 LF	60610020IB	60".N12 HWY.WTIB.PERF.20'	STAN	ADS	FIELD CUT
5	36		6065AA	60".SPLIT COUPLER.(25/PALLET)	STAN	ADS	NOT SHOWN
6	7 ROLLS	3500 SY	0601TG	601.15' X 300'.(500 SY).(NTPEP SCAN) (20% OVERAGE)	STAN	ADS	SEE DETAIL
7	2239 TONS	1600 CY	BY OTHERS	STONE (0% OVERAGE)	NA	BY OTHERS	NOT SHOWN
8	76195 CF	2823 CY	NA	EXCAVATION	NA	NA	NOT SHOWN

NOTES

- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE PIPE COVER REQUIREMENTS ARE MET.
- STUB SIZES AND INVERTS TO BE VERIFIED BY THE SITE DESIGN ENGINEER PRIOR TO FABRICATION.
- ADS RISERS ARE FABRICATED 36" (900 mm) FROM TOP OF PIPE TO TOP OF RISER DUE TO SHIPPING LIMITATIONS. ADDITIONAL PIPE AND COUPLERS CAN BE USED TO EXTEND THE RISERS TO GRADE.
- LAYOUT SHOWN DOES NOT INCLUDE ADDITIONAL PIPE & MANIFOLD NEEDED FOR PROPER PIPE INSERTION INTO STRUCTURES.
- **NOT FOR CONSTRUCTION:** THIS LAYOUT IS FOR DIMENSIONAL PURPOSES ONLY TO PROVE CONCEPT & THE REQUIRED STORAGE VOLUME CAN BE ACHIEVED ON SITE.



ADS GEOTEXTILE FABRIC

PHELAN TSC
PHELAN, CA
DATE: 06/10/2025 | DRAWN: BB | CHECKED: N/A
PROJECT #:

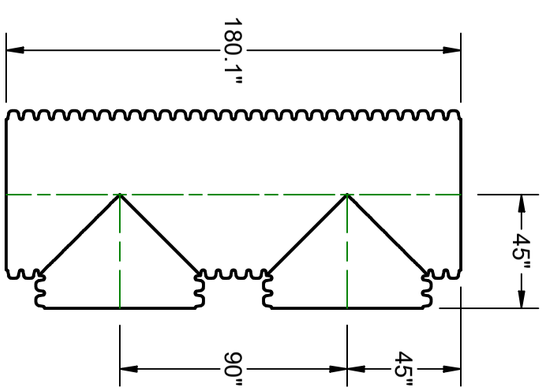
DATE	DRW	CHK	DESCRIPTION

60" STIB PERF
DETENTION SYSTEM
LandMax
Stormwater Management System

4640 TRUEMAN BLVD
HILLIARD, OH 43026
1-800-733-7473

0 15 30

60" DOUBLE MANIFOLD TEE [6052AN]



ITEM #: 1
QTY: 10
6052AN

4640 TRUEMAN BLVD
HILLIARD, OH 43026
1-800-733-7473

60" STIB PERF
DETENTION SYSTEM

LandMax

Stormwater Management System

DATE	DRW	CHK	DESCRIPTION

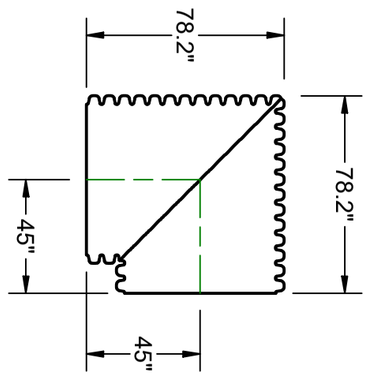
PHELAN TSC

PHELAN, CA

DATE: 06/10/2025 | DRAWN: BB

PROJECT #: | CHECKED: N/A

60" X 90° MANIFOLD BEND [6098AN]



ITEM #: 2
QTY: 4
6098AN

4640 TRUEMAN BLVD
HILLIARD, OH 43026
1-800-733-7473

60" STIB PERF
DETENTION SYSTEM

LandMax

Stormwater Management System

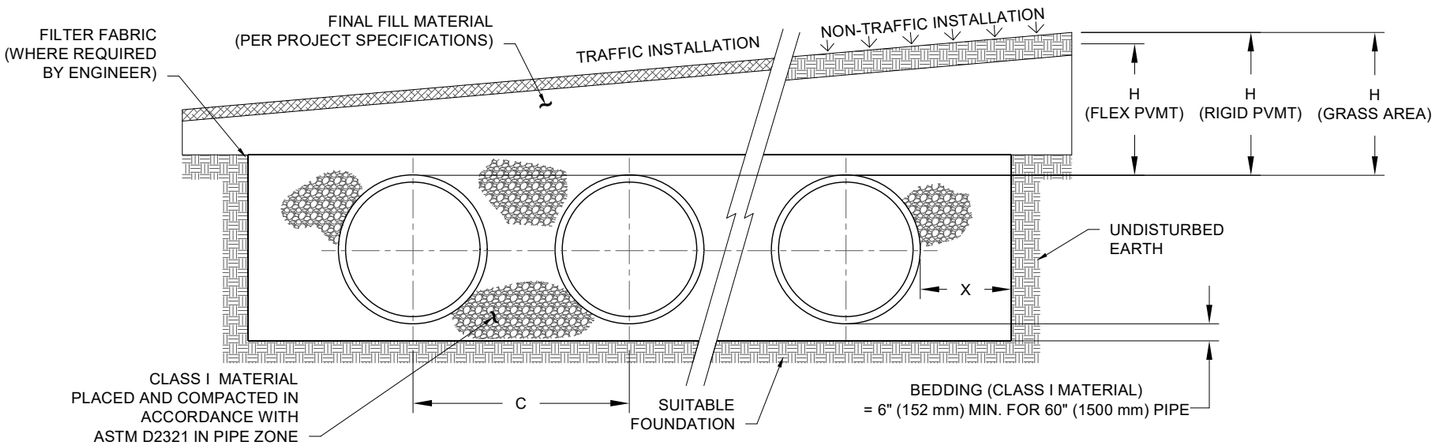
DATE	DRW	CHK	DESCRIPTION

PHELAN TSC

PHELAN, CA

DATE: 06/10/2025 | DRAWN: BB

PROJECT #: | CHECKED: N/A



NOMINAL DIAMETER	NOMINAL O.D.	TYPICAL SPACING "C"	TYPICAL SIDE WALL "X"	MIN. H (NON-TRAFFIC)	MIN. H (TRAFFIC)	MAX. H*
60" (1500 mm)	67" (1702 mm)	90" (2286 mm)	18" (457 mm)	12" (305 mm)	24" (610 mm)	8' (2.4 m)

* MAXIMUM FILL HEIGHTS OVER MANIFOLD FITTINGS. CONTACT MANUFACTURER'S REPRESENTATIVE FOR INSTALLATION CONSIDERATIONS WHEN COVER EXCEEDS 8 FT (2.4 m).
**60" (1500 mm) SYSTEMS REQUIRE CLASS I BACKFILL AROUND ALL LATERALS AND FITTINGS.

NOTES:

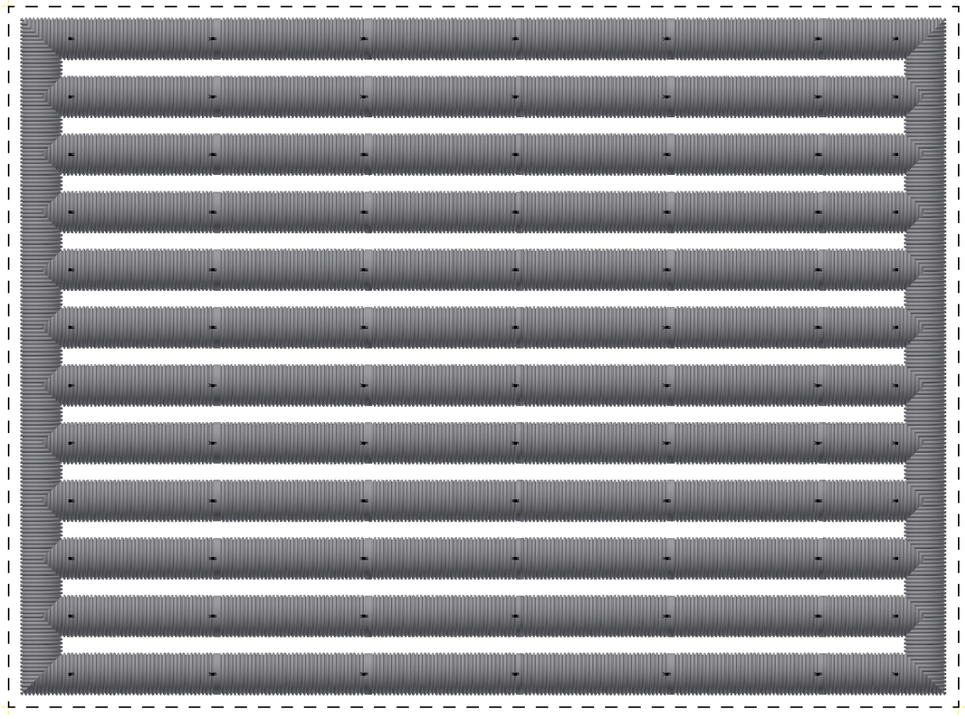
1. ALL REFERENCES TO CLASS I MATERIAL ARE PER ASTM D2321 "STANDARD PRACTICE FOR UNDERGROUND INSTALLATION OF THERMOPLASTIC PIPE FOR SEWERS AND OTHER GRAVITY FLOW APPLICATIONS", LATEST EDITION.
2. ALL RETENTION AND DETENTION SYSTEMS SHALL BE INSTALLED IN ACCORDANCE WITH ASTM D2321, LATEST EDITION AND THE MANUFACTURER'S PUBLISHED INSTALLATION GUIDELINES.
3. MEASURES SHOULD BE TAKEN TO PREVENT THE MIGRATION OF NATIVE FINES INTO THE BACKFILL MATERIAL, WHEN REQUIRED. SEE ASTM D2321.
4. FILTER FABRIC: A GEOTEXTILE FABRIC MAY BE USED AS SPECIFIED BY THE ENGINEER TO PREVENT THE MIGRATION OF FINES FROM THE NATIVE SOIL INTO THE SELECT BACKFILL MATERIAL.
5. FOUNDATION: WHERE THE TRENCH BOTTOM IS UNSTABLE. THE CONTRACTOR SHALL EXCAVATE TO A DEPTH REQUIRED BY THE ENGINEER AND REPLACE WITH SUITABLE MATERIAL AS SPECIFIED BY THE ENGINEER. AS AN ALTERNATIVE AND AT THE DISCRETION OF THE DESIGN ENGINEER, THE TRENCH BOTTOM MAY BE STABILIZED USING A GEOTEXTILE MATERIAL.
6. BEDDING: SUITABLE MATERIAL SHALL BE CLASS I. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. UNLESS OTHERWISE NOTED BY THE ENGINEER, MINIMUM BEDDING THICKNESS SHALL BE 4" (102 mm) FOR 4"-24" (100-600 mm); 6" (152 mm) FOR 30-60" (750-900 mm).
7. INITIAL BACKFILL: SUITABLE MATERIAL SHALL BE CLASS I IN THE PIPE ZONE EXTENDING NOT LESS THAN 6" (152 mm) ABOVE CROWN OF PIPE. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. MATERIAL SHALL BE INSTALLED AS REQUIRED IN ASTM D2321, LATEST EDITION.
8. COVER: MINIMUM COVER OVER ALL RETENTION/DETENTION SYSTEMS IN NON-TRAFFIC APPLICATIONS (GRASS OR LANDSCAPE AREAS) IS 12" (305 mm) FROM TOP OF PIPE TO GROUND SURFACE. ADDITIONAL COVER MAY BE REQUIRED TO PREVENT FLOATATION. FOR TRAFFIC APPLICATIONS, MINIMUM COVER IS 12" (305 mm) UP TO 36" (900 mm) DIAMETER PIPE AND 24" (610 mm) OF COVER FOR 42-60" (1050-1500 mm) DIAMETER PIPE, MEASURED FROM TOP OF PIPE TO BOTTOM OF FLEXIBLE PAVEMENT OR TO TOP OF RIGID PAVEMENT. MAXIMUM FILL HEIGHT LIMITED TO 8 FT (2.4 m) OVER FITTINGS FOR STANDARD INSTALLATIONS. CONTACT A SALES REPRESENTATIVE WHEN MAXIMUM FILL HEIGHTS EXCEED 8 FT (2.4 m) FOR INSTALLATION CONSIDERATIONS.

PHELAN TSC
PHELAN, CA
DATE: 06/10/2025 | DRAWN: BB | CHECKED: N/A
PROJECT #:

DATE	DRW	CHK	DESCRIPTION

60" STIB PERF
DETENTION SYSTEM
LandMax
Stormwater Management System

4640 TRUEMAN BLVD
HILLIARD, OH 43026
1-800-733-7473


Z
X

Maximum Pipe Demand and Sizing

Peak Demand Flow Rate (100-Year, 5 Minute Event)	12.72	ft^3/s
Try 24" Pipe at 0.5% Slope:		
Manning's Value for PVC, n	0.011	
Slope, (ft/ft), s	0.005	
Area, A	3.14	ft^2
Perimeter, P	6.28	ft
Hydraulic Radius, R	0.5	ft
Q (flowing full)	**18.96**	**ft^3/s**

Utilize 24" pipe at location identified on BMP Exhibit

APPENDIX G: Web Soil Survey Results and Geotechnical Investigation

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for San Bernardino County, California, Mojave River Area

May 18, 2025

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....12
Map Unit Descriptions.....12
San Bernardino County, California, Mojave River Area.....14
167—TUJUNGA SAND, COOL, 2 TO 9 PERCENT SLOPES.....14
References.....16

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

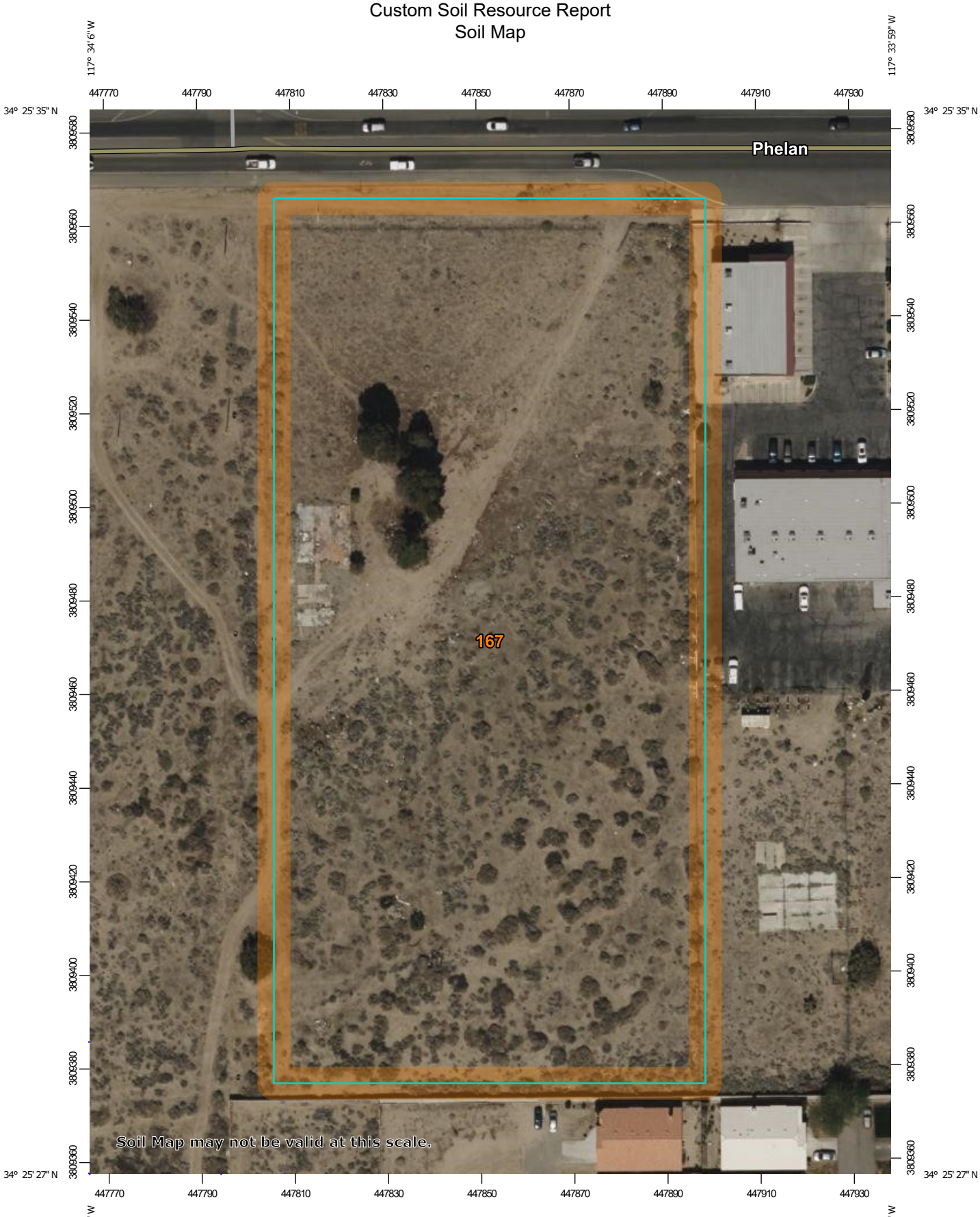
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:1,110 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 15 30 60 90

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 16, Aug 30, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 17, 2022—Jun 12, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
167	TUJUNGA SAND, COOL, 2 TO 9 PERCENT SLOPES	4.3	100.0%
Totals for Area of Interest		**4.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

San Bernardino County, California, Mojave River Area

167—TUJUNGA SAND, COOL, 2 TO 9 PERCENT SLOPES

Map Unit Setting

National map unit symbol: hkt9
Elevation: 2,700 to 4,300 feet
Mean annual precipitation: 6 to 9 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 150 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Tujunga and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tujunga

Setting

Landform: Fan aprons
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 14 inches: sand
H2 - 14 to 60 inches: stratified gravelly sand to gravelly loamy sand

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: R030XE006CA - COARSE LOAMY
Hydric soil rating: No

Minor Components

Unnamed

Percent of map unit: 4 percent
Landform: Fan remnants
Hydric soil rating: Yes

Hanford

Percent of map unit: 4 percent
Hydric soil rating: No

Soboba

Percent of map unit: 4 percent

Unnamed soils

Percent of map unit: 3 percent
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

PARTNER
Engineering and Science, Inc.

