Hydrology & Hydraulics Preliminary Report

City of Redlands
County of San Bernardino

Prepared: November 2019 (Preliminary Report)
Revised: -

FOR:
Diversified Pacific Communities
Tract 20305

Prepared For:
Diversified Pacific Communities
Nolan Leggio, Director of Forward Planning
10621 Civic Center Drive
Rancho Cucamonga, CA 91730
909-373-2628

Prepared by:
Hicks & Hartwick, Inc.
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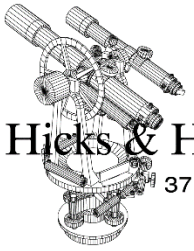
Redlands, CA 92373
909-793-2257



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Preliminary Report
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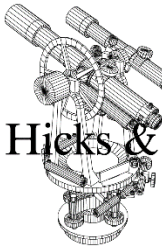
Dated: November 17, 2019



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City of Redlands
Diversified Pacific Communities

Tract No. 20305

Hydrology & Hydraulics
Preliminary Report

GENERAL

The subject property of this report is an approximately 9.4 acre parcel of land bounded on the northwest by West Palm Avenue, on the southwest by Alvarado Street, and on the southeast and northeast by existing single family development. The parcel is an old orange grove with two existing single family dwellings.

The area generally drains to the northwest; however, there are channels as part of the groves that generally divert the runoff southwest to Alvarado Street. There is offsite run-on from residential development on South Eureka Street, between the site and Walnut Avenue.

This report covers the drainage conditions including the existing conditions and with the proposed development. The watershed runoff rates are determined using San Bernardino County standards and computer calculations. Rational Method Hydrology Computer Program Package, developed by Advanced Engineering Software (AES), is used to calculate the storm runoff rates.

The hydrologic soil type, ground cover and development type are user specified. Rational Hydrology analysis was performed for the theoretical 2-year, 10-year and 100-year storm events. The detailed summary computer output for each analysis is attached as Exhibits. Maps are provided, illustrating the layout for, and as referenced by, the computer models.

EXISTING CONDITIONS

This drainage study includes runoff analysis of only the onsite areas that drain to West Palm Avenue on the northwest and Alvarado Street on the southwest, plus the run-on from South Eureka Street. The two street flow paths converge at the intersection of West Palm Avenue and Alvarado Street.

The existing onsite watershed is primarily orange groves. There are two existing single family dwellings onsite that will remain. The South Eureka Street run-on is approximately 1.73 ac.

The offsite flow running through West Palm Avenue and Alvarado Street is not calculated as beyond the scope of this report. The onsite flow running through West Palm Avenue and Alvarado Street is calculated without regard to the offsite flows so that a before and after comparison of site runoff can be performed.

The existing hydrology is calculated based on the existing coverage as illustrated on the accompanying map. The calculated 2-year, 10-year and 100-year runoff for the existing conditions is attached hereto. The existing conditions reference map is also attached.

PROPOSED CONDITIONS

The development proposed in conjunction with this study is a single family residential subdivision of 30 lots on a little more than 6 of the 9.4 ac. The remainder of the site will remain unchanged with the exception of an about 0.4 ac. public park at the intersection of West Palm Avenue and Alvarado Street. The existing flow patterns will have only minor changes.

The proposed development includes a minor onsite storm drain, which will convey the South Eureka Street run-on to Alvarado Street.

The proposed development, as described above, is shown on the proposed conditions map. The calculated 2-year, 10-year and 100-year runoff for the proposed conditions is attached hereto. The proposed conditions reference maps are also attached.

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Preliminary Report

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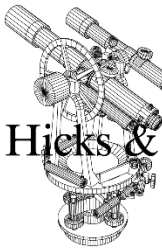
EXISTING HYDROLOGY
2-YEAR RUNOFF



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```
**************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2015 Advanced Engineering Software (aes)
             Ver. 22.0  Release Date: 07/01/2015  License ID 1302

                              Analysis prepared by:

                                  Hicks & Hartwick, Inc.
                              37 East Olive Avenue, Suite C
                                    Redlands, CA 92373
                                     (909) 793-2257

--------------------------------------------------------------------------
  FILE NAME: 0034HEA2.DAT
  TIME/DATE OF STUDY: 09:42 11/07/2019
==========================================================================
  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 = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6500
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.4730

  *ANTECEDENT MOISTURE CONDITION (AMC) II 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
  2   18.0      5.5    0.015/0.026/0.021   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  1.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint = 10.0 (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) =   379.00
  ELEVATION DATA: UPSTREAM(FEET) =   1536.00  DOWNSTREAM(FEET) =   1521.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
```

```
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.450
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.691
 SUBAREA Tc AND LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"       B        1.73      0.75     0.600    56    8.45
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
 SUBAREA RUNOFF(CFS) =      1.93
 TOTAL AREA(ACRES) =      1.73   PEAK FLOW RATE(CFS) =      1.93

****************************************************************************
 FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  52
----------------------------------------------------------------------------
 >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1521.00  DOWNSTREAM(FEET) =   1513.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   478.00   CHANNEL SLOPE =  0.0167
 CHANNEL FLOW THRU SUBAREA(CFS) =       1.93
 FLOW VELOCITY(FEET/SEC) =   2.21 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =   3.60   Tc(MIN.) =   12.05
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     857.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      3.00 TO NODE      3.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =   12.05
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.343
 SUBAREA LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 AGRICULTURAL POOR COVER
 "ORCHARDS"                 B        0.34      0.50     1.000    73
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"       B        0.07      0.75     0.600    56
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.53
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.932
 SUBAREA AREA(ACRES) =    0.41      SUBAREA RUNOFF(CFS) =    0.31
 EFFECTIVE AREA(ACRES) =      2.14   AREA-AVERAGED Fm(INCH/HR) =  0.46
 AREA-AVERAGED Fp(INCH/HR) =  0.69  AREA-AVERAGED Ap =  0.66
 TOTAL AREA(ACRES) =        2.1       PEAK FLOW RATE(CFS) =       1.93
 NOTE: PEAK FLOW RATE DEFAULTED TO UPSTREAM VALUE

****************************************************************************
 FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) = 1513.00  DOWNSTREAM ELEVATION(FEET) = 1491.00
 STREET LENGTH(FEET) =   601.00   CURB HEIGHT(INCHES) =  8.0
 STREET HALFWIDTH(FEET) = 18.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
```

```
  INSIDE STREET CROSSFALL(DECIMAL) =  0.015
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.75
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.33
    HALFSTREET FLOOD WIDTH(FEET) =    7.23
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.42
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.47
  STREET FLOW TRAVEL TIME(MIN.) =   2.27   Tc(MIN.) =   14.32
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.200
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  AGRICULTURAL POOR COVER
  "ORCHARDS"                 B        5.39      0.50     1.000    73
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        0.33      0.75     0.600    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.51
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.977
  SUBAREA AREA(ACRES) =    5.72      SUBAREA RUNOFF(CFS) =    3.61
  EFFECTIVE AREA(ACRES) =      7.86    AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap =  0.89
  TOTAL AREA(ACRES) =        7.9        PEAK FLOW RATE(CFS) =       5.04

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.36   HALFSTREET FLOOD WIDTH(FEET) =   8.38
  FLOW VELOCITY(FEET/SEC.) =  4.67   DEPTH*VELOCITY(FT*FT/SEC.) =   1.69
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      4.00 =    1458.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      4.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =   14.32
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.200
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  AGRICULTURAL POOR COVER
  "ORCHARDS"                 B        2.28      0.50     1.000    73
  RESIDENTIAL
  "1 DWELLING/ACRE"          B        1.09      0.75     0.800    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.57
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.935
  SUBAREA AREA(ACRES) =    3.37      SUBAREA RUNOFF(CFS) =    2.02
  EFFECTIVE AREA(ACRES) =     11.23   AREA-AVERAGED Fm(INCH/HR) =  0.50
  AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap =  0.90
  TOTAL AREA(ACRES) =       11.2       PEAK FLOW RATE(CFS) =       7.06
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       11.2  TC(MIN.) =     14.32
```

```
  EFFECTIVE AREA(ACRES) =     11.23  AREA-AVERAGED Fm(INCH/HR)=  0.50
  AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap = 0.905
  PEAK FLOW RATE(CFS)   =       7.06
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

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Preliminary Report

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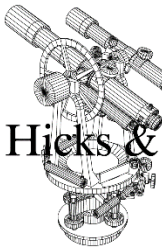
County of San Bernardino

EXISTING HYDROLOGY
10-YEAR RUNOFF



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                              Analysis prepared by:

                                  Hicks & Hartwick, Inc.
                              37 East Olive Avenue, Suite C
                                    Redlands, CA 92373
                                     (909) 793-2257

--------------------------------------------------------------------------
  FILE NAME: 0034HEAT.DAT
  TIME/DATE OF STUDY: 09:41 11/07/2019
==========================================================================
  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 = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6500
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.7300

  *ANTECEDENT MOISTURE CONDITION (AMC) II 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
  2   18.0      5.5    0.015/0.026/0.021   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  1.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint = 10.0 (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) =   379.00
  ELEVATION DATA: UPSTREAM(FEET) =   1536.00  DOWNSTREAM(FEET) =   1521.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
```

```
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.450
 *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.610
 SUBAREA Tc AND LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"       B        1.73      0.75     0.600    56    8.45
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
 SUBAREA RUNOFF(CFS) =      3.37
 TOTAL AREA(ACRES) =      1.73   PEAK FLOW RATE(CFS) =      3.37

****************************************************************************
 FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  52
----------------------------------------------------------------------------
 >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1521.00  DOWNSTREAM(FEET) =   1513.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   478.00   CHANNEL SLOPE =  0.0167
 CHANNEL FLOW THRU SUBAREA(CFS) =       3.37
 FLOW VELOCITY(FEET/SEC) =   2.49 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =   3.20   Tc(MIN.) =   11.65
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     857.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      3.00 TO NODE      3.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =   11.65
 *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.119
 SUBAREA LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 AGRICULTURAL POOR COVER
 "ORCHARDS"                 B        0.34      0.50     1.000    73
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"       B        0.07      0.75     0.600    56
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.53
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.932
 SUBAREA AREA(ACRES) =    0.41      SUBAREA RUNOFF(CFS) =    0.60
 EFFECTIVE AREA(ACRES) =      2.14   AREA-AVERAGED Fm(INCH/HR) =  0.46
 AREA-AVERAGED Fp(INCH/HR) =  0.69  AREA-AVERAGED Ap =  0.66
 TOTAL AREA(ACRES) =        2.1       PEAK FLOW RATE(CFS) =       3.37
 NOTE: PEAK FLOW RATE DEFAULTED TO UPSTREAM VALUE

****************************************************************************
 FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) = 1513.00  DOWNSTREAM ELEVATION(FEET) = 1491.00
 STREET LENGTH(FEET) =   601.00   CURB HEIGHT(INCHES) =  8.0
 STREET HALFWIDTH(FEET) = 18.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
```

```
  INSIDE STREET CROSSFALL(DECIMAL) =  0.015
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       7.02
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.40
    HALFSTREET FLOOD WIDTH(FEET) =    9.73
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.03
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.00
  STREET FLOW TRAVEL TIME(MIN.) =   1.99   Tc(MIN.) =   13.64
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.912
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  AGRICULTURAL POOR COVER
  "ORCHARDS"                 B        5.39      0.50     1.000    73
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        0.33      0.75     0.600    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.51
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.977
  SUBAREA AREA(ACRES) =    5.72      SUBAREA RUNOFF(CFS) =    7.28
  EFFECTIVE AREA(ACRES) =      7.86    AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap =  0.89
  TOTAL AREA(ACRES) =        7.9        PEAK FLOW RATE(CFS) =      10.08

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.44   HALFSTREET FLOOD WIDTH(FEET) =  11.37
  FLOW VELOCITY(FEET/SEC.) =  5.48   DEPTH*VELOCITY(FT*FT/SEC.) =   2.41
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      4.00 =    1458.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      4.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =   13.64
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.912
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  AGRICULTURAL POOR COVER
  "ORCHARDS"                 B        2.28      0.50     1.000    73
  RESIDENTIAL
  "1 DWELLING/ACRE"          B        1.09      0.75     0.800    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.57
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.935
  SUBAREA AREA(ACRES) =    3.37      SUBAREA RUNOFF(CFS) =    4.18
  EFFECTIVE AREA(ACRES) =     11.23   AREA-AVERAGED Fm(INCH/HR) =  0.50
  AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap =  0.90
  TOTAL AREA(ACRES) =       11.2       PEAK FLOW RATE(CFS) =      14.26
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       11.2  TC(MIN.) =     13.64
```

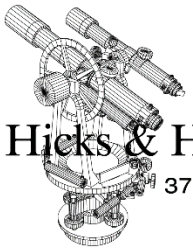
```
  EFFECTIVE AREA(ACRES) =     11.23  AREA-AVERAGED Fm(INCH/HR)=  0.50
  AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap = 0.905
  PEAK FLOW RATE(CFS)   =      14.26
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

Hydrology & Hydraulics
Preliminary Report

City of Redlands

County of San Bernardino

EXISTING HYDROLOGY
100-YEAR RUNOFF



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```
**************************************************************************
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                          Analysis prepared by:

                              Hicks & Hartwick, Inc.
                          37 East Olive Avenue, Suite C
                                Redlands, CA 92373
                                  (909) 793-2257

--------------------------------------------------------------------------
  FILE NAME: 0034HEAH.DAT
  TIME/DATE OF STUDY: 09:44 11/07/2019
==========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==========================================================================
                     --*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 = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6500
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 1.1500

  *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
  2   18.0      5.5    0.015/0.026/0.021   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  1.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint = 10.0 (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) =   379.00
  ELEVATION DATA: UPSTREAM(FEET) =   1536.00  DOWNSTREAM(FEET) =   1521.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
```

```
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.450
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.112
 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.)
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"       B        1.73      0.42      0.600    76    8.45
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
 SUBAREA RUNOFF(CFS) =      6.01
 TOTAL AREA(ACRES) =      1.73   PEAK FLOW RATE(CFS) =      6.01

****************************************************************************
 FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  52
----------------------------------------------------------------------------
 >>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   1521.00  DOWNSTREAM(FEET) =   1513.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   478.00   CHANNEL SLOPE =  0.0167
 CHANNEL FLOW THRU SUBAREA(CFS) =       6.01
 FLOW VELOCITY(FEET/SEC) =   2.85 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)
 TRAVEL TIME(MIN.) =   2.79   Tc(MIN.) =   11.24
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     857.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      3.00 TO NODE      3.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =   11.24
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.415
 SUBAREA LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 AGRICULTURAL POOR COVER
 "ORCHARDS"                 B        0.34      0.23      1.000    89
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"       B        0.07      0.42      0.600    76
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.25
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.932
 SUBAREA AREA(ACRES) =    0.41      SUBAREA RUNOFF(CFS) =    1.17
 EFFECTIVE AREA(ACRES) =      2.14   AREA-AVERAGED Fm(INCH/HR) =  0.25
 AREA-AVERAGED Fp(INCH/HR) =  0.38  AREA-AVERAGED Ap =  0.66
 TOTAL AREA(ACRES) =        2.1       PEAK FLOW RATE(CFS) =       6.10

****************************************************************************
 FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) = 1513.00  DOWNSTREAM ELEVATION(FEET) = 1491.00
 STREET LENGTH(FEET) =   601.00   CURB HEIGHT(INCHES) =  8.0
 STREET HALFWIDTH(FEET) = 18.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
 INSIDE STREET CROSSFALL(DECIMAL) =  0.015
```

```
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      13.51
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.48
    HALFSTREET FLOOD WIDTH(FEET) =   13.23
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.81
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.78
  STREET FLOW TRAVEL TIME(MIN.) =   1.72   Tc(MIN.) =   12.97
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.112
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  AGRICULTURAL POOR COVER
  "ORCHARDS"                 B        5.39      0.23     1.000    89
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        0.33      0.42     0.600    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.24
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.977
  SUBAREA AREA(ACRES) =    5.72      SUBAREA RUNOFF(CFS) =   14.83
  EFFECTIVE AREA(ACRES) =      7.86    AREA-AVERAGED Fm(INCH/HR) =  0.24
  AREA-AVERAGED Fp(INCH/HR) =  0.27  AREA-AVERAGED Ap =  0.89
  TOTAL AREA(ACRES) =        7.9        PEAK FLOW RATE(CFS) =      20.34

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.54   HALFSTREET FLOOD WIDTH(FEET) =  17.53
  FLOW VELOCITY(FEET/SEC.) =  6.13   DEPTH*VELOCITY(FT*FT/SEC.) =   3.33
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      4.00 =    1458.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      4.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =   12.97
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.112
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  AGRICULTURAL POOR COVER
  "ORCHARDS"                 B        2.28      0.23     1.000    89
  RESIDENTIAL
  "1 DWELLING/ACRE"          B        1.09      0.42     0.800    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.28
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.935
  SUBAREA AREA(ACRES) =    3.37      SUBAREA RUNOFF(CFS) =    8.64
  EFFECTIVE AREA(ACRES) =     11.23   AREA-AVERAGED Fm(INCH/HR) =  0.25
  AREA-AVERAGED Fp(INCH/HR) =  0.27  AREA-AVERAGED Ap =  0.90
  TOTAL AREA(ACRES) =       11.2       PEAK FLOW RATE(CFS) =      28.98
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       11.2  TC(MIN.) =     12.97
  EFFECTIVE AREA(ACRES) =     11.23  AREA-AVERAGED Fm(INCH/HR)=  0.25
```

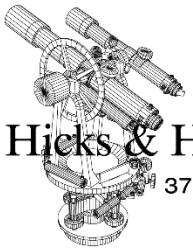
```
  AREA-AVERAGED Fp(INCH/HR) =  0.27  AREA-AVERAGED Ap = 0.905
  PEAK FLOW RATE(CFS)   =      28.98
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

Hydrology & Hydraulics
Preliminary Report

City of Redlands

County of San Bernardino

PROPOSED HYDROLOGY
2-YEAR RUNOFF



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```
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                          Analysis prepared by:

                              Hicks & Hartwick, Inc.
                         37 East Olive Avenue, Suite C
                               Redlands, CA 92373
                                 (909) 793-2257

--------------------------------------------------------------------------
  FILE NAME: 0034HPA2.DAT
  TIME/DATE OF STUDY: 09:48 11/07/2019
==========================================================================
  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 = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6500
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.4730

  *ANTECEDENT MOISTURE CONDITION (AMC) II 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
  2   18.0      5.5    0.015/0.026/0.021   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  1.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint = 10.0 (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) =   392.00
  ELEVATION DATA: UPSTREAM(FEET) =   1536.00  DOWNSTREAM(FEET) =   1520.90

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
```

```
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.611
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.671
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        1.73      0.75     0.600    56    8.61
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA RUNOFF(CFS) =      1.90
  TOTAL AREA(ACRES) =      1.73   PEAK FLOW RATE(CFS) =      1.90

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      5.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  1517.50  DOWNSTREAM(FEET) =  1505.00
  FLOW LENGTH(FEET) =   670.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   4.5 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.43
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       1.90
  PIPE TRAVEL TIME(MIN.) =   2.05    Tc(MIN.) =   10.67
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      5.00 =    1062.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   10.67
  RAINFALL INTENSITY(INCH/HR) =   1.45
  AREA-AVERAGED Fm(INCH/HR) =  0.45
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.60
  EFFECTIVE STREAM AREA(ACRES) =       1.73
  TOTAL STREAM AREA(ACRES) =       1.73
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       1.90

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   744.00
  ELEVATION DATA: UPSTREAM(FEET) =   1520.50  DOWNSTREAM(FEET) =   1507.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.935
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.282
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
```

```
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        3.19      0.75     0.600    56   12.94
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA RUNOFF(CFS) =      2.39
  TOTAL AREA(ACRES) =      3.19   PEAK FLOW RATE(CFS) =      2.39

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1507.00  DOWNSTREAM ELEVATION(FEET) = 1505.00
  STREET LENGTH(FEET) =    70.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
  INSIDE STREET CROSSFALL(DECIMAL) =  0.015
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.41
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.30
    HALFSTREET FLOOD WIDTH(FEET) =    6.12
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.65
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.11
  STREET FLOW TRAVEL TIME(MIN.) =   0.32   Tc(MIN.) =   13.25
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.262
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        0.04      0.75     0.400    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA AREA(ACRES) =    0.04      SUBAREA RUNOFF(CFS) =    0.03
  EFFECTIVE AREA(ACRES) =      3.23    AREA-AVERAGED Fm(INCH/HR) =  0.45
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.60
  TOTAL AREA(ACRES) =        3.2        PEAK FLOW RATE(CFS) =       2.39
  NOTE: PEAK FLOW RATE DEFAULTED TO UPSTREAM VALUE

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   6.08
  FLOW VELOCITY(FEET/SEC.) =  3.66   DEPTH*VELOCITY(FT*FT/SEC.) =   1.11
  LONGEST FLOWPATH FROM NODE      3.00 TO NODE      5.00 =     814.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
```

```
==============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.25
  RAINFALL INTENSITY(INCH/HR) =   1.26
  AREA-AVERAGED Fm(INCH/HR) =  0.45
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.60
  EFFECTIVE STREAM AREA(ACRES) =       3.23
  TOTAL STREAM AREA(ACRES) =       3.23
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       2.39

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        1.90   10.67    1.454  0.75( 0.45) 0.60       1.7       1.00
      2        2.39   13.25    1.262  0.75( 0.45) 0.60       3.2       3.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        4.28   10.67    1.454  0.75( 0.45) 0.60       4.3       1.00
      2        3.93   13.25    1.262  0.75( 0.45) 0.60       5.0       3.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       4.28    Tc(MIN.) =    10.67
  EFFECTIVE AREA(ACRES) =       4.33   AREA-AVERAGED Fm(INCH/HR) =  0.45
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.60
  TOTAL AREA(ACRES) =        5.0
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      5.00 =    1062.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      8.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
==============================================================================
  UPSTREAM ELEVATION(FEET) = 1505.00  DOWNSTREAM ELEVATION(FEET) = 1491.00
  STREET LENGTH(FEET) =   408.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
  INSIDE STREET CROSSFALL(DECIMAL) =  0.015
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       4.95
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.36
    HALFSTREET FLOOD WIDTH(FEET) =    8.42
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.55
```

```
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.65
 STREET FLOW TRAVEL TIME(MIN.) =   1.50   Tc(MIN.) =   12.16
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.335
 SUBAREA LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 AGRICULTURAL POOR COVER
 "ORCHARDS"                B        1.15      0.50     1.000    73
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"      B        0.27      0.75     0.600    56
 PUBLIC PARK               B        0.42      0.75     0.850    56
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.58
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.907
 SUBAREA AREA(ACRES) =    1.84      SUBAREA RUNOFF(CFS) =    1.34
 EFFECTIVE AREA(ACRES) =      6.17    AREA-AVERAGED Fm(INCH/HR) =  0.47
 AREA-AVERAGED Fp(INCH/HR) =  0.68  AREA-AVERAGED Ap =  0.69
 TOTAL AREA(ACRES) =        6.8        PEAK FLOW RATE(CFS) =       4.80

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.36   HALFSTREET FLOOD WIDTH(FEET) =   8.30
 FLOW VELOCITY(FEET/SEC.) =  4.52   DEPTH*VELOCITY(FT*FT/SEC.) =   1.63
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      8.00 =    1470.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      8.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
 TIME OF CONCENTRATION(MIN.) =   12.16
 RAINFALL INTENSITY(INCH/HR) =   1.33
 AREA-AVERAGED Fm(INCH/HR) =  0.47
 AREA-AVERAGED Fp(INCH/HR) =  0.68
 AREA-AVERAGED Ap =  0.69
 EFFECTIVE STREAM AREA(ACRES) =       6.17
 TOTAL STREAM AREA(ACRES) =       6.80
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       4.80

****************************************************************************
 FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   679.00
 ELEVATION DATA: UPSTREAM(FEET) =   1519.00  DOWNSTREAM(FEET) =   1496.20

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.026
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.423
 SUBAREA Tc AND LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"      B        2.98      0.75     0.600    56   11.03
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
```

```
 SUBAREA RUNOFF(CFS) =      2.61
 TOTAL AREA(ACRES) =      2.98   PEAK FLOW RATE(CFS) =      2.61

****************************************************************************
 FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) = 1496.20  DOWNSTREAM ELEVATION(FEET) = 1491.00
 STREET LENGTH(FEET) =   466.00   CURB HEIGHT(INCHES) =  8.0
 STREET HALFWIDTH(FEET) = 18.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
 INSIDE STREET CROSSFALL(DECIMAL) =  0.015
 OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
 STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
 Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
 Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

   **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.03
   STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
   STREET FLOW DEPTH(FEET) =  0.37
   HALFSTREET FLOOD WIDTH(FEET) =    8.71
   AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.63
   PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.97
 STREET FLOW TRAVEL TIME(MIN.) =   2.95   Tc(MIN.) =   13.98
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.219
 SUBAREA LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 AGRICULTURAL POOR COVER
 "ORCHARDS"                  B        0.33      0.50     1.000    73
 RESIDENTIAL
 "1 DWELLING/ACRE"           B        1.11      0.75     0.800    56
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.68
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.846
 SUBAREA AREA(ACRES) =    1.44      SUBAREA RUNOFF(CFS) =    0.83
 EFFECTIVE AREA(ACRES) =      4.42    AREA-AVERAGED Fm(INCH/HR) =  0.49
 AREA-AVERAGED Fp(INCH/HR) =  0.72  AREA-AVERAGED Ap =  0.68
 TOTAL AREA(ACRES) =        4.4        PEAK FLOW RATE(CFS) =       2.90

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.37   HALFSTREET FLOOD WIDTH(FEET) =   8.54
 FLOW VELOCITY(FEET/SEC.) =  2.60   DEPTH*VELOCITY(FT*FT/SEC.) =   0.95
 LONGEST FLOWPATH FROM NODE      6.00 TO NODE      8.00 =    1145.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      8.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
 TIME OF CONCENTRATION(MIN.) =   13.98
```

```
 RAINFALL INTENSITY(INCH/HR) =   1.22
 AREA-AVERAGED Fm(INCH/HR) =  0.49
 AREA-AVERAGED Fp(INCH/HR) =  0.72
 AREA-AVERAGED Ap =  0.68
 EFFECTIVE STREAM AREA(ACRES) =       4.42
 TOTAL STREAM AREA(ACRES) =       4.42
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       2.90

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
     1        4.80   12.16    1.335  0.68( 0.47) 0.69       6.2       1.00
     1        4.33   14.78    1.176  0.69( 0.47) 0.68       6.8       3.00
     2        2.90   13.98    1.219  0.72( 0.49) 0.68       4.4       6.00

 RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
 CONFLUENCE FORMULA USED FOR  2 STREAMS.

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
     1        7.70   12.16    1.335  0.70( 0.48) 0.69      10.0       1.00
     2        7.37   13.98    1.219  0.70( 0.48) 0.68      11.0       6.00
     3        7.06   14.78    1.176  0.70( 0.48) 0.68      11.2       3.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =       7.70    Tc(MIN.) =    12.16
 EFFECTIVE AREA(ACRES) =      10.01   AREA-AVERAGED Fm(INCH/HR) =  0.48
 AREA-AVERAGED Fp(INCH/HR) =  0.70  AREA-AVERAGED Ap =  0.69
 TOTAL AREA(ACRES) =       11.2
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      8.00 =    1470.00 FEET.
============================================================================
 END OF STUDY SUMMARY:
 TOTAL AREA(ACRES)     =       11.2  TC(MIN.) =     12.16
 EFFECTIVE AREA(ACRES) =     10.01  AREA-AVERAGED Fm(INCH/HR)=  0.48
 AREA-AVERAGED Fp(INCH/HR) =  0.70  AREA-AVERAGED Ap = 0.687
 PEAK FLOW RATE(CFS)   =       7.70

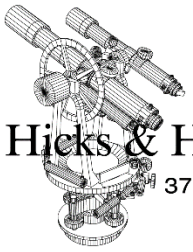
 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
     1        7.70   12.16    1.335  0.70( 0.48) 0.69      10.0       1.00
     2        7.37   13.98    1.219  0.70( 0.48) 0.68      11.0       6.00
     3        7.06   14.78    1.176  0.70( 0.48) 0.68      11.2       3.00
============================================================================
============================================================================
 END OF RATIONAL METHOD ANALYSIS
```

Hydrology & Hydraulics
Preliminary Report

City of Redlands

County of San Bernardino

PROPOSED HYDROLOGY
10-YEAR RUNOFF



Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

```
**************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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             Ver. 22.0  Release Date: 07/01/2015  License ID 1302

                          Analysis prepared by:

                              Hicks & Hartwick, Inc.
                          37 East Olive Avenue, Suite C
                                Redlands, CA 92373
                                  (909) 793-2257

--------------------------------------------------------------------------
  FILE NAME: 0034HPAT.DAT
  TIME/DATE OF STUDY: 09:47 11/07/2019
==========================================================================
  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 = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6500
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.7300

  *ANTECEDENT MOISTURE CONDITION (AMC) II 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
  2   18.0      5.5    0.015/0.026/0.021   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  1.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint = 10.0 (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) =   392.00
  ELEVATION DATA: UPSTREAM(FEET) =   1536.00  DOWNSTREAM(FEET) =   1520.90

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
```

```
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.611
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.578
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        1.73      0.75     0.600    56    8.61
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA RUNOFF(CFS) =      3.32
  TOTAL AREA(ACRES) =      1.73   PEAK FLOW RATE(CFS) =      3.32

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      5.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  1517.50  DOWNSTREAM(FEET) =  1505.00
  FLOW LENGTH(FEET) =   670.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   6.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.35
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       3.32
  PIPE TRAVEL TIME(MIN.) =   1.76    Tc(MIN.) =   10.37
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      5.00 =    1062.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   10.37
  RAINFALL INTENSITY(INCH/HR) =   2.29
  AREA-AVERAGED Fm(INCH/HR) =  0.45
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.60
  EFFECTIVE STREAM AREA(ACRES) =       1.73
  TOTAL STREAM AREA(ACRES) =       1.73
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       3.32

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   744.00
  ELEVATION DATA: UPSTREAM(FEET) =   1520.50  DOWNSTREAM(FEET) =   1507.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.935
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.979
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
```

```
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        3.19      0.75     0.600    56   12.94
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA RUNOFF(CFS) =      4.39
  TOTAL AREA(ACRES) =      3.19   PEAK FLOW RATE(CFS) =      4.39

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1507.00  DOWNSTREAM ELEVATION(FEET) = 1505.00
  STREET LENGTH(FEET) =    70.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
  INSIDE STREET CROSSFALL(DECIMAL) =  0.015
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       4.42
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.36
    HALFSTREET FLOOD WIDTH(FEET) =    8.34
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.13
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.49
  STREET FLOW TRAVEL TIME(MIN.) =   0.28   Tc(MIN.) =   13.22
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.951
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        0.04      0.75     0.400    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA AREA(ACRES) =    0.04      SUBAREA RUNOFF(CFS) =    0.06
  EFFECTIVE AREA(ACRES) =      3.23    AREA-AVERAGED Fm(INCH/HR) =  0.45
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.60
  TOTAL AREA(ACRES) =        3.2        PEAK FLOW RATE(CFS) =       4.39
  NOTE: PEAK FLOW RATE DEFAULTED TO UPSTREAM VALUE

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.36   HALFSTREET FLOOD WIDTH(FEET) =   8.30
  FLOW VELOCITY(FEET/SEC.) =  4.14   DEPTH*VELOCITY(FT*FT/SEC.) =   1.49
  LONGEST FLOWPATH FROM NODE      3.00 TO NODE      5.00 =     814.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
```

```
==========================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.22
  RAINFALL INTENSITY(INCH/HR) =   1.95
  AREA-AVERAGED Fm(INCH/HR) =  0.45
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.60
  EFFECTIVE STREAM AREA(ACRES) =       3.23
  TOTAL STREAM AREA(ACRES) =       3.23
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       4.39

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        3.32   10.37    2.285  0.75( 0.45) 0.60       1.7       1.00
      2        4.39   13.22    1.951  0.75( 0.45) 0.60       3.2       3.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        7.53   10.37    2.285  0.75( 0.45) 0.60       4.3       1.00
      2        7.11   13.22    1.951  0.75( 0.45) 0.60       5.0       3.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       7.53    Tc(MIN.) =    10.37
  EFFECTIVE AREA(ACRES) =       4.26   AREA-AVERAGED Fm(INCH/HR) =  0.45
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.60
  TOTAL AREA(ACRES) =        5.0
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      5.00 =    1062.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      8.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
==========================================================================
  UPSTREAM ELEVATION(FEET) = 1505.00  DOWNSTREAM ELEVATION(FEET) = 1491.00
  STREET LENGTH(FEET) =   408.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
  INSIDE STREET CROSSFALL(DECIMAL) =  0.015
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       8.84
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.43
    HALFSTREET FLOOD WIDTH(FEET) =   10.92
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.17
```

```
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.21
 STREET FLOW TRAVEL TIME(MIN.) =   1.32   Tc(MIN.) =   11.68
 *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.114
 SUBAREA LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 AGRICULTURAL POOR COVER
 "ORCHARDS"                 B        1.15      0.50     1.000    73
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"       B        0.27      0.75     0.600    56
 PUBLIC PARK                B        0.42      0.75     0.850    56
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.58
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.907
 SUBAREA AREA(ACRES) =    1.84      SUBAREA RUNOFF(CFS) =    2.63
 EFFECTIVE AREA(ACRES) =      6.10    AREA-AVERAGED Fm(INCH/HR) =  0.47
 AREA-AVERAGED Fp(INCH/HR) =  0.68  AREA-AVERAGED Ap =  0.69
 TOTAL AREA(ACRES) =        6.8        PEAK FLOW RATE(CFS) =       9.03

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.43   HALFSTREET FLOOD WIDTH(FEET) =  11.00
 FLOW VELOCITY(FEET/SEC.) =  5.21   DEPTH*VELOCITY(FT*FT/SEC.) =   2.24
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      8.00 =    1470.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      8.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
 TIME OF CONCENTRATION(MIN.) =   11.68
 RAINFALL INTENSITY(INCH/HR) =   2.11
 AREA-AVERAGED Fm(INCH/HR) =  0.47
 AREA-AVERAGED Fp(INCH/HR) =  0.68
 AREA-AVERAGED Ap =  0.69
 EFFECTIVE STREAM AREA(ACRES) =       6.10
 TOTAL STREAM AREA(ACRES) =       6.80
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       9.03

****************************************************************************
 FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   679.00
 ELEVATION DATA: UPSTREAM(FEET) =   1519.00  DOWNSTREAM(FEET) =   1496.20

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.026
 *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.196
 SUBAREA Tc AND LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 RESIDENTIAL
 "3-4 DWELLINGS/ACRE"       B        2.98      0.75     0.600    56   11.03
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
```

```
 SUBAREA RUNOFF(CFS) =      4.68
 TOTAL AREA(ACRES) =      2.98   PEAK FLOW RATE(CFS) =      4.68

****************************************************************************
 FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) = 1496.20  DOWNSTREAM ELEVATION(FEET) = 1491.00
 STREET LENGTH(FEET) =   466.00   CURB HEIGHT(INCHES) =  8.0
 STREET HALFWIDTH(FEET) = 18.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
 INSIDE STREET CROSSFALL(DECIMAL) =  0.015
 OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
 STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
 Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
 Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

   **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       5.55
   STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
   STREET FLOW DEPTH(FEET) =  0.44
   HALFSTREET FLOOD WIDTH(FEET) =   11.37
   AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.02
   PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.33
 STREET FLOW TRAVEL TIME(MIN.) =   2.57   Tc(MIN.) =   13.60
 *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.916
 SUBAREA LOSS RATE DATA(AMC  II):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 AGRICULTURAL POOR COVER
 "ORCHARDS"                 B        0.33      0.50     1.000    73
 RESIDENTIAL
 "1 DWELLING/ACRE"          B        1.11      0.75     0.800    56
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.68
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.846
 SUBAREA AREA(ACRES) =    1.44      SUBAREA RUNOFF(CFS) =    1.74
 EFFECTIVE AREA(ACRES) =      4.42    AREA-AVERAGED Fm(INCH/HR) =  0.49
 AREA-AVERAGED Fp(INCH/HR) =  0.72  AREA-AVERAGED Ap =  0.68
 TOTAL AREA(ACRES) =        4.4        PEAK FLOW RATE(CFS) =       5.67

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.44   HALFSTREET FLOOD WIDTH(FEET) =  11.45
 FLOW VELOCITY(FEET/SEC.) =  3.04   DEPTH*VELOCITY(FT*FT/SEC.) =   1.34
 LONGEST FLOWPATH FROM NODE      6.00 TO NODE      8.00 =    1145.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      8.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
 TIME OF CONCENTRATION(MIN.) =   13.60
```

```
 RAINFALL INTENSITY(INCH/HR) =   1.92
 AREA-AVERAGED Fm(INCH/HR) =  0.49
 AREA-AVERAGED Fp(INCH/HR) =  0.72
 AREA-AVERAGED Ap =  0.68
 EFFECTIVE STREAM AREA(ACRES) =       4.42
 TOTAL STREAM AREA(ACRES) =       4.42
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       5.67

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
     1        9.03   11.68    2.114  0.68( 0.47) 0.69       6.1       1.00
     1        8.35   14.55    1.833  0.69( 0.47) 0.68       6.8       3.00
     2        5.67   13.60    1.916  0.72( 0.49) 0.68       4.4       6.00

 RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
 CONFLUENCE FORMULA USED FOR  2 STREAMS.

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
     1       14.58   11.68    2.114  0.70( 0.48) 0.69       9.9       1.00
     2       14.25   13.60    1.916  0.70( 0.48) 0.68      11.0       6.00
     3       13.69   14.55    1.833  0.70( 0.48) 0.68      11.2       3.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      14.58    Tc(MIN.) =    11.68
 EFFECTIVE AREA(ACRES) =       9.90   AREA-AVERAGED Fm(INCH/HR) =  0.48
 AREA-AVERAGED Fp(INCH/HR) =  0.70  AREA-AVERAGED Ap =  0.69
 TOTAL AREA(ACRES) =       11.2
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      8.00 =    1470.00 FEET.
============================================================================
 END OF STUDY SUMMARY:
 TOTAL AREA(ACRES)     =       11.2  TC(MIN.) =     11.68
 EFFECTIVE AREA(ACRES) =      9.90  AREA-AVERAGED Fm(INCH/HR)=  0.48
 AREA-AVERAGED Fp(INCH/HR) =  0.70  AREA-AVERAGED Ap = 0.687
 PEAK FLOW RATE(CFS)   =      14.58

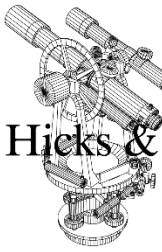
 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
     1       14.58   11.68    2.114  0.70( 0.48) 0.69       9.9       1.00
     2       14.25   13.60    1.916  0.70( 0.48) 0.68      11.0       6.00
     3       13.69   14.55    1.833  0.70( 0.48) 0.68      11.2       3.00
============================================================================
============================================================================
 END OF RATIONAL METHOD ANALYSIS
```

Hydrology & Hydraulics
Preliminary Report

City of Redlands

County of San Bernardino

PROPOSED HYDROLOGY
100-YEAR RUNOFF



Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

```
**************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2015 Advanced Engineering Software (aes)
             Ver. 22.0  Release Date: 07/01/2015  License ID 1302

                              Analysis prepared by:

                                  Hicks & Hartwick, Inc.
                              37 East Olive Avenue, Suite C
                                    Redlands, CA 92373
                                     (909) 793-2257

--------------------------------------------------------------------------
  FILE NAME: 0034HPAH.DAT
  TIME/DATE OF STUDY: 09:49 11/07/2019
==========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==========================================================================
                      --*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 = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6500
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 1.1500

  *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
  2   18.0      5.5    0.015/0.026/0.021   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  1.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint = 10.0 (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) =   392.00
  ELEVATION DATA: UPSTREAM(FEET) =   1536.00  DOWNSTREAM(FEET) =   1520.90

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
```

```
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.611
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.062
  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.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        1.73      0.42      0.600    76    8.61
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA RUNOFF(CFS) =      5.93
  TOTAL AREA(ACRES) =      1.73   PEAK FLOW RATE(CFS) =      5.93

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      5.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  1517.50  DOWNSTREAM(FEET) =  1505.00
  FLOW LENGTH(FEET) =   670.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   8.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.44
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       5.93
  PIPE TRAVEL TIME(MIN.) =   1.50    Tc(MIN.) =   10.11
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      5.00 =    1062.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   10.11
  RAINFALL INTENSITY(INCH/HR) =   3.66
  AREA-AVERAGED Fm(INCH/HR) =  0.25
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.60
  EFFECTIVE STREAM AREA(ACRES) =       1.73
  TOTAL STREAM AREA(ACRES) =       1.73
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       5.93

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   744.00
  ELEVATION DATA: UPSTREAM(FEET) =   1520.50  DOWNSTREAM(FEET) =   1507.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.935
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.118
  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.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       B        3.19      0.42     0.600    76   12.94
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA RUNOFF(CFS) =      8.22
  TOTAL AREA(ACRES) =      3.19   PEAK FLOW RATE(CFS) =      8.22

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1507.00  DOWNSTREAM ELEVATION(FEET) = 1505.00
  STREET LENGTH(FEET) =    70.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
  INSIDE STREET CROSSFALL(DECIMAL) =  0.015
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       8.27
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.43
    HALFSTREET FLOOD WIDTH(FEET) =   11.04
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.74
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.04
  STREET FLOW TRAVEL TIME(MIN.) =   0.25   Tc(MIN.) =   13.18
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.080
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        0.04      0.42     0.400    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA AREA(ACRES) =    0.04      SUBAREA RUNOFF(CFS) =    0.10
  EFFECTIVE AREA(ACRES) =      3.23    AREA-AVERAGED Fm(INCH/HR) =  0.25
  AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap =  0.60
  TOTAL AREA(ACRES) =        3.2        PEAK FLOW RATE(CFS) =       8.22
  NOTE: PEAK FLOW RATE DEFAULTED TO UPSTREAM VALUE

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.43   HALFSTREET FLOOD WIDTH(FEET) =  11.00
  FLOW VELOCITY(FEET/SEC.) =  4.74   DEPTH*VELOCITY(FT*FT/SEC.) =   2.04
  LONGEST FLOWPATH FROM NODE      3.00 TO NODE      5.00 =     814.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
```

```
==============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.18
  RAINFALL INTENSITY(INCH/HR) =   3.08
  AREA-AVERAGED Fm(INCH/HR) =  0.25
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.60
  EFFECTIVE STREAM AREA(ACRES) =       3.23
  TOTAL STREAM AREA(ACRES) =       3.23
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       8.22

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        5.93   10.11    3.659  0.42( 0.25) 0.60       1.7       1.00
      2        8.22   13.18    3.080  0.42( 0.25) 0.60       3.2       3.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       13.53   10.11    3.659  0.42( 0.25) 0.60       4.2       1.00
      2       13.14   13.18    3.080  0.42( 0.25) 0.60       5.0       3.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      13.53    Tc(MIN.) =    10.11
  EFFECTIVE AREA(ACRES) =       4.21   AREA-AVERAGED Fm(INCH/HR) =  0.25
  AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap =  0.60
  TOTAL AREA(ACRES) =        5.0
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      5.00 =    1062.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      8.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
==============================================================================
  UPSTREAM ELEVATION(FEET) = 1505.00  DOWNSTREAM ELEVATION(FEET) = 1491.00
  STREET LENGTH(FEET) =   408.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
  INSIDE STREET CROSSFALL(DECIMAL) =  0.015
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      16.13
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.51
    HALFSTREET FLOOD WIDTH(FEET) =   15.46
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.74
```

```
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.94
  STREET FLOW TRAVEL TIME(MIN.) =   1.18   Tc(MIN.) =   11.30
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.405
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  AGRICULTURAL POOR COVER
  "ORCHARDS"                B        1.15      0.23     1.000    89
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"      B        0.27      0.42     0.600    76
  PUBLIC PARK               B        0.42      0.42     0.850    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.29
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.907
  SUBAREA AREA(ACRES) =    1.84      SUBAREA RUNOFF(CFS) =    5.20
  EFFECTIVE AREA(ACRES) =      6.05    AREA-AVERAGED Fm(INCH/HR) =  0.26
  AREA-AVERAGED Fp(INCH/HR) =  0.37  AREA-AVERAGED Ap =  0.69
  TOTAL AREA(ACRES) =        6.8        PEAK FLOW RATE(CFS) =      17.14

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.52   HALFSTREET FLOOD WIDTH(FEET) =  16.07
  FLOW VELOCITY(FEET/SEC.) =  5.81   DEPTH*VELOCITY(FT*FT/SEC.) =   3.03
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      8.00 =    1470.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      8.00 TO NODE      8.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.30
  RAINFALL INTENSITY(INCH/HR) =   3.40
  AREA-AVERAGED Fm(INCH/HR) =  0.26
  AREA-AVERAGED Fp(INCH/HR) =  0.37
  AREA-AVERAGED Ap =  0.69
  EFFECTIVE STREAM AREA(ACRES) =       6.05
  TOTAL STREAM AREA(ACRES) =       6.80
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      17.14

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   679.00
  ELEVATION DATA: UPSTREAM(FEET) =   1519.00  DOWNSTREAM(FEET) =   1496.20

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.026
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.459
  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.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"      B        2.98      0.42     0.600    76   11.03
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
```

```
 SUBAREA RUNOFF(CFS) =      8.60
 TOTAL AREA(ACRES) =      2.98   PEAK FLOW RATE(CFS) =      8.60

****************************************************************************
 FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) = 1496.20  DOWNSTREAM ELEVATION(FEET) = 1491.00
 STREET LENGTH(FEET) =   466.00   CURB HEIGHT(INCHES) =  8.0
 STREET HALFWIDTH(FEET) = 18.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.50
 INSIDE STREET CROSSFALL(DECIMAL) =  0.015
 OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.026

 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
 STREET PARKWAY CROSSFALL(DECIMAL)  =  0.021
 Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
 Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

   **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      10.37
   STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
   STREET FLOW DEPTH(FEET) =  0.53
   HALFSTREET FLOOD WIDTH(FEET) =   16.75
   AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.33
   PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.77
 STREET FLOW TRAVEL TIME(MIN.) =   2.34   Tc(MIN.) =   13.36
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.053
 SUBAREA LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 AGRICULTURAL POOR COVER
 "ORCHARDS"                 B        0.33      0.23     1.000    89
 RESIDENTIAL
 "1 DWELLING/ACRE"          B        1.11      0.42     0.800    76
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.37
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.846
 SUBAREA AREA(ACRES) =    1.44      SUBAREA RUNOFF(CFS) =    3.55
 EFFECTIVE AREA(ACRES) =      4.42    AREA-AVERAGED Fm(INCH/HR) =  0.27
 AREA-AVERAGED Fp(INCH/HR) =  0.40  AREA-AVERAGED Ap =  0.68
 TOTAL AREA(ACRES) =        4.4        PEAK FLOW RATE(CFS) =      11.06

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.54   HALFSTREET FLOOD WIDTH(FEET) =  17.36
 FLOW VELOCITY(FEET/SEC.) =  3.38   DEPTH*VELOCITY(FT*FT/SEC.) =   1.83
 LONGEST FLOWPATH FROM NODE      6.00 TO NODE      8.00 =    1145.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      8.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
 TIME OF CONCENTRATION(MIN.) =   13.36
```

```
  RAINFALL INTENSITY(INCH/HR) =   3.05
  AREA-AVERAGED Fm(INCH/HR) =  0.27
  AREA-AVERAGED Fp(INCH/HR) =  0.40
  AREA-AVERAGED Ap =  0.68
  EFFECTIVE STREAM AREA(ACRES) =       4.42
  TOTAL STREAM AREA(ACRES) =       4.42
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      11.06

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       17.14   11.30    3.405  0.37( 0.26) 0.69       6.0       1.00
      1       16.25   14.37    2.911  0.38( 0.26) 0.68       6.8       3.00
      2       11.06   13.36    3.053  0.40( 0.27) 0.68       4.4       6.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       27.67   11.30    3.405  0.38( 0.26) 0.69       9.8       1.00
      2       27.60   13.36    3.053  0.38( 0.26) 0.68      11.0       6.00
      3       26.74   14.37    2.911  0.39( 0.26) 0.68      11.2       3.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      27.67    Tc(MIN.) =    11.30
  EFFECTIVE AREA(ACRES) =       9.78   AREA-AVERAGED Fm(INCH/HR) =  0.26
  AREA-AVERAGED Fp(INCH/HR) =  0.38  AREA-AVERAGED Ap =  0.69
  TOTAL AREA(ACRES) =       11.2
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      8.00 =    1470.00 FEET.
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       11.2  TC(MIN.) =     11.30
  EFFECTIVE AREA(ACRES) =      9.78  AREA-AVERAGED Fm(INCH/HR)=  0.26
  AREA-AVERAGED Fp(INCH/HR) =  0.38  AREA-AVERAGED Ap = 0.688
  PEAK FLOW RATE(CFS)   =      27.67

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       27.67   11.30    3.405  0.38( 0.26) 0.69       9.8       1.00
      2       27.60   13.36    3.053  0.38( 0.26) 0.68      11.0       6.00
      3       26.74   14.37    2.911  0.39( 0.26) 0.68      11.2       3.00
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

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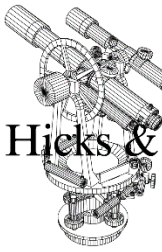
Preliminary Report

City of Redlands

County of San Bernardino

SMALL AREA
UNIT HYDROGRAPH CALCULATIONS



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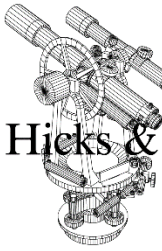
SURFACE HYDRAULICS



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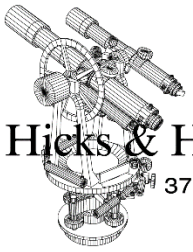
CATCH BASIN INLET HYDRAULICS



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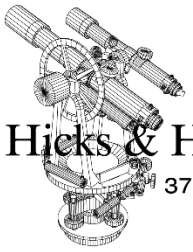
STORM DRAIN HYDRAULICS



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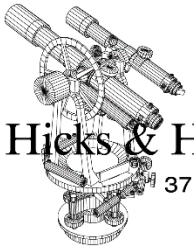
HYDROLOGY MAPS



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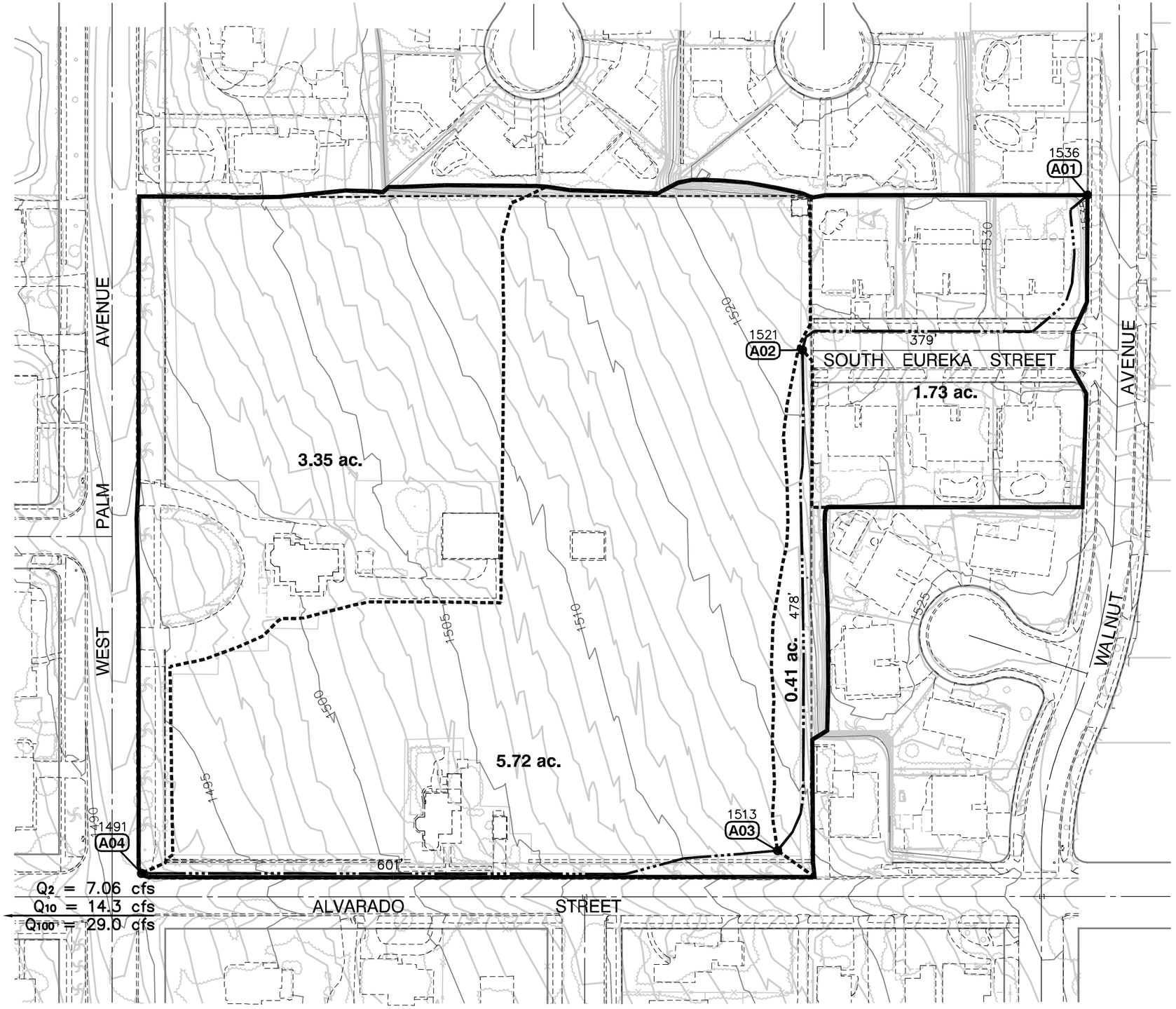
Diversified Pacific Communities

Tract No. 20305
City of Redlands
SAN BERNARDINO COUNTY
EXISTING HYDROLOGY



HYDROLOGIC DATA

SCS SOILS GROUP: B
INTENSITY-DURATION SLOPE: 0.65
2-YR/1-HR RAINFALL (AMC II): 0.473 in/hr
10-YR/1-HR RAINFALL (AMC II): 0.730 in/hr
100-YR/1-HR RAINFALL (AMC III): 1.15 in/hr

HICKS & HARTWICK, Inc.
CIVIL ENGINEERS · LAND SURVEYORS

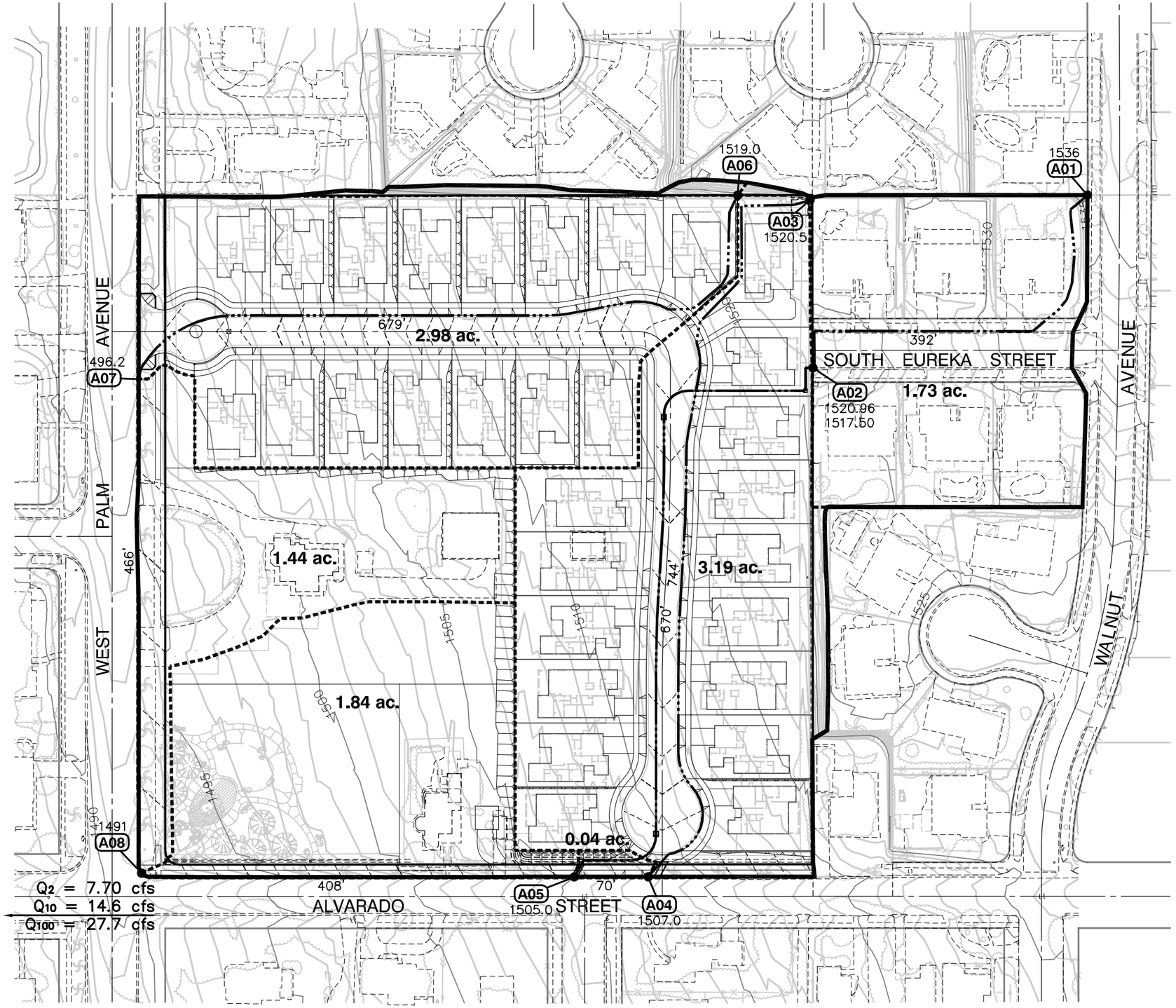
37 East Olive Avenue
REDLANDS, CALIFORNIA 92373
909.793.2257

PREPARED: NOVEMBER 2019

REGISTERED PROFESSIONAL ENGINEER
RILEY CLARK
No. C 40606
exp. 3/31/2021
CIVIL
STATE OF CALIFORNIA

SCALE: 1" = 100'

10034 Hydrology.dwg : Existing 9:08am – Nov 07, 2019 (c) Hicks & Hartwick, Inc.



Diversified Pacific Communities

Tract No. 20305
City of Redlands
SAN BERNARDINO COUNTY
PROPOSED HYDROLOGY

HYDROLOGIC DATA

SCS SOILS GROUP: B
INTENSITY-DURATION SLOPE: 0.65
2-YR/1-HR RAINFALL (AMC II): 0.473 in/hr
10-YR/1-HR RAINFALL (AMC II): 0.730 in/hr
100-YR/1-HR RAINFALL (AMC III): 1.15 in/hr

HICKS & HARTWICK, Inc.
CIVIL ENGINEERS · LAND SURVEYORS

37 East Olive Avenue
REDLANDS, CALIFORNIA 92373
909.793.2257

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10034 Hydrology.dwg : Proposed 9:08am – Nov 07, 2019 (c) Hicks & Hartwick, Inc.

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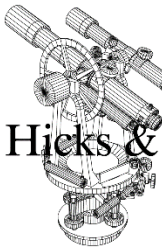

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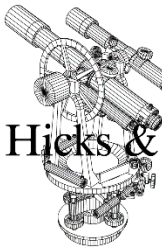
Hydrology & Hydraulics Preliminary Report

City of Redlands

County of San Bernardino

STORM DRAIN PLANS



Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

Preliminary Water Quality Management Plan

For:

301 West Palm Avenue

CUP 1143

PM 20185/TR. 20305

(APN 0173-231-05)

Prepared for:

Diversified Pacific Communities

10621 Civil Center Drive

Rancho Cucamonga, CA 91730

Phone: (909)-481-1150

Fax: (909)-481-1151

Prepared by:

Hicks & Hartwick, Inc.

37 E Olive Ave. STE C

Redlands, CA 92373

Phone: (909)-793-2257

Job No. 10034

Approval Date: To be Determined

HICKS & HARTWICK, INC.
ENGINEERS & SURVEYORS
ESTABLISHED 1902

Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for PM 20185/Tract 20305 by Hicks & Hartwick, Inc.. The WQMP is intended to comply with the requirements of the City of Redlands and the NPDES Areawide Stormwater Program requiring the preparation of a WQMP. The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with San Bernardino County's Municipal Storm Water Management Program and the intent of the NPDES Permit for San Bernardino County and the incorporated cities of San Bernardino County within the Santa Ana Region. Once the undersigned transfers its interest in the property, its successors in interest and the city/county shall be notified of the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity.

"I certify under a penalty of law that the provisions (implementation, operation, maintenance, and funding) of the WQMP have been accepted and that the plan will be transferred to future successors."

.

Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):	PM 20185/TR 20305	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			**CUP 1143** **APN 0173-231-05**

Owner's Signature		
Owner Name: Diversified Pacific Communities – Nolan Leggio		
Title	Director of Forward Planning	
Company	Diversified Pacific Communities	
Address	10621 Civil Center Drive, Rancho Cucamonga, CA 91730	
Email	NLeggio@DiversifiedPacific.com	
Telephone #	(909) 373-2628	
Signature	Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):	PM 20185/TR 20305	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			**CUP 1143** **APN 0173-231-05**

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan were prepared under my oversight and meet the requirements of Regional Water Quality Control Board Order No. R8-2010-0036."

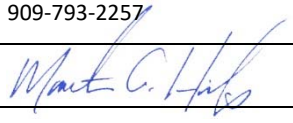
Engineer: Matthew C. Hicks		PE Stamp Below
Title	Principal	
Company	Hicks & Hartwick, Inc.	
Address	37 E Olive Ave STE C Redlands, CA 92372	
Email	matt@verycivil.com	
Telephone #	909-793-2257	
Signature		
Date	**1/25/2020**	

Table of Contents

Section 1 Discretionary Permits 1-1

Section 2 Project Description 2-1

2.1 Project Information 2-1
2.2 Property Ownership / Management 2-2
2.3 Potential Stormwater Pollutants 2-3
2.4 Water Quality Credits 2-4

Section 3 Site and Watershed Description 3-1

Section 4 Best Management Practices 4-1

4.1 Source Control BMP 4-1
4.1.1 Pollution Prevention 4-1
4.1.2 Preventative LID Site Design Practices 4-7
4.2 Project Performance Criteria 4-9
4.3 Project Conformance Analysis 4-18
4.3.1 Site Design Hydrologic Source Control BMP 4-21
4.3.2 Infiltration BMP 4-25
4.3.3 Harvest and Use BMP 4-28
4.3.4 Biotreatment BMP 4-29
4.3.5 Conformance Summary 4-33
4.3.6 Hydromodification Control BMP 4-35
4.4 Alternative Compliance Plan (if applicable) 4-36

Section 5 Inspection & Maintenance Responsibility Post Construction BMPs 5-1

Section 6 Site Plan and Drainage Plan 6-1

6.1. Site Plan and Drainage Plan 6-1
6.2 Electronic Data Submittal 6-1
6.3 O&M Agreement 6-1
6.4A Hydrology 6-4A
6.4B BMP 6-4B
6.4C Educational Information 6-4C
6.4D Calculations 6-4D
6.4E Miscellaneous Data 6-4E

Forms

Form 1-1 Project Information 1-1
Form 2.1-1 Description of Proposed Project 2-1
Form 2.2-1 Property Ownership/Management 2-2
Form 2.3-1 Pollutants of Concern 2-3
Form 2.4-1 Water Quality Credits 2-4
Form 3-1 Site Location and Hydrologic Features 3-1
Form 3-2 Hydrologic Characteristics 3-2

Form 3-3 Watershed Description 3-7
Form 4.1-1 Non-Structural Source Control BMP 4-2
Form 4.1-2 Structural Source Control BMP 4-5
Form 4.1-3 Site Design Practices Checklist 4-7
Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume 4-9
Form 4.2-2 Summary of HCOC Assessment 4-10
Form 4.2-3 HCOC Assessment for Runoff Volume 4-11
Form 4.2-4 HCOC Assessment for Time of Concentration 4-14
Form 4.2-5 HCOC Assessment for Peak Runoff 4-16
Form 4.3-1 Infiltration BMP Feasibility 4-19
Form 4.3-2 Site Design Hydrologic Source Control BMP 4-21
Form 4.3-3 Infiltration LID BMP 4-26
Form 4.3-4 Harvest and Use BMP 4-28
Form 4.3-5 Selection and Evaluation of Biotreatment BMP 4-29
Form 4.3-6 Volume Based Biotreatment – Bioretention and Planter Boxes w/Underdrains 4-30
Form 4.3-7 Volume Based Biotreatment- Constructed Wetlands and Extended Detention 4-31
Form 4.3-8 Flow Based Biotreatment 4-32
Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate 4-33
Form 4.3-10 Hydromodification Control BMP 4-35
Form 5-1 BMP Inspection and Maintenance 5-1

Section 1 Discretionary Permit(s)

Form 1-1 Project Information					
Project Name	301 West Palm Avenue				
Project Owner Contact Name:	Nolan Leggio				
Mailing Address:	10621 Civic Center Drive Rancho Cucamonga, CA 91730	E-mail Address:	NLeggio@DiversifiedPacific.com	Telephone:	(909) 481-1150
Permit/Application Number(s):			Tract/Parcel Map Number(s):	PM 20185/TR 20305	
Additional Information/ Comments:					
Description of Project:	**Water Treatment Overview** The proposed project is a 30-lot single family residential subdivision of an existing 8.81 ac. residence and orange grove. Three parcels are proposed for the portion of the site not included in the residential tract – two parcels for the existing houses on the site and a third parcel for a proposed public park at the corner of Palm Avenue and Alvarado Street. Proposed Parcel Map 20185/Tract 20305 is bounded on the east by existing single-family residential development and Palm Avenue and Alvarado Street run along the westerly property limits. Project flows drain westerly across the orange grove and outlet predominately as sheet flow into Palm Avenue and Alvarado Street. The site accepts run-on from the adjacent residential subdivisions primarily thru South Eureka Street which appears to be originally designed to extend to Palm Avenue. For purposes of analyzing DCV and HCOC values a portion of the run-on area from adjacent slopes will be included in project calculations. A by-pass storm drain system is proposed to carry run-off from South Eureka Street through the tract to an outlet at Alvarado Street. The project site is within soils group B indicating infiltration feasibility however based on initial soils percolation testing completed at depths of 6-10 feet, infiltration rates are below the acceptable minimum rates for using infiltration BMPs. Additional testing will be completed to determine if infiltration is feasible at greater depths however for the purposes of this preliminary study the full LID DCV and HCOC requirements will be managed through the use of hydrologic source control measures, bioinfiltration swales located within the private street's parkway area and a bioretention system.				
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.					

Section 2 Project Description

2.1 Project Information

This section of the WQMP should provide the information listed below. The information provided for Conceptual/ Preliminary WQMP should give sufficient detail to identify the major proposed site design and LID BMPs and other anticipated water quality features that impact site planning. Final Project WQMP must specifically identify all BMP incorporated into the final site design and provide other detailed information as described herein.

The purpose of this information is to help determine the applicable development category, pollutants of concern, watershed description, and long term maintenance responsibilities for the project, and any applicable water quality credits. This information will be used in conjunction with the information in Section 3, Site Description, to establish the performance criteria and to select the LID BMP or other BMP for the project or other alternative programs that the project will participate in, which are described in Section 4.

Form 2.1-1 Description of Proposed Project

1 Development Category (Select all that apply):

☐ Significant re-development involving the addition or replacement of 5,000 ft^2 or more of impervious surface on an already developed site	☒ New development involving the creation of 10,000 ft^2 or more of impervious surface collectively over entire site	☐ Automotive repair shops with standard industrial classification (SIC) codes 5013, 5014, 5541, 7532- 7534, 7536-7539	☐ Restaurants (with SIC code 5812) where the land area of development is 5,000 ft^2 or more
☐ Hillside developments of 5,000 ft^2 or more which are located on areas with known erosive soil conditions or where the natural slope is 25 percent or more	☐ Developments of 2,500 ft^2 of impervious surface or more adjacent to (within 200 ft) or discharging directly into environmentally sensitive areas or waterbodies listed on the CWA Section 303(d) list of impaired waters.	☐ Parking lots of 5,000 ft^2 or more exposed to storm water	☐ Retail gasoline outlets that are either 5,000 ft^2 or more, or have a projected average daily traffic of 100 or more vehicles per day

☐ Non-Priority / Non-Category Project *May require source control LID BMPs and other LIP requirements. Please consult with local jurisdiction on specific requirements*.

2 Project Area (ft2):	383,736	**3** Number of Dwelling Units:	30	**4** SIC Code:	1521

5 Is Project going to be phased? Yes ☐ No ☒ *If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.*

6 Does Project include roads? Yes ☒ No ☐ *If yes, ensure that applicable requirements for transportation projects are addressed (see Appendix A of TGD for WQMP)*

2.2 Property Ownership/Management

Describe the ownership/management of all portions of the project and site. State whether any infrastructure will transfer to public agencies (City, County, Caltrans, etc.) after project completion. State if a homeowners or property owners association will be formed and be responsible for the long-term maintenance of project stormwater facilities. Describe any lot-level stormwater features that will be the responsibility of individual property owners.

Form 2.2-1 Property Ownership/Management

Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities:

The project will form a "Homeowner's Association" to handle "Water Quality Management Plan" related issues. Water Quality Management Plan related maintenance issues will be addressed as follows:

1. The Homeowners will be responsible for maintenance on their individual lots (Tr. 20305 Lots 1-20 and PM 20185 Parcels 1 & 2)
2. A Homeowner's Association will be responsible for maintenance of the open space lots A-D.

A public park is proposed with the project (PM 20185 Parcel 3) to be transferred to the City after project completion.

2.3 Potential Stormwater Pollutants

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-3 in the TGD for WQMP).

Form 2.3-1 Pollutants of Concern			
Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E ☒	N ☐	
Nutrients - Phosphorous	E ☒	N ☐	
Nutrients - Nitrogen	E ☒	N ☐	
Noxious Aquatic Plants	E ☒	N ☐	
Sediment	E ☒	N ☐	
Metals	E ☒	N ☐	
Oil and Grease	E ☒	N ☐	
Trash/Debris	E ☒	N ☐	
Pesticides / Herbicides	E ☒	N ☐	
Organic Compounds	E ☒	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

2.4 Water Quality Credits

A water quality credit program is applicable for certain types of development projects if it is not feasible to meet the requirements for on-site LID. Proponents for eligible projects, as described below, can apply for water quality credits that would reduce project obligations for selecting and sizing other treatment BMP or participating in other alternative compliance programs. Refer to Section 6.2 in the TGD for WQMP to determine if water quality credits are applicable for the project.

Form 2.4-1 Water Quality Credits

1 Project Types that Qualify for Water Quality Credits: *Select all that apply*

☐ Redevelopment projects that reduce the overall impervious footprint of the project site. [Credit = % impervious reduced] Current= - SF New= - SF Credit=0%	Higher density development projects ☐ Vertical density [20%] ☐ 7 units/ acre [5%]	☐ Mixed use development, (combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that demonstrate environmental benefits not realized through single use projects) [20%]	☐ Brownfield redevelopment (redevelop real property complicated by presence or potential of hazardous contaminants) [25%]
☐ Redevelopment projects in established historic district, historic preservation area, or similar significant core city center areas [10%]	☐ Transit-oriented developments (mixed use residential or commercial area designed to maximize access to public transportation) [20%]	☐ In-fill projects (conversion of empty lots & other underused spaces < 5 acres, substantially surrounded by urban land uses, into more beneficially used spaces, such as residential or commercial areas) [10%]	☐ Live-Work developments (variety of developments designed to support residential and vocational needs) [20%]

2 Total Credit 0% *(Total all credit percentages up to a maximum allowable credit of 50 percent)*

Description of Water Quality Credit Eligibility (if applicable)	N/A

Section 3 Site and Watershed Description

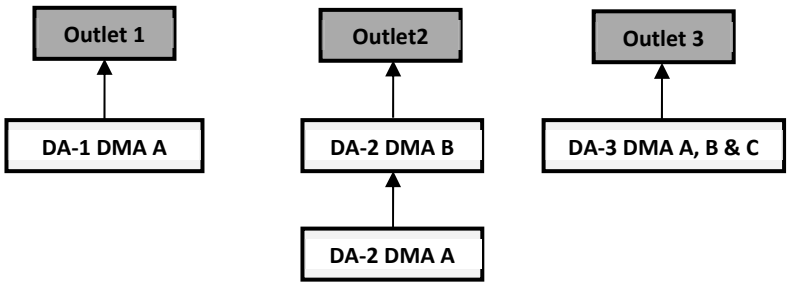
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and sub-watershed DMAs) is conveyed to the site outlet(s). Refer to Section 3.2 in the TGD for WQMP. The form below is provided as an example. Then complete Forms 3.2 and 3.3 for each DA on the project site. ***If the project has more than one drainage area for stormwater management, then complete additional versions of these forms for each DA / outlet.***

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude 34.04198°	Longitude -117.17616°	Thomas Bros Map pg. 648-C2

1 San Bernardino County climatic region: ☒ Valley ☐ Mountain

2 Does the site have more than one drainage area (DA): Yes☒ No☐ *If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached*



Example only – modify for project specific WQMP using additional form

Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA-1 DMA A flows to Outlet 1	Project flows in DA-1 will travel through vegetated swales in the private street parkways and a secondary swale through open space Lot B for DCV treatment before draining to Palm Avenue through a parkway drain outlet.
DA-2 DMA A flows to Outlet 2	Project flows from DA-2 will travel through vegetated swales in the private street parkways and pass through a bioretention system before draining to Alvarado Street through a parkway drain outlet.
DA-3 DMA A, B & C flows to Outlet 3	Project flows from DA-3 that are not retained within the DMA's are primarily from the two existing residences that will maintain their historic sheet flow drainage patterns to Palm Avenue and Alvarado Street.

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1				
For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft^2)	131,294			
2 Existing site impervious area (ft^2)	0			
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	II			
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	B			
5 Longest flowpath length (ft)	597			
6 Longest flowpath slope (ft/ft)	.040			
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Orchard			
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Good			

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 2

For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA	DMA
1 DMA drainage area (ft^2)	82,597	56,254		
2 Existing site impervious area (ft^2)	1,179	715		
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	II	II		
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	B	B		
5 Longest flowpath length (ft)	303	468		
6 Longest flowpath slope (ft/ft)	0.017	0.027		
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Orchard	Orchard		
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Good	Good		

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 3				
For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft^2)	66,940	37,389	18,564	
2 Existing site impervious area (ft^2)	17,024	0	3,654	
3 Antecedent moisture condition *For desert areas, use* *http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	II	II	II	
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	B	B	B	
5 Longest flowpath length (ft)	341	283	172	
6 Longest flowpath slope (ft/ft)	.042	.034	.015	
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Orchard/ Residential Landscaping	Orchard	Orchard/ Residential Landscaping	
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Poor	Poor	Poor	

Photo 1: On Palm Avenue looking southeasterly across project site at existing house.

Photo 2: On Alvarado Street looking northeasterly across project site at existing house.

Photo 3: At Alvarado St./Palm Ave. intersection and westerly project corner looking northeasterly along Palm Avenue sidewalk.

Photo 4: At Alvarado St./Palm Ave. intersection and westerly project corner looking southeasterly along Alvarado St. parkway.

Photo 5: On South Eureka St. looking southwesterly along property line at rear of project site.

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1 (use only as needed for additional DMA w/in DA 1)				
For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA E	DMA F	DMA G	DMA H
1 DMA drainage area (ft^2)				
2 Existing site impervious area (ft^2)				
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*				
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*				
5 Longest flowpath length (ft)				
6 Longest flowpath slope (ft/ft)				
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*				
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*				

Form 3-3 Watershed Description for Drainage Area

Receiving waters *Refer to Watershed Mapping Tool - http://sbcounty.permitrack.com/WAP See 'Drainage Facilities" link at this website*	Morrey Arroyo Canal v Zanja Mission Channel v Santa Ana River Reach 5 v Santa Ana River Reach 4 v Santa Ana River Reach 3 v Prado Basin
Applicable TMDLs *Refer to Local Implementation Plan*	None
303(d) listed impairments *Refer to Local Implementation Plan and Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP and State Water Resources Control Board website – http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml*	None for immediate receiving waters Santa Ana River Reach 4 – pathogens Santa Ana River Reach 3 – pathogens / metals
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	None
Unlined Downstream Water Bodies *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	Zanja Mission Channel
Hydrologic Conditions of Concern	☒ Yes *Complete Hydrologic Conditions of Concern (HCOC) Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-10 in submittal* ☐ No
Watershed–based BMP included in a RWQCB approved WAP	☐ Yes *Attach verification of regional BMP evaluation criteria in WAP* • *More Effective than On-site LID* • *Remaining Capacity for Project DCV* • *Upstream of any Water of the US* • *Operational at Project Completion* • *Long-Term Maintenance Plan* ☒ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMP

4.1.1 Pollution Prevention

Non-structural and structural source control BMP are required to be incorporated into all new development and significant redevelopment projects. Form 4.1-1 and 4.1-2 are used to describe specific source control BMPs used in the WQMP or to explain why a certain BMP is not applicable. Table 7-3 of the TGD for WQMP provides a list of applicable source control BMP for projects with specific types of potential pollutant sources or activities. The source control BMP in this table must be implemented for projects with these specific types of potential pollutant sources or activities.

The preparers of this WQMP have reviewed the source control BMP requirements for new development and significant redevelopment projects. The preparers have also reviewed the specific BMP required for project as specified in Forms 4.1-1 and 4.1-2. All applicable non-structural and structural source control BMP shall be implemented in the project.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☒	☐	The project owner will provide educational materials to property owners within the project. The materials will discuss water quality management issues relating to the project and property owners individual and corporate responsibilities. The materials will contain appropriate information from private and government resources. These materials will include information on general good housekeeping practices that contribute to protection of Storm water quality, and BMPs that eliminate or reduce pollution. The materials will describe the use of chemicals (including household type) that should be limited to the property, with no discharge of specified wastes via hosing or other direct discharge to gutters, catch basins, and storm drains. These materials will be made available by the owner and are included in the WQMP in **Section 6.4C** – **Educational Information**. The owner will note the availability of stormwater information and educational materials available on the San Bernardino County Website http://www.sbcountystormwater.org/ A copy of these materials and a copy of the WQMP must be given to each property owner with the purchase of a lot within the subdivision at the close of purchase.
N2	Activity Restrictions	☒	☐	All activities are restricted for which there isn't an appropriate BMP provided for in this WQMP.
N3	Landscape Management BMPs	☒	☐	The Homeowners shall comply with landscape management guidelines described in the Stormwater Pollution Prevention Home & Garden educational sheet found in Section 6.4C – Educational Information.
N4	BMP Maintenance	☒	☐	1. The Homeowners will be responsible for BMP maintenance on their individual lots (Lots 1-30 and Parcels 1 & 2). 2. The City of Redlands will own Lots A-D in Fee Title and will be responsible for BMP Maintenance via a Home Owner's Association. 3. The City of Redlands will own Parcel 3 (Public Park) in Fee Title and will be responsible for BMP Maintenance via a Community Facilities District.
N5	Title 22 CCR Compliance (How development will comply)	☒	☐	The homeowners must comply the County ordinances for Hazardous waste and waste disposal. The City of Redlands through the Fire Department provides for household hazardous waste collection. The homeowners shall comply by using this facility to

Form 4.1-1 Non-Structural Source Control BMPs				
				dispose of all leftover pesticides, fertilizers, herbicides, oil, paints, antifreeze, batteries, corrosives and flammables. Alternate approved sites for disposal are available. See the San Bernardino County stormwater website for additional disposal locations. Additionally, there are educational material covering hazardous waste covered under N1. The current educational materials are attached to this WQMP.
N6	Local Water Quality Ordinances	☒	☐	The Project must comply with any applicable local water quality ordinances. The local jurisdiction (City of Redlands), under local water quality ordinances (Ord. 13.54), has authority to ensure clean stormwater discharges from areas of concern to public properties.
N7	Spill Contingency Plan	☐	☒	Not required for single family residences.
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tanks on this site.
N9	Hazardous Materials Disclosure Compliance	☐	☒	Not required for single family residences.
N10	Uniform Fire Code Implementation	☒	☐	The project shall comply with Article 80 of the Uniform Fire Code enforced by the City of Redlands Fire department. All hazardous materials covered by this code are banned from this project.
N11	Litter/Debris Control Program	☒	☐	1. The Homeowners will be responsible for litter and debris on their individual lots (Lots 1-30 and Parcels 1 & 2). 2. The City of Redlands will own Lots A-D in Fee Title and will be responsible for litter and debris control via a Home Owner's Association. The City of Redlands will own Parcel 3 (Public Park) in Fee Title and will be responsible for litter and debris control via a Community Facilities District.
N12	Employee Training	☐	☒	This does not apply to a single-family residential project.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N13	Housekeeping of Loading Docks	☐	☒	There are no loading docks.
N14	Catch Basin Inspection Program	☒	☐	The single-family residences have no catch basins within their single-family lots. The proposed catch basins will be within the City of Redlands maintenance areas and will be covered by their own inspection program.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	The Home Owner's Association shall have the private street swept on a regular frequency based on usage and field observations of waste accumulation, using a vacuum assisted sweeper.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	This is not a public agency project.
N17	Comply with all other applicable NPDES permits	☒	☐	A SWPPP will be prepared for construction activities and a notice of intent will be filed with the State Water Resources Control Board.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	Signage notices regarding discharge prohibitions will be placed at storm drain inlets to eliminate or reduce dumping and littering. The phrase "No Dumping – Drains to River," or an equally effective phrase as approved by the City of Redlands, will be stenciled on catch basins (inlets) to alert the public as to the destination of pollutants discharged into storm drains. The stencil shall be blue on a white background with lettering 2-1/2" in height or a catch basin curb marker, circular or rectangular, at least 4" in height or diameter may be used. This signage will be maintained by the owner. This project site will include storm drain signage implemented consistent with BMP SD-13 (Reference SD-13 attached under the BMP section 6.4B). The above phrase has been approved by the City of Redlands.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	There will be no outdoor material storage on this site.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☐	☒	There are no trash or waste storage areas on this site
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	Irrigation systems for this project have been designed to minimize runoff of excess irrigation water across impervious surfaces and into the storm water conveyance systems. Such measures employed include rain-triggered shutoff devices to eliminate or reduce irrigation during and immediately after precipitation, using mulches (such as wood chips) to minimize sediment in runoff and to maintain soil infiltration capacity, and coordination of the design of the irrigation system and landscape to minimize overspray and runoff. Irrigation systems incorporate flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or water supply lines. Water conservation devices such as programmable irrigation timers and soil moisture sensors have been used. This project incorporates efficient irrigation by implementation of BMP SD-12. Reference SD-12 attached under the BMP section 6.4B.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	All parkway strips not used as vegetate swale shall be finish-graded at a minimum of 1-2 inches below top of curb or sidewalk for increased retention/infiltration of stormwater and irrigation water.

S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☒	☐	Project plans will include Source-Control BMPs to decrease the potential for erosion of slopes, channels, and storm drain outlets. Slope runoff will be conveyed safely from the tops of slopes. 1. All manufactured slopes within the project will be landscaped and protected. 2. Prior to slope landscaping slopes shall be stabilized per the SWPPP. Onsite conveyance channels (drainage swales) will be lined, where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	There will be no covered dock areas on this site.
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	There will be no maintenance bays on this site.
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	There will be no vehicle wash areas on this site
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	There are no outdoor processing areas.
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	None on this site.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	None on this site.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	None on this site.
S14	Wash water control for food preparation areas	☐	☒	None on this site.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	None on this site.

4.1.2 Preventative LID Site Design Practices

Site design practices associated with new LID requirements in the MS4 Permit should be considered in the earliest phases of a project. Preventative site design practices can result in smaller DCV for LID BMP and hydromodification control BMP by reducing runoff generation. Describe site design and drainage plan including:

- A narrative of site design practices utilized or rationale for not using practices
- A narrative of how site plan incorporates preventive site design practices
- Include an attached Site Plan layout which shows how preventative site design practices are included in WQMP

Refer to Section 5.2 of the TGD for WQMP for more details.

Form 4.1-3 Preventative LID Site Design Practices Checklist

Site Design Practices *If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets*
Minimize impervious areas: Yes ☒ No ☐ Explanation: Sidewalks will be designed to connect to the driveway only, eliminating some impervious area. A narrower street section than the City standard width is being used minimizing impervious street area. The project will use only 2-car garages reducing driveway area with common 3-car garages.
Maximize natural infiltration capacity: Yes ☐ No ☒ Explanation: Based on the poor infiltration capacity of the existing site, site design practices to maximize natural infiltration capacity of the site are not implemented.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: The project maintains the existing site drainage pattern and the use of vegetated swales is intended to preserve the existing time of concentration that typically decreases due to the addition of impervious site area.
Disconnect impervious areas: Yes ☒ No ☐ Explanation: The project is proposing to direct runoff to planters and landscaped areas and incorporates permeable areas throughout the site to accept runoff. All roof downspouts will drain to pervious areas.
Protect existing vegetation and sensitive areas: Yes ☒ No ☐ Explanation: A portion of the existing orange grove orchard will be preserved within DA-3. The limits of grading around the existing orchard will be staked during construction to indicate those trees to be removed or remain.
Re-vegetate disturbed areas: Yes ☒ No ☐ Explanation: All disturbed areas without impervious construction will be revegetated.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☐ No ☒ Explanation: There are no proposed basins on this project.
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☒ No ☐ Explanation: Individual lots will be surrounded with a vegetated swale sloping at 1% minimum. Vegetated drainage swales will be used along the private street in the parkway areas and through one open space lot.
Stake off areas that will be used for landscaping to minimize compaction during construction: Yes ☐ No ☒ Explanation: The house pads and street areas will not utilize this feature, but the proposed park area and open space lots will use this feature.

4.2 Project Performance Criteria

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in the MS4 Permit. These targets include runoff volume for water quality control (referred to as LID design capture volume), and runoff volume, time of concentration, and peak runoff for protection of any downstream waterbody segments with a HCOC. ***If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.***

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), the San Bernardino County Stormwater Program requires use of the P_6 method (MS4 Permit Section XI.D.6a.ii) – Form 4.2-1
- For HCOC pre- and post-development hydrologic calculation, the San Bernardino County Stormwater Program requires the use of the Rational Method (San Bernardino County Hydrology Manual Section D). Forms 4.2-2 through Form 4.2-5 calculate hydrologic variables including runoff volume, time of concentration, and peak runoff from the project site pre- and post-development using the Hydrology Manual Rational Method approach. For projects greater than 640 acres (1.0 mi²), the Rational Method and these forms should not be used. For such projects, the Unit Hydrograph Method (San Bernardino County Hydrology Manual Section E) shall be applied for hydrologic calculations for HCOC performance criteria.

Refer to Section 4 in the TGD for WQMP for detailed guidance and instructions.

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA-1 DMA A)

1 Project area DA 1 (ft^2): 131,294	**2** Imperviousness after applying preventative site design practices (Imp%): 58.80%	**3** Runoff Coefficient (Rc): 0.40 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.473. *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.70 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; 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): 6,014 *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*		

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA-2 DMA A)

1 Project area DA- 2 DMA A (ft^2): 82,597	**2** Imperviousness after applying preventative site design practices (Imp%): 60.16%	**3** Runoff Coefficient (Rc): 0.41 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.473 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.70 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; 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): 3,881 *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*		

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA-2 DMA B)

1 Project area DA- 2 DMA B (ft^2): 56,254	**2** Imperviousness after applying preventative site design practices (Imp%): 61.38%	**3** Runoff Coefficient (Rc): 0.42 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.473 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.70 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; 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): 2,704 *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*		

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA-3 DMA A)

1 Project area DA- 3 DMA A (ft^2): 37,389	**2** Imperviousness after applying preventative site design practices (Imp%): 12.69%	**3** Runoff Coefficient (Rc): 0.13 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*

4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.473 *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*

5 Compute P_6, Mean 6-hr Precipitation (inches): 0.70

*P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; 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): 546

*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

Form 4.2-2 Summary of HCOC Assessment (DA-1)

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☒ No ☐

Go to: http://sbcounty.permitrack.com/WAP

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below

(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** 11,592 *Form 4.2-3 Item 12*	**2** 18.75 *Form 4.2-4 Item 13*	**3** 1.22 *Form 4.2-5 Item 10*
Post-developed	**4** 4,861 *Form 4.2-3 Item 13*	**5** 11.00 *Form 4.2-4 Item 14*	**6** 2.72 *Form 4.2-5 Item 14*
Difference	**7** *-6,731* *Item 4 – Item 1*	**8** *7.75* *Item 2 – Item 5*	**9** *1.50* *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** *-58.1%* *Item 7 / Item 1*	**11** *41.3%* *Item 8 / Item 2*	**12** *123.0%* *Item 9 / Item 3*

Form 4.2-2 Summary of HCOC Assessment (DA-2 DMA A)

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☒ No ☐

Go to: http://sbcounty.permitrack.com/WAP

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below

(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** 7,456 *Form 4.2-3 Item 12*	**2** 12.00 *Form 4.2-4 Item 13*	**3** 1.24 *Form 4.2-5 Item 10*
Post-developed	**4** 3,127 *Form 4.2-3 Item 13*	**5** 10.25 *Form 4.2-4 Item 14*	**6** 1.77 *Form 4.2-5 Item 14*
Difference	**7** *–4,329* *Item 4 – Item 1*	**8** *1.75* *Item 2 – Item 5*	**9** *0.53* *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** *-58.1%* *Item 7 / Item 1*	**11** *14.6%* *Item 8 / Item 2*	**12** *42.7%* *Item 9 / Item 3*

Form 4.2-2 Summary of HCOC Assessment (DA-2 DMA B)

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☒ No ☐

Go to: http://sbcounty.permitrack.com/WAP

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below

(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** 5,210 *Form 4.2-3 Item 12*	**2** 13.00 *Form 4.2-4 Item 13*	**3** 0.79 *Form 4.2-5 Item 10*
Post-developed	**4** 2,185 *Form 4.2-3 Item 13*	**5** 12.25 *Form 4.2-4 Item 14*	**6** 1.09 *Form 4.2-5 Item 14*
Difference	**7** *-3,025* *Item 4 – Item 1*	**8** *0.75* *Item 2 – Item 5*	**9** *0.30* *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** *-58.1%* *Item 7 / Item 1*	**11** *5.8%* *Item 8 / Item 2*	**12** *38.0%* *Item 9 / Item 3*

Form 4.2-2 Summary of HCOC Assessment (DA-3)

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☒ No ☐

Go to: http://sbcounty.permitrack.com/WAP

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below

(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** 10,082 *Form 4.2-3 Item 12*	**2** 10.75 *Form 4.2-4 Item 13*	**3** 2.31 *Form 4.2-5 Item 10*
Post-developed	**4** 7,827 *Form 4.2-3 Item 13*	**5** 10.75 *Form 4.2-4 Item 14*	**6** 2.37 *Form 4.2-5 Item 14*
Difference	**7** *-2,225* *Item 4 – Item 1*	**8** *0* *Item 2 – Item 5*	**9** *0.06* *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** *-22.4%* *Item 7 / Item 1*	**11** *0%* *Item 8 / Item 2*	**12** *2.6%* *Item 9 / Item 3*

Form 4.2-3 HCOC Assessment for Runoff Volume (DA 1)

Weighted Curve Number Determination for: Pre-developed DA	DMA A				DMA B	DMA C	DMA D
1a Land Cover type	Agriculture Poor Cover						
2a Hydrologic Soil Group (HSG)	B						
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	125,157						
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	89						
Weighted Curve Number Determination for: Post-developed DA	DMA A				DMA B	DMA C	DMA D
1b Land Cover type	Residential 3-4 units/ac						
2b Hydrologic Soil Group (HSG)	B						
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	125,157						
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	76						

5 Pre-Developed area-weighted CN: 89	**7** Pre-developed soil storage capacity, S (in): 1.24 *S = (1000 / Item 5) - 10*	**9** Initial abstraction, I_a (in): 0.25 *I_a = 0.2 * Item 7*
6 Post-Developed area-weighted CN: 76	**8** Post-developed soil storage capacity, S (in): 3.16 *S = (1000 / Item 6) - 10*	**10** Initial abstraction, I_a (in): 0.63 *I_a = 0.2 * Item 8*

11 Precipitation for 2 yr, 24 hr storm (in): 2.10
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3): 11,592
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3): 4,861
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet HCOC Requirement, (ft^3): -6,974
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

Form 4.2-3 HCOC Assessment for Runoff Volume (DA-2)

Weighted Curve Number Determination for: Pre-developed DA	DMA A		DMA B	DMA C	DMA D
1a Land Cover type	Agriculture Poor Cover		Agriculture Poor Cover		
2a Hydrologic Soil Group (HSG)	B		B		
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	80,506		55,180		
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	89		89		
Weighted Curve Number Determination for: Post-developed DA	DMA A		DMA B	DMA C	DMA D
1b Land Cover type	Residential 3-4 units/ac		Residential 3-4 units/ac		
2b Hydrologic Soil Group (HSG)	B		B		
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	80,506		55,180		
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	76		76		

5 Pre-Developed area-weighted CN: 89	**7** Pre-developed soil storage capacity, S (in): 1.24 *S = (1000 / Item 5) - 10*	**9** Initial abstraction, I_a (in): 0.25 *I_a = 0.2 * Item 7*
6 Post-Developed area-weighted CN: 76	**8** Post-developed soil storage capacity, S (in): 3.16 *S = (1000 / Item 6) - 10*	**10** Initial abstraction, I_a (in): 0.63 *I_a = 0.2 * Item 8*

11 Precipitation for 2 yr, 24 hr storm (in): 2.10
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3): 12,567
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3): 5,270
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet HCOC Requirement, (ft^3): -7,561
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

Form 4.2-3 HCOC Assessment for Runoff Volume (DA-3)

Weighted Curve Number Determination for: Pre-developed DA	DMA A, B & C				DMA B	DMA C	DMA D
1a Land Cover type	Agriculture Poor Cover	Residential 3-4 units/ac	Residential 1 unit/ac				
2a Hydrologic Soil Group (HSG)	B	B	B				
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	102,420	3,485	16,988				
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	89	76	76				
Weighted Curve Number Determination for: Post-developed DA	DMA A, B & C				DMA B	DMA C	DMA D
1b Land Cover type	Agriculture Poor Cover	Residential 3-4 units/ac	Residential 1 unit/ac	Commercial Landscaping			
2b Hydrologic Soil Group (HSG)	B	B	B	B			
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	87,767	3,485	16,988	14,653			
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	89	76	76	56			

5 Pre-Developed area-weighted CN: 87	**7** Pre-developed soil storage capacity, S (in): 1.49 *S = (1000 / Item 5) - 10*	**9** Initial abstraction, I_a (in): 0.30 *I_a = 0.2 * Item 7*
6 Post-Developed area-weighted CN: 83	**8** Post-developed soil storage capacity, S (in): 2.05 *S = (1000 / Item 6) - 10*	**10** Initial abstraction, I_a (in): 0.41 *I_a = 0.2 * Item 8*

11 Precipitation for 2 yr, 24 hr storm (in): 2.10
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3): 10,082
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3): 7,827
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet HCOC Requirement, (ft^3): -2,646
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

Form 4.2-4 HCOC Assessment for Time of Concentration (DA 1)

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below)*

Variables	Pre-developed DA1 *Use additional forms if there are more than 4 DMA*				Post-developed DA1 *Use additional forms if there are more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*	597				793			
2 Change in elevation (ft)	24				24			
3 Slope (ft/ft), *S_o = Item 2 / Item 1*	0.040				0.030			
4 Land cover	Orchard				SFR 3-4 units/ac			
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*	18.75				11.00			
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*	0				0			
7 Cross-sectional area of channel (ft^2)	N/A				N/A	-		
8 Wetted perimeter of channel (ft)	N/A				N/A	-		
9 Manning's roughness of channel (n)	N/A				N/A	-		
10 Channel flow velocity (ft/sec) *V_{fps} = (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5*	N/A				N/A	-		
11 Travel time to outlet (min) *T_t = Item 6 / (Item 10 * 60)*	N/A				N/A	-		
12 Total time of concentration (min) *T_c = Item 5 + Item 11*	N/A				N/A			

13 Pre-developed time of concentration (min): 18.75 *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): 11.00 *Minimum of Item 12 post-developed DMA*

15 Additional time of concentration needed to meet HCOC requirement (min): 6.8 *$T_{C\text{-}HCOC}$ = (Item 13 * 0.95) – Item 14*

Form 4.2-4 HCOC Assessment for Time of Concentration (DA 2)

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below)*

Variables	Pre-developed DA2 *Use additional forms if there are more than 4 DMA*				Post-developed DA2 *Use additional forms if there are more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*	303	468			514	230		
2 Change in elevation (ft)	5.1	12.4			11.2	3.8		
3 Slope (ft/ft), S_o *= Item 2 / Item 1*	0.017	0.026			0.022	0.017		
4 Land cover	Orchard	Orchard			SFR 3-4 units/ac	SFR 3-4 units/ac		
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*	12.00	13.00			10.25	12.25		
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*	0	0			0	0		
7 Cross-sectional area of channel (ft^2)	N/A	N/A			N/A	N/A		
8 Wetted perimeter of channel (ft)	N/A	N/A			N/A	N/A		
9 Manning's roughness of channel (n)	N/A	N/A			N/A	N/A		
10 Channel flow velocity (ft/sec) V_{fps} *= (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5*	N/A	N/A			N/A	N/A		
11 Travel time to outlet (min) T_t *= Item 6 / (Item 10 * 60)*	N/A	N/A			N/A	N/A		
12 Total time of concentration (min) T_c *= Item 5 + Item 11*	N/A	N/A			N/A	N/A		

13 Pre-developed time of concentration (min): 12.00 *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): 10.25 *Minimum of Item 12 post-developed DMA*

15 Additional time of concentration needed to meet HCOC requirement (min): 1.2 $T_{C\text{-}HCOC}$ *= (Item 13 * 0.95) – Item 14*

Form 4.2-4 HCOC Assessment for Time of Concentration (DA 3)

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below)*

Variables	Pre-developed DA2 *Use additional forms if there are more than 4 DMA*				Post-developed DA2 *Use additional forms if there are more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*	341				341			
2 Change in elevation (ft)	14.2				14.2			
3 Slope (ft/ft), S_o *= Item 2 / Item 1*	0.042				0.042			
4 Land cover	Orchard				Orchard			
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*	10.75				10.75			
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*	0				0			
7 Cross-sectional area of channel (ft^2)	N/A				N/A			
8 Wetted perimeter of channel (ft)	N/A				N/A			
9 Manning's roughness of channel (n)	N/A				N/A			
10 Channel flow velocity (ft/sec) V_{fps} *= (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5*	N/A				N/A			
11 Travel time to outlet (min) T_t *= Item 6 / (Item 10 * 60)*	N/A				N/A			
12 Total time of concentration (min) T_c *= Item 5 + Item 11*	N/A				N/A			

13 Pre-developed time of concentration (min): 10.75 *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): 10.75 *Minimum of Item 12 post-developed DMA*

15 Additional time of concentration needed to meet HCOC requirement (min): -0.5 $T_{C\text{-}HCOC}$ *= (Item 13 * 0.95) – Item 14*

Form 4.2-5 HCOC Assessment for Peak Runoff (DA 1)

Compute peak runoff for pre- and post-developed conditions

Variables		Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*			Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*		0.95			1.31		
2 Drainage Area of each DMA (Acres) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		3.01			3.01		
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		1.00			0.41		
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		0.50			0.74		
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.50			0.30		
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		1.22			2.72		
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: 1.22

*Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*

9 Pre-developed Q_p at T_c for DMA B:

*Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*

10 Pre-developed Q_p at T_c for DMA C:

*Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*

10 Peak runoff from pre-developed condition confluence analysis (cfs): 1.22 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA A: 2.72

Same as Item 8 for post-developed values

12 Post-developed Q_p at T_c for DMA B:

Same as Item 9 for post-developed values

13 Post-developed Q_p at T_c for DMA C:

Same as Item 10 for post-developed values

14 Peak runoff from post-developed condition confluence analysis (cfs): 2.72

Maximum of Item 11, 12, and 13 (including additional forms as needed)

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): 1.37 *$Q_{p\text{-}HCOC}$ = (Item 14 * 0.95) – Item 10*

Form 4.2-5 HCOC Assessment for Peak Runoff (DA 2)

Compute peak runoff for pre- and post-developed conditions

Variables		Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*			Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*		1.24	1.18		1.37	1.23	
2 Drainage Area of each DMA (Acres) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		1.85	1.29		1.85	1.29	
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		1.00	1.00		0.41	0.39	
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		0.50	0.50		0.74	0.74	
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.50	0.50		0.30	0.29	
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		1.24	0.79		1.77	1.09	
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: 2.03

*Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*

9 Pre-developed Q_p at T_c for DMA B:

*Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*

10 Pre-developed Q_p at T_c for DMA C:

*Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*

10 Peak runoff from pre-developed condition confluence analysis (cfs): 2.03 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA A: 2.86

Same as Item 8 for post-developed values

12 Post-developed Q_p at T_c for DMA B:

Same as Item 9 for post-developed values

13 Post-developed Q_p at T_c for DMA C:

Same as Item 10 for post-developed values

14 Peak runoff from post-developed condition confluence analysis (cfs): 2.86

Maximum of Item 11, 12, and 13 (including additional forms as needed)

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): 0.68 *$Q_{p\text{-}HCOC}$ = (Item 14 * 0.95) – Item 10*

Form 4.2-5 HCOC Assessment for Peak Runoff (DA 3)

Compute peak runoff for pre- and post-developed conditions

Variables		Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*			Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*		1.33			1.33		
2 Drainage Area of each DMA (Acres) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		2.82			2.82		
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.83			0.79		
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		0.50			0.50		
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.42			0.40		
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		2.31			2.37		
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: 2.31

*Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*

9 Pre-developed Q_p at T_c for DMA B:

*Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*

10 Pre-developed Q_p at T_c for DMA C:

*Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*

10 Peak runoff from pre-developed condition confluence analysis (cfs): 2.31 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA A: 2.37

Same as Item 8 for post-developed values

12 Post-developed Q_p at T_c for DMA B:

Same as Item 9 for post-developed values

13 Post-developed Q_p at T_c for DMA C:

Same as Item 10 for post-developed values

14 Peak runoff from post-developed condition confluence analysis (cfs): 2.37

Maximum of Item 11, 12, and 13 (including additional forms as needed)

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): -0.07 *$Q_{p\text{-}HCOC}$ = (Item 14 * 0.95) – Item 10*

4.3 Project Conformance Analysis

Complete the following forms for each project site DA to document that the proposed LID BMPs conform to the project DCV developed to meet performance criteria specified in the MS4 Permit (WQMP Template Section 4.2). For the LID DCV, the forms are ordered according to hierarchy of BMP selection as required by the MS4 Permit (see Section 5.3.1 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design and Hydrologic Source Controls (Form 4.3-2)
- Retention and Infiltration (Form 4.3-3)
- Harvested and Use (Form 4.3-4) or
- Biotreatment (Form 4.3-5).

At the end of each form, additional fields facilitate the determination of the extent of mitigation provided by the specific BMP category, allowing for use of the next category of BMP in the hierarchy, if necessary.

The first step in the analysis, using Section 5.3.2.1 of the TGD for WQMP, is to complete Forms 4.3-1 and 4.3-3) to determine if retention and infiltration BMPs are infeasible for the project. For each feasibility criterion in Form 4.3-1, if the answer is "Yes," provide all study findings that includes relevant calculations, maps, data sources, etc. used to make the determination of infeasibility.

Next, complete Forms 4.3-2 and 4.3-4 to determine the feasibility of applicable HSC and harvest and use BMPs, and, if their implementation is feasible, the extent of mitigation of the DCV.

If no site constraints exist that would limit the type of BMP to be implemented in a DA, evaluate the use of combinations of LID BMPs, including all applicable HSC BMPs to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV within the minimum effective area.

If the combination of LID HSC, retention and infiltration, and harvest and use BMPs are unable to mitigate the entire DCV, then biotreatment BMPs may be implemented by the project proponent. If biotreatment BMPs are used, then they must be sized to provide sufficient capacity for effective treatment of the remainder of the volume-based performance criteria that cannot be achieved with LID BMPs (TGD for WQMP Section 5.4.4.2). **Under no circumstances shall any portion of the DCV be released from the site without effective mitigation and/or treatment**.

Form 4.3-1 Infiltration BMP Feasibility (DA 1)

Feasibility Criterion – Complete evaluation for each DA on the Project Site

1 Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☒

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

2 Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☒

(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

- The location is less than 50 feet away from slopes steeper than 15 percent
- The location is less than eight feet from building foundations or an alternative setback.
- A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards.

If Yes, Provide basis: (attach)

3 Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☒

If Yes, Provide basis: (attach)

4 Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☒

If Yes, Provide basis: (attach)

5 Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☒ No ☐

If Yes, Provide basis: (see infiltration testing results in appendix)

6 Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☒

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

7 Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☒

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

8 Any answer from Item 4 through Item 6 is "Yes": Yes ☒ No ☐

If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

9 All answers to Item 1 through Item 6 are "No":

Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.
Proceed to Form 4.3-2, Hydrologic Source Control BMP.

Form 4.3-1 Infiltration BMP Feasibility (DA 2)

Feasibility Criterion – Complete evaluation for each DA on the Project Site

1 Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☒

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

2 Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☒

(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

If Yes, Provide basis: 15' building foundation setback required for infiltration – see infiltration report in Section 6.4E.

3 Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☒

If Yes, Provide basis: (attach)

4 Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☒

If Yes, Provide basis: (attach)

5 Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☒ No ☐

If Yes, Provide basis: (see infiltration testing results in appendix)

6 Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☒

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

7 Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☒

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

8 Any answer from Item 4 through Item 6 is "Yes": Yes ☒ No ☐

If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

9 All answers to Item 1 through Item 6 are "No":

Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.
Proceed to Form 4.3-2, Hydrologic Source Control BMP.

Form 4.3-1 Infiltration BMP Feasibility (DA 3)

Feasibility Criterion – Complete evaluation for each DA on the Project Site

1 Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☒

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

2 Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☒

(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

If Yes, Provide basis: 15' building foundation setback required for infiltration – see infiltration report in Section 6.4E.

3 Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☒

If Yes, Provide basis: (attach)

4 Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☒

If Yes, Provide basis: (attach)

5 Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☒ No ☐

If Yes, Provide basis: (see infiltration testing results in appendix)

6 Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☒

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

7 Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☒

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

8 Any answer from Item 4 through Item 6 is "Yes": Yes ☒ No ☐

If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

9 All answers to Item 1 through Item 6 are "No":

Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.
Proceed to Form 4.3-2, Hydrologic Source Control BMP.

4.3.1 Site Design Hydrologic Source Control BMP

Section XI.E. of the Permit emphasizes the use of LID preventative measures; and the use of LID HSC BMPs reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable HSC shall be provided except where they are mutually exclusive with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of HSC, if a project cannot feasibly meet BMP sizing requirements or cannot fully address HCOCs, feasibility of all applicable HSC must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design HSC BMP. Refer to Section 5.4.1 in the TGD for more detailed guidance.

Form 4.3-2 Site Design Hydrologic Source Control BMPs (DA 1)

1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☐ No ☒ *If yes, complete Items 2-5; If no, proceed to Item 6*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Total impervious area draining to pervious area (ft^2)			
3 Ratio of pervious area receiving runoff to impervious area			
4 Retention volume achieved from impervious area dispersion (ft^3) *V = Item2 * Item 3 * (0.5/12), assuming retention of 0.5 inches of runoff*			
5 Sum of retention volume achieved from impervious area dispersion (ft^3): 0 $V_{retention}$ *=Sum of Item 4 for all BMPs*			
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
7 Ponding surface area (ft^2)			
8 Ponding depth (ft)			
9 Surface area of amended soil/gravel (ft^2)			
10 Average depth of amended soil/gravel (ft)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft^3) $V_{retention}$ *= (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*			
13 Runoff volume retention from on-lot infiltration (ft^3): 0 $V_{retention}$ *=Sum of Item 12 for all BMPs*			

Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs (DA 1)

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☒ *If yes, complete Items 15-20. If no, proceed to Item 21*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Rooftop area planned for ET BMP (ft^2)			
16 Average wet season ET demand (in/day) *Use local values, typical ~ 0.1*			
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*			
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*			
19 Retention Volume (ft^3) *$V_{retention}$ = Item 17 * (Item 18 / 24)*			
20 Runoff volume retention from evapotranspiration BMPs (ft^3): 0 *$V_{retention}$ =Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 22-25. If no, proceed to Item 26*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
22 Number of Street Trees			
23 Average canopy cover over impervious area (ft^2)			
24 Runoff volume retention from street trees (ft^3) *$V_{retention}$ = Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*			
25 Runoff volume retention from street tree BMPs (ft^3): 0 *$V_{retention}$ = Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrel/cisterns: Yes☐ No ☒ *If yes, complete Items 27-29; If no, proceed to Item 30*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft^3) *$V_{retention}$ = Item 27 * 3*			
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): 0 *$V_{retention}$ =Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 0 *Sum of Items 5, 13, 20, 25 and 29*			

Form 4.3-2 Site Design Hydrologic Source Control BMPs (DA-2)

1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☐ No ☒ *If yes, complete Items 2-5; If no, proceed to Item 6*	DA-1 DMA A BMP Type Impervious Area Dispersion	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Total impervious area draining to pervious area (ft^2)			
3 Ratio of pervious area receiving runoff to impervious area			
4 Retention volume achieved from impervious area dispersion (ft^3) *V = Item2 * Item 3 * (0.5/12), assuming retention of 0.5 inches of runoff*			
5 Sum of retention volume achieved from impervious area dispersion (ft^3): 0 $V_{retention}$ *=Sum of Item 4 for all BMPs*			
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
7 Ponding surface area (ft^2)			
8 Ponding depth (ft)			
9 Surface area of amended soil/gravel (ft^2)			
10 Average depth of amended soil/gravel (ft)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft^3) $V_{retention}$ *= (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*			
13 Runoff volume retention from on-lot infiltration (ft^3): 0 $V_{retention}$ *=Sum of Item 12 for all BMPs*			

Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs (DA-2)

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☒ *If yes, complete Items 15-20. If no, proceed to Item 21*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Rooftop area planned for ET BMP (ft^2)			
16 Average wet season ET demand (in/day) *Use local values, typical ~ 0.1*			
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*			
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*			
19 Retention Volume (ft^3) *$V_{retention}$ = Item 17 * (Item 18 / 24)*			
20 Runoff volume retention from evapotranspiration BMPs (ft^3): 0 *$V_{retention}$ =Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 22-25. If no, proceed to Item 26*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
22 Number of Street Trees			
23 Average canopy cover over impervious area (ft^2)			
24 Runoff volume retention from street trees (ft^3) *$V_{retention}$ = Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*			
25 Runoff volume retention from street tree BMPs (ft^3): 0 *$V_{retention}$ = Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrel/cisterns: Yes☐ No ☒ *If yes, complete Items 27-29; If no, proceed to Item 30*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft^3) *$V_{retention}$ = Item 27 * 3*			
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): 0 *$V_{retention}$ =Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 0 *Sum of Items 5, 13, 20, 25 and 29*			

Form 4.3-2 Site Design Hydrologic Source Control BMPs (DA-3)

1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☒ No ☐ *If yes, complete Items 2-5; If no, proceed to Item 6*	DA-3 DMA A BMP Type Impervious Area Dispersion	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Total impervious area draining to pervious area (ft^2)	4,746		
3 Ratio of pervious area receiving runoff to impervious area	2.10		
4 Retention volume achieved from impervious area dispersion (ft^3) *V = Item2 * Item 3 * (0.7/12), assuming retention of 0.7 inches of runoff (typ. Is 0.5", 0.7" used for park area).*	581		
5 Sum of retention volume achieved from impervious area dispersion (ft^3): 581 $V_{retention}$ *=Sum of Item 4 for all BMPs*			
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
7 Ponding surface area (ft^2)			
8 Ponding depth (ft)			
9 Surface area of amended soil/gravel (ft^2)			
10 Average depth of amended soil/gravel (ft)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft^3) $V_{retention}$ *= (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*			
13 Runoff volume retention from on-lot infiltration (ft^3): 0 $V_{retention}$ *=Sum of Item 12 for all BMPs*			

Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs (DA-3)

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☒ *If yes, complete Items 15-20. If no, proceed to Item 21*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Rooftop area planned for ET BMP (ft^2)			
16 Average wet season ET demand (in/day) *Use local values, typical ~ 0.1*			
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*			
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*			
19 Retention Volume (ft^3) $V_{retention}$ = *Item 17 * (Item 18 / 24)*			
20 Runoff volume retention from evapotranspiration BMPs (ft^3): 0 $V_{retention}$ =*Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 22-25. If no, proceed to Item 26*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
22 Number of Street Trees			
23 Average canopy cover over impervious area (ft^2)			
24 Runoff volume retention from street trees (ft^3) $V_{retention}$ = *Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*			
25 Runoff volume retention from street tree BMPs (ft^3): 0 $V_{retention}$ = *Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrel/cisterns: Yes☐ No ☒ *If yes, complete Items 27-29; If no, proceed to Item 30*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft^3) $V_{retention}$ = *Item 27 * 3*			
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): 0 $V_{retention}$ =*Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 581 *Sum of Items 5, 13, 20, 25 and 29*			

1

4.3.2 Infiltration BMPs

Use Form 4.3-3 to compute on-site retention of runoff from proposed retention and infiltration BMPs. Volume retention estimates are sensitive to the percolation rate used, which determines the amount of runoff that can be infiltrated within the specified drawdown time. The infiltration safety factor reduces field measured percolation to account for potential inaccuracy associated with field measurements, declining BMP performance over time, and compaction during construction. Appendix D of the TGD for WQMP provides guidance on estimating an appropriate safety factor to use in Form 4.3-3.

If site constraints limit the use of BMPs to a single type and implementation of retention and infiltration BMPs mitigate no more than 40% of the DCV, then they are considered infeasible and the Project Proponent may evaluate the effectiveness of BMPs lower in the LID hierarchy of use (Section 5.5.1 of the TGD for WQMP)

If implementation of infiltrations BMPs is feasible as determined using Form 4.3-1, then LID infiltration BMPs shall be implemented to the MEP (section 4.1 of the TGD for WQMP).

Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA-1)

1 Remaining LID DCV not met by site design HSC BMP (ft^3): *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30*			
BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA 1 DMA A BMP Type (Infiltration Basin)	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods*			
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*			
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*			
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*			
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*			
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*			
8 Infiltrating surface area, *SA_{BMP}* (ft^2) *the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP*			
9 Amended soil depth, *d_{media}* (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*			
10 Amended soil porosity			
11 Gravel depth, *d_{media}* (ft) *Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details*			
12 Gravel porosity			
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
14 Above Ground Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*			
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*			
16 Total Retention Volume from LID Infiltration BMPs: *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*			
17 Fraction of DCV achieved with infiltration BMP: *Retention% = Item 16 / Form 4.2-1 Item 7*			
18 Is full LID DCV retained on-site with combination of hydrologic source control and LID retention and infiltration BMPs? Yes ☐ No ☐ *If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.*			

4.3.3 Harvest and Use BMP

Harvest and use BMP may be considered if the full LID DCV cannot be met by maximizing infiltration BMPs. Use Form 4.3-4 to compute on-site retention of runoff from proposed harvest and use BMPs.

Volume retention estimates for harvest and use BMPs are sensitive to the on-site demand for captured stormwater. Since irrigation water demand is low in the wet season, when most rainfall events occur in San Bernardino County, the volume of water that can be used within a specified drawdown period is relatively low. The bottom portion of Form 4.3-4 facilitates the necessary computations to show infeasibility if a minimum incremental benefit of 40 percent of the LID DCV would not be achievable with MEP implementation of on-site harvest and use of stormwater (Section 5.5.4 of the TGD for WQMP).

Form 4.3-4 Harvest and Use BMPs (DA 1)

1 Remaining LID DCV not met by site design HSC or infiltration BMP (ft^3): 0 *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16*			
BMP Type(s) *Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Describe cistern or runoff detention facility			
3 Storage volume for proposed detention type (ft^3) *Volume of cistern*			
4 Landscaped area planned for use of harvested stormwater (ft^2)			
5 Average wet season daily irrigation demand (in/day) Use local values, typical ~ 0.1 in/day			
6 Daily water demand (ft^3/day) *Item 4 * (Item 5 / 12)*			
7 Drawdown time (hrs) *Copy Item 6 from Form 4.2-1*			
8 Retention Volume (ft^3) *$V_{retention}$ = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))*			
9 Total Retention Volume (ft^3) from Harvest and Use BMP 0 *Sum of Item 8 for all harvest and use BMP included in plan*			
10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest and use BMPs? Yes ☐ No ☐ *If yes, demonstrate conformance using Form 4.3-10. If no, then re-evaluate combinations of all LID BMP and optimize their implementation such that the maximum portion of the DCV is retained on-site (using a single BMP type or combination of BMP types). If the full DCV cannot be mitigated after this optimization process, proceed to Section 4.3.4.*			

4.3.4 Biotreatment BMP

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration, and harvest and use BMPs. A key consideration when using biotreatment BMP is the effectiveness of the proposed BMP in addressing the pollutants of concern for the project (see Table 5-5 of the TGD for WQMP).

Use Form 4.3-5 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV w. Biotreatment computations are included as follows:

- Use Form 4.3-6 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-7 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-8 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

Form 4.3-5 Selection and Evaluation of Biotreatment BMP (DA-1)

1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft^3): 6,014 *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*	List pollutants of concern *Copy from Form 2.3-1.* Pathogens (Bacterial / Virus), Nutrients – Phosphorous and Nitrogen, Noxious Aquatic Plants, Sediment, Metals, Oil and Grease, Trash/Debris, Pesticides / Herbicides, Organic Compounds	
2 Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)*	Volume-based biotreatment *Use Forms 4.3-6 and 4.3-7 to compute treated volume*	Flow-based biotreatment *Use Form 4.3-8 to compute treated volume*
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	☒ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft^3): *Form 4.3-6 Item 15 + Form 4.3-7 Item 13*	**4** Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): *Item 1 – Item 3*	**5** Remaining fraction of LID DCV for sizing flow based biotreatment BMP: *Item 4 / Item 1*
6 Flow-based biotreatment BMP capacity provided (cfs): 0.24 *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*		
7 Metrics for MEP determination: • Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*		

Form 4.3-5 Selection and Evaluation of Biotreatment BMP (DA-2 DMA A)

1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft^3): 3,881 *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*	List pollutants of concern *Copy from Form 2.3-1.* Pathogens (Bacterial / Virus), Nutrients – Phosphorous and Nitrogen, Noxious Aquatic Plants, Sediment, Metals, Oil and Grease, Trash/Debris, Pesticides / Herbicides, Organic Compounds

2 Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)*	Volume-based biotreatment *Use Forms 4.3-6 and 4.3-7 to compute treated volume*	Flow-based biotreatment *Use Form 4.3-8 to compute treated volume*
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	☒ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment

3 Volume biotreated in volume based biotreatment BMP (ft^3): *Form 4.3-6 Item 15 + Form 4.3-7 Item 13*	**4** Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): *Item 1 – Item 3*	**5** Remaining fraction of LID DCV for sizing flow based biotreatment BMP: *Item 4 / Item 1*

6 Flow-based biotreatment BMP capacity provided (cfs): 0.16 *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*

7 Metrics for MEP determination:

- Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*

Form 4.3-6 Volume Based Biotreatment (DA-2 DMA B) – Bioretention and Planter Boxes with Underdrains

Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)*	DA-2 DMA B BMP Type Bioretention w/underdrain	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*	Pathogens, Metals, Sediment/TSS, Organic Compounds, Pesiticides/Herbicides, Trash and Debris, Oil and Grease.		
2 Amended soil infiltration rate *Typical ~ 5.0 (Soil infiltration rate is not supplied for the Filterra system supplied by Contech)*	N/A		
3 Amended soil infiltration safety factor *Typical ~ 2.0*	N/A		
4 Amended soil design percolation rate (in/hr) P_{design} *= Item 2 / Item 3 (Design percolation rate for Filterra Media supplied by Contech)*	100		
5 Ponded water drawdown time (hr) *Copy Item 6 from Form 4.2-1*	48		
6 Maximum ponding depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	.75		
7 Ponding Depth (ft) d_{BMP} *= Minimum of (1/12 * Item 4 * Item 5) or Item 6*	.75		
8 Amended soil surface area (ft^2)	112		
9 Amended soil depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	1.75		
10 Amended soil porosity, *n*	0.35		
11 Gravel depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	0.5		
12 Gravel porosity, *n*	0.35		
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	3		
14 Biotreated Volume (ft^3) $V_{biotreated}$ *= Item 8 * [(Item 7/2) + (Item 9 * Item 10) +(Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*	2,930		
15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: 2,930 *Sum of Item 14 for all volume-based BMPs included in this form*			

Form 4.3-7 Volume Based Biotreatment (DA) – Constructed Wetlands and Extended Detention

Biotreatment BMP Type *Constructed wetlands, extended wet detention, extended dry detention, or other comparable proprietary BMP. If BMP includes multiple modules (e.g. forebay and main basin), provide separate estimates for storage and pollutants treated in each module.*	DA DMA BMP Type		DA DMA BMP Type *(Use additional forms for more BMPs)*	
	Forebay	Basin	Forebay	Basin
1 Pollutants addressed with BMP forebay and basin *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*				
2 Bottom width (ft)				
3 Bottom length (ft)				
4 Bottom area (ft^2) A_{bottom} *= Item 2 * Item 3*				
5 Side slope (ft/ft)				
6 Depth of storage (ft)				
7 Water surface area (ft^2) $A_{surface}$ *=(Item 2 + (2 * Item 5 * Item 6)) * (Item 3 + (2 * Item 5 * Item 6))*				
8 Storage volume (ft^3) *For BMP with a forebay, ensure fraction of total storage is within ranges specified in BMP specific fact sheets, see Table 5-6 of the TGD for WQMP for reference to BMP design details* V *=Item 6 / 3 * [Item 4 + Item 7 + (Item 4 * Item 7)^0.5]*				
9 Drawdown Time (hrs) *Copy Item 6 from Form 2.1*				
10 Outflow rate (cfs) Q_{BMP} *= (Item* $8_{forebay}$ *+ Item* 8_{basin}*) / (Item 9 * 3600)*				
11 Duration of design storm event (hrs)				
12 Biotreated Volume (ft^3) $V_{biotreated}$ *= (Item* $8_{forebay}$ *+ Item* 8_{basin}*) +(Item 10 * Item 11 * 3600)*				
13 Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention : 0 *(Sum of Item 12 for all BMP included in plan)*				

Form 4.3-8 Flow Based Biotreatment (DA-1 & DA-2)
(see Section 6.4D Misc. Calculations for Vegetated Swale Sizing)

Biotreatment BMP Type *Vegetated swale, vegetated filter strip, or other comparable proprietary BMP*	DA-1 DMA A BMP Type Vegetated Swales	DA-2 DMA A BMP Type Vegetated Swales	DA DMA BMP Type *(Use additional forms for more BMPs)*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in TGD Table 5-5*	Pathogens, Metals, Sediment/TSS, Organic Compounds, Pesiticides/Herbicides, Trash and Debris, Oil and Grease.	Pathogens, Metals, Sediment/TSS, Organic Compounds, Pesiticides/Herbicides, Trash and Debris, Oil and Grease.	
2 Flow depth for water quality treatment (ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*	0.18	0.17	
3 Bed slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*	0.050	0.026	
4 Manning's roughness coefficient	0.20	0.20	
5 Bottom width (ft) b_w *= (Form 4.3-5 Item 6 * Item 4) / (1.49 * Item 2^1.67 * Item 3^0.5)*	2.50	2.50	
6 Side Slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*	0.33	0.33	
7 Cross sectional area (ft^2) *A = (Item 5 * Item 2) + (Item 6 * Item 2^2)*	0.55	0.51	
8 Water quality flow velocity (ft/sec) *V = Form 4.3-5 Item 6 / Item 7*	0.44	0.31	
9 Hydraulic residence time (min) *Pollutant specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*	10	10	
10 Length of flow based BMP (ft) *L = Item 8 * Item 9 * 60*	263	188	
11 Water surface area at water quality flow depth (ft^2) SA_{top} *= (Item 5 + (2 * Item 2 * Item 6)) * Item 10*	689	490	

4.3.5 Conformance Summary

Complete Form 4.3-9 to demonstrate how on-site LID DCV is met with proposed site design hydrologic source control, infiltration, harvest and use, and/or biotreatment BMP. The bottom line of the form is used to describe the basis for infeasibility determination for on-site LID BMP to achieve full LID DCV, and provides methods for computing remaining volume to be addressed in an alternative compliance plan. If the project has more than one outlet, then complete additional versions of this form for each outlet.

