Preliminary Drainage Study

for

West Grove

San Bernardino County, California

Assessor's Parcel Number: 0292-053-08

Prepared for:
West Grove S.C., Inc.
P.O. Box 9716
Redlands, CA 92408

County of San Bernardino
BUILDING AND SAFETY
PRELIMINARY
APPROVAL
THE APPROVAL OF THIS REPORT SHALL NOT BE CONSTRUED TO BE A PERMIT FOR ANY DEVELOPMENT OR SITE IMPROVEMENT.
By
Date 09/10/2019
This report has Preliminary Approval. Prior to Final Approval the report, all outstanding comments/ requirements shall be met.

Prepared by:
Transtech Engineers, Inc.
413 Mackay Drive
San Bernardino, CA 92408
909-384-7464

December 17, 2018
Revised
Project No. 18702

TRANSTECH

David B. Ragland, RCE

Signature and stamp required on final

Table of Contents

1. INTRODUCTION

This report presents the design criteria, hydrologic conditions and preliminary hydrologic analysis for a proposed apartment project located at the north side of Lugonia Avenue, between Nevada Street and California Street in the County of San Bernardino. The proposed project is located immediately adjacent to the City of Redlands.

The proposed project is the development of an approximate 282 unit apartment project to be situated on 9.5 acres. The project will consist of studio, one, two and three bedroom apartment units in two and three story buildings. Approximately 8,484 square feet of leasing area, lounge, club and fitness area will be included. Parking on the site will be in tuck under garages, covered carports and open parking spaces.

1.1 Site Description

The proposed project site is currently undeveloped. The existing use of the project site has been orchard and farmland. The site has recently been disked and irrigation installed in anticipation of temporarily planting crops. The project site is bounded on the north by an industrial building and associated parking and truck loading facilities; on the east by a vacant lot with an approved apartment project preparing to commence construction; on the south by Lugonia Avenue and commercial development and on the west by an industrial building and parking lot.

2. HYDROLOGIC CONDITIONS

Natural drainage on the site tends to flow in a southeasterly to northwesterly direction. Natural slope across the site is approximately two percent. There are not any natural drainage courses on the site due to farming and flows tend to be sheet flow. Runoff from the site is conveyed along the sides of the streets in a westerly and northerly direction.

The frontage street of Lugonia Avenue is a paved street, but does not have storm drain improvements such as curbs and gutters along the project frontage.

There is an existing 48 and 51-inch reinforced concrete pipe storm drain located on the south side of Lugonia Avenue adjacent to the subject property. This storm drain pipe conveys flows from watersheds to the east of the site. Flows are conveyed westerly in this storm drain system to the Mission Channel and finally into the Santa Ana River.

2.1 Soils

The Natural Resource Conservation Service soil data base was used to cl
on the site are comprised of Handford sandy loam, 0 to 2 percent slopes (
consists of very deep, well drained soils that formed in moderately coarse textured alluvium dominantly from granite. Hanford soils are on stream bottoms, floodplains and alluvial fans and have slopes of 0 to 15 percent. The mean annual precipitation is about 12 inches and the mean annual air temperature is about 63 degrees F. The Natural Resource Conservation Service and the County of San Bernardino Hydrologic Soil Rating for these soils is B.

USGS websoils survey identifies the hydrologic soil group for this site as "A". Revise all calculations to use this more accurate and conservative condition.

3. PROJECT DESCRIPTION AND PROPOSED STORM DRAIN

3.1 Proposed Storm Drain Water Quality Management and Detention System

The proposed project storm drain system will collect runoff from the building roofs, parking areas and other impervious surfaces in an on-site storm drainage system. Storm water runoff will generally be conveyed and directed to the southwesterly portion of the project site. The low flow water quality flows will be diverted to a combination of underground water quality infiltration/detention chambers.

During the street and storm drain improvement plan review process, the City of Redlands made us aware of a couple of storm drainage issues and concerns the City has regarding the master storm drainage system in Lugonia Avenue. Specifically, the City has 1) identified additional areas of concern regarding the proposed pipe sizes for the Lugonia Avenue storm drain and 2) indicated areas along Lugonia Avenue that have been subject to flooding and storm drain manholes becoming dislodged during rain storm events. Transtech has prepared a preliminary assessment of the above noted concerns of the City

Therefore, to mitigate the project's impact to the storm drainage system, the proposed West Grove project will install an onsite underground detention system. The detention system will collect storm water runoff from the onsite catch basins, detain the volume necessary to release a flow rate of the project's site predeveloped condition. The water quality volume will continue to be retained and infiltrated into the underlying soils.

Water quality flows from the West Grove project will be conveyed via the onsite storm drain system to underground infiltration chambers located throughout the project site. The water quality volumes will be infiltrated under the parking areas and in the landscaped areas. Storm water flows greater than the water quality storm event would overflow and be detained in the underground detention chambers. The restricted peak flow rate or the detained storm water flows will be discharged to the existing 51-inch storm drain pipe located in Lugonia Avenue.

4. HYDROLOGY AND WQMP

The results of the Rational Method Hydrology Analysis for the pre and post-development runoff conditions for this analysis are summarized in Table 4.1. A detailed analysis will be prepared for the project as the improvement plans are developed which will include detailed onsite hydrology, pipe size determination, hydraulic grade line calculations and verification of water quality flow rates and volumes.

Table 4.1 Existing and Developed Condition Peak Flow Rate (cfs) Summary

2 Year		10 Year		25 Year		100 Year	
Existing	Developed	Existing	Developed	Existing	Developed	Existing	Developed
3.97	7.91	7.73	12.72	10.09	15.74	13.78	20.46

AES Hydrologic Results indicated in Table 4.1 and the Hydrology Map for the West Grove Development Project are included in the appendix. The 100 year storm event was used to determine the peak flow runoff from each subarea and the underground storm drain system sizing and analysis. Since development over the entire site is fairly consistent, peak runoff rates and required detention volumes from each onsite drainage subarea was determined by proportion. The water quality design capture volume for each drainage area is calculated individually. The design capture volume for each drainage area is included in the project WQMP.