More Than Just Assessments.
Solutions.

GEOTECHNICAL REPORT

Proposed Tractor Supply Co.
4333 Phelan Road
Phelan, California 92371

Report Date:
December 12, 2023

Partner Project No.
23-425363.2

Prepared for:
Durban Development Group
106 Foster Avenue
Charlotte, North Carolina 28203


Building Science


Environmental Consulting


Construction & Development


Energy & Sustainability

PARTNER

December 12, 2023

Stephen Knudsen
Durban Development Group
106 Foster Avenue
Charlotte, North Carolina 28203

Subject: **Geotechnical Report**
Proposed Tractor Supply Co.
4333 Phelan Road
Phelan, California 92371
Partner Project No.: 23-425363.2

Dear Stephen Knudsen:

Partner Assessment Corporation (Partner) presents the following general opinion regarding the geotechnical conditions at the subject site, based on the information contained within this geotechnical report and our general experience with construction practices and geotechnical conditions on other sites. This statement does not constitute an engineering recommendation.

- *The geotechnical conditions on the site related to the planned construction are expected to be similar to difficult in comparison with other similar sites*; given challenges associated with the hydrocollapse potential of the material encountered on site and excavation of dry cohesionless soils.*

The descriptions and findings of our geotechnical report are presented for your use in this electronic format, for your use as shown in the hyperlinked outline below. To return to this page after clicking a hyperlink, hold "alt" and press the "left arrow key" on your keyboard.

1.0 Geotechnical Executive Summary
2.0 Report Overview and Limitations
3.0 Geologic Conditions and Hazards
4.0 Geotechnical Exploration and Laboratory Results
5.0 Geotechnical Recommendations

Figures & Appendices

We appreciate the opportunity to be of service during this phase of the work.

Sincerely,

Andrew J. Atry, PE
Senior Engineer

REGISTERED PROFESSIONAL ENGINEER
ANDREW J. ATRY
C 84728
CIVIL
STATE OF CALIFORNIA

Yuri Kawashima, GIT
Project Geologist

[1] *"similar sites" refers to sites with similar planned and current use, where we have recently performed similar work, and is a general statement not based on statistical analysis.*

1. GEOTECHNICAL EXECUTIVE SUMMARY

The executive summary is meant to consolidate information provided in more detail in the body of this report. This summary in no way replaces or overrides the detailed sections of the report.

Geologic Zones and Site Hazards

The site is located in the City of Phelan within the Mojave Desert geomorphic province of the state of California. Based on the geologic maps provided by the United States Geological Survey (USGS), surficial geology at the site can be described as Young alluvial-fan deposits, Unit 3. The site is relatively flat and slopes down gently towards the northeast. The site is currently vacant land with heavy vegetation. According to historic aerials, the site appears to have been previously developed for residential and commercial purposes until around 2016. As such, the site may be impacted by undocumented fills as well as other remnants of previous construction including utility lines. According to California and San Bernardino County geologic hazard maps, this portion of the state is prone to ground shaking. The site was not mapped within a zone of seismically included hazard for landslide, liquefaction, or tsunami. No other hazards are known or suspected on the site at the time of this report.

Excavation Conditions

We anticipate excavations on the site to depths of up to 5 feet for building foundations and utility lines. Based on boring data, heavy conventional construction equipment in good working condition should be able to perform the planned excavations. As previously mentioned, undocumented fill, native dry granular soils, and remnants of previous construction activities may be present on the site and could cave or be difficult to remove and require additional planning and equipment. Clearing and grubbing of plant material should be expected. Groundwater was not encountered at the time of drilling. Groundwater was not encountered on the site in our borings at the time of drilling. However, groundwater levels fluctuate over time and may be different at the time of construction and during the project life.

Foundation/Slab Support

We anticipate that the new building may be supported on conventional spread foundations and/or slabs on grade bearing on re-worked site soils. Given the dry and loose nature of the on-site material, we recommend that the upper 5 feet of site material be over-excavated, moisture conditioned and recompacted below buildings and/or foundations, to create a uniform fill pad. The new building foundations and slabs can be supported within this pad. In structural areas, prior to the placement of new fills or pavements, we recommend the subgrade be proofrolled or otherwise evaluated and repaired under the direction of the engineer and then should be scarified to a depth of 18 inches or more, moisture-conditioned, and compacted in-place.

Soil Reuse

Based on our borings site soils will generally be usable as structural fill provided it is free of deleterious material, although construction water will be needed for soil compaction. We anticipate that some volume loss will occur in native soils after compaction, and this should be accounted for in the contractor's grading estimates. We recommend engineered fill for the site be moisture conditioned and compacted to at least 95% of the maximum dry density in accordance with ASTM D1557 and Appendix C of this report.

Pavement Design

Roadway Type	Subgrade Preparation	Pavement Section
Parking Area	Proofrolled/Compacted Subgrade	4 in asphalt/ 4 in aggregate base
Drive Thru/ Trash Enclosure	Proofrolled/Compacted Subgrade	7 in concrete / 4 in aggregate base

2. REPORT OVERVIEW & LIMITATIONS

2.1 Report Overview

To develop this report, Partner accessed existing information and obtained site specific data from our exploration program. Partner also used standard industry practices and our experience on previous projects to perform engineering analysis and provide recommendations for construction along with construction considerations to guide the methods of site development. The opinions on the cover letter of this report do not constitute engineering recommendations, and are only general, based on our recent anecdotal experiences and not statistical analysis. Section 1.0, Executive Geotechnical Summary, compiles data from each of the report sections, while each of sections in the report presents a detailed description of our work. The detailed descriptions in Section 5.0 and Appendix C constitute our engineering recommendations for the project, and they supersede the Executive Geotechnical Summary.

The report overview, including a description of the planned construction and a list of references, as well as an explanation of the report limitations is provided in Section 2.0. The findings of Partner's geologic review are included in Section 3.0 Geologic Conditions and Hazards. The descriptions of our methods of exploration and testing, as well as our findings are included in Section 4.0 Geotechnical Exploration and Laboratory Results. In addition, logs of our exploration excavations are included in Appendix A of the report, and laboratory testing is included in Appendix B of the report. Site Location and Site Plan maps are included as Figures in the report.

2.2 Assumed Construction

Partner's understanding of the planned construction was based on information provided by the project team. The proposed site plan is included as Figure 2 to this report. Partner's assumptions regarding the new construction are presented in the below table.

Project Data	
Proposed Use	Tractor Supply Company Buildings
Building footprint/height	Approximately 23,957 sf building, garden center, small shed, and trailer area
Land Acreage (Ac)	Approximately 0.59 acres
Number of Buildings	1
Expected Cuts and Fills	Up to 5 feet of excavation for building area and utility installation
Type of Construction	Assumed slab-on-grade with wood framing and/or masonry units
Foundations Type	Assumed conventional spread foundations and slab on grade
Anticipated Loads	Unknown, assumed 100 to 150-kip column loads and 3-5 kips/ft wall loads
Traffic Loading	Primarily frequent vehicular traffic with occasional heavy truck traffic
Site Information Sources	Google Earth Pro and Source: Durban Development, Phelan Rd Site Plan, dated 9/7/2023

2.3 References

The following references were used to generate this report:

California Geological Survey (CGS), Note 36, California Geomorphic Provinces, 2002.

California State Water Resource Control Board (SWRCB), GeoTracker tool, accessed 12/4/2023

Federal Emergency Management Agency, FEMA Flood Map Service Center, accessed 12/4/2023

Google Earth Pro (Online), accessed 12/4/2023

Historic Aerials by NETR Online, accessed 12/4/2023

Morton, D.M., and Miller, F.K., 2006, Geologic map of the San Bernardino and Santa Ana 30' x 60' quadrangles, California, U.S. Geological Survey Open-File Report OF-2006-1217, scale 1:100,000

San Bernardino County Hazards Maps, accessed 12/4/2023

OSHPD Seismic Design Maps, accessed online 12/4/2023

Partner Engineering and Science, Inc., Phase I Environmental Assessment Report – Proposed Tractor Supply Co., dated 10/31/2023

United States Department of Agriculture (USDA), Web Soil Survey, accessed online 12/4/2023

United States Geological Survey, California Interactive Geologic Map accessed 12/4/2023

United States Geological Survey, Lower 48 States 2014 Seismic Hazard Map, accessed online 12/4/2023

United States Geologic Survey, Earthquake Hazards Program (Online), accessed 12/4/2023

2.4 Limitations

The conclusions, recommendations, and opinions in this report are based upon soil samples and data obtained in widely spaced locations that were accessible at the time of exploration and collected based on project information available at that time. Our findings are subject to field confirmation that the samples we obtained were representative of site conditions. If conditions on the site are different than what was encountered in our borings, the report recommendations should be reviewed by our office, and new recommendations should be provided based on the new information and possible additional exploration if needed. It should be noted that geotechnical subsurface evaluations are not capable of predicting all subsurface conditions, and that our evaluation was performed to industry standards at the time of the study, no other warranty or guarantee is made.

Likewise, our document review and geologic research study made a good-faith effort to review readily available documents that we could access and were aware of at the time, as listed in this letter. We are not able to guarantee that we have discovered, observed, and reviewed all relevant site documents and conditions. If new documents or studies are available following the completion of the report, the recommendations herein should be reviewed by our office, and new recommendations should be provided based on the new information and possible additional exploration if needed.

This report is intended for the use of the client in its entirety for the proposed project as described in the text. Information from this report is not to be used for other projects or for other sites. All of the report must be reviewed and applied to the project or else the report recommendations may no longer apply. If

pertinent changes are made in the project plans or conditions are encountered during construction that appear to be different than indicated by this report, please contact this office for review. Significant variations may necessitate a re-evaluation of the recommendations presented in this report. The findings in this report are valid for one year from the date of the report. This report has been completed under specific Terms and Conditions relating to scope, relying parties, limitations of liability, indemnification, dispute resolution, and other factors relevant to any reliance on this report.

If a building permit is obtained for the project based on the submittal of this report, it would become the design geotechnical report for the project. If parties other than Partner are engaged to provide construction geotechnical special inspection services, they will also be required to assume construction geotechnical engineer of record (GEOR) services as well. To confirm this, they should issue a letter concurring with the findings and recommendations in this geotechnical design report or providing alternate recommendations prior to the start of construction. The GEOR should be directly involved in the construction process, provide engineering review the special inspection reports on a daily basis, and sign off at the end of the project that the construction was done per the geotechnical design report. If Partner is not the GEOR, we should be contacted as the design geotechnical engineer in the case of changed conditions or changes to the planned construction. Interpretation of the design geotechnical report during construction, response to project RFI's, and oversight of special inspectors and quality control testing is to be handled by the GEOR. Partner can provide a proposal for special inspection and GEOR services upon request.

3. GEOLOGIC CONDITIONS & HAZARDS

This section presents the results of a geologic review performed by Partner, for the proposed new construction on site. The general location of the project is shown on Figure 1.

3.1 Site Location and Project Information

The planned construction will be situated on a mostly vacant parcel in a mixed commercial/residential area of Phelan, California. The site is currently on vacant land with heavy desert vegetation. According to historic aerials, the site may have been developed with residential and commercial buildings prior to around 2016. The immediately surrounding properties consist of Phelan Road followed by vacant land to the north, commercial buildings to the east, residential buildings to the south, and vacant land to the west. The site is relatively flat, gently sloping down to the northeast. Figures 2 and 3 present the project site and the locations of our site explorations. Based on our review of available documents, the site has had the following previous uses:

Historical Use Information		
Period/Date	**Source**	**Description/Use**
1901 – 1942	Aerial Photographs, Topographic Maps	Undeveloped land
1952 – 2016	Aerial Photographs, Topographic Maps, City Directories	Residential and Commercial Use
2018 – Current	Aerial Photographs, Onsite Observations	Current Use / Vacant land

3.2 Geologic Setting

The subject property is situated within the City of Phelan in the Mojave Desert physiographic province of the State of California. According to CGS, the province is broad interior region of isolated mountain ranges separated by expanses of desert plains. According to the geologic map of this region, surficial geology at the site is mapped as Young alluvial-fan deposits, Unit 3. This deposit generally consists of slightly to moderately consolidated silt, sand, and coarse-grained sand to boulder alluvial-fan deposits having slightly to moderately dissected surfaces. The unit is middle Holocene in age and is underlain by other alluvial deposits in the area.

The subject property is largely mapped as Tujunga sand, cool according to the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey online database. The Tujunga series consists of very deep, somewhat excessively drained soils that formed in alluvium from granitic sources.

A general summary of the geologic data compiled for this project is provided in the below table.

Geologic Data		
Parameter	**Value**	**Source**
Geomorphic Zone	Mojave Desert	CGS
Ground Elevation	Approximately 1410 to 1415 feet above MSL (Mean Sea Level)	Google Earth Pro, Topographic Maps
Flood Elevation	Zone AO – Special Flood Hazard Zone (Depth 1 foot)	FEMA

Geologic Data		
Parameter	**Value**	**Source**
Seismic Hazard Zone	Moderate	USGS
Geologic Hazards	Ground shaking	CGS, San Bernardino County Maps
Surface Cover	Unimproved surface with vegetation	Partner Borings
Site Modifications	Previous residential/commercial use	Historic Aerials
Surficial Geology	Young alluvial-fan deposits	USGS
Depth to Bedrock	Unknown	Partner Borings
Groundwater Depth	Not Encountered	Partner Borings
Historic Groundwater	Assumed > 50 feet	Partner ESA

3.3 Geologic Hazards

California is tectonically active and contains numerous large, active faults. As a result, geologic hazards with the greatest potential to affect California include earthquakes and related hazards such as tsunamis, landslides, liquefaction, and ground shaking. According to the USGS Unified Hazard Tool Deaggregation, the fault most relevant to the site is the San Andreas fault (10.1 miles from the site, Mmax: 7.69). According to CGS and San Bernardino geologic hazard maps, the site was not mapped within a zone of seismically included hazard for landslide, liquefaction, or tsunami. The site will be subject to ground shaking as described below. No other geologic hazards are known or suspected to impact the site. Due to the hydrosulfate an issue on this site.

3.4 Seismic Design Parameters

The site latitude and longitude are 34.4256217 degrees N and -117.5679161 degrees W, respectively.

Based on the recent edition of ASCE 7-16 and its subsequent supplements, a site-specific ground motion hazard analysis (GMHA) is required for sites with

- Structures on Site Class D site with S_1 greater than or equal to 0.2.
- Structures on Site Class E site with S_s greater than or equal to 1.0 or S_1 greater than or equal to 0.2.

However, a ground motion hazard analysis is not required if the following exemptions are met:

1) Structures on Site Class D site with S_1 greater than or equal to 0.2, provided the value of the parameter S_{M1} determined by Eq. (11.4-2) is increased by 50% for all applications of S_{M1} in this Standard. The resulting value of the parameter S_{D1} determined by Eq. (11.4-4) shall be used for all applications of S_{D1} in this Standard.

2) Structures on Site Class E with S_s greater than or equal to 1.0 or S_1 greater than or equal to 0.2, provided the equivalent lateral force procedure is used for design and the value of C_s is determined by Eq. (12.8-2) for all values of T, or. where both the value of S_{ai} is determined by Eq. (15.7-7) for all values of T_i and the value of the parameter S_{D1} is replaced with $1.5S_{D1}$ in Eq. (15.7-10) and Eq. (15.7-11).

Based on boring logs, SPT N values, and the conditions described above the site is determined to be Site Class D. The site qualifies for exemption No. 1. Therefore, a site-specific ground motion hazard analysis is

NOT needed for this site provided the value of the parameter S_{M1} determined by Eq. (11.4-2) is increased by 50% for all applications of S_{M1} for this site. The resulting value of the parameter S_{D1} determined by Eq. (11.4-4) shall be used for all applications of S_{D1} for the site.

Using information obtained from the SEAOC (Structural Engineers Association of California) / OSHPD (Office of Statewide Health Planning and Development) Seismic Design Maps for ASCE 7-16, for a Site Class of D and risk category of I, the following values were obtained as shown on the below table.

Seismic Item	Value	Seismic Item	Value
Site Classification	D	Seismic Design Category	D
F_a	1.0	F_v	1.7
S_s	1.507g	S_1	0.618g
S_{MS}	1.507g	S_{M1} (increased by 50% per exemption No. 1)	1.576g
S_{DS}	1.005g	S_{D1} (determined using increased S_{D1})	1.051g
PGA_M	0.727g	Design PGA (2/3 PGA_M)	0.485g

4. GEOTECHNICAL EXPLORATION & LABORATORY RESULTS

Our evaluation of soils on the site included field exploration and laboratory testing. The field exploration and laboratory testing programs are briefly described below. Data reports from the field exploration and laboratory testing are provided in Appendix A and Appendix B, respectively.