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA-1)

1 Total LID DCV for the Project DA-1 (ft^3): 6,014 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 0 *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 0 *Copy Item 16 in Form 4.3-3*

4 On-site retention with LID harvest and use BMP (ft^3): 0 *Copy Item 9 in Form 4.3-4*

5 On-site biotreatment with volume based biotreatment BMP (ft^3): 0 *Copy Item 3 in Form 4.3-5*

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0.24 *Copy Item 6 in Form 4.3-5*

7 LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☐ No ☒
  If yes, sum of Items 2, 3, and 4 is greater than Item 1
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒
  If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized
- On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☒ No ☐
  If yes, Form 4.3-1 Items 7 and 8 were both checked yes

8 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐
  *Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} = (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*
- An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐
  Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA-2 DMA A)

1 Total LID DCV for the Project DA-2 DMA A(ft^3): 3,881 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 0 *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 0 *Copy Item 16 in Form 4.3-3*

4 On-site retention with LID harvest and use BMP (ft^3): 0 *Copy Item 9 in Form 4.3-4*

5 On-site biotreatment with volume based biotreatment BMP (ft^3): 0 *Copy Item 3 in Form 4.3-5*

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0.16 *Copy Item 6 in Form 4.3-5*

7 LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☐ No ☒
  If yes, sum of Items 2, 3, and 4 is greater than Item 1
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒
  If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized
- On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☒ No ☐
  If yes, Form 4.3-1 Items 7 and 8 were both checked yes

8 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐
  *Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} = (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*
- An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐
  Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA-2 DMA B)

1 Total LID DCV for the Project DA-2 DMA B(ft^3): 2,704 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 0 *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 0 *Copy Item 16 in Form 4.3-3*

4 On-site retention with LID harvest and use BMP (ft^3): 0 *Copy Item 9 in Form 4.3-4*

5 On-site biotreatment with volume based biotreatment BMP (ft^3): 2,930 *Copy Item 3 in Form 4.3-5*

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 *Copy Item 6 in Form 4.3-5*

7 LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☐ No ☒
  If yes, sum of Items 2, 3, and 4 is greater than Item 1
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒
  If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized
- On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☒ No ☐
  If yes, Form 4.3-1 Items 7 and 8 were both checked yes

8 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐
  *Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} = (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*
- An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐
  Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA-3 DMA A)

1 Total LID DCV for the Project DA-3 DMA A (ft^3): 546 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 581 *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 0 *Copy Item 16 in Form 4.3-3*

4 On-site retention with LID harvest and use BMP (ft^3): 0 *Copy Item 9 in Form 4.3-4*

5 On-site biotreatment with volume based biotreatment BMP (ft^3): 0 *Copy Item 3 in Form 4.3-5*

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 *Copy Item 6 in Form 4.3-5*

7 LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☒ No ☐
  If yes, sum of Items 2, 3, and 4 is greater than Item 1
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒
  If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized
- On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☐ No ☒
  If yes, Form 4.3-1 Items 7 and 8 were both checked yes

8 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐
  *Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} = (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*
- An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐
  Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed

4.3.6 Hydromodification Control BMP

Use Form 4.3-10 to compute the remaining runoff volume retention, after LID BMP are implemented, needed to address HCOC, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential HCOC. Describe hydromodification control BMP that address HCOC, which may include off-site BMP and/or in-stream controls. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-10 Hydromodification Control BMPs (DA-1, DA-2 & DA-3)

HCOC requirements for DA-1, DA-2 & DA-3 have been combined due to the close proximity/confluence location of the outlet locations along Palm Avenue and Alvarado Street.

1 Volume reduction needed for HCOC performance criteria (ft^3): -17,181 *(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1*	**2** On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft^3): 581 *Sum of Form 4.3-9 Items 2, 3, and 4 Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving HCOC volume reduction*
3 Remaining volume for HCOC volume capture (ft^3): -17,762 *Item 1 – Item 2*	**4** Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft^3): 0 *Existing downstream BMP may be used to demonstrate additional volume capture (if so, attach to this WQMP a hydrologic analysis showing how the additional volume would be retained during a 2-yr storm event for the regional watershed)*

5 If Item 4 is less than Item 3, incorporate in-stream controls on downstream waterbody segment to prevent impacts due to hydromodification ☐ *Attach in-stream control BMP selection and evaluation to this WQMP*

6 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☒

If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site or off-site retention BMP ☒ Vegetated Swales with minimum 10 Min. hydraulic resonance time are provided for primary project drainage areas (DA-1 and DA-2) increasing the overall project time of concentration.
  BMP upstream of a waterbody segment with a potential HCOC may be used to demonstrate increased time of concentration through hydrograph attenuation (if so, show that the hydraulic residence time provided in BMP for a 2-year storm event is equal or greater than the addition time of concentration requirement in Form 4.2-4 Item 15)
- Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☐
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

7 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☒

If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site or off-site retention BMPs ☒ Vegetated Swales with minimum 10 Min. hydraulic resonance time are provided for primary project drainage areas (DA-1 & DA-2) and hydraulic source control retention is provided in DA-3 decreasing peak run-off. DA-2 is also routed through a bioretention system further reducing peak run-off from this drainage area.
  BMPs upstream of a waterbody segment with a potential HCOC may be used to demonstrate additional peak runoff reduction through hydrograph attenuation (if so, attach to this WQMP, a hydrograph analysis showing how the peak runoff would be reduced during a 2-yr storm event)
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

4.4 Alternative Compliance Plan (if applicable)

Describe an alternative compliance plan (if applicable) for projects not fully able to infiltrate, harvest and use, or biotreat the DCV via on-site LID practices. A project proponent must develop an alternative compliance plan to address the remainder of the LID DCV. Depending on project type some projects may qualify for water quality credits that can be applied to reduce the DCV that must be treated prior to development of an alternative compliance plan (see Form 2.4-1, Water Quality Credits). Form 4.3-9 Item 8 includes instructions on how to apply water quality credits when computing the DCV that must be met through alternative compliance. Alternative compliance plans may include one or more of the following elements:

- On-site structural treatment control BMP - All treatment control BMP should be located as close to possible to the pollutant sources and should not be located within receiving waters;
- Off-site structural treatment control BMP - Pollutant removal should occur prior to discharge of runoff to receiving waters;
- Urban runoff fund or In-lieu program, if available

Depending upon the proposed alternative compliance plan, approval by the executive officer may or may not be required (see Section 6 of the TGD for WQMP).

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMP included as part of the project WQMP are required to be maintained through regular scheduled inspection and maintenance (refer to Section 8, Post Construction BMP Requirements, in the TGD for WQMP). Fully complete Form 5-1 summarizing all BMP included in the WQMP. Attach additional forms as needed. The WQMP shall also include a detailed Operation and Maintenance Plan for all BMP and may require a Maintenance Agreement (consult the jurisdiction's LIP). If a Maintenance Agreement is required, it must also be attached to the WQMP.

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)

BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Education of Property Owners, Tenants and Occupants	Lot Owners	The project owner is responsible for the initial distribution of the WQMP and educational materials to the individual lot owners at the close of escrow on each lot. Individual lot owners are responsible for staying informed regarding current storm water quality requirements by downloading the latest educational material published by the County of San Bernardino and available on the County's website at: http://www.sbcountystormwater.org/ agency.	Yearly
Activity Restrictions	Lot Owners	Lot owner to review activity restrictions for the community (e.g. – car washing restrictions, hazardous material storage requirements, etc.) on an annual basis for changes in local City ordinance. These restrictions include any activities that violate the ordinances in Chapter 13.54 of the City of Redlands Municipal Codes and any activities for which adequate BMPs have not been provided.	Yearly
BMP Maintenance	Lot Owners, HOA and City of Redlands through a CFD	Lot owners to inspect and maintain routine structural BMPs on their lots per the BMP maintenance recommendations provided on BMP reference sheets in Section 6.4B of this manual. The Home Owner's Association to inspect and maintain Lots A-D per the BMP maintenance recommendations provided on BMP reference sheets in Section 6.4B of this manual. The City of Redlands, through a CFD, to inspect and maintain Parcel 3 per the BMP maintenance recommendations provided on BMP reference sheets in Section 6.4B of this manual.	Monthly
Local Water Quality Ordinances	Lot Owners	City regulated compliance. Check with City of Redlands regarding changes in local water quality ordinance on annual basis. The ordinances may be found in Chapter 13.54 of the City of Redlands	Yearly

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
		Municipal Code and on the City's web site at www.cityofredlands.org	
Spill Contingency Plan	N/A	Not applicable for residential subdivision project where storage of hazardous materials not permitted.	N/A
Litter / Debris Control Program	Lot Owners and City of Redlands	Maintenance shall consist of litter patrol, emptying of trash receptacles (trash collection service provided by City of Redlands), picking up pet waste and using the proper containers for trash pickup. Containers should be cleaned at least every six months by Lot Owners.	Daily & 6 Months
Storm Drain Signage	Project Owner (prior to City acceptance) then City of Redlands	Owner to inspect and replace storm drain signage as necessary. The City of Redlands will not inspect or maintain any devices until the infrastructure is accepted by the City. Until that time it is the owner's responsibility to inspect and maintain this BMP.	Yearly (prior to City acceptance) then City Determined
Landscape Finished Grade	Lot Owners	This inspection and maintenance normally refers to some landscape areas and parkway grade held at a lower grade than the surrounding area. Verfify landscaping is 1-2" below the adjacent finished surface grade to allow for ponding. Remove excessive soil and/or vegetation to restore 1" minimum depth of lanscaping area below adjacent grade. Replant landscaping areas disturbed during soil removal.	Monthly
Protect Slopes and Channels and provide Energy Dissipation	Lot Owners	Channels (Drainage Swales) – Lot owner's to inspect for debris and/or overgrowth, clean, repair and replace all channel stabilization and vegetation. Slopes - Lot owner's to inspect for erosion and/or overgrowth, clean, repair and replace all slope stabilization and vegetation as necessary.	Monthly
Landscape Maintenance	Lot Owners	Landscapes shall be maintained to ensure water efficiency and healthy appearance. A regular maintenance schedule shall include, but not be limited to: 1. Checking, adjusting, and repairing the irrigation equipment; 2. Resetting the automatic controller; 3. Aerating and dethatching turf areas; 4. Replenishing mulch; 5. Fertilizing;	Weekly

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
		6. Pruning, weeding, removing litter and replacement of plants as required. Verify fertilizer and pesticide usage requirements consistent with the instructions contained on product labels and with the regulations administered by the State Department of Pesticide Regulation Comply with product labels as new products are purchased and update new regulations by the State Department of Pesticide Regulation (http://www.cdpr.ca.gov/)	
Roof Runoff Controls	Lot Owners	Roof Inlets and Outlets - Inspect and clean as necessary all roof inlets, outlets and drains (CASQA New Development BMP Handbook SD-11)	Twice a year – once in October and once in April/May
Efficient Irrigation	Lot Owners	1. Rain and pressure shutoff devices inspect and replace as necessary 2. Timers inspect and replace as necessary 3. Add mulch (wood chips) 4. Overspray Inspect and adjust system	Monthly
SD-21 Alternative Building Materials	Lot Owners	Decking & Fencing - inspect, repair and replace. Use no Chromated Copper Arsenate products for repair or replacement. Roofing - inspect, repair and replace. If repair or replacement product is metal, use only appropriately coated products.Paved areas - see pervious pavement maintenance. Building siding - inspect, repair and replace. Pesticide reduction - inspect, repair and replace termite barriers	Yearly
TC-30 Vegetated Swales	HOA	1. Inspect for standing water, erosion, sediment accumulation and trash/debris. 2. Remove trash and debris. 3. Trim vegetation or revegetate where erosion has occurred. 4. Remove accumulated sediment and regrade when sediment accumulation exceeds 10% of swale depth.	Monthly
TC-32 Filterra Bioretention System (Bioretention)	HOA	See maintenance instructions in Appendix 6.4B	Twice a year – once in October and once in April/May

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

Include a site plan and drainage plan sheet set containing the following minimum information:

- Project location
- Site boundary
- Land uses and land covers, as applicable
- Suitability/feasibility constraints
- Structural Source Control BMP locations
- Site Design Hydrologic Source Control BMP locations
- LID BMP details
- Drainage delineations and flow information
- Drainage connections

6.2 Electronic Data Submittal

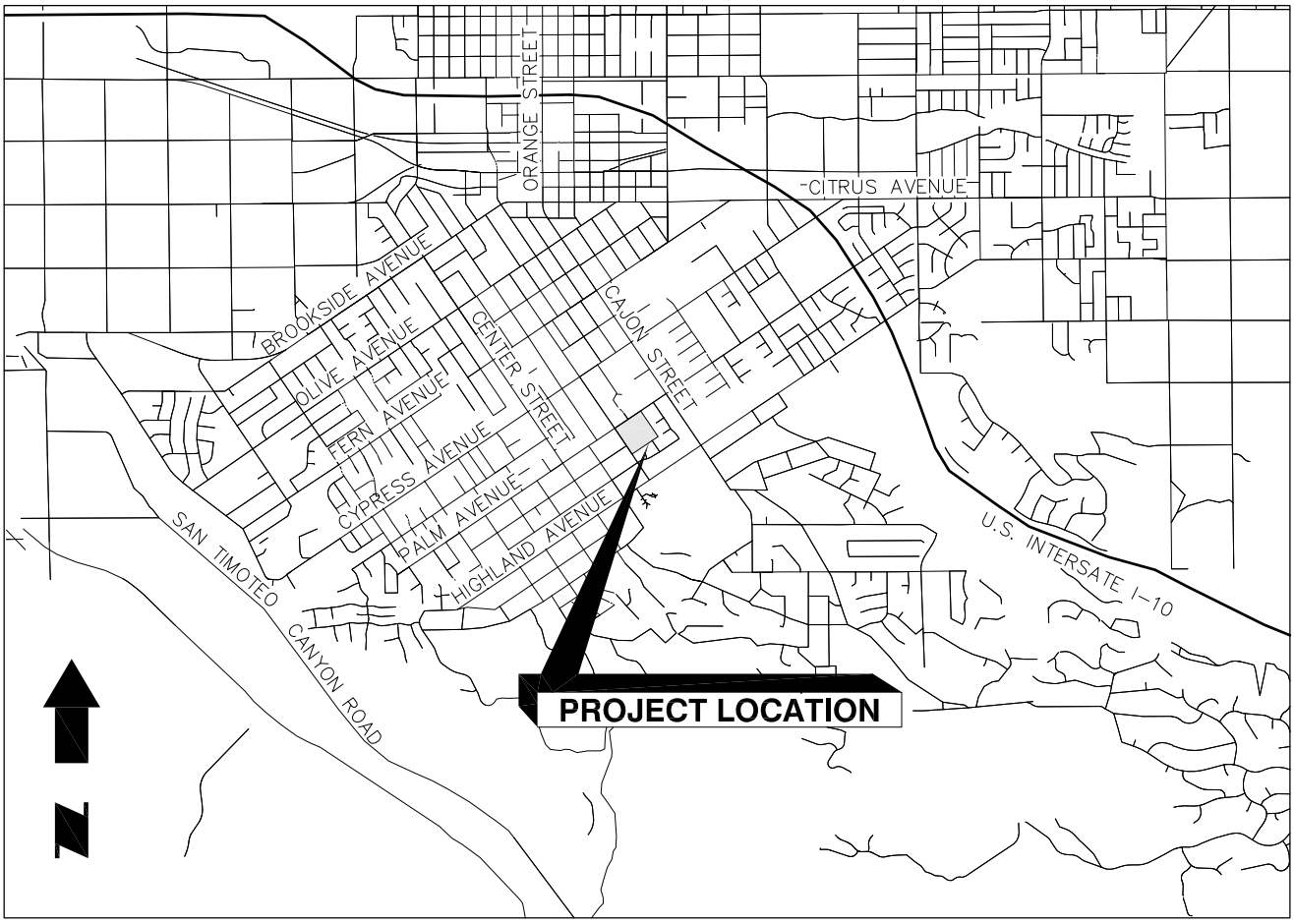
Minimum requirements include submittal of PDF exhibits in addition to hard copies. Format must not require specialized software to open. If the local jurisdiction requires specialized electronic document formats (as described in their local Local Implementation Plan), this section will describe the contents (e.g., layering, nomenclature, geo-referencing, etc.) of these documents so that they may be interpreted efficiently and accurately.

6.3 Post Construction

Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

- BMP Exhibits
- BMP Educational Materials

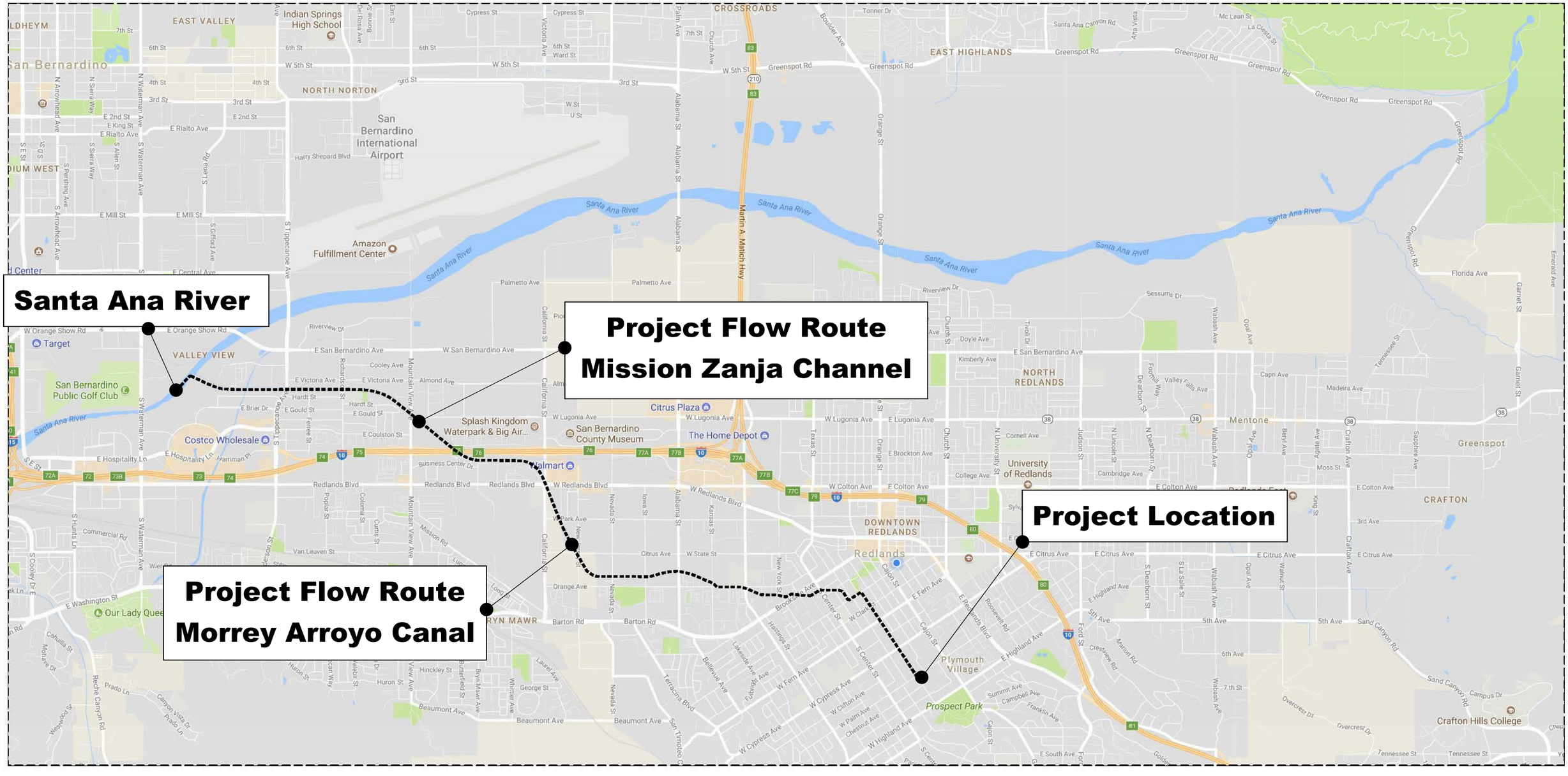


VICINITY MAP

CITY OF REDLANDS, CALIFORNIA
SCALE: NTS

10034_VMAP.dwg 2:31pm - Oct 03, 2019 (c) Hicks & Hartwick, Inc.

Project Drainage Path

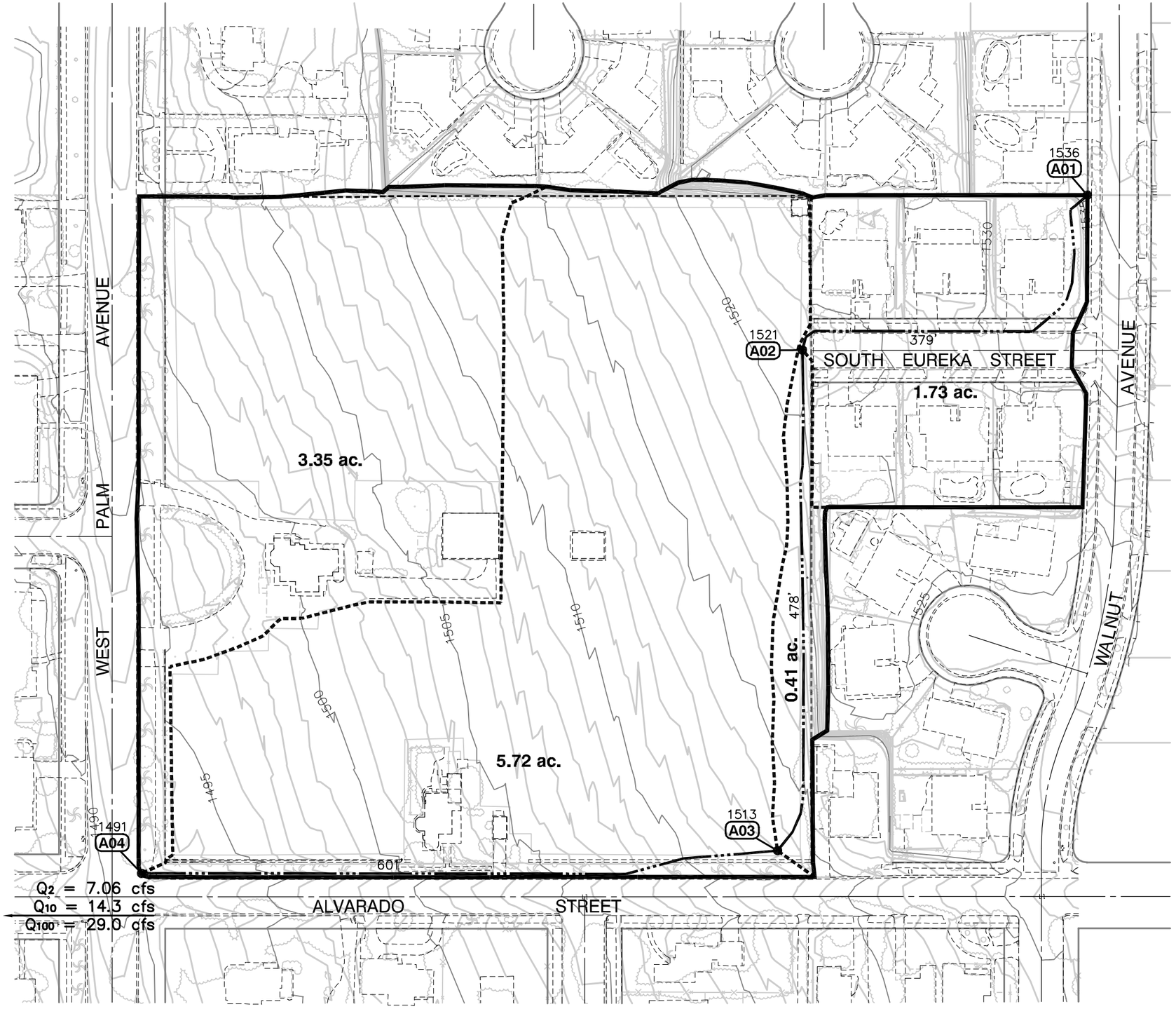


Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

Project Drainage Path
City of Redlands
Tract No. 20305

Diversified Pacific Communities

Tract No. 20305
City of Redlands
SAN BERNARDINO COUNTY
EXISTING HYDROLOGY



HYDROLOGIC DATA

SCS SOILS GROUP: B
INTENSITY-DURATION SLOPE: 0.65
2-YR/1-HR RAINFALL (AMC II): 0.473 in/hr
10-YR/1-HR RAINFALL (AMC II): 0.730 in/hr
100-YR/1-HR RAINFALL (AMC III): 1.15 in/hr

HICKS & HARTWICK, Inc.
CIVIL ENGINEERS · LAND SURVEYORS

37 East Olive Avenue
REDLANDS, CALIFORNIA 92373
909.793.2257

PREPARED: NOVEMBER 2019

REGISTERED PROFESSIONAL ENGINEER
RILEY CLARK
No. C 40606
exp. 3/31/2021
CIVIL
STATE OF CALIFORNIA

SCALE: 1" = 100'

10034 Hydrology.dwg : Existing 9:08am – Nov 07, 2019 (c) Hicks & Hartwick, Inc.

ALTA/ACSM LAND TITLE SURVEY

LEGAL DESCRIPTION

LOT 7, BLOCK "K", ACCORDING TO MAP OF ADDITION NO. 7 TO THE SECOND PRELIMINARY MAP OF REDLANDS, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 5 OF MAPS, PAGE 8, RECORDS OF SAID COUNTY.

MAP PREPARED BY:

HICKS & HARTWICK, INC.
37 E. OLIVE AVENUE
REDLANDS, CALIFORNIA 92373
(909) 793-2257

MAP PREPARED FOR:

DIVERSIFIED PACIFIC
10621 CIVIC CENTER DRIVE
RANCHO CUCAMONGA, CA 91730
PHONE: (909) 481-1150

SURVEYOR'S ALTA/ACSM CERTIFICATE

TO DIVERSIFIED PACIFIC AND 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 2011 MINIMUM STANDARD DETAIL REQUIREMENTS FOR ALTA/ACSM LAND TITLE SURVEYS, JOINTLY ESTABLISHED AND ADOPTED BY ALTA AND NSPS, AND INCLUDES ITEMS 2, 3, 4, 5, 6a, 7a, 8, AND 11b OF TABLE "A" THEREOF. THE FIELD WORK WAS COMPLETED ON OCTOBER 22, 2014.

DATED: NOVEMBER 19, 2018

MARK S. WHITMER, L.S NO. 5535

LICENSED LAND SURVEYOR — MARK S. WHITMER — L.S. No. 5535 — STATE OF CALIFORNIA

SURVEYOR'S NOTES

1. THIS SURVEY MAP WAS PLOTTED BY A COMBINATION OF AERIAL MAPPING AND FIELD METHODS
2. THE BASIS OF BEARINGS FOR THIS SURVEY WAS DERIVED FROM THE CENTERLINE OF PALM AVENUE SHOWN AS N56°20'00"E ON TRACT NO. 6640, M.B. 84/6-7
3. ● DENOTES FOUND MONUMENTS AS NOTED
4. ( ) DENOTES RECORD DATA PER TRACT NO. 6640, M.B. 84/6-7
4. [ ] DENOTES RECORD DATA PER TRACT NO. 7918, M.B. 100/99-100
5. ALL BUILDING DIMENSIONS SHOWN ARE TO OUTSIDE FACE OF BUILDING
6. ADEQUATE INGRESS TO AND EGRESS FROM THE SUBJECT PROPERTY IS PROVIDED BY PALM AVENUE AND ALVARADO STREET. THE SAME BEING PAVED, DEDICATED PUBLIC RIGHT-OF-WAY MAINTAINED BY THE CITY OF REDLANDS.
7. EXCEPT AS SET FORTH BELOW, THERE ARE NO ENCROACHMENTS UPON THE SUBJECT PROPERTY BY IMPROVEMENTS ON ADJACENT PROPERTY, NO ENCROACHMENTS ON ANY EASEMENTS OR ON ADJACENT PROPERTY, STREETS, OR ALLEYS BY ANY IMPROVEMENTS ON THE SUBJECT PROPERTY, NO PARTY WALLS, NO CONFLICTS OR PROTUSIONS. THE EXCEPTIONS TO THE ABOVE STATEMENTS ARE AS FOLLOWS:
   - ITEM A: A 0.35' ENCROACHMENT OF CONCRETE WALL ALONG THE NORTH SIDE OF PROPERTY ONTO PUBLIC RIGHT OF WAY AS SHOWN ON DETAILS 1 AND 2, AND SECTION D-D
   - ITEM B: A 0.1' ENCROACHMENT OF CONCRETE FLUME ALONG THE EAST SIDE OF PROPERTY ONTO ADJACENT PROPERTY AS SHOWN ON DETAILS 1.
   - ITEM C: A 0.15' ENCROACHMENT OF CONCRETE FLUME AND WEIR BOX ALONG THE EAST SIDE OF PROPERTY ONTO ADJACENT PROPERTY AS SHOWN ON DETAIL 3.
   - ITEM D: ENCROACHMENT OF TREE TRUNKS AND CANOPIES ONTO PROPERTY MARKED WITH (D) SYMBOL.
   - ITEM E: HOG WIRE FENCE ALONG THE EAST SIDE OF PROPERTY LEANS ONTO PROPERTY 1.0'± IN VARIOUS SPOTS
8. DATE SURVEY WAS COMPLETED: OCTOBER 22, 2014
9. DATE ALTA SURVEY COMPLETED: NOVEMBER 11, 2014
9. ALTA SURVEY WAS REVISED WITH UPDATED TITLE REPORT AND MAP REQUESTER ON NOVEMBER 19, 2018

ALTA TABLE "A" NOTES

2. STREET ADDRESS: 301 WEST PALM AVENUE
3. FLOOD ZONE CLASSIFICATION: ZONE X – AREAS DETERMINED TO BE OUTSIDE THE 500-YEAR FLOOD PLAIN.

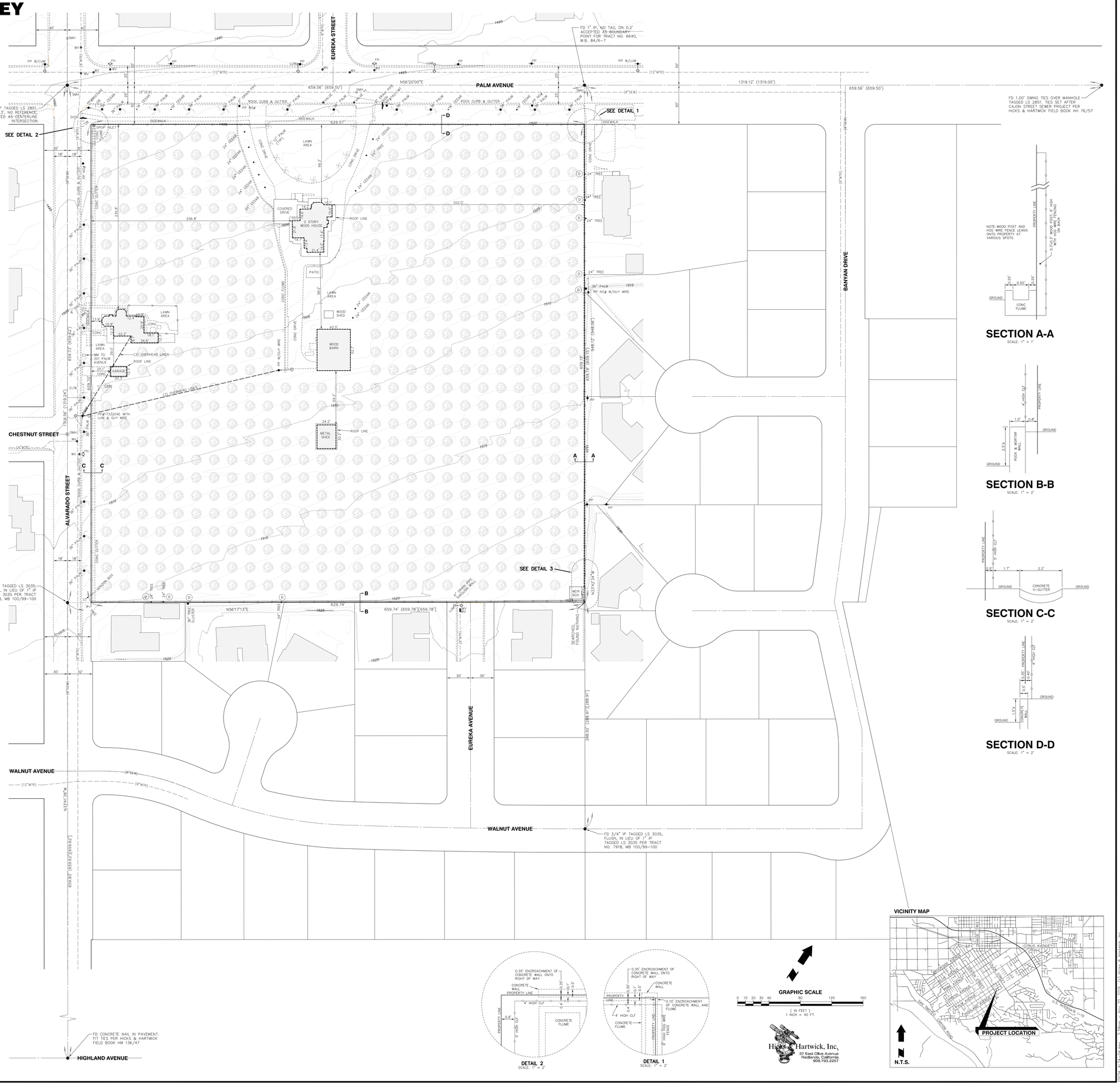
   FLOOD ZONE INFORMATION AS SHOWN ON FLOOD INSURANCE RATE MAP (FIRM) MAP NUMBER 06071C8712H, EFFECTIVE DATE: AUGUST 28, 2008.
4. GROSS LOT AREA: 435,012.26 SF (9.99 AC)
   NET LOT AREA: 383,742.47 SF (8.81 AC)
5. VERTICAL RELIEF PROVIDED BY AERIAL MAPPING. CONTOUR INTERVAL = 1 FT.

   BENCH MARK: CITY OF REDLANDS BENCH MARK R-82. BRASS DISK IN TOP OF CURB AT THE SE CORNER OF CAJON STREET AND PALM AVENUE. EAST END OF RETURN.
   ELEVATION = 1506.628 (NAVD29)
6a. CURRENT ZONING CLASSIFICATION: R-S (SINGLE FAMILY RESIDENTIAL)
7a. EXTERIOR DIMENSIONS OF BUILDINGS; SEE MAP
8. SUBSTANTIAL FEATURES OBSERVE IN THE PROCESS OF CONDUCTING THE SURVEY: SEE MAP
11b. OBSERVED AND RECORD UTILITY INFORMATION: SEE MAP

EASEMENTS OF RECORD

EASEMENTS AND RESTRICTIONS OF RECORD UNDER TITLE REPORT PREPARED BY CHICAGO TITLE COMPANY, DATED OCTOBER 23, 2018, ORDER NO. 7101407137-DA

(1) REDLANDS WATER COMPANY, THE HOLDER OF AN EASEMENT FOR PUBLIC UTILITIES AND INCIDENTAL PURPOSES AS DISCLOSED BY DOCUMENT RECORDED FEBRUARY 24, 1882, IN BOOK 28 OF DEEDS, PAGE 233 AND MARCH 7, 1882, IN BOOK 29 OF DEEDS, PAGE 65, OFFICIAL RECORDS OF SAN BERNARDINO COUNTY. SAID EASEMENT CANNOT BE LOCATED FROM RECORD.



SECTION A-A

SCALE: 1" = 1'

SECTION B-B

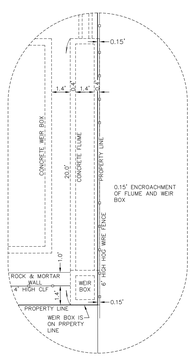
SCALE: 1" = 2'

SECTION C-C

SCALE: 1" = 2'

SECTION D-D

SCALE: 1" = 2'



DETAIL 3

SCALE: 1" = 4'

DETAIL 2

SCALE: 1" = 2'

DETAIL 1

SCALE: 1" = 2'

GRAPHIC SCALE

0 10 20 30 40 80 120 160

(IN FEET)
1 INCH = 40 FT.

Hicks & Hartwick, Inc.
37 East Olive Avenue
Redlands, California
909.793.2257

VICINITY MAP

LEGEND

CB	CATCH BASIN
CLF	CHAIN LINK FENCE
CONC	CONCRETE SURFACE
D/W	DRIVEWAY
FH	FIRE HYDRANT
LUM	LUMINAIRE
PP	POWER POLE
SMH	SEWER MANHOLE
WM	WATER METER
WV	WATER VALVE
	EXISTING STRUCTURE
	CITRUS TREE
	HOG WIRE FENCE
	CHAIN LINK FENCE

10034_ALTA-14.dwg 3:58pm – Nov 20, 2019 (c) Hicks & Hartwick, Inc.

TENTATIVE TRACT MAP No. 20305-PRD
APN 0173-231-05 (301 WEST PALM AVE.)

APPLICANT
DIVERSIFIED PACIFIC COMMUNITIES
10621 CIVIC CENTER DRIVE
RANCHO CUCAMONGA, CA 91730
PH: (909) 481-1150
FAX: (909) 481-1151

CIVIL ENGINEER
HICKS & HARTWICK, INC.
37 EAST OLIVE AVE, SUITE C
REDLANDS, CA 92373
PH: (909) 793-2257

MAP PREPARED BY:
Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

REGISTERED PROFESSIONAL ENGINEER
MATTHEW C. HICKS
No. 63494
CIVIL
STATE OF CALIFORNIA

GENERAL NOTES
1. TOTAL PROJECT GROSS AREA: 383,773 SF (8.81 AC) (INCLUDES TPM NO. 20185)
2. PROJECT CONSISTS OF APN: 0173-231-05
3. NUMBER OF LOTS: 30
4. DATE PREPARED: 11-20-19
5. NET DEVELOPMENT AREA: 383,736 SF (8.81 AC) (INCLUDES TPM NO. 20185)
   (SEE PROJECT AREA CALCULATIONS BELOW)
6. REQUIRED OPEN SPACE: (20.00%) 76,747 SF (1.76 AC)
7. OPEN SPACE PROVIDED: (25.30%) 97,085 SF (2.23 AC)
8. OPEN SPACE LOTS/PARCELS: A–D & PCL. 1&3 OF TPM NO. 20185
9. COVERAGE OF PLANNED RESIDENTIAL DEVELOPMENT STRUCTURES:
   2.20 AC (24.90%) – USING NET DEVELOPMENT AREA

REQUIREMENTS FOR TRACT MAPS
PER CITY OF REDLANDS DEVELOPMENT APPLICATION (JANUARY, 2019)

1A. DATE OF MAP PREPARATION: 10-01-2019
1B. NORTH ARROW DELINEATED ON MAP AS REQUIRED
1C. SCALE USED: 1"= 50'
1D. ADJACENT SUBDIVISION INFO: DELINEATED ON MAP AS REQUIRED
2. INFORMATION DELINEATED ON MAP AS REQUIRED
3. EASEMENTS AND RIGHTS OF RECORD PER PRELIMINARY REPORT PREPARED BY CHICAGO TITLE COMPANY, NO. 7101407137-DA DATED 10-23-2018.
4–10. DELINEATED ON MAP AS REQUIRED
11. STATEMENT AS TO THE INTENTION IN REGARD TO SLOPE PLANTING AND EROSION CONTROL: DELINEATED ON MAP
12. VICINITY MAP: DELINEATED ON MAP
13. CONTOUR INTERVAL: 1' CONTOURS
14. ALL EXISTING STRUCTURES AND TREES TO BE REMOVED: DELINEATED ON MAP AS REQUIRED
15A. LOCATION OF ALL AREAS OF POTENTIAL STORMWATER OVERFLOW; THE LOCATION, WIDTH AND DIRECTION OF FLOW: DELINEATED ON MAP
15B. FEMA PANEL: PANEL 8716 OF 9400 PER FLOOD INSURANCE RATE MAP: 06071C8716H, AUGUST 28, 2008
AREA DESIGNATION: ZONE X
(AREAS DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOODPLAIN)

EXHIBIT REQUIREMENTS - PART ONE
PER CITY OF REDLANDS DEVELOPMENT APPLICATION (JANUARY, 2019)

1. INDEX MAP ON ALL SHEETS: DOES NOT APPLY
2. NAME AND ADDRESS OF OWNER/APPLICANT/MAP PREPARER: DELINEATED ON MAP AS REQUIRED
3. ACREAGE, NORTH ARROW, VICINITY MAP, DATE OF PREPARATION: DELINEATED ON MAP AS REQUIRED
4. EXISTING STRUCTURES AND FEATURES SUCH AS WALLS, BUILDING, AND TREES: DELINEATED ON MAP AS REQUIRED
5. DIMENSIONS AND PROPERTY LINES FOR EACH LOT: DELINEATED ON MAP AS REQUIRED
6. NAMES OF ADJOINING SUBDIVISIONS AND LANDOWNERS AND ABUTTING LAND USES: DELINEATED ON MAP AS REQUIRED
7. LANDS DEDICATED FOR PUBLIC USE: DELINEATED ON MAP AS REQUIRED
8. POINTS OF INGRESS AND EGRESS: PALM AVENUE
9. PRELIMINARY GRADING, INCLUDING PAD ELEVATIONS AND FLOW LINES WITH LOCATION OF ALL CUT AND FILL SLOPES IDENTIFIED: DELINEATED ON MAP AS REQUIRED

EXHIBIT REQUIREMENTS - PART TWO
PER CITY OF REDLANDS DEVELOPMENT APPLICATION (JANUARY, 2019)
PUBLIC WORKS REQUIREMENTS FOR SITE PLANS

1. LOCATIONS, NAME, AND WIDTH OF STREETS AND ADJACENT STREETS ALSO SHOW WIDTH OF ALLEYS IF APPLICABLE: DELINEATED ON MAP AS REQUIRED
2. PROPOSED STREET GRADES AND GRADES FOR STREETS 100 FEET BEYOND APPLICANTS PROPERTY: DELINEATED ON MAP AS REQUIRED.
3. CROSS SECTION OF PROPOSED STREET IMPROVEMENTS IF DIFFERENT FROM STANDARD: DELINEATED ON MAP AS REQUIRED.
4. LOCATION, DIMENSION, AND PURPOSE OF ANY EASEMENT ON AND ADJACENT TO PROJECT SITE: DELINEATED ON MAP AS REQUIRED.
5. LOCATION OF EXISTING PUBLIC UTILITIES, CULVERTS, DRAIN PIPES, AND WATER COURSES: DELINEATED ON MAP AS REQUIRED.
6. APPROXIMATE RADIUS OF CURVES: DELINEATED ON MAP AS REQUIRED.
7. TOPOGRAPHICAL DATA TO MAKE CLEAR THE EFFECT OF THE PROPOSAL 2' CONTOURS AT GRADES 5% OR LESS, 5' CONTOURS AT GRADES OF MORE THAN 5% SOURCE OF THE CONTOURS SHALL BE STATED ON MAP: DELINEATED ON MAP AS REQUIRED.

BENCH MARK
CITY OF REDLANDS BENCH MARK R–82. BRASS DISK IN TOP OF CURB AT THE SE CORNER OF CAJON STREET AND PALM AVENUE, EAST END OF RETURN.
ELEVATION = 1317.581

BASIS OF BEARINGS
THE BASIS OF BEARINGS FOR THIS MAP IS DERIVED FROM THE CENTERLINE OF PALM AVENUE SHOWN AS N56°20'00"E ON TRACT NO. 6640, MB 84/6–7.

TOPOGRAPHIC MAP NOTE
TOPOGRAPHIC MAP PREPARED BY: INLAND AERIAL SURVEYS, INC.

SOILS ENGINEER / GEOLOGIST
GEOTECHNICAL INVESTIGATION CONDUCTED BY: PETRA GEOSCIENCES INC.
JOB NO. 18-430, DATED FEBRUARY 15, 2019

PUBLIC UTILITY COMPANIES
GAS:
SOUTHERN CALIFORNIA GAS CO.
1981 W. LUGONIA AVENUE
REDLANDS, CA 92374–9720
(800) 427–2200

WATER:
CITY OF REDLANDS
P.O. BOX 6905
REDLANDS, CA 92375–0903
(909) 798–7516

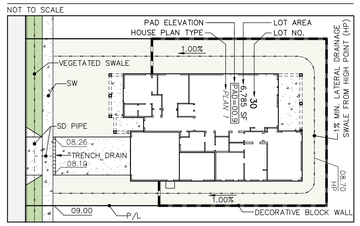
ELECTRIC:
SOUTHERN CALIFORNIA EDISON CO.
287 TENNESSEE STREET
REDLANDS, CA 92373
(909) 307–6731

SEWER:
CITY OF REDLANDS
P.O. BOX 6905
REDLANDS, CA 92375–0903
(909) 798–7516

CABLE:
TIME WARNER CABLE
1722 ORANGE TREE LANE
REDLANDS, CA 92373
(909) 793–2321

TELEPHONE:
VERIZON INC.
1500 CRAFTON AVENUE
MENTONE, CA 92359
(909) 794–8210

TYPICAL LOT DRAINAGE
NOT TO SCALE



EASEMENTS AND RIGHTS
EASEMENTS AND RESTRICTIONS OF RECORD UNDER TITLE REPORT PREPARED BY CHICAGO TITLE COMPANY, DATED OCTOBER 23, 2018, ORDER NO. 7101407137-DA

EASEMENTS AFFECTING THAT PORTION OF SAID LAND AND FOR THE PURPOSES STATED HEREIN AND INCIDENTAL PURPOSES AS PROVED IN THE FOLLOWING INSTRUMENTS:

(1) 1. GRANTED TO : REDLANDS WATER COMPANY
PURPOSE(S) : PUBLIC UTILITIES AND INCIDENTAL PURPOSES
RECORDING DATE : FEBRUARY 24, 1882
RECORDING NO. : BOOK 28, PAGE 233 OF DEEDS, AND BOOK 29, PAGE 65 OF DEEDS
NOTES : EASEMENT CANNOT BE LOCATED FROM RECORD

LEGAL DESCRIPTION
LOT 7, BLOCK "K", ACCORDING TO MAP OF ADDITION NO. 7 TO THE SECOND PRELIMINARY MAP OF REDLANDS, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 5 OF MAPS, PAGE 8, RECORDS OF SAID COUNTY.

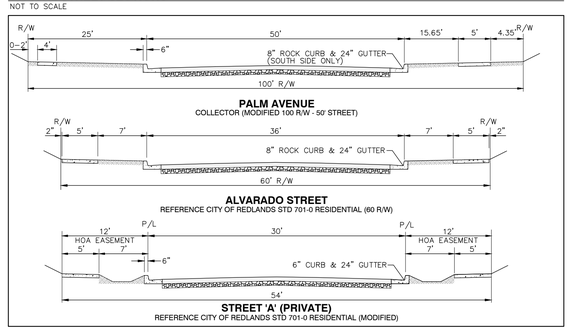
ADJACENT PROPERTY OWNERS
01. 0173-242-01 BENTON REVOCABLE LIVING TRUST	02. 0173-242-08 LOCKWOOD, LESLIE	03. 0173-242-09 CHAPARRO, GUSTAVO	04. 0173-242-10 WALCK, ELLIZABETH LIVING TRUST	05. 0173-242-17 O DONNELL TRUST
06. 0173-242-18 NEWBERRY FAMILY TRUST	07. 0173-231-12 DEDOES, MATTHEW	08. 0173-231-13 CONREY TRUST	09. 0173-231-17 CARLSON FAMILY TRUST	10. 0173-231-18 SWEET, STUART
11. 0173-231-09 STRUNK, TIMOTHY	12. 0173-222-10 STEWARD, JOHN	13. 0173-222-09 ALVAREZ, SERGIO	14. 0173-221-17 DEAN, CHRISTOPHER & JOYCE	15. 0173-221-18 COLE, MARY ELIZABETH LIVING TRUST
16. 0173-221-07 CAMP COLE FAMILY TRUST	17. 0173-151-35 JOHNSON, GREG R & DJ LEEPER-JOHNSON	18. 0173-151-62 MCCLON FAMILY TRUST	19. 0173-152-03 MELZER, ERICH & MARJORIE	20. 0173-152-02 SWARM, ORVAL & MARJORIE
21. 0173-152-01 LANDRETH, JAMES LIVING TRUST				

SLOPE PLANTING AND EROSION CONTROL NOTE
FACES OF FINISHED CUT AND FILL SLOPES SHALL BE PREPARED AND MAINTAINED TO CONTROL AGAINST EROSION. DEVELOPER INTENDS TO PROVIDE ADEQUATE EROSION CONTROL AND PROTECTION FOR THE SLOPES PER CALIFORNIA SWPPP AND WATER QUALITY STANDARDS

OWNERSHIP AND MAINTENANCE RESPONSIBILITY STATEMENT
OWNERSHIP AND MAINTENANCE RESPONSIBILITY FOR THE PROJECT DEVELOPMENT PARTS ARE PROPOSED AS NOTED:

ITEM	RESPONSIBLE PARTY
PRIVATE STREET 'A'	HOME OWNER'S ASSOCIATION
OPEN SPACE LOTS 'A'–'D'	HOME OWNER'S ASSOCIATION
STREET 'A' STORM DRAIN	HOME OWNER'S ASSOCIATION
PARCELS 1 & 2	LOT OWNERS
LOTS 1–30	LOT OWNERS
PARCEL 3 – PUBLIC PARK	CITY OF REDLANDS
PALM AVENUE	CITY OF REDLANDS
ALVARADO STREET	CITY OF REDLANDS
STREET 'A' SEWER & WATER	CITY OF REDLANDS

TYPICAL STREET SECTIONS
NOT TO SCALE

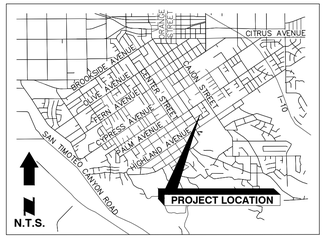


LEGEND
- EX. 5' CONTOUR
- EX. 1' CONTOUR
- PROP. 5' CONTOUR
- PROP. 1' CONTOUR
- DAYLIGHT LINE
- PROP. WALL
- CHAIN LINK FENCE
- ASPHALT PAVEMENT
- CONCRETE
- XX LOT NUMBER
- X,XXX SF LOT AREA
- 00.0 PAD ELEVATION
- OPEN SPACE & LANDSCAPING
- 2:1 SLOPE OR LESS
- VEGETATED SWALE
- CONSERVATION EASEMENT
- WTR PROPOSED WATER MAIN (SIZE AS SHOWN)
- SEW PROPOSED SEWER (SIZE AS SHOWN)
- (WTR) EXISTING WATER MAIN (SIZE AS SHOWN)
- (SEW) EXISTING SEWER (SIZE AS SHOWN)
- EXISTING STORM DRAIN (SIZE AS SHOWN)
- EXISTING UNDERGROUND UTILITY AS SHOWN
- (PP) EXISTING POWER POLE
- (OH) OVERHEAD UTILITY LINES
- PROPOSED FIRE HYDRANT
- PROPOSED STORM DRAIN PIPE
- WATER VALVE
- EXISTING FIRE HYDRANT
- PROPOSED STREET LIGHT

ABBREVIATIONS
DWY	DRIVEWAY
ELEV	ELEVATION
EG	EXISTING GRADE
EX	EXISTING
FG	FINISH GRADE
F/L	FLOWLINE
HP	HIGH POINT
INV	INVERT
MIN	MINIMUM
MAX	MAXIMUM
NG	NATURAL GROUND
PL	PROPERTY LINE
GB	GRADE BREAK
NTS	NOT TO SCALE
HP	HIGH POINT
RW	RIGHT OF WAY
REF	REFERENCE
S'LY	SOUTHERLY
ST	STREET
SW	SIDEWALK
TC	TOP OF CURB
TD	TOP OF DIKE
TF	TOP OF FOOTING
TG	TOP OF GRATE
TW	TOP OF WALL
TRW	TOP OF RETAINING WALL
O.C.	ON CENTER
W'LY	WESTERLY
W/	WITH

CURVE TABLE
(C#)	DELTA	RADIUS	LENGTH	(C#)	DELTA	RADIUS	LENGTH	(C#)	DELTA	RADIUS	LENGTH
C1	Δ=90°00'00"	25.00'	39.27'	C9	Δ=47°41'42"	20.00'	16.65'	C16	Δ=04°32'33"	1215.00'	96.33'
C2	Δ=20°45'37"	25.00'	9.06'	C10	Δ=10°42'10"	100.00'	18.68'	C17	Δ=04°32'33"	1185.00'	93.95'
C4	Δ=91°02'12"	32.00'	50.84'	C11	Δ=111°24'20"	58.00'	112.77'	C18	Δ=44°32'58"	47.00'	36.54'
C5	Δ=47°41'42"	20.00'	16.65'	C12	Δ=90°00'00"	15.00'	23.56'	C19	Δ=44°32'58"	47.00'	36.54'
C6	Δ=90°00'00"	25.00'	39.27'	C13	Δ=10°42'10"	100.00'	18.68'	C20	Δ=269°05'56"	40.00'	187.87'
C7	Δ=43°20'50"	12.00'	9.08'	C14	Δ=04°32'33"	1185.00'	93.95'	C21	Δ=90°01'25"	25.00'	39.28'
C8	Δ=91°02'12"	32.00'	50.84'	C15	Δ=04°32'33"	1215.00'	96.33'				

VICINITY MAP



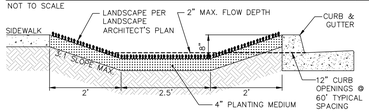
PROJECT AREA CALCULATIONS
TOTAL SITE GROSS AREA:	8.81 AC	383,773 SF
PALM AVE:	0.00 AC	37 SF
TOTAL SUBTRACTED:	0.00 AC	37 SF
NET DEVELOPMENT AREA:	8.81 AC	383,736 SF

PERMANENT OPEN SPACE LOTS	LOT AREA	LOT USE
LOT A	3,022 SF	OPEN SPACE
LOT B	2,801 SF	OPEN SPACE
LOT C	1,353 SF	OPEN SPACE
LOT D	2,104 SF	OPEN SPACE
PARCEL 1	66,940 SF	EXISTING PALM AVENUE HOUSE (CONSERVATION EASEMENT)
PARCEL 3	37,389 SF	PUBLIC PARK
TOTAL AREA:	114,109 SF (2.62 AC)	

EXCLUDED AREA		DESCRIPTION
PARCEL 1	17,024 SF	EXISTING DRIVEWAY & BUILDINGS – PALM AVENUE HOUSE
TOTAL SUBTRACTED AREA:	17,024 SF (0.39 AC)	
TOTAL OPEN SPACE:	2.23 AC	97,085 SF

LOT COVERAGE
LOT NO.	LOT AREA	LOT COVERAGE	LOT NO.	LOT AREA	LOT COVERAGE
1	7,430 SF	2,795 SF	16	7,395 SF	3,112 SF
2	6,776 SF	3,112 SF	17	7,182 SF	2,795 SF
3	6,778 SF	3,452 SF	18	6,389 SF	2,795 SF
4	6,781 SF	3,112 SF	19	7,058 SF	3,112 SF
5	6,783 SF	3,452 SF	20	7,412 SF	3,452 SF
6	6,710 SF	3,112 SF	21	7,459 SF	3,112 SF
7	7,121 SF	2,795 SF	22	7,656 SF	3,452 SF
8	7,208 SF	2,795 SF	23	7,834 SF	3,452 SF
9	10,447 SF	3,452 SF	24	7,955 SF	3,452 SF
10	6,644 SF	2,795 SF	25	6,812 SF	3,112 SF
11	6,955 SF	3,112 SF	26	6,812 SF	3,452 SF
12	7,157 SF	3,452 SF	27	6,812 SF	3,452 SF
13	7,314 SF	3,112 SF	28	6,812 SF	3,112 SF
14	7,529 SF	3,452 SF	29	6,812 SF	3,452 SF
15	7,596 SF	3,452 SF	30	6,693 SF	2,795 SF
TOTAL LOT COVERAGE AREA:		2.20 AC			95,561 SF

VEGETATED SWALE - TYPICAL STREET 'A' PARKWAY (SHEET 2)
NOT TO SCALE



SHEET INDEX

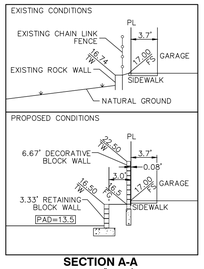
SHEET NO.	DESCRIPTION
1	TENTATIVE TRACT MAP & GENERAL NOTES
2	PRELIMINARY GRADING & PLOT PLAN

GRAPHIC SCALE
0 25 50 100 150 200
(IN FEET)
1 INCH =50 FT.