The onsite detention chambers are designed to restrict the 100 year storm event peak discharge flow rate to that of the predeveloped project runoff of 13.78 cubic feet per second as indicated by the onsite rational method hydrology. Based upon discussions with the City of Redlands, the proposed project will provide stormwater detention in order to restrict the developed condition peak flow rate to less than the predeveloped peak flow rate. The calculations presented herein for allowable peak discharge from the project site will be based upon 13.78 cubic feet per second.

4.1 Proposed Water Quality

The project proposes to infiltrate the water quality volume utilizing a combination of underground storage chambers for infiltration.

The infiltration rate used for the design of the water quality infiltration chambers is 5.42 inches per hour *(Soils Southwest, Inc. Report of Water Infiltration Rate, November 12, 2018).* Percolation testing was performed by Soils Southwest in November 2018. In-situ soil infiltration rates were established using the standardized double-ring infiltrometer test procedures prescribed by the County of San Bernardino Environmental Health Department.

The percolation tests were performed at the approximate depth of the proposed detention basin chambers. The results of these tests indicate the infiltration rate should be 5.42 inches per hour. Using a factor of safety of 2.5, the design infiltration rate is 2.17 inches per hour. *(See Infiltration Worksheet provided in the project's WQMP)*

A complete and detailed Water Quality Management Plan (WQMP) will be prepared and submitted under separate cover.

4.2 Proposed Detention Facilities

The proposed project will provide onsite underground detention in addition to the water quality volume infiltration. A flow through underground detention basin comprised of large diameter perorated storm drain pipes for each subarea will be sized to accept the differential or increase in the runoff for a 100 year storm between the pre-project development condition and the post-project development condition. Each subarea drainage system is designed to allow the initial storm water flow or water quality flow rate to pass directly to the water quality volume infiltration chamber. The water quality chambers are sized to capture and infiltrate 100 percent of the calculated water quality design volume.

Flows and volumes from storm events greater than the initial runoff and water quality flow rates will continue through the storm drain system until the pre-developed condition flow rate is reached. Discharge to the storm drain system will be restricted to the pre-developed condition flow rate with the use of orifice control devices placed in the catch basin diversion structures. The flow greater than the pre-developed flow rate will be diverted to the detention basin chambers and the volume stored by a flow through detention basin. The estimated required volume for the detention basins was calculated using the AES software for flow through detention basin. For preliminary detention basin sizing, the total required detained volume was prorated over each subarea to estimate the size of the chambers required. Detailed in-flow outflow calculations will be performed on each detention basin with the final hydrology report.

A brief discussion is presented herein of the how the proposed water quality management detention/infiltration system will function. The water quality detention/infiltration system will be designed as follows:

1. Water quality flows from the West Grove project will be contained and infiltrated entirely onsite. New underground 36-inch to 72-inch perforated storm drain chambers will be located within the project. Water quality flows from the onsite catch basins will be directed to the underground chambers. The first level of volume in each sub-area chamber will be sized to accommodate the water quality volume. The water quality volume is the volume of runoff produced from a 24-hour 85th percentile storm event per the County Technical Guidance Manual.

2. Upon reaching the first level of pool volume, the basin (chambers) will begin to operate as fully functional detention basins. The diversion structure orifice plate at each catch basin or sub-area is sized to discharge no greater than the peak allowable discharge for that sub-area. The catch basin in Drainage Management Area G chambers are sized to collect the released upstream flows and attenuate the peak flow for discharge of the restricted pre-developed runo 13.78 cubic feet per second.

Calculations for each area not provided and will be required on final report.

5. CONCLUSION

The proposed project will increase peak runoff rates as indicated in Table 4.1. However, the installation of the underground storm drainage detention improvements will control project storm water discharge to pre-developed levels.

The design of the water quality system will provide for infiltration chambers to capture the water quality volume from the West Grove project and infiltrate onsite.