4.1 Soil Borings

The soil boring program was conducted on November 14 and 15, 2023. Thirteen (13) borings designated B1 through B13, were advanced by the use of a truck-mounted drill rig in approved locations using hollow-stem auger drilling techniques. The borings were drilled to depths ranging from 11.5 to 21.5 feet in and around the proposed building footprint. Four (4) infiltration tests were also performed at a depth of 5 feet. The approximate locations of the exploratory borings are shown on Figure 3.

Logs of subsurface conditions encountered in the borings were prepared in the field by a representative of Partner Engineering. Soil samples consisting of modified California split-spoon samplers (CalMod) and Standard Penetration Tests (SPT) samples were collected at approximately 2.5 and 5-foot depth intervals and were returned to the laboratory for testing. The CalMod samples were performed in general accordance with ASTM D 3550 and SPTs were performed in general accordance with ASTM D 1586. Typed boring logs were prepared from the field logs and are presented in Appendix A. A summary table description is provided below:

Surficial Geology		
Strata	**Depth to Bottom of Layer (bgs*)**	**Description**
Surface Cover	Up to 12 inches	Heavily vegetated unimproved surface
Native Stratum 1	> 21.5 feet	Silty sandy soil
Groundwater	Not Encountered	Not Encountered
Bedrock	Depths greater than explored	Not observed

4.2 Groundwater

Groundwater was not encountered on the site in our borings at the time of drilling. However, groundwater levels fluctuate over time and may be different at the time of construction and during the project life.

4.3 Laboratory Evaluation

Selected samples collected during drilling activities were tested in the laboratory to assist in evaluating engineering properties of subsurface materials at the site. The results of laboratory analyses are presented in Appendix B.

4.4 Infiltration Testing

Two tests designated P1 through P4 were performed using the shallow percolation Test procedure as outlined in the *County of San Bernardino TECHNICAL GUIDANCE DOCUMENT APPENDICES, APPENDIX VII. INFILTRATION RATE EVALUATION PROTOCOL AND FACTOR OF SAFETY RECOMMENDATIONS, dated May 19, 2011*. The borings were 8 inches in diameter and lined with screened 3-inch diameter pipes. Well screens

were installed from near the bottom of the borings to ground surface. The annular space of the well screen sections was filled with #3 Monterey sand. Subsequent to completion of well installation, the casings were then filled with water and allowed to presoak.

Upon completion of testing the percolation rate measured in the field was converted into an infiltration rate using the Porchet methods. Percolation Test Locations can be found on Figures 2 and 3. Boring logs and Percolation test data can be found in Appendix A and is summarized below. The reported values are unfactored. The civil engineer should apply the proper reduction factors or factors of safety based on the type of system used.:

Test Number	P1	P2	P3	P4
Location	See Figure 2	See Figure 2	See Figure 2	See Figure 2
Depth of Test	5 ft	5 ft	5 ft	5 ft
Pre-soak Depth	5 ft	5 ft	5 ft	5 ft
Test Start Depth	3.45 ft.	2.0 ft	1.2 ft	2.0 ft
Final Water Drop	21.6 in.	22.8 in.	8.4 in.	13.2 in.
Un-factored Infiltration Rate	24.45 in./hr	13.35 in./hr	6.42 in./hr	15.09 in./hr

5. GEOTECHNICAL RECOMMENDATIONS & PARAMETERS

The following discussion of findings for the site is based on the assumed construction, geologic review, results of the field exploration, and laboratory testing programs. The recommendations of this report are contingent upon adherence to Appendix C of this report, General Geotechnical Design and Construction Considerations. For additional details on the below recommendations, please see Appendix C.

5.1 Geotechnical Recommendations

The proposed construction is generally feasible from a geotechnical perspective provided the recommendations and assumptions of this report are followed.

Geologic/General Site Considerations

- The site is located in the City of Phelan within the Mojave Desert geomorphic province of the state of California. Based on the geologic maps provided by the United States Geological Survey (USGS), surficial geology at the site can be described as Young alluvial-fan deposits, Unit 3. The site is relatively flat and slopes down gently towards the northeast. The site is currently vacant land with heavy vegetation. According to historic aerials, the site appears to have been previously developed for residential and commercial purposes until around 2016. As such, the site may be impacted by undocumented fills as well as other remnants of previous construction including utility lines. According to California and San Bernardino County geologic hazard maps, this portion of the state is prone to ground shaking. The site was not mapped within a zone of seismically included hazard for landslide, liquefaction, or tsunami. No other hazards are known or suspected on the site at the time of this report.
- Given the presence of the site in the southern desert region, consideration should be given to weather conditions at the time of grading. Earthwork should be scheduled during seasonally dry periods and proper preparations should be made to deal with monsoon rain events, dust storms, winter storms, and extreme heat.
- Given the presence of the site in a seismically active area, ground shaking during earthquakes should be anticipate during the project life. State, County, City, and other jurisdictions in seismically active areas update seismic standards on a regular basis. The design team should carefully evaluate all of the building requirements for the project.

Excavation Considerations

- We anticipate excavations on the site to depths of up to 5 feet for building foundations and utility lines. Based on boring data, heavy conventional construction equipment in good working condition should be able to perform the planned excavations. As previously mentioned, undocumented fill, native dry granular soils, and remnants of previous construction activities may be present on the site and could cave or be difficult to remove and require additional planning and equipment. Clearing and grubbing of plant material should be expected.

- Groundwater was not encountered on the site in our borings at the time of drilling. However, groundwater levels fluctuate over time and may be different at the time of construction and during the project life.
- Appendix C further discusses excavation recommendations in the following sections, which can be accessed by clicking hyperlinks: Earthwork, Underground Pipeline, Excavation De-Watering.

Foundations

- We anticipate that the new building may be supported on conventional spread foundations and/or slabs on grade bearing on re-worked site soils. Given the dry and loose nature of the on-site material, we recommend that the upper 7 feet of site material be over-excavated, moisture conditioned and recompacted below buildings and/or foundations, to create a uniform fill pad. The new building foundations and slabs can be supported within this pad. In structural areas, prior to the placement of new fills or pavements, we recommend the subgrade be proofrolled or otherwise evaluated and repaired under the direction of the engineer and should then be scarified to a depth of 18 inches or more, moisture-conditioned, and compacted in-place.
- Section 5.2 of this report provides a table outlining the embedment depth, bearing capacity, settlement and other parameters for foundation design and construction.

On-Grade Construction Considerations

- In new structural areas of the site, all remnants of previous construction, vegetation and/or deleterious materials should be completely removed to exposed clean subgrade soil. In new fill, structural, and pavement areas, cleaned subgrade should be proofrolled and evaluated by the engineer with a loaded water truck (4,000 gallon) or equivalent rubber-tired equipment. In locations where proofrolling is not feasible, probing, dynamic cone penetration testing or other methods may be employed. Soft or unstable areas should be repaired per the direction of the engineer. Once approved, the subgrade soil should be scarified to a depth of 12 inches, moisture conditioned, and compacted as engineered fill. Improvements in these areas should extend laterally beyond the new structure limits 2 feet or a distance equal to or greater than the layer thickness, whichever is greater. This zone should extend vertically from the bearing grade elevation to the base of the fill. The thicknesses of the layer, settlement estimates, and modulus values are provided on the design tables in the next section.
- Appendix C provides additional recommendations for foundations in the following sections: Cast-in-place Concrete, Foundations, Earthwork, Paving, Subgrade Preparation which can be accessed by clicking the hyperlinks.

Soil Reuse Considerations

- Based on our borings site soils will generally be usable as structural fill provided it is free of deleterious material, although construction water will be needed for soil compaction. We anticipate that some volume loss will occur in native soils after compaction, and this should be accounted for in the contractor's grading estimates. We recommend engineered fill for the site be moisture

conditioned and compacted to at least 95% of the maximum dry density in accordance with ASTM D1557 and Appendix C of this report.

- Appendix C provides additional recommendations for foundations in the following sections: EARTHWORK, SUBGRADE PREPARATION which can be accessed by clicking the hyperlinks.

Geotechnical Concrete and Steel Construction Considerations

- According to the USDA Web Soil Survey online database, onsite soils may have low corrosive potential to concrete. We recommend using corrosion resistant concrete (*e.g.* Type II Portland Cement, a fly ash mixture of 25 percent cement replacement, and a water/cement ratio of 0.5 or less) as directed by the producer, engineer or other qualified party based on their knowledge of the materials and site conditions. Concrete exposed to freezing weather should be air-entrained. Mix designs should be well-established and reviewed by the project engineers prior to placement, to verify the design is appropriate to meet the project needs and parameters provided in this report. Quality control testing should be performed to verify appropriate mixes are used and are properly handled and placed. Please refer to Appendix C, Cast In-Place Concrete for more details.
- According to the USDA NRCS Web Soil Survey online database, site soils may have low corrosive potential to un-protected metallic elements such as pipes, poles, rebar, etc. We recommend the use of coatings and/or cathodic protection for metals in contact with the ground, as directed by the product manufacturer, engineer or other qualified party based on their knowledge of the materials to be used and site soil conditions.

Site Storm Water Considerations

- Surface drainage and landscaping design should be carefully planned to protect the new structures from erosion/undermining, and to maintain the site earthwork and structure subgrades in a relatively consistent moisture condition. Adequate site drainage should be established, such that water should not flow towards or pond near to new structures, and high water-demand plants should not be planned near to structures. Appendix C provides additional recommendations for foundations in the following sections: SITE GRADING AND DRAINAGE, WATER PROOFING which can be accessed by clicking the hyperlinks.
- We recommend consulting with the landscape designer and civil engineer regarding management of site storm water and irrigation water, as changes in moisture content below the site after construction will lead to soil movement and potential distress to the building.

5.2 Geotechnical Parameters

Based on the findings of our field and laboratory testing, we recommend that design and construction proceed per industry accepted practices and procedures, as described in Appendix C, General Geotechnical Design and Construction Considerations (Considerations).

Prepared Subgrade Parameters – (hyperlink to Construction Considerations)

Prepared Subgrade Parameters				
Structure	**Design Values**	**Cover Depth**	**Bearing Surface [a]**	**Static Settlement [d]**
Slab on Grade	k=150 pci [b] q_{all} = 150 psf[c] μ = 0.40	N/A	Within uniform fill pad extending 5 feet below existing grades – See Section 5.1	<1 inch
Shallow Foundations	q_{all} = 3.0 ksf[c] μ = 0.40	18-inches	Within uniform fill pad extending 5 feet below existing grades – See Section 5.1	<1 inch

[a] Repairs in bearing surface areas should be structural fill per the recommendation of the Earthwork section of Appendix C that is moisture conditioned to within 3 percent below to optimum moisture content and compacted to 95 percent or more of the soil maximum dry density per ASTM D1557.

[b] Subgrade modulus value "k", assuming the grade slab is supported by aggregate layer roughly equal to slab thickness (minimum 4 inches), as required for capillary break.

[c] Can be increased by 1/3 for temporary loading such as seismic and wind, allowable parameters, estimated FS of 2.5.

[d] Differential settlement is expected to be half to ¾ of total settlement.

Pavement Design and Construction Recommendations

- In our experience we recommend that multiple different pavement sections be considered for the project for economic and performance reasons. For drive-thru lanes and trash enclosures we recommend that thickened reinforced concrete pavement be utilized. For heavily used and ADA parking spaces, etc., we recommend the use of thinner reinforced concrete pavement. We understand that asphalt is not planned, however, if plans change, we recommend a heavy-duty asphalt pavement section, and thinner sections can be used in the parking field if any. We recommend concrete pavements consist of local DOT, or otherwise jurisdictionally approved mixes, and that paving cross slopes, curbs, and other features conform to the applicable local standard specifications and details.
- The following sections are provided for native soil subgrade conditions. If imported fill is used, the section may need to be adjusted. This information assumes that construction will proceed per the provided Construction Considerations, presented in Appendix C.

Paving Structural Sections – (hyperlink to Construction Considerations)

Pavement Sections		
Roadway Type	**Subgrade Preparation [a]**	**Pavement Section [bc]**
Parking Area	Proofrolled/Compacted Subgrade	4 in concrete / 4 in aggregate base
ADA Spaces	Proofrolled/Compacted Subgrade	6 in. Concrete/ 4 in. Aggregate Base
Trash enclosure / Drive-thru Lanes	Proofrolled/Compacted Subgrade	7 in. Concrete / 4 in. Aggregate Base

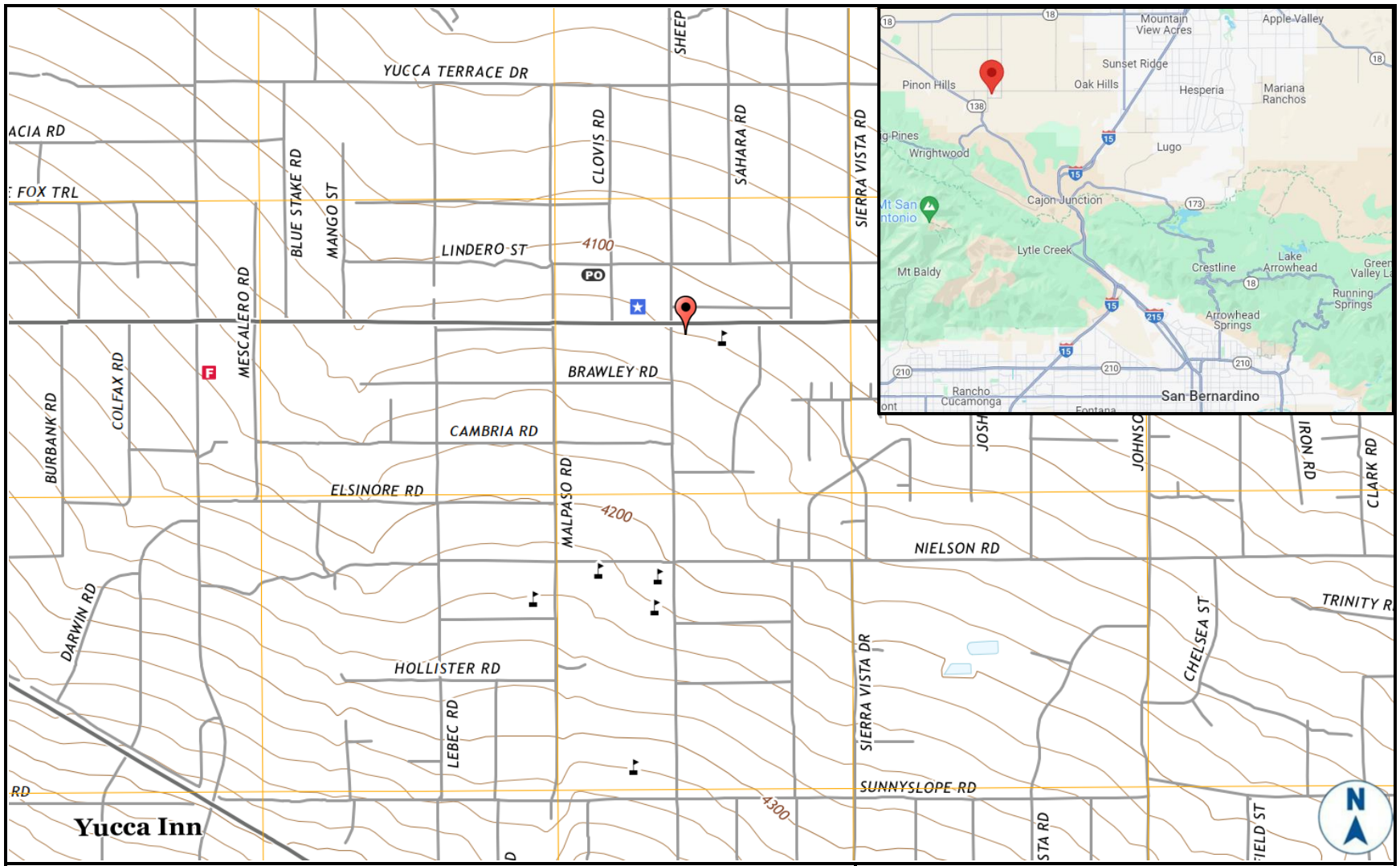
[a] Repairs in proof rolled areas should be structural fill per the recommendation of the Earthwork (hyperlink to Construction Considerations) that is moisture conditioned to within 3 percent above to optimum moisture content and compacted to 95 percent or more of the soil maximum dry density per ASTM D1557.

[b] 1 inch of pavement may be reduced if 6-in of lime or cement-treated soil is used with a 500 psi 28-day compressive strength. Soils with Plasticity Index of 10 or more are generally candidates for lime treatment, other soils are candidates for cement treatment, if any.