\\T1\acaddata_10000_\10034 Heeney Tract\c_Exhibit\TTM_TTM04_A.dwg 1:45pm – Jan 28, 2020

TENTATIVE TRACT MAP No. 20305-PRD

PRELIMINARY GRADING & PLOT PLAN



SECTION A-A
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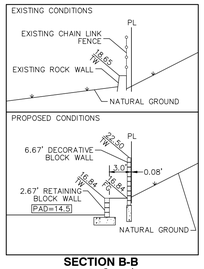

SECTION B-B
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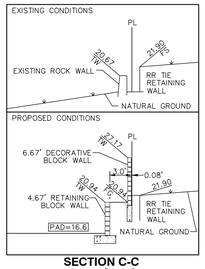

SECTION C-C
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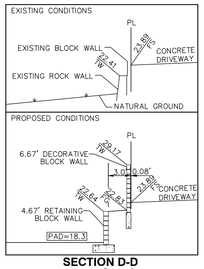

SECTION D-D
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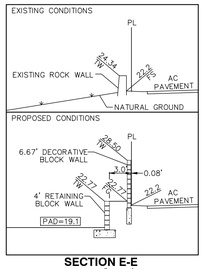

SECTION E-E
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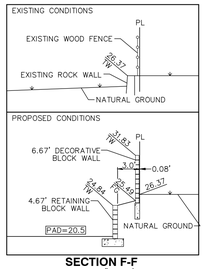

SECTION F-F
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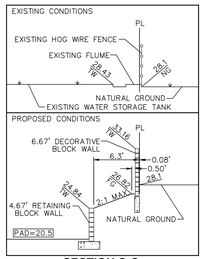

SECTION G-G
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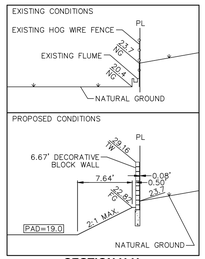

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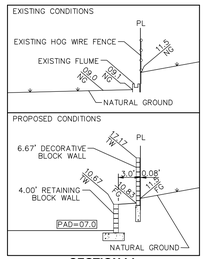

SECTION I-I
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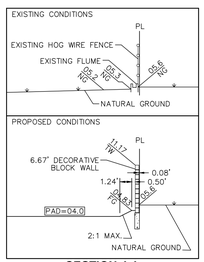

SECTION J-J
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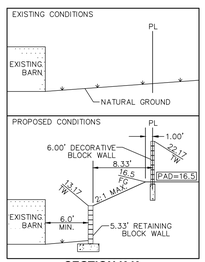
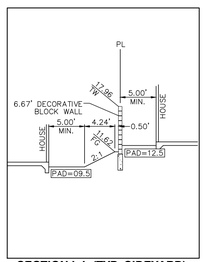


SECTION K-K
SCALE: 1" = 10'



SECTION L-L (TYP. SIDEYARD)
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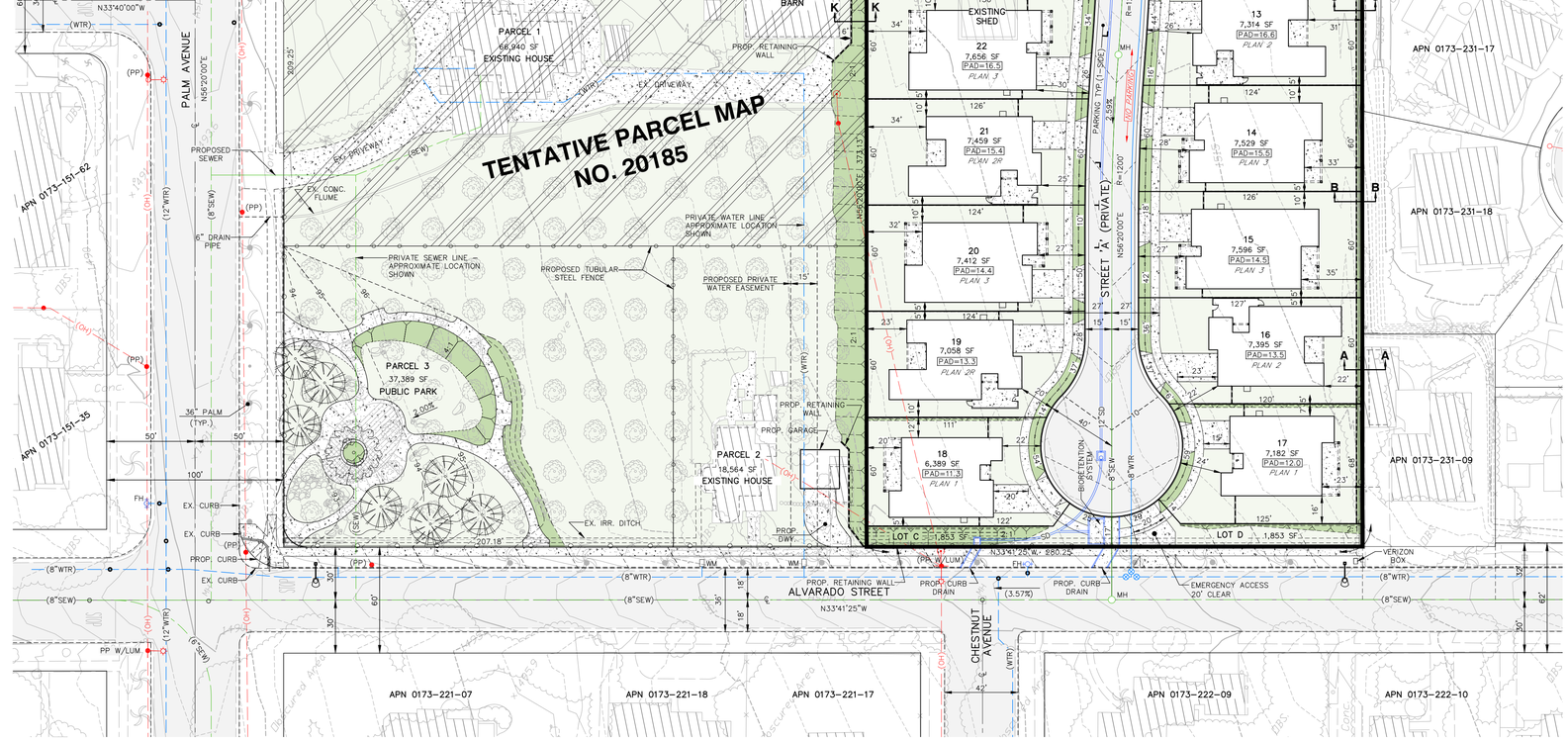
TRACT NO. 6640
TENTATIVE PARCEL MAP NO. 20185
APN 0173-242-01
APN 0173-242-08
APN 0173-242-09
APN 0173-242-10
APN 0173-242-17
APN 0173-242-18
APN 0173-231-12
APN 0173-231-13
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APN 0173-231-18
APN 0173-231-09
APN 0173-152-01
APN 0173-152-02
APN 0173-152-03
APN 0173-151-62
APN 0173-151-35
APN 0173-221-07
APN 0173-221-18
APN 0173-221-17
APN 0173-222-09
APN 0173-222-10
TRACT NO. 7918
LOT A 3,022 SF
LOT B 2,801 SF
LOT C 1,853 SF
LOT D 1,853 SF
STREET 'A' (PRIVATE)
SOUTH EUREKA STREET (4.89%)
EUREKA STREET
PALM AVENUE
ALVARADO STREET
CHESTNUT AVENUE
PARCEL 1 68,940 SF EXISTING HOUSE
PARCEL 2 18,564 SF EXISTING HOUSE
PARCEL 3 37,389 SF PUBLIC PARK
EXISTING BARN
EXISTING SHED
NO PARKING
PARKING TYP (1-SIDE)
PROP. RETAINING WALL
PROP. CURB DRAIN
6" DRAIN PIPE
PROPOSED SEWER
EX. CONC. FLUME
EX. DRIVEWAY
PRIVATE SEWER LINE APPROXIMATE LOCATION SHOWN
PROPOSED TUBULAR STEEL FENCE
PROPOSED PRIVATE WATER EASEMENT
PRIVATE WATER LINE APPROXIMATE LOCATION SHOWN
PROP. GARAGE
EX. IRR. DITCH
PROP. DWY
EX. CURB
PROP. CURB
BIORETENTION SYSTEM
EMERGENCY ACCESS 20' CLEAR
VERIZON BOX
PP W/LUM
N33°42'14"W 609.24'
N33°40'00"W 329.40'
N33°41'25"W 880.25'
N56°20'00"E 373.13'
N56°17'46"E 629.79'
N33°40'00"W
N33°41'25"W
R=1200'
4.59%
3.57%
2.39%
2.00%
1.38%
2.11%
2.10%
1.00%
1.50%
1.67%
1.71%
1.72%
1.73%
1.74%
1.75%
1.76%
1.77%
1.78%
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2.01%
2.02%
2.03%
2.04%
2.05%
2.06%
2.07%
2.08%
2.09%
2.10%

PRELIMINARY WATER QUALITY MANAGEMENT PLAN

TENTATIVE TRACT No. 20305 & TENTATIVE PARCEL MAP No. 20185

OWNER / APPLICANT

DIVERSIFIED PACIFIC COMMUNITIES
10621 CIVIL CENTER DRIVE
RANCHO CUCAMONGA, CA 92660
PH: (909)-481-1150

CIVIL ENGINEER

HICKS & HARTWICK, INC.
37 EAST OLIVE AVENUE, SUITE C
REDLANDS, CA 92373
PH: (909) 793-2257

TENTATIVE MAP PREPARED BY:

Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

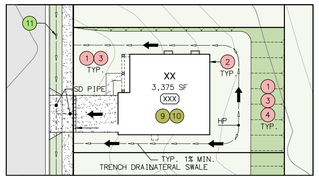
REGISTERED PROFESSIONAL ENGINEER
MATTHEW C. HICKS
No. 63494
CIVIL
STATE OF CALIFORNIA

GENERAL NOTES

1. TOTAL WQMP PROJECT AREA: 393,038 SF (9.02 AC)
2. DATE PREPARED: 12/16/2019
3. NO FEASIBILITY CONSTRAINT PRESENT ON SITE.

TYPICAL LOT BMPS

NOT TO SCALE



9 APPLIES TO PATIO AND WALKWAY AREAS
10 APPLIES TO FENCING AND DECKING

LEGEND

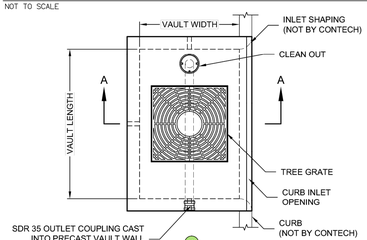
- EXISTING 5' CONTOUR
- EXISTING 1' CONTOUR
- PROPOSED 5' CONTOUR
- PROPOSED 1' CONTOUR
- TOTAL WQMP PROJECT AREA BOUNDARY
- DRAINAGE AREAS PER HYDRO STUDY
- OFF-TRACT BYPASS AREA BOUNDARY
- PROPOSED STORM DRAIN PIPE
- OPEN SPACE & LANDSCAPING
- 2: 1 SLOPE OR LESS
- AC PAVEMENT
- HYDROLOGIC SOURCE CONTROL AREA
- OFF-TRACT AREA
- CONCRETE
- VEGETATED SWALE
- FLOW ARROW

ABBREVIATIONS

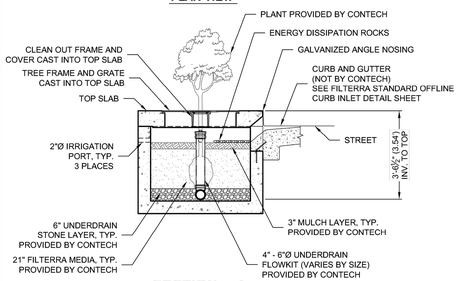
AC	ASPHALT CONCRETE/ACRES
AVE	AVENUE
BLDG.	BUILDING
℄	CENTERLINE
CF	CUBIC FEET
CFS	CUBIC FEET PER SECOND
ELEV	ELEVATION
EX.	EXISTING
L=	LENGTH
MAX.	MAXIMUM
MB	MAP BOOK
MIN.	MINIMUM
PROP.	PROPOSED
R=	RADIUS
SD	STORM DRAIN
SF	SQUARE FEET
TYP	TYPICAL

BIORETENTION SYSTEM - FILTERRA BY CONTECH

NOT TO SCALE



PLAN VIEW



SECTION A-A

SITE IMPLEMENTED BMP's

NOTE: ALL BMPs LISTED ARE PER CALIFORNIA STORMWATER QUALITY ASSOCIATION BEST MANAGEMENT PRACTICE HANDBOOK, (CONSTRUCTION, JULY 2012)

SOURCE CONTROL BMP's
ROUTINE, STRUCTURAL

1	LANDSCAPE PLANNING		SD-10
2	ROOF RUNOFF CONTROLS		SD-11
3	EFFICIENT IRRIGATION		SD-12
4	PROTECT SLOPES AND CHANNELS		–
5	STORM DRAIN SIGNAGE		SD-13
6	INLET TRASH RACKS		–
7	ENERGY DISSIPATERS		–

HYDROLOGIC SOURCE CONTROL

8	IMPERVIOUS AREA DISPERSION	–

ALTERNATIVE MATERIAL

9	PERVIOUS PAVEMENT (DECOMPOSED GRANITE, ETC.)	SD-20
10	ALTERNATIVE BUILDING MATERIALS	SD-21

DESIGN BASIS OF TREATMENT CONTROL BMP's
TREATMENT CONTROL BMP

11	VEGETATED SWALE (BIOSWALE)	FLOW BASED	TC-30
12	BIORETENTION SYSTEM	VOLUME BASED	TC-32

WQMP STUDY AREA SUMMARY

WQMP TOTAL STUDY AREA	393,038 SF	9.02 AC

WQMP STUDY AREA CONSISTS OF:

TRACT & PARCEL MAP AREA	383,736 SF	8.81 AC	
WQMP AREA FROM OFF TRACT			9.02 AC
OFF TRACT AREA 1	6,137 SF	0.14 AC	
OFF TRACT AREA 2	3,165 SF	0.07 AC	

DA-1, DA-2 & DA-3 SUMMARY

TOTAL WQMP SITE AREA: 393,038 SF (9.02 AC)
NOTE: TOTAL STUDY AREA INCLUDES OFFSITE DRAINAGE

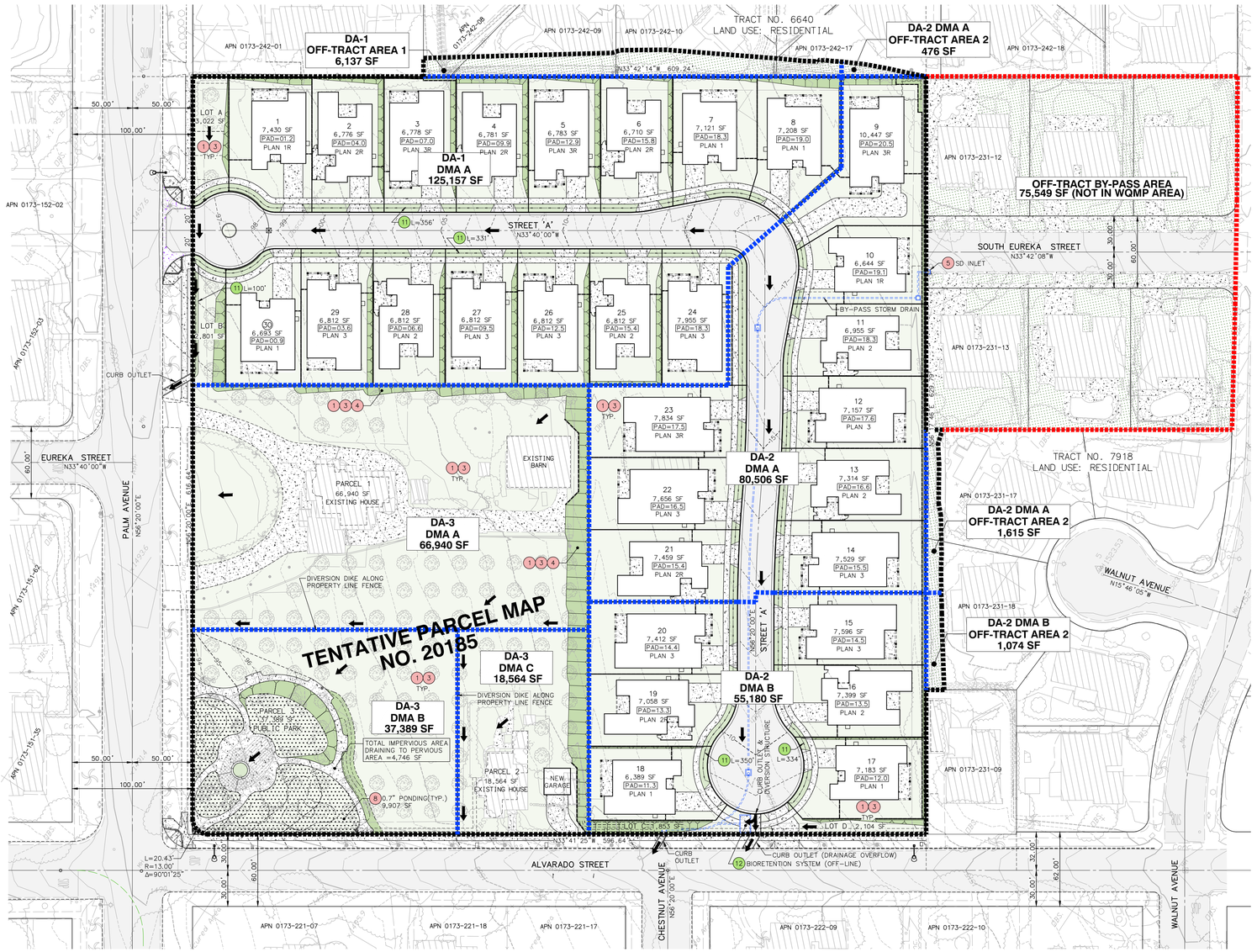
DA-1 DMA A	131,294 SF	3.01 AC
BUILDINGS	40,862 SF	
ASPHALT CONCRETE PAVEMENT	14,598 SF	
CONC. SIDEWALK, CONC. CURB/GUTTER, TRASH ENCLOSURE ETC.	21,735 SF	
TOTAL IMPERVIOUS	77,195 SF	1.77 AC
LANDSCAPING (TURF, PLANTERS, SLOPES & DECOMPOSED GRANITE)	47,962 SF	
OFF TRACT AREA 1	6,137 SF	
TOTAL PERVIOUS	54,099 SF	1.24 AC
DA-2	138,851 SF	3.19 AC
DA-2 DMA A	82,597 SF	1.90 AC
BUILDINGS	27,572 SF	
ASPHALT CONCRETE PAVEMENT	8,694 SF	
CONC. SIDEWALK, CONC. CURB/GUTTER, TRASH ENCLOSURE ETC.	13,426 SF	
TOTAL IMPERVIOUS	49,692 SF	1.14 AC
LANDSCAPING (TURF, PLANTERS, SLOPES & DECOMPOSED GRANITE)	30,814 SF	
OFF TRACT AREA 2	2,091 SF	
TOTAL PERVIOUS	32,905 SF	0.76 AC
DA-2 DMA B	56,254 SF	1.29 AC
BUILDINGS	13,858 SF	
ASPHALT CONCRETE PAVEMENT	7,361 SF	
CONC. SIDEWALK, CONC. CURB/GUTTER, TRASH ENCLOSURE ETC.	13,307 SF	
TOTAL IMPERVIOUS	34,526 SF	0.79 AC
LANDSCAPING (TURF, PLANTERS, SLOPES & DECOMPOSED GRANITE)	20,654 SF	
OFF TRACT AREA 2	1,074 SF	
TOTAL PERVIOUS	21,728 SF	0.50 AC
DA-3	122,893 SF	2.82 AC
DA-3 DMA A	66,940 SF	1.54 AC
EXISTING BUILDINGS	7,063 SF	
EXISTING CONC. SIDEWALK, CONC. CURB/GUTTER, ETC.	9,961 SF	
TOTAL IMPERVIOUS	17,024 SF	0.39 AC
LANDSCAPING (TURF, PLANTERS, SLOPES & DECOMPOSED GRANITE)	49,916 SF	
TOTAL PERVIOUS	49,916 SF	1.15 AC
DA-3 DMA B	37,389 SF	0.86 AC
PROPOSED CONC. SIDEWALK, CONC. CURB/GUTTER, ETC.	4,746 SF	
TOTAL IMPERVIOUS	4,746 SF	0.11 AC
LANDSCAPING (TURF, PLANTERS, SLOPES & DECOMPOSED GRANITE)	32,643 SF	
TOTAL PERVIOUS	32,643 SF	0.75 AC
DA-3 DMA C	18,564 SF	0.43 AC
EXISTING BUILDINGS	2,477 SF	
EXISTING CONC. SIDEWALK, CONC. CURB/GUTTER, ETC.	1,177 SF	
TOTAL IMPERVIOUS	3,654 SF	0.08 AC
LANDSCAPING (TURF, PLANTERS, SLOPES & DECOMPOSED GRANITE)	14,910 SF	
TOTAL PERVIOUS	14,910 SF	0.34 AC

TREATMENT FLOW SUMMARY

				TREATMENT VOLUME REQUIRED	
DA-1 DMA A	131,294 SF	3.01 AC		DCV	6,014 c.f.
IMPERVIOUS AREA	77,195 SF				
DA-2 DMA A	138,851 SF	3.19 AC		DCV	6,170 c.f.
IMPERVIOUS AREA	79,372 SF				
DA-2 DMA B	56,254 SF	1.29 AC		DCV	2,704 c.f.
IMPERVIOUS AREA	34,526 SF				
DA-3 DMA B	37,389 SF	0.86 AC		DCV	546 c.f.
IMPERVIOUS AREA	4,746 SF				

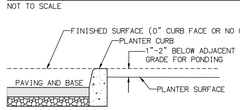
TREATMENT FLOW TOTAL

			TREATMENT VOLUME REQUIRED	
DA-1, -2 & -3	393,038 SF	9.02 AC	DCV	16,039 c.f.
IMPERVIOUS AREA	180,510 SF			

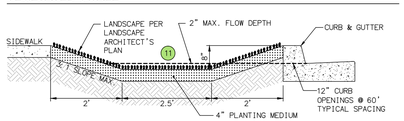


TYPICAL PLANTER

NOT TO SCALE



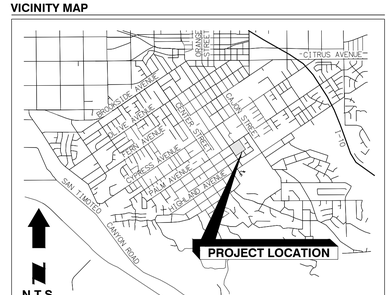
VEGETATED SWALE



GRAPHIC SCALE

0 25 50 100 150 200
(IN FEET)
1 INCH =50 FT.

VICINITY MAP



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RECORDING REQUESTED BY
AND WHEN RECORDED MAIL TO:

CITY CLERK
CITY OF REDLANDS
P.O. BOX 3005
REDLANDS, CA 92373

SPACE ABOVE THIS LINE FOR RECORDER'S USE

STORMWATER TREATMENT DEVICE AND CONTROL MEASURE ACCESS AND MAINTENANCE AGREEMENT

Assessor's Parcel Number(s)
APN 0173-231-05

THIS AGREEMENT is made and entered into this _____ day of _____, 20__, by and between Diversified Pacific Communities ("Owner"), and the City of Redlands, a municipal corporation ("City"). The Owner and the City are sometimes each individually referred to herein as a "Party" and, collectively, as the "Parties."

RECITALS

WHEREAS, the Owner owns real property ("Property") in the City specifically described in Exhibits "A" and "B" which are attached hereto and incorporated herein by this reference; and

WHEREAS, at the time of approval of the Owner's development project commonly known as XXXX and filed as Tract 20305 (the "Project"), the City required the Project to employ on-site control measures to minimize pollutants in urban stormwater runoff; and

WHEREAS, the Owner has chosen to install XXX Infiltration Basins and XXX Catch Basin Drain Inserts (the "Devices") to minimize pollutants in urban stormwater runoff; specifically described in Exhibit "C" and shown in Exhibit "D" both of which are attached hereto and incorporated herein by this reference; and

WHEREAS, the Devices have been installed in accordance with plans and specifications approved by the City; and

WHEREAS, the Devices being installed on private property and draining only private property, are private facilities with all maintenance or replacement therefor being the sole responsibility of the Owner; and

WHEREAS, the Owner is aware that periodic and continuous maintenance including, but not necessarily limited to, filter material replacement and sediment removal is required to assure proper performance of the Devices and that such maintenance activity will require compliance with all Federal, State and local laws and regulations, including those pertaining to confined space and waste disposal methods in effect at the time such maintenance occurs;

NOW, THEREFORE, in consideration of the City's approval of the Project and the mutual promises contained herein, the City of Redlands and Heritage agree as follows:

AGREEMENT

1. The Owner hereby provides the City and its designees with full right of access to the Devices and the Owner's Property in the immediate vicinity of the Devices (a) at any time, upon reasonable notice; or (b) in the event of emergency, as determined by the City Engineer with no advance notice; for the purpose of inspecting, sampling and testing of the Devices, and in cases of emergency, to undertake all necessary repairs or other preventative measures at the Owner's expense as provided for in Section 3, below. The City shall make every effort at all times to minimize or avoid interference with the Owner's use of the Property when undertaking such inspections and repairs.

2. The Owner shall diligently maintain the Devices in a manner consistent with the manufacturers' recommended maintenance schedule to ensure efficient performance. All reasonable precautions shall be exercised by the Owner and the Owner's representatives in the removal and extraction of materials from the Devices, and the ultimate disposal of the materials in a manner consistent with all applicable laws. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the materials removed, the quantity and the location of disposal destinations, as appropriate.

3. In the event the Owner fails to perform the necessary maintenance required by this Agreement within thirty (30) days of being given written notice by the City to do so, setting forth with specificity the action to be taken, the City is authorized to cause any maintenance necessary to be done and charge the entire cost and expense to the Owner, including administrative costs, attorneys' fees and interest thereon at the maximum rate authorized by law, twenty (20) days after the Owner's receipt of the notice of expense until paid in full.

4. This Agreement affects County of San Bernardino Assessor's Parcel No. 0173-231-05 shall be recorded in the Official Records of the County of San Bernardino at the expense of the Owner and shall constitute notice to all successors and assigns to the title to the Property of the obligations herein set forth. This Agreement shall also constitute a lien against the Property in such amount as will fully reimburse the City, including interest as herein above set forth, subject to foreclosure in event of default in payment.

5. In event any action is commenced to enforce or interpret any of the terms or conditions of this Agreement the prevailing Party shall, in addition to any costs and other relief, be entitled to

DRAFT

the recovery of its reasonable attorneys' fees, including fees for the use of in-house counsel by a Party.

6. It is the intent of the Parties that the burdens and benefits herein undertaken shall constitute equitable servitudes that run with the Property and shall be binding upon future owners of all or any portion of the Property. Any owner's liability hereunder shall terminate at the time it ceases to be an owner of the encumbered Property, except for obligations which accrue prior to the date of transfer by such owner, which shall remain the personal obligation of such owner.

7. Time is of the essence in the performance of this Agreement.

8. Any notice to a Party required or called for in this Agreement shall be served in person, or by deposit in the U.S. Mail, first class postage prepaid, to the address set forth below. Notice(s) shall be deemed effective upon receipt, or seventy-two (72) hours after deposit in the U.S. Mail, whichever is earlier. A Party may change notice address only by providing written notice thereof to the other Party.

CITY	OWNER
City Engineer City of Redlands P.O. Box 3005 Redlands, CA 92373	Diversified Pacific Communities 10621 Civil Center Drive Rancho Cucamonga, CA 91730

9. This Agreement shall be governed by and construed in accordance with the laws of the State of California.

10. Any amendment to this Agreement shall be in writing and approved by the City Council of City and signed by the City and the Owner.

IN WITNESS WHEREOF, the Parties hereto have affixed their signatures as of the date first written above.

CITY OF REDLANDS:	OWNER:
_____ Paul W. Foster, Mayor	_____ Diversified Pacific Communities XXX, Authorized Representative

Attest:

_____
Jeanne Donaldson, City Clerk

DRAFT

Replace this page with a fully executed Notary Acknowledgment page.

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Exhibit "A"
Legal Description

DRAFT

Exhibit "B"
Plat Exhibit

(replace this sheet with plat map in pdf file)

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Exhibit C
Stormwater Pollution Control Devices

Stormwater Pollution Control Devices					
BMP #	BMP or Pollution Control Device	Latitude	Longitude	Maintenance Provided By	Frequency
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

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Exhibit D
BMP Map

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Roof Runoff Controls SD-11

Rain Garden

Design Objectives

- ✓ Maximize Infiltration
- ✓ Provide Retention
- ✓ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ✓ Contain Pollutants
- Collect and Convey

Description

Various roof runoff controls are available to address stormwater that drains off rooftops. The objective is to reduce the total volume and rate of runoff from individual lots, and retain the pollutants on site that may be picked up from roofing materials and atmospheric deposition. Roof runoff controls consist of directing the roof runoff away from paved areas and mitigating flow to the storm drain system through one of several general approaches: cisterns or rain barrels; dry wells or infiltration trenches; pop-up emitters, and foundation planting. The first three approaches require the roof runoff to be contained in a gutter and downspout system. Foundation planting provides a vegetated strip under the drip line of the roof.

Approach

Design of individual lots for single-family homes as well as lots for higher density residential and commercial structures should consider site design provisions for containing and infiltrating roof runoff or directing roof runoff to vegetative swales or buffer areas. Retained water can be reused for watering gardens, lawns, and trees. Benefits to the environment include reduced demand for potable water used for irrigation, improved stormwater quality, increased groundwater recharge, decreased runoff volume and peak flows, and decreased flooding potential.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

One method of addressing roof runoff is to direct roof downspouts to cisterns or rain barrels. A cistern is an above ground storage vessel with either a manually operated valve or a permanently open outlet. Roof runoff is temporarily stored and then released for irrigation or infiltration between storms. The number of rain

barrels needed is a function of the rooftop area. Some low impact developers recommend that every house have at least 2 rain barrels, with a minimum storage capacity of 1000 liters. Roof barrels serve several purposes including mitigating the first flush from the roof which has a high volume, amount of contaminants, and thermal load. Several types of rain barrels are commercially available. Consideration must be given to selecting rain barrels that are vector proof and childproof. In addition, some barrels are designed with a bypass valve that filters out grit and other contaminants and routes overflow to a soak-away pit or rain garden.

If the cistern has an operable valve, the valve can be closed to store stormwater for irrigation or infiltration between storms. This system requires continual monitoring by the resident or grounds crews, but provides greater flexibility in water storage and metering. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern must be covered to prevent mosquitoes from breeding.

A cistern system with a permanently open outlet can also provide for metering stormwater runoff. If the cistern outlet is significantly smaller than the size of the downspout inlet (say ¼ to ½ inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. This is a feasible way to mitigate the peak flow increases caused by rooftop impervious land coverage, especially for the frequent, small storms.

Dry wells and Infiltration Trenches

Roof downspouts can be directed to dry wells or infiltration trenches. A dry well is constructed by excavating a hole in the ground and filling it with an open graded aggregate, and allowing the water to fill the dry well and infiltrate after the storm event. An underground connection from the downspout conveys water into the dry well, allowing it to be stored in the voids. To minimize sedimentation from lateral soil movement, the sides and top of the stone storage matrix can be wrapped in a permeable filter fabric, though the bottom may remain open. A perforated observation pipe can be inserted vertically into the dry well to allow for inspection and maintenance.

In practice, dry wells receiving runoff from single roof downspouts have been successful over long periods because they contain very little sediment. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top (maximum depth of 10 feet).

To protect the foundation, dry wells must be set away from the building at least 10 feet. They must be installed in solids that accommodate infiltration. In poorly drained soils, dry wells have very limited feasibility.

Infiltration trenches function in a similar manner and would be particularly effective for larger roof areas. An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. These are described under Treatment Controls.

Pop-up Drainage Emitter

Roof downspouts can be directed to an underground pipe that daylights some distance from the building foundation, releasing the roof runoff through a pop-up emitter. Similar to a pop-up irrigation head, the emitter only opens when there is flow from the roof. The emitter remains flush to the ground during dry periods, for ease of lawn or landscape maintenance.

Foundation Planting

Landscape planting can be provided around the base to allow increased opportunities for stormwater infiltration and protect the soil from erosion caused by concentrated sheet flow coming off the roof. Foundation plantings can reduce the physical impact of water on the soil and provide a subsurface matrix of roots that encourage infiltration. These plantings must be sturdy enough to tolerate the heavy runoff sheet flows, and periodic soil saturation.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Supplemental Information

Examples

- City of Ottawa's Water Links Surface –Water Quality Protection Program
- City of Toronto Downspout Disconnection Program
- City of Boston, MA, Rain Barrel Demonstration Program

Other Resources

Hager, Marty Catherine, Stormwater, "Low-Impact Development", January/February 2003. www.stormh2o.com

Low Impact Urban Design Tools, Low Impact Development Design Center, Beltsville, MD. www.lid-stormwater.net

Start at the Source, Bay Area Stormwater Management Agencies Association, 1999 Edition

Efficient Irrigation SD-12

Design Objectives

- ✓ Maximize Infiltration
- ✓ Provide Retention
- ✓ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Irrigation water provided to landscaped areas may result in excess irrigation water being conveyed into stormwater drainage systems.

Approach

Project plan designs for development and redevelopment should include application methods of irrigation water that minimize runoff of excess irrigation water into the stormwater conveyance system.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Designing New Installations

The following methods to reduce excessive irrigation runoff should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

- Employ rain-triggered shutoff devices to prevent irrigation after precipitation.
- Design irrigation systems to each landscape area's specific water requirements.
- Include design featuring flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- Implement landscape plans consistent with County or City water conservation resolutions, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

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- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:
  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff
  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect
  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible
  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth
- Employ other comparable, equally effective methods to reduce irrigation water runoff.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Storm Drain Signage SD-13

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ✓ Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include "NO DUMPING –

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DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.

- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Pervious Pavements SD-20

Design Objectives

- ✓ Maximize Infiltration
- ✓ Provide Retention
- ✓ Slow Runoff
- ✓ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Pervious paving is used for light vehicle loading in parking areas. The term describes a system comprising a load-bearing, durable surface together with an underlying layered structure that temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface can itself be porous such that water infiltrates across the entire surface of the material (e.g., grass and gravel surfaces, porous concrete and porous asphalt), or can be built up of impermeable blocks separated by spaces and joints, through which the water can drain. This latter system is termed 'permeable' paving. Advantages of pervious pavements is that they reduce runoff volume while providing treatment, and are unobtrusive resulting in a high level of acceptability.

Approach

Attenuation of flow is provided by the storage within the underlying structure or sub base, together with appropriate flow controls. An underlying geotextile may permit groundwater recharge, thus contributing to the restoration of the natural water cycle. Alternatively, where infiltration is inappropriate (e.g., if the groundwater vulnerability is high, or the soil type is unsuitable), the surface can be constructed above an impermeable membrane. The system offers a valuable solution for drainage of spatially constrained urban areas.

Significant attenuation and improvement in water quality can be achieved by permeable pavements, whichever method is used. The surface and subsurface infrastructure can remove both the soluble and fine particulate pollutants that occur within urban runoff. Roof water can be piped into the storage area directly, adding areas from which the flow can be attenuated. Also, within lined systems, there is the opportunity for stored runoff to be piped out for reuse.

Suitable Applications

Residential, commercial and industrial applications are possible. The use of permeable pavement may be restricted in cold regions, arid regions or regions with high wind erosion. There are some specific disadvantages associated with permeable pavement, which are as follows:

- Permeable pavement can become clogged if improperly installed or maintained. However, this is countered by the ease with which small areas of paving can be cleaned or replaced when blocked or damaged.

- Their application should be limited to highways with low traffic volumes, axle loads and speeds (less than 30 mph limit), car parking areas and other lightly trafficked or non-trafficked areas. Permeable surfaces are currently not considered suitable for adoptable roads due to the risks associated with failure on high speed roads, the safety implications of ponding, and disruption arising from reconstruction.

- When using un-lined, infiltration systems, there is some risk of contaminating groundwater, depending on soil conditions and aquifer susceptibility. However, this risk is likely to be small because the areas drained tend to have inherently low pollutant loadings.

- The use of permeable pavement is restricted to gentle slopes.

- Porous block paving has a higher risk of abrasion and damage than solid blocks.

Design Considerations

Designing New Installations

If the grades, subsoils, drainage characteristics, and groundwater conditions are suitable, permeable paving may be substituted for conventional pavement on parking areas, cul de sacs and other areas with light traffic. Slopes should be flat or very gentle. Scottish experience has shown that permeable paving systems can be installed in a wide range of ground conditions, and the flow attenuation performance is excellent even when the systems are lined.

The suitability of a pervious system at a particular pavement site will, however, depend on the loading criteria required of the pavement.

Where the system is to be used for infiltrating drainage waters into the ground, the vulnerability of local groundwater sources to pollution from the site should be low, and the seasonal high water table should be at least 4 feet below the surface.

Ideally, the pervious surface should be horizontal in order to intercept local rainfall at source. On sloping sites, pervious surfaces may be terraced to accommodate differences in levels.

Design Guidelines

The design of each layer of the pavement must be determined by the likely traffic loadings and their required operational life. To provide satisfactory performance, the following criteria should be considered:

- The subgrade should be able to sustain traffic loading without excessive deformation.

- The granular capping and sub-base layers should give sufficient load-bearing to provide an adequate construction platform and base for the overlying pavement layers.

- The pavement materials should not crack of suffer excessive rutting under the influence of traffic. This is controlled by the horizontal tensile stress at the base of these layers.

There is no current structural design method specifically for pervious pavements. Allowances should be considered the following factors in the design and specification of materials:

- Pervious pavements use materials with high permeability and void space. All the current UK pavement design methods are based on the use of conventional materials that are dense and relatively impermeable. The stiffness of the materials must therefore be assessed.

- Water is present within the construction and can soften and weaken materials, and this must be allowed for.

- Existing design methods assume full friction between layers. Any geotextiles or geomembranes must be carefully specified to minimize loss of friction between layers.

- Porous asphalt loses adhesion and becomes brittle as air passes through the voids. Its durability is therefore lower than conventional materials.

The single sized grading of materials used means that care should be taken to ensure that loss of finer particles between unbound layers does not occur.

Positioning a geotextile near the surface of the pervious construction should enable pollutants to be trapped and retained close to the surface of the construction. This has both advantages and disadvantages. The main disadvantage is that the filtering of sediments and their associated pollutants at this level may hamper percolation of waters and can eventually lead to surface ponding. One advantage is that even if eventual maintenance is required to reinstate infiltration, only a limited amount of the construction needs to be disturbed, since the sub-base below the geotextile is protected. In addition, the pollutant concentration at a high level in the structure allows for its release over time. It is slowly transported in the stormwater to lower levels where chemical and biological processes may be operating to retain or degrade pollutants.

The design should ensure that sufficient void space exists for the storage of sediments to limit the period between remedial works.

- Pervious pavements require a single size grading to give open voids. The choice of materials is therefore a compromise between stiffness, permeability and storage capacity.

- Because the sub-base and capping will be in contact with water for a large part of the time, the strength and durability of the aggregate particles when saturated and subjected to wetting and drying should be assessed.

- A uniformly graded single size material cannot be compacted and is liable to move when construction traffic passes over it. This effect can be reduced by the use of angular crushed rock material with a high surface friction.

In pollution control terms, these layers represent the site of long term chemical and biological pollutant retention and degradation processes. The construction materials should be selected, in addition to their structural strength properties, for their ability to sustain such processes. In general, this means that materials should create neutral or slightly alkaline conditions and they should provide favorable sites for colonization by microbial populations.

Construction/Inspection Considerations

- Permeable surfaces can be laid without cross-falls or longitudinal gradients.

- The blocks should be lain level

- They should not be used for storage of site materials, unless the surface is well protected from deposition of silt and other spillages.
- The pavement should be constructed in a single operation, as one of the last items to be built, on a development site. Landscape development should be completed before pavement construction to avoid contamination by silt or soil from this source.
- Surfaces draining to the pavement should be stabilized before construction of the pavement.
- Inappropriate construction equipment should be kept away from the pavement to prevent damage to the surface, sub-base or sub-grade.

Maintenance Requirements

The maintenance requirements of a pervious surface should be reviewed at the time of design and should be clearly specified. Maintenance is required to prevent clogging of the pervious surface. The factors to be considered when defining maintenance requirements must include:

- Type of use
- Ownership
- Level of trafficking
- The local environment and any contributing catchments

Studies in the UK have shown satisfactory operation of porous pavement systems without maintenance for over 10 years and recent work by Imbe et al. at 9th ICUD, Portland, 2002 describes systems operating for over 20 years without maintenance. However, performance under such regimes could not be guaranteed, Table 1 shows typical recommended maintenance regimes:

Table 1 Typical Recommended Maintenance Regimes	
Activity	**Schedule**
■ Minimize use of salt or grit for de-icing ■ Keep landscaped areas well maintained ■ Prevent soil being washed onto pavement	Ongoing
■ Vacuum clean surface using commercially available sweeping machines at the following times: - End of winter (April) - Mid-summer (July / August) - After Autumn leaf-fall (November)	2/3 x per year
■ Inspect outlets	Annual
■ If routine cleaning does not restore infiltration rates, then reconstruction of part of the whole of a pervious surface may be required. ■ The surface area affected by hydraulic failure should be lifted for inspection of the internal materials to identify the location and extent of the blockage. ■ Surface materials should be lifted and replaced after brush cleaning. Geotextiles may need complete replacement. ■ Sub-surface layers may need cleaning and replacing. ■ Removed silts may need to be disposed of as controlled waste.	As needed (infrequent) Maximum 15-20 years

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 1 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Cost Considerations

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 2 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

Table 2 Engineer's Estimate for Porous Pavement

Porous Pavement													
Item	Units	Price	Cycles/ Year	Quant. 1 Acre WS	Total	Quant. 2 Acre WS	Total	Quant. 3 Acre WS	Total	Quant. 4 Acre WS	Total	Quant. 5 Acre WS	Total
Grading	SY	$2.00		604	$1,208	1209	$2,418	1812	$3,624	2419	$4,838	3020	$6,040
Paving	SY	$19.00		212	$4,028	424	$8,056	636	$12,084	848	$16,112	1060	$20,140
Excavation	CY	$3.60		201	$724	403	$1,451	604	$2,174	806	$2,902	1008	$3,629
Filter Fabric	SY	$1.15		700	$805	1400	$1,610	2000	$2,300	2800	$3,220	3600	$4,140
Stone Fill	CY	$16.00		201	$3,216	403	$6,448	604	$9,664	806	$12,896	1008	$16,128
Sand	CY	$7.00		100	$700	200	$1,400	300	$2,100	400	$2,800	500	$3,500
Sight Well	EA	$300.00		2	$600	3	$900	4	$1,200	7	$2,100	7	$2,100
Seeding	LF	$0.05		644	$32	1288	$64	1932	$97	2576	$129	3220	$161
Check Dam	CY	$35.00		0	$0	0	$0	0	$0	0	$0	0	$0
Total Construction Costs					**$10,105**		**$19,929**		**$29,619**		**$40,158**		**$49,798**
Construction Costs Amortized for 20 Years					**$505**		**$996**		**$1,481**		**$2,008**		**$2,490**
Annual Maintenance Expense													
Item	Units	Price	Cycles/ Year	Quant. 1 Acre WS	Total	Quant. 2 Acre WS	Total	Quant. 3 Acre WS	Total	Quant. 4 Acre WS	Total	Quant. 5 Acre WS	Total
Sweeping	AC	$250.00	6	1	$1,500	2	$3,000	3	$4,500	4	$6,000	5	$7,500
Washing	AC	$250.00	6	1	$1,500	2	$3,000	3	$4,500	4	$6,000	5	$7,500
Inspection	MH	$20.00	5	5	$100	5	$100	5	$100	5	$100	5	$100
Deep Clean	AC	$450.00	0.5	1	$225	2	$450	3	$675	3.9	$878	5	$1,125
Total Annual Maintenance Expense					**$3,960**		**$7,792**		**$11,651**		**$15,483**		**$19,370**

Supplemental Information

■

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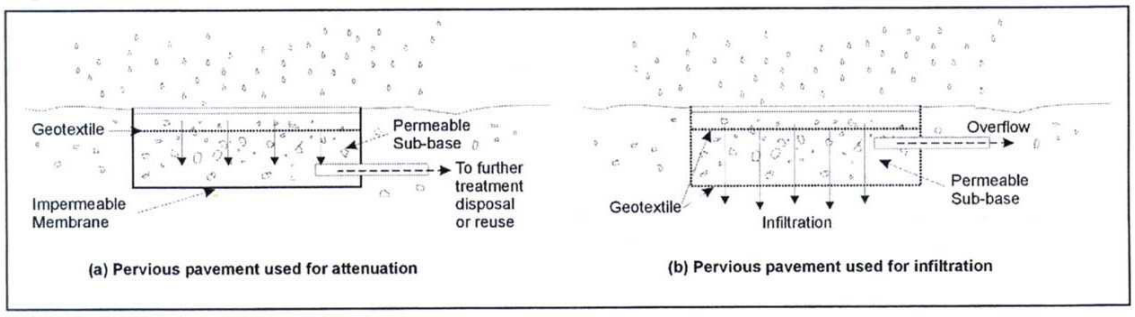

Schematics of a Pervious Pavement System

Alternative Building Materials SD-21

Design Objectives

- ✓ Maximize Infiltration
- ✓ Provide Retention
- ✓ Source Control
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutant
- Collect and Convey

Description

Alternative building materials are selected instead of conventional materials for new construction and renovation. These materials reduce potential sources of pollutants in stormwater runoff by eliminating compounds that can leach into runoff, reducing the need for pesticide application, reducing the need for painting and other maintenance, or by reducing the volume of runoff.

Approach

Alternative building materials are available for use as lumber for decking, roofing materials, home siding, and paving for driveways, decks, and sidewalks.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Designing New Installations

Decking

One of the most common materials for construction of decks and other outdoor construction has traditionally been pressure treated wood, which is now being phased out. The standard treatment is called CCA, for chromated copper arsenate. The key ingredients are arsenic (which kills termites, carpenter ants and other insects), copper (which kills the fungi that cause wood to rot) and chromium (which reacts with the other ingredients to bind them to the wood). The amount of arsenic is far from trivial. A deck just 8 feet x 10 feet contains more than 1 1/3 pounds of this highly potent poison. Replacement materials include a new type of pressure treated wood, plastic and composite lumber.

There are currently over 20 products in the market consisting of plastic or plastic-wood composites. Plastic lumber is made from 100% recycled plastic, # 2 HDPE and polyethylene plastic milk jugs

and soap bottles. Plastic-wood composites are a combination of plastic and wood fibers or sawdust. These materials are a long lasting exterior weather, insect, and chemical resistant wood lumber replacement for non structural applications. Use it for decks, docks, raised garden beds and planter boxes, pallets, hand railings, outdoor furniture, animal pens, boat decks, etc.

New pressure treated wood uses a much safer recipe, ACQ, which stands for ammoniacal copper quartenary. It contains no arsenic and no chromium. Yet the American Wood Preservers Association has found it to be just as effective as the standard formula. ACQ is common in Japan and Europe.

Roofing

Several studies have indicated that metal used as roofing material, flashing, or gutters can leach metals into the environment. The leaching occurs because rainfall is slightly acidic and slowly dissolved the exposed metals. Common traditional applications include copper sheathing and galvanized (zinc) gutters.

Coated metal products are available for both roofing and gutter applications. These products eliminate contact of bare metal with rainfall, eliminating one source of metals in runoff. There are also roofing materials made of recycled rubber and plastic that resemble traditional materials.

A less traditional approach is the use of green roofs. These roofs are not just green, they're alive. Planted with grasses and succulents, low- profile green roofs reduce the urban heat island effect, stormwater runoff, and cooling costs, while providing wildlife habitat and a connection to nature for building occupants. These roofs are widely used on industrial facilities in Europe and have been established as experimental installations in several locations in the US, including Portland, Oregon. Their feasibility is questionable in areas of California with prolonged, dry, hot weather.

Paved Areas

Traditionally, concrete is used for construction of patios, sidewalks, and driveways. Although it is non-toxic, these paved areas reduce stormwater infiltration and increase the volume and rate of runoff. This increase in the amount of runoff is the leading cause of stream channel degradation in urban areas.

There are a number of alternative materials that can be used in these applications, including porous concrete and asphalt, modular blocks, and crushed granite. These materials, especially modular paving blocks, are widely available and a well established method to reduce stormwater runoff.

Building Siding

Wood siding is commonly used on the exterior of residential construction. This material weathers fairly rapidly and requires repeated painting to prevent rotting. Alternative “new” products for this application include cement-fiber and vinyl. Cement-fiber siding is a masonry product made from Portland cement, sand, and cellulose and will not burn, cup, swell, or shrink.

Pesticide Reduction

A common use of powerful pesticides is for the control of termites. Chlordane was used for many years for this purpose and is now found in urban streams and lakes nationwide. There are a

number of physical barriers that can be installed during construction to help reduce the use of pesticides.

Sand barriers for subterranean termites are a physical deterrent because the termites cannot tunnel through it. Sand barriers can be applied in crawl spaces under pier and beam foundations, under slab foundations, and between the foundation and concrete porches, terraces, patios and steps. Other possible locations include under fence posts, underground electrical cables, water and gas lines, telephone and electrical poles, inside hollow tile cells and against retaining walls.

Metal termite shields are physical barriers to termites which prevent them from building invisible tunnels. In reality, metal shields function as a helpful termite detection device, forcing them to build tunnels on the outside of the shields which are easily seen. Metal termite shields also help prevent dampness from wicking to adjoining wood members which can result in rot, thus making the material more attractive to termites and other pests. Metal flashing and metal plates can also be used as a barrier between piers and beams of structures such as decks, which are particularly vulnerable to termite attack.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of "redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Other Resources

There are no good, independent, comprehensive sources of information on alternative building materials for use in minimizing the impacts of stormwater runoff. Most websites or other references to "green" or "alternative" building materials focus on indoor applications, such as formaldehyde free plywood and low VOC paints, carpets, and pads. Some supplemental information on alternative materials is available from the manufacturers.

Fires are a source of concern in many areas of California. Information on the flammability of alternative decking materials is available from the University of California Forest Product Laboratory (UCFPL) website at: http://www.ucfpl.ucop.edu/WDDeckIntro.htm

Vegetated Swale TC-30

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

Targeted Constituents

✓	Sediment	▲
✓	Nutrients	●
✓	Trash	●
✓	Metals	▲
✓	Bacteria	●
✓	Oil and Grease	▲
✓	Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

CASQA California Stormwater Quality Association

- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

Table 1 Grassed swale pollutant removal efficiency data							
	Removal Efficiencies (% Removal)						
Study	TSS	TP	TN	NO_3	Metals	Bacteria	Type
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.

- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.

- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.

- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.

- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately $0.25 per ft^2. This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately $0.50 per ft^2, which compares favorably with other stormwater management practices.

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b]	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c]	Acre	0.25	$3,800	$5,200	$6,600	$950	$1,300	$1,650
General Excavation[d]	Yd^3	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e]	Yd^2	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil Seed, and Mulch[f]	Yd^2	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Sod[g]	Yd^2	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Subtotal	--	–	--	–	--	$5,116	$9,388	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	–	--	–	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $\left(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}\right) \times$ swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Table 3 Estimated Maintenance Costs (SEWRPC, 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	$0.85 / 1,000 ft^2/ mowing	$0.14 / linear foot	$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	$9.00 / 1,000 ft^2/ year	$0.18 / linear foot	$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	$0.10 / linear foot / year	$0.10 / linear foot	$0.10 / linear foot	–
Grass Reseeding with Mulch and Fertilizer	$0.30 / yd^2	$0.01 / linear foot	$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	$0.15 / linear foot / year, plus $25 / inspection	$0.15 / linear foot	$0.15 / linear foot	Inspect four times per year
Total	--	**$0.58 / linear foot**	**$ 0.75 / linear foot**	--

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

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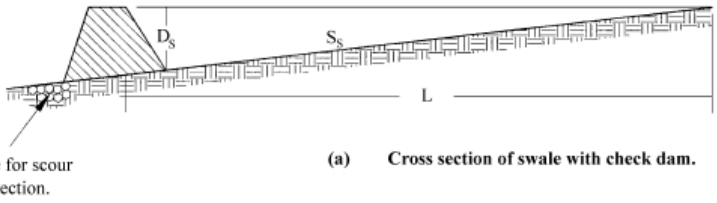
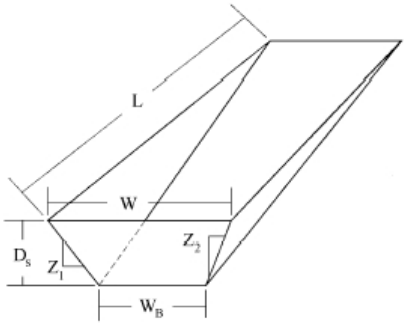


(a) Cross section of swale with check dam.



(b) Dimensional view of swale impoundment area.

Notation:
L = Length of swale impoundment area per check dam (ft)
D_S = Depth of check dam (ft)
S_S = Bottom slpe of swale (ft/ft)
W = Top width of check dam (ft)
W_B = Bottom width of check dam (ft)
$Z_{1\&2}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

Bioretention TC-32

Design Considerations

- Soil for Infiltration
- Tributary Area
- Slope
- Aesthetics
- Environmental Side-effects

Description

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

Targeted Constituents

✓	Sediment	■
✓	Nutrients	▲
✓	Trash	■
✓	Metals	■
✓	Bacteria	■
✓	Oil and Grease	■
✓	Organics	■

Legend ***(Removal Effectiveness)***

- ● Low
- ▲ Medium
- ■ High

California Experience

None documented. Bioretention has been used as a stormwater BMP since 1992. In addition to Prince George's County, MD and Alexandria, VA, bioretention has been used successfully at urban and suburban areas in Montgomery County, MD; Baltimore County, MD; Chesterfield County, VA; Prince William County, VA; Smith Mountain Lake State Park, VA; and Cary, NC.

Advantages

- Bioretention provides stormwater treatment that enhances the quality of downstream water bodies by temporarily storing runoff in the BMP and releasing it over a period of four days to the receiving water (EPA, 1999).
- The vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

Limitations

- The bioretention BMP is not recommended for areas with slopes greater than 20% or where mature tree removal would

CASQA California Stormwater Quality Association

be required since clogging may result, particularly if the BMP receives runoff with high sediment loads (EPA, 1999).

- Bioretention is not a suitable BMP at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
- By design, bioretention BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water.
- In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

Design and Sizing Guidelines

- The bioretention area should be sized to capture the design storm runoff.
- In areas where the native soil permeability is less than 0.5 in/hr an underdrain should be provided.
- Recommended minimum dimensions are 15 feet by 40 feet, although the preferred width is 25 feet. Excavated depth should be 4 feet.
- Area should drain completely within 72 hours.
- Approximately 1 tree or shrub per 50 ft^2 of bioretention area should be included.
- Cover area with about 3 inches of mulch.

Construction/Inspection Considerations

Bioretention area should not be established until contributing watershed is stabilized.

Performance

Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization (EPA, 1999). Adsorption is the process whereby particulate pollutants attach to soil (e.g., clay) or vegetation surfaces. Adequate contact time between the surface and pollutant must be provided for in the design of the system for this removal process to occur. Thus, the infiltration rate of the soils must not exceed those specified in the design criteria or pollutant removal may decrease. Pollutants removed by adsorption include metals, phosphorus, and hydrocarbons. Filtration occurs as runoff passes through the bioretention area media, such as the sand bed, ground cover, and planting soil.

Common particulates removed from stormwater include particulate organic matter, phosphorus, and suspended solids. Biological processes that occur in wetlands result in pollutant uptake by plants and microorganisms in the soil. Plant growth is sustained by the uptake of nutrients from the soils, with woody plants locking up these nutrients through the seasons. Microbial activity within the soil also contributes to the removal of nitrogen and organic matter. Nitrogen is removed by nitrifying and denitrifying bacteria, while aerobic bacteria are responsible for the decomposition of the organic matter. Microbial processes require oxygen and can result in depleted oxygen levels if the bioretention area is not adequately

aerated. Sedimentation occurs in the swale or ponding area as the velocity slows and solids fall out of suspension.

The removal effectiveness of bioretention has been studied during field and laboratory studies conducted by the University of Maryland (Davis et al, 1998). During these experiments, synthetic stormwater runoff was pumped through several laboratory and field bioretention areas to simulate typical storm events in Prince George's County, MD. Removal rates for heavy metals and nutrients are shown in Table 1.

Table 1 Laboratory and Estimated Bioretention Davis et al. (1998); PGDER (1993)

Pollutant	Removal Rate
Total Phosphorus	70-83%
Metals (Cu, Zn, Pb)	93-98%
TKN	68-80%
Total Suspended Solids	90%
Organics	90%
Bacteria	90%

Results for both the laboratory and field experiments were similar for each of the pollutants analyzed. Doubling or halving the influent pollutant levels had little effect on the effluent pollutants concentrations (Davis et al, 1998).

The microbial activity and plant uptake occurring in the bioretention area will likely result in higher removal rates than those determined for infiltration BMPs.

Siting Criteria

Bioretention BMPs are generally used to treat stormwater from impervious surfaces at commercial, residential, and industrial areas (EPA, 1999). Implementation of bioretention for stormwater management is ideal for median strips, parking lot islands, and swales. Moreover, the runoff in these areas can be designed to either divert directly into the bioretention area or convey into the bioretention area by a curb and gutter collection system.

The best location for bioretention areas is upland from inlets that receive sheet flow from graded areas and at areas that will be excavated (EPA, 1999). In order to maximize treatment effectiveness, the site must be graded in such a way that minimizes erosive conditions as sheet flow is conveyed to the treatment area. Locations where a bioretention area can be readily incorporated into the site plan without further environmental damage are preferred. Furthermore, to effectively minimize sediment loading in the treatment area, bioretention only should be used in stabilized drainage areas.

Additional Design Guidelines

The layout of the bioretention area is determined after site constraints such as location of utilities, underlying soils, existing vegetation, and drainage are considered (EPA, 1999). Sites with loamy sand soils are especially appropriate for bioretention because the excavated soil can be backfilled and used as the planting soil, thus eliminating the cost of importing planting soil.

The use of bioretention may not be feasible given an unstable surrounding soil stratum, soils with clay content greater than 25 percent, a site with slopes greater than 20 percent, and/or a site with mature trees that would be removed during construction of the BMP.

Bioretention can be designed to be off-line or on-line of the existing drainage system (EPA, 1999). The drainage area for a bioretention area should be between 0.1 and 0.4 hectares (0.25 and 1.0 acres). Larger drainage areas may require multiple bioretention areas. Furthermore, the maximum drainage area for a bioretention area is determined by the expected rainfall intensity and runoff rate. Stabilized areas may erode when velocities are greater than 5 feet per second (1.5 meter per second). The designer should determine the potential for erosive conditions at the site.

The size of the bioretention area, which is a function of the drainage area and the runoff generated from the area is sized to capture the water quality volume.

The recommended minimum dimensions of the bioretention area are 15 feet (4.6 meters) wide by 40 feet (12.2 meters) long, where the minimum width allows enough space for a dense, randomly-distributed area of trees and shrubs to become established. Thus replicating a natural forest and creating a microclimate, thereby enabling the bioretention area to tolerate the effects of heat stress, acid rain, runoff pollutants, and insect and disease infestations which landscaped areas in urban settings typically are unable to tolerate. The preferred width is 25 feet (7.6 meters), with a length of twice the width. Essentially, any facilities wider than 20 feet (6.1 meters) should be twice as long as they are wide, which promotes the distribution of flow and decreases the chances of concentrated flow.

In order to provide adequate storage and prevent water from standing for excessive periods of time the ponding depth of the bioretention area should not exceed 6 inches (15 centimeters). Water should not be left to stand for more than 72 hours. A restriction on the type of plants that can be used may be necessary due to some plants' water intolerance. Furthermore, if water is left standing for longer than 72 hours mosquitoes and other insects may start to breed.

The appropriate planting soil should be backfilled into the excavated bioretention area. Planting soils should be sandy loam, loamy sand, or loam texture with a clay content ranging from 10 to 25 percent.

Generally the soil should have infiltration rates greater than 0.5 inches (1.25 centimeters) per hour, which is typical of sandy loams, loamy sands, or loams. The pH of the soil should range between 5.5 and 6.5, where pollutants such as organic nitrogen and phosphorus can be adsorbed by the soil and microbial activity can flourish. Additional requirements for the planting soil include a 1.5 to 3 percent organic content and a maximum 500 ppm concentration of soluble salts.

Soil tests should be performed for every 500 cubic yards (382 cubic meters) of planting soil, with the exception of pH and organic content tests, which are required only once per bioretention area (EPA, 1999). Planting soil should be 4 inches (10.1 centimeters) deeper than the bottom of the largest root ball and 4 feet (1.2 meters) altogether. This depth will provide adequate soil for the plants' root systems to become established, prevent plant damage due to severe wind, and provide adequate moisture capacity. Most sites will require excavation in order to obtain the recommended depth.

Planting soil depths of greater than 4 feet (1.2 meters) may require additional construction practices such as shoring measures (EPA, 1999). Planting soil should be placed in 18 inches or greater lifts and lightly compacted until the desired depth is reached. Since high canopy trees may be destroyed during maintenance the bioretention area should be vegetated to resemble a terrestrial forest community ecosystem that is dominated by understory trees. Three species each of both trees and shrubs are recommended to be planted at a rate of 2500 trees and shrubs per hectare (1000 per acre). For instance, a 15 foot (4.6 meter) by 40 foot (12.2 meter) bioretention area (600 square feet or 55.75 square meters) would require 14 trees and shrubs. The shrub-to-tree ratio should be 2:1 to 3:1.

Trees and shrubs should be planted when conditions are favorable. Vegetation should be watered at the end of each day for fourteen days following its planting. Plant species tolerant of pollutant loads and varying wet and dry conditions should be used in the bioretention area.

The designer should assess aesthetics, site layout, and maintenance requirements when selecting plant species. Adjacent non-native invasive species should be identified and the designer should take measures, such as providing a soil breach to eliminate the threat of these species invading the bioretention area. Regional landscaping manuals should be consulted to ensure that the planting of the bioretention area meets the landscaping requirements established by the local authorities. The designers should evaluate the best placement of vegetation within the bioretention area. Plants should be placed at irregular intervals to replicate a natural forest. Trees should be placed on the perimeter of the area to provide shade and shelter from the wind. Trees and shrubs can be sheltered from damaging flows if they are placed away from the path of the incoming runoff. In cold climates, species that are more tolerant to cold winds, such as evergreens, should be placed in windier areas of the site.