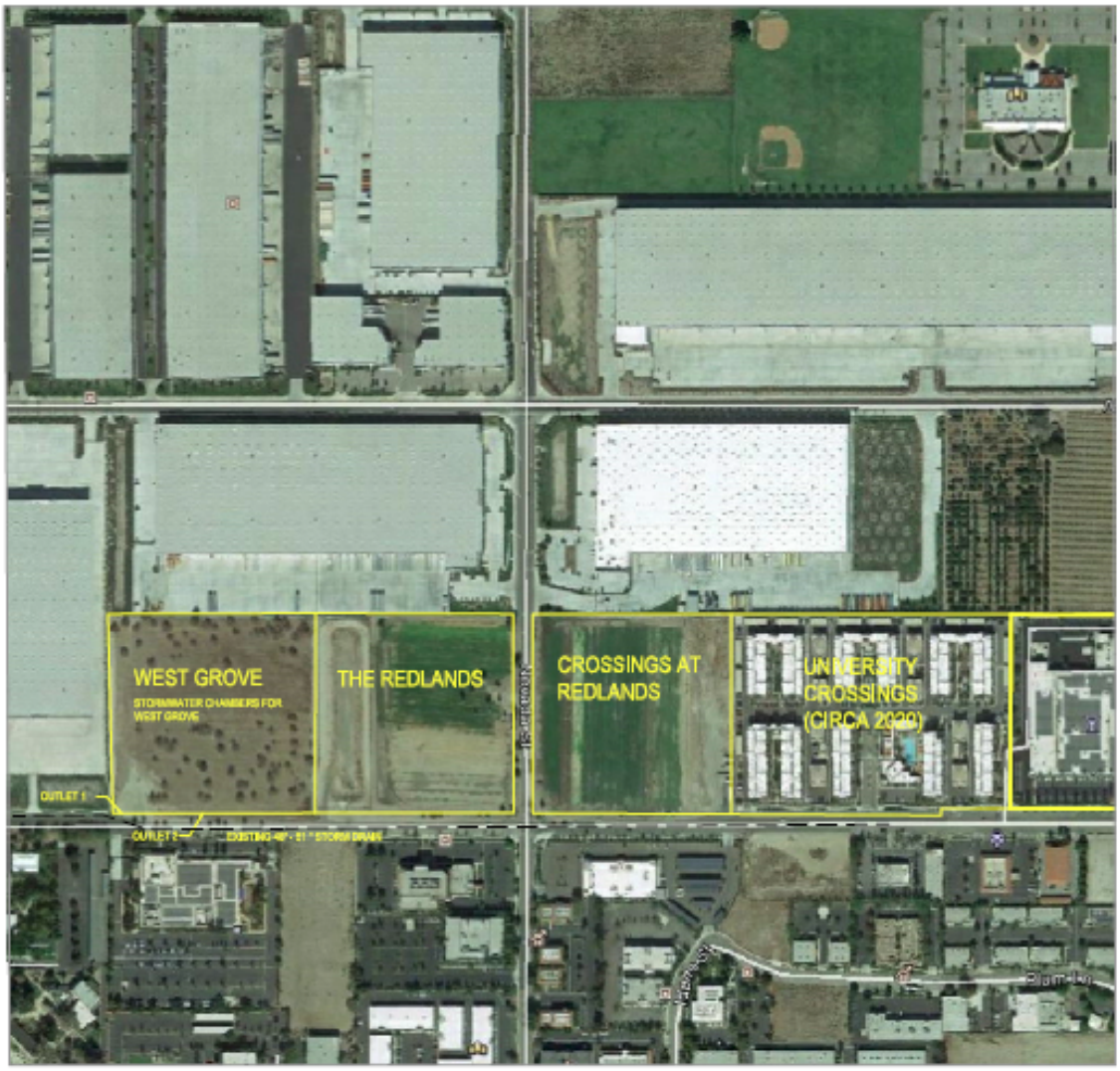

Figure 1. Location Map

REFERENCES

City of Redlands, “Drainage Master Plan,” May 2014.

County of San Bernardino, Department of Public Works “Hydrology Manual,” August 1986.

County of San Bernardino, Department of Public Works “Detention Basin Design Criteria for San Bernardino County.”

County of San Bernardino, Transportation Flood Control Water Resources Division, “Master Drainage Study,” November, 2004.

Soils Southwest, Inc. “Report of Water Infiltration Rate Proposed Stormwater Disposal System Design Planned West Grove 9.5 Apartment Complex on West Lugonia Avenue County of San Bernardino,” November 12, 2018.

Transtech Engineers, Inc. “Detention and Water Quality Infiltration Basin Analysis,” June 2014.

Transtech Engineers, Inc. “Hydrology Report for the Crossings at Redlands,” December 2017.

APPENDIX A
Rational Method Hydrology

West Grove
Pre and Post Condition Hydrology Calculations

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**************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
        (c) Copyright 1983-2012 Advanced Engineering Software (aes)
            Ver. 18.2  Release Date: 05/08/2012  License ID 1542

                          Analysis prepared by:

                        Transtech Engineers, Inc.
                             413 Mackay Drive
                         San Bernardino, CA 92408
```

EXISTING 2 YEAR STORM

```
--------------------------------------------------------------------------
  FILE NAME: WGROVE.DAT
  TIME/DATE OF STUDY: 11:17 11/30/2018
==========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==========================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.4760

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

**************************************************************************
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```
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
 ----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
 ============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   912.00
  ELEVATION DATA: UPSTREAM(FEET) =   1184.80  DOWNSTREAM(FEET) =   1174.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   26.189
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  0.783
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  AGRICULTURAL FAIR COVER
  "ORCHARDS"                 B        9.54      0.32     1.000    83   26.19
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.32
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =      3.97
  TOTAL AREA(ACRES) =      9.54   PEAK FLOW RATE(CFS) =      3.97
```

DEVELOPED 2 YEAR STORM

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 ****************************************************************************
  FLOW PROCESS FROM NODE     10.00 TO NODE     20.00 IS CODE =  21
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  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
 ============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1271.00
  ELEVATION DATA: UPSTREAM(FEET) =   1182.00  DOWNSTREAM(FEET) =   1175.60

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.285
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.041
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  APARTMENTS                 B        9.19      0.42     0.200    76   16.29
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA RUNOFF(CFS) =      7.91
  TOTAL AREA(ACRES) =      9.19   PEAK FLOW RATE(CFS) =      7.91
 ============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        9.2  TC(MIN.) =     16.29
  EFFECTIVE AREA(ACRES) =      9.19  AREA-AVERAGED Fm(INCH/HR)=  0.08
  AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap = 0.200
  PEAK FLOW RATE(CFS)   =       7.91
 ============================================================================
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EXISTING 10 YEAR STORM

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============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
 ============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--
```

```
  USER SPECIFIED STORM EVENT(YEAR) =   10.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.7420

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  ========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   912.00
  ELEVATION DATA: UPSTREAM(FEET) =   1184.80  DOWNSTREAM(FEET) =   1174.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   26.189
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.220
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  AGRICULTURAL FAIR COVER
  "ORCHARDS"                  B        9.54      0.32     1.000    83   26.19
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.32
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =      7.73
  TOTAL AREA(ACRES) =      9.54   PEAK FLOW RATE(CFS) =      7.73
```