FIGURES

- Site Vicinity Plan
- Exploration Plan (Aerial)
- Exploration Plan (Site Plan)
- Geologic Map

PARTNER

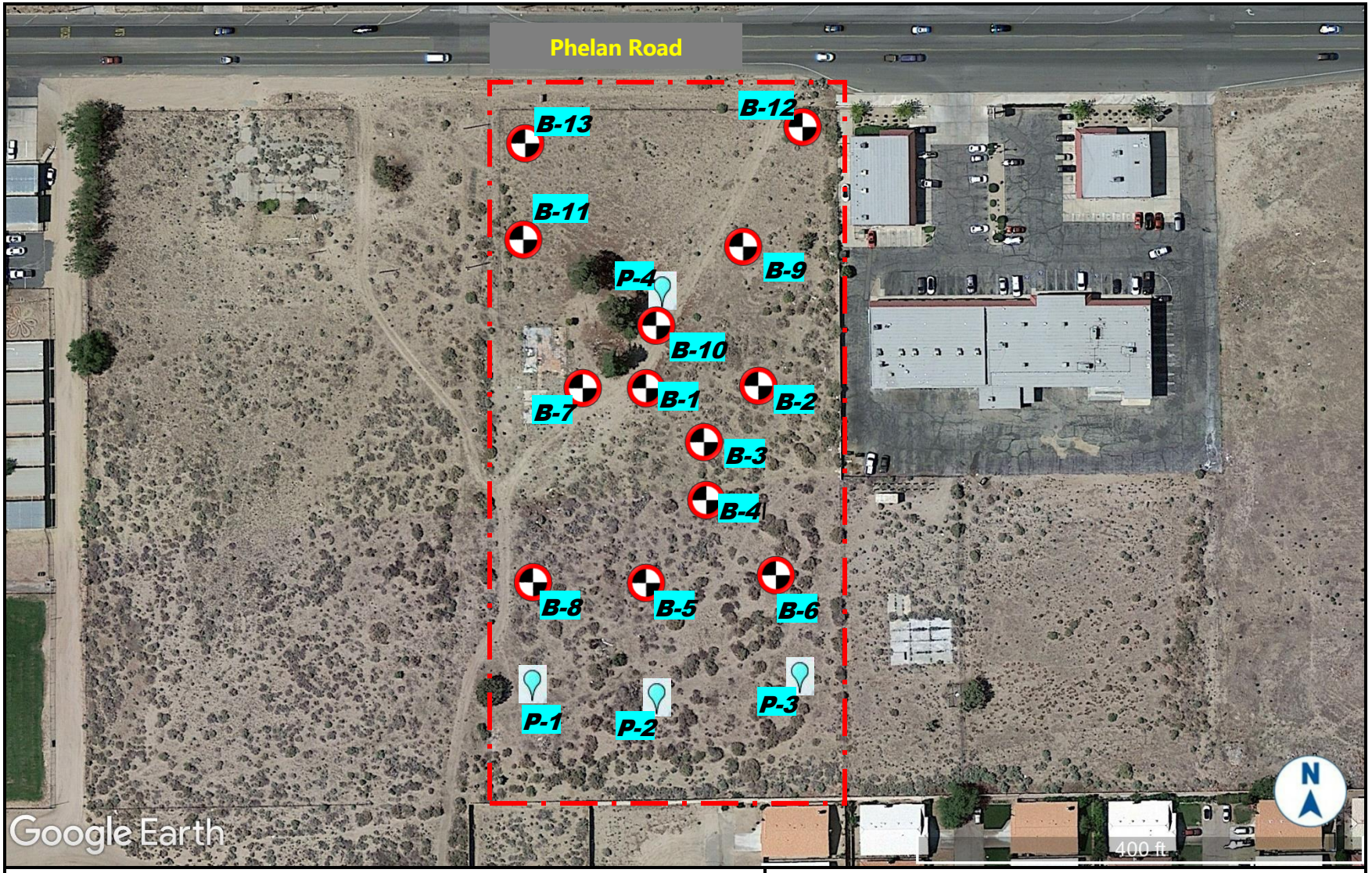


Source: U.S. Geological Survey, 2021, US Topo 7.5-minute map for Phelan Quadrangle, California-Sn Bernardino County

FIGURE 1 – SITE VICINITY PLAN

KEY

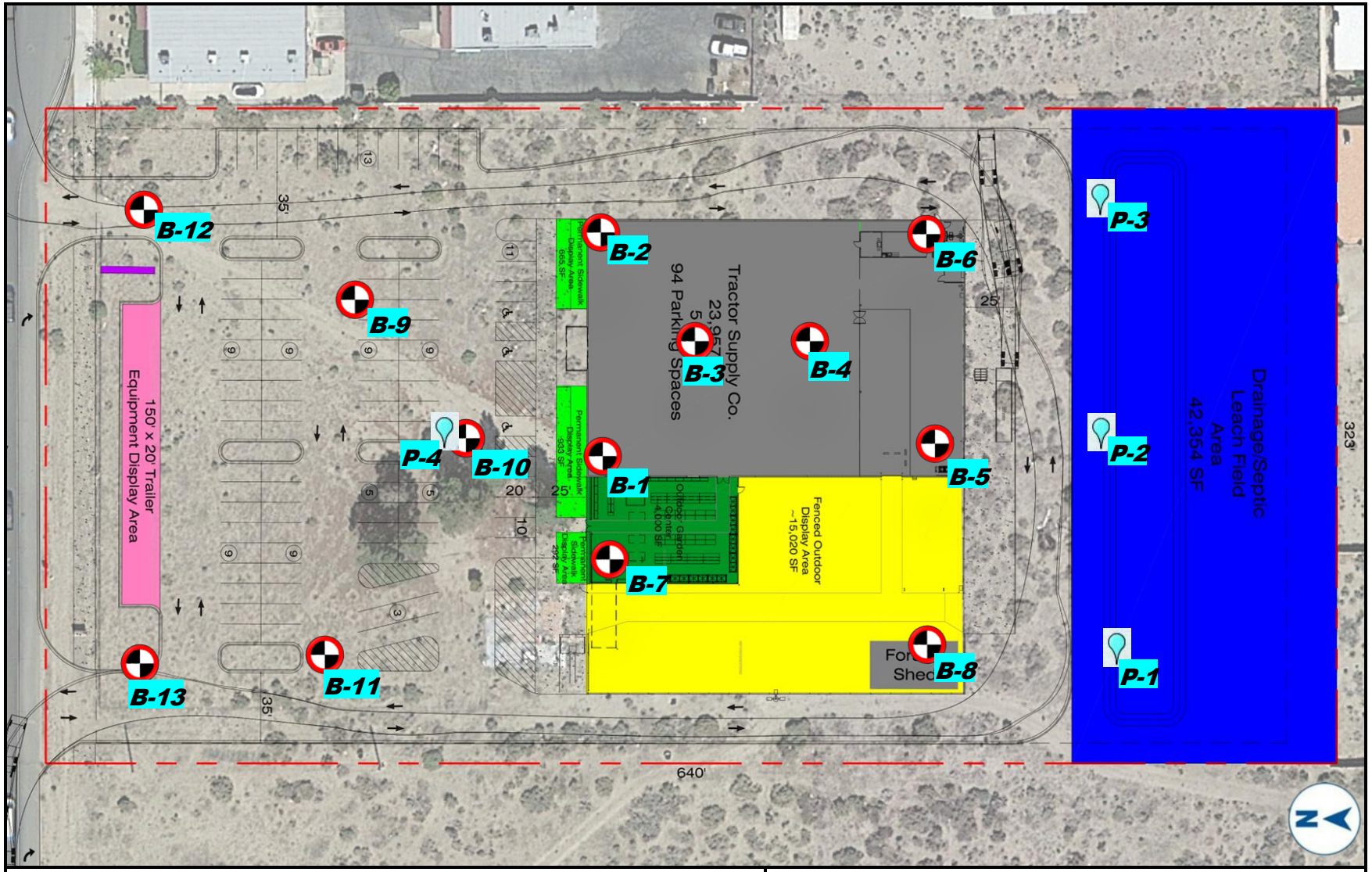
Approximate Site Location



Source: Google Earth Pro

FIGURE 2 – EXPLORATION PLAN (AERIAL)

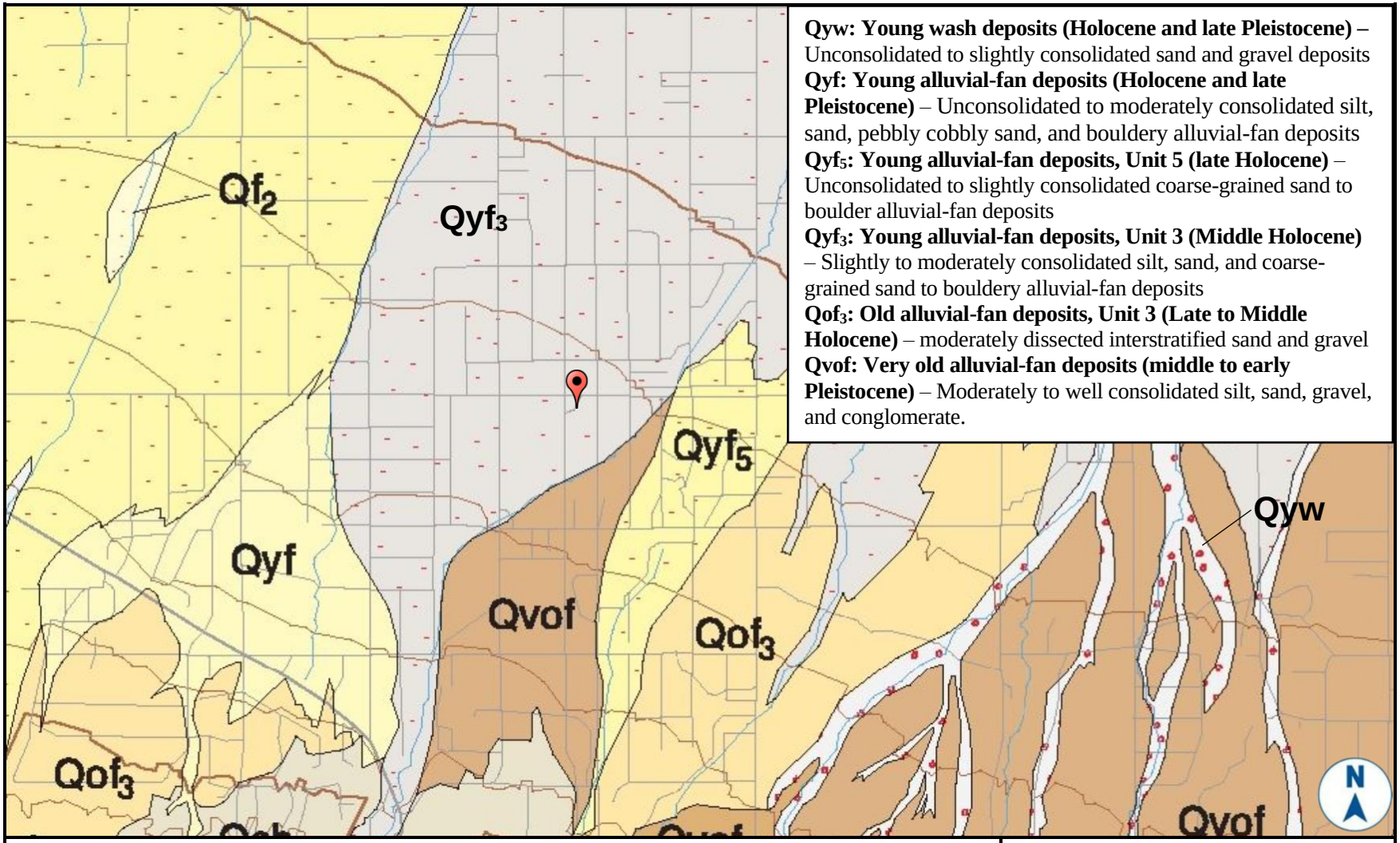
KEY Approximate Project Site Limits | Approximate Boring Location | Approximate Infiltration Test Location



Source: Durban Development, Phelan Rd Site Plan, dated 9/7/2023

FIGURE 3 – EXPLORATION PLAN (SITE PLAN)

KEY Approximate Project Site Limits | Approximate Boring Location | Approximate Infiltration Test Location



Qyw: Young wash deposits (Holocene and late Pleistocene) – Unconsolidated to slightly consolidated sand and gravel deposits
Qyf: Young alluvial-fan deposits (Holocene and late Pleistocene) – Unconsolidated to moderately consolidated silt, sand, pebbly cobbly sand, and bouldery alluvial-fan deposits
Qyf_5: Young alluvial-fan deposits, Unit 5 (late Holocene) – Unconsolidated to slightly consolidated coarse-grained sand to boulder alluvial-fan deposits
Qyf_3: Young alluvial-fan deposits, Unit 3 (Middle Holocene) – Slightly to moderately consolidated silt, sand, and coarse-grained sand to bouldery alluvial-fan deposits
Qof_3: Old alluvial-fan deposits, Unit 3 (Late to Middle Holocene) – moderately dissected interstratified sand and gravel
Qvof: Very old alluvial-fan deposits (middle to early Pleistocene) – Moderately to well consolidated silt, sand, gravel, and conglomerate.

Source: Morton, D.M., and Miller, F.K., 2006, Geologic map of the San Bernardino and Santa Ana 30' x 60' quadrangles, California, U.S. Geological Survey Open-File Report OF-2006-1217, scale 1:100,000

FIGURE 4 – GEOLOGIC MAP

KEY

Approximate Site Location

APPENDIX A

Boring Logs

Percolation Test Logs

PARTNER

BORING LOG KEY - EXPLANATION OF TERMS

SURFACE COVER: General discription with thickness to the inch, ex. Topsoil, Concrete, Asphalt, etc,

FILL: General description with thickness to the 0.5 feet. Ex. Roots, Debris, Processed Materials (Pea Gravel, etc.)

NATIVE GEOLOGIC MATERIAL: Deposit type, 1.Color, 2.moisture, 3.density, 4.SOIL TYPE, other notes - Thickness to 0.5 feet

1. Color - Generalized

Light Brown (usually indicates dry soil, rock, caliche)
Brown (usually indicates moist soil)
Dark Brown (moist to wet soil, organics, clays)
Reddish (or other bright colors) Brown (moist, indicates some soil development/or residual soil)
Greyish Brown (Marine, sub groundwater - not the same as light brown above)
Mottled (brown and gray, indicates groundwater fluctuations)

2. Moisture

dry - only use for wind-blown silts in the desert
damp - soil with little moisture content
moist - near optimum, has some cohesion and stickyness
wet - beyond the plastic limit for clayey soils, and feels wet to the touch for non clays
saturated - Soil below the groundwater table, sampler is wet on outside

3A. Relative Density for Granular Soils

Relative Density	Ring	SPT
very loose	0-7	0-4
loose	7-14	4-10
medium dense	14-28	10-30
dense	28-100	30-50
very dense	100+	Over 50

3B. Consistency of Fine-Grained Cohesive Soils

Consistnecy	SPT	Undrained Shear Strength, tsf
very soft	0-2	less than 0.125
soft	2-4	0.125 - 0.25
medium stiff	4-8	0.25 - 0.50
stiff	8-15	0.50 - 1.0
very stiff	15-30	1.0 - 2.0
hard	Over 30	Over 2.0

4. Classification

Determine percent Gravel (Material larger than the No. 4 Sieve)
Determine percent fines (Material passing the No. 200 Sieve)
Determine percent sand (Passing the No. 4 and retained on the No. 200 Sieve)
Determine if clayey (make soil moist, if it easily roll into a snake it is clayey)

Coarse Grained Soils (Less than 50% Passing the No. 200 Sieve)

GP	SP	Mostly sand and gravel, with less than 5 % fines	sandy GRAVEL	SAND
GP-GM	SP-SM	Mostly sand and gravel 5-12% fines, non-clayey	sandy GRAVEL with silt	SAND with Silt
GP-GC	SP-SC	Mostly sand and gravel 5-12% fines, clayey	sandy GRAVEL with clay	SAND with clay
GC	SC	Mostly sand and gravel >12% fines clayey	clayey GRAVEL	clayey SAND
GM	SM	Mostly sand and gravel >12% fines non-clayey	silty GRAVEL	silty SAND

Fine Grained Soils (50% or more passes the No. 200 Sieve)

ML	Soft, non clayey	SILT with sand
MH	Very rare, holds a lot of water, and is pliable with very low strength	high plasticity SILT
CL	If sandy can be hard when dry, will be stiff/plastic when wet	CLAY with sand/silt
CH	Hard and resiliant when dry, very strong/sticky when wet (may have sand in it)	FAT CLAY

H = Liquid limit over 50%, L - LL under 50%
C = Clay
M = Silt

Samplers

S = Standard split spoon (SPT)
R = Modified ring
Bulk = Excavation spoils
ST = Shelby tube
C = Rock core

Boring Number:	B-1	Boring Log Page 1 of 2	
Location:	See Figure 2	Date Started:	11/14/2023
Site Address:	4333 Phelan Road	Date Completed:	11/14/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	6	SP-SM	**NATIVE:** Brown, dry, loose, SAND with silt
2.5				(Moisture Content: 1.7%, Fines: 6.1%, LL: NP, PI: NP)
3				
3.5				
4				
4.5				
5	S	21		--- Medium dense
5.5				
6				
6.5				
7				
7.5	S	22		
8				(Moisture Content: 1.6%, Fines: 9.2%)
8.5				
9				
9.5				
10	S	27		--- Tan, damp
10.5				
11				
11.5				
12				
12.5				
13				
13.5				
14				
14.5				
15	S	32	SP	Tan, damp, dense, SAND with gravel
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20	S	16	SP-SM	Tan, damp, medium dense, SAND with silt