Following placement of the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses or legumes can be planted at the beginning of the growing season. Mulch should be placed immediately after trees and shrubs are planted. Two to 3 inches (5 to 7.6 cm) of commercially-available fine shredded hardwood mulch or shredded hardwood chips should be applied to the bioretention area to protect from erosion.

Maintenance

The primary maintenance requirement for bioretention areas is that of inspection and repair or replacement of the treatment area's components. Generally, this involves nothing more than the routine periodic maintenance that is required of any landscaped area. Plants that are appropriate for the site, climatic, and watering conditions should be selected for use in the bioretention cell. Appropriately selected plants will aide in reducing fertilizer, pesticide, water, and overall maintenance requirements. Bioretention system components should blend over time through plant and root growth, organic decomposition, and the development of a natural

soil horizon. These biologic and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Routine maintenance should include a biannual health evaluation of the trees and shrubs and subsequent removal of any dead or diseased vegetation (EPA, 1999). Diseased vegetation should be treated as needed using preventative and low-toxic measures to the extent possible. BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water. Routine inspections for areas of standing water within the BMP and corrective measures to restore proper infiltration rates are necessary to prevent creating mosquito and other vector habitat. In addition, bioretention BMPs are susceptible to invasion by aggressive plant species such as cattails, which increase the chances of water standing and subsequent vector production if not routinely maintained.

In order to maintain the treatment area's appearance it may be necessary to prune and weed. Furthermore, mulch replacement is suggested when erosion is evident or when the site begins to look unattractive. Specifically, the entire area may require mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas. Mulch replacement should be done prior to the start of the wet season.

New Jersey's Department of Environmental Protection states in their bioretention systems standards that accumulated sediment and debris removal (especially at the inflow point) will normally be the primary maintenance function. Other potential tasks include replacement of dead vegetation, soil pH regulation, erosion repair at inflow points, mulch replenishment, unclogging the underdrain, and repairing overflow structures. There is also the possibility that the cation exchange capacity of the soils in the cell will be significantly reduced over time. Depending on pollutant loads, soils may need to be replaced within 5-10 years of construction (LID, 2000).

Cost

Construction Cost

Construction cost estimates for a bioretention area are slightly greater than those for the required landscaping for a new development (EPA, 1999). A general rule of thumb (Coffman, 1999) is that residential bioretention areas average about $3 to $4 per square foot, depending on soil conditions and the density and types of plants used. Commercial, industrial and institutional site costs can range between $10 to $40 per square foot, based on the need for control structures, curbing, storm drains and underdrains.

Retrofitting a site typically costs more, averaging $6,500 per bioretention area. The higher costs are attributed to the demolition of existing concrete, asphalt, and existing structures and the replacement of fill material with planting soil. The costs of retrofitting a commercial site in Maryland, Kettering Development, with 15 bioretention areas were estimated at $111,600.

In any bioretention area design, the cost of plants varies substantially and can account for a significant portion of the expenditures. While these cost estimates are slightly greater than those of typical landscaping treatment (due to the increased number of plantings, additional soil excavation, backfill material, use of underdrains etc.), those landscaping expenses that would be required regardless of the bioretention installation should be subtracted when determining the net cost.

Perhaps of most importance, however, the cost savings compared to the use of traditional structural stormwater conveyance systems makes bioretention areas quite attractive financially. For example, the use of bioretention can decrease the cost required for constructing stormwater conveyance systems at a site. A medical office building in Maryland was able to reduce the amount of storm drain pipe that was needed from 800 to 230 feet - a cost savings of $24,000 (PGDER, 1993). And a new residential development spent a total of approximately $100,000 using bioretention cells on each lot instead of nearly $400,000 for the traditional stormwater ponds that were originally planned (Rappahanock,). Also, in residential areas, stormwater management controls become a part of each property owner's landscape, reducing the public burden to maintain large centralized facilities.

Maintenance Cost

The operation and maintenance costs for a bioretention facility will be comparable to those of typical landscaping required for a site. Costs beyond the normal landscaping fees will include the cost for testing the soils and may include costs for a sand bed and planting soil.

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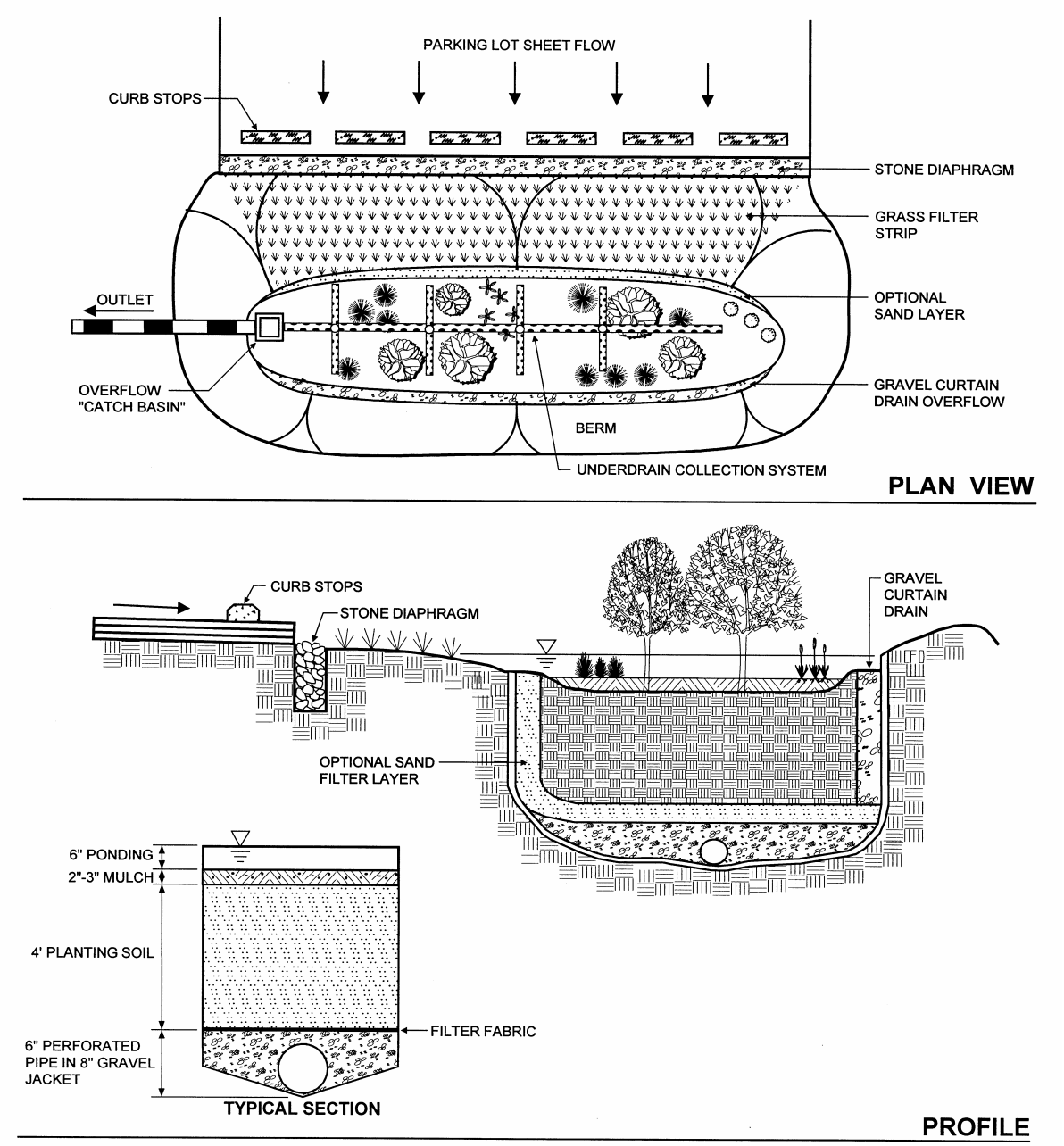

Schematic of a Bioretention Facility (MDE, 2000)

Filterra Owner's Manual

filterra®

Bioretention Systems

CONTECH®

ENGINEERED SOLUTIONS

filterra®
Bioretention Systems

Table of Contents

Introduction 4

Activation Overview 4

Filterra Plant Selection Overview 6

Warranty Overview 6

Routine Maintenance Guidelines 6

Maintenance Visit Procedure 9

Appendix 1 – Activation Checklist 12

Appendix 2 – Planting Requirements for Filterra Systems 13

Enclosed

Local Area Filterra Plant List

CONTECH®
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Introduction

Thank you for your purchase of the Filterra® Bioretention System. Filterra is a specially engineered stormwater treatment system incorporating high performance biofiltration media to remove pollutants from stormwater runoff. The system's biota (vegetation and soil microorganisms) then further breakdown and absorb captured pollutants. All components of the system work together to provide a sustainable long-term solution for treating stormwater runoff.

The Filterra system has been delivered to you with protection in place to resist intrusion of construction related sediment which can contaminate the biofiltration media and result in inadequate system performance. These protection devices are intended as a best practice and cannot fully prevent contamination. It is the purchaser's responsibility to provide adequate measures to prevent construction related runoff from entering the Filterra system.

Included with your purchase is Activation of the Filterra system by the manufacturer as well as a 1-year warranty from delivery of the system and 1-year of routine maintenance (mulch replacement, debris removal, and pruning of vegetation) up to twice during the first year after activation.

Design and Installation

Each project presents different scopes for the use of Filterra systems. Information and help may be provided to the design engineer during the planning process. Correct Filterra box sizing (by rainfall region) is essential to predict pollutant removal rates for a given area. The engineer shall submit calculations for approval by the local jurisdiction. The contractor is responsible for the correct installation of Filterra units as shown in approved plans. A comprehensive installation manual is available at www.ContechES.com.

Activation Overview

Activation of the Filterra system is a procedure completed by the manufacturer to place the system into working condition. This involves the following items:

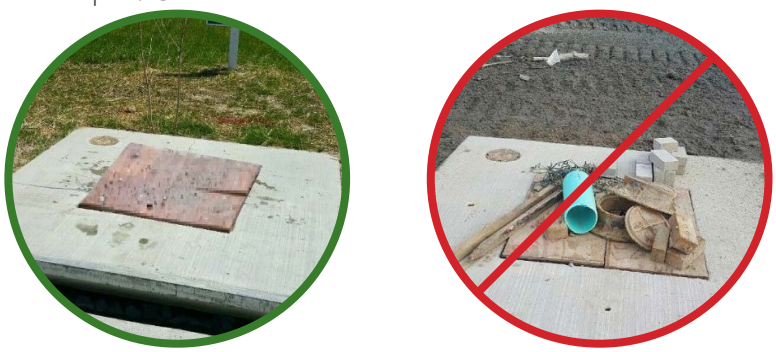
- Removal of construction runoff protection devices
- Planting of the system's vegetation
- Placement of pretreatment mulch layer using mulch certified for use in Filterra systems.

Activation MUST be provided by the manufacturer to ensure proper site conditions are met for Activation, proper installation of the vegetation, and use of pretreatment mulch certified for use in Filterra systems.

Minimum Requirements

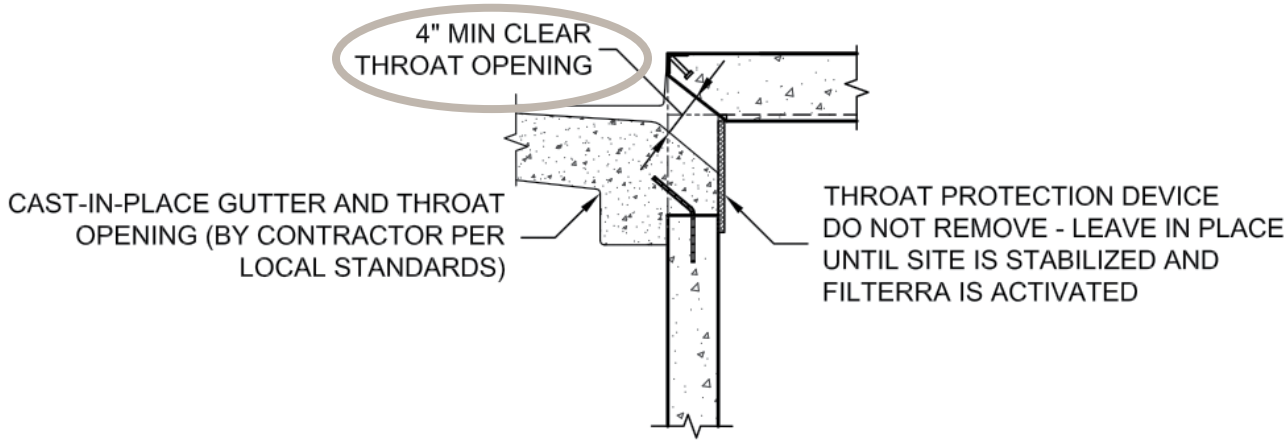
The minimum requirements for Filterra Activation are as follows:

1. The site landscaping must be fully stabilized, i.e. full landscaping installed and some grass cover (not just straw and seed) is required to reduce sediment transport. Construction debris and materials should be removed from surrounding area.



2. Final paving must be completed. Final paving ensures that paving materials will not enter and contaminate the Filterra system during the paving process, and that the plant will receive runoff from the drainage area, assisting with plant survival for the Filterra system.

3. Filterra throat opening should be at least 4" in order to ensure adequate capacity for inflow and debris.



An Activation Checklist is included on page 12 to ensure proper conditions are met for Contech to perform the Activation services. A charge of $500.00 will be invoiced for each Activation visit requested by Customer where Contech determines that the site does not meet the conditions required for Activation.

Filterra Plant Selection Overview

A Plant List has been enclosed with this packet highlighting recommended plants for Filterra systems in your area. Keep in mind that plants are subject to availability due to seasonality and required minimum size for the Filterra system. Plants installed in the Filterra system are container plants (max 15 gallon) from nursery stock and will be immature in height and spread at Activation.

It is the responsibility of the owner to provide adequate irrigation when necessary to the plant of the Filterra system.

The "Planting Requirements for Filterra Systems" document is included as an appendix and discusses proper selection and care of the plants within Filterra systems.

Warranty Overview

Refer to the Contech Engineered Solutions LLC Stormwater Treatment System LIMITED WARRANTY for further information. The following conditions may void the Filterra system's warranty and waive the manufacturer provided Activation and Maintenance services:

- Unauthorized activation or performance of any of the items listed in the activation overview
- Any tampering, modifications or damage to the Filterra system or runoff protection devices
- Removal of any Filterra system components
- Failure to prevent construction related runoff from entering the Filterra system
- Failure to properly store and protect any Filterra components (including media and underdrain stone) that may be shipped separately from the vault

Routine Maintenance Guidelines

With proper routine maintenance, the biofiltration media within the Filterra system should last as long as traditional bioretention media. Routine maintenance is included by the manufacturer on all Filterra systems for the first year after activation. This includes a maximum of 2 visits to remove debris, replace pretreatment mulch, and prune the vegetation. More information is provided in the Operations and Maintenance Guidelines. Some Filterra systems also contain pretreatment or outlet bays. Depending on site pollutant loading, these bays may require periodic removal of debris, however this is not included in the first year of maintenance, and would likely not be required within the first year of operation.

These services, as well as routine maintenance outside of the included first year, can be provided by certified maintenance providers listed on the Contech website. Training can also be provided to other stormwater maintenance or landscape providers.

Why Maintain?

All stormwater treatment systems require maintenance for effective operation. This necessity is often incorporated in your property's permitting process as a legally binding BMP maintenance agreement. Other reasons to maintain are:

- Avoiding legal challenges from your jurisdiction's maintenance enforcement program.
- Prolonging the expected lifespan of your Filterra media.
- Avoiding more costly media replacement.
- Helping reduce pollutant loads leaving your property.

Simple maintenance of the Filterra is required to continue effective pollutant removal from stormwater runoff before discharge into downstream waters. This procedure will also extend the longevity of the living biofilter system. The unit will recycle and accumulate pollutants within the biomass, but is also subjected to other materials entering the inlet. This may include trash, silt and leaves etc. which will be contained above the mulch layer. Too much silt may inhibit the Filterra's flow rate, which is the reason for site stabilization before activation. Regular replacement of the mulch stops accumulation of such sediment.

When to Maintain?

Contech includes a 1-year maintenance plan with each system purchase. Annual included maintenance consists of a maximum of two (2) scheduled visits. Additional maintenance may be necessary depending on sediment and trash loading (by Owner or at additional cost). The start of the maintenance plan begins when the system is activated.

Maintenance visits are scheduled seasonally; the spring visit aims to clean up after winter loads including salts and sands while the fall visit helps the system by removing excessive leaf litter.

It has been found that in regions which receive between 30-50 inches of annual rainfall, (2) two visits are generally required; regions with less rainfall often only require (1) one visit per annum. Varying land uses can affect maintenance frequency; e.g. some fast food restaurants require more frequent trash removal. Contributing drainage areas which are subject to new development wherein the recommended erosion and sediment control measures have not been implemented may require additional maintenance visits.

Some sites may be subjected to extreme sediment or trash loads, requiring more frequent maintenance visits. This is the reason for detailed notes of maintenance actions per unit, helping the Supplier and Owner predict future maintenance frequencies, reflecting individual site conditions.

Owners must promptly notify the (maintenance) Supplier of any damage to the plant(s), which constitute(s) an integral part of the bioretention technology. Owners should also advise other landscape or maintenance contractors to leave all maintenance to the Supplier (i.e. no pruning or fertilizing) during the first year.

Exclusion of Services

Clean up due to major contamination such as oils, chemicals, toxic spills, etc. will result in additional costs and are not covered under the Supplier maintenance contract. Should a major contamination event occur the Owner must block off the outlet pipe of the Filterra (where the cleaned runoff drains to, such as drop inlet) and block off the throat of the Filterra. The Supplier should be informed immediately.

Maintenance Visit Summary

Each maintenance visit consists of the following simple tasks (detailed instructions below).

1. Inspection of Filterra and surrounding area
2. Removal of tree grate and erosion control stones
3. Removal of debris, trash and mulch
4. Mulch replacement
5. Plant health evaluation and pruning or replacement as necessary
6. Clean area around Filterra
7. Complete paperwork

Maintenance Tools, Safety Equipment and Supplies

Ideal tools include: camera, bucket, shovel, broom, pruners, hoe/rake, and tape measure. Appropriate Personal Protective Equipment (PPE) should be used in accordance with local or company procedures. This may include impervious gloves where the type of trash is unknown, high visibility clothing and barricades when working in close proximity to traffic and also safety hats and shoes. A T-Bar or crowbar should be used for moving the tree grates (up to 170 lbs ea.). Most visits require minor trash removal and a full replacement of mulch. See below for actual number of bagged mulch that is required in each media bay size. Mulch should be a double shredded, hardwood variety. Some visits may require additional Filterra engineered soil media available from the Supplier.

Box Length	Box Width	Filter Surface Area (ft^2)	Volume at 3" (ft^3)	# of 2 ft^3 Mulch Bags
4	4	4	4	2
6	4	6	6	3
8	4	8	8	4
6	6	9	9	5
8	6	12	12	6
10	6	15	15	8
12	6	18	18	9
13	7	23	23	12

Maintenance Visit Procedure

Keep sufficient documentation of maintenance actions to predict location specific maintenance frequencies and needs. An example Maintenance Report is included in this manual.

1. Inspection of Filterra and surrounding area

- Record individual unit before maintenance with photograph (numbered). Record on Maintenance Report (see example in this document) the following:

Record on Maintenance Report the following:

Standing Water	yes | no
Damage to Box Structure	yes | no
Damage to Grate	yes | no
Is Bypass Clear	yes | no

If yes answered to any of these observations, record with close-up photograph (numbered).

2. Removal of tree grate and erosion control stones

- Remove cast iron grates for access into Filterra box.
- Dig out silt (if any) and mulch and remove trash & foreign items.

3. Removal of debris, trash and mulch

Record on Maintenance Report the following:

Silt/Clay	yes | no
Cups/ Bags	yes | no
Leaves	yes | no
Buckets Removed	_____

- After removal of mulch and debris, measure distance from the top of the Filterra engineered media soil to the top of the top slab. Compare the measured distance to the distance shown on the approved Contract Drawings for the system. Add Filterra media (not top soil or other) to bring media up as needed to distance indicated on drawings.

Record on Maintenance Report the following:

Distance to Top of Top Slab (inches)	_____
Inches of Media Added	_____

4. Mulch replacement

- Add double shredded mulch evenly across the entire unit to a depth of 3".
- Refer to Filterra Mulch Specifications for information on acceptable sources.
- Ensure correct repositioning of erosion control stones by the Filterra inlet to allow for entry of trash during a storm event.
- Replace Filterra grates correctly using appropriate lifting or moving tools, taking care not to damage the plant.

5. Plant health evaluation and pruning or replacement as necessary

- Examine the plant's health and replace if necessary.
- Prune as necessary to encourage growth in the correct directions

Record on Maintenance Report the following:

Height above Grate	_____ (ft)
Width at Widest Point	_____ (ft)
Health	healthy | unhealthy
Damage to Plant	yes | no
Plant Replaced	yes | no

6. Clean area around Filterra

- Clean area around unit and remove all refuse to be disposed of appropriately.

7. Complete paperwork

- Deliver Maintenance Report and photographs to appropriate location (normally Contech during maintenance contract period).
- Some jurisdictions may require submission of maintenance reports in accordance with approvals. It is the responsibility of the Owner to comply with local regulations.

Maintenance Checklist

Drainage System Failure	Problem	Conditions to Check	Condition that Should Exist	Actions
Inlet	Excessive sediment or trash accumulation.	Accumulated sediments or trash impair free flow of water into Filterra.	Inlet should be free of obstructions allowing free distributed flow of water into Filterra.	Sediments and/or trash should be removed.
Mulch Cover	Trash and floatable debris accumulation.	Excessive trash and/or debris accumulation.	Minimal trash or other debris on mulch cover.	Trash and debris should be removed and mulch cover raked level. Ensure bark nugget mulch is not used.
Mulch Cover	"Ponding" of water on mulch cover.	"Ponding" in unit could be indicative of clogging due to excessive fine sediment accumulation or spill of petroleum oils.	Stormwater should drain freely and evenly through mulch cover.	Recommend contact manufacturer and replace mulch as a minimum.
Vegetation	Plants not growing or in poor condition.	Soil/mulch too wet, evidence of spill. Incorrect plant selection. Pest infestation. Vandalism to plants.	Plants should be healthy and pest free.	Contact manufacturer for advice.
Vegetation	Plant growth excessive.	Plants should be appropriate to the species and location of Filterra.		Trim/prune plants in accordance with typical landscaping and safety needs.
Structure	Structure has visible cracks.	Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks.		Vault should be repaired.
Maintenance is ideally to be performed twice annually.				

Filterra Inspection & Maintenance Log

Filterra System Size/Model:_____ **Location:** _____

Date	Mulch & Debris Removed	Depth of Mulch Added	Mulch Brand	Height of Vegetation Above Grate	Vegetation Species	Issues with System	Comments
1/1/17	*5 – 5 gal Buckets*	*3″*	*Lowe's Premium Brown Mulch*	*4′*	*Galaxy Magnolia*	*- Standing water in downstream structure*	*- Removed blockage in downstream structure*

Appendix 1 – Filterra® Activation Checklist

Project Name: _____ Company: _____

Site Contact Name: _____ Site Contact Phone/Email: _____

Site Owner/End User Name: _____ Site Owner/End User Phone/Email: _____

Preferred Activation Date: _____ (provide 2 weeks minimum from date this form is submitted)

Site Designation	System Size	Final Pavement / Top Coat Complete	Landscaping Complete / Grass Emerging	Construction materials / Piles / Debris Removed	Throat Opening Measures 4" Min. Height	Plant Species Requested
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	
		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	

Attach additional sheets as necessary.

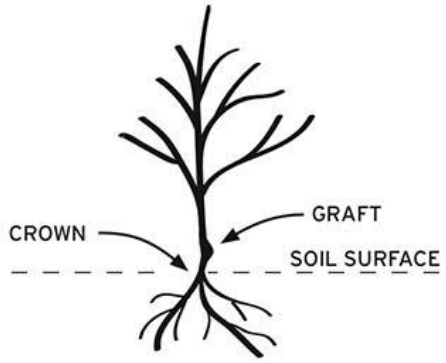
NOTE: A charge of $500.00 will be invoiced for each Activation visit requested by Customer where Contech determines that the site does not meet the conditions required for Activation. ONLY Contech authorized representatives can perform Activation of Filterra systems; unauthorized Activations will void the system warranty and waive manufacturer supplied Activation and 1st Year Maintenance.

_____ _____

Signature Date

Appendix 2 – Planting Requirements for Filterra® Systems

Plant Material Selection



- Select plant(s) as specified in the engineering plans and specifications.
- Select plant(s) with full root development but not to the point where root bound.
- Use local nursery container plants only. Ball and burlapped plants are not permitted.
- For precast Filterra systems with a tree grate, plant(s) must not have scaffold limbs at least 14 inches from the crown due to spacing between the top of the mulch and the tree grate. Lower branches can be pruned away provided there are sufficient scaffold branches for tree or shrub development.
- For precast Filterra systems with a tree grate, at the time of installation, it is required that plant(s) must be at least 6" above the tree grate opening at installation for all Filterra configurations. This DOES NOT apply to Full Grate Cover designs.
- Plant(s) shall not have a mature height greater than 25 feet.
- For standard 21" media depth, a 7 – 15 gallon container size shall be used. Media less than 21" (Filterra boxes only) will require smaller container plants.
- For precast Filterra systems, plant(s) should have a single trunk at installation, and pruning may be necessary at activation and maintenance for some of the faster growing species, or species known to produce basal sprouts.

Plant Installation

- During transport protect the plant leaves from wind and excessive jostling.
- Prior to removing the plant(s) from the container, ensure the soil moisture is sufficient to maintain the integrity of the root ball. If needed, pre-wet the container plant.
- Cut away any roots which are growing out of the container drain holes. Plants with excessive root growth from the drain holes should be rejected.
- Plant(s) should be carefully removed from the pot by gently pounding on the sides of the container with the fist to loosen root ball. Then carefully slide out. Do not lift plant(s) by trunk as this can break roots and cause soil to fall off. Extract the root ball in a horizontal position and support it to prevent it from breaking apart. Alternatively the pot can be cut away to minimize root ball disturbance.
- Remove any excess soil from above the root flare after removing plant(s) from container.
- Excavate a hole with a diameter 4" greater than the root ball, gently place the plant(s).
- If plant(s) have any circling roots from being pot bound, gently tease them loose without breaking them.
- If root ball has a root mat on the bottom, it should be shaved off with a knife just above the mat line.
- Plant the tree/shrub/grass with the top of the root ball 1" above surrounding media to allow for settling.
- All plants should have the main stem centered in the tree grate (where applicable) upon completion of installation.
- With all trees/shrubs, remove dead, diseased, crossed/rubbing, sharply crotched branches or branches growing excessively long or in wrong direction compared to majority of branches.
- To prevent transplant shock (especially if planting takes place in the hot season), it may be necessary to prune some of the foliage to compensate for reduced root uptake capacity. This is accomplished by pruning away some of the smaller secondary branches or a main scaffold branch if there are too many. Too much foliage relative to the root ball can dehydrate and damage the plant.
- Plant staking may be required.

Mulch Installation

- Only mulch that has been meeting Contech Engineered Solutions' mulch specifications can be used in the Filterra system.
- Mulch must be applied to a depth of 3" evenly over the surface of the media.

Irrigation Requirements

- Each Filterra system must receive adequate irrigation to ensure survival of the living system during periods of drier weather.
- Irrigation sources include rainfall runoff from downspouts and/or gutter flow, applied water through the tree grate or in some cases from an irrigation system with emitters installed during construction.
- At Activation: Apply about one (cool climates) to two (warm climates) gallons of water per inch of trunk diameter over the root ball.
- During Establishment: In common with all plants, each Filterra plant will require more frequent watering during the establishment period. One inch of applied water per week for the first three months is recommended for cooler climates (2 to 3 inches for warmer climates). If the system is receiving rainfall runoff from the drainage area, then irrigation may not be needed. Inspection of the soil moisture content can be evaluated by gently brushing aside the mulch layer and feeling the soil. Be sure to replace the mulch when the assessment is complete. Irrigate as needed**.
- Established Plants: Established plants have fully developed root systems and can access the entire water column in the media. Therefore irrigation is less frequent but requires more applied water when performed. For a mature system assume 3.5 inches of available water within the media matrix. Irrigation demand can be estimated as 1" of irrigation demand per week. Therefore if dry periods exceed 3 weeks, irrigation may be required. It is also important to recognize that plants which are exposed to windy areas and reflected heat from paved surfaces may need more frequent irrigation. Long term care should develop a history which is more site specific.

** Five gallons per square yard approximates 1 inch of water Therefore for a 6' by 6' Filterra approximately 20-60 gallons of water is needed. To ensure even distribution of water it needs to be evenly sprinkled over the entire surface of the filter bed, with special attention to make sure the root ball is completely wetted. NOTE: if needed, measure the time it takes to fill a five gallon bucket to estimate the applied water flow rate then calculate the time needed to irrigate the Filterra. For example, if the flow rate of the sprinkler is 5 gallons/minute then it would take 12 minutes to irrigate a 6' by 6' filter.

Notes

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capture
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STEAM CLEAN
DETERGENT

STORMWATER Pollution Prevention

Stormwater Management Practices for Carpet Cleaning Activities

Toxic chemicals and discharged waste water from carpet, drapery, furniture and window cleaning often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Following these best management practices will prevent pollution, comply with regulations and protect public health.

These guidelines apply even if the cleaning products are labeled "nontoxic" or "biodegradable". Although these products may be less harmful to the environment, they can still have harmful effects if they enter the storm drain untreated.

Dispose of Wastewater Properly
Wastewater from cleaning equipment must be discharged into a sink, toilet, or other drain connected to the sanitary sewer system within sanitary sewer discharge limits, hauled off and disposed of properly, or may be discharged to a pervious area, for example, a lawn area, as long as it does not overflow into the street, gutter, parking lot or storm drain. Wastewater should never be discharged into a street, gutter, parking lot or storm drain.

Filter Wastewater
Carpet cleaning wastewater should be filtered before discharging it to the sanitary sewer since fibers and other debris in the wastewater can clog pipes. The filtered material can be disposed of in the garbage, provided that the waste is not contaminated with hazardous pollutants.

To report illegal dumping call
(877) WASTE18
or visit our website:
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

WASH YOUR CAR THE ECO-FRIENDLY WAY!

When possible, wash in a professional car wash.

1. **Locate** the nearest storm drain and ensure that wash water does not flow into it.

2. **Wash** in a contained area or on grass*, gravel or other permeable surface. Dispose of excess soapy water into the sanitary sewer *(ie. sink or toilet)* or onto grass.

3. **Use** eco-friendly cleaning products (*non-toxic, phosphate free or biodegradable*). Use as little soap as possible and wipe brake dust off tires with a rag before washing.

4. **Conserve** water by using a high pressure hose and turn off the water when not in use.

**Some local ordinances may not allow a car to be parked on the front lawn. Check with your City's Building and Code department if you are unsure.*

How Does Eco Car Washing Help Local Waterways?

When excess wash water travels through the street it has the potential to pick up oil, grease and other chemicals along the way before it ends up in the curb, gutter and the storm drain system. **This contaminated water then travels to our creeks and the Santa Ana River making it unsafe for people and wildlife.**

To report illegal dumping, call **(877) WASTE18** or visit **sbcountystormwater.org**
To find a Hazardous Waste Facility, call **(800) OILY CAT**

Big Bear • Chino • Chino Hills • Colton • Fontana • Grand Terrace • Highland • Loma Linda • Montclair • Ontario • Rancho Cucamonga
Redlands • Rialto • San Bernardino • San Bernardino County • San Bernardino County Flood Control District • Upland • Yucaipa

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¡LAVE SU AUTO DE MANERA ECOLÓGICA!

Cuando sea posible, lávelo en un lavadero profesional de autos.

1. **Ubique** el desagüe pluvial más cercano y asegúrese de que nada pueda entrar en él o que pueda descargarse allí.

2. **Lave** su auto sobre el cesped, grava u otras superficies permeables. Elimine el exceso de agua jabonosa en un drenaje sanitario *(por ejemplo, lavamanos o inodoro)* o en el césped.

3. **Use** productos de limpieza ecológicos *(no tóxicos, sin fosfato o biodegradables)*. Use la menor cantidad de jabón posible y limpie el polvo de frenos de los neumáticos con un trapo antes de lavar.

4. **Conserve** agua usando una manguera de alta presión y cierre el agua cuando no la use.

** Es posible que algunas ordenanzas locales no permitan estacionar sobre el césped en el frente de la casa. Consulte con el departamento de Código Urbano y Edificación de su ciudad si no está seguro.*

¿De qué Manera el Lavado de Autos Ecológico Ayuda a Proteger los Canales Fluviales Locales?

Cuando el exceso de agua de lavado viaja por la calle, es posible que recoja aceite, grasa y otros elementos químicos en el camino antes de que llegue en el desagüe pluvial y el sistema de la boca de tormenta. **Esa agua contaminada luego viaja hacia nuestros arroyos y al Río Santa Ana, haciendo que sea inseguro para la gente y los animales.**

Para reportar actividades ilegales, llame a **(877) WASTE18** o visite **sbcountystormwater.org**. Para encontrar un establecimiento de Desechos Peligrosos, llame al **(800) OILY CAT**

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Pool Discharge Tips

Maintain your pool properly and help protect the environment

DID YOU KNOW?

Routine swimming pool maintenance generates a variety of wastes such as cleaning wastewater, filter back-wash residues, biocides and acid washes that can contribute to stormwater pollution. Chlorine and other pool chemicals can harm our waterways when they are discharged improperly.

Share these good housekeeping practices with your pool service personnel to keep pollutants out of our waterways:

HOLD IT BEFORE YOU DRAIN IT.

- De-chlorinate the water before draining the pool to the storm drain.
- Consult with your pool contractor before de-chlorinating the pool to learn about your options.

IMPORTANT:

- Dispose of filter backwash solids in the trash or landscape area.
- Neutralize acid washes before discharging to the sewer. Do not discharge to the storm drain.

SHUT: Shut off the chlorination system or stop adding chlorine.

HOLD: Hold the water in the pool for at least 5 days or add a de-chlorinating agent.

TEST: Use a pool testing kit to ensure the level of chlorine is at 0.1ppm before discharging the water.

- Make sure all debris is removed and chemicals are dissipated.
- pH of pool water should be between 6.5 and 8.5 before discharging.
- Make sure the water is free of any discoloration, mosquitoes, dirt or algae.

DRAIN: Check with your city for local requirements before discharging your pool to the storm drain or sewer.

- **Alternative 1:** Sanitary Sewer — Some cities allow pools to be drained to the sanitary sewer during non-peak hours.
- **Alternative 2:** Lawn or Garden — Discharge the pool water through the lawn or garden. The flow should be controlled to prevent erosion problems or the water entering a neighbor's property.
- **For Saltwater Pools:** Saltwater pools should only be drained to the sewer or hauled away.

To report illegal dumping, call (877) WASTE18 or visit sbcountystormwater.org

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Consejos para Vaciar su Piscina

Conserve su piscina en buen estado y ayude a proteger el medio ambiente

¿Sabía que...?

El mantenimiento de la piscina genera desechos, como las aguas residuales de limpieza, los residuos del agua estancada de los filtros y los lavados al ácido y otros químicos, que pueden contribuir a la contaminación de las aguas en las alcantarillas. El cloro y otros productos químicos para piscinas pueden dañar el medio ambiente cuando se desechan de manera inadecuada.

Comparta estas buenas prácticas de limpieza con su personal de servicio de piscinas para mantener las alcantarillas libres de contaminantes:

ESPERE ANTES DE VACIAR.

- Debe eliminar el cloro del agua antes de vaciar la piscina en las alcantarillas.
- Consulte con su contratista de piscina para obtener más información sobre sus opciones.

IMPORTANTE:

- Deseche los sólidos del agua estancada de los filtros en la basura o en el jardín.
- Neutralice los lavados al ácido antes de vaciarlos en la alcantarilla. No deseche nada contaminante en las alcantarillas.

CORTAR:

Corte el sistema de cloración o deje de agregar cloro.

CONSERVAR:

Conserve el agua en la piscina 5 días o agregue un agente de descloración.

PROBAR:

Utilice un equipo de pruebas para piscinas con el fin de asegurar que el nivel de cloro esté en 0.1ppm antes de vaciar el agua.

- Asegúrese de retirar todos los desechos y disipar los químicos.
- El pH del agua de la piscina debe estar entre 6.5 y 8.5 antes del vaciado.
- Asegúrese de que el agua no contenga contaminacion, zancudos, suciedad o algas.

VACIAR:

Verifique los requisitos locales de su ciudad antes de vaciar su piscina en el desagüe de las alcantarillas.

- **Alternativa 1:** Drenaje Sanitario — Algunas ciudades permiten que las piscinas se vacíen en el drenaje sanitario.
- **Alternativa 2:** Césped o Jardín — Vacíe el agua de la piscina en el césped o jardín. Se debe controlar la corriente de agua para evitar problemas de erosión o que el agua entre en la propiedad del vecino.
- **Para las Piscinas de Agua Salada:** Estas piscinas solo se deben ser vaciados en la alcantarilla o se debe transportar el agua y los residuos a algún lugar adecuado.

Para reportar desechos ilegales, comuníquese al (877) WASTE18 o visite sbcountystormwater.org
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WISHFUL THINKING...

UNTIL THIS IS A REALITY,

PLEASE PICK UP AFTER YOUR PET.

San Bernardino County STORMWATER PROGRAM

sbcountystormwater.org
or (877) WASTE18

Artwork Courtesy of the City of Los Angeles Stormwater Program.

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MOBILE VEHICLE CLEANING & MAINTENANCE

DISCHARGE INTO THE STORM DRAIN, **ACCIDENTAL OR NOT,**
CAN LEAD TO ENFORCEMENT ACTIONS, WHICH CAN INCLUDE FINES.

These best management practices will help you **prevent polluted water and other materials from flowing into the street, gutter and storm drain.**

WASH WATER DISPOSAL

- When washing items contaminated by hazardous materials, wash water should be collected and hauled off-site for proper disposal.
- Wash in customers wash bay or pump wastewater to the wash bays' pretreatment system.

Engine cleaning must be performed at a facility that has the equipment to properly process the contaminated wash water runoff.

HAZARDOUS WASTE SPILL CLEAN-UP & DISPOSAL

- If a spill occurs, use an absorbent material such as kitty litter or absorbent pads.
- Clean up the excess. Properly dispose of absorbent material used to clean up spills - contact an approved hauler for assistance/disposal. Sweep work area thoroughly after cleaning.
- Keep toxics out of the trash by disposing of them properly, this includes absorbent materials used to clean up toxic waste spills. Toxic materials may include used motor oil and oil filters, antifreeze, batteries and gasoline. Make sure to maintain hauling records for all hazardous waste.

To report illegal dumping, call (877) WASTE18 or visit sbcountystormwater.org
To report toxic spills call (800) 33 TOXIC
To dispose of hazardous waste, call the CUPA Program (909) 386-8401

sbcountystormwater.org

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Regulatory information

The Federal Water Pollution Control Act prohibits the discharge of any pollutant to navigable waters from a point source unless the discharge is authorized by a National Pollutant Discharge Elimination System (NPDES) permit. The 1987 passage of the Water Quality Act established NPDES permit requirements for discharges of storm water. The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

Industrial facilities and construction sites are regulated by the Regional Water Quality Control Board and State Water Resources Control Board, through general storm water permits. Most industrial, manufacturing or transportation businesses that store materials, products or equipment outdoors, or conduct vehicle washing or process operations outdoors are required to obtain coverage under the State Water Resources Control Board's General Industrial Activities Stormwater Permit. For more information about this permit, visit www.swrcb.ca.gov/stormwtr/industrial.html or contact your local storm water coordinator.

If your business conducts construction activities, including clearing, grading, stockpiling or excavation that results in soil disturbances of at least one acre, you are subject to the State Water Resources Control Board's General Construction Activities Stormwater Permit. To find out more about this storm water permit for construction, visit: www.swrcb.ca.gov/stormwtr/construction.html.

Cities and counties are regulated through permits issued by the Regional Boards. Since 1990, operators of large storm drain systems such as San Bernardino County's have been required to:

- Develop a storm water management program designed to prevent harmful pollutants from being dumped or washed by storm water runoff, into the storm water system, then discharged into local water bodies; and
- Obtain a National Pollutant Discharge Elimination System (NPDES) permit.

The NPDES permit programs in California are administered by the State Water Resources Control Board and by nine regional boards that issue NPDES permits and enforce regulations within their respective region.

San Bernardino County lies within the jurisdiction of the Santa Ana Region. This regional board issues a permit to the San Bernardino County Permittees, which includes the County of San Bernardino, San Bernardino County Flood Control District and incorporated cities of San Bernardino County. Since the program's inception, the County of San Bernardino has served as the principal permittee.

SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

Documents & reports:

The following documents describe the regulations and programs for water quality in San Bernardino County. You can review the latest Basin Plan, National Pollutant Discharge Elimination System (NPDES) Permit and Drainage Area Management Plan (DAMP).

- **Basin Plans:** The document for each region of the State Water Quality Board's jurisdiction, including Santa Ana, is the Water Quality Control Plan, commonly referred to as the Basin Plan. It is the foundation for the regulatory programs of each regional board. The Basin Plan documents the beneficial uses of the region's ground and surface waters, existing water quality conditions, problems, and goals, and actions by the regional board and others that are necessary to achieve and maintain water quality standards.

▶Water Control Plan for the Santa Ana River Basin

- **Municipal National Pollutant Discharge Elimination System (NPDES) Permits:** The permits of each region outline additional steps for a storm water management program and specify requirements to help protect the beneficial uses of the receiving waters. They require permittees to develop and implement Best Management Practices (BMPs) to control/reduce the discharge of pollutants to waters of the United States to the maximum extent practicable (MEP).

  ▶Santa Ana Regional Water Quality Control Board Municipal NPDES Permit Order No. R8-2002-0012

- **Report of Waste Discharge:** The Report of Waste Discharge (ROWD) describes the San Bernardino Stormwater Program, implemented by the County and cities to comply with their jointly held stormwater permit. It is the principle policy and guidance document for the NPDES Stormwater Program.

  ▶Report of Waste Discharge 2000

- **San Bernardino County Storm Water Program Annual Status Report:** The Annual Status Report is a requirement of the NPDES permit for submittal to the Regional Boards and United States Environmental Protection Agency. The report presents an analysis and assessment of permit compliance activities.

▶Annual report - will be posted soon

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

IT'S A WIN WIN
FOR A FREE RAIN BARREL

Be part of the solution and join the great giveaway!

Sign up for San Bernardino County Stormwater's e-newsletter for a chance to win this FREE rain barrel (estimated value: $125 dollars).

Note: we will not share, sell or otherwise distribute email addresses to other organizations or companies.

EVERY DROP COUNTS!

Safely capture rainwater on your property and then reuse it for your home's irrigation. Join others in saving on water expenses and preserving our local waterways.

PICK UP
After Your Pet!

Protect the health of your pet and the environment

For more information about current campaigns visit **sbcountystormwater.org/dog**

facebook.com/sbcountystormwater

San Bernardino County Stormwater Program

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WHY IT MATTERS

PROTECT
YOUR FAMILY AND YOUR PET

- Dog waste can infect children and adults with disease-causing bacteria and parasites.
- Your dog can get infected from the waste of other dogs.

PROTECT
OUR ENVIRONMENT

Leaving dog waste on the streets or on your property can have a negative impact on water quality. Pet waste that's not disposed of properly flows untreated through the storm drain system and directly into our local water bodies. Pet waste is a pollutant that contains nutrients, parasites and bacteria that can affect the quality of our rivers and the ocean and make the water unsafe for swimming, drinking or fishing.

BAG IT AND TRASH IT

It's that simple to protect our health and the environment!

- Keep a supply of bags near your dog leash or tie them to the leash
- Use a poop scooper
- Bring several plastic bags with you
- Reuse plastic grocery bags or purchase special doggie waste bags at pet supplies stores
- Make sure your pet's waste gets into a trash can

Encourage your neighbors and other pet owners to do the right thing and pick up after their pets.

¡RECOJA los desechos de sus mascotas!

Proteja la salud de su mascota y el medio ambiente

Si desea más información, visite
sbcountystormwater.org/dog

facebook.com/sbcountystormwater

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POR QUÉ ES IMPORTANTE

PROTEJA
A SU FAMILIA Y A SU MASCOTA

- Los desechos de los perros pueden infectar a niños y adultos con enfermedades causadas por bacterias y parásitos.
- Su perro puede contraer una infección de los desechos de otros perros.

PROTEJA
EL MEDIO AMBIENTE

Dejar desechos de perros en la calle o en su propiedad puede tener un impacto negativo en la calidad del agua. Los desechos de mascotas que no se eliminan de la propiedad fluyen sin tratamiento por el sistema de drenaje de tormentas y llegan directamente a las masas de agua locales. Los desechos de mascotas son agentes contaminantes que contienen nutrientes, parásitos y bacterias que pueden afectar la calidad de nuestros ríos y océanos, y hacer que el agua no sea segura para nadar, beber o pescar.

COLÓQUELA EN UNA BOLSA Y TÍRELA EN LA BASURA

Así de simple es proteger nuestra salud y el medio ambiente.

- Guarde algunas bolsas cerca de la correa de su perro o átelas a la correa;
- Use una cuchara para recojer el desecho;
- Lleve varias bolsas plásticas;
- Reutilice bolsas plásticas de comestibles o compre bolsas especiales para desechos de perros en las tiendas para mascotas;
- Asegúrese de tirar los desechos de su perro en un cesto de basura.

Aliente a sus vecinos y otros dueños de mascotas a hacer lo correcto y levantar los desechos de sus mascotas.

WE DID IT OURSELVES AND WE DID IT RIGHT

When painting your home, protect your family and community.

- **PAINTS** that are water-based are less toxic and should be used whenever possible.
- **BRUSHES** with water-based paint should be washed in the sink. Those with oil-based paint should be cleaned with paint thinner.
- **SAFELY** dispose of unwanted paint. The County of San Bernardino offers 9 HHW Centers that accept paint and other toxic waste FREE of charge.

To report illegal dumping, call
(877) WASTE18 or visit
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

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LO HICIMOS NOSOTROS MISMOS
Y LO HICIMOS BIEN

Cuando pinte su casa, proteja a su familia y a su comunidad.

- **PINTURAS** a base de agua son menos tóxicas y debe de utilizarlas cuando sea posible.
- **BROCHAS** a base de agua deben ser lavadas en el lavabo. Esas con pintura a base de aceite deben ser limpiadas con disolvente.
- **SANAMENTE** deshágase de la pintura que no necesita. El Condado de San Bernardino ofrece 9 centros de recolección que aceptan pintura y otros desechos tóxicos GRATUITAMENTE.

Para reportar actividades ilegales llamar al
(877) WASTE18 o visite
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

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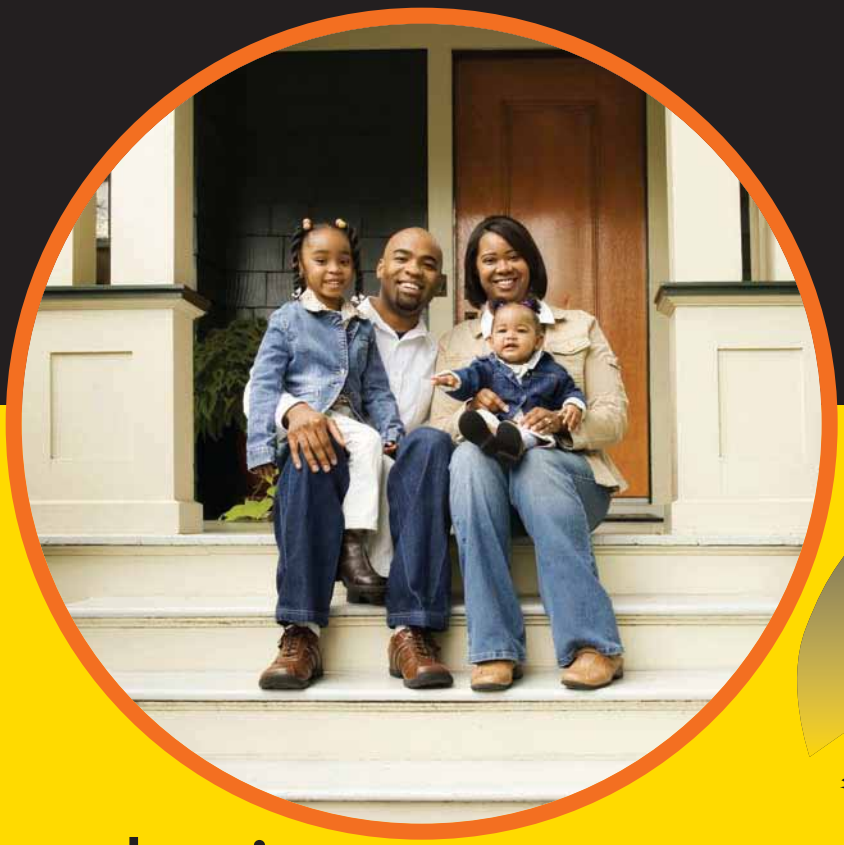
LO HICIMOS NOSOTROS MISMOS
Y LO HICIMOS BIEN



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Paint SAFELY

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AND WE DID IT RIGHT

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Pinte De Manera

S A N A

PINTURAS a base de agua son menos tóxicas y debe de utilizarlas cuando sea posible.

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San Bernardino County STORMWATER PROGRAM

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Mobile vehicle maintenance

Wash in a designated area that has been bermed up to contain the wash water.

Common water control devices are: recycling systems; pretreatment or sewer discharge systems; limited recycling systems; wash pits(portable vinyl wash pads), vacuum sludge filtering systems; wet-dry vacuums, sump pumps; drain covers; portable dams; vacu-brooms; oil absorbent pads, booms, pillows, and tubes; plastic sheeting; filter tubs; buckets; pans; and squeegees.

When cleaning engines using chemical additives like soaps, solvents or degreasers, the cleaning must be performed at a facility that has the equipment to properly process the contaminated wastewater runoff, or using a leak-proof ground cover device that will catch and contain all contaminated wastewater runoff for later disposal in a manner that complies with city, county, state and federal codes.

Wastewater from cleaning equipment must be discharged into a sink, toilet, or other drain connected to the sanitary sewer

LANDSCAPE MAINTENANCE

DISCHARGE TO THE STORM DRAIN, **ACCIDENTAL OR NOT**, COULD LEAD TO ENFORCEMENT ACTIONS, WHICH COULD INCLUDE FINES.

Follow the best practices below to **prevent water pollution from landscaping activities.**

RECYCLE YARD WASTE

- Recycle leaves, grass clippings and other yard waste.
- Do not blow, sweep, rake or hose yard waste into the street or catch basin.
- **Try grasscycling:** the natural recycling of grass by leaving clippings on the lawn when mowing.

  For more information, please visit: **www.calrecycle.ca.gov/organics/grasscycling**

USE FERTILIZERS, HERBICIDES AND PESTICIDES SAFELY

- Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use natural and non-toxic alternatives as often as possible.
- If you must use chemical fertilizers, herbicides or pesticides:
  - Spot apply, rather than blanketing entire areas.
  - Avoid applying near curbs and driveways, and **never** before a rain.
  - Apply fertilizers as needed: when plants could best use it and when the potential runoff would be low.
  - Follow the manufacturer's instructions carefully—this will not only give the best results, but will save money.

USE WATER WISELY

- Control the amount of water and direction of sprinklers. Sprinklers should only be on long enough to allow water to soak into the ground, but not so long as to cause runoff.
- Periodically inspect, fix leaks and realign sprinkler heads.
- Plant native vegetation to reduce the need of water, fertilizers, herbicides and pesticides.

HOMEOWNERS

KEEP THESE TIPS IN MIND WHEN HIRING PROFESSIONAL LANDSCAPERS AND REMIND AS NECESSARY.

Leftover pesticides, fertilizers, and herbicides contaminate landfills and should be disposed of through a Hazardous Waste Facility.

For more information on proper disposal call,

(909) 382-5401 or 1-800-OILY CAT.

*FREE for San Bernardino County residents only. Businesses can call for cost inquiries and to schedule an appointment.

To report illegal dumping, call (877) WASTE18 or visit sbcountystormwater.org
To report toxic spills, call 1(800) 33 TOXIC
To dispose of hazardous waste, call 1(800) OILY CAT

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MANTENIMIENTO DE JARDINERÍA

LAS DESCARGAS A LOS DESAGUES PLUVIALES, DE MANERA ACCIDENTAL O NO, PUEDEN INDUCIR A LA APLICACIÓN DE MULTAS Y OTRAS MEDIDAS.

Siga las mejores prácticas descritas debajo para evitar la contaminación del agua por actividades de jardinería.

RECICLAJE DE LOS DESECHOS DE JARDÍN

- Reciclar las hojas, recortes de césped y otros desechos de jardín.
- No soplar, barrer, o usar la manguera para empujar los desechos de jardín a la calle.
- **Poner a prueba el reciclaje de césped (grasscycling): la manera natural de reciclar el césped dejando los recortes sobre el césped cuando son cortados. Para más información, visite la página web: www.calrecycle.ca.gov/organics/grasscycling**

USAR FERTILIZANTES, HERBICIDAS Y PESTICIDAS DE MANERA SEGURA

- Los fertilizantes, herbicidas y pesticidas son arrastrados con frecuencia hacia el sistema de desagüe pluvial mediante el escurrimiento de los rociadores. Use alternativas naturales no tóxicas siempre que sea posible.
- Si tiene que usar fertilizantes, herbicidas o pesticidas químicos:
  Aplicar solo en el sitio necesario, en lugar de cubrir todas las áreas.
  Evitar aplicar cerca de los bordillos y las calzadas, y nunca antes de que llueva.
  Aplicar los fertilizantes cuando sea necesario: esto es, cuando las plantas mejor podrían usarlo y el posible escurrimiento sea bajo.
  Seguir las instrucciones del fabricante cuidadosamente – esto no solo le proporcionará los mejores resultados, pero le permitirá ahorrar dinero.

USAR EL AGUA DE MANERA PRUDENTE

- Controlar la cantidad de agua y la orientación de los rociadores. Los rociadores deben ser **solo lo suficientemente largos como para** permitir que el agua remoje el suelo, pero no tan largos que causen un escurrimiento.
- Inspeccione, repare los escapes y alinee los aspersores periódicamente.
- Siembre plantas nativas para reducir el uso de agua, fertilizantes, herbicidas y pesticidas.

PROPIETARIOS DE HOGARES

Tengan en cuenta estos consejos cuando contraten a paisajistas profesionales y recuérdenselos según sea necesario.

Los sobrantes de pesticidas, fertilizantes y herbicidas contaminan los vertederos y deben ser desechados a través de Plantas de Tratamiento para Residuos Peligrosos.

Para más información sobre el manejo adecuado de residuos peligrosos, llame a (909) 382-5401 o 1-800-OILY CAT.

*GRATIS únicamente para los residentes del Condado de San Bernardino. Las empresas pueden llamar para indagar sobre los costos y concertar una cita

Para denunciar el vertido ilegal de basura, llame al (877) WASTE18 o visite sbcountystormwater.org
Para denunciar derrames tóxicos, llame al 1(800) 33 TOXIC
Para desechar residuos peligrosos, llame al 1(800) OILY CAT

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San Bernardino County STORMWATER PROGRAM

FOR MORE INFORMATION ON PREVENTING STORMWATER POLLUTION

CALL 1(800) CLEANUP OR VISIT WWW.SBCOUNTY.GOV/STORMWATER

The San Bernardino County Stormwater Program is a cooperative effor t including the Flood Control District, the County of San Bernardino,and the cities of
Big Bear Lake, Chino, Chino Hills, Colton, Fontana, Grand T errace, Highland, Loma Linda, Montclair, Ontario, Rancho Cucamonga, Redlands, Rialto, San Ber nardino, Upland, and Yucaipa.

Stormwater Pollution Prevention

Best Management Practices for Homeowner's Associations, Property Managers and Property Owners

Your Guide To Maintaining Water Friendly Standards In Your Community

sbcountystormwater.org

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Table of Contents

Commercial Trash Enclosures	1
Hazardous Waste	2
Working Outdoors & Handling Spills	4
Commercial Landscape	5
Sidewalk, Plaza, Entry Monument & Fountain Maintenance	6
Equipment Maintenance & Repair	10
Pool Maintenance	14
Paint	16
Vehicle Maintenance	17
Pet Waste Disposal	18
Get In Touch With Us Online	19

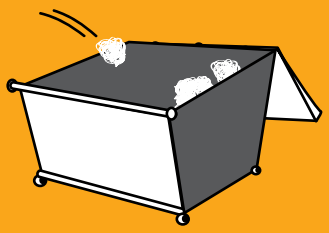
COMMERCIAL TRASH ENCLOSURES

FOLLOW THESE **REQUIREMENTS** TO **KEEP OUR WATERWAYS CLEAN**

Trash enclosures, such as those found in commercial and apartment complexes, typically contain materials that are intended to find their way to a landfill or a recycling facility. **These materials are NOT meant to go into our local lakes and rivers.**

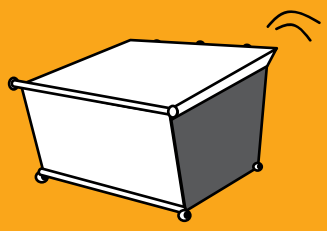
PROTECT WATER QUALITY BY FOLLOWING THESE SIMPLE STEPS

PUT TRASH INSIDE



Place trash inside the bin (preferably in sealed bags)

CLOSE THE LID



Prevent rain from entering the bin in order to avoid leakage of polluted water runoff

KEEP TOXICS OUT

- Paint
- Grease, fats and used oils
- Batteries, electronics and fluorescent lights

SOME ADDITIONAL GUIDELINES, INCLUDE

✓ SWEEP FREQUENTLY
Sweep trash enclosure areas frequently, instead of hosing them down, to prevent polluted water from flowing into the streets and storm drains.

✓ FIX LEAKS
Address trash bin leaks immediately by using dry clean up methods and report to your waste hauler to receive a replacement.

✓ CONSTRUCT ROOF
Construct a solid cover roof over the existing trash enclosure structure to prevent rainwater from coming into contact with trash and garbage. Check with your local City/County for Building Codes.

In San Bernardino County, stormwater pollution is caused by food waste, landscape waste, chemicals and other debris that are washed into storm drains and end up in our waterways - untreated! You can be part of the solution by maintaining a water-friendly trash enclosure.

THANK YOU FOR HELPING TO KEEP SAN BERNARDINO COUNTY CLEAN AND HEALTHY!

San Bernardino County STORMWATER PROGRAM

In the event of a spill or discharge to a storm drain or waterway, contact San Bernadino County Stormwater immediately: (877) WASTE18 | sbcountystormwater.org/report

sbcountystormwater.org

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CESQG PROGRAM

Conditionally Exempt Small Quantity Generator

WHAT IS A CESQG?

Businesses that generate 27 gallons or 220 lbs. of hazardous waste, or 2.2 lbs. of extremely hazardous waste per month are called "Conditionally Exempt Small Quantity Generators," or CESQGs. San Bernardino County Household Hazardous Program provides waste management services to CESQG businesses. The most common CESQGs in San Bernardino County are painters, print shops, auto shops, builders, agricultural operators and property managers, but there are many others. When you call, be ready to describe the types and amounts of waste your business generates in a typical month. If you generate hazardous waste on a regular basis, you must:

- Register with San Bernardino County Fire Department (909) 386-8401 as a hazardous waste generator.
- To obtain an EPA ID# and application form from the State visit www.dtsc.ca.gov.
- Manage hazardous waste in accordance with all applicable local, state and federal laws and regulations.

HOW DO I GET SERVICE?

To arrange an appointment for the CESQG Program, call 1-800-OILY CAT or 909-382-5401. Be ready to describe the type and amount of hazardous waste your business is ready to dispose of, and the types and size(s) of containers that the waste is in.

Waste Type and Cost

There is a small handling fee involved in the collection of hazardous waste from your business. Disposal costs depend on the type of waste.

Aerosols	$1.29/lb.
Automobile motor oil	$.73/gal.
Anti-freeze	$1.57/gal.
Contaminated oil	$4.48/gal.
Car batteries	$.62/ea.
Corrosive liquids, solids	$2.80/lb.
Flammable solids, liquids	$1.57/lb.
Latex Paint	$.73/lb.
Mercury	$10.08/lb.
NiCad/Alkaline Batteries	$2.13/lb.
Oil Base Paints	$1.00/lb.
Oil Filters	$.56/ea.
Oxidizers	$9.63/lb.
PCB Ballasts	$5.94/lb.
Pesticides (most)	$2.91/lb.
Photofixer, developer	$4.31/gal.
Television & Monitors	$11.20/ea.
Additional Handling	$138.00/hr.

Rates subject to change without notice

WE CANNOT ACCEPT

- Radioactives
- Water reactives
- Explosives
- Compressed gas cylinders
- Medical or biohazardous waste
- Asbestos
- Remediation wastes

HAZARDOUS WASTE

WHY IS THE FIRE DEPARTMENT COLLECTING HAZARDOUS WASTE?