DEVELOPED 10 YEAR STORM

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****************************************************************************
  FLOW PROCESS FROM NODE     10.00 TO NODE     20.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
```

```
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1271.00
  ELEVATION DATA: UPSTREAM(FEET) =   1182.00  DOWNSTREAM(FEET) =   1175.60

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.285
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.623
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  APARTMENTS                 B        9.19      0.42     0.200    76   16.29
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA RUNOFF(CFS) =     12.72
  TOTAL AREA(ACRES) =      9.19   PEAK FLOW RATE(CFS) =     12.72
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        9.2  TC(MIN.) =     16.29
  EFFECTIVE AREA(ACRES) =      9.19  AREA-AVERAGED Fm(INCH/HR)=  0.08
  AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap = 0.200
  PEAK FLOW RATE(CFS)   =      12.72
================================================================================
```

EXISTING 25 YEAR STORM

```
--*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   10.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.9090

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
```

```
================================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   912.00
  ELEVATION DATA: UPSTREAM(FEET) =   1184.80  DOWNSTREAM(FEET) =   1174.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   26.189
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.495
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  AGRICULTURAL FAIR COVER
  "ORCHARDS"                 B        9.54      0.32     1.000    83   26.19
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.32
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =     10.09
  TOTAL AREA(ACRES) =      9.54   PEAK FLOW RATE(CFS) =     10.09
```

DEVELOPED 25 YEAR STORM

```
********************************************************************************
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  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
================================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1271.00
  ELEVATION DATA: UPSTREAM(FEET) =   1182.00  DOWNSTREAM(FEET) =   1175.60

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.285
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.988
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  APARTMENTS                 B        9.19      0.42     0.200    76   16.29
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA RUNOFF(CFS) =     15.74
  TOTAL AREA(ACRES) =      9.19   PEAK FLOW RATE(CFS) =     15.74
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        9.2  TC(MIN.) =     16.29
  EFFECTIVE AREA(ACRES) =      9.19  AREA-AVERAGED Fm(INCH/HR)=  0.08
  AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap = 0.200
  PEAK FLOW RATE(CFS)   =      15.74
================================================================================
```

EXISTING 100 YEAR STORM

```
================================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
```

```
  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 1.1700

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   912.00
  ELEVATION DATA: UPSTREAM(FEET) =   1184.80  DOWNSTREAM(FEET) =   1174.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   26.189
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.924
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  AGRICULTURAL FAIR COVER
  "ORCHARDS"                 B        9.54      0.32      1.000    83   26.19
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.32
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =     13.78
  TOTAL AREA(ACRES) =      9.54   PEAK FLOW RATE(CFS) =     13.78
```

Show on plan

A per USGS websoils survey. Please revise calculations

DEVELOPED 100 YEAR STORM

```
****************************************************************************
  FLOW PROCESS FROM NODE     10.00 TO NODE     20.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1271.00
  ELEVATION DATA: UPSTREAM(FEET) =   1182.00  DOWNSTREAM(FEET) =   1175.60

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.285
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  2.559
```

Show on plan

```
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  APARTMENTS                  B        9.19      0.42      0.200    76   16.29
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
  SUBAREA RUNOFF(CFS) =     20.46
  TOTAL AREA(ACRES) =      9.19   PEAK FLOW RATE(CFS) =     20
================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        9.2  TC(MIN.) =     16.29
  EFFECTIVE AREA(ACRES) =      9.19  AREA-AVERAGED Fm(INCH/HR)=  0.08
  AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap = 0.200
  PEAK FLOW RATE(CFS)   =      20.46
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