Boring Number:	B-1			Boring Log Page 2 of 2	
Location:	See Figure 2			Date Started:	11/14/2023
Site Address:	4333 Phelan Road			Date Completed:	11/14/2023
	Phelan, CA (2731			Depth to Groundwater:	N/E
Project Number:	23-425363.2			Field Technician:	JAH
Drill Rig Type:	CME-75			Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler			2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches			Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
20	S	16	SP-SM	Tan, damp, medium dense, SAND with silt
20.5				
21				
21.5				Boring terminated at 21.5 feet below the ground surface
22				Boring backfilled with soil cuttings upon completion
22.5				Groundwater not encountered
23				
23.5				
24				
24.5				
25				
25.5				
26				
26.5				
27				
27.5				
28				
28.5				
29				
29.5				
30				
30.5				
31				
31.5				
32				
32.5				
33				
33.5				
34				
34.5				
35				
35.5				
36				
36.5				
37				
37.5				
38				
38.5				
39				
39.5				
40				

Boring Number:	B-2	Boring Log Page 1 of 2	
Location:	See Figure 2	Date Started:	11/15/2023
Site Address:	4333 Phelan Road	Date Completed:	11/15/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	R	26	SM	**NATIVE:** Tan, dry, medium dense, silty SAND with some clay
2.5				(Dry Density: 106.6 pcf, Moisture Content: 2.5%)
3				
3.5				
4				
4.5				
5	S	12	SP-SM	Brown, dry, medium dense, SAND with silt
5.5				(Moisture Content: 2.1%, Fines: 6.1%)
6				
6.5				
7				
7.5	R	54		--- Dense, with some gravel
8				(Dry Density: 117.5 pcf, Moisture Content: 3.3%)
8.5				
9				
9.5				
10	S	15		--- Tan, damp, medium dense
10.5				
11				
11.5				
12				
12.5				
13				
13.5				
14				
14.5				
15	S	32		--- Dense
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20	S	17		--- Red brown, medium dense

Boring Number:	B-2			Boring Log Page 2 of 2	
Location:	See Figure 2			Date Started:	11/15/2023
Site Address:	4333 Phelan Road			Date Completed:	11/15/2023
	Phelan, CA (2731			Depth to Groundwater:	N/E
Project Number:	23-425363.2			Field Technician:	JAH
Drill Rig Type:	CME-75			Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler			2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches			Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
20	S	16	SM	Red brown, medium dense, silty SAND with some gravel
20.5				
21				
21.5				Boring terminated at 21.5 feet below the ground surface
22				Boring backfilled with soil cuttings upon completion
22.5				Groundwater not encountered
23				
23.5				
24				
24.5				
25				
25.5				
26				
26.5				
27				
27.5				
28				
28.5				
29				
29.5				
30				
30.5				
31				
31.5				
32				
32.5				
33				
33.5				
34				
34.5				
35				
35.5				
36				
36.5				
37				
37.5				
38				
38.5				
39				
39.5				
40				

Boring Number:	B-3	Boring Log Page 1 of 2	
Location:	See Figure 2	Date Started:	11/15/2023
Site Address:	4333 Phelan Road	Date Completed:	11/15/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	5	SP-SM	**NATIVE:** Light brown, dry, loose, SAND with silt
2.5				(Moisture Content: 2.4%, Fines: 9.5%)
3				
3.5				
4				
4.5				
5	S	13		--- Brown
5.5				(Moisture Content: 2.7%, Fines: 6.2%)
6				
6.5				
7				
7.5	S	11		--- with gravel
8				
8.5				
9				
9.5				
10	S	13		--- Tan
10.5				
11				
11.5				
12				
12.5				
13				
13.5				
14				
14.5				
15	S	17		--- Light brown
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20	S	22		--- With gravel

Boring Number:	B-3			Boring Log Page 2 of 2	
Location:	See Figure 2			Date Started:	11/15/2023
Site Address:	4333 Phelan Road			Date Completed:	11/15/2023
	Phelan, CA (2731			Depth to Groundwater:	N/E
Project Number:	23-425363.2			Field Technician:	JAH
Drill Rig Type:	CME-75			Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler			2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches			Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
20	S	22	SP-SM	Light brown, damp, medium dense, SAND with silt and gravel
20.5				
21				
21.5				Boring terminated at 21.5 feet below the ground surface
22				Boring backfilled with soil cuttings upon completion
22.5				Groundwater not encountered
23				
23.5				
24				
24.5				
25				
25.5				
26				
26.5				
27				
27.5				
28				
28.5				
29				
29.5				
30				
30.5				
31				
31.5				
32				
32.5				
33				
33.5				
34				
34.5				
35				
35.5				
36				
36.5				
37				
37.5				
38				
38.5				
39				
39.5				
40				

Boring Number:	B-4	Boring Log Page 1 of 2	
Location:	See Figure 2	Date Started:	11/15/2023
Site Address:	4333 Phelan Road	Date Completed:	11/15/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	4	SM	**NATIVE:** Tan, damp, loose, silty SAND with some clay
2.5				(Moisture Content: 3.7%, Fines: 13.6%)
3				
3.5				
4				
4.5				
5	R	23	SP-SM	Tan, damp, medium dense, SAND with silt
5.5				(Dry Density: 115.7 pcf, Moisture Content: 3.3%)
6				
6.5				
7				
7.5	S	17		
8				
8.5				
9				
9.5				
10	R	41		--- Dense
10.5				(Dry Density: 115.2 pcf, Moisture Content: 2.5%)
11				
11.5				
12				
12.5				
13				
13.5				
14				
14.5				
15	S	15		--- Medium dense
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20	S	22		--- With gravel

Boring Number:	B-4			Boring Log Page 2 of 2	
Location:	See Figure 2			Date Started:	11/15/2023
Site Address:	4333 Phelan Road			Date Completed:	11/15/2023
	Phelan, CA (2731			Depth to Groundwater:	N/E
Project Number:	23-425363.2			Field Technician:	JAH
Drill Rig Type:	CME-75			Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler			2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches			Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
20	S	22	SP-SM	Brown, damp, medium dense, SAND with silt and gravel
20.5				
21				
21.5				Boring terminated at 21.5 feet below the ground surface
22				Boring backfilled with soil cuttings upon completion
22.5				Groundwater not encountered
23				
23.5				
24				
24.5				
25				
25.5				
26				
26.5				
27				
27.5				
28				
28.5				
29				
29.5				
30				
30.5				
31				
31.5				
32				
32.5				
33				
33.5				
34				
34.5				
35				
35.5				
36				
36.5				
37				
37.5				
38				
38.5				
39				
39.5				
40				

Boring Number:	B-5	Boring Log Page 1 of 2	
Location:	See Figure 2	Date Started:	11/15/2023
Site Address:	4333 Phelan Road	Date Completed:	11/15/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	R	19	SM	**NATIVE:** Light brown, damp, medium dense, silty SAND
2.5				(Dry Density: 106.6 pcf, Moisture Content: 2.5%)
3				
3.5				
4				
4.5				
5	S	14	SP-SM	Brown, damp, medium dense, SAND with silt and clay
5.5				
6				
6.5				
7				
7.5	R	34		--- Tan, dense
8				(Dry Density: 107.1 pcf, Moisture Content: 1.6%)
8.5				
9				
9.5				
10	S	19		--- Medium dense
10.5				
11				
11.5				
12				
12.5				
13				
13.5				
14				
14.5				
15	S	27		
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20	S	24		--- Red brown

Boring Number:	B-5			Boring Log Page 2 of 2	
Location:	See Figure 2			Date Started:	11/15/2023
Site Address:	4333 Phelan Road			Date Completed:	11/15/2023
	Phelan, CA (2731			Depth to Groundwater:	N/E
Project Number:	23-425363.2			Field Technician:	JAH
Drill Rig Type:	CME-75			Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler			2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches			Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
20	S	22	SP-SM	Red brown, damp, medium dense, SAND with silt
20.5				
21				
21.5				Boring terminated at 21.5 feet below the ground surface
22				Boring backfilled with soil cuttings upon completion
22.5				Groundwater not encountered
23				
23.5				
24				
24.5				
25				
25.5				
26				
26.5				
27				
27.5				
28				
28.5				
29				
29.5				
30				
30.5				
31				
31.5				
32				
32.5				
33				
33.5				
34				
34.5				
35				
35.5				
36				
36.5				
37				
37.5				
38				
38.5				
39				
39.5				
40				

Boring Number:	B-6	Boring Log Page 1 of 2	
Location:	See Figure 2	Date Started:	11/15/2023
Site Address:	4333 Phelan Road	Date Completed:	11/15/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	5	SP-SM	**NATIVE:** Brown, damp, loose, SAND with silt
2.5				
3				
3.5				
4				
4.5				
5	S	12		--- Medium dense
5.5				(Moisture Content: 1.6%, Fines: 5.3%)
6				
6.5				
7				
7.5	S	14		--- Tan, dense
8				
8.5				
9				
9.5				
10	S	17	ML	Tan, damp, very stiff, sandy SILT
10.5				
11				
11.5				
12				
12.5				
13				
13.5				
14				
14.5				
15	S	19	SM	Tan, damp, medium dense, silty SAND with gravel
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20	S	32		--- Red brown, dense

Boring Number:	B-6			Boring Log Page 2 of 2	
Location:	See Figure 2			Date Started:	11/15/2023
Site Address:	4333 Phelan Road			Date Completed:	11/15/2023
	Phelan, CA (2731			Depth to Groundwater:	N/E
Project Number:	23-425363.2			Field Technician:	JAH
Drill Rig Type:	CME-75			Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler			2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches			Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
20	S	32	SM	Red brown, damp, dense, silty SAND with gravel
20.5				
21				
21.5				Boring terminated at 21.5 feet below the ground surface
22				Boring backfilled with soil cuttings upon completion
22.5				Groundwater not encountered
23				
23.5				
24				
24.5				
25				
25.5				
26				
26.5				
27				
27.5				
28				
28.5				
29				
29.5				
30				
30.5				
31				
31.5				
32				
32.5				
33				
33.5				
34				
34.5				
35				
35.5				
36				
36.5				
37				
37.5				
38				
38.5				
39				
39.5				
40				

Boring Number:	B-7	Boring Log Page 1 of 1	
Location:	See Figure 2	Date Started:	11/14/2023
Site Address:	4333 Phelan Road	Date Completed:	11/14/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	12	SP	**NATIVE:** Tan, dry, medium dense, SAND with gravel
2.5				
3				
3.5				
4				
4.5				
5	R	25		
5.5				(Dry Density: 112.0 pcf, Moisture Content: 1.9%)
6				
6.5				
7				
7.5	S	10		
8				(Moisture Content: 1.4%, Fines: 4.7%)
8.5				
9				
9.5				
10	S	25		
10.5				(Moisture Content: 1.7%)
11				
11.5				
12				
12.5				
13				
13.5				
14				
14.5				
15	S	47	SP-SM	Tan, damp, dense, SAND with silt
15.5				
16				
16.5				Boring terminated at 16.5 feet below the ground surface
17				Boring backfilled with soil cuttings upon completion
17.5				Groundwater not encountered
18				
18.5				
19				
19.5				
20				

Boring Number:	B-8			Boring Log Page 1 of 1
Location:	See Figure 2		Date Started:	11/14/2023
Site Address:	4333 Phelan Road		Date Completed:	11/14/2023
	Phelan, CA (2731		Depth to Groundwater:	N/E
Project Number:	23-425363.2		Field Technician:	JAH
Drill Rig Type:	CME-75		Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler		2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches		Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	6	SP-SM	**NATIVE:** Brown, dry, loose, SAND with silt
2.5				(Moisture Content: 3.6%, Fines: 11.6%)
3				
3.5				
4				
4.5				
5	S	8		
5.5				
6				
6.5				
7				
7.5	S	16		--- Medium dense
8				
8.5				
9				
9.5				
10	S	14	SC	Brown, damp, medium dense, clayey SAND
10.5				
11				
11.5				Boring terminated at 11.5 feet below the ground surface
12				Boring backfilled with soil cuttings upon completion
12.5				Groundwater not encountered
13				
13.5				
14				
14.5				
15				
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20				

Boring Number:	B-9	Boring Log Page 1 of 1	
Location:	See Figure 2	Date Started:	11/14/2023
Site Address:	4333 Phelan Road	Date Completed:	11/14/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	16	SP-SM	**NATIVE:** Brown, dry, medium dense, SAND with silt
2.5				
3				
3.5				
4				
4.5				
5	S	4		--- Tan, loose
5.5				
6				
6.5				
7				
7.5	S	26	SM	Tan, damp, medium dense, silty SAND
8				
8.5				
9				
9.5				
10	S	26		
10.5				
11				
11.5				Boring terminated at 11.5 feet below the ground surface
12				Boring backfilled with soil cuttings upon completion
12.5				Groundwater not encountered
13				
13.5				
14				
14.5				
15				
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20				

Boring Number:	B-10	Boring Log Page 1 of 1	
Location:	See Figure 2	Date Started:	11/14/2023
Site Address:	4333 Phelan Road	Date Completed:	11/14/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	13	SM	**NATIVE:** Tan, dry, medium dense, SAND
2.5				(Moisture Content: 1.3%, Fines: 4.0%)
3				
3.5				
4				
4.5				
5	S	25	SP-SM	Tan, damp, medium dense, SAND with silt and gravel
5.5				
6				
6.5				
7				
7.5	S	27		
8				
8.5				
9				
9.5				
10	S	14		
10.5				
11				
11.5				Boring terminated at 11.5 feet below the ground surface
12				Boring backfilled with soil cuttings upon completion
12.5				Groundwater not encountered
13				
13.5				
14				
14.5				
15				
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20				

Boring Number:	B-11			Boring Log Page 1 of 1	
Location:	See Figure 2			Date Started:	11/14/2023
Site Address:	4333 Phelan Road			Date Completed:	11/14/2023
	Phelan, CA (2731			Depth to Groundwater:	N/E
Project Number:	23-425363.2			Field Technician:	JAH
Drill Rig Type:	CME-75			Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler			2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches			Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	10	SP-SM	**NATIVE:** Brown, dry, medium dense, SAND with silt and gravel
2.5				
3				
3.5				
4				
4.5				
5	S	15		--- with clay
5.5				
6				
6.5				
7				
7.5	S	21		
8				
8.5				
9				
9.5				
10	S	18		--- Light brown
10.5				
11				
11.5				Boring terminated at 11.5 feet below the ground surface
12				Boring backfilled with soil cuttings upon completion
12.5				Groundwater not encountered
13				
13.5				
14				
14.5				
15				
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20				

Boring Number:	B-12			Boring Log Page 1 of 1	
Location:	See Figure 2			Date Started:	11/14/2023
Site Address:	4333 Phelan Road			Date Completed:	11/14/2023
	Phelan, CA (2731			Depth to Groundwater:	N/E
Project Number:	23-425363.2			Field Technician:	JAH
Drill Rig Type:	CME-75			Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler			2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches			Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	5	SP-SM	**NATIVE:** Brown, dry, loose, SAND with silt and gravel
2.5				(Moisture Content: 2.8%, Fines: 7.2%)
3				
3.5				
4				
4.5				
5	S	7	SM	Brown, damp, loose, silty SAND
5.5				
6				
6.5				
7				
7.5	S	17		--- With gravel
8				
8.5				
9				
9.5				
10	S	9		--- Loose
10.5				
11				
11.5				Boring terminated at 11.5 feet below the ground surface
12				Boring backfilled with soil cuttings upon completion
12.5				Groundwater not encountered
13				
13.5				
14				
14.5				
15				
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20				

Boring Number:	B-13	Boring Log Page 1 of 1	
Location:	See Figure 2	Date Started:	11/14/2023
Site Address:	4333 Phelan Road	Date Completed:	11/14/2023
	Phelan, CA (2731	Depth to Groundwater:	N/E
Project Number:	23-425363.2	Field Technician:	JAH
Drill Rig Type:	CME-75	Partner Engineering and Science, Inc.	
Sampling Equipment:	Hollow Stem Auger / Split Spoon Sampler	2154 Torrance Boulevard, Suite 200	
Borehole Diameter:	8 inches	Torrance, California 90501	

Depth, FT	Sample	N-Value	USCS	Description
0				**SURFACE COVER:** Vegetated unimproved surface
0.5				
1				
1.5				
2	S	6	SM	**NATIVE:** Brown, dry, loose, silty SAND
2.5				
3				
3.5				
4				
4.5				
5	S	17	SP-SM	Brown, dry, medium dense, SAND with silt
5.5				(Moisture Content: 1.3%, Fines: 4.7%)
6				
6.5				
7				
7.5	S	15		--- With gravel
8				
8.5				
9				
9.5				
10	S	23		
10.5				
11				
11.5				Boring terminated at 11.5 feet below the ground surface
12				Boring backfilled with soil cuttings upon completion
12.5				Groundwater not encountered
13				
13.5				
14				
14.5				
15				
15.5				
16				
16.5				
17				
17.5				
18				
18.5				
19				
19.5				
20				

PERCOLATION TEST DATA SHEET - Porchet Method

PARTNER

Project:		Phelan, CA					Project No.:		23-425363.2			Date:	11/14/2023
Test Hole No.:		P1					Tested By:		JAH				
Depth of Test Hole, D_t (ft):		5					USCS Soil Classification:		SP/SP-SM				
Casing Depth (ft):		5					Test Hole Diameter (in):		8				