Small Quantity Generators often have difficulty disposing of small quantities of hazardous waste. Hazardous waste companies usually have a minimum amount of waste that they will pick up, or charge a minimum fee for service. Typically, the minimum fee exceeds the cost of disposal for the hazardous waste. This leaves the small quantity generator in a difficult situation. Some respond by storing hazardous waste until it becomes economical for the hazardous waste transporter to pick it up, putting the business out of compliance by exceeding regulatory accumulation time limits. Other businesses simply store their hazardous wastes indefinitely, creating an unsafe work environment and exceeding accumulation time limits. Yet other businesses attempt to illegally dispose of their waste at household hazardous waste collection facilities. These facilities are not legally permitted to accept commercial wastes, nor are prepared to provide legal documentation for commercial hazardous waste disposal. In answer to the problems identified above, the San Bernardino County Fire Department Household Hazardous Program instituted the Conditionally Exempt Small Quantity Generator Program.

PAYMENT FOR SERVICES

The CESQG Program will prepare an invoice for your business at the time of service. You can pay at the time of service with cash or a check, or you can mail your payment to the Fire Department within 30 days. Please note that we do not accept credit card payments. The preferred method of payment is to handle payment at time of service. Additional charges may apply for accounts not paid within 30 days.

ARE THERE ANY OTHER WAYS THAT I CAN SAVE MONEY ON HAZARDOUS WASTE DISPOSAL?

Yes! First, start by reducing the amount of waste that you produce by changing processes or process chemicals, at your business. Next, examine if there is a way that you can recycle your waste back into your processes. Network with similar businesses or trade associations for waste minimization and pollution prevention solutions.

WHAT IF YOUR BUSINESS DOES NOT QUALIFY?

Call the San Bernardino County Fire Department Field Services Division for assistance with hazardous waste management at 909-386-8401. If you reduce the amount of waste you generate each month to 27 gallons or less, you may qualify in the future.

WHAT HAPPENS TO YOUR HAZARDOUS WASTE?

Hazardous waste collected by the CESQG Program is transported to a state permitted processing facility in San Bernardino. The waste is further processed at this point and packaged for off-site recycling (oil filters, oil, latex paint, antifreeze, and batteries) or destructive incineration (pesticides, corrosives, flammables, oil based paint).

San Bernardino County Fire Department
CESQG Program
2824 East "W" Street
San Bernardino, CA 92415-0799
Phone: 909-382-5401
Fax: 909-382-5413
www.sbcfire.org/hazmat/hhw.asp
Email: jschwab@sbcfire.org

WHEN WORKING OUTDOORS USE THE 3Cs

CUANDO TRABAJE AL AIRE LIBRE UTILICE LAS 3Cs

CONTROL | CONTROL

Locate the nearest storm drain and ensure nothing can enter or be discharged into it.
Ubique el desagüe de aguas pluviales más cercano y asegúrese de que nada pueda ingresar a éste ni descargarse en él.

CONTAIN | CONTENER

Isolate your area to prevent material from potentially flowing or being blown away.
Aísle su área para evitar que el material pueda discurrirse o ser llevado por el viento.

CAPTURE | CAPTURAR

Sweep up debris and place it in the trash. Clean up spills with an absorbent material (e.g. kitty litter) or vacuum with a Wet-Vac and dispose of properly.
Recoja los restos y colóquelos en la basura. Limpie los derrames con un material absorbente (como la arena para gatos) o aspírelos con una Wet-Vac (aspiradora de humedad) y deséchelos correctamente.

COMMERCIAL LANDSCAPE

DISCHARGE TO THE STORM DRAIN, **ACCIDENTAL OR NOT**, COULD LEAD TO ENFORCEMENT ACTIONS, WHICH COULD INCLUDE FINES.

Follow the best practices below to **prevent water pollution from landscaping activities.**

RECYCLE YARD WASTE

- Recycle leaves, grass clippings and other yard waste.
- Do not blow, sweep, rake or hose yard waste into the street or catch basin.
- **Try grasscycling:** the natural recycling of grass by leaving clippings on the lawn when mowing.

  For more information, please visit: **www.calrecycle.ca.gov/organics/grasscycling**

USE FERTILIZERS, HERBICIDES AND PESTICIDES SAFELY

- Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use natural and non-toxic alternatives as often as possible.
- If you must use chemical fertilizers, herbicides or pesticides:
  - Spot apply, rather than blanketing entire areas.
  - Avoid applying near curbs and driveways, and **never** before a rain.
  - Apply fertilizers as needed: when plants could best use it and when the potential runoff would be low.
  - Follow the manufacturer's instructions carefully—this will not only give the best results, but will save money.

USE WATER WISELY

- Control the amount of water and direction of sprinklers. Sprinklers should only be on long enough to allow water to soak into the ground, but not so long as to cause runoff.
- Periodically inspect, fix leaks and realign sprinkler heads.
- Plant native vegetation to reduce the need of water, fertilizers, herbicides and pesticides.

HOMEOWNERS

KEEP THESE TIPS IN MIND WHEN HIRING PROFESSIONAL LANDSCAPERS AND REMIND AS NECESSARY.

Leftover pesticides, fertilizers, and herbicides contaminate landfills and should be disposed of through a Hazardous Waste Facility.

For more information on proper disposal call,

(909) 382-5401 or 1-800-OILY CAT.

*FREE for San Bernardino County residents only. Businesses can call for cost inquiries and to schedule an appointment.

In the event of a spill or discharge to a storm drain or waterway, contact San Bernadino County Stormwater immediately: (877) WASTE18 | sbcountystormwater.org/report

sbcountystormwater.org

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SIDEWALK, PLAZA, ENTRY MONUMENT & FOUNTAIN MAINTENANCE

Pollutants on sidewalks and other pedestrian traffic areas and plazas are typically due to littering and vehicle use. Fountain water containing chlorine and copperbased algaecides is toxic to aquatic life. Proper inspection, cleaning, and repair of pedestrian areas and HOA owned surfaces and structures can reduce pollutant runoff from these areas. Maintaining these areas may involve one or more of the following activities:

1. **Surface Cleaning**
2. **Graffiti Cleaning**
3. **Sidewalk Repair**
4. **Controlling Litter**
5. **Fountain Maintenance**

POLLUTION PREVENTION:

Pollution prevention measures have been considered and incorporated in the model procedures. Implementation of these measures may be more effective and reduce or eliminate the need to implement other more complicated or costly procedures. Possible pollution prevention measures for sidewalk, plaza, and fountain maintenance and cleaning include:

- Use dry cleaning methods whenever practical for surface cleaning activities.
- Use the least toxic materials available (e.g. water based paints, gels or sprays for graffiti removal).
- Once per year, educate HOA staff and tenants on pollution prevention measures.

MODEL PROCEDURES:

1. Surface Cleaning

Discharges of wash water to the storm water drainage system from cleaning or hosing of impervious surfaces is prohibited.

Sidewalks, Plazas

✓ Use dry methods (e.g. sweeping, backpack blowers, vacuuming) whenever practical to clean sidewalks and plazas rather than hosing, pressure washing, or steam cleaning. DO NOT sweep or blow material into curb; use devices that contain the materials.

✓ If water must be used, block storm drain inlets and contain runoff. Discharge wash water to landscaping or contain and dispose of properly.

SIDEWALK, PLAZA, ENTRY MONUMENT & FOUNTAIN MAINTENANCE

Parking Areas, Driveways, Drive-thru

✓ Parking facilities should be swept/vacuumed on a regular basis. Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.

✓ If water must be used, block storm drain inlets and contain runoff. Discharge wash water to landscaping or contain and dispose of properly.

✓ Sweep all parking lots at least once before the onset of the wet season.

✓ Use absorbents to pick up oil; then dry sweep.

✓ Appropriately dispose of spilled materials and absorbents.

OPTIONAL:

- Consider increasing sweeping frequency based on factors such as traffic volume, land use, field observations of sediment and trash accumulation, proximity to water courses, etc.

Building Surfaces, Decks, etc., without loose paint

✓ Use high-pressure water, no soap.

✓ If water must be used, block storm drain inlets and contain runoff. Discharge wash water to landscaping or contain and dispose of properly.

Unpainted Building Surfaces, Wood Decks, etc.

✓ If water must be used, block storm drain inlets and contain runoff. Discharge wash water to landscaping or contain and dispose of properly.

✓ Use biodegradable cleaning agents to remove deposits.

✓ Make sure pH is between 6.5 and 8.5 THEN discharge to landscaping (if cold water without a cleaning agent) otherwise dispose of properly.

2. Graffiti Cleaning

Graffiti Removal

✓ Avoid graffiti abatement activities during rain events.

✓ When graffiti is removed by painting over, implement the procedures under Painting and Paint Removal in the Roads, Streets, and Highway Operation and Maintenance procedure sheet.

✓ Protect nearby storm drain inlets prior to removing graffiti from walls, signs, sidewalks, or other structures needing graffiti abatement. Clean up afterwards by sweeping or vacuuming thoroughly, and/or by using absorbent and properly disposing of the absorbent.

SIDEWALK, PLAZA, ENTRY MONUMENT & FOUNTAIN MAINTENANCE

✓ Note that care should be taken when disposing of waste since it may need to be disposed of as hazardous waste.

OPTIONAL:

• Consider using a waterless and non-toxic chemical cleaning method for graffiti removal (e.g. gels or spray compounds).

3. Sidewalk Repair

Surface Removal and Repair

✓ Schedule surface removal activities for dry weather if possible.

✓ Avoid creating excess dust when breaking asphalt or concrete.

✓ Take measures to protect nearby storm drain inlets prior to breaking up asphalt or concrete (e.g. place hay bales or sand bags around inlets). Clean afterwards by sweeping up material.

✓ Designate an area for clean up and proper disposal of excess materials.

✓ Remove and recycle as much of the broken pavement as possible.

✓ When making saw cuts in pavement, use as little water as possible. Cover each storm drain inlet with filter fabric during the sawing operation and contain the slurry by placing straw bales, sandbags, or gravel dams around the inlets. After the liquid drains shovel or vacuum the slurry, remove from site and dispose of properly.

✓ Always dry sweep first to clean up tracked dirt. Use a street sweeper or vacuum truck. Do not dump vacuumed liquid in storm drains. Once dry sweeping is complete, the area may be hosed down if needed. Discharge wash water to landscaping, pump to the sanitary sewer if permitted to do so or contain and dispose of properly.

Concrete Installation and Repair

✓ Avoid mixing excess amounts of fresh concrete or cement mortar on-site. Only mix what is needed for the job.

✓ Wash concrete trucks off-site or in designated areas on-site, such that there is no discharge of concrete wash water into storm drain inlets, open ditches, streets, or other storm water conveyance structures. (See Concrete Waste Management BMP WM – 8)

SIDEWALK, PLAZA, ENTRY MONUMENT & FOUNTAIN MAINTENANCE

✓ Store dry and wet concrete materials under cover, protected from rainfall and runoff and away from drainage areas. After job is complete remove temporary stockpiles (asphalt materials, sand, etc.) and other materials as soon as possible.

✓ Return leftover materials to the transit mixer. Dispose of small amounts of excess concrete, grout, and mortar in the trash.

✓ When washing concrete to remove fine particles and expose the aggregate, contain the wash water for proper disposal.

✓ Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stock pile, or dispose in the trash.

✓ Protect applications of fresh concrete from rainfall and runoff until the material has hardened.

4. Litter Control

✓ Enforce anti-litter laws.

✓ Provide litter receptacles in busy, high pedestrian traffic areas of the community, at recreational facilities, and at community events.

✓ Cover litter receptacles and clean out frequently to prevent leaking/spillage or overflow.

OPTIONAL:

• Post "No Littering" signs.

5. Fountain Maintenance

✓ Do not use copper-based algaecides. Control algae with chlorine or other alternatives, such as sodium bromide.

✓ Allow chlorine to dissipate for a few days and then recycle/reuse water by draining it gradually onto a landscaped area. Water must be tested prior to discharge to ensure that chlorine is not present (concentration must be less than 0.1 ppm).

✓ Contact local agency for approval to drain into sewer or storm drain.

✓ Avoid mixing excess amounts of fresh concrete or cement mortar on-site. Only mix what is needed for the job.

EQUIPMENT MAINTENANCE & REPAIR

Vehicle or equipment maintenance has the potential to be a significant source of stormwater pollution. Engine repair and service (parts cleaning, spilled fuel, oil, etc.), replacement of fluids, and outdoor equipment storage and parking (dripping engines) can all contaminate stormwater. Conducting the following activities in a controlled manner will reduce the potential for stormwater contamination:

1. **General Maintenance and Repair**
2. **Vehicle and Machine Repair**
3. **Waste Handling/Disposal**

Related vehicle maintenance activities are covered under the following program headings in this manual: "Vehicle and Equipment Cleaning", "Vehicle and Equipment Storage", and "Vehicle Fueling".

POLLUTION PREVENTION:

Pollution prevention measures have been considered and incorporated in the model procedures. Implementation of these measures may be more effective and reduce or eliminate the need to implement other more complicated or costly procedures. Possible pollution prevention measures for equipment maintenance and repair include:

- Review maintenance activities to verify that they minimize the amount of pollutants discharged to receiving waters. Keep accurate maintenance logs to evaluate materials removed and improvements made.
- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Minimize use of solvents. Clean parts without using solvents whenever possible. Recycle used motor oil, diesel oil, and other vehicle fluids and parts whenever possible.
- Once per year, educate HOA staff and tenants on pollution prevention measures.

EQUIPMENT MAINTENANCE & REPAIR

MODEL PROCEDURES:

1. General Maintenance and Repair

General Guidelines

➔ *Note: Permission must be obtained for any discharge of wash water to the sanitary sewer from the local sewering agency.*

- ✓ Review maintenance activities to verify that they minimize the amount of pollutants discharged to receiving waters. Keep accurate maintenance logs to evaluate materials removed and improvements made.
- ✓ Regularly inspect vehicles and equipment for leaks.
- ✓ Move activity indoors or cover repair area with a permanent roof if feasible.
- ✓ Minimize contact of stormwater with outside operations through berming the local sewering and drainage routing.
- ✓ Place curbs around the immediate boundaries of the process equipment.
- ✓ Clean yard storm drain inlets regularly and stencil them.

Good Housekeeping

- ✓ Avoid hosing down work areas. If work areas are washed and if discharge to the sanitary sewer is allowed, treat water with an appropriate treatment device (e.g. clarifier) before discharging. If discharge to the sanitary sewer is not permitted, pump water to a tank and dispose of properly.
- ✓ Collect leaking or dripping fluids in drip pans or container. Fluids are easier to recycle or dispose of properly if kept separate.
- ✓ Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, any discharge of or remove other parts. Place a drip pan under any vehicle that might leak while you work on it to keep splatters or drips off the shop floor.
- ✓ Educate employees on proper handling and disposal of engine fluids.
- ✓ Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- ✓ Do not pour liquid waste to floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.
- ✓ Post signs at sinks and stencil outdoor storm drain inlets.

2. Vehicle Repair

General Guidelines

- ✓ Perform vehicle fluid removal or changing inside of a building or in a contained covered area, where feasible, to prevent the run-on of stormwater and the runoff of spills.
- ✓ Regularly inspect vehicles and equipment for leaks, and repair as needed.

EQUIPMENT MAINTENANCE & REPAIR

- ✓ Use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- ✓ Immediately drain all fluids from wrecked vehicles. Ensure that the drain pan or drip pan is large enough to contain drained fluids (e.g. larger pans are needed to contain antifreeze, which may gush from some vehicles).
- ✓ Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- ✓ Recycle used motor oil, diesel oil, and other vehicle fluids and parts whenever possible.
- ✓ Oil filters disposed of in trash cans or dumpsters can leak oil. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- ✓ Store cracked batteries in a non-leaking secondary container and dispose of properly at recycling facilities or at County hazardous waste disposal site.

Vehicle Leak and Spill Control

- ✓ Use absorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- ✓ Place a stockpile of spill cleanup materials where it will be readily accessible.
- ✓ Sweep floor using dry absorbent material.

3. Machine Repair

- ✓ Keep equipment clean; don't allow excessive build-up of oil or grease.
- ✓ Minimize use of solvents.
- ✓ Use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- ✓ Perform major equipment repairs at the corporation yard, when practical.
- ✓ Following good housekeeping measures in Vehicle Repair section.

4. Waste Handling/Disposal

Waste Reduction

- ✓ Prevent spills and drips of solvents and cleansers to the shop floor.
- ✓ Do liquid cleaning at a centralized station so the solvents and residues stay in one area. Recycle liquid cleaners when feasible.

✓ Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for reuse.

OPTIONAL:

- If possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous material:

  -Use non-caustic detergents instead of caustic cleaning for parts cleaning.

  -Use a water-based cleaning service and have tank cleaned. Use detergent-based or water-based cleaning systems in place of organic solvent degreasers.

  -Replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents.

  -Choose cleaning agents that can be recycled.

Recycling

OPTIONAL:

- Separate wastes for easier recycling. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents separate from non-chlorinated solvents.

- Label and track the recycling of waste material (e.g. used oil, spent solvents, batteries).

- Purchase recycled products to support the market for recycled materials.

LIMITATIONS:

Space and time limitations may preclude all work being conducted indoors. It may not be possible to contain and clean up spills from vehicles/equipment brought on-site after working hours. Dry floor cleaning methods may not be sufficient for some spills – see spill prevention and control procedures sheet. Identification of engine leaks may require some use of solvents.

POOL MAINTENANCE

Pool chemicals and filter solids, when discharged to the City streets, gutters or storm drans, DO NOT GET TREATED before reaching the Santa Ana River. Chlorine, acid cleaning chemicals and metal-based algaecides used in pools can kill beneficial organisms in the food chain and pollute our drinking water.

When emptying your swimming pool, spa or fountain, please use one of the following best management practices to prevent water pollution:

- Reuse the water as landscape irrigation
- Empty the water into the sewer between midnight and 6:00 am
- Remove solids and floating debris and dispose of in the trash, de-chlorinate the water to a chlorine residual = 0, wait 24 hours, then discharge the water to the street or storm drain
- Try not to use metal-based algaecides (i.e. copper sulfate) in your pool or spa. If you have, empty your pool or spa into the sewer. *Prior to discharging pool water into the sanitary sewer system, contact your local agency.*
- If the pool contains algae and mosquito larvae, discharge the water to the sewer

When acid cleaning or other chemical cleaning:

- Neutralize the pool water to pH of 6.5 to 8.5, then discharge to the sewer

For swimming pool and spa filter backwash:

- Dispose of solids into trash bag, then wash filter into a landscape area
- Settle, dispose of solids in trash and discharge water to the sewer, never to the storm drain

» For Residents

The following is a preview of the information we have available to residents. For more fact sheets, visit ***sbcountystormwater.org***

Household Hazardous Waste Center Locations

TOO TOXIC TO TRASH

Dispose of your **HOUSEHOLD HAZARDOUS WASTE** (HHW) at a **FREE** HHW Center near you. Examples of items collected: pesticides, fertilizers, paints, cleaners, antifreeze, batteries, motor oil, oil filters, and electronic waste.

SERVICE AREA	LOCATION	DAYS OPEN	HOURS
Big Bear Lake (does not accept E-waste)	42040 Garstin Dr. (cross: Big Bear Blvd.)	Saturdays	9 a.m. - 2 p.m.
Chino	5050 Schaefer Ave. (cross: 4th St.)	2nd & 4th Sat.	8 a.m. - 1 p.m.
Fontana (Fontana residents only)	16454 Orange Way (cross: Cypress Ave.) Note: Provide a trash bill and a driver's license as proof of residency.	Saturdays	8 a.m. - 12 p.m.
Ontario	1430 S. Cucamonga Ave. (cross: Belmont St.)	Fri. & Sat.	9 a.m. - 2 p.m.
Rancho Cucamonga	8794 Lion Street. (Off 9th St, between Vineyard and Hellman)	Saturdays	8 a.m. - 12 p.m.
Redlands	500 Kansas St. (cross: Park Ave.)	Saturdays	9:30 a.m. - 12:30 p.m.
Rialto (does not accept E-waste)	246 Willow Ave. (cross: Rialto Ave.)	2nd & 4th Fri. & Sat.	8 a.m. - 12 p.m.
San Bernardino	2824 East 'W' St., 302 (cross: Victoria Ave.)	Mon. – Fri.	9 a.m. - 4 p.m.
Upland	1370 N. Benson Ave. (cross: 14th St.)	Saturdays	9 a.m. - 2 p.m.

San Bernardino County STORMWATER PROGRAM

To report illegal dumping, call (877) WASTE18
or visit sbcountystormwater.org

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

TAKE ONE

WE DID IT OURSELVES AND WE DID IT RIGHT

When painting your home, protect your family and community.

- **PAINTS** that are water-based are less toxic and should be used whenever possible.
- **BRUSHES** with water-based paint should be washed in the sink. Those with oil-based paint should be cleaned with paint thinner.
- **SAFELY** dispose of unwanted paint and paint thinner. The County of San Bernardino offers 9 HHW Centers that accept paint and other household hazardous waste from residents FREE of charge. For a list of acceptable materials, location information, and hours of operation call 1-800-OILY CAT.

VEHICLE MAINTENANCE

Oil, grease, anti-freeze and other toxic automotive fluids often make their way into the San Bernardino County storm drain system, and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

Cleaning Auto Parts
Scrape parts with a wire brush or use a bake oven rather than liquid cleaners. Arrange drip pans, drying racks and drain boards so that fluids are directed back into the parts washer or the fluid holding tank. Do not wash parts or equipment in a sink, parking lot, driveway or street.

Storing Hazardous Waste
Keep your liquid waste segregated. Many fluids can be recycled via hazardous waste disposal companies if they are not mixed. Store all materials under cover with spill containment or inside to prevent contamination of rainwater runoff.

Preventing Leaks and Spills
Conduct all vehicle maintenance inside of a garage. Place drip pans underneath vehicle to capture fluids. Use absorbent materials instead of water to clean work areas.

Cleaning Spills
Use dry methods for spill cleanup (sweeping, absorbent materials). To report accidental spills into the street or storm drain call (877) WASTE18 or 911.

Proper Disposal of Hazardous Waste
Dispose of household hazardous waste by taking it to your nearest household hazardous waste center. For more information, call 1-800-OILY CAT or check out sbcountystormwater.org/Disposal.html

PET WASTE DISPOSAL

FREE

DOGGIE WASTE BAGS

Remember to pick up after your pet every time to keep San Bernardino County clean and healthy!

San Bernardino County STORMWATER PROGRAM

In the event of a spill or discharge to a storm drain or waterway, contact San Bernadino County Stormwater immediately: (877) WASTE18 | sbcountystormwater.org/report

sbcountystormwater.org

Big Bear • Chino • Chino Hills • Colton • Fontana • Grand Terrace • Highland • Loma Linda • Montclair • Ontario • Rancho Cucamonga
Redlands • Rialto • San Bernadino • San Bernadino County • San Bernadino County Flood Control District • Upland • Yucaipa

» Get In Touch With Us Online!

» Website
sbcountystormwater.org

» eUpdates
sbcountystormwater.org/newsletter

» Facebook
facebook.com/sbcountystormwater

» YouTube
youtube.com/sbcountystormwater

» Report Pollution Violations
sbcountystormwater.org/report

» Email
info@sbcountystormwater.org

TOO TOXIC TO TRASH

Dispose of your **HOUSEHOLD HAZARDOUS WASTE** (HHW) at a **FREE** HHW Center near you. Examples of items collected: pesticides, fertilizers, paints, cleaners, antifreeze, batteries, motor oil, oil filters, and electronic waste.

SERVICE AREA	LOCATION	DAYS OPEN	HOURS
Big Bear Lake (does not accept E-waste)	42040 Garstin Dr. (cross: Big Bear Blvd.)	Saturdays	9 a.m. - 2 p.m.
Chino	5050 Schaefer Ave. (cross: 4th St.)	2nd & 4th Sat.	8 a.m. - 1 p.m.
Fontana (Fontana residents only)	16454 Orange Way (cross: Cypress Ave.) Note: Provide a trash bill and a driver's license as proof of residency.	Saturdays	8 a.m. - 12 p.m.
Ontario	1430 S. Cucamonga Ave. (cross: Belmont St.)	Fri. & Sat.	9 a.m. - 2 p.m.
Rancho Cucamonga	8794 Lion Street. (Off 9th St, between Vineyard and Hellman)	Saturdays	8 a.m. - 12 p.m.
Redlands	500 Kansas St. (cross: Park Ave.)	Saturdays	9:30 a.m. - 12:30 p.m.
Rialto (does not accept E-waste)	246 Willow Ave. (cross: Rialto Ave.)	2nd & 4th Fri. & Sat.	8 a.m. - 12 p.m.
San Bernardino	2824 East 'W' St., 302 (cross: Victoria Ave.)	Mon. – Fri.	9 a.m. - 4 p.m.
Upland	1370 N. Benson Ave. (cross: 14th St.)	Saturdays	9 a.m. - 2 p.m.

San Bernardino County STORMWATER PROGRAM

To report illegal dumping, call (877) WASTE18
or visit sbcountystormwater.org

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

TAKE ONE

MUY TÓXICO PARA LA BASURA

Desháguese de sus **DESECHOS PELIGROSOS** gratuitamente en un centro de recolección cerca de usted. Ejemplos de artículos que se aceptan: pesticidas, fertilizantes, pinturas, limpiadores, anticongelante, baterías, aceite de motores y filtros, y aparatos electrónicos.

ÁREA DE SERVICIO	UBICACIÓN	ABIERTO	HORARIO
Big Bear Lake (no se acepta materiales electronicas)	42040 Garstin Dr. (Big Bear Blvd.)	Sábado	9 a.m. - 2 p.m.
Chino	5050 Schaefer Ave. (4th St.)	2nd & 4th Sábado	8 a.m. - 1 p.m.
Fontana (residentes de Fontana solamente)	16454 Orange Way (Cypress Ave.) Nota: Presentar un recibo de basura y licencia de conducir como prueba de residencia.	Sábado	8 a.m. - 12 p.m.
Ontario	1430 S. Cucamonga Ave. (Belmont St.)	Viernes & Sábado	9 a.m. - 2 p.m.
Rancho Cucamonga	8794 Lion Street (Off 9th St, between Vineyard & Hellman)	Sábado	8 a.m. - 12 p.m.
Redlands	500 Kansas St. (Park Ave.)	Sábado	9:30 a.m. - 12:30 p.m.
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San Bernardino	2824 East 'W' St., 302 (Victoria Ave.)	Lunes – Viernes	9 a.m. - 4 p.m.
Upland	1370 N. Benson Ave. (14th St.)	Sábado	9 a.m. - 2 p.m.

San Bernardino County STORMWATER PROGRAM

Para reportar actividades ilegales llamar al (877) WASTE18
o visite sbcountystormwater.org

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

TOME UNO

A SAFE GARDEN:
A LOT DEPENDS ON IT.

Protect your family and community when using pesticides and fertilizers.

- **STRATEGICALLY** apply products on your lawn when rain is not expected. Rain can wash toxic chemicals from your lawn into local waterways.
- **SPOT-APPLY** products directly on the problem instead of the whole area. Use less chemicals, and conserve the supply of your product.
- **SAFELY** dispose of unwanted products. The County of San Bernardino offers 9 HHW Centers that accept pesticides, fertilizers and other toxic waste FREE of charge.

To report illegal dumping, call
(877) WASTE18 or visit
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

UN JARDÍN SANO:
MUCHO DEPENDE DE ÉL.

Proteja a su familia y a su comunidad cuando utilice pesticidas y fertilizantes.

- **ESTRATÉGICAMENTE** aplique productos en su césped solamente cuando no se espera lluvia. La lluvia puede llevarse químicos tóxicos de su césped hacia los canales pluviales en su área.
- **ESCASAMENTE** aplique los productos directamente en el área en donde exista el problema en lugar de distribuirlo en todo el jardín. Así, utilizará menos productos químicos y le rendirá más.
- **ELIMINE** productos tóxicos sanamente. El Condado de San Bernardino ofrece 9 centros de recolección que aceptan pesticidas, fertilizantes y otros desechos tóxicos GRATUITAMENTE.

Para reportar actividades ilegales llamar al
(877) WASTE18 o visite
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

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San Bernardino County
STORMWATER PROGRAM

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San Bernardino County
STORMWATER PROGRAM

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

SPOT-APPLY

pesticides directly on the problem rather than blanketing the whole area.

sbcountystormwater.org

A SAFE GARDEN:
A LOT DEPENDS ON IT.

San Bernardino County STORMWATER PROGRAM

(877) WASTE18

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

ESCASAMENTE

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sbcountystormwater.org

UN J ARDÍN SANO:
MUCHO DEPENDE DE EL.

San Bernardino County
STORMWATER PROGRAM

(877) WASTE18

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GARDEN SMART:
Use Pesticides and Fertilizers Sparingly

sbcounty.gov/stormwater

Artwork Courtesy of the City of Los Angeles Stormwater Program

Managing FATS, OIL and GREASE

"It's Easier than YOU Think!"

THE WRONG WAY
La Forma Incorrecta

1

Do not pour cooking residue directly into the drain.

No vierta residuos de cocinar directamente en el desague.

2

Do not dispose of food waste into the garbage disposal.

No ponga desperdicios de comida en el triturador de comida.

3

Do not pour waste oil directly into the drain.

No ponga desperdicio de aceite directamente en el desague.

4

Do not wash floor mats where water will run off directly into the storm drain.

No lave tapetes de piso en un lugar donde el agua corra hacia el desague.

THE RIGHT WAY
La Forma Correcta

1

Wipe pots, pans, and work areas prior to washing.

Limpie con una toallita las ollas, cazuelas, y areas de trabajo antes de lavarlos.

2

Dispose of food waste directly into the trash.

Deseche los desperdicios de comida en el bote de basura.

3

Collect waste oil and store for recycling.

Junte el desperdicio de aceite y guardelo para que sea reciclado.

4

Clean mats inside over a utility sink.

Limpie los tapetes de piso detro de un lavabo o fregador.

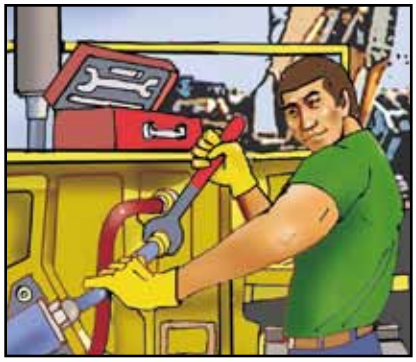
STORMWATER Pollution Prevention

ROADWORK AND PAVING

Asphalt, saw-cut slurry and excavated materials from road paving, surfacing and pavement removal often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

Preventing Erosion
Schedule excavation and grading work during dry weather. Develop and implement erosion and sediment control plans for excavated embankments. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

During Construction
Cover catch basins and maintenance holes when applying seal coat, slurry seal or fog seal. Use check dams, ditches or berms around excavations, and avoid over applying water for dust control. Never wash excess materials from exposed aggregate or concrete into the street, gutter or a storm drain.



Maintaining Vehicles & Equipment
Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids.

Asphalt & Concrete Removal
Barricade storm drain openings during saw-cutting, and recycle broken up pavement at a crushing company. For recycling information, call (909) 386-8401.

Cleaning & Preventing Spills
Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. Sweep up dry spills, instead of hosing. Prevent spills from paver machines by using drip pans, or by placing absorbent materials like cloths or rags under the machines when not in use. To report serious spills, call 911.

To report illegal dumping call

(877) WASTE18

sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

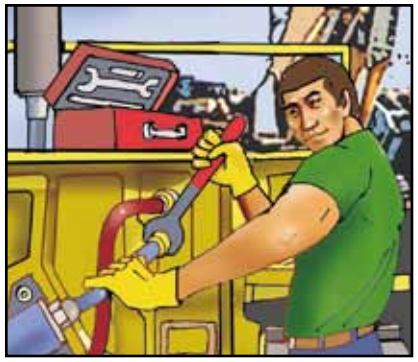
Prevención de Contaminación del Desagüe

TRABAJO DE CARRETERAS & PAVIMENTO

Asfalto, mezcla y materiales de excavaciones del pavimento acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

Previniendo Erosiones
Planea las excavaciones trabajo de jardineria durante el clima seco. Desarrolla e implementa planes de embancamientos de control de sedimento y excavaciones. Cubre montones de tierra, grava y otros materiales con un plastico para protejerlos de la llvia, aire y desagüe.

Durante Construcción
Cubre los lavados y da mantenimiento a los hoyos al aplicar selladura o mezcla. Revisa las areas de excavaciones, y evita pasarte de agua para preveenir polvadura. Nunca laves los materiales llenos de concreto en la calle, drenajes o en el desagüe.



Mantenimiento de Vehiculos & Herramientas
Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura y evita goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador.

Removiendo Asfalto & Concreto
Bloquea alrededor de los drenajes cuando estes usando las maquinas de sierra, tambien recicla todo el pavimento roto en la compañia demolidora. Para más información llama al (909) 386-8401.

Limpiando & Previniendo Derrames
Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin Barre los derrames en ves de lavarlos con la manguera. Previene los derrames de las maquinas usando enbudos o colocanto garras para absorver cualquier liquido. Para reportar derrames llama al 911.

Para reportar actividades ilegales llamar al:

(877) WASTE18

sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

HOME & GARDEN

Yard waste and household toxics like paints and pesticides often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.

Recycle Household Hazardous Waste
Household products like paint, pesticides, solvents and cleaners are too dangerous to dump and too toxic to trash. Take them to be recycled at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

Disposing of Yard Waste
Recycle leaves, grass clippings and other yard waste, instead of blowing, sweeping or hosing into the street. Try grasscycling, leaving grass clippings on your lawn instead of using a grass catcher. The clippings act as a natural fertilizer, and because grass is mostly water, it also irrigates your lawn, conserving water.

Use Fertilizers & Pesticides Safely
Fertilizers and pesticides are often carried into the storm drain system by sprinkler runoff. Try using organic or non-toxic alternatives. If you use chemical fertilizers or pesticides, avoid applying near curbs and driveways and never apply before a rain.

Planting in the Yard
Produce less yard waste and save water by planting low maintenance, drought-tolerant trees and shrubs. Using drip irrigation, soaker hoses or micro-spray systems for flower beds and vegetation can also help reduce your water bill and prevent runoff.

Use Water Wisely
Cut your water costs and prevent runoff by controlling the amount of water and direction of sprinklers. The average lawn needs about an inch of water a week, including rainfall, or 10 to 20 minutes of watering. A half-inch per week is enough for fall and spring. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff.

To report illegal dumping call

(877) WASTE18

sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

JARDIN

Basura del jardín y otros toxicos caseros como pintura, pesticidas y otros mas acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

Disponiendo Desechos del Jardin
Recicla hojas, pasto y otras basuras del jardín en ves de soplarlas, barrerlas hacia la calle. El pasto sirve como fertilizante, y como el pasta es la mayoria agua tambien riega tu jardín, ahorrandote agua.

Reciclando Materiales del Hogar Peligrosos
Limpiadores del hogar como pintura, pesticidas, solventes y limpiadores son demasiado toxicos para tirarlos en la basura. Desechalos en unlugar de colección de desechos peligrosos. Llama al (800) CLEANUP para un lugar en tu area.

Usando Fertilizantes & Pesticidas Adecuadamente
Fertilizantes y pesticidas muchas veces terminan en los drenajes. Usa alternativas que no sean toxicas. Si tu usas fertilizantes y pesticidas con quimicos, no los uses cerca de las banquetas y cocheras y nunca los uses en tiempos de lluvia.

Cembrando en el Jardin
Reduce la basura del jardín y ahorra agua plantando arboles y plantas de bajo mantenimiento. Riega moderadamente con mangueras u otros metodos para las flores o vegetacion asi reduciras tu pago del mes y previenes el desagüe.

Usando el Agua Adecuadamente
Reduce el pago del agua y previene el desagüe controlando la cantidad y direccion de tus regaderas para el jardin. Solo necesitas regar de 10 a 20 minutos a la semana. Durante la primavera y otoño es la mitad. Las regaderas del jardin deverian estar ajustadas a que rieguen lo suficinete y evitar el desagüe.

Para reportar actividades ilegales llamar al:

(877) WASTE18

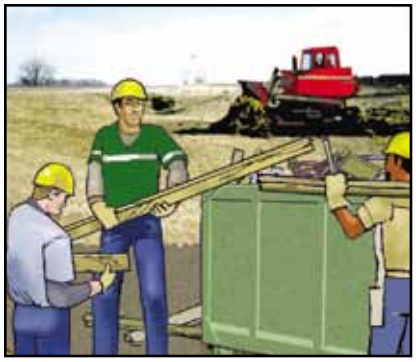
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

EXCAVATION AND GRADING

Sediment, cement wash, asphalt and vehicle fluids from soil excavation and grading often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Recycling Waste

Recycle broken asphalt, concrete, wood, and cleared vegetation whenever possible. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.

Maintaining Vehicles & Equipment

Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutters and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks. Use gravel approaches where truck traffic is heavy to reduce soil compaction and limit the tracking of sediment into the street.

Cleaning & Preventing Spills

Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. Prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids. To report serious spills, call 911.

Storing Materials

Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

Preventing Erosion

Avoid excavation or grading during wet weather. Plant temporary vegetation on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff. Channels can be lined with grass or roughened pavement to reduce runoff velocity.

To report illegal dumping call

(877) WASTE18

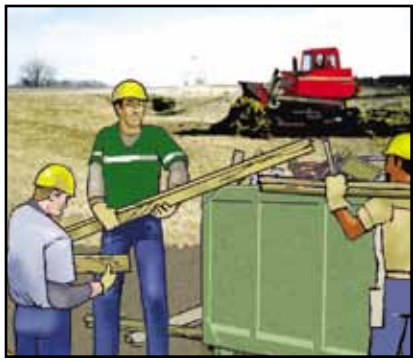
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

EXCAVACIONES

Sedimento, cemento, asfalto y liquidos de auto, tierra y residuos peligrosos de lugares de construcción acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.



Reciclando Desechos
Recicla el aspfalto, concreto, madera y la vegetacion cuando sea posible. Materiales no reciclados se deverian llevar a lugares de desechos peligrosos. Para màs informacion llama al (909) 386-8401.

Manteniendo Vehiculos & Herramientas
Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura. Usa grava donde mayormente se consentra el trafico de camiones para y reducir el sedimento en las calles.

Limpiando & Previniendo Derrames
Usa siempre un enbudo al vaciar liquidos. Barre los derrames en ves de lavarlos con la manguera. Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin. Preveen goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador. Para reportar derrames llama al 911.

Almacenando Materiales
Manten materiales de construccion y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y erramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.

Previniendo Erosiones
Evita las excavaciones durante lluvia. Planta vegetacion temporal en colinas donde aun no hay planes de construcción y planta vegetacion permanente al terminar las excavaciones. Construye algunos canales para el desagüe. Estos pueden ser creados con pasto y cemento para reducir la velocidad del desagüe.

Para reportar actividades ilegales llamar al:

(877) WASTE18

sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

CONSTRUCTION

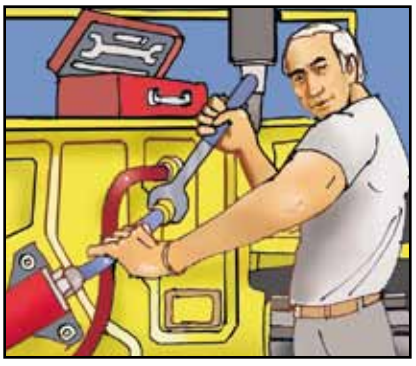
Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

Store Materials Safely
Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

Ordering Materials & Recycling Waste
Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. You can recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.

Cleaning & Preventing Spills
Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. To report serious spills, call 911.

Preventing Erosion
Avoid excavation or grading during wet weather. Plant temporary vegetation or add hydromulch on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff to a detention basin and around the construction site. Channels can be lined with grass or roughened pavement to reduce runoff velocity.



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sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

CONSTRUCCIÓN

Cemento, sedimentos, liquidos de auto, polvos y residuos peligrosos acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

Almacenando Materiales Cuidadosamente

Manten materiales de construcción y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y herramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.

Ordenando Materiales & Reciclando Desechos

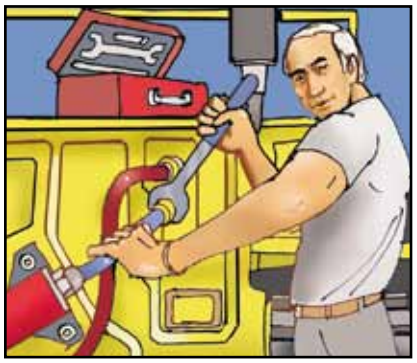
Reduce la cantidad al ordenar el material, solo ordena lo necesario. Usa materiales que se puedan reciclar cuando sea posible. Se puede reciclar el aspfalto, concreto, madera y la vegetacion. Materiales no reciclados se deven llevar a lugares de desechos peligrosos. Para mas información llama al (909) 386-8401.

Limpiando & Previniendo Derrames

Usa siempre un enbudo al vaciar liquidos. Barre los derrames en ves de lavarlos con la manguera. Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin. Para reportar derrames llama al 911.

Previniendo Erosiones

Evita las excavaciones durante lluvia. Planta vegetacion temporal en colinas donde aun no hay planes de construccion y planta vegetacion permanente al terminar las excavaciones. Construye algunos canales para el desagüe. Estos pueden ser creados con pasto y cemento para reducir la velocidad del desagüe.



Mantenimiento de Vehiculos & Herramientas

Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura y preveen goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador.

Para reportar actividades ilegales llamar al:

(877) WASTE18

sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

FRESH CONCRETE & MORTAR APPLICATION

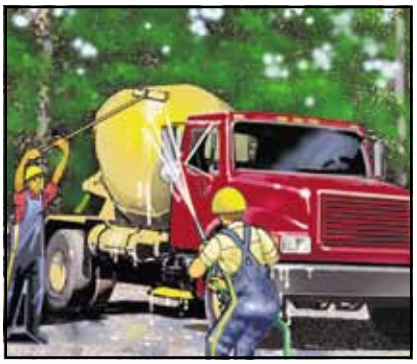
Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

Storing Materials
Keep construction materials and debris away from the street, gutter and storm drains. Secure open bags of cement and cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

Ordering Materials & Recycling Waste
Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. When breaking up paving, recycle the pieces at a crushing company. You can also recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. Call (909) 386-8401 for recycling and disposal information.

During Construction
Schedule excavation and grading during dry weather. Prevent mortar and cement from entering the street and storm drains by placing erosion controls. Setup small mixers on tarps or drop cloths, for easy cleanup of debris. Never bury waste material. Recycle or dispose of it as hazardous waste.

Cleaning Up
Wash concrete dust onto designated dirt areas, not down driveways or into the street or storm drains. Wash out concrete mixers and equipment in specified washout areas, where water can flow into a containment pond. Cement washwater can be recycled by pumping it back into cement mixers for reuse. Never dispose of cement washout into driveways, streets, gutters, storm drains or drainage ditches.



To report illegal dumping call
(877) WASTE18
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

APLICANDO CONCRETO FRESCO

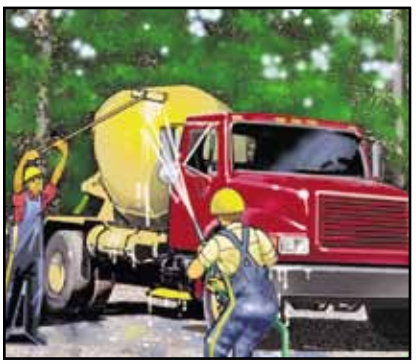
Cemento, grava, asfalto y liquidos de auto, tierra y residuos peligrosos de lugares de concreto fresco por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

Almacenando Materiales
Manten materiales de construcción y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y herramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.

Ordenando Materiales & Reciclando
Reduce la cantidad al ordenar el material, solo ordena lo necesario. Usa materiales recicables cuando sea posible. Cuando estes rompiendo el pavimento, recicla los pedasos en la compañia demolidora. Se puede reciclar el aspfalto, concreto, madera y la vegetacion. Materiales no reciclados se deverian llevar a lugares de desechos peligrosos. llama al (909) 386-8401 para más información.

Durante Construcción
Planea las excavaciones durante clima seco. No dejes que el cemento o la cal lleguen hasta las calles o drenajes, evita esto con plantas temporales para detener el desagüe. Cubre las maquinas de mesclar con alguna garra para que se facilite la limpieza de residuos. Nunca entierres los desechos. Recicla todos los desechos peligrosos.

Limpiando
Lava la cal en un area designada, no la eches hacia la cochera o en la calle. Lava las mescladoras y las herramientas en un lugar especifico, donde el agua llegue a un contenedor. El agua de cemento se puede reciclar volviendola a usar en las mescladoras. Nunca dejes el agua de cemento que corra hacia las calles, alcantarillas o drenajes.



Para reportar actividades ilegales llamar al:

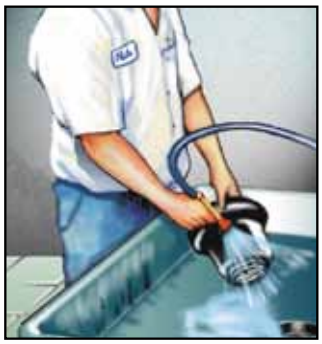
(877) WASTE18
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

STORMWATER Pollution Prevention

AUTO MAINTENANCE

Oil, grease, anti-freeze and other toxic automotive fluids often make their way into the San Bernardino County storm drain system, and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Cleaning Auto Parts
Scrape parts with a wire brush or use a bake oven rather than liquid cleaners. Arrange drip pans, drying racks and drain boards so that fluids are directed back into the parts washer or the fluid holding tank. Do not wash parts or equipment in a shop sink, parking lot, driveway or street.

Storing Hazardous Waste
Keep your liquid waste segregated. Many fluids can be recycled via hazardous waste disposal companies if they are not mixed. Store all materials under cover with spill containment or inside to prevent contamination of rainwater runoff.

Metal Grinding and Polishing
Keep a bin under your lathe or grinder to capture metal filings. Send uncontaminated filings to a scrap metal recycler for reclamation. Store metal filings in a covered container or indoors.

Preventing Leaks and Spills
Place drip pans underneath to capture fluids. Use absorbent cleaning agents instead of water to clean work areas.

Cleaning Spills
Use dry methods for spill cleanup (sweeping, absorbent materials). Follow your hazardous materials response plan, as filed with your local fire department or other hazardous materials authority. Be sure that all employees are aware of the plan and are capable of implementing each phase. To report serious toxic spills, call 911.

Proper Disposal of Hazardous Waste
Recycle used motor oil and oil filters, anti-freeze and other hazardous automotive fluids, batteries, tires and metal filings collected from grinding or polishing auto parts. Contact a licensed hazardous waste hauler. For more recycling information, call (909) 386-8401.

To report illegal dumping call

(877) WASTE18

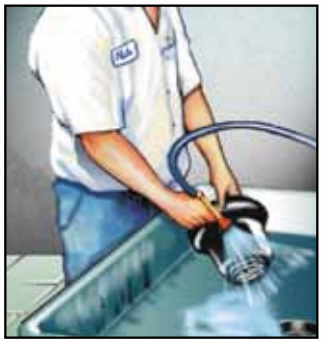
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

MANTENIMIENTO DE AUTO

Aceite, grasa, anti-congelantes y otros liquidos toxicos para el auto acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.



Limpiar Partes De Autos
Limpia las partes de auto con un cepillo de alambres o usa un limpiador de hornos en vez de usar limpiadores líquidos. Arregla las graseras, perchas para secar y tablas de escurrir para que los líquidos sean dirigidos al lavadero o recipientes para guardar líquidos. No laves las partes de auto o herramientas en el estacionamiento, la cochera o la calle.

Almacenando Desechos Peligrosos
Manten los desechos líquidos separados. Varios líquidos pueden ser reciclados por compañias que se especializan en desechos tóxicos si aun no estan mezclados. Guarda y cubre todos los materiales dentro de un lugar para prevenir la contaminación del desagüe.

Desechos de Metal & Pulidos
Manten un recipiente debajo de las maquinas de tornos o amoladoras para colectar desechos de metal. Manda los desechos de metal a un centro de reciclaje de metales. Guarda los desechos de metal en un recipiente cuvierto o dentro del local.

Prevenir Goteaduras & Derrames
Utilisa caserolas para el goteo de líquidos. Use limpiadores absorbentes en lugar de agua para limpiar el área de trabajo.

Limpiando Derrames
Sigue tu plan de como actuar sobre los materiales tóxicos, como esta indicado en el departamento de bomberos local u otras autoridades de materiales tóxicos. Asegurate que todos los empleados estén informados y capaz de aplicar cada fase del plan. Usa métodos secos para limpiar derramamientos (barriendo, materiales absorbentes, etc.).

Manera Correcta de Depositar los Desechos Peligrosos
Recicla el aceite de motor y filtros de aceite usados, anti-congelante, baterias, lubricantes, y desechos de metal y partes de auto pulidas. Llama a un colector de desechos tóxicos para disponer de absorbentes saturados. Mas iformación sobre reciclaje, llama al (909) 386-8401.

Para reportar actividades ilegales llamar al:

(877) WASTE18
sbcountystormwater.org

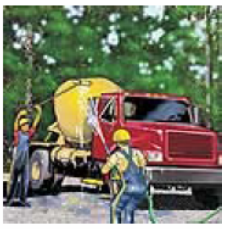
San Bernardino County
STORMWATER PROGRAM

SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

Construction & development:

Soil, cement wash, asphalt, oil and other hazardous debris from construction sites often make their way into the San Bernardino County storm drain system, and flow untreated into local waterways. Follow these best management practices to prevent pollution, protect public health and avoid fines or legal action.

- **Store Materials Safely:** Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.
- **Preventing Erosion:** Avoid excavation or grading during wet weather. Plant temporary vegetation or add hydro mulch on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff to a detention basin and around the construction site. Use gravel approaches where truck traffic is frequent to reduce soil compaction and limit the tracking of sediment into the streets. For more information on erosion control, call (909) 799-7407.



- **Cleaning & Preventing Spills:** Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. To report serious spills, call 911.
- **Maintaining Vehicles & Equipment:** Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, and brake and radiator fluids.
- **Ordering Materials & Recycling Waste:** Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. You can recycle broken asphalt, concrete, wood, and cleared vegetation. Dispose of hazardous materials through a hazardous waste hauler or other means in accordance with the construction permit. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.
- **Concrete and mortar application:** Never dispose of cement washout into driveways, streets, gutters or drainage ditches. Wash concrete mixers and equipment only in specified washout areas, where the water flows into lined containment ponds. Cement wash water can be recycled by pumping it back into cement mixers for reuse.

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

NOTICE

DISCHARGE INTO OUR WATERWAYS, ACCIDENTAL OR NOT, CAN LEAD TO ENFORCEMENT ACTIONS, WHICH CAN INCLUDE FINES.

WHEN WORKING WITH CONCRETE

USE THE 3Cs

CONTROL

Locate the nearest storm drain and ensure nothing can enter or be discharged into it. Use plastic covers and sandbags when working within 50' of a storm drain or catch basin.

CONTAIN

Isolate area and secure bags of cement after they are open. Keep cement, sand and aggregate (wet/dry) and slurries from saw cutting, from flowing into the streets, gutter and storm drains or being blown away. Cover bags of cement in case of rain.

CAPTURE

Sweep dry residue or vacuum wet concrete residue and dispose of properly. Create a designated washout area for equipment and tools and place away from driveways and storm drains. Dispose of concrete/plaster waste and rinsewater by hauling off to an approved disposal site.

To report illegal dumping, call **(877) WASTE18** or visit **sbcountystormwater.org**

SAN BERNARDINO COUNTY STORMWATER POLLUTION PREVENTION

Big Bear • Chino • Chino Hills • Colton • Fontana • Grand Terrace • Highland • Loma Linda • Montclair • Ontario • Rancho Cucamonga
Redlands • Rialto • San Bernardino • San Bernardino County • San Bernardino County Flood Control District • Upland • Yucaipa

AVISO

LA DESCARGA EN NUESTRAS VÍAS FLUVIALES, DE FORMA ACCIDENTAL O NO, PUEDE LLEVAR A TOMAR MEDIDAS PARA CUMPLIR CON LA LEY QUE PUEDEN INCLUIR MULTAS.

CUANDO TRABAJE CON CONCRETO APLIQUE LAS 3 C

CONTROL

Ubique el desagüe pluvial más cercano y asegúrese de que nada pueda entrar en él o que pueda descargarse allí. Use cubiertas de plástico y bolsas de arena cuando trabaje a una distancia de 50' de un desagüe pluvial o sumidero.

CONTENCIÓN

Aísle el área y asegure las bolsas de cemento una vez que las haya abierto. Impida que el cemento, la arena y los componentes del concreto (secos y húmedos) y los residuos acuosos resultantes después de cortar con sierra, fluyan hacia la calle, la alcantarilla y los desagües o que se vuelen con el viento.
Cubra las bolsas de cemento en caso de lluvia.

CAPTURA

Barra los residuos secos o limpie con una aspiradora los residuos de concreto húmedo y elimínelos en forma apropiada. Cree un área específica para enjuagar equipos y herramientas, y colóquela lejos de las entradas de automóviles y de los desagües pluviales.
Desheche los residuos de concreto o yeso y el agua de enjuague, llevándolos a un sitio aprobado para su eliminación.

Para informar sobre el vaciado ilegal de residuos, llame al **(877) WASTE18** o visite el sitio: **sbcountystormwater.org**

PREVENCIÓN DE CONTAMINACIÓN DE AGUAS PLUVIALES EN EL CONDADO DE SAN BERNARDINO

Big Bear • Chino • Chino Hills • Colton • Fontana • Grand Terrace • Highland • Loma Linda • Montclair • Ontario • Rancho Cucamonga • Redlands
Rialto • San Bernardino • Condado de San Bernardino • Distrito de Control de Inundaciones del Condado de San Bernardino • Upland • Yucaipa

SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

Commercial landscape maintenance:

Yard waste, sediments and toxic lawn and garden chemicals used in commercial landscape maintenance often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution, protect public health and avoid fines or legal action.

- **Recycle Yard Waste:** Recycle leaves, grass clippings and other yard waste. Do not blow, sweep, rake or hose yard waste into the street. Let your customers know about grass cycling --the natural recycling of grass by leaving clippings on the lawn when mowing instead of using a grass catcher. Grass clippings will quickly decompose, returning valuable nutrients to the soil. You can get more information at www.ciwmb.ca.gov/Organics.
- **Use Fertilizers, Herbicides & Pesticides Safely:** Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use natural, non-toxic alternatives to traditional garden chemicals. If you must use chemical fertilizers, herbicides, or pesticides spot apply rather than blanketing entire areas, avoid applying near curbs and driveways and never apply before a rain.
- **Recycle Hazardous Waste:** Pesticides, fertilizers, herbicides and motor oil contaminate landfills and should be disposed of through a Hazardous Waste Facility. For information on proper disposal, call (909) 386-8401.
- **Use Water Wisely:** Conserve water and prevent runoff by controlling the amount of water and direction of sprinklers. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff. Periodically inspect, fix leaks and realign sprinkler heads.

- **Planting:** Plant native vegetation to reduce the need of water, fertilizers, herbicides and pesticides.
- **Prevent Erosion:** Erosion washes sediments, debris and toxic runoff into the storm drain system, polluting waterways. Prevent erosion and sediment runoff by using ground cover, berms and vegetation down-slope to capture runoff. Avoid excavation or grading during wet weather.

- **Store Materials Safely:** Keep landscaping materials and debris away from the street, gutter and storm drains. On-site stockpiles of materials should be covered with plastic sheeting to protect from rain, wind and runoff.

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

Carpet cleaning:

Toxic chemicals and discharged waste water from carpet, drapery, furniture and window cleaning often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Following these best management practices will prevent pollution, comply with regulations and protect public health.

These guidelines apply even if the cleaning products are labeled "nontoxic" or "biodegradable". Although these products may be less harmful to the environment, they can still have harmful effects if they enter the storm drain untreated.

- **Dispose of wastewater properly:** Wastewater from cleaning equipment must be discharged into a sink, toilet, or other drain connected to the sanitary sewer system within sanitary sewer discharge limits, or hauled off and disposed of properly. Wastewater should never be discharged into a street, gutter, parking lot or storm drain.
- **Filter wastewater:** Carpet cleaning wastewater should be filtered before discharging it to the sanitary sewer since fibers and other debris in the wastewater can clog pipes. The filtered material can be disposed of in the garbage, as long as the waste is not contaminated with hazardous pollutants.

San Bernardino County Stormwater Program
825 East Third Street · Room 127
San Bernardino, CA 94215-0835

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STORMWATER Pollution Prevention

Stormwater Management Practices for Commercial Landscape Maintenance

Yard waste, sediments, and toxic lawn/garden chemicals used in commercial landscape maintenance often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Following these best management practices will prevent pollution, comply with regulations and protect public health.

Recycle Yard Waste

Recycle leaves, grass clippings and other yard waste. Do not blow, sweep, rake or hose yard waste into the street. Try grasscycling - the natural recycling of grass by leaving clippings on the lawn when mowing. Grass clippings will quickly decompose, returning valuable nutrients to the soil. Further information can be obtained at www.ciwmb.ca.gov/Organics.

Use Fertilizers, Herbicides and Pesticides Safely

Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use of natural, non-toxic alternatives to the traditional fertilizers, herbicides and pesticides is highly recommended. If you must use chemical fertilizers, herbicides, or pesticides:

- Spot apply pesticides and herbicides, rather than blanketing entire areas.
- Avoid applying near curbs and driveways, and never apply before a rain.
- Apply fertilizers as needed, when plants can best use it, and when the potential for it being carried away by runoff is low.

Recycle Hazardous Waste

Pesticides, fertilizers, herbicides and motor oil contaminate landfills and should be disposed of through a Hazardous Waste Facility, which accepts these types of materials. For information on proper disposal call, (909) 386-8401.

Use Water Wisely

Conserve water and prevent runoff by controlling the amount of water and direction of sprinklers. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff. Periodically inspect, fix leaks and realign sprinkler heads. Plant native vegetation to reduce the need of water, fertilizers, herbicides, and pesticides.

Prevent Erosion

Erosion washes sediments, debris and toxic runoff into the storm drain system, polluting waterways.

- Prevent erosion and sediment runoff by using ground cover, berms and vegetation down-slope to capture runoff.
- Avoid excavation or grading during wet weather.

Store Materials Safely

Keep landscaping materials and debris away from the street, gutter and storm drains. On-site stockpiles of materials must be covered with plastic sheeting to protect from rain, wind and runoff.

San Bernardino County STORMWATER PROGRAM

To report illegal dumping call

(877) WASTE18

or visit our website:

sbcountystormwater.org

DA-1 DMA A

Vegetated Swale Calculations

Lot 30

DCV Analysis - LOT NO. 30 W/STREET FRONTAGE
PALM
Tract 20305

Design Capture Volume Calculation	Template Item	Value	Comment
Project Area (ft^2)	1	8,033	
Impervious Area (ft^2)		5,109	
Imperviousness (Imp %)	2	63.60%	Imperviousness after applying preventative site design practices
Runoff Coefficient (Rc)	3	0.44	$Rc=0.858(Imp\%)^3-0.78(Imp\%)^2+0.774(Imp\%)+0.04$
$P_{2yr\text{-}1hr}$(in)	4	0.473	Determine 1-hour rainfall depth for a 2-year return period from NOAA
C_1		1.4807	Climatic region Valley=1.4807, Mountain=1.909, Desert=1.2371
P_6(in)	5	0.70	Mean 6-hr precipitation = $P_{2yr\text{-}1hr}(in)*C_1$
C_2	6	1.963	24 hrs = 1.582, 48 hrs = 1.963 Drawdown Rate
DCV (ft^3)	7	**403**	Design Capture Volume
Water Quality Credits Volume Reduction (ft^3)			
Remaining DCV (ft^3)		**403**	Remaining Design Capture Volume after Water Qaulity Credits applied
Flow Based BMP Calculation (Qbmp)			
Design Rainfall Intensity		0.2	Uniform Intensity Approach: I=0.2 in/hr
Qbmp(ft^3/sec)		**0.02**	Qbmp = CIA

NOTE:
LOT 30 IS THE FURTHEST DOWNSTREAM LOT IN DA-1. THIS ANALYSIS IS USED TO DETERMINE THE MINIMUM SWALE LENGTH NECESSARY TO PROVIDE THE REQUIRED HYDRAULIC RESONANCE TIME WITHIN THE SWALE FOR RUNOFF FROM LOT 30. RUNOFF FROM LOTS UPSTREAM OF LOT 30 IN DA-1 WILL PASS THROUGH THE SAME LOWER SECTION OF SWALE AND WILL HAVE A RELATIVELY LONGER HYDRAULIC RESONANCE TIME.