A per USGS websoils survey. Please revise calculations

Detention Basin Required Volume Estimate

```
********************************************************************************
                      SMALL AREA UNIT HYDROGRAPH MODEL
================================================================================
         (C) Copyright 1989-2012 Advanced Engineering Software (aes)
             Ver. 19.0  Release Date: 06/01/2012  License ID 1542

                           Analysis prepared by:

                         Transtech Engineers, Inc.
                              413 Mackay Drive
                          San Bernardino, CA 92408


********************************************************************************
--------------------------------------------------------------------------------

 Problem Descriptions:



--------------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 1.08
    TOTAL CATCHMENT AREA(ACRES) =    9.19
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.084
    LOW LOSS FRACTION = 0.500
    TIME OF CONCENTRATION(MIN.) = 16.30
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) = 100
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.31
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.80
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  1.17
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.95
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  2.69
```

```
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  4.89

--------------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     2.71
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     1.03

********************************************************************************
  TIME     VOLUME       Q    0.        7.5      15.0      22.5      30.0
 (HOURS)    (AF)      (CFS)
--------------------------------------------------------------------------------
  0.24      0.0049      0.44  Q         .         .         .         .
  0.52      0.0148      0.44  Q         .         .         .         .
  0.79      0.0247      0.44  Q         .         .         .         .
  1.06      0.0348      0.45  Q         .         .         .         .
  1.33      0.0449      0.45  Q         .         .         .         .
  1.60      0.0552      0.46  Q         .         .         .         .
  1.87      0.0655      0.46  Q         .         .         .         .
  2.15      0.0760      0.47  Q         .         .         .         .
  2.42      0.0866      0.47  Q         .         .         .         .
  2.69      0.0973      0.48  Q         .         .         .         .
  2.96      0.1081      0.48  Q         .         .         .         .
  3.23      0.1191      0.49  Q         .         .         .         .
  3.50      0.1302      0.50  Q         .         .         .         .
  3.78      0.1414      0.50  Q         .         .         .         .
  4.05      0.1528      0.51  Q         .         .         .         .
  4.32      0.1643      0.52  Q         .         .         .         .
  4.59      0.1759      0.52  Q         .         .         .         .
  4.86      0.1878      0.53  Q         .         .         .         .
  5.13      0.1997      0.54  Q         .         .         .         .
  5.41      0.2119      0.55  Q         .         .         .         .
  5.68      0.2242      0.55  Q         .         .         .         .
  5.95      0.2367      0.56  Q         .         .         .         .
  6.22      0.2494      0.57  Q         .         .         .         .
  6.49      0.2623      0.58  Q         .         .         .         .
  6.76      0.2754      0.59  Q         .         .         .         .
  7.04      0.2887      0.60  Q         .         .         .         .
  7.31      0.3023      0.61  Q         .         .         .         .
  7.58      0.3160      0.62  Q         .         .         .         .
  7.85      0.3301      0.63  Q         .         .         .         .
  8.12      0.3444      0.64  Q         .         .         .         .
  8.39      0.3589      0.65  Q         .         .         .         .
  8.66      0.3738      0.67  Q         .         .         .         .
  8.94      0.3889      0.68  Q         .         .         .         .
  9.21      0.4044      0.70  Q         .         .         .         .
  9.48      0.4202      0.71  Q         .         .         .         .
  9.75      0.4364      0.73  Q         .         .         .         .
 10.02      0.4530      0.74  Q         .         .         .         .
 10.30      0.4700      0.77  .Q        .         .         .         .
 10.57      0.4875      0.78  .Q        .         .         .         .
 10.84      0.5054      0.81  .Q        .         .         .         .
 11.11      0.5239      0.83  .Q        .         .         .         .
 11.38      0.5433      0.90  .Q        .         .         .         .
 11.65      0.5638      0.93  .Q        .         .         .         .
 11.93      0.5858      1.02  .Q        .         .         .         .
```

```
  12.20      0.6093      1.08  .Q        .          .          .          .
  12.47      0.6362      1.32  .Q        .          .          .          .
  12.74      0.6664      1.38  .Q        .          .          .          .
  13.01      0.6988      1.51  . Q       .          .          .          .
  13.28      0.7335      1.58  . Q       .          .          .          .
  13.55      0.7709      1.76  . Q       .          .          .          .
  13.83      0.8115      1.86  . Q       .          .          .          .
  14.10      0.8559      2.10  . Q       .          .          .          .
  14.37      0.9047      2.25  .  Q      .          .          .          .
  14.64      0.9594      2.62  .  Q      .          .          .          .
  14.91      1.0209      2.86  .  Q      .          .          .          .
  15.18      1.0927      3.53  .   Q     .          .          .          .
  15.46      1.1775      4.03  .    Q    .          .          .          .
  15.73      1.2980      6.71  .       Q .          .          .          .
  16.00      1.4701      8.62  .         .Q         .          .          .
             1.6123     13.78
  16.27      1.7965     20.46  .         .          .      Q   .          .
             1.9244     13.78
Existing Q= 13.78                                   Estimated Storage
Developed Q= 20.46                                  Volume = 13,595 cubic feet

  16.54      2.0861      5.33  .      Q  .          .          .          .
  16.82      2.1814      3.15  .   Q     .          .          .          .
  17.09      2.2440      2.42  .  Q      .          .          .          .
  17.36      2.2933      1.97  . Q       .          .          .          .
  17.63      2.3341      1.66  . Q       .          .          .          .
  17.90      2.3689      1.44  .Q        .          .          .          .
  18.17      2.3992      1.26  .Q        .          .          .          .
  18.44      2.4244      0.98  .Q        .          .          .          .
  18.72      2.4450      0.86  .Q        .          .          .          .
  18.99      2.4636      0.80  .Q        .          .          .          .
  19.26      2.4811      0.76  .Q        .          .          .          .
  19.53      2.4977      0.72  Q         .          .          .          .
  19.80      2.5135      0.69  Q         .          .          .          .
  20.08      2.5287      0.66  Q         .          .          .          .
  20.35      2.5432      0.64  Q         .          .          .          .
  20.62      2.5573      0.61  Q         .          .          .          .
  20.89      2.5708      0.59  Q         .          .          .          .
  21.16      2.5839      0.57  Q         .          .          .          .
  21.43      2.5966      0.56  Q         .          .          .          .
  21.70      2.6089      0.54  Q         .          .          .          .
  21.98      2.6209      0.53  Q         .          .          .          .
  22.25      2.6326      0.51  Q         .          .          .          .
  22.52      2.6440      0.50  Q         .          .          .          .
  22.79      2.6551      0.49  Q         .          .          .          .
  23.06      2.6659      0.48  Q         .          .          .          .
  23.33      2.6765      0.47  Q         .          .          .          .
  23.61      2.6868      0.46  Q         .          .          .          .
  23.88      2.6970      0.45  Q         .          .          .          .
  24.15      2.7069      0.44  Q         .          .          .          .
  24.42      2.7119      0.00  Q         .          .          .          .
 ------------------------------------------------------------------------------
------------------------------------------------------------------------------
    TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
    (Note: 100% of Peak Flow Rate estimate assumed to have
```

an instantaneous time duration)

Percentile of Estimated Peak Flow Rate	Duration (minutes)
0%	1450.7
10%	195.6
20%	65.2
30%	48.9
40%	32.6
50%	16.3
60%	16.3
70%	16.3
80%	16.3
90%	16.3

APPENDIX B
Detention Basin Sizing

Storage Required for The West Grove Site

The West Grove project will utilize a combination of underground pipes:

96-inch diameter (8 feet) perforated storm drain pipe: Area = 50.27 sf Volume: 50.27 cf/ft
72-inch diameter (6 feet) perforated storm drain pipe: Area = 28.27 sf Volume: 28.27 cf/ft
60-inch diameter (5 feet) perforated storm drain pipe: Area = 19.63 sf Volume: 19.63 cf/ft
48-inch diameter (4 feet) perforated storm drain pipe: Area = 12.56 sf Volume: 12.56 cf/ft
36-inch diameter (3 feet) perforated storm drain pipe: Area = 7.07 sf Volume: 7.07cf/ft

See Unit Hydrograph for estimated required detention storage = 13,595 c.f.