Trial No.	Date	Start Time, t_o	Initial Depth to Water, D_0 (ft)	Stop Time, T_f	Final Depth to Water, D_f (ft)	Time Interval, Δt (min)	Initial Head, H_0 (ft)	Final Head, H_f (ft)	Water Level Drop, ΔH (in)	Average Head Height, H_{avg} (in)	Tested Infiltration Rate, I_t (in/hr)	Notes
Trial 1	11/14/2023	7:50 AM	0.25	8:00 AM	5.00	10.0	4.75	0.00	57.00	28.50		10-min readings for an hour
Trial 2	11/14/2023	11:40 AM	0.21	11:50 AM	5.00	10.0	4.79	0.00	57.50	28.75		
1	11/14/2023	2:12 PM	3.45	2:14 PM	4.25	2.0	1.55	0.75	9.60	13.80		
2	11/14/2023	2:44 PM	0.69	2:49 PM	2.70	5.0	4.31	2.30	24.12	39.66		
3	11/14/2023	2:54 PM	2.70	2:57 PM	3.19	3.0	2.30	1.81	5.88	24.66		
4	11/14/2023	2:59 PM	3.19	3:04 PM	5.00	5.0	1.81	0.00	21.72	10.86		
5	11/14/2023	1:18 PM	2.10	1:23 PM	3.70	5.0	2.90	1.30	19.20	25.20		
6	11/14/2023	1:48 PM	2.50	1:53 PM	4.30	5.0	2.50	0.70	21.60	19.20	24.45	

Comments:

1. Percolation test was performed in accordance with the San Bernardino County Public Health Environmental Health Services Percolation Testing and Reporting Standards for Onsite Wastewater Treatment Systems
2. Weather: sunny

PERCOLATION TEST DATA SHEET - Porchet Method

PARTNER

Project:	Phelan, CA	Project No.:	23-425363.2	Date:	11/15/2023
Test Hole No.:	P2	Tested By:	JAH		
Depth of Test Hole, D_t (ft):	5	USCS Soil Classification:	SP/SP-SM		
Casing Depth (ft):	5	Test Hole Diameter (in):	8		

Trial No.	Date	Start Time, t_o	Initial Depth to Water, D_0 (ft)	Stop Time, T_f	Final Depth to Water, D_f (ft)	Time Interval, Δt (min)	Initial Head, H_0 (ft)	Final Head, H_f (ft)	Water Level Drop, ΔH (in)	Average Head Height, H_{avg} (in)	Tested Infiltration Rate, I_t (in/hr)	Notes
Trial 1	11/15/2023	8:07 AM	1.00	8:20 AM	5.00	13.0	4.00	0.00	48.00	24.00		10-min readings for an hour
Trial 2	11/15/2023	8:30 AM	2.50	8:40 AM	5.00	10.0	2.50	0.00	30.00	15.00		
1	11/15/2023	8:14 AM	2.00	8:16 AM	3.90	2.0	3.00	1.10	22.80	24.60		
2	11/15/2023	8:16 AM	3.90	8:19 AM	4.17	3.0	1.10	0.83	3.24	11.58		
3	11/15/2023	8:19 AM	3.60	8:21 AM	4.00	2.0	1.40	1.00	4.80	14.40		
4	11/15/2023	8:21 AM	3.60	8:24 AM	4.50	3.0	1.40	0.50	10.80	11.40		
5	11/15/2023	8:25 AM	1.30	8:30 AM	3.10	5.0	3.70	1.90	21.60	33.60		
6	11/15/2023	8:30 AM	0.80	8:35 AM	2.70	5.0	4.20	2.30	22.80	39.00	13.35	

Comments:	1. Percolation test was performed in accordance with the San Bernardino County Public Health Environmental Health Services Percolation Testing and Reporting Standards for Onsite Wastewater Treatment Systems
	2. Weather: sunny

PERCOLATION TEST DATA SHEET - Porchet Method

PARTNER

Project:		Phelan, CA					Project No.:		23-425363.2			Date:	11/15/2023
Test Hole No.:		P3					Tested By:		JAH				
Depth of Test Hole, D_t (ft):		5					USCS Soil Classification:		SP/SP-SM				
Casing Depth (ft):		5					Test Hole Diameter (in):		8				
Trial No.	Date	Start Time, t_o	Initial Depth to Water, D_0 (ft)	Stop Time, T_f	Final Depth to Water, D_f (ft)	Time Interval, Δt (min)	Initial Head, H_0 (ft)	Final Head, H_f (ft)	Water Level Drop, ΔH (in)	Average Head Height, H_{avg} (in)	Tested Infiltration Rate, I_t (in/hr)	Notes	
Trial 1	11/15/2023	8:27 AM	1.00	8:45 AM	5.00	18.0	4.00	0.00	48.00	24.00		10-min readings for an hour	
Trial 2	11/15/2023	8:37 AM	2.50	8:47 AM	5.00	10.0	2.50	0.00	30.00	15.00			
1	11/15/2023	8:35 AM	1.20	8:37 AM	2.20	2.0	3.80	2.80	12.00	39.60			
2	11/15/2023	8:37 AM	1.20	8:40 AM	3.10	3.0	3.80	1.90	22.80	34.20			
3	11/15/2023	8:40 AM	3.10	8:42 AM	3.40	2.0	1.90	1.60	3.60	21.00			
4	11/15/2023	8:42 AM	3.10	8:45 AM	3.80	3.0	1.90	1.20	8.40	18.60			
5	11/15/2023	1:10 PM	2.00	1:15 PM	2.80	5.0	3.00	2.20	9.60	31.20			
6	11/15/2023	1:15 PM	2.20	1:20 PM	2.90	5.0	2.80	2.10	8.40	29.40	6.42		

Comments:	1. Percolation test was performed in accordance with the San Bernardino County Public Health Environmental Health Services Percolation Testing and Reporting Standards for Onsite Wastewater Treatment Systems
	2. Weather: sunny

PERCOLATION TEST DATA SHEET - Porchet Method

PARTNER

Project:	Phelan, CA	Project No.:	23-425363.2	Date:	11/14/-15/2023
Test Hole No.:	P4	Tested By:	JAH		
Depth of Test Hole, D_t (ft):	5	USCS Soil Classification:	SP/SP-SM		
Casing Depth (ft):	5	Test Hole Diameter (in):	8		

Trial No.	Date	Start Time, t_o	Initial Depth to Water, D_0 (ft)	Stop Time, T_f	Final Depth to Water, D_f (ft)	Time Interval, Δt (min)	Initial Head, H_0 (ft)	Final Head, H_f (ft)	Water Level Drop, ΔH (in)	Average Head Height, H_{avg} (in)	Tested Infiltration Rate, I_t (in/hr)	Notes
Trial 1	11/14/2023	10:05 AM	1.00	10:15 AM	5.00	10.0	4.00	0.00	48.00	24.00		10-min readings for an hour
Trial 2	11/14/2023	10:45 AM	2.50	10:55 AM	5.00	10.0	2.50	0.00	30.00	15.00		
1	11/14/2023	2:58 PM	1.20	3:06 PM	2.20	8.0	3.80	2.80	12.00	39.60		
2	11/15/2023	8:10 AM	1.20	8:12 AM	3.10	2.0	3.80	1.90	22.80	34.20		
3	11/15/2023	8:12 AM	3.10	8:15 AM	3.40	3.0	1.90	1.60	3.60	21.00		
4	11/15/2023	8:20 AM	0.35	8:22 AM	3.80	2.0	4.65	1.20	41.42	35.11		
5	11/15/2023	8:22 AM	2.00	8:25 AM	2.80	3.0	3.00	2.20	9.60	31.20		
6	11/15/2023	8:28 AM	2.20	8:30 AM	2.90	2.0	2.80	2.10	8.40	29.40		
7	11/15/2023	8:30 AM	1.70	8:33 AM	2.80	3.0	3.30	2.20	13.20	33.00	15.09	

Comments:

1. Percolation test was performed in accordance with the San Bernardino County Public Health Environmental Health Services Percolation Testing and Reporting Standards for Onsite Wastewater Treatment Systems
2. Weather: sunny

APPENDIX B

Lab Data

PARTNER

Moisture and Density Data

Soil Sample	Dry Density (pcf)	Moisture Content (%)
B2 @ 2 feet	106.6	2.5
B2 @ 7 feet	117.5	3.3
B4 @ 5 feet	115.7	3.3
B4 @ 10 feet	115.2	2.5
B5 @ 2 feet	111.6	3.4
B5 @ 7 feet	107.1	1.6
B7 @ 5 feet	112.0	1.9
B7 @ 10 ft	-	1.7

Index Test Data

Soil Sample	Plasticity Index	Liquid Limit	Percent Passing #200 Sieve	Moisture Content (%)
B1 @ 2 feet	NP	NP	6.1	1.7
B1 @ 7 feet	-	-	9.2	1.6
B2 @ 5 feet	-	-	6.1	2.1
B3 @ 2 feet	-	-	9.5	2.4
B3 @ 5 feet	-	-	6.2	2.7
B4 @ 2 feet	-	-	13.6	3.7
B6 @ 5 feet	-	-	5.3	1.6
B7 @ 7 feet	-	-	4.7	1.4
B8 @ 2 feet	-	-	11.6	3.6
B8 @ 7 feet	-	-	9.8	2.9
B10 @ 2 feet	-	-	4	1.3
B12 @ 2 feet	-	-	7.2	2.8
B13 @ 5 feet	-	-	4.7	1.3

APPENDIX C

General Geotechnical Design and Construction Considerations

Subgrade Preparation

Earthwork – Structural Fill/Excavations

Underground Pipeline Installation – Structural Backfill

Cast-in-Place Concrete

Foundations

Laterally Loaded Structures

Excavations and Dewatering

Waterproofing and Drainage

Chemical Treatment of Soils

Paving

Site Grading and Drainage

PARTNER

SUBGRADE PREPARATION

1. In general, construction should proceed per the project specifications and contract documents, as well as governing jurisdictional guidelines for the project site, including but not limited to the applicable State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Subgrade preparation in this section is considered to apply to the initial modifications to existing site conditions to prepare for new planned construction.
3. Prior to the start of subgrade preparation, a detailed conflict study including as-builts, utility locating, and potholing should be conducted. Existing features that are to be demolished should also be identified and the geotechnical study should be referenced to determine the need for subgrade preparation, such as over-excavation, scarification and compaction, moisture conditioning, and/or other activities below planned new structural fills, slabs on grade, pavements, foundations, and other structures.
4. The site conflicts, planned demolitions, and subgrade preparation requirements should be discussed in a pre-construction meeting with the pertinent parties, including the geotechnical engineer, inspector, contractors, testing laboratory, surveyor, and others.
5. In the event of preparations that will require work near to existing structures to remain in-place, protection of the existing structures should be considered. This also includes a geotechnical review of excavations near to existing structures and utilities and other concerns discussed in General Geotechnical Design and Construction Considerations, EARTHWORK and UNDERGROUND PIPELINE INSTALLATION.
6. Features to be demolished should be completely removed and disposed of per jurisdictional requirements and/or other conditions set forth as a part of the project. Resulting excavations or voids should be backfilled per the recommendations in the General Geotechnical Design and Construction Considerations, EARTHWORK section.
7. Vegetation, roots, soils containing organic materials, debris and/or other deleterious materials on the site should be removed from structural areas and should be disposed of as above. Replacement of such materials should be in accordance with the recommendations in the General Geotechnical Design and Construction Considerations, EARTHWORK section
8. Subgrade preparation required by the geotechnical report may also call for as over-excavation, scarification and compaction, moisture conditioning, and/or other activities below planned structural fills, slabs on grade, pavements, foundations, and other structures. These requirements should be provided within the geotechnical report. The execution of this work should be observed by the geotechnical engineering representative or inspector for the site. Testing of the subgrade preparation should be performed per the recommendations in the General Geotechnical Design and Construction Considerations, EARTHWORK section.

9. Subgrade Preparation cannot be completed on frozen ground or on ground that is not at a proper moisture condition. Wet subgrades may be dried under favorable weather if they are disked and/or actively worked during hot, dry, weather, when exposed to wind and sunlight. Frozen ground or wet material can be removed and replaced with suitable material. Dry material can be pre-soaked or can have water added and worked in with appropriate equipment. The soil conditions should be monitored by the geotechnical engineer prior to compaction. Following this type of work, approved subgrades should be protected by direction of surface water, covering, or other methods, otherwise, re-work may be needed.

EARTHWORK – STRUCTURAL FILL

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Earthwork in this section is considered to apply to the re-shaping and grading of soil, rock, and aggregate materials for the purpose of supporting man-made structures. Where earthwork is needed to raise the elevation of the site for the purpose of supporting structures or forming slopes, this is referred to as the placement of structural fill. Where lowering of site elevations is needed prior to the installation of new structures, this is referred to as earthwork excavations.
3. Prior to the start of earthwork operations, the geotechnical study should be referenced to determine the need for subgrade preparation, such as over-excavation or scarification and compaction of unsuitable soils below planned structural fills, slabs on grade, pavements, foundations, and other structures. These required preparations should be discussed in a pre-construction meeting with the pertinent parties, including the geotechnical engineer, inspector, contractors, testing laboratory, surveyor, and others. The preparations should be observed by the inspector or geotechnical engineer representative, and following such subgrade preparation, the geotechnical engineer should observe the prepared subgrade to approve it for the placement of earthwork fills or new structures.
4. Structural fill materials should be relatively free of organic materials, man-made debris, environmentally hazardous materials, and brittle, non-durable aggregate, frozen soil, soil clods or rocks and/or any other materials that can break down and degrade over time.
5. In deeper structural fill zones, expansive soils (greater than 1.5 percent swell at 100 pounds per square foot surcharge) and rock fills (fills containing particles larger than 4 inches and/or containing more than 35 percent gravel larger than ¾-inch diameter or more than 50 percent gravel) may be used with the approval and guidance of the geotechnical report or geotechnical engineer. This may require the placement of geotextiles or other added costs and/or conditions. These conditions may also apply to corrosive soils (less than 2,000 ohm-cm resistivity, more than 50 ppm chloride content, more than 0.1 percent sulfates)
6. For structural fill zones that are closer in depth below planed structures, low expansive materials, and materials with smaller particle size are generally recommended, as directed by the geotechnical report (see criteria above in 5). This may also apply to corrosive soils.
7. For structural fill materials, in general the compaction equipment should be appropriate for the thickness of the loose lift being placed, and the thickness of the loose lift being placed should be at least two times the maximum particle size incorporated in the fill.
8. Fill lift thickness (including bedding) should generally be proportioned to achieve 95 percent or more of a standard proctor (ASTM D689) maximum dry density (MDD) or 90 percent or more of a modified proctor (ASTM D1557) MDD, depending on the state practices. For subgrades below

roadways, the general requirement for soil compaction is usually increased to 100 percent or more of the standard proctor MDD and 95 percent or more of the modified proctor MDD.

9. Soil compaction should be performed at a moisture content generally near optimum moisture content determined by either standard or modified proctor, and ideally within 3 percent below to 1 percent over the optimum for a standard proctor, and from 2 percent below to 2 percent above optimum for a modified proctor.
10. In some instances, fill areas are difficult to access. In such cases a low-strength soil-cement slurry can be used in the place of compacted fill soil. In general, such fills should be rated to have a 28-day strength of 75 to 125 psi, which in some areas is referred to as a "1-sack" slurry. It should be noted that these materials are wet during placement and require a period of 2 days (24 hours) to cure before additional fill can be placed above them. Testing of this material can be done using concrete cylinder compression strength testing equipment, but care is needed in removing the test specimens from the molds. Field testing using the ball method and spread, or flow testing is also acceptable.
11. For fills to be placed on slopes, benching of fill lifts is recommended, which may require cutting into existing slopes to create a bench perpendicular to the slope where soil can be placed in a relatively horizontal orientation. For the construction of slopes, the slopes should be over-built and cut back to grade, as the material in the outer portion of the slope may not be well compacted.
12. For subgrade below roadways, runways, railways or other areas to receive dynamic loading, a proofroll of the finished, compacted subgrade should be performed by the geotechnical engineer or inspector prior to the placement of structural aggregate, asphalt or concrete. Proofrolling consists of observing the performance of the subgrade under heavy-loaded equipment, such as full, 4,000 Gallon water truck, loaded tandem-axel dump truck or similar. Areas that exhibit instability during proofroll should be marked for additional work prior to approval of the subgrade for the next stage of construction.
13. Quality control testing should be provided on earthwork. Proctor testing should be performed on each soil type, and one-point field proctors should be used to verify the soil types during compaction testing. If compaction testing is performed with a nuclear density gauge, it should be periodically correlated with a sand cone test for each soil type. Density testing should be performed per project specifications and or jurisdictional requirements, but not less than once per 12 inches elevation of any fill area, with additional tests per 12-inch fill area for each additional 7,500 square-foot section or portion thereof.
14. For earthwork excavations, OSHA guidelines should be referenced for sloping and shoring. Excavations over a depth of 20 feet require a shoring design. In the event excavations are planned near to existing structures, the geotechnical engineer should be consulted to evaluate whether such excavation will call for shoring or underpinning the adjacent structure. Pre-construction and post-construction condition surveys and vibration monitoring might also be helpful to evaluate any potential damage to surrounding structures.
15. Excavations into rock, partially weathered rock, cemented soils, boulders and cobbles, and other hard soil or "hard-pan" materials, may result in slower excavation rates, larger equipment with specialized digging tools, and even blasting. It is also not unusual in these situations for screening

and or crushing of rock to be called for. Blasting, hard excavating, and material processing equipment have special safety concerns and are more costly than the use of soil excavation equipment. Additionally, this type of excavation, especially blasting, is known to cause vibrations that should be monitored at nearby structures. As above, a pre-blast and post-blast conditions assessment might also be warranted.