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Saturday, Dec 7 2019

DA-1 Lot 30 w/Street Frontage - Vegetated Swale - Slope = 0.0500

Trapezoidal

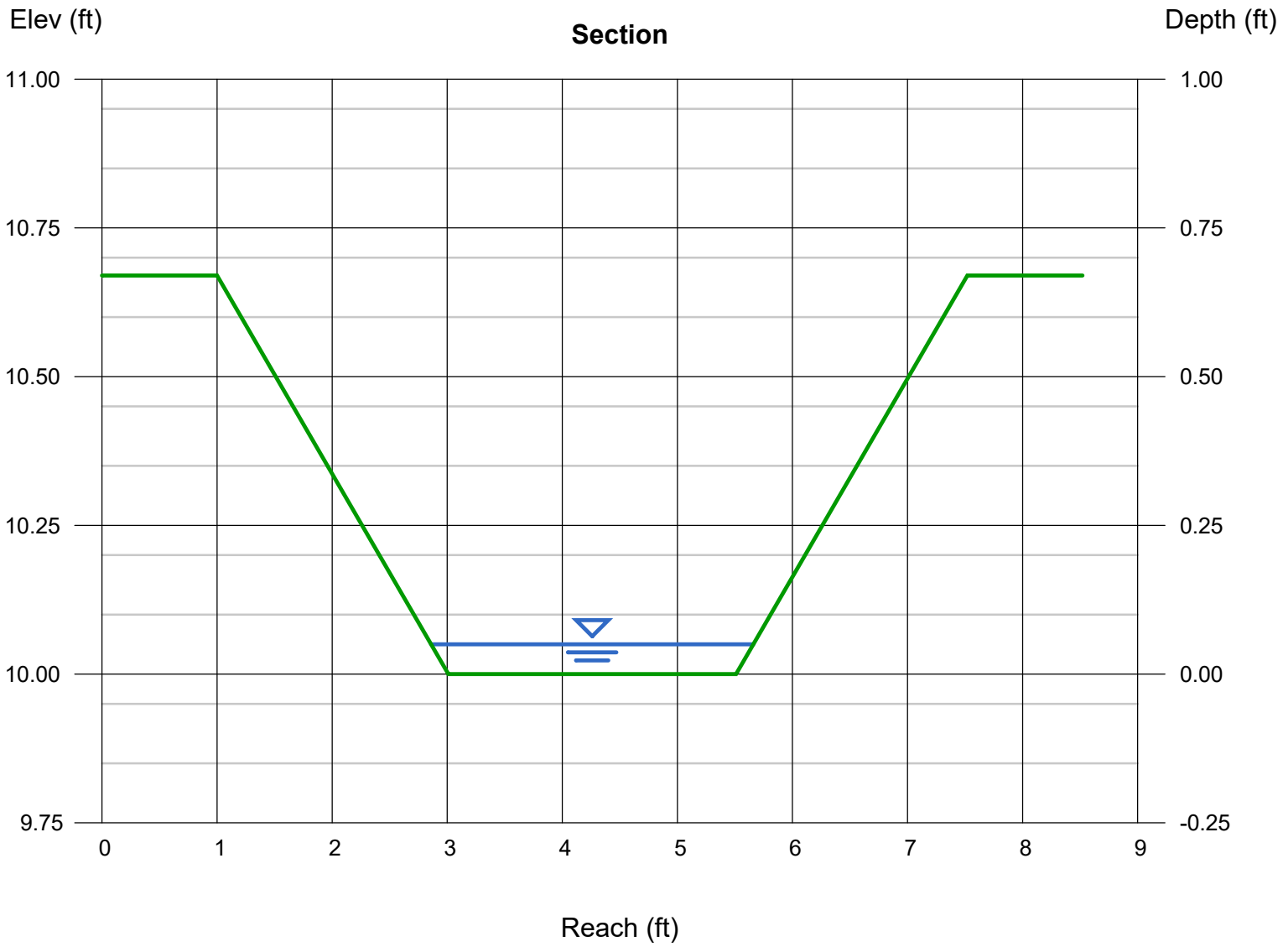
Bottom Width (ft)	= 2.50
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 0.67
Invert Elev (ft)	= 10.00
Slope (%)	= 5.00
N-Value	= 0.200

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.02

Highlighted

Depth (ft)	= 0.05
Q (cfs)	= 0.020
Area (sqft)	= 0.13
Velocity (ft/s)	= 0.15
Wetted Perim (ft)	= 2.82
Crit Depth, Yc (ft)	= 0.02
Top Width (ft)	= 2.80
EGL (ft)	= 0.05



PWQMP Vegetated Swale - LOT NO. 30 W/STREET FRONTAGE

PALM

Tract 20305

Vegetated Swale (WQMP Guidance Design)				**Notes**
Q_{DESIGN}	1	0.02	ft^3/sec	
Flow Depth for WQ Treatment	2	0.05	ft	Depth from hydraulic section
Bed Slope	3	0.05	ft/ft	
Manning's Roughness Coefficient	4	0.200		Shallow Flow Condition
Bottom Width	5	2.50	ft	
Side Slope	6	0.33	ft/ft	3:1 Side Slope
Cross Sectional Area	7	0.13	ft^2	
Water Quality Flow Velocity	8	0.15	ft/sec	
Hydraulic Resonance Time	9	10	min	
Length of Flow Based BMP	10	91	ft	
Water Surface Area at WQ Flow Depth	11	229	ft^2	

Velocity (from Hydraulic Section)=	0.15	fps				
Minimum Hydraulic Resonance Time=	10	min				
Minimum Required Length =	91	ft				
Length Provided=	127	ft				

DA-1 DMA A

Vegetated Swale Calculations

DMA A

DCV Analysis - DA-1
PALM
Tract 20305

Design Capture Volume Calculation	Template Item	Value	Comment
Project Area (ft^2)	1	131,294	
Impervious Area (ft^2)		77,195	
Imperviousness (Imp %)	2	58.80%	Imperviousness after applying preventative site design practices
Runoff Coefficient (Rc)	3	0.40	$Rc=0.858(Imp\%)^3-0.78(Imp\%)^2+0.774(Imp\%)+0.04$
$P_{2yr\text{-}1hr}$(in)	4	0.473	Determine 1-hour rainfall depth for a 2-year return period from NOAA
C_1		1.4807	Climatic region Valley=1.4807, Mountain=1.909, Desert=1.2371
P_6(in)	5	0.70	Mean 6-hr precipitation = $P_{2yr\text{-}1hr}(in)*C_1$
C_2	6	1.963	24 hrs = 1.582, 48 hrs = 1.963 Drawdown Rate
DCV (ft^3)	7	**6,014**	Design Capture Volume
Water Quality Credits Volume Reduction (ft^3)			
Remaining DCV (ft^3)		**6,014**	Remaining Design Capture Volume after Water Qaulity Credits applied
Flow Based BMP Calculation (Qbmp)			
Design Rainfall Intensity		0.2	Uniform Intensity Approach: I=0.2 in/hr
Qbmp(ft^3/sec)		**0.24**	Qbmp = CIA

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jan 27 2020

DA-1 DMA A - Vegetated Swale - Slope = 0.0500

Trapezoidal

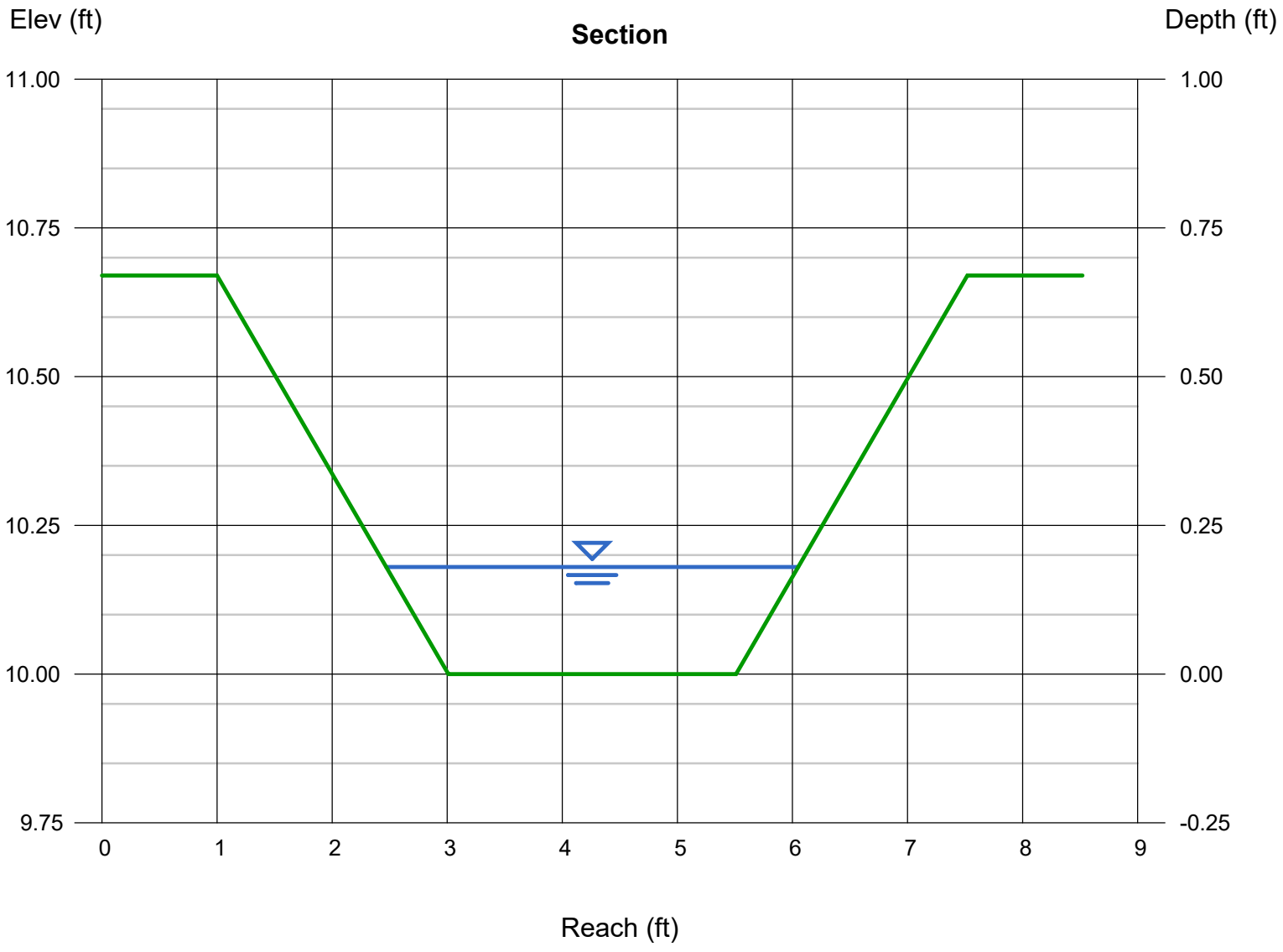
Bottom Width (ft)	= 2.50
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 0.67
Invert Elev (ft)	= 10.00
Slope (%)	= 5.00
N-Value	= 0.200

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.24

Highlighted

Depth (ft)	= 0.18
Q (cfs)	= 0.240
Area (sqft)	= 0.55
Velocity (ft/s)	= 0.44
Wetted Perim (ft)	= 3.64
Crit Depth, Yc (ft)	= 0.07
Top Width (ft)	= 3.58
EGL (ft)	= 0.18



PWQMP Vegetated Swale - DA-1 DMA A
PALM
Tract 20305

Vegetated Swale (WQMP Guidance Design)				**Notes**
Q_{DESIGN}	1	0.24	ft^3/sec	
Flow Depth for WQ Treatment	2	0.18	ft	Depth from hydraulic section
Bed Slope	3	0.05	ft/ft	
Manning's Roughness Coefficient	4	0.200		Shallow Flow Condition
Bottom Width	5	2.50	ft	
Side Slope	6	0.33	ft/ft	3:1 Side Slope
Cross Sectional Area	7	0.55	ft^2	
Water Quality Flow Velocity	8	0.44	ft/sec	
Hydraulic Resonance Time	9	10	min	
Length of Flow Based BMP	10	263	ft	
Water Surface Area at WQ Flow Depth	11	689	ft^2	

Velocity (from Hydraulic Section)=	0.44	fps	
Minimum Hydraulic Resonance Time=	10	min	
Minimum Required Length =	263	ft	
Length Provided=	787	ft	

DA-2 DMA A

Vegetated Swale Calculations

Lot 21

DCV Analysis - LOT NO. 21 W/STREET FRONTAGE
PALM
Tract 20305

Design Capture Volume Calculation	Template Item	Value	Comment
Project Area (ft^2)	1	8,354	
Impervious Area (ft^2)		4,821	
Imperviousness (Imp %)	2	57.71%	Imperviousness after applying preventative site design practices
Runoff Coefficient (Rc)	3	0.39	$Rc=0.858(Imp\%)^3-0.78(Imp\%)^2+0.774(Imp\%)+0.04$
$P_{2yr\text{-}1hr}$(in)	4	0.473	Determine 1-hour rainfall depth for a 2-year return period from NOAA
C_1		1.4807	Climatic region Valley=1.4807, Mountain=1.909, Desert=1.2371
P_6(in)	5	0.70	Mean 6-hr precipitation = $P_{2yr\text{-}1hr}(in)*C_1$
C_2	6	1.963	24 hrs = 1.582, 48 hrs = 1.963 Drawdown Rate
DCV (ft^3)	7	**375**	Design Capture Volume
Water Quality Credits Volume Reduction (ft^3)			
Remaining DCV (ft^3)		**375**	Remaining Design Capture Volume after Water Qaulity Credits applied
Flow Based BMP Calculation (Qbmp)			
Design Rainfall Intensity		0.2	Uniform Intensity Approach: I=0.2 in/hr
Qbmp(ft^3/sec)		**0.02**	Qbmp = CIA

NOTE:
LOT 21 IS THE FURTHEST DOWNSTREAM LOT IN DA-2 DMA A. THIS ANALYSIS IS USED TO DETERMINE THE MINIMUM SWALE LENGTH NECESSARY TO PROVIDE THE REQUIRED HYDRAULIC RESONANCE TIME WITHIN THE SWALE FOR RUNOFF FROM LOT 21. RUNOFF FROM LOTS UPSTREAM OF LOT 21 IN DA-2 DMA A WILL PASS THROUGH THE SAME LOWER SECTION OF SWALE AND WILL HAVE A RELATIVELY LONGER HYDRAULIC RESONANCE TIME.

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Saturday, Dec 7 2019

DA-2 Lot 21 w/Street Frontage - Vegetated Swale - Slope = 0.0260

Trapezoidal

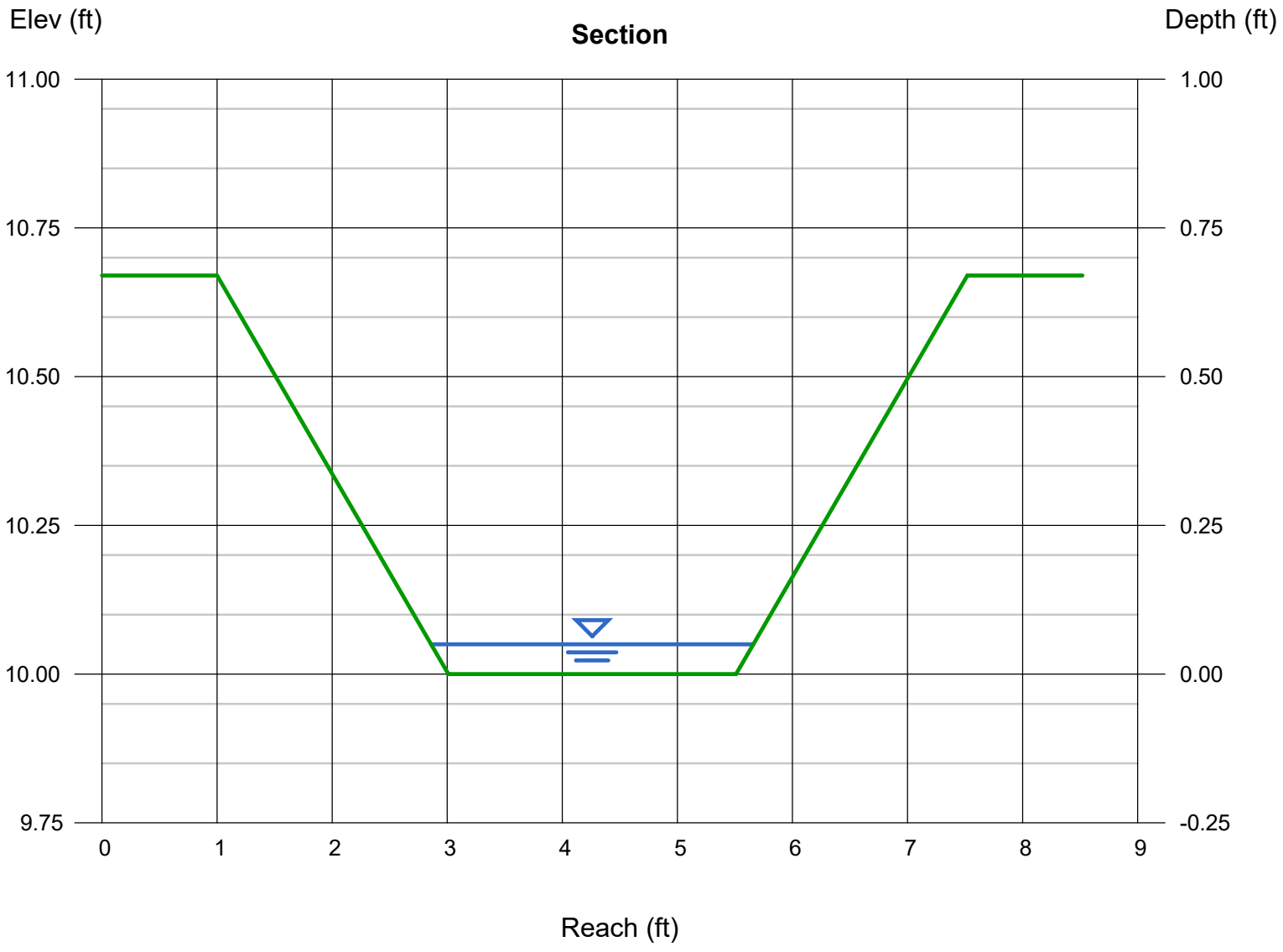
Bottom Width (ft)	= 2.50
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 0.67
Invert Elev (ft)	= 10.00
Slope (%)	= 2.60
N-Value	= 0.200

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.02

Highlighted

Depth (ft)	= 0.05
Q (cfs)	= 0.020
Area (sqft)	= 0.13
Velocity (ft/s)	= 0.15
Wetted Perim (ft)	= 2.82
Crit Depth, Yc (ft)	= 0.02
Top Width (ft)	= 2.80
EGL (ft)	= 0.05



PWQMP Vegetated Swale - LOT NO. 21 W/STREET FRONTAGE

PALM

Tract 20305

Vegetated Swale (WQMP Guidance Design)				**Notes**
Q_{DESIGN}	1	0.02	ft^3/sec	
Flow Depth for WQ Treatment	2	0.05	ft	Depth from hydraulic section
Bed Slope	3	0.026	ft/ft	
Manning's Roughness Coefficient	4	0.200		Shallow Flow Condition
Bottom Width	5	2.50	ft	
Side Slope	6	0.33	ft/ft	3:1 Side Slope
Cross Sectional Area	7	0.13	ft^2	
Water Quality Flow Velocity	8	0.15	ft/sec	
Hydraulic Resonance Time	9	10	min	
Length of Flow Based BMP	10	91	ft	
Water Surface Area at WQ Flow Depth	11	229	ft^2	

Velocity (from Hydraulic Section)=	0.15	fps				
Minimum Hydraulic Resonance Time=	10	min				
Minimum Required Length =	91	ft				
Length Provided=	119	ft				

DA-2 DMA A

Vegetated Swale Calculations

DMA A

DCV Analysis - DA-2 DMA A
PALM
Tract 20305

Design Capture Volume Calculation	Template Item	Value	Comment
Project Area (ft^2)	1	82,597	
Impervious Area (ft^2)		49,692	
Imperviousness (Imp %)	2	60.16%	Imperviousness after applying preventative site design practices
Runoff Coefficient (Rc)	3	0.41	$Rc=0.858(Imp\%)^3-0.78(Imp\%)^2+0.774(Imp\%)+0.04$
$P_{2yr\text{-}1hr}$(in)	4	0.473	Determine 1-hour rainfall depth for a 2-year return period from NOAA
C_1		1.4807	Climatic region Valley=1.4807, Mountain=1.909, Desert=1.2371
P_6(in)	5	0.70	Mean 6-hr precipitation = $P_{2yr\text{-}1hr}(in)*C_1$
C_2	6	1.963	24 hrs = 1.582, 48 hrs = 1.963 Drawdown Rate
DCV (ft^3)	7	**3,881**	Design Capture Volume
Water Quality Credits Volume Reduction (ft^3)			
Remaining DCV (ft^3)		**3,881**	Remaining Design Capture Volume after Water Qaulity Credits applied
Flow Based BMP Calculation (Qbmp)			
Design Rainfall Intensity		0.2	Uniform Intensity Approach: I=0.2 in/hr
Qbmp(ft^3/sec)		**0.16**	Qbmp = CIA

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Saturday, Dec 7 2019

DA-2 DMA A - Vegetated Swale - Slope = 0.0260

Trapezoidal

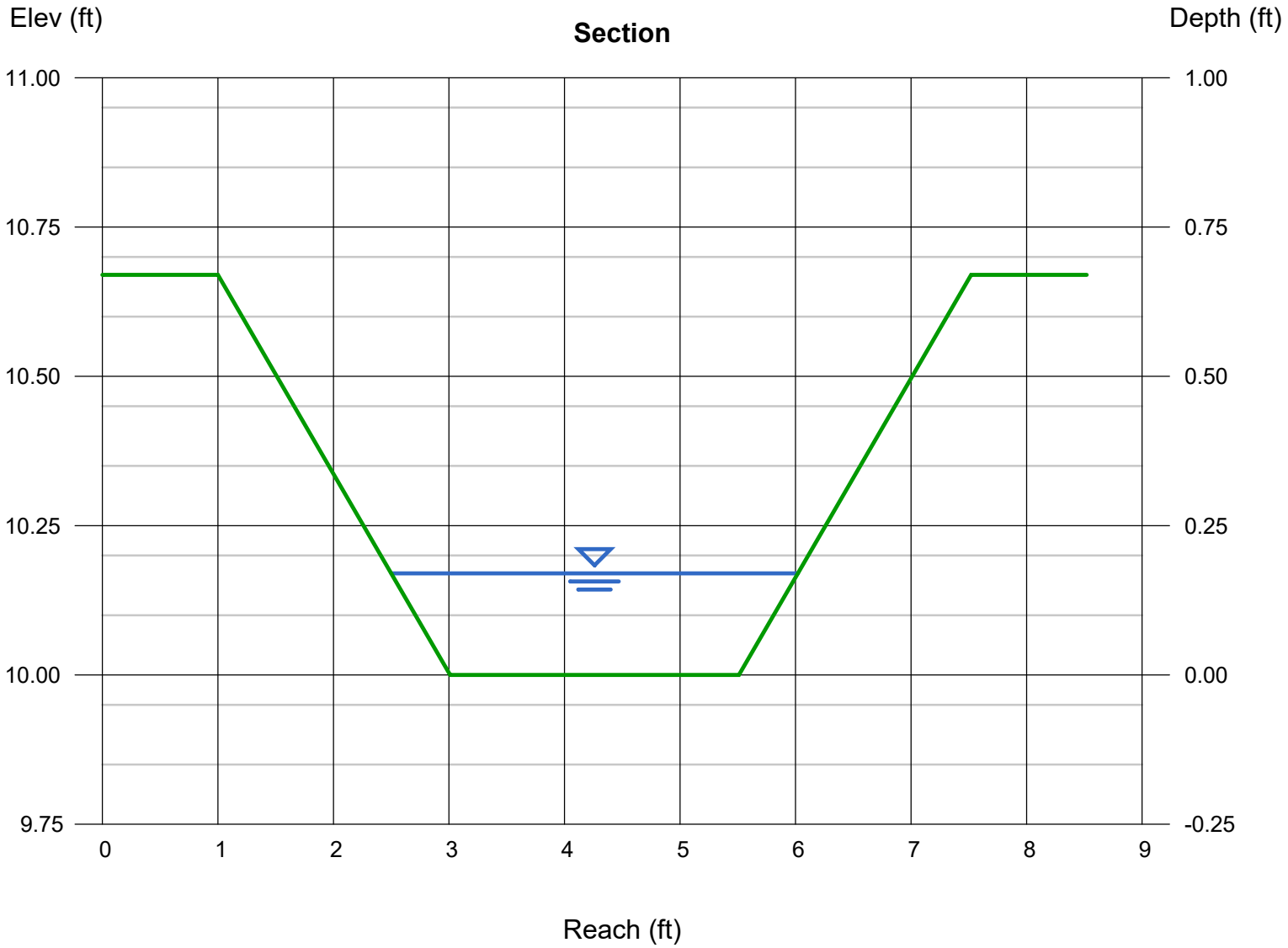
Bottom Width (ft)	= 2.50
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 0.67
Invert Elev (ft)	= 10.00
Slope (%)	= 2.60
N-Value	= 0.200

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.16

Highlighted

Depth (ft)	= 0.17
Q (cfs)	= 0.160
Area (sqft)	= 0.51
Velocity (ft/s)	= 0.31
Wetted Perim (ft)	= 3.58
Crit Depth, Yc (ft)	= 0.05
Top Width (ft)	= 3.52
EGL (ft)	= 0.17



PWQMP Vegetated Swale - DA-2 DMA A
PALM
Tract 20305

Vegetated Swale (WQMP Guidance Design)				**Notes**
Q_{DESIGN}	1	0.16	ft^3/sec	
Flow Depth for WQ Treatment	2	0.17	ft	Depth from hydraulic section
Bed Slope	3	0.026	ft/ft	
Manning's Roughness Coefficient	4	0.200		Shallow Flow Condition
Bottom Width	5	2.50	ft	
Side Slope	6	0.33	ft/ft	3:1 Side Slope
Cross Sectional Area	7	0.51	ft^2	
Water Quality Flow Velocity	8	0.31	ft/sec	
Hydraulic Resonance Time	9	10	min	
Length of Flow Based BMP	10	188	ft	
Water Surface Area at WQ Flow Depth	11	490	ft^2	

Velocity (from Hydraulic Section)=	0.31	fps				
Minimum Hydraulic Resonance Time=	10	min				
Minimum Required Length =	188	ft				
Length Provided=	684	ft				

DA-2 DMA B

Bioretention System Calculations

DMA B

DCV Analysis - DA-2 DMA B
PALM
Tract 20305

Design Capture Volume Calculation	Template Item	Value	Comment
Project Area (ft^2)	1	56,254	
Impervious Area (ft^2)		34,526	
Imperviousness (Imp %)	2	61.38%	Imperviousness after applying preventative site design practices
Runoff Coefficient (Rc)	3	0.42	$Rc=0.858(Imp\%)^3-0.78(Imp\%)^2+0.774(Imp\%)+0.04$
$P_{2yr\text{-}1hr}$(in)	4	0.473	Determine 1-hour rainfall depth for a 2-year return period from NOAA
C_1		1.4807	Climatic region Valley=1.4807, Mountain=1.909, Desert=1.2371
P_6(in)	5	0.70	Mean 6-hr precipitation = $P_{2yr\text{-}1hr}(in)*C_1$
C_2	6	1.963	24 hrs = 1.582, 48 hrs = 1.963 Drawdown Rate
DCV (ft^3)	7	**2,704**	Design Capture Volume
Water Quality Credits Volume Reduction (ft^3)			
Remaining DCV (ft^3)		**2,704**	Remaining Design Capture Volume after Water Qaulity Credits applied
Flow Based BMP Calculation (Qbmp)			
Design Rainfall Intensity		0.2	Uniform Intensity Approach: I=0.2 in/hr
Qbmp(ft^3/sec)		**0.11**	Qbmp = CIA

PWQMP Bioretention with Underdain/Planter Box Sizing (DA-2 DMA B)
PALM
Tract 20305

Filterra Bioretention System Sizing (14'x8' - 112 ft^2 Box)			
Remaining DCV	1	2,704	ft^3
Amended Soil Infiltration Rate	2	-	in/hr
Safety Factor	3	-	
P_{design} (Per Manufacturer's Spec.s)	4	100.00	in/hr
Max Drawdown Time	5	48	hrs
Max Pond Depth to Drain in 48 hrs	6	400.00	ft
Max Pond Depth (available in planter)	6	0.75	ft
Pond Depth	7	0.75	ft
Amended Soil Surface Area	8	112	ft^2
Amended Soil Depth d_{media}	9	1.75	ft
Amended Soil Porosity	10	0.35	
Gravel Depth d_{media}	11	0.5	ft
Gravel Porosity	12	0.35	
Storm Duration	13	3	hrs
$V_{biotreated}$ =	14	2,930	ft^3
Total Biotreated Volume	16	2,930	ft^3
Fraction of DCV Achieved	17	108.37%	
Full DCV Achieved	18	Yes	
Actual		0.18	hrs

Filterra Sizing Guidelines – Southern California
Biotreatment Volume Approach
Filterra Media Infiltration Rate = 100 in/hr

Explanation: Using the Bioretention with Underdrain / Planter Box method calculation from the Riverside County LID BMP Manual, we can estimate the volume treated by a Filterra bioretention system for a three hour storm.

Table 5-6 Estimation methods for biotreatment BMP's

BMP Type	Bioretention with underdrain / Planter Box
Runoff Volume Calculation	$V_{biotreated} = (P_{design}/12 * SA_{inf} * T_{fill}) + (SA_{ponded} * D_{ponded}/2) + (SA_{soil} * d_{soil} * n_{soil}) + (SA_{gravel} * d_{gravel} * N_{gravel})$ *where* $d_{ponded} \leq T_{drawdown} * P_{design}/12$
Variables	P_{design} = design percolation rate into amended soil layer (in/hr), default 2.5 in/hr $SA_{amended\ soil}$ = surface area (ft2) of amended soil layer of bioretention area and surface ponding $T_{drawdown}$ = drawdown time for stored runoff (hrs), default is 48 hours T_{fill} = duration of storm when biotreatment is occurring as basin is filling (hrs), default is 3 hours $d_{ponded,soil,gravel}$ = depth (ft) of ponding and gravel layers, zero ponding for planter box $n_{amended\ soil,\ gravel}$ = porosity of amended soil and gravel layer
Fact Sheet Reference for Design Details	Riverside County LID BMP Manual San Bernardino County Stormwater Program

MANUFACTURER'S SPECIFIED DESIGN INFILTRATION RATE

Variables

- P_{design} = 100 in/hr
- d_{ponded} = 9″
- T_{fill} = 3 hrs
- SA = Table Below*
- d_{soil} = 21"
- d_{gravel} = 6″
- n_{soil} = 35%
- n_{gravel} = 35%
- *SAinf = SAponded = SAgravel = SA

Filterra	Surface Area (ft²)	Biotreated Volume (ft³)
4x4	16	419
4x6.5	26	680
4x8	32	837
6x6	36	942
6x8	48	1256
6x10	60	1570
6x12	70	1831
7x13	91	2381
8x12	96	2512
8x16	128	3349
8x18	144	3767
8x20	160	4186
8x14	112	2930

USE 8'x14' SYSTEM

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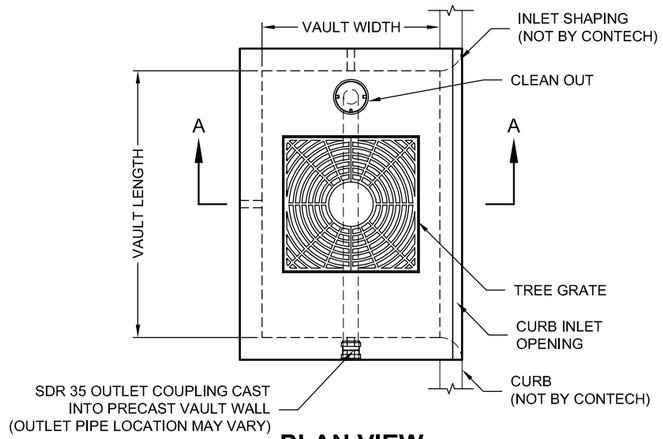
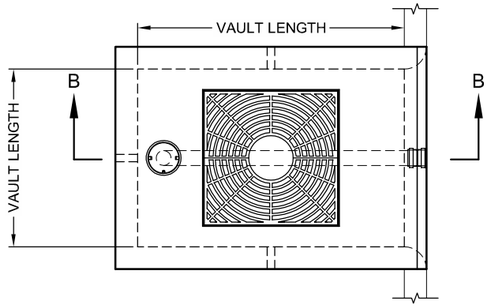
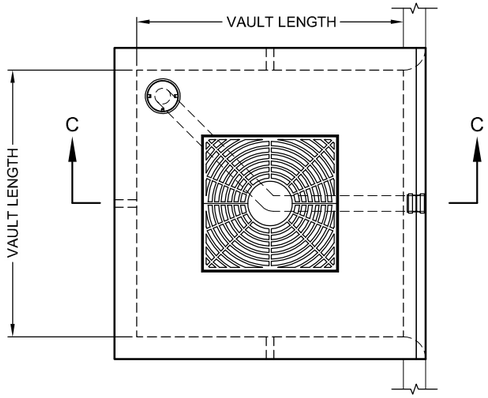


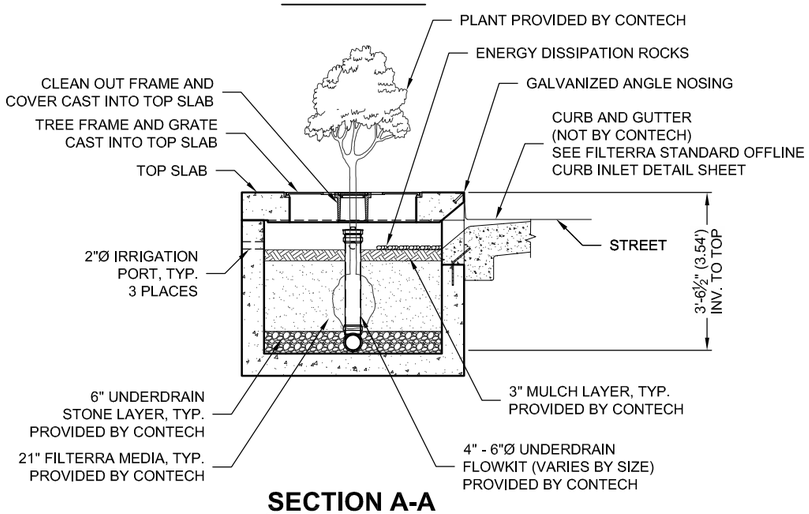
PLAN VIEW



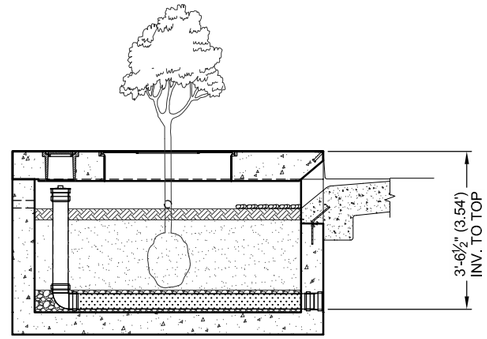
PLAN VIEW



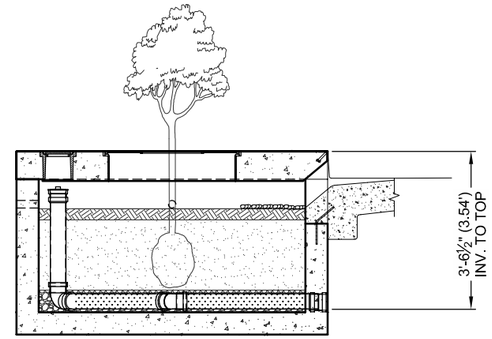
PLAN VIEW



SECTION A-A



SECTION B-B



SECTION C-C

FT LONG SIDE INLET CONFIGURATION

DESIGNATION	AVAILABILITY	MEDIA BAY SIZE	VAULT SIZE (L x W)	OUTLET PIPE DIA	TREE GRATE QTY & SIZE
FT0604	N/A CA	6 x 4	6 x 4	4" SDR 35	(1) 3' x 3'
FT06504	CA ONLY	6.5 x 4	6.5 x 4	4" SDR 35	(1) 3' x 3'
FT078045	MID-ATL ONLY	7.83 x 4.5	7.83 x 4.5	4" SDR 35	(1) 3' x 3'
FT0804	N/A MID-ATL	8 x 4	8 x 4	4" SDR 35	(1) 3' x 3'
FT0806	ALL	8 x 6	8 x 6	4" SDR 35	(1) 4' x 4'
FT1006	ALL	10 x 6	10 x 6	6" SDR 35	(1) 4' x 4'
FT1206	ALL	12 x 6	12 x 6	6" SDR 35	(2) 4' x 4'
FT1307	ALL	13 x 7	13 x 7	6" SDR 35	(2) 4' x 4'
FT1408	CALL CONTECH	14 x 8	14 x 8	6" SDR 35	(2) 4' x 4'
FT1608	CALL CONTECH	16 x 8	16 x 8	6" SDR 35	(2) 4' x 4'
FT1808	CALL CONTECH	18 x 8	18 x 8	6" SDR 35	(2) 4' x 4'
FT2008	CALL CONTECH	20 x 8	20 x 8	6" SDR 35	(3) 4' x 4'
FT2208	CALL CONTECH	22 x 8	22 x 8	6" SDR 35	(3) 4' x 4'

N/A = NOT AVAILABLE

USE 14'X8' UNIT

FT SHORT SIDE INLET CONFIGURATION

DESIGNATION	AVAILABILITY	MEDIA BAY SIZE	VAULT SIZE (W x L)	OUTLET PIPE DIA	TREE GRATE QTY & SIZE
FT0406	N/A CA	4 x 6	4 x 6	4" SDR 35	(1) 3' x 3'
FT04065	CA ONLY	4 x 6.5	4 x 6.5	4" SDR 35	(1) 3' x 3'
FT0408	N/A MID-ATL	4 x 8	4 x 8	4" SDR 35	(1) 3' x 3'
FT045078	MID-ATL ONLY	4.5 x 7.83	4.5 x 7.83	4" SDR 35	(1) 3' x 3'
FT0608	ALL	6 x 8	6 x 8	4" SDR 35	(1) 4' x 4'
FT0610	ALL	6 x 10	6 x 10	6" SDR 35	(1) 4' x 4'
FT0612	ALL	6 x 12	6 x 12	6" SDR 35	(2) 4' x 4'
FT0713	ALL	7 x 13	7 x 13	6" SDR 35	(2) 4' x 4'

N/A = NOT AVAILABLE

FT SQUARE INLET CONFIGURATION

DESIGNATION	AVAILABILITY	MEDIA BAY SIZE	VAULT SIZE (W x L)	OUTLET PIPE DIA	TREE GRATE QTY & SIZE
FT0404	ALL	4 x 4	4 x 4	4" SDR 35	(1) 3' x 3'
FT0606	ALL	6 x 6	6 x 6	4" SDR 35	(1) 3' x 3'

N/A = NOT AVAILABLE

INTERNAL PIPE CONFIGURATION MAY VARY
DEPENDING UPON OUTLET LOCATION.

filterra®
THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 6,277,274; 6,569,321; 7,625,485; 7,425,261; 7,833,412. RELATED FOREIGN PATENTS.

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FILTERRA OFFLINE (FT) CONFIGURATION DETAIL

I:\COMMON\CAD\TREATMENT\54 FILTERRA\40 STANDARD DRAWINGS\FT - OFFLINE\LAYOUT DETAILS\DWG\FILTERRA STANDARD OFFLINE CONFIG DTL.DWG 11/1/2017 11:31 AM

WQMP Project Report

County of San Bernardino Stormwater Program

Santa Ana River Watershed Geodatabase

Monday, November 11, 2019

Note: The information provided in this report and on the Stormwater Geodatabase for the County of San Bernardino Stormwater Program is intended to provide basic guidance in the preparation of the applicant's Water Quality Management Plan (WQMP) and should not be relied upon without independent verification.

Project Site Parcel Number(s):	017323105
Project Site Acreage:	8.815
HCOC Exempt Area:	No
Closest Receiving Waters: (Applicant to verify based on local drainage facilities and topography.)	**System Number** - 509 **Facility Name** - Reservoir Canyon SD **Owner** - OTHERS
Closest channel segment's susceptibility to Hydromodification:	EHM
Highest downstream hydromodification susceptibility:	High
Is this drainage segment subject to TMDLs?	No
Are there downstream drainage segments subject to TMDLs?	No
Is this drainage segment a 303d listed stream?	No
Are there 303d listed streams downstream?	Yes
Are there unlined downstream waterbodies?	No
Project Site Onsite Soil Group(s):	B
Environmentally Sensitive Areas within 200':	None
Groundwater Depth (FT):	-82
Parcels with potential septic tanks within 1000':	No
Known Groundwater Contamination Plumes within 1000':	Yes
Studies and Reports Related to Project Site:	CSDP 4 CALC SHEET FOR HYDRO CSDP 4 Hydrological Design Criteria SBVMWD High Groundwater / Pressure Zone Area

NOAA Atlas 14, Volume 6, Version 2
Location name: Redlands, California, USA*
Latitude: 34.0424°, Longitude: -117.1766°
Elevation: 1504.31 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** (0.082-0.119)	**0.127** (0.105-0.154)	**0.164** (0.136-0.200)	**0.195** (0.161-0.240)	**0.239** (0.190-0.303)	**0.272** (0.212-0.354)	**0.307** (0.233-0.409)	**0.343** (0.253-0.471)	**0.393** (0.278-0.563)	**0.433** (0.295-0.642)
10-min	**0.141** (0.117-0.171)	**0.181** (0.151-0.220)	**0.235** (0.195-0.287)	**0.280** (0.230-0.344)	**0.342** (0.272-0.435)	**0.390** (0.303-0.507)	**0.440** (0.334-0.586)	**0.492** (0.363-0.675)	**0.564** (0.398-0.807)	**0.621** (0.423-0.920)
15-min	**0.170** (0.142-0.206)	**0.219** (0.182-0.266)	**0.285** (0.236-0.347)	**0.339** (0.279-0.416)	**0.414** (0.329-0.526)	**0.472** (0.367-0.613)	**0.532** (0.403-0.709)	**0.595** (0.438-0.816)	**0.682** (0.481-0.976)	**0.751** (0.512-1.11)
30-min	**0.252** (0.210-0.306)	**0.325** (0.271-0.395)	**0.422** (0.350-0.515)	**0.503** (0.413-0.618)	**0.613** (0.487-0.780)	**0.700** (0.544-0.909)	**0.789** (0.599-1.05)	**0.883** (0.650-1.21)	**1.01** (0.714-1.45)	**1.11** (0.759-1.65)
60-min	**0.367** (0.305-0.445)	**0.473** (0.393-0.574)	**0.613** (0.509-0.747)	**0.730** (0.600-0.897)	**0.891** (0.708-1.13)	**1.02** (0.791-1.32)	**1.15** (0.869-1.53)	**1.28** (0.945-1.76)	**1.47** (1.04-2.10)	**1.62** (1.10-2.40)
2-hr	**0.521** (0.434-0.632)	**0.669** (0.556-0.812)	**0.865** (0.717-1.05)	**1.03** (0.844-1.26)	**1.25** (0.992-1.59)	**1.42** (1.11-1.85)	**1.60** (1.21-2.13)	**1.79** (1.32-2.45)	**2.04** (1.44-2.92)	**2.24** (1.53-3.32)
3-hr	**0.642** (0.534-0.779)	**0.823** (0.684-1.00)	**1.06** (0.881-1.29)	**1.26** (1.04-1.55)	**1.53** (1.22-1.95)	**1.74** (1.35-2.26)	**1.96** (1.48-2.61)	**2.18** (1.61-2.99)	**2.49** (1.76-3.56)	**2.73** (1.86-4.04)
6-hr	**0.905** (0.754-1.10)	**1.16** (0.964-1.41)	**1.50** (1.24-1.82)	**1.77** (1.46-2.17)	**2.15** (1.71-2.73)	**2.44** (1.90-3.17)	**2.73** (2.07-3.64)	**3.04** (2.24-4.17)	**3.46** (2.44-4.95)	**3.79** (2.58-5.62)
12-hr	**1.22** (1.01-1.48)	**1.56** (1.30-1.90)	**2.01** (1.67-2.45)	**2.38** (1.96-2.92)	**2.88** (2.29-3.66)	**3.26** (2.54-4.24)	**3.65** (2.77-4.86)	**4.05** (2.99-5.56)	**4.60** (3.25-6.58)	**5.02** (3.42-7.44)
24-hr	**1.63** (1.44-1.87)	**2.10** (1.86-2.42)	**2.71** (2.39-3.14)	**3.21** (2.81-3.74)	**3.88** (3.29-4.68)	**4.40** (3.65-5.41)	**4.92** (3.98-6.19)	**5.45** (4.30-7.05)	**6.17** (4.67-8.32)	**6.73** (4.92-9.38)
2-day	**2.02** (1.78-2.32)	**2.63** (2.33-3.04)	**3.45** (3.04-3.99)	**4.11** (3.60-4.79)	**5.01** (4.25-6.04)	**5.71** (4.74-7.03)	**6.42** (5.21-8.09)	**7.16** (5.64-9.27)	**8.16** (6.18-11.0)	**8.94** (6.54-12.5)
3-day	**2.18** (1.93-2.51)	**2.89** (2.55-3.33)	**3.83** (3.38-4.44)	**4.62** (4.04-5.39)	**5.70** (4.83-6.87)	**6.55** (5.44-8.06)	**7.43** (6.02-9.36)	**8.35** (6.58-10.8)	**9.62** (7.28-13.0)	**10.6** (7.77-14.8)
4-day	**2.36** (2.09-2.72)	**3.15** (2.79-3.63)	**4.22** (3.72-4.88)	**5.11** (4.47-5.95)	**6.35** (5.38-7.65)	**7.33** (6.08-9.01)	**8.35** (6.76-10.5)	**9.42** (7.43-12.2)	**10.9** (8.26-14.7)	**12.1** (8.86-16.9)
7-day	**2.73** (2.42-3.15)	**3.67** (3.25-4.24)	**4.94** (4.35-5.71)	**5.99** (5.24-6.99)	**7.47** (6.33-9.00)	**8.64** (7.17-10.6)	**9.85** (7.98-12.4)	**11.1** (8.78-14.4)	**12.9** (9.78-17.4)	**14.3** (10.5-20.0)
10-day	**2.96** (2.62-3.41)	**3.99** (3.53-4.60)	**5.38** (4.74-6.22)	**6.54** (5.72-7.63)	**8.16** (6.91-9.84)	**9.45** (7.84-11.6)	**10.8** (8.74-13.6)	**12.2** (9.63-15.8)	**14.2** (10.7-19.1)	**15.8** (11.5-22.0)
20-day	**3.67** (3.25-4.22)	**4.98** (4.40-5.74)	**6.75** (5.95-7.81)	**8.24** (7.21-9.61)	**10.3** (8.75-12.4)	**12.0** (9.95-14.7)	**13.7** (11.1-17.3)	**15.6** (12.3-20.1)	**18.1** (13.7-24.5)	**20.2** (14.8-28.2)
30-day	**4.31** (3.82-4.97)	**5.88** (5.20-6.78)	**7.99** (7.05-9.25)	**9.77** (8.55-11.4)	**12.3** (10.4-14.8)	**14.3** (11.8-17.6)	**16.4** (13.3-20.6)	**18.6** (14.7-24.1)	**21.7** (16.4-29.3)	**24.2** (17.7-33.8)
45-day	**5.15** (4.56-5.93)	**7.01** (6.20-8.09)	**9.55** (8.42-11.0)	**11.7** (10.2-13.6)	**14.7** (12.4-17.7)	**17.1** (14.2-21.0)	**19.6** (15.9-24.7)	**22.3** (17.6-28.9)	**26.1** (19.8-35.2)	**29.2** (21.3-40.7)
60-day	**6.02** (5.33-6.94)	**8.18** (7.23-9.44)	**11.1** (9.80-12.9)	**13.6** (11.9-15.9)	**17.1** (14.5-20.6)	**19.9** (16.5-24.5)	**22.8** (18.5-28.7)	**25.9** (20.5-33.6)	**30.4** (23.0-40.9)	**33.9** (24.8-47.3)

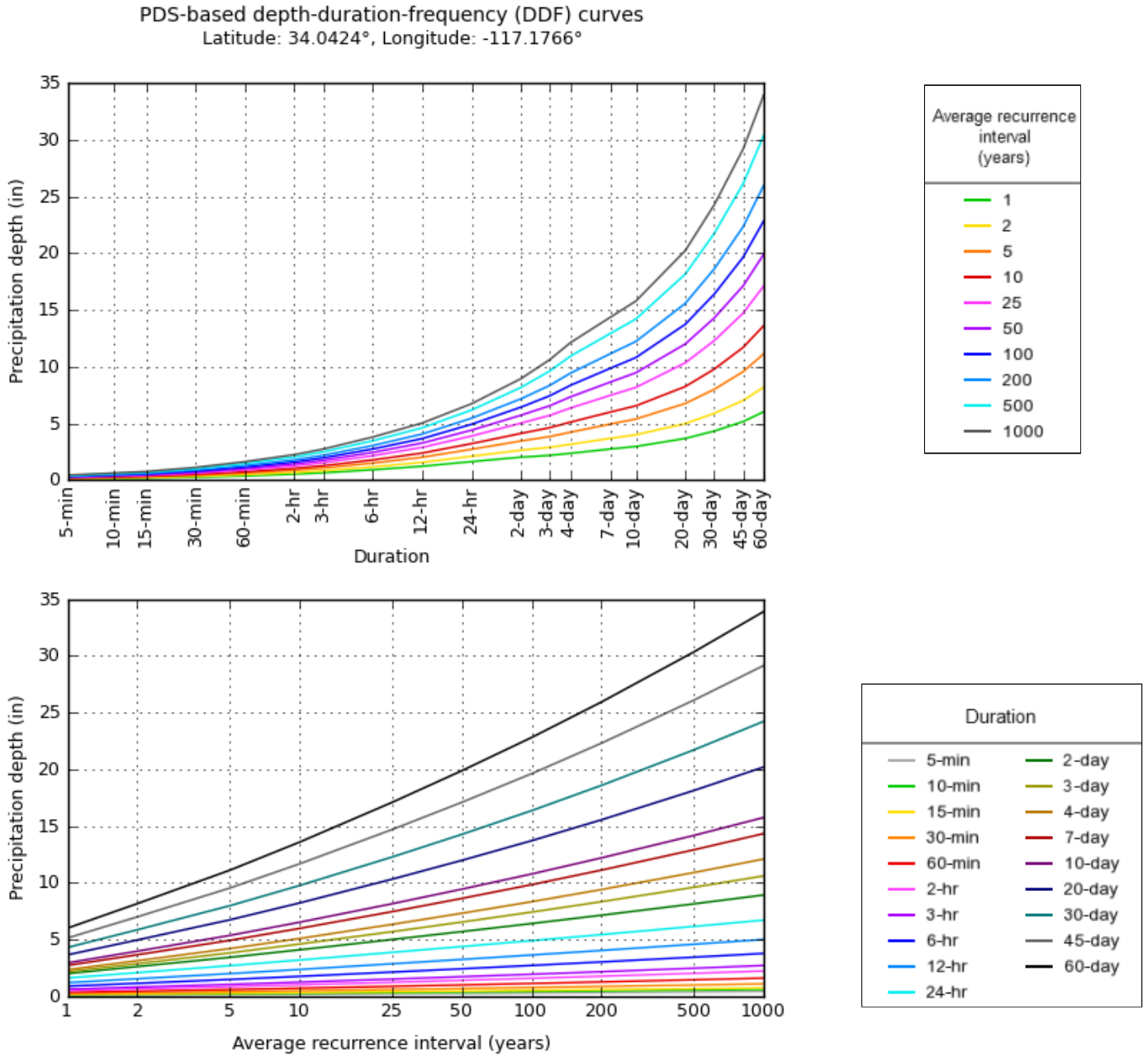
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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



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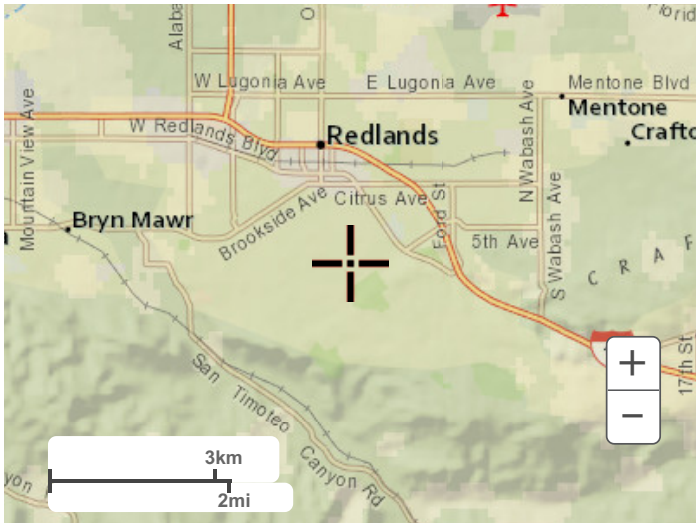
Back to Top

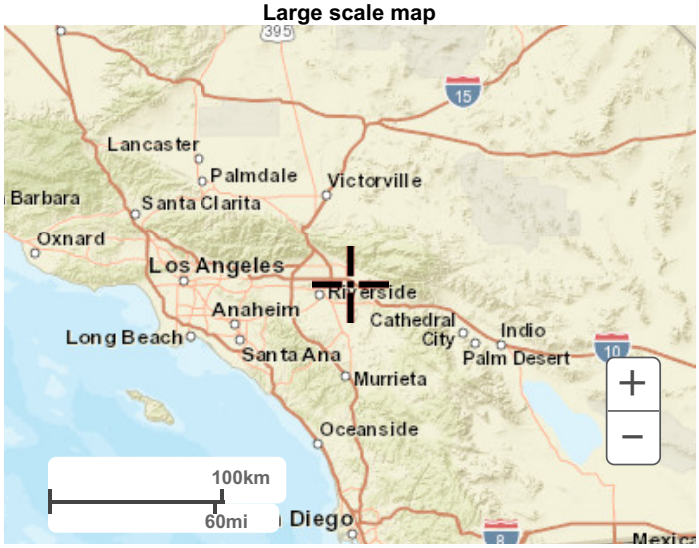
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map



Large scale aerial

Back to Top

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Disclaimer

PRELIMINARY GEOTECHNICAL EVALUATION
PROPOSED 30-LOT RESIDENTIAL DEVELOPMENT
APPROXIMATELY 8.8-ACRE SITE AT 301 WEST PALM AVENUE
CITY OF REDLANDS, SAN BERNARDINO COUNTY, CALIFORNIA

DIVERSIFIED PACIFIC COMMUNITIES

February 15, 2019
J.N. 18-430

February 15, 2019
J.N. 18-430

DIVERSIFIED PACIFIC COMMUNITIES
10621 Civic Center Drive
Rancho Cucamonga, CA 91730

Attention: Mr. Nolan C. Leggio

Subject: **Preliminary Geotechnical Evaluation, Proposed 30-Lot Residential Development, Approximately 8.8-Acre Site at 301 West Palm Avenue, City of Redlands, San Bernardino County, California**

Dear Mr. Leggio:

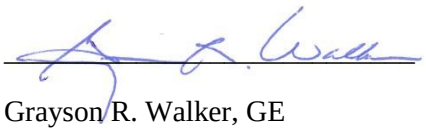
In accordance with your request and authorization, **Petra Geosciences, Inc. (Petra)** is submitting this preliminary geotechnical investigation report for the proposed mixed-use residential/commercial development in the city of Redlands, California. This work was performed in general accordance with the scope of work outlined in our proposal dated January 7, 2019.

The purposes of our evaluation were to obtain available geotechnical and geologic information on the nature of current site conditions, to evaluate the potential geologic constraints that may affect development of the property, and to provide recommendations pertaining to site remedial grading and construction of anticipated site improvements. This report presents the results of our preliminary field exploration, limited laboratory testing, engineering judgment, opinions, conclusions and recommendations pertaining to geotechnical design aspects for the presumed site development. It is presumed the development will consist of lightly-loaded residential and/or commercial structures.

It has been a pleasure to be of service to you on this project. Should you have questions regarding the contents of this report or should you require additional information, please contact the undersigned.

Respectfully submitted,

PETRA GEOSCIENCES, INC.



Grayson R. Walker, GE
Principal Engineer

TABLE OF CONTENTS

Page

INTRODUCTION 1
SCOPE OF WORK 1
LOCATION AND SITE DESCRIPTION 2
PROPOSED DEVELOPMENT 2
Literature and Aerial Photo Review 2
Field Exploration and Testing 2
Laboratory Testing 3
FINDINGS 4
Regional Geologic Setting 4
Local Geology and Subsurface Soil Conditions 4
Groundwater 4
Faulting 5
Secondary Seismic Effects 5
Liquefaction and Seismically-Induced Settlement 5
Compressible Soils 6
CONCLUSIONS AND RECOMMENDATIONS 6
Development Feasibility 6
Seismic Shaking 6
Remedial Grading 6
Earthwork Recommendations 7
General Recommendations 7
Geotechnical Observations and Testing 7
Clearing and Grubbing 7
Geotechnical Observations 8
Unsuitable Soil Removals and Bottom Processing 8
Boundary Conditions 8
Suitability of On-Site Materials for Use as Engineered Fill 9
Excavation Characteristics 9
Fill Placement 9
Temporary Excavations 9
Import Soils for Grading 10
Volumetric Changes - Shrinkage and Subsidence 10
Preliminary Foundation Design Considerations 10
Expansive Soil Conditions 10
Foundation System 10
Allowable Soil Bearing Capacity 11
Footing Settlement 11
Lateral Resistance 11
Slab-on-Ground Design and Construction Considerations 11
Conventional Slabs-on-Ground 12
Soil Corrosivity 14
Concrete in Contact with Site Soils 15
Metals Encased in Concrete 16
Metallic Elements in Contact with Site Soils 17
Preliminary Infiltration Rates 18
Shallow Infiltration Test Results 18
Post-Grading Considerations 18
Utility Trenches 18
Site Drainage 19
Tentative Pavement Design Recommendations 19

TABLE OF CONTENTS

Page

GRADING PLAN REVIEW 20
REPORT LIMITATIONS 21
REFERENCES 22

ATTACHMENTS

FIGURE 1 – SITE LOCATION MAP
FIGURE 2 – GEOTECHNICAL MAP
APPENDIX A – FIELD EXPLORATION LOGS (BORINGS)
APPENDIX B – LABORATORY TEST PROCEDURES / LABORATORY DATA SUMMARY
APPENDIX C – PERCOLATION FIELD TEST DATA

PRELIMINARY GEOTECHNICAL EVALUATION
PROPOSED 30-LOT RESIDENTIAL DEVELOPMENT
8.8-ACRE SITE AT 301 WEST PALM AVENUE, CITY OF REDLANDS, CALIFORNIA

INTRODUCTION

Petra Geosciences, Inc. (Petra) is presenting herein the results of our preliminary geotechnical investigation for the proposed development of an approximately 8.8-acre property situated southeast of West Palm Avenue and northeast of Alvarado Street, in the city of Redlands, California. The purpose of this study was to obtain preliminary information on the general geologic and geotechnical conditions within the project area in order to provide conclusions and recommendations for the feasibility of the proposed project, and preliminary geotechnical recommendations for site grading and improvements. Our geotechnical evaluation included a review of geological maps and data for the site and surrounding area, drilling four exploratory borings, performing two field percolation tests, laboratory testing, and geologic and engineering analysis.

SCOPE OF WORK

The scope of our evaluation consisted of the following.

- Review of available published and unpublished data, concerning geologic and soil conditions within the site and nearby area, that could have an impact on the proposed development.
- Review readily available aerial photographs of the site and surrounding area.
- Coordinate with the local underground utility locating service (i.e., Underground Service Alert [USA]) to obtain an underground-utility clearance, prior to commencement of the subsurface exploration.
- Geotechnical drilling, logging, and sampling of four (4) exploratory soil borings utilizing a hollow-stem auger drill rig, plus two (2) additional borings for field percolation testing. Log and visually classify soil and materials encountered in our borings in accordance with the Unified Soil Classification System (USCS).
- Perform two falling-head percolation tests in the vicinity of proposed storm water infiltration facilities.
- Conduct laboratory testing of representative samples (bulk and undisturbed) obtained from the borings to determine their engineering properties.
- Engineering and geologic analysis of the research, field exploration findings and laboratory data with respect to the proposed site development.
- Preparation of this geotechnical report presenting the results of our evaluation and providing recommendations for the proposed site development in general conformance with the requirements of the 2016 California Building Code (2016 CBC), as well as in accordance with applicable state and local jurisdictional requirements.

LOCATION AND SITE DESCRIPTION

The subject property is a square-shaped, approximately 8.8-acre parcel situated on the east corner of the intersection of West Palm Avenue and Alvarado Street in the city of Redlands, California. The site is bounded on the northeast and southeast by residential developments. The site location map, showing the general location of the site, is included as Figure 1. The site is currently occupied by an active citrus grove and several buildings, some of which will remain.

The existing structures on site consist of two single-family residences, one two-story and the other one-story, as well as a centrally located barn, a storage shed, and a single car detached garage. Site improvements consist of concrete driveways, planters, and irrigation systems.

The property is relatively flat, sloping gently to the west. Site elevations range from approximately 1,494 feet above mean sea level (msl) at the west corner to approximately 1,523 feet msl at the east corner.

PROPOSED DEVELOPMENT

Based the preliminary study map Alternate E (Hick and Hartwick, Inc., 2018), the planned development will consist of approximately 30 new residential lots and appurtenant interior streets. We anticipate ancillary site improvements to include underground utilities, asphalt pavement, perimeter walls underground storm water facilities and/or retention basins and landscaping. The currently proposed grading will generally entail shallow cuts and fills on the order of 1 to 3 feet from existing grades, however maximum fills are on the order of 10 feet from current grades and maximum cuts are on the order of 6 feet from current grades. Cut and or fill slopes are anticipated to be constructed at 2:1 (h:v) gradients.