Permeability Rate = Average rate = 5.42 in/hr w/ F.S of 2.5 = 2.17 in/hr (Percolation Testing Report November, 2017)

2.17in/hr x 1ft/12in x 1hr/3600sec = 0.00005 cfs/sf

Maximum Discharge Duration: 48 hours

Combination Water Quality and Detention Basin Design

Length of pipe to store Volume: The following tables provides the individual sizing of each underground system by sub-drainage area.

Required Detention Storage Volume: Utilizing the AES Unit Hydrograph Model Flow By Storage Basin the estimated required storage volume is 13,593 c.f. The initial estimated storage volume for each subarea is determined by proportion. Allowable discharge rates and outlet restriction orifices in the catch basin were sized to restrict discharge to the storm drain system to the allowable discharge rate for each subarea. Orifice sizing is based upon the FHWA Chart 2 *Headwater Depth for Pipe Culverts with Inlet Control* and discharge through orifice calculations using weir flow and/or orifice flow depending upon the depth of the water at the entrance. Subarea volumes were determined using the AES Flow Thru Storage Basin Model and prorated for each subarea. See detention basin tables for allowable discharge rates and storage volumes.

DETENTION AND WATER QUALITY VOLUME SUMMARY

Drainage Area DA	Area (s.f.)(1)	Sub-Area Design WQ Vol (c.f.)	Sub-Area Volume to be Detained (c.f.)	Estimated Sub-Area Detention Volume to be Stored(c.f.)
DA-1				
A	51,095	3910	1,774	5,680
B	33,920	2595	1,178	3,773
C	28,832	2206	1,001	3,207
D	66,991	5126	2,326	7,452
E	67,822	5196	2,355	7,551
F	37,963	2905	1,318	4,223
G	27,594	2111	958	3,069
DA-2 A	32,079	2,723	1,114	3,837
B	45,217	3,838	1,570	5,407
Area without Retention	8,735	0	0	0
	400,248	30,604(1)	13,595	44,199

(1) Per Form 4.2-1 of the WQMP

Estimated Detention Basin Sizing

Drainage Area DMA	Peak Flow Rate Q100 (cfs)	Allowable Peak Flow Rate (cfs)	Estimated Sub-Area Detention Volume to be Stored(c.f.)	Underground Pipe Length(ft) (size)
DA-1 A	2.61	1.74	5,680	290'(60")
B	1.73	1.16	3,773	192'(60")
C	1.47	0.98	3,207	164'(60")
D	3.43	2.28	7,452	181'(72")
E	3.47	2.31	7,551	185'(72")
F	1.94	1.29	4,223	215'(60")
G	1.41	0.94	3,069	154'(60")
DA-2 A	1.64	1.09	3,837	196'(60")
B	2.31	1.54	5,407	276'(60")
Area without Retention	0.45	.45		
	20.46	13.78	44,199	

INFILTRATION BASIN PECOLATION RATES

Drainage Area DA	Underground Pipe Length(ft) (size)	Area of Infiltration (s.f.)	Infiltration Flow Rate (cfs)	Water Quality Volume	Discharge Time (hrs)
DA-1 A	290'(60")	1,450	0.051	3910	14.9
B	192'(60")	975	0.034	2595	14.7
C	164'(60")	820	0.029	2206	14.9
D	181'(72")	1,086	0.067	5126	26.1
E	185'(72")	1,110	0.068	5196	25.4
F	215'(60")	1,075	0.038	2905	14.9
G	154'(60")	770	0.028	2111	15.2
DA-2 A	196'(60")	980	0.032	2,723	15.4
B	276'(60")	1,380	0.045	3,838	15.4

APPENDIX C
Rainfall Point Precipitation

11/29/2018

Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: Redlands, California, USA*
Latitude: 34.0715°, Longitude: -117.2203°
Elevation: 1182.75 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