UNDERGROUND PIPELINE – STRUCTURAL BACKFILL

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable State Department of Transportation, the State Department of Environmental Quality, the US Environmental Protection Agency, City and/or County Public Works, Occupational Safety and Health Administration (OSHA), Private Utility Companies, and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered, and in some cases, work may take place to multiple different standards. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Underground pipeline in this section is considered to apply to the installation of underground conduits for water, storm water, irrigation water, sewage, electricity, telecommunications, gas, etc. Structural backfill refers to the activity of restoring the grade or establishing a new grade in the area where excavations were needed for the underground pipeline installation.
3. Prior to the start of underground pipeline installation, a detailed conflict study including as-builts, utility locating, and potholing should be conducted. The geotechnical study should be referenced to determine subsurface conditions such as caving soils, unsuitable soils, shallow groundwater, shallow rock and others. In addition, the utility company responsible for the line also will have requirements for pipe bedding and support as well as other special requirements. Also, if the underground pipeline traverses other properties, rights-of-way, and/or easements etc. (for roads, waterways, dams, railways, other utility corridors, etc.) those owners may have additional requirements for construction.
4. The required preparations above should be discussed in a pre-construction meeting with the pertinent parties, including the geotechnical engineer, inspector, contractors, testing laboratory, surveyor, and other stake holders.
5. For pipeline excavations, OSHA guidelines should be referenced for sloping and shoring. Excavations over a depth of 20 feet require a shoring design. In the event excavations are planned near to existing structures or pipelines, the geotechnical engineer should be consulted to evaluate whether such excavation will call for shoring or supporting the adjacent structure or pipeline. A pre-construction and post-construction condition survey and vibration monitoring might also be helpful to evaluate any potential damage to surrounding structures.
6. Excavations into rock, partially weathered rock, cemented soils, boulders and cobbles, and other hard soil or "hard-pan" materials, may result in slower excavation rates, larger equipment with specialized digging tools, and even blasting. It is also not unusual in these situations for screening and or crushing of rock to be called for. Blasting, hard excavating and material processing equipment have special safety concerns and are more costly than the use soil excavation equipment. Additionally, this type of excavation, especially blasting, is known to cause vibrations that should be monitored at nearby structures. As above, a pre-blast and post-blast conditions assessment might also be warranted.
7. Bedding material requirements vary between utility companies and might depend of the type of pipe material and availability of different types of aggregates in different locations. In general,

bedding refers to the material that supports the bottom of the pipe, and extends to 1 foot above the top of the pipe. In general the use of aggregate base for larger diameter pipes (6-inch diameter or more) is recommended lacking a jurisdictionally specified bedding material. Gas lines and smaller diameter lines are often backfilled with fine aggregate meeting the ASTM requirements for concrete sand. In all cases bedding with less than 2,000 ohm-cm resistivity, more than 50 ppm chloride content or more than 0.1 percent sulfates should not be used.

8. Structural backfill materials above the bedding should be relatively free of organic materials, man-made debris, environmentally hazardous materials, frozen material, and brittle, non-durable aggregate, soil clods or rocks and/or any other materials that can break down and degrade over time.
9. In general the backfill soil requirements will depend on the future use of the land above the buried line, but in most cases, excessive settlement of the pipe trench is not considered advisable or acceptable. As such, the structural backfill compaction equipment should be appropriate for the thickness of the loose lift being placed. The thickness of the loose lift being placed should be at least two times the maximum particle size incorporated in the fill. Care should be taken not to damage the pipe during compaction or compaction testing.
10. Fill lift thickness (including bedding) should generally be proportioned to achieve 95 percent or more of a standard proctor (ASTM D689) maximum dry density (MDD) or 90 percent or more of a modified proctor (ASTM D1557) MDD, depending on the state practices (in general the modified proctor is required in California and for projects in the jurisdiction of the Army Corps of Engineers). For backfills within the upper poritons of roadway subgrades, the general requirement for soil compaction is usually increased to 100 percent or more of the standard proctor MDD and 95 percent or more of the modified proctor MDD.
11. Soil compaction should be performed at a moisture content generally near optimum moisture content determined by either standard or modified proctor, and ideally within 3 percent below to 1 percent over the optimum for a standard proctor, and from 2 percent below to 2 percent above optimum for a modified proctor.
12. In some instances fill areas are difficult to access. In such cases a low-strength soil-cement slurry can be used in the place of compacted fill soil. In general such fills should be rated to have a 28-day strength of 75 to 125 psi, which in some areas is referred to as a "1-sack" slurry. It should be noted that these materials are wet, and require a period of 2 days (24 hours) to cure before additional fill can be placed above it. Testing of this material can be done using concrete cylinder compression strength testing equipment, but care is needed in removing the test specimens from the molds. Field testing using the ball method, and spread or flow testing is also acceptable.
13. Quality control testing should be provided on structural backfill to assist the contractor in meeting project specifications. Proctor testing should be performed on each soil type, and one-point field proctors should be used to verify the soil types during compaction testing. If compaction testing is performed with a nuclear density gauge, it should be periodically correlated with a sand cone test for each soil type.

14. Density testing should be performed on structural backfill per project specifications and or jurisdictional requirements, but not less than once per 12 inches elevation in each area, and additional tests for each additional 500 linear-foot section or portion thereof.

CAST-IN-PLACE CONCRETE

SLABS-ON-GRADE/STRUCTURES/PAVEMENTS

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Cast-in-place concrete (concrete) in this section is considered to apply to the installation of cast-in-place concrete slabs on grade, including reinforced and non-reinforced slabs, structures, and pavements.
3. In areas where concrete is bearing on prepared subgrade or structural fill soils, testing and approval of this work should be completed prior to the beginning of concrete construction.
4. In locations where a concrete is approved to bear on in-place (native) soil or in locations where approved documented fills have been exposed to weather conditions after approval, a concrete subgrade evaluation should be performed prior to the placement of reinforcing steel and or concrete. This can consist of probing with a "t"-handled rod, borings, penetrometer testing, dynamic cone penetration testing and/or other methods requested by the geotechnical engineer and/or inspector. Where unsuitable, wet, or frozen bearing material is encountered, the geotechnical engineer should be consulted for additional recommendations.
5. Slabs on grade should be placed on a 4-inch thick or more capillary barrier consisting of non-corrosive (more than 2,000 ohm-cm resistivity, less than 50 ppm chloride content and less than 0.1 percent sulfates) aggregate base or open-graded aggregate material. This material should be compacted or consolidated per the recommendations of the structural engineer or otherwise would be covered by the General Considerations for EARTHWORK.
6. Depending on the site conditions and climate, vapor barriers may be required below in-door grade-slabs to receive flooring. This reduces the opportunity for moisture vapor to accumulate in the slab, which could degrade flooring adhesive and result in mold or other problems. Vapor barriers should be specified by the structural engineer and/or architect. The installation of the barrier should be inspected to evaluate the correct product and thickness is used, and that it has not been damaged or degraded.
7. At times when rainfall is predicted during construction, a mud-mat or a thin concrete layer can be placed on prepared and approved subgrades prior to the placement of reinforcing steel or tendons. This serves the purpose of protecting the subgrades from damage once the reinforcement placement has begun.
8. Prior to the placement of concrete, exposed subgrade or base material and forms should be wetted, and form release compounds should be applied. Reinforcement support stands or ties should be checked. Concrete bases or subgrades should not be so wet that they are softened or have standing water.

9. For a cast-in-place concrete, the form dimensions, reinforcement placement and cover, concrete mix design, and other code requirements should be carefully checked by an inspector before and during placement. The reinforcement should be specified by the structural engineering drawings and calculations.
10. For post-tension concrete, an additional check of the tendons is needed, and a tensioning inspection form should be prepared prior to placement of concrete.
11. For Portland cement pavements, forms an additional check of reinforcing dowels should performed per the design drawings.
12. During placement, concrete should be tested, and should meet the ACI and jurisdictional requirements and mix design targets for slump, air entrainment, unit weight, compressive strength, flexural strength (pavements), and any other specified properties. In general concrete should be placed within 90 minutes of batching at a temperature of less than 90 degrees Fahrenheit. Adding of water to the truck on the jobsite is generally not encouraged.
13. Concrete mix designs should be created by the accredited and jurisdictionally approved supplier to meet the requirements of the structural engineer. In general a water/cement ratio of 0.45 or less is advisable, and aggregates, cement, flyash, and other constituents should be tested to meet ASTM C-33 standards, including Alkali Silica Reaction (ASR). To further mitigate the possibility of concrete degradation from corrosion and ASR, Type II or V Portland Cement should be used, and fly ash replacement of 25 percent is also recommended. Air entrained concrete should be used in areas where concrete will be exposed to frozen ground or ambient temperatures below freezing.
14. Control joints are recommended to improve the aesthetics of the finished concrete by allowing for cracking within partially cut or grooved joints. The control joints are generally made to depths of about 1/4 of the slab thickness and are generally completed within the first day of construction. The spacing should be laid out by the structural engineer, and is often in a square pattern. Joint spacing is generally 5 to 15 feet on-center but this can vary and should be decided by the structural engineer. For pavements, construction joints are generally considered to function as control joints. Post-tensioned slabs generally do not have control joints.
15. Some slabs are expected to meet flatness and levelness requirements. In those cases, testing for flatness and levelness should be completed as soon as possible, usually the same day as concrete placement, and before cutting of control joints if possible. Roadway smoothness can also be measured, and is usually specified by the jurisdictional owner if is required.
16. Prior to tensioning of post-tension structures, placement of soil backfills or continuation of building on newly-placed concrete, a strength requirement is generally required, which should be specified by the structural engineer. The strength progress can be evaluated by the use of concrete compressive strength cylinders or maturity monitoring in some jurisdictions. Advancing with backfill, additional concrete work or post-tensioning without reaching strength benchmarks could result in damage and failure of the concrete, which could result in danger and harm to nearby people and property.
17. In general, concrete should not be exposed to freezing temperatures in the first 7 days after placement, which may require insulation or heating. Additionally, in hot or dry, windy weather,

misting, covering with wet burlap or the use of curing compounds may be called for to reduce shrinkage cracking and curling during the first 7 days.

FOUNDATIONS

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Foundations in this section are considered to apply to the construction of structural supports which directly transfer loads from man-made structures into the earth. In general, these include shallow foundations and deep foundations. Shallow foundations are generally constructed for the purpose of distributing the structural loads horizontally over a larger area of earth. Some types of shallow foundations (or footings) are spread footings, continuous footings, mat foundations, and reinforced slabs-on-grade. Deep foundations are generally designed for the purpose of distributing the structural loads vertically deeper into the soil by the use of end bearing and side friction. Some types of deep foundations are driven piles, auger-cast piles, drilled shafts, caissons, helical piers, and micro-piles.
3. For shallow foundations, the minimum bearing depth considered should be greater than the maximum design frost depth for the location of construction. This can be found on frost depth maps (ICC), but the standard of practice in the city and/or county should also be consulted. In general the bearing depth should never be less than 18 inches below planned finished grades.
4. Shallow continuous foundations should be sized with a minimum width of 18 inches and isolated spread footings should be a minimum of 24 inches in each direction. Foundation sizing, spacing, and reinforcing steel design should be performed by a qualified structural engineer.
5. The geotechnical engineer will provide an estimated bearing capacity and settlement values for the project based on soil conditions and estimated loads provided by the structural engineer. It is assumed that appropriate safety factors will be applied by the structural engineer.
6. In areas where shallow foundations are bearing on prepared subgrade or structural fill soils, testing and approval of this work should be completed prior to the beginning of foundation construction.
7. In locations where the shallow foundations are approved to bear on in-place (native) soil or in locations where approved documented fills have been exposed to weather conditions after approval, a foundation subgrade evaluation should be performed prior to the placement of reinforcing steel. This can consist of probing with a "t"-handled rod, borings, penetrometer testing, dynamic cone penetration testing and/or other methods requested by the geotechnical engineer and/or inspector. Where unsuitable foundation bearing material is encountered, the geotechnical engineer should be consulted for additional recommendations.
8. For shallow foundations to bear on rock, partially weathered rock, hard cemented soils, and/or boulders, the entire foundation system should bear directly on such material. In this case, the rock surface should be prepared so that it is clean, competent, and formed into a roughly horizontal, stepped base. If that is not possible, then the entire structure should be underlain by a zone of

structural fill. This may require the over-excavation in areas of rock removal and/or hard dig. In general this zone can vary in thickness but it should be a minimum of 1 foot thick. The geotechnical engineer should be consulted in this instance.

9. At times when rainfall is predicted during construction, a mud-mat or a thin concrete layer can be placed on prepared and approved subgrades prior to the placement of reinforcing steel. This serves the purpose of protecting the subgrades from damage once the reinforcing steel placement has begun.
10. For cast-in-place concrete foundations, the excavations dimensions, reinforcing steel placement and cover, structural fill compaction, concrete mix design, and other code requirements should be carefully checked by an inspector before and during placement.

---

11. For deep foundations, the geotechnical engineer will generally provide design charts that provide foundations axial capacity and uplift resistance at various depths given certain-sized foundations. These charts may be based on blow count data from drilling and or laboratory testing. In general safety factors are included in these design charts by the geotechnical engineer.
12. In addition, the geotechnical engineer may provide other soil parameters for use in the lateral resistance analysis. These parameters are usually raw data, and safety factors should be provided by the shaft designer. Sometimes, direct shear and or tri-axial testing is performed for this analysis.
13. In general the spacing of deep foundations is expected to be 6 shaft diameters or more. If that spacing is reduced, a group reduction factor should be applied by the structural engineer to the foundation capacities per FHWA guidelines. The spacing should not be less than 2.5 shaft diameters.
14. For deep foundations, a representative of the geotechnical engineer should be on-site to observe the excavations (if any) to evaluate that the soil conditions are consistent with the findings of the geotechnical report. Soil/rock stratigraphy will vary at times, and this may result in a change in the planned construction. This may require the use of fall protection equipment to perform observations close to an open excavation.
15. For driven foundations, a representative of the geotechnical engineer should be on-site to observe the driving process and to evaluate that the resistance of driving is consistent with the design assumptions. Soil/rock stratigraphy will vary at times and may this may result in a change in the planned construction.
16. For deep foundations, the size, depth, and ground conditions should be verified during construction by the geotechnical engineer and/or inspector responsible. Open excavations should be clean, with any areas of caving and groundwater seepage noted. In areas below the groundwater table, or areas where slurry is used to keep the trench open, non-destructive testing techniques should be used as outlined below.
17. Steel members including structural steel piles, reinforcing steel, bolts, threaded steel rods, etc. should be evaluated for design and code compliance prior to pick-up and placement in the foundation. This includes verification of size, weight, layout, cleanliness, lap-splices, etc. In addition, if non-destructive testing such as crosshole sonic logging or gamma-gamma logging is required, access tubes should be attached to the steel reinforcement prior to placement, and should be

relatively straight, capped at the bottom, and generally kept in-round. These tubes must be filled with water prior to the placement of concrete.

18. In cases where steel welding is required, this should be observed by a certified welding inspector.
19. In many cases, a crane will be used to lower steel members into the deep foundations. Crane picks should be carefully planned, including the ground conditions at placement of outriggers, wind conditions, and other factors. These are not generally provided in the geotechnical report, but can usually be provided upon request.
20. Cast-in-place concrete, grout or other cementations materials should be pumped or distributed to the bottom of the excavation using a tremmie pipe or hollow stem auger pipe. Depending on the construction type, different mix slumps will be used. This should be carefully checked in the field during placement, and consolidation of the material should be considered. Use of a vibrator may be called for.
21. For work in a wet excavation (slurry), the concrete placed at the bottom of the excavation will displace the slurry as it comes up. The upper layer of concrete that has interacted with the slurry should be removed and not be a part of the final product.
22. Bolts or other connections to be set in the top after the placement is complete should be done immediately after final concrete placement, and prior to the on-set of curing.
23. For shafts requiring crosshole sonic logging or gamma-gamma testing, this should be performed within the first week after placement, but not before a 2 day curing period. The testing company and equipment manufacturer should provide more details on the requirements of the testing.
24. Load testing of deep foundations is recommended, and it is often a project requirement. In some cases, if test piles are constructed and tested, it can result in a significant reduction of the amount of needed foundations. The load testing frame and equipment should be sized appropriately for the test to be performed, and should be observed by the geotechnical engineer or inspector as it is performed. The results are provided to the structural engineer for approval.

LATERALLY LOADED STRUCTURES - RETAINING WALLS/SLOPES/DEEP FOUNDATIONS/MISCELLANEOUS

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Laterally loaded structures for this section are generally meant to describe structures that are subjected to loading roughly horizontal to the ground surface. Such structures include retaining walls, slopes, deep foundations, tall buildings, box culverts, and other buried or partially buried structures.
3. The recommendations put forth in General Geotechnical Design and Construction Considerations for FOUNDATIONS, CAST-IN-PLACE CONCRETE, EARTHWORK, and SUBGRADE PREPARATION should be reviewed, as they are not all repeated in this section, but many of them will apply to the work. Those recommendations are incorporated by reference herein.
4. Laterally loaded structures are generally affected by overburden pressure, water pressure, surcharges, and other static loads, as well as traffic, seismic, wind, and other dynamic loads. The structural engineer must account for these loads. In addition, eccentric loading of the foundation should be evaluated and accounted for by the structural engineer. The structural engineer is also responsible for applying the appropriate factors of safety to the raw data provided by the geotechnical engineer.
5. The geotechnical report should provide data regarding soil lateral earth pressures, seismic design parameters, and groundwater levels. In the report the pressures are usually reported as raw data in the form of equivalent fluid pressures for three cases. 1. Static is for soil pressure against a structure that is fixed at top and bottom, like a basement wall or box culvert. 2. Active is for soil pressure against a wall that is free to move at the top, like a retaining wall. 3. Passive is for soil that is resisting the movement of the structure, usually at the toe of the wall where the foundation and embedded section are located. The structural engineer is responsible for deciding on safety factors for design parameters and groundwater elevations based on the raw data in the geotechnical report.
6. Generally speaking, direct shear or tri-axial shear testing should be performed for this evaluation in cases of soil slopes or unrestrained soil retaining walls over 6 feet in height or in lower walls in some cases based on the engineer's judgment. For deep foundations and completely buried structures, this testing will be required per the discretion of the structural engineer.
7. For non-confined retaining walls (walls that are not attached at the top) and slopes, a geotechnical engineer should perform overall stability analysis for sliding, overturning, and global stability. For walls that are structurally restrained at the top, the geotechnical engineer does not generally perform this analysis. Internal wall stability should be designed by the structural engineer.

8. Cut slopes into rock should be evaluated by an engineering geologist, and rock coring to identify the orientation of fracture plans, faults, bedding planes, and other features should be performed. An analysis of this data will be provided by the engineering geologist to identify modes of failure including sliding, wedge, and overturning, and to provide design and construction recommendations.
9. For laterally loaded deep foundations that support towers, bridges or other structures with high lateral loads, geotechnical reports generally provide parameters for design analysis which is performed by the structural engineer. The structural engineer is responsible for applying appropriate safety factors to the raw data from the geotechnical engineer.
10. Construction recommendations for deep foundations can be found in the General Geotechnical Design and Construction Considerations-FOUNDATIONS section.
11. Construction of retaining walls often requires temporary slope excavations and shoring, including soil nails, soldier piles and lagging or laid-back slopes. This should be done per OSHA requirements and may require specialty design and contracting.
12. In general, surface water should not be directed over a slope or retaining wall, but should be captured in a drainage feature trending parallel to the slope, with an erosion protected outlet to the base of the wall or slope.
13. Waterproofing for retaining walls is generally required on the backfilled side, and they should be backfilled with an 18-inch zone of open graded aggregate wrapped in filter fabric or a synthetic draining product, which outlets to weep holes or a drain at the base of the wall. The purpose of this zone, which is immediately behind the wall is to relieve water pressures from building behind the wall.
14. Backfill compaction around retaining walls and slopes requires special care. Lighter equipment should be considered, and consideration to curing of cementitious materials used during construction will be called for. Additionally, if mechanically stabilized earth walls are being constructed, or if tie-backs are being utilized, additional care will be necessary to avoid damaging or displacing the materials. Use of heavy or large equipment, and/or beginning of backfill prior to concrete strength verification can create dangers to construction and human safety. Please refer to the General Geotechnical Design and Construction Considerations-CAST-IN-PLACE CONCRETE section. These concerns will also apply to the curing of cell grouting within reinforced masonry walls.
15. Usually safety features such as handrails are designed to be installed at the top of retaining walls and slopes. Prior to their installation, workers in those areas will need to be equipped with appropriate fall protection equipment.

EXCAVATION AND DEWATERING

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Excavation and Dewatering for this section are generally meant to describe structures that are intended to create stable, excavations for the construction of infrastructure near to existing development and below the groundwater table.
3. The recommendations put forth in General Geotechnical Design and Construction Considerations for LATERALLY LOADED STRUCTURES, FOUNDATIONS, CAST-IN-PLACE CONCRETE, EARTHWORK, and SUBGRADE PREPARATION should be reviewed, as they are not all repeated in this section, but many of them will apply to the work. Those recommendations are incorporated by reference herein.
4. The site excavations will generally be affected by overburden pressure, water pressure, surcharges, and other static loads, as well as traffic, seismic, wind, and other dynamic loads. The structural engineer must account for these loads as described in Section 5.2 of this report. In addition, eccentric loading of the foundation should be evaluated and accounted for by the structural engineer. The structural engineer is also responsible for applying the appropriate factors of safety to the raw data provided by the geotechnical engineer.
5. The geotechnical report should provide data regarding soil lateral earth pressures, seismic design parameters, and groundwater levels. In the report the pressures are usually reported as raw data in the form of equivalent fluid pressures for three cases. 1. Static is for soil pressure against a structure that is fixed at top and bottom, like a basement wall or box culvert. 2. Active is for soil pressure against a wall that is free to move at the top, like a retaining wall. 3. Passive is for soil that is resisting the movement of the structure, usually at the toe of the wall where the foundation and embedded section are located. The structural engineer is responsible for deciding on safety factors for design parameters and groundwater elevations based on the raw data in the geotechnical report.
6. The parameters provided above are based on laboratory testing and engineering judgement. Since numerous soil layers with different properties will be encountered in a large excavation, assumptions and judgement are used to generate the equivalent fluid pressures to be used in design. Factors of safety are not included in those numbers and should be evaluated prior to design.
7. Groundwater, if encountered will dramatically change the stability of the excavation. In addition, pumping of groundwater from the bottom of the excavation can be difficult and costly, and it can result in potential damage to nearby structures if groundwater drawdown occurs. As such, we recommend that groundwater monitoring be performed across the site during design and prior to construction to assist in the excavation design and planning.
8. Groundwater pumping tests should be performed if groundwater pumping will be needed during construction. The pumping tests can be used to estimate drawdown at nearby properties, and also

will be needed to determine the hydraulic conductivity of the soil for the design of the dewatering system.

9. For excavation stabilization in granular and dense soil, the use of soldier piles and lagging is recommended. The soldier pile spacing and size should be determined by the structural engineer based on the lateral loads provided in the report. In general, the spacing should be more than two pile diameters, and less than 8 feet. Soldier piles should be advanced 5 feet or more below the base of the excavation. Passive pressures from Section 5.2 can be used in the design of soldier piles for the portions of the piles below the excavation.
10. If the piles are drilled, they should be grouted in-place. If below the groundwater table, the grouting should be accomplished by tremmie pipe, and the concrete should be a mix intended for placement below the groundwater table. For work in a wet excavation, the concrete placed at the bottom of the excavation will displace the water as it comes up. The upper layer of concrete that has interacted with the water should be removed and not be a part of the final product. Lagging should be specially designed timber or other lagging. The temporary excavation will need to account for seepage pressures at the toe of the wall as well as hydrostatic forces behind the wall.
11. Depending on the loading, tie back anchors and/or soil nails may be needed. These should be installed beyond the failure envelope of the wall. This would be a plane that is rotated upward 55 degrees from horizontal. The strength of the anchors behind this plane should be considered, and bond strength inside the plane should be ignored. If friction anchors are used, they should extend 10 feet or more beyond the failure envelope. Evaluation of the anchor length and encroachment onto other properties, and possible conflicts with underground utilities should be carefully considered. Anchors are typically installed 25 to 40 degrees below horizontal. The capacity of the anchors should be checked on 10% of locations by loading to 200% of the design strength. All should be loaded to 120% of design strength, and should be locked off at 80%
12. The shoring and tie backs should be designed to allow less than ½ inch of deflection at the top of the excavation wall, where the wall is within an imaginary 1:1 line extending downward from the base of surrounding structures. This can be expanded to 1 inch of deflection if there is no nearby structure inside that plane. An analysis of nearby structures to locate their depth and horizontal position should be conducted prior to shored excavation design.
13. Assuming that the excavations will encroach below the groundwater table, allowances for drainage behind and through the lagging should be made. The drainage can be accomplished by using an open-graded gravel material that is wrapped in geotextile fabric. The lagging should allow for the collected water to pass through the wall at select locations into drainage trenches below the excavation base. These trenches should be considered as sump areas where groundwater can be pumped out of the excavation.
14. The pumped groundwater needs to be handled properly per jurisdictional guidelines.
15. In general, surface water should not be directed over a slope or retaining wall, but should be captured in a drainage feature trending parallel to the slope, with an erosion protected outlet to the base of the wall or slope.

16. Safety features such as handrails or barriers are to be designed to be installed at the top of retaining walls and slopes. Prior to their installation, workers in those areas will need to be equipped with appropriate fall protection equipment.

Waterproofing and Back Drainage

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Waterproofing and Back drainage structures for this section are generally meant to describe permanent subgrade structures that are planned to be below the historic high groundwater elevation of 20 feet below existing grades.
3. The recommendations put forth in General Geotechnical Design and Construction Considerations for FOUNDATIONS, CAST-IN-PLACE CONCRETE, EARTHWORK, and SUBGRADE PREPARATION should be reviewed, as they are not all repeated in this section, but many of them will apply to the work. Those recommendations are incorporated by reference herein.
4. In general, surface water should not be directed over a slope or retaining wall, but should be captured in a drainage feature trending parallel to the slope, with an erosion protected outlet to the base of the wall or slope.
5. Waterproofing for retaining walls is generally required on the backfilled side, and they should be backfilled with an 18-inch zone of open graded aggregate wrapped in filter fabric or a synthetic draining product, which outlets to weep holes or a drain at the base of the wall. The purpose of this zone, which is immediately behind the wall is to relieve water pressures from building behind the wall.
6. For the basement walls on this site, sump pumps will be needed to reduce the build-up of water in the basement. The design should be for a historic high groundwater level of 20 feet bgs. The pumping system should be designed to keep the slab and walls relatively dry so that mold, efflorescence, and other detrimental effects to the concrete structure will not result.
7. Backfill compaction around retaining walls and slopes requires special care. Lighter equipment should be considered, and consideration to curing of cementitious materials used during construction will be called for. Additionally, if mechanically stabilized earth walls are being constructed, or if tie-backs are being utilized, additional care will be necessary to avoid damaging or displacing the materials. Use of heavy or large equipment, and/or beginning of backfill prior to concrete strength verification can create dangers to construction and human safety. Please refer to the General Geotechnical Design and Construction Considerations-CAST-IN-PLACE CONCRETE section. These concerns will also apply to the curing of cell grouting within reinforced masonry walls.

CHEMICAL TREATMENT OF SOIL

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, State Department of Environmental Quality, the US Environmental Protection Agency, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Chemical treatment of soil for this section is generally meant to describe the process of improving soil properties for a specific purpose, using cement or chemical lime.
3. A mix design should be performed by the geotechnical engineer to help it meet the specific strength, plasticity index, durability, and/or other desired properties. The mix design should be performed using the proposed chemical lime or cement proposed for use by the contractor, along with samples of the site soil that are taken from the material to be used in the process.
4. For the mix design the geotechnical engineer should perform proctor testing to determine optimum moisture content of the soil, and then mix samples of the soil at 3 percent above optimum moisture content with varying concentrations of lime or cement. The samples will be prepared and cured per ASTM standards, and then after 7-days for curing, they will be tested for compression strength. Durability testing goes on for 28 days.
5. Following this testing, the geotechnical engineer will provide a recommended mix ratio of cement or chemical lime in the geotechnical report for use by the contractor. The geotechnical engineer will generally specify a design ratio of 2 percent more than the minimum to account for some error during construction.
6. Prior to treatment, the in-place soil moisture should be measured so that the correct amount of water can be used during construction. Work should not be performed on frozen ground.
7. During construction, special considerations for construction of treated soils should be followed. The application process should be conducted to prevent the loss of the treatment material to wind which might transport the materials off site, and workers should be provided with personal protective equipment for dust generated in the process.
8. The treatment should be applied evenly over the surface, and this can be monitored by use of a pan placed on the subgrade. This can also be tested by preparing test specimens from the in-place mixture for laboratory testing.
9. Often, after or during the chemical application, additional water may be needed to activate the chemical reaction. In general, it should be maintained at about 3 percent or more above optimum moisture. Following this, mixing of the applied material is generally performed using specialized equipment.
10. The total amount of chemical provided can be verified by collecting batch tickets from the delivery trucks, and the depth of the treatment can be verified by digging of test pits, and the use of reagents that react with lime and or cement.

11. For the use of lime treatment, compaction should be performed after a specified amount of time has passed following mixing and re-grading. For concrete, compaction should be performed immediately after mixing and re-grading. In both cases, some swelling of the surface should be expected. Final grading should be performed the following day of the initial work for lime treatment, and within 2 to 4 hours for soil cement.
12. Quality control testing of compacted treated subgrades should be performed per the recommendations of the geotechnical report, and generally in accordance with General Geotechnical Design and Construction Considerations - EARTHWORK

PAVING

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Paving for this section is generally meant to describe the placement of surface treatments on travel-ways to be used by rubber-tired vehicles, such as roadways, runways, parking lots, etc.
3. The geotechnical engineer is generally responsible for providing structural analysis to recommend the thickness of pavement sections, which can include asphalt, concrete pavements, aggregate base, cement or lime treated aggregate base, and cement or lime treated subgrades.
4. The civil engineer is generally responsible for determining which surface finishes and mixes are appropriate, and often the owner, general contractor and/or other party will decide on lift thickness, the use of tack coats and surface treatments, etc.
5. The geotechnical engineer will generally be provided with the planned traffic loading, as well as reliability, design life, and serviceability factors by the jurisdiction, traffic engineer, designer, and/or owner. The geotechnical study will provide data regarding soil resiliency and strength. A pavement modeling software is generally used to perform the analysis for design, however, jurisdictional minimum sections also must be considered, as well as construction considerations and other factors.
6. The geotechnical report report will generally provide pavement section thicknesses if requested.
7. For construction of overlays, where new pavement is being placed on old pavement, an evaluation of the existing pavement is needed, which should include coring the pavement, evaluation of the overall condition and thickness of the pavement, and evaluation of the pavement base and subgrade materials.
8. In general, the existing pavement is milled and treated with a tack coat prior to the placement of new pavement for the purpose of creating a stronger bond between the old and new material. This is also a way of removing aged asphalt and helping to maintain finished grades closer to existing conditions grading and drainage considerations.
9. If milling is performed, a minimum of 2 inches of existing asphalt should be left in-place to reduce the likelihood of equipment breaking through the asphalt layer and destroying its integrity. After milling and before the placement of tack coat, the surface should be evaluated for cracking or degradation. Cracked or degraded asphalt should be removed, spanned with geosynthetic reinforcement, or be otherwise repaired per the direction of the civil and or geotechnical engineer prior to continuing construction. Proofrolling may be requested.
10. For pavements to be placed on subgrade or base materials, the subgrade and base materials should be prepared per the General Geotechnical Design and Construction Considerations – EARTHWORK section.

11. Following the proofrolling as described in the General Geotechnical Design and Construction Considerations – EARTHWORK section, the application of subgrade treatment, base material, and paving materials can proceed per the recommendations in the geotechnical report and/or project plans. The placement of pavement materials or structural fills cannot take place on frozen ground.
12. The placement of aggregate base material should conform to the jurisdictional guidelines. In general the materials should be provided by an accredited supplier, and the material should meet the standards of ASTM C-33. Material that has been stockpiled and exposed to weather including wind and rain should be retested for compliance since fines could be lost. Frozen material cannot be used.
13. The placement of asphalt material should conform to the jurisdictional guidelines. In general the materials should be provided by an accredited supplier, and the material should meet the standards of ASTM C-33. The material can be placed in a screed by end-dumping, or it can be placed directly on the paving surface. The temperature of the mix at placement should generally be on the order of 300 degrees Fahrenheit at time of placement and screeding.
14. Compaction of the screeded asphalt should begin as soon as practical after placement, and initial rolling should be performed before the asphalt has cooled significantly. Compaction equipment should have vibratory capabilities, and should be of appropriate size and weight given the thickness of the lift being placed and the sloping of the ground surface.
15. In cold and/or windy weather, the cooling of the screeded asphalt is a quality issue, so preparations should be made to perform screeding immediately after placement, and compaction immediately after screeding.
16. Quality control testing of the asphalt should be performed during placement to verify compaction and mix design properties are being met and that delivery temperatures are correct. Results of testing data from asphalt laboratory testing should be provided within 24 hours of the paving.

SITE GRADING AND DRAINAGE

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, State Department of Environmental Quality, the US Environmental Protection Agency, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Site grading and drainage for this section is generally meant to describe the effect of new construction on surface hydrology, which impacts the flow of rainfall or other water running across, onto or off-of, a newly constructed or modified development.
3. This section does not apply to the construction of site grading and drainage features. Recommendations for the construction of such features are covered in General Geotechnical Design and Construction Considerations for Earthwork – Structural Fills section and Underground Pipeline Installation – Backfill section.
4. In general, surface water flows should be directed towards storm drains, natural channels, retention or detention basins, swales, and/or other features specifically designed to capture, store, and or transmit them to specific off-site outfalls.
5. The surface water flow design is generally performed by a site civil engineer, and it can be impacted by hydrology, roof lines, and other site structures that do not allow for water to infiltrate into the soil, and that modify the topography of the site.
6. Soil permeability, density, and strength properties are relevant to the design of storm drain systems, including dry wells, retention basins, swales, and others. These properties are usually only provided in a geotechnical report if specifically requested, and recommendations will be provided in the geotechnical report in those cases.
7. Structures or site features that are not a part of the surface water drainage system should not be exposed to surface water flows, standing water or water infiltration. In general, roof drains and scuppers, exterior slabs, pavements, landscaping, etc. should be constructed to drain water away from structures and foundations. The purpose of this is to reduce the opportunity for water damage, erosion, and/or altering of structural soil properties by wetting. In general, a 5 percent or more slope away from foundations, structural fills, slopes, structures, etc. should be maintained.
8. Special considerations should be used for slopes and retaining walls, as described in the General Geotechnical Design and Construction Considerations - LATERALLY LOADED STRUCTURES section.
9. Additionally, landscaping features including irrigation emitters and plants that require large amounts of water should not be placed near to new structures, as they have the potential to alter soil moisture states. Changing of the moisture state of soil that provides structural support can lead to damage to the supported structures.