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	0.098 (0.081-0.118)	0.127 (0.105-0.154)	0.166 (0.137-0.202)	0.198 (0.162-0.243)	0.242 (0.192-0.308)	0.277 (0.215-0.359)	0.312 (0.237-0.416)	0.350 (0.258-0.479)	0.401 (0.283-0.574)	0.442 (0.301-0.655)
10-min	0.140 (0.116-0.170)	0.182 (0.151-0.221)	0.237 (0.197-0.289)	0.283 (0.233-0.348)	0.347 (0.275-0.441)	0.396 (0.308-0.515)	0.448 (0.339-0.596)	0.501 (0.369-0.687)	0.575 (0.406-0.823)	0.633 (0.431-0.939)
15-min	0.169 (0.141-0.205)	0.220 (0.183-0.267)	0.287 (0.238-0.350)	0.343 (0.282-0.421)	0.419 (0.333-0.533)	0.479 (0.373-0.623)	0.541 (0.410-0.721)	0.606 (0.446-0.831)	0.695 (0.491-0.995)	0.766 (0.522-1.14)
30-min	0.251 (0.209-0.305)	0.326 (0.271-0.396)	0.426 (0.353-0.519)	0.509 (0.418-0.625)	0.622 (0.494-0.792)	0.712 (0.553-0.925)	0.804 (0.609-1.07)	0.900 (0.663-1.23)	1.03 (0.729-1.48)	1.14 (0.775-1.69)
60-min	0.367 (0.305-0.445)	0.476 (0.396-0.579)	0.622 (0.516-0.758)	0.742 (0.610-0.912)	0.909 (0.722-1.16)	1.04 (0.808-1.35)	1.17 (0.889-1.56)	1.31 (0.967-1.80)	1.51 (1.06-2.16)	1.66 (1.13-2.46)
2-hr	0.525 (0.437-0.637)	0.674 (0.560-0.819)	0.871 (0.722-1.06)	1.03 (0.849-1.27)	1.26 (0.998-1.60)	1.43 (1.11-1.86)	1.61 (1.22-2.14)	1.79 (1.32-2.46)	2.04 (1.44-2.93)	2.24 (1.53-3.32)
3-hr	0.646 (0.537-0.784)	0.826 (0.686-1.00)	1.06 (0.881-1.30)	1.26 (1.03-1.55)	1.53 (1.21-1.94)	1.73 (1.35-2.25)	1.95 (1.48-2.59)	2.17 (1.60-2.97)	2.47 (1.74-3.53)	2.70 (1.84-4.00)
6-hr	0.905 (0.753-1.10)	1.15 (0.959-1.40)	1.48 (1.23-1.81)	1.75 (1.44-2.15)	2.12 (1.68-2.69)	2.40 (1.86-3.12)	2.69 (2.04-3.58)	2.98 (2.20-4.09)	3.39 (2.39-4.85)	3.70 (2.52-5.49)
12-hr	1.20 (1.00-1.46)	1.54 (1.28-1.87)	1.98 (1.64-2.41)	2.34 (1.92-2.87)	2.83 (2.25-3.59)	3.20 (2.49-4.16)	3.58 (2.71-4.77)	3.97 (2.93-5.45)	4.50 (3.18-6.44)	4.91 (3.35-7.28)
24-hr	1.61 (1.42-1.85)	2.08 (1.84-2.39)	2.69 (2.37-3.11)	3.19 (2.79-3.72)	3.86 (3.27-4.65)	4.37 (3.63-5.38)	4.89 (3.96-6.16)	5.43 (4.28-7.03)	6.15 (4.65-8.29)	6.70 (4.90-9.35)
2-day	1.97 (1.75-2.28)	2.59 (2.29-2.99)	3.40 (3.00-3.93)	4.06 (3.55-4.73)	4.96 (4.20-5.97)	5.65 (4.69-6.95)	6.35 (5.15-8.00)	7.08 (5.58-9.17)	8.07 (6.11-10.9)	8.84 (6.46-12.3)
3-day	2.13 (1.89-2.46)	2.83 (2.51-3.27)	3.77 (3.32-4.36)	4.54 (3.97-5.29)	5.59 (4.74-6.74)	6.42 (5.33-7.89)	7.26 (5.88-9.15)	8.14 (6.42-10.5)	9.35 (7.08-12.6)	10.3 (7.54-14.4)
4-day	2.29 (2.02-2.63)	3.07 (2.71-3.54)	4.11 (3.62-4.75)	4.97 (4.35-5.80)	6.17 (5.23-7.43)	7.11 (5.90-8.74)	8.08 (6.54-10.2)	9.09 (7.17-11.8)	10.5 (7.94-14.1)	11.6 (8.49-16.2)
7-day	2.64 (2.34-3.04)	3.58 (3.17-4.13)	4.85 (4.27-5.61)	5.90 (5.16-6.88)	7.36 (6.23-8.86)	8.51 (7.06-10.5)	9.69 (7.85-12.2)	10.9 (8.62-14.2)	12.7 (9.58-17.1)	14.0 (10.3-19.6)
10-day	2.86 (2.53-3.29)	3.91 (3.46-4.51)	5.32 (4.69-6.16)	6.50 (5.69-7.58)	8.14 (6.89-9.81)	9.43 (7.82-11.6)	10.8 (8.72-13.6)	12.2 (9.59-15.8)	14.1 (10.7-19.0)	15.7 (11.5-21.9)
20-day	3.52 (3.12-4.06)	4.87 (4.30-5.62)	6.69 (5.90-7.73)	8.21 (7.18-9.57)	10.3 (8.76-12.5)	12.0 (9.98-14.8)	13.8 (11.2-17.4)	15.6 (12.3-20.3)	18.2 (13.8-24.6)	20.3 (14.9-28.3)
30-day	4.15 (3.67-4.78)	5.74 (5.08-6.62)	7.90 (6.97-9.14)	9.72 (8.50-11.3)	12.3 (10.4-14.8)	14.3 (11.9-17.6)	16.4 (13.3-20.7)	18.7 (14.7-24.2)	21.8 (16.5-29.4)	24.3 (17.8-33.9)
45-day	4.98 (4.41-5.74)	6.85 (6.06-7.91)	9.40 (8.30-10.9)	11.6 (10.1-13.5)	14.6 (12.4-17.6)	17.0 (14.1-20.9)	19.6 (15.9-24.6)	22.3 (17.6-28.8)	26.1 (19.7-35.1)	29.1 (21.3-40.6)
60-day	5.84 (5.17-6.73)	7.97 (7.05-9.19)	10.9 (9.60-12.6)	13.3 (11.7-15.6)	16.8 (14.2-20.3)	19.6 (16.3-24.1)	22.5 (18.2-28.4)	25.6 (20.2-33.2)	30.0 (22.7-40.4)	33.5 (24.5-46.7)

[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.

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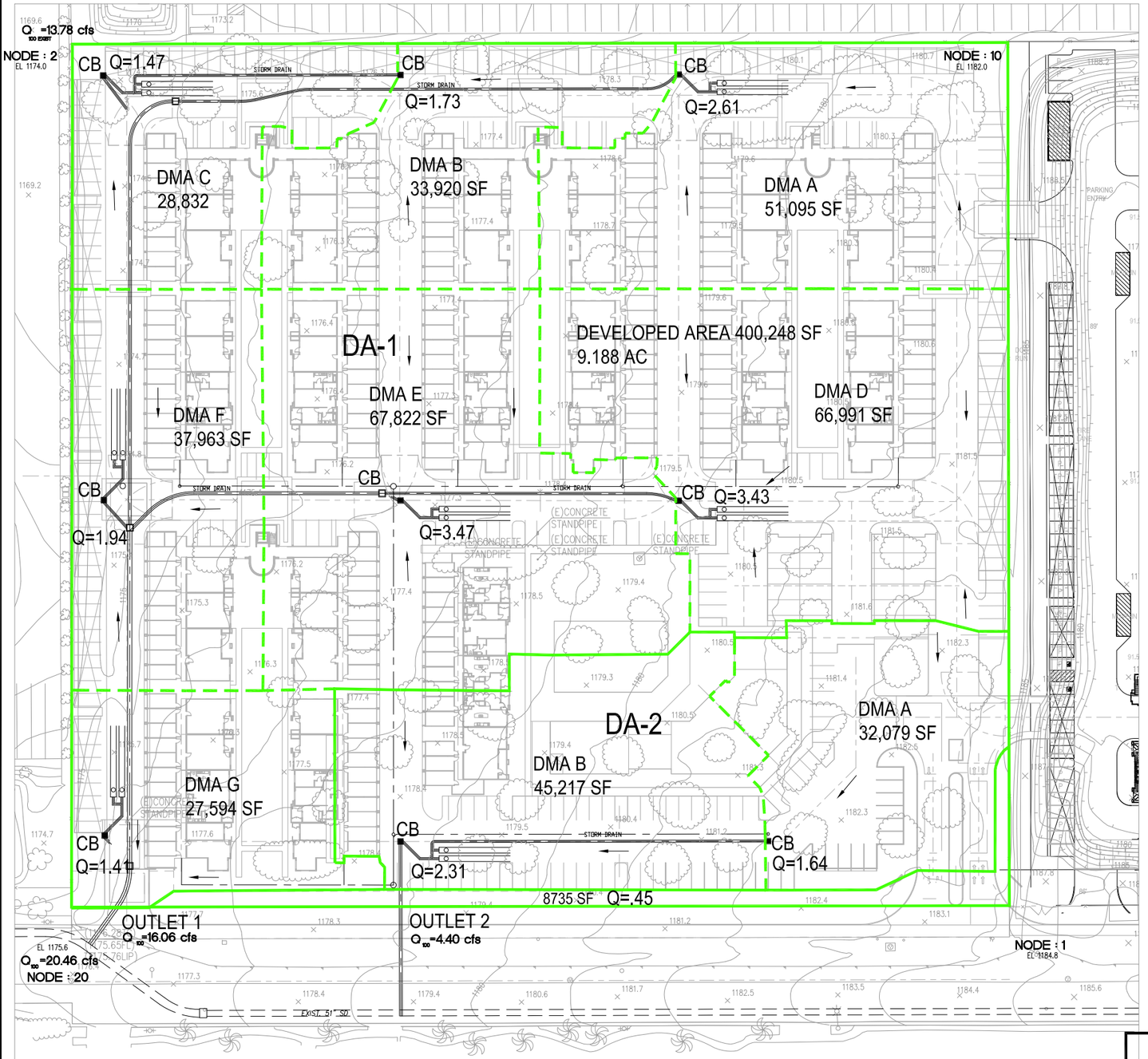
IN THE COUNTY OF SAN BERNARDINO,
STATE OF CALIFORNIA

WEST GROVE - PRELIMINARY HYDROLOGY MAP



SUB-AREA FLOW RATES:

SUB-AREA	AREA (SF)	FLOW RATE (CFS)
DA-1		
A	51,095	2.61
B	33,920	1.73
C	28,832	1.47
D	66,991	3.43
E	67,822	3.47
F	37,963	1.94
G	24,594	1.41
DA-2		
A	32,079	1.64
B	45,217	2.31
C	8,735	0.45
TOTALS	400,248	20.46

LEGEND:

SUB-AREA BOUNDARY

100 YEAR PEAK FLOW RATE FROM SUB-BAREA — 24.0 CFS

NORTH
SCALE: 1"= 40'

40' 0' 40' 80' 120'
GRAPHIC SCALE: 1" = 40'

OWNER / APPLICANT:
WEST GROVE 9.5, INC.
74-478 HIGHWAY 111, NO. 378
PALM DESERT, CA 92260
(909) 831-6130

ENGINEER / SURVEYOR:
TRANSTECH
413 MACKAY DRIVE
SAN BERNARDINO, CA 92408
(909) 384-7464

ASSESSOR'S PARCEL NUMBER:
0292-053-08

REVISIONS		
DATE	NOTES	APP.

REGISTERED PROFESSIONAL ENGINEER
DAVID B. RAGLAND
REG. NO. 35985
EXP. 6/30/20
CIVIL
STATE OF CALIFORNIA

DAVID B. RAGLAND R.C.E. 35985
EXPIRATION DATE: JUNE 30, 2020
DATE

TRANSTECH
413 MACKAY DRIVE
SAN BERNARDINO, CA 92408
(909) 384-7464

COUNTY OF SAN BERNARDINO

THE REDLANDS
PRELIMINARY HYDROLOGY MAP

DRAWN BY:	DATE:	SCALE:	SHEET:	JOB NO.
G.D.A..	11/29/2018	1"= 40'	1 OF 1	18702