Literature and Aerial Photo Review

Petra researched and reviewed available published and unpublished geologic data pertaining to regional geology, faulting and geologic hazards that may affect the site. The results of this review are included within this report.

Readily available online aerial imagery was reviewed to assess previous land use. Based on recent aerial imagery, the site has been utilized as a citrus grove with several residential structures for at least the past several decades.

Field Exploration and Testing

A subsurface exploration program was conducted under the supervision of an engineering geologist from Petra on January 21, 2019. Subsurface exploration involved the drilling of four (4) exploratory borings,

designated B-1 through B-4, to depths of 26.2 to 51.5 feet below existing site grade. Two additional borings, designated P-1 and P-2 and ranging in depth from 10 to 13 feet below the ground surface, were drilled for the purpose of conducting falling-head percolation tests to determine infiltration rates. Drilling was performed with a track-mounted drill rig equipped with 6-inch outside diameter, hollow-stem augers. Earth materials encountered within the exploratory borings were classified and logged in accordance with the visual-manual procedures of the Unified Soil Classification System (USCS). The approximate locations of the exploratory and percolation test borings are shown on the attached Geotechnical Map, Figure 2. Descriptive logs of the borings are presented in Appendix A.

Subsurface exploration also included the collection of bulk samples and relatively undisturbed samples of soil materials for classification, laboratory testing and geotechnical engineering analyses. Bulk samples consisted of selected soil materials obtained from the exploratory borings. Relatively undisturbed samples were obtained using a 3-inch outside diameter modified California split-spoon soil sampler lined with brass rings**.** The soil samples were mechanically driven to a depth of 18 inches with successive 30-inch drops of a 140-pound automatic trip hammer and the number of blows required to drive the sampler for each 6-inch increment inches are noted in the boring logs in Appendix A. The driven core samples were placed in sealed containers and transported to Petra's laboratory for laboratory testing.

Standard Penetration Tests (SPT) were also performed at selected depth intervals in accordance with ASTM D1586. This method consists of mechanically driving an unlined, 2.0-inch outside diameter (OD) standard penetrometer split-barrel sampler 18 inches into the soil with successive 30-inch drops of the 140-pound automatic trip hammer. Blow counts are also noted on the exploration logs. Disturbed soil samples from the unlined standard split-spoon samplers were placed in sealed plastic bags and transported to our laboratory for testing.

Laboratory Testing

Laboratory testing for selected samples of onsite soils materials included in-situ dry density and moisture content, maximum dry density and optimum moisture content, expansion index, consolidation potential, general soil corrosion potential (sulfate content, chloride content, pH/resistivity), and remolded shear strength. A description of laboratory test methods and laboratory testing are presented in Appendix B and the results of in-situ moisture content and dry density tests are summarized in the boring logs presented in Appendix A.

FINDINGS

Regional Geologic Setting

Geologically, the site lies within the northern portion of the Peninsular Ranges Geomorphic Province (CGS, 2002). The Peninsular Range Province extends from the tip of Baja California north to the Transverse Ranges Geomorphic Province and is characterized by northwest trending mountain ranges separated by subparallel fault zones. The San Bernardino Mountains, located on the north side of the valley, provides the boundary between the Peninsula Range Province and the Transverse Ranges Province. In general, the province is underlain primarily of plutonic rock of the Southern California Batholith. These rocks formed from the cooling of molten magma deep within the earth's crust. Intense heat associated with the plutonic magma metamorphosed the ancient sedimentary rocks into which the plutons intruded. The Peninsular Range Geomorphic Province is generally characterized by alluviated basins and elevated erosional surfaces.

Local Geology and Subsurface Soil Conditions

The geologic map of the Redlands quadrangle (Morton & Cox, 2003) depict the subject property sitting near the central portion of a localized old alluvial fan deposits of the late to middle Pleistocene era generally surrounded by very old axial valley deposits of the middle to early Pleistocene era. Bedrock belonging to the San Timeteo formation is located several miles to the south/southwest. A general description of the units are provided below.

Young Alluvial Fan Deposits (map symbol Qyf) – Young Alluvial Fan of Holocene age is present at the surface or beneath the topsoil across the vast majority of the site. The upper 10 feet of these soils generally consist of interbedded silty sand and sands with minor interbeds of clayey sands. These materials were generally medium dense and moist. Below depths of 15 feet we generally encountered more coarse-grained interbedded poorly-graded sands and sands with silt that were generally medium dense with occasional zones that were dense.

Old Alluvial Fan Deposits (map symbol Qof) – Old Alluvial Fan of the middle to late Pleistocene is present beneath the young alluvial fan deposits across the entire site. Generally, the soils consist of silty sands to sands with trace slightly clayey sands. The materials were generally dense to very dense and moist.

Groundwater

Groundwater was not encountered within our deep boring, drilled to a maximum depth of 51.5 feet below the ground surface (bgs). Recent groundwater levels are reported within a well approximately 6,000 feet to the northwest at approximately 199 feet bgs (California Department of Water Resources).

Based on our research within the nearby area, groundwater is not anticipated to affect the proposed development; however, as with any development, there is the possibility of localized perched water and minor seepage may occur in fill layers of differing permeability once site landscaping is installed and irrigation implemented.

Faulting

Based on our review of published and unpublished geotechnical maps and literature pertaining to site geology, no active or potentially active faults are known to project through the site and the site does not lie within the bounds of an "Earthquake Fault Zone" as defined by the State of California in the Alquist-Priolo (AP) Earthquake Fault Hazard Zoning Act (Bryant and Hart, 2007). In addition, the site does not lie with a fault zone established by the County of San Bernardino. Our review shows the closest known active earthquake fault is the San Andreas Fault zone which lies approximately 5.4 miles (8.6 km) to the northeast (San Bernardino County, 2010). The potential for active fault rupture at the site is considered to be very low.

Secondary Seismic Effects

Secondary effects of seismic activity normally considered as possible hazards to a site include several types of ground failure. Various general types of ground failures, which might occur as a consequence of severe ground shaking at the site, include ground subsidence, ground lurching and lateral spreading. The probability of occurrence of each type of ground failure depends on the severity of the earthquake, distance from faults, topography, subsoil and groundwater conditions, in addition to other factors. The subject property proposed for development exhibits level topography that is not prone to landsliding, and the potential for ground lurching and lateral spreading are considered very low. The potential for seismically-induced flooding due to tsunami or seiche (i.e., a wave-like oscillation of the surface of water in an enclosed basin) is considered negligible at this site.

Liquefaction and Seismically-Induced Settlement

Liquefaction occurs when dynamic loading of a saturated sand or silt causes pore-water pressures to increase to levels where grain-to-grain contact is lost and the material temporarily behaves as a viscous fluid. Liquefaction can cause settlement of the ground surface, settlement and tilting of engineered structures, flotation of buoyant buried structures and fissuring of the ground surface. A common manifestation of liquefaction is the formation of sand boils, which are short-lived fountains of soil and water that emerge from fissures or vents and leave freshly deposited conical mounds of sand or silt on the ground surface.

San Bernardino County has identified located the subject property area within a low liquefaction susceptibility zone. Based on the lack of shallow groundwater encountered and the medium dense to very dense nature of the older alluvial fan deposits, the potential for manifestation of liquefaction and for seismic (i.e., dynamic) settlement, in the form of dry sand settlement, are anticipated to be very low.

Compressible Soils

A geotechnical factor affecting the project site is the presence of shallow topsoil and unconsolidated, near-surface young alluvial fan deposits. Such materials in their present state are not considered suitable for support of fill or structural loads. Accordingly, these materials will require removal to competent alluvial deposits as observed by the geotechnical consultant and replacement as properly moisture-conditioned and compacted fill.

CONCLUSIONS AND RECOMMENDATIONS

Development Feasibility

Based on our preliminary field exploration, research and review of pertinent geologic literature, and preliminary laboratory testing, development of the project site is considered feasible for the proposed residential development from a geotechnical standpoint. The following geotechnical factors should be considered during the design process.

Seismic Shaking

The site is located within an active tectonic area of southern California with several significant faults capable of producing moderate to strong earthquakes. The site will likely be subjected to very strong seismically related ground shaking during the anticipated life span of the project and structures within the site should therefore be designed and constructed to resist the effects of strong ground motion in accordance with the most current edition of the California Building Code, i.e. anticipated to be the 2016 CBC.

Remedial Grading

Near-surface soils are loose and inconsistent due to their variable nature and are subject to static settlement due to dead and live loading conditions of structures and hydro-consolidation due to the introduction of water due to either the establishment of an irrigation system(s) or storm water control. Accordingly, remedial grading of the upper portions of the alluvial soils will be necessary for support of shallow foundations and engineered fills. In general, in all areas where structures are proposed, all existing

undocumented fill and near-surface compressible soils will need to be removed (over-excavated), to be placed as properly compacted fill.

Earthwork Recommendations

General Recommendations

Earthwork should be performed in accordance with the Grading Code of the City of Redlands, in addition to the applicable provisions of the 2016 CBC. Grading should also be performed in accordance with the following site-specific recommendations prepared by Petra based on the proposed construction.

Geotechnical Observations and Testing

Prior to the start of earthwork, a meeting should be held at the site with the owner, contractor and geotechnical consultant to discuss the work schedule and geotechnical aspects of the grading. Earthwork, which in this instance will generally entail removal and re-compaction of loose existing soils to expose competent natural soils, should be accomplished under full-time observation and testing of the geotechnical consultant. A representative of the project geotechnical consultant should be present onsite during all earthwork operations to document proper placement and compaction of fills, as well as to document compliance with the other recommendations presented herein.

Clearing and Grubbing

All existing trees and vegetation within areas to be graded should be stripped and removed from the site. Clearing operations should also include the removal of any remaining irrigation pipes, trash, debris, vegetation and similar deleterious materials. Any cavities or excavations created upon removal of any unknown subsurface structure(s) should be cleared of loose soil, shaped to provide access for backfilling and compaction equipment and then backfilled with properly compacted fill. Due to the presence of a grove, following removal of the tree root balls, any remaining roots may need to be removed by hand (i.e. root pickers), during grading operations.

The project geotechnical consultant should provide periodic observation and testing services during clearing and grubbing operations to document compliance with the above recommendations. In addition, should unusual or adverse soil conditions or buried structures be encountered during grading that are not described herein, these conditions should be brought to the immediate attention of the project geotechnical consultant for corrective recommendations.

Geotechnical Observations

Exposed bottom surfaces in remedial removal areas should be observed and approved by a representative of the project geotechnical consultant ***prior to the placement of fill***. A representative of the project geotechnical consultant should also be present on site during major grading operations to document that proper placement and adequate compaction of fills has been achieved, as well as to observe compliance with the other recommendations presented herein. It is the grading contractor's responsibility to notify the project geotechnical consultant at least 24 hours prior to requiring observation (including excavation bottom verification).

Unsuitable Soil Removals and Bottom Processing

Existing surficial undocumented fill and shallow native alluvial soils are considered unsuitable for support of proposed fills, structures, flatwork, pavement or other improvements and should be removed to underlying competent alluvial materials as approved by the project geotechnical consultant. The estimated depth of removal of alluvial soils is recommended to be approximately 3 feet below the existing ground surface in proposed building areas, but no less than 2 feet below the bottom-of-footings. Soil removals may need to be locally deeper depending upon the exposed conditions encountered during grading. Soil removals in street or landscaped areas are anticipated to be on the order of 2 feet below existing grade or proposed grade, whichever is deeper.

Prior to placing engineered fill, the exposed bottom surfaces in the removal areas should be approved by a representative of project geotechnical consultant. The exposed removal bottoms should be scarified to a minimum depth of 12 inches, moisture-conditioned to achieve at least 1 to 2 percent above optimum moisture content and compacted with a heavy construction equipment prior to placement of fill. Minimum compaction of the upper 12 inches of the removal bottom should meet or exceed 90 percent relative compaction with reference to ASTM D1557. The laboratory maximum dry density and optimum moisture content for each change in soil type should be determined in accordance with test method ASTM D1557.

Boundary Conditions

Average remedial removals within the building pad areas of the subject site are anticipated to be on the order of 3 feet below the existing ground surface. Temporary backcut slopes adjacent to the tract boundaries should generally be restricted to a slope ratio of 1:1 (h:v) or flatter to protect adjacent offsite improvements (including pavement, sidewalks, walls, etc.) along the property boundaries. Depending on the actual horizontal extent of remedial grading that is achievable by the grading contractor, it is likely that a wedge

of unsuitable soil will remain in place along the site perimeter that will extend into the site to a horizontal distance equal to as much as twice the depth of remedial removals. Since new perimeter wall improvements may be proposed within this zone, such improvements may need to be designed and constructed with deepened and/or strengthened foundation systems designed to withstand relative movement that is likely to result from settlement of these likely compressible surficial soils. The use temporary shoring or slot cut techniques along perimeter of the site may also be considered.

Suitability of On-Site Materials for Use as Engineered Fill

Based on our field observations and subsurface soil conditions encountered in our borings, the on-site soil materials would be suitable for use as engineered fill provided they are clean of construction debris or other deleterious materials. As with most remedial grading, the majority of soils exposed at or near the surface would require moisture-conditioning to near optimum moisture for use as engineered fill.

Excavation Characteristics

The existing site soils are expected to be readily excavated with conventional earthmoving equipment.

Fill Placement

Fill materials should be placed in approximately 6- to 8-inch thick loose lifts, watered or air-dried as necessary to achieve a moisture content of at least above optimum moisture condition, and then compacted in-place to a minimum relative compaction of no less than 90 percent. The laboratory maximum dry density and optimum moisture content for each change in soil type should be determined in accordance with ASTM D1557.

Temporary Excavations

Temporary excavations varying up to a height of 5± feet below existing grades may be required to accommodate the recommended over-excavation of existing soft/loose alluvial soils. Based on the physical properties of the onsite soils, temporary excavations which are constructed exceeding 4 feet in height should be cut back to a ratio of 1:1 (h:v) or flatter for the duration of the over-excavation of unsuitable soil material and replacement as compacted fill, as well as placement of underground utilities. The temporary excavations should be observed by a representative of the project geotechnical consultant for evidence of potential instability. Depending on the results of these observations, revised slope configurations may be necessary. Other factors which should be considered with respect to the stability of the temporary slopes include construction traffic and/or storage of materials on or near the tops of the slopes, construction

scheduling, presence of nearby walls or structures on adjacent properties and weather conditions at the time of construction. Applicable requirements of the California Construction and General Industry Safety Orders, the Occupational Safety and Health act of 1970 and the Construction Safety Act should also be followed.

Import Soils for Grading

If import soils are needed to achieve final design grades the soils should be free of deleterious materials, oversize rock and any hazardous materials. The soils should also be non-expansive and essentially non-corrosive and approved by the project geotechnical consultant *prior* to being brought onsite. The geotechnical consultant should visit the potential borrow site and conduct testing of the soil at least three days before the commencement of import operations.

Volumetric Changes - Shrinkage and Subsidence

Volumetric changes in earth quantities will occur when onsite soils are excavated and replaced as properly compacted fill. Based on in-place densities of earth materials encountered during our evaluation, a shrinkage factor on the order of 15± percent may be anticipated during removal and recompaction. The actual shrinkage that will occur during grading will depend on the average degree of relative compaction achieved. A maximum subsidence of approximately 0.10 to 0.20 feet may be anticipated as a result of the scarification and recompaction of the exposed bottom surfaces within the removal areas.

The above estimates of shrinkage and subsidence are intended for use by project planners in estimating earthwork quantities and should not be considered absolute values. Contingencies should be made for balancing earthwork quantities based on actual shrinkage and subsidence that will occur during site grading.

Preliminary Foundation Design Considerations

Expansive Soil Conditions

Preliminary laboratory testing indicates that the soils in the upper 5 feet possess a very low expansion potential, classifying the material as non-expansive.

Foundation System

In view of the anticipated post-grading soil conditions and the proposed development, Petra recommends using conventional slab-on-ground foundations for the proposed residential structures, however this should be confirmed with additional sampling and testing of near surface pad soils during site grading.

Allowable Soil Bearing Capacity

A basic allowable soil bearing capacity of 1,500 pounds per square foot, including dead and live loads, may be utilized for design of 24-inch square pad footing and 12-inch-wide continuous footings founded at a minimum depth of 12 inches below the lowest adjacent final grade. This value may be increased by 20 percent for each additional foot of depth and by 10 percent for each additional foot of width to a maximum value of 2,500 pounds per square foot. Recommended allowable bearing values include both dead and live loads, and may be increased by one-third for short duration wind and seismic forces.

Footing Settlement

Based on the allowable bearing values provided above, total settlement of the footings is anticipated to be less than 1 inch. Differential settlement is expected to be less than 0.5 inch over a horizontal span of 40 feet. The majority of settlement is likely to take place as footing loads are applied or shortly thereafter.

Lateral Resistance

A passive earth pressure of 250 pounds per square foot per foot of depth, to a maximum value of 2,500 pounds per square foot, may be used to determine lateral bearing resistance for footings. In addition, a coefficient of friction of 0.30 times the dead load forces may be used between concrete and the supporting soils to determine lateral sliding resistance. The above values may be increased by one-third when designing for transient wind or seismic forces. It should be noted that the above values are based on the condition where footings are cast in direct contact with compacted fill or competent native soils. In cases where the footing sides are formed, all backfill placed against the footings upon removal of forms should be compacted to at least 90 percent of the applicable maximum dry density.

Slab-on-Ground Design and Construction Considerations

The results of our preliminary laboratory test performed on one representative sample of near-surface soils within the site indicate that these material exhibit expansion potentials that are within the Very Low range (Expansion Index from 0 to 20). As such, the design of slabs-on-grade is considered to be non-expansive and exempt from the procedures outlined in Sections 1803.5.3 and 1808.6.2 of the 2016 CBC and may be performed using any method deemed rational and appropriate by the project structural engineer. However, the following minimum recommendations are presented herein for conditions where the project design team may require geotechnical engineering guidelines for design and construction of footings and slabs on-grade the project site.

The design and construction recommendations that follow are based on the above soil conditions and may be considered for reducing the effects of variability in composition and behavior within the site soils and long-term differential settlement. These recommendations have been developed on the basis of the previous experience of this firm on projects with similar soil conditions. Although construction performed in accordance with these recommendations has been found to reduce post-construction movement and/or distress, they generally do not positively eliminate all potential effects of variability in soils characteristics and future settlement.

It should also be noted that the recommendations for reinforcement provided herein are performance-based and intended only as guidelines to achieve adequate performance under the anticipated soil conditions. The project structural engineer, architect and/or civil engineer should make appropriate adjustments to reinforcement type, size and spacing to account for internal concrete forces (e.g., thermal, shrinkage and expansion), as well as external forces (e.g., applied loads) as deemed necessary. Consideration should also be given to minimum design criteria as dictated by local building code requirements.

Conventional Slabs-on-Ground

Given the very low expansion potential exhibited by onsite soils, we recommend that footings and floor slabs be designed and constructed in accordance with the following minimum criteria.

Footings

1. Exterior continuous footings supporting one- and two-story structures should be founded at a minimum depth of 12 inches below the lowest adjacent final grade, respectively. Interior continuous footings may be founded at a minimum depth of 10 inches below the top of the adjacent finish floor slabs.

2. In accordance with Table 1809.7 of 2016 CBC for light-frame construction, all continuous footings should have minimum widths of 12 inches for one- and two-story construction. We recommend all continuous footings should be reinforced with a minimum of two No. 4 bars, one top and one bottom.

3. A minimum 12-inch-wide grade beam founded at the same depth as adjacent footings should be provided across garage entrances or similar openings (such as large doors or bay windows). The grade beam should be reinforced with a similar manner as provided above.

4. Interior isolated pad footings, if required, should be a minimum of 24 inches square and founded at a minimum depth of 12 inches below the bottoms of the adjacent floor slabs for one- and two-story buildings. Pad footings should be reinforced with No. 4 bars spaced a maximum of 18 inches on centers, both ways, placed near the bottoms of the footings.

5. Exterior isolated pad footings intended for support of roof overhangs such as second-story decks, patio covers and similar construction should be a minimum of 24 inches square and founded at a minimum depth of 18 inches below the lowest adjacent final grade. The pad footings should be reinforced with No. 4 bars spaced a maximum of 18 inches on centers, both ways, placed near the bottoms of the footings. Exterior isolated pad footings may need to be connected to adjacent pad and/or continuous footings via tie beams at the discretion of the project structural engineer.

6. The minimum footing dimensions and reinforcement recommended herein may be modified (increased or decreased subject to the constraints of Chapter 18 of the 2016 CBC) by the structural engineer responsible for foundation design based on his/her calculations, engineering experience and judgment.

Building Floor Slabs

1. Concrete floor slabs should be a minimum 4 inches thick and reinforced with No. 3 bars spaced a maximum of 24 inches on centers, both ways. Alternatively, the structural engineer may recommend the use of prefabricated welded wire mesh for slab reinforcement. For this condition, the welded wire mesh should be of sheet type (not rolled) and should consist of 6x6/W2.9xW2.9 WWF (per the Wire Reinforcement Institute, WRI, designation) or stronger. All slab reinforcement should be supported on concrete chairs or brick to ensure the desired placement near mid-depth. Care should be exercised to prevent warping of the welded wire mesh between the chairs in order to ensure its placement at the desired mid-slab position.

   Slab dimension, reinforcement type, size and spacing need to account for internal concrete forces (e.g., thermal, shrinkage and expansion) as well as external forces (e.g., applied loads), as deemed necessary.

2. Living area concrete floor slabs and areas to receive moisture sensitive floor covering should be underlain with a moisture vapor retarder consisting of a minimum 10-mil-thick polyethylene or polyolefin membrane that meets the minimum requirements of ASTM E96 and ASTM E1745 for vapor retarders (such as Husky Yellow Guard®, Stego® Wrap, or equivalent). All laps within the membrane should be sealed, and at least 2 inches of clean sand should be placed over the membrane to promote uniform curing of the concrete. To reduce the potential for punctures, the membrane should be placed on a pad surface that has been graded smooth without any sharp protrusions. If a smooth surface cannot be achieved by grading, consideration should be given to lowering the pad finished grade an additional inch and then placing a 1-inch-thick leveling course of sand across the pad surface prior to the placement of the membrane.

   At the present time, some slab designers, geotechnical professionals and concrete experts view the sand layer below the slab (blotting sand) as a place for entrapment of excess moisture that could adversely impact moisture-sensitive floor coverings. As a preventive measure, the potential for moisture intrusion into the concrete slab could be reduced if the concrete is placed directly on the vapor retarder. However, if this sand layer is omitted, appropriate curing methods must be implemented to ensure that the concrete slab cures uniformly. A qualified materials engineer with experience in slab design and construction should provide recommendations for alternative methods of curing and supervise the construction process to ensure uniform slab curing. Additional steps would also need to be taken to prevent puncturing of the vapor retarder during concrete placement.

3. Garage floor slabs should be a minimum 4 inches thick and reinforced in a similar manner as living area floor slabs. Garage slabs should also be poured separately from adjacent wall footings with a positive separation maintained using ¾-inch-minimum felt expansion joint material. To control the propagation of shrinkage cracks, garage floor slabs should be quartered with weakened plane joints. Consideration should be given to placement of a moisture vapor retarder below the garage slab, similar to that provided in Item 2 above, should the garage slab be overlain with moisture sensitive floor covering.

4. Presaturation of the subgrade below floor slabs will not be required; however, prior to placing concrete, the subgrade below all dwelling and garage floor slab areas should be thoroughly moistened to achieve a moisture content that is at least equal to or slightly greater than optimum moisture content. This moisture content should penetrate to a minimum depth of 12 inches below the bottoms of the slabs.

5. The minimum dimensions and reinforcement recommended herein for building floor slabs may be modified (increased or decreased subject to the constraints of Chapter 18 of the 2016 CBC) by the structural engineer responsible for foundation design based on his/her calculations, engineering experience and judgment.

Soil Corrosivity

As a screening level study, limited chemical and electrical tests were performed on one representative sample of onsite soils to identify potential corrosive characteristics of these soils. Additional sampling and testing of finish pad grades soils is recommended during future site grading. The following sections present the test results and an interpretation of current codes and guidelines that are commonly used in our industry as they relate to the adverse impact of chemical contents of the site soils and their associated moisture on various components of the proposed structures in contact with site soils.

A variety of test methods are available to quantify corrosive potential of soils for various elements of construction materials. Depending on the test procedures adopted, characteristics of the leachate that is used to extract the target chemicals from the soils and the test equipment; the results can vary appreciably for different test methods in addition to those caused by variability in soil composition. The testing procedures referred to herein are considered to be typical for our industry and have been adopted and/or approved by many public or private agencies. In drawing conclusions from the results of our chemical and electrical laboratory testing and providing mitigation recommendation to reduce the detrimental impact of corrosive site soils on various components of the structure in contact with site soils, heavy references were made to 2016 CBC and American Concrete Institute, 2011 Structural Concrete Building Code (ACI 318-11). Where relevant information was not available in these codes, references were made to guidelines developed by California Department of Transportation (Caltrans), mainly because their risk tolerance for highway bridges are considered comparable to those for residential or commercial structures

and that Post Tensioning Institute (PTI), in part, accepts and uses Caltrans' relevant corrosivity criteria for post-tensioned slabs on-grade.

It should be noted that Petra does not practice corrosion engineering; therefore, these preliminary test result and our opinion and engineering judgment provided herein should be considered as general guidelines only. Additional analyses would be warranted, especially, for cases where buried metallic building materials (such as copper and cast or ductile iron) in contact with site soils are planned for the project. In many cases, the project geotechnical engineer is not informed of these choices. Therefore, for conditions where such elements are considered, we recommend that the project design professionals (i.e., the architect and/or structural engineer) consider recommending a qualified corrosion engineer to conduct additional sampling and testing of near-surface soils during the final stages of site grading to provide a complete assessment of soil corrosivity. Recommendations to mitigate the detrimental effects of corrosive soils on buried metallic and other building materials that may be exposed to corrosive soils should be provided by the corrosion engineer as deemed appropriate.

Concrete in Contact with Site Soils

Soils containing soluble sulfates beyond certain threshold levels, as well as acidic soils are considered to be detrimental to long-term integrity of concrete placed in contact with such soils. For the purpose of this study, soluble sulfates (SO_4) concentration in soils determined in accordance with California Test Method No. 417. Soil acidity, as indicated by hydrogen-ion concentration (pH), was determined in accordance with California Test Method No. 643.

The results of our limited in-house laboratory tests indicate that on-site soils contain a water-soluble sulfate content *0.01 percent by weight*. Based on Article 1904.1 of Section 1904 of the 2016 CBC, concrete that will be exposed to sulfates in site soil should be assigned exposure classes in accordance with the durability requirements of ACI 318. Based on the test results and in reference to Table 4.2.1 of ACI 318-11, an exposure class of **S0** is appropriate for onsite soils. Accordingly, a severity level of **Not Applicable** for exposure to sulfate may be expected for concrete placed in contact with the onsite soil materials. As such, Table 4.3.1 of ACI 318-11 provides that no restriction for cement type or maximum water-cement ratio for the fresh concrete would be required. However, this table indicates that the concrete minimum unconfined compressive strength should not be less than 2,500 psi.

Further, the results of limited in-house testing of a representative sample indicate that soils within the subject site are alkaline with respect to pH (a *pH of 7.3*). Based on this finding and according to Section

8.22.2 of Caltrans' 2003 Bridge Design Specifications (2003 BDS) requirements (which consider the combined effects of soluble sulfates and soil pH), a commercially available Type II Modified cement may be used.

The preliminary guidelines provided herein should be evaluated and confirmed, or modified, in its entirety by the project structural engineer and the contractor responsible for concrete placement for concrete used in exterior and interior footings, interior slabs on-ground, garage slabs walls foundation and concrete exposed to weather such as driveways, patios, porches, walkways, ramps, steps, curbs, etc.

Metals Encased in Concrete

Soils containing a soluble chloride concentration beyond a certain threshold level are considered corrosive to metallic elements such as reinforcement bars, tendons, cables, bolts, etc. that are encased in concrete that, in turn, is in contact with such soils. For the purpose of this study, soluble chlorides (Cl) in soils were determined in accordance with California Test Method No. 422.

Based on Article 1904.1 of Section 1904 of the 2016 CBC, concrete that will be exposed to chlorides from "*deicing chemicals, salt, saltwater, brackish water, seawater or spray from these sources, where concrete has steel reinforcement*" should be assigned exposure classes in accordance with the durability requirements of ACI 318. According to Table 4.2.1 of ACI 318-11, an exposure class of **C0** with a severity designation of **Not Applicable** is appropriate for reinforced concrete that remains dry or protected from moisture. Similarly, an exposure class of **C1** with a severity designation of **Moderate** is appropriate for reinforced concrete that is exposed to moisture but not to external sources of chlorides. And, lastly, an exposure class of **C2** with a severity designation of **Severe** is appropriate for reinforced concrete that is exposed to moisture and external sources of chlorides as enumerated above.

Based on our understanding of the project, it is our professional opinion that an exposure class of **C1** with a severity designation of **Moderate** is appropriate for a majority of reinforced concrete, to be placed at the site, that are in contact with site soils. It should be noted, however, that an exposure class of **C2** with a severity designation of **Severe** is more appropriate for reinforced concrete that is planned for pool walls and decking.

The results of our limited laboratory tests performed indicate that onsite soils contain a water-soluble chloride concentration of *420 milligrams per Liter (mg/L) or parts per million (ppm)*. Article 1904.2 of Section 1904 of the 2016 CBC requires that concrete mixtures conform to the most restrictive maximum water-cementitious material ratios, maximum cementitious admixture, minimum air-entrainment and

minimum specified concrete compressive strength requirements of ACI 318 based on the exposure classes assigned in Article 1904.1. No maximum water/cement ratio for the fresh concrete is prescribed by ACI 318 for class **C1** (or **Moderate** severity) exposure condition. However, Table 4.3.1 of ACI 318-11indicates that concrete minimum unconfined compressive strength, f'_c, should not be less than 2,500 psi. For class **C2** (or **Severe**) exposure condition, Table 4.3.1 of ACI 318-11requires that the maximum water/cement ratio of the fresh concrete should not exceed 0.40 and concrete minimum unconfined compressive strength, f'_c, should not be less than 5,000 psi.

It should be noted that another source of elevated chloride-ion concentration can be the chloride content of water that is used to prepare the fresh concrete at the plant. The protection against high chloride concentration in fresh concrete should therefore be provided by concrete suppliers for the project in accordance with Table 4.3.1 of ACI 318-11.

The guidelines provided herein should be evaluated and confirmed, or modified, in its entirety by the project structural engineer for reinforced concrete placement for concrete used in exterior and interior footings, interior slabs on-ground, garage slabs walls foundation and concrete exposed to weather such as driveways, patios, porches, walkways, ramps, steps, curbs, etc.

Metallic Elements in Contact with Site Soils

Elevated concentrations of soluble salts in soils tend to induce low level electrical currents in metallic objects in contact with such soils. This process promotes metal corrosion and can lead to distress to building metallic components that are in contact with site soils. The minimum electrical resistivity indicates the relative concentration of soluble salts in the soil and, therefore, can be used to estimate soil corrosivity with regard to metals. For the purpose of this evaluation, the minimum resistivity in soils is measured in accordance with California Test Method No. 643.

The minimum electrical resistivity for onsite soils was found to be *4,800 ohm-cm* based on limited testing. This indicates that on-site soils may be **Corrosive** to ferrous metals and copper. As such, any ferrous metal or copper components of the subject buildings (such as cast iron or ductile iron piping, copper tubing, etc.) that are expected to be placed in direct contact with site soils should be protected against detrimental effects of moderately corrosive soils. Such protection could include the use of galvanized tubing or coated pipes or wrapping or encasing these metallic objects in special protection wrappings or conduits, respectively. Should such elements be considered for buildings or site improvements, we recommend that a corrosion engineer to be consulted to provide appropriate recommendations for long term protection of metallic elements in contact with site soils.

Preliminary Infiltration Rates

Shallow Infiltration Test Results

Falling head percolation tests were performed at two locations within the subject site to evaluate the infiltration rate of native alluvial soils at depths between 5 to 10 and 8 to 13 feet below existing grades. The borings for the percolation tests were drilled with a hollow-stem auger drill rig and the soils encountered in test borings consisted of interbedded loose to medium dense, silty fine- to medium-grained sand. The percolation tests were conducted in the lower 5± feet of the boreholes and the un-factored test results are summarized in Table 1. In view of the test data, the shallow subsurface native alluvium soils had very low test results (0.05 to 0.15 in./hr.) suggesting the site is relatively impermeable. Appendix C contains the field percolation test data sheets and conversion into the calculated infiltration rates.

TABLE 1

Test No.	Approximate Test Location	Test Zone Depth (ft)	Infiltration Rate, I_t (in./hr.)
P-1	North site corner (see Figure 2)	8-13	0.05
P-2	South site corner (see Figure 2)	5-10	0.15

Post-Grading Considerations

Utility Trenches

All utility trench backfill should be compacted to a minimum relative compaction of 90 percent. Trench backfill materials should be free of oversize rock and placed in lifts no greater than approximately 12 inches in thickness, watered or air-dried as necessary to achieve near optimum moisture conditions, and then mechanically compacted in place to a minimum relative compaction of 90 percent. A representative of the project geotechnical consultant should probe and test the backfills to verify adequate compaction.

As an alternative for shallow trenches where pipe or utility lines may be damaged by mechanical compaction equipment, such as under building floor slabs, clean sand having a sand equivalent (SE) value of 30 or greater may be utilized. The sand backfill materials should be watered to achieve near optimum moisture conditions and then tamped into place. No specific relative compaction will be required; however, observation, probing, and if deemed necessary, testing should be performed by a representative of the project geotechnical consultant to verify an adequate degree of compaction.

If clean, imported sand is to be used for backfill of exterior utility trenches, it is recommended that the upper 12 inches of trench backfill materials consist of properly compacted onsite soil materials. This is to mitigate infiltration of irrigation and rainwater into granular trench backfill materials.

Where an exterior and/or interior utility trench is proposed in a direction parallel to a building footing, the bottom of the trench should not extend below a 1:1 (horizontal to vertical) plane projected downward from the bottom edge of the adjacent footing. Where this condition occurs, the adjacent footing should be deepened or the utility constructed and the trench backfilled and compacted prior to footing construction. Where utility trenches cross under a building footing, these trenches should be backfilled with on-site soils at the point where the trench crosses under the footing to reduce the potential for water to migrate under the floor slabs.

Site Drainage

Positive surface drainage systems consisting of a combination of sloped concrete flatwork/asphalt pavement, sheet flow gradients, swales and surface area drains (where needed) should be provided around the building and within the planter areas to collect and direct all surface waters to an appropriate drainage facility as determined by the project civil engineer. The ground surfaces of planter and landscape areas that are located within 10 feet of building foundations should be sloped at a minimum gradient of 5 percent away from the foundations and towards the nearest area drains. The ground surface of planter and landscape areas that are located more than 10 feet away from building foundations may be sloped at a minimum gradient of 2 percent away from the foundations and towards the nearest area drains.

Concrete flatwork surfaces that are located within 10 feet of building foundations should be inclined at a minimum gradient of one percent away from the building foundations and towards the nearest area drains. Concrete flatwork surfaces that are located more than 10 feet away from building foundations may be sloped at a minimum gradient of 1 percent towards the nearest area drains. Surface waters should not be allowed to collect or pond against building foundations and within the level areas of the site. All drainage devices should be properly maintained throughout the lifetime of the development. Future changes to site improvements, or planting and watering practices, should not be allowed to cause over-saturation of site soils adjacent to the structures.

Tentative Pavement Design Recommendations

The final pavement section should be designed once rough grading has occurred and the R-Value of the resulting subgrade can be determined. For the purposes of this preliminary evaluation, we utilized an

assumed R-value of 50 and Traffic Indices (TI) of 5.0 and 5.5 for the interior streets and cul-de-sac. The following pavement sections have been computed in accordance with Caltrans design procedures and presented in the following table, Table 2.

TABLE 2

Preliminary Structural Pavement Section

Location	Design R-value	Traffic Index	Pavement Section
Streets 'A' and 'B'	50	5.5	3 in. AC / 4 in. AB
Cul-de-Sac	50	5.0	3 in. AC / 4 in. AB

Notes: AC = Asphalt Concrete AB = Aggregate Base

Final pavement design recommendations should be provided based on sampling and testing at the completion of rough grading and the values of traffic indices that should be provided by the project civil engineer. The project civil engineer should confirm with the City before specifying any pavement section that may be less than the presumed minimum. Subgrade soils should be properly compacted, smooth, and non-yielding prior to pavement construction. The upper 12 inches of subgrade soils should be compacted to no less than 95 percent relative compaction with reference to ASTM D1557.

Aggregate base materials in paved areas should be Crushed Aggregate Base, Crushed Miscellaneous Base, or Processed Miscellaneous Base conforming to Section 200-2 of the Standard Specifications for Public Works Construction (Greenbook). The base materials should be brought to uniform moisture near optimum moisture then compacted to at least 95 percent of the applicable maximum density standard as determined per ASTM D1557. Asphaltic concrete materials, where utilized, and construction should conform to Section 203 of the Greenbook.

GRADING PLAN REVIEW

This report is based on the information provided to us by the client as well as the tentative Study Map - Alternative E by Hicks and Hardwick, Inc. We recommend that our firm be retained to review the finalized grading plan when they become available. Additional recommendations and/or modification of the recommendations provided herein will be provided if necessary depending on the results of the grading plan review.

If additional or alternative improvements are considered in the future, our firm should be notified so that we may provide design recommendations. It is further recommended that we be engaged to review the final

design drawings, specifications and grading plan prior to any new construction. If we are not provided the opportunity to review these documents with respect to the geotechnical aspects of new construction and grading, it should not be assumed that the recommendations provided herein are wholly or in part applicable to the proposed construction.

REPORT LIMITATIONS

This report is based on the project site, as we understand, and our preliminary subsurface exploration and geotechnical laboratory testing and analysis. The materials encountered on the project site and utilized in our laboratory evaluation are believed representative of the total area; however, soil materials and conditions can vary in characteristics between excavations, both laterally and vertically.

The conclusions and opinions contained in this report are based on the results of the described geotechnical evaluations and represent our professional judgment. This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and in the same time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes. In addition, this report should be reviewed and updated after a period of 1 year or if the site ownership or project concept changes from that described herein.

It has been a pleasure to be of service to you on this project. Should you have questions regarding the contents of this report or should you require additional information, please contact this office.

Respectfully submitted,

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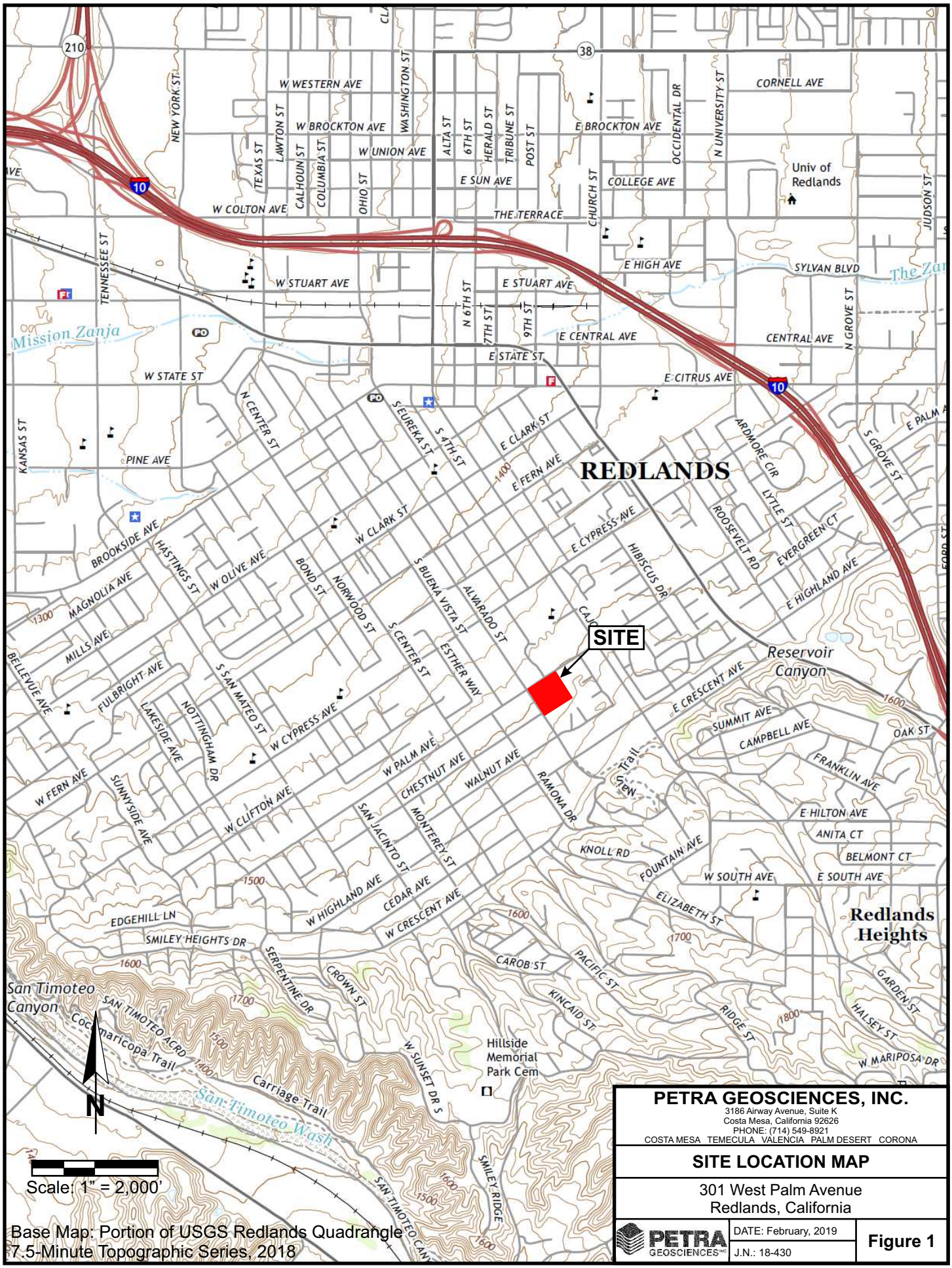
FIGURES



Base Map: Portion of USGS Redlands Quadrangle
7.5-Minute Topographic Series, 2018

PETRA GEOSCIENCES, INC.
3186 Airway Avenue, Suite K
Costa Mesa, California 92626
PHONE: (714) 549-8921
COSTA MESA TEMECULA VALENCIA PALM DESERT CORONA

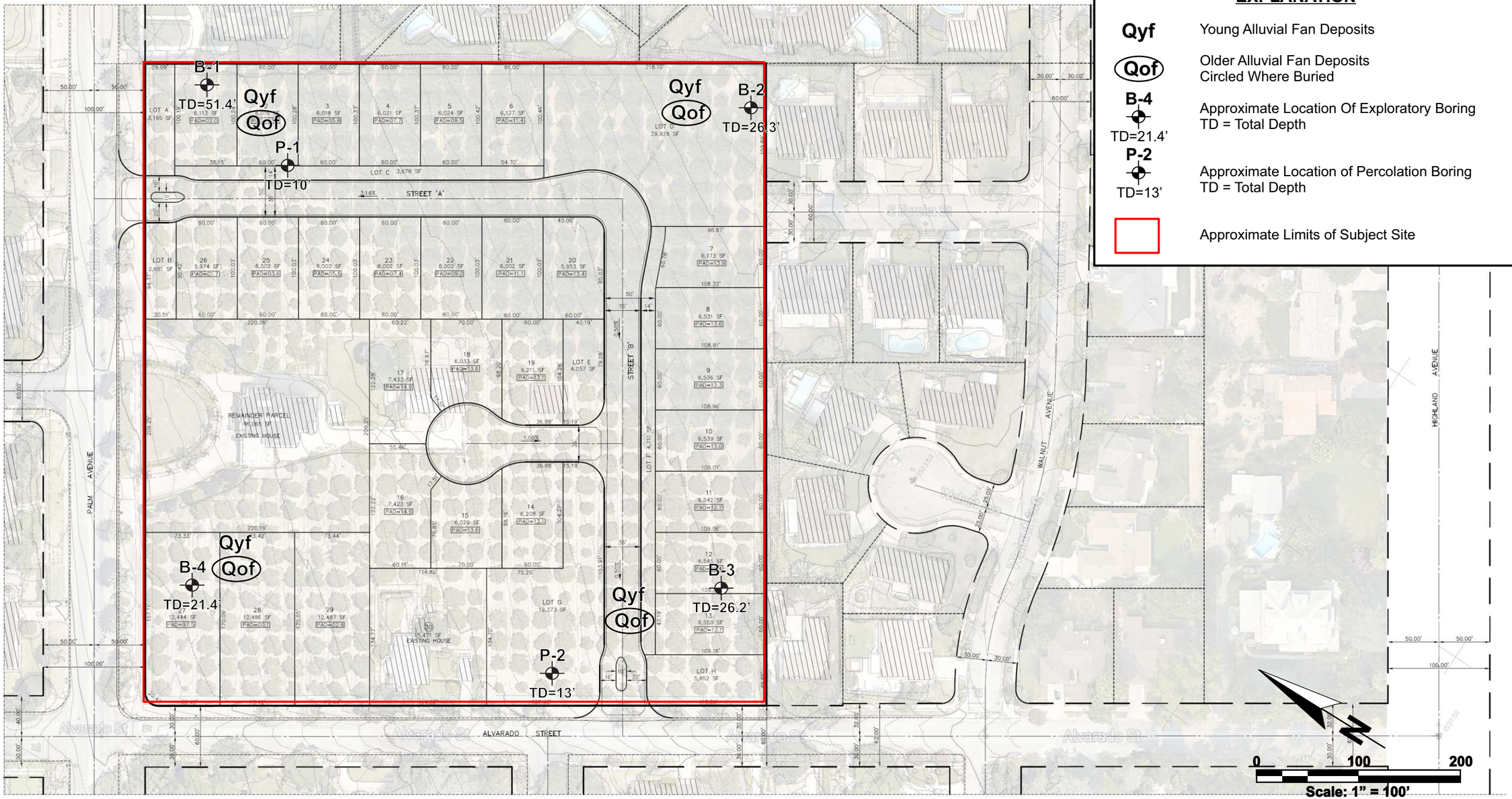
SITE LOCATION MAP

301 West Palm Avenue
Redlands, California

PETRA GEOSCIENCES

DATE: February, 2019
J.N.: 18-430

Figure 1



EXPLANATION

Qyf	Young Alluvial Fan Deposits
Qof	Older Alluvial Fan Deposits Circled Where Buried
B-4 TD=21.4'	Approximate Location Of Exploratory Boring TD = Total Depth
P-2 TD=13'	Approximate Location of Percolation Boring TD = Total Depth
	Approximate Limits of Subject Site

Base Map Reference: =Hicks & HArdwick Inc. 2018, Study Map - Alternative E, APN 0173-231-05 (301 West Palm Avenue), dated November 31.

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GEOTECHNICAL MAP

301 West Palm Avenue
Redlands, California

DATE: February, 2019
J.N.: 18-430

Figure 2

APPENDIX A

FIELD EXPLORATION LOGS (BORINGS)

Key to Soil and Bedrock Symbols and Terms

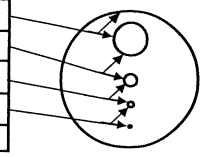
PETRA

Unified Soil Classification System

Coarse-grained Soils > 1/2 of materials is larger than #200 sieve	The No. 200 U.S. Standard Sieve is about the smallest particle visible to the naked eye	**GRAVELS** more than half of coarse fraction is larger than #4 sieve	Clean Gravels (less than 5% fines)	**GW**	Well-graded gravels, gravel-sand mixtures, little or no fines
				GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
			Gravels with fines	**GM**	Silty Gravels, poorly-graded gravel-sand-silt mixtures
				GC	Clayey Gravels, poorly-graded gravel-sand-clay mixtures
		SANDS more than half of coarse fraction is smaller than #4 sieve	Clean Sands (less than 5% fines)	**SW**	Well-graded sands, gravelly sands, little or no fines
				SP	Poorly-graded sands, gravelly sands, little or no fines
			Sands with fines	**SM**	Silty Sands, poorly-graded sand-gravel-silt mixtures
				SC	Clayey Sands, poorly-graded sand-gravel-clay mixtures
Fine-grained Soils > 1/2 of materials is smaller than #200 sieve		**SILTS & CLAYS** Liquid Limit Less Than 50		**ML**	Inorganic silts & very fine sands, silty or clayey fine sands, clayey silts with slight plasticity
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
				OL	Organic silts & clays of low plasticity
		SILTS & CLAYS Liquid Limit Greater Than 50		**MH**	Inorganic silts, micaceous or diatomaceous fine sand or silt
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic silts and clays of medium-to-high plasticity
Highly Organic Soils				**PT**	Peat, humus swamp soils with high organic content

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		>12"	>12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19"	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock salt-sized
	fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized to
Fines		Passing #200	<0.0029"	Flour-sized and smaller



Laboratory Test Abbreviations

MAX	Maximum Dry Density	MA	Mechanical (Particle Size) Analysis
EXP	Expansion Potential	AT	Atterberg Limits
SO4	Soluble Sulfate Content	#200	#200 Screen Wash
RES	Resistivity	DSU	Direct Shear (Undisturbed Sample)
pH	Acidity	DSR	Direct Shear (Remolded Sample)
CON	Consolidation	HYD	Hydrometer Analysis
SW	Swell	SE	Sand Equivalent
CL	Chloride Content	OC	Organic Content
RV	R-Value	COMP	Mortar Cylinder Compression

Modifiers

Trace	< 1 %
Few	1 - 5%
Some	5 - 12 %
Numerous	12 - 20 %

Sampler and Symbol Descriptions

- Approximate Depth of Seepage
- Approximate Depth of Standing Groundwater
- Modified California Split Spoon Sample
- Standard Penetration Test
- Bulk Sample
- Shelby Tube
- No Recovery in Sampler

Bedrock Hardness

Soft	Can be crushed and granulated by hand; "soil like" and structureless
Moderately Hard	Can be grooved with fingernails; gouged easily with butter knife; crumbles under light hammer blows
Hard	Cannot break by hand; can be grooved with a sharp knife; breaks with a moderate hammer blow
Very Hard	Sharp knife leaves scratch; chips with repeated hammer blows

Notes:

Blows Per Foot: Number of blows required to advance sampler 1 foot (unless a lesser distance is specified). Samplers in general were driven into the soil or bedrock at the bottom of the hole with a standard (140 lb.) hammer dropping a standard 30 inches unless noted otherwise in Log Notes. Drive samples collected in bucket auger borings may be obtained by dropping non-standard weight from variable heights. When a SPT sampler is used the blow count conforms to ASTM D-1586

EXPLORATION LOG

Project:	**301 West Palm Avenue**		Boring No.: **P-1**
Location:	**Redlands**		Elevation: **±1516'**
Job No.:	**18-430**	Client: **Diversified Pacific**	Date: **1/21/19**
Drill Method:	**6" Hollow Stem Auger**	Driving Weight: **140lbs/30"**	Logged By: **KTM**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		**TOPSOIL** Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.							
		ALLUVIAL FAN DEPOSITS (Qal) Silty Sand (SM): Reddish-brown, moist, medium-dense, fine- to medium-grained sand.							
5									
10									
		Total Depth= 13' No groundwater encountered Percolation pipe placed in boring with gravel Presoak started at 8:20 AM.							
15									
20									
25									
30									

PLATE A-1

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**301 West Palm Avenue**		Boring No.: **P-2**
Location:	**Redlands**		Elevation: **±1514'**
Job No.:	**18-430**	Client: **Diversified Pacific**	Date: **1/21/19**
Drill Method:	**6" Hollow Stem Auger**	Driving Weight: **140lbs/30"**	Logged By: **KTM**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		**TOPSOIL** Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.							
		ALLUVIAL FAN DEPOSITS (Qal) Silty Sand (SM): Reddish-brown, moise, medium-dense, fine- to medium-grained sand.							
5									
10		Total Depth= 10' No groundwater encountered Percolation pipe placed in boring with gravel Presoak started at 9:00 AM.							
15									
20									
25									
30									

PLATE A-2

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**301 West Palm Avenue**		Boring No.: **B-1**
Location:	**Redlands**		Elevation: **±1510'**
Job No.:	**18-430**	Client: **Diversified Pacific**	Date: **1/21/19**
Drill Method:	**6" Hollow Stem Auger**	Driving Weight:	Logged By: **KTM**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		**TOPSOIL** Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.							
		YOUNG ALLUVIAL FAN DEPOSITS (Qyf) Silty Sand (SM): Reddish-brown, moist, medium-dense, fine- to medium-grained sand.		4 7 12	■	■	12.3	123.4	MAX, EI, DSR
		Same as above.							
5		Same as above with trace coarse-grained sand.		13 14 20	■	■	11.1	120.8	
		Becomes fine- to coarse-grained.		10 16 22	■		10.3	117.8	
		Same as above with trace roots.		10 9 13	■		6.8	109.8	
10		Same as above with trace clay.		6 9 9	■		12.7	117.1	
15		**OLD ALLUVIAL FAN DEPOSITS (Qof)** Sand with Silt (SP): Reddish-brown, moist, dense, fine- to coarse-grained sand, poorly graded.		20 36 50	■		8.0	126.2	
20		Same as above.		13 18 27	■		6.6	107.2	
25		Same as above except very dense.		16 29 39	◪		9.4		
30		Same as above except with trace silt and very dense.		28 50	■		8.2	113.7	

PLATE A-3

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**301 West Palm Avenue**		Boring No.: **B-1**
Location:	**Redlands**		Elevation: **±1510'**
Job No.:	**18-430**	Client: **Diversified Pacific**	Date: **1/21/19**
Drill Method:	**6" Hollow Stem Auger**	Driving Weight:	Logged By: **KTM**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
35		Silty Sand (SM): Reddish-brown, moist, dense, fine- to coarse-grained.		15 17 22			11.6		
40		Becomes orangish-brown and very dense.		28 42 50			8.2	124.9	
45		Same as above.		19 34 37			8.3		
50		Sand (SP): Olive brown, moist, very dense, fine- to medium-grained, trace quartz crystals.		24 44 50			13.1	110.2	
		Total Depth= 51' 5" No groundwater encountered Boring backfilled with cuttings and tamped.							
55									
60									
65									

PLATE A-3

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**301 West Palm Avenue**		Boring No.: **B-2**
Location:	**Redlands**		Elevation: **±1531'**
Job No.:	**18-430**	Client: **Diversified Pacific**	Date: **1/21/19**
Drill Method:	**6" Hollow Stem Auger**	Driving Weight:	Logged By: **KTM**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		**TOPSOIL** Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.							
		YOUNG ALLUVIAL FAN DEPOSITS (Qyf) Silty Sand (SM): Dark reddish-brown, very moist, medium-dense, fine- to medium-grained sand. Same as above.		1 4 6	■		13.9	117.0	
		Becomes reddish-brown, moist, fine- to coarse-grained, with trace clay.		6 9 12	■		13.3	118.0	
5		Same as above.		6 11 11	■		12.9	118.5	
		Sand (SP): Reddish-brown, moist, medium-dense, fine- to medium-grained sand, poorly graded.		4 8 11	■		9.0	107.9	
10		Becomes fine- to coarse-grained sand.		6 12 16	■		6.5	109.6	
15		**OLD ALLUVIAL FAN DEPOSITS (Qof)** Silty Sand (SM): Reddish-brown, moist, dense, fine- to medium-grained sand.		11 23 48	■		11.7	123.7	
20		Becomes very dense and fine- to coarse grained.		23 50	■		9.8	118.8	
25		Same a above and slightly cemented.		16 42 50	■		10.3	116.4	
		Total Depth= 26'3" No groundwater encountered Boring backfilled with cuttings and tamped.							
30									

PLATE A-4

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**301 West Palm Avenue**		Boring No.: **B-3**
Location:	**Redlands**		Elevation: **±1524'**
Job No.:	**18-430**	Client: **Diversified Pacific**	Date: **1/21/19**
Drill Method:	**6" Hollow Stem Auger**	Driving Weight: **140lbs/30"**	Logged By: **KTM**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		**TOPSOIL** Silty Sand (SM): Brown, very moist, loose, fine- to medium-grained sand.							
		YOUNG ALLUVIAL FAN DEPOSITS (Qyf) Silty Sand (SM): Orangish-brown, moist, very dense, fine- to medium-grained sand, with trace gravel up to 1.5" in diameter.		7 20 44	■	■	5.4	109.4	pH, RES, S04, CL
		Same as above.							
5		Sand (SP): Reddish-brown, moist, medium-dense, fine- to coarse-grained sand.		12 15 17	■	■	6.9	112.5	
		Silty Sand (SM): Reddish-brown, moist, medium-dense, fine- to medium-grained, with trace coarse-grained sand, trace clay.		8 14 24	■		8.9	117.0	
		Same as above.		8 14 14	■		10.4	118.2	
10		Same as above, dense.		7 16 24	■		11.9	119.0	
15		**OLD ALLUVIAL FAN DEPOSITS (Qof)** Sand (SP): Reddish- brown, moist, very dense, fine- to medium-grained, with trace coarse-grained sand, trace clay, Disturbed.		11 28 50	■		10.9	103.9	
20		Becomes fine- to coarse-grained.		15 36 50	■		5.6	118.1	
25		Same as above.		21 38 50	■		7.4	118.8	
		Total Depth= 26'2" No groundwater encountered Boring backfilled with cuttings and tamped.							
30									

PLATE A-5

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**301 West Palm Avenue**		Boring No.: **B-4**
Location:	**Redlands**		Elevation: **±1503'**
Job No.:	**18-430**	Client: **Diversified Pacific**	Date: **1/21/19**
Drill Method:	**6" Hollow Stem Auger**	Driving Weight: **140lbs/30"**	Logged By: **KTM**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		**TOPSOIL** Silty Sand (SM): Brown, very moist, loose to medium-dense, fine- to medium-grained sand.							
		YOUNG ALLUVIAL FAN DEPOSITS (Qyf) Silty Sand (SM): Reddish-brown, moist, medium-dense, fine- to medium-grained sand, trace rootlets.		7 8 9	■		7.2	108.5	CON
		Same as above.		13 17 17	■		5.9	114.5	
5		Sand (SP): Reddish-brown, moist, medium-dense, very fine- to medium-grained sand, poorly graded, trace clay.							
		Becomes very dense.		10 24 50	■		8.8	120.7	
		Same as above.		24 50	■		10.7	116.9	
10		**OLDER FAN DEPOSITS (Qof)** Silty Sand (SM): Reddish-brown, moist, very dense, fine- to coarse-grained sand.		22 45 48	■		6.8	125.3	
15		Same as above.		14 28 47	■		8.2	119.2	
20		Same as above and very fine- to medium-grained sand.		17 37 50	■		3.6	114.0	
		Total Depth= 21'5" No groundwater encountered Boring backfilled with cuttings and tamped.							
25									
30									

PLATE A-6

Petra Geosciences, Inc.

APPENDIX B

LABORATORY TEST PROCEDURES

LABORATORY DATA SUMMARY

LABORATORY TEST PROCEDURES

Soil Classification

Soils encountered within the exploration borings were initially classified in the field in general accordance with the visual-manual procedures of the Unified Soil Classification System (ASTM D2488). The samples were re-examined in the laboratory and the classifications reviewed and then revised where appropriate.

In-Situ Moisture and Density

Moisture content and unit dry density of in-place soil were determined in representative strata and are depicted on the Exploration Logs, Appendix A.

Laboratory Maximum Dry Density

Maximum dry density and optimum moisture content were determined for selected samples of soil in accordance with ASTM D1557. Pertinent test values are given on Plate B-1.

Expansion Index

An expansion index test was performed on a selected sample of soil in accordance with ASTM D4829. The expansion potential classification was determined from 2010 CBC Section 1802.3.2 on the basis of the expansion index value. The test result and expansion potentials are presented on Plate B-1.

Soil Corrosivity

Chemical analyses were performed on a selected sample of soil to determine concentrations of soluble sulfate and chloride, as well as pH and resistivity. These tests were performed in accordance with California Test Method Nos. 417 (sulfate), 422 (chloride) and 643 (pH and resistivity). Test results are included on Plate B-1.

Consolidation

Volume change (settlement or heave) characteristics of select undisturbed soils were determined by one-dimensional consolidation tests. These tests were performed in general accordance with the current version of the Test Method ASTM D2435. Axial loads were applied in several increments to laterally restrained 1-inch-high samples. The resulting deformations were recorded at selected time intervals. The test samples were inundated at the approximate in-situ and/or anticipated design overburden pressure in order to evaluate the effect of an increase in moisture content, e.g., hydro-consolidation potential or heave. Results of these tests are graphically presented on Plate B-2.

Direct Shear

The Coulomb shear strength parameters, i.e., angle of internal friction and cohesion, were determined for a remolded sample of onsite soil. This test was performed in general accordance with the current version of Test Method ASTM D 3080. Three specimens were prepared for each test. The test specimens were inundated and then sheared under various normal loads at a constant strain rate of 0.005 inch per minute. The results of the direct shear test are graphically presented on Plate B-3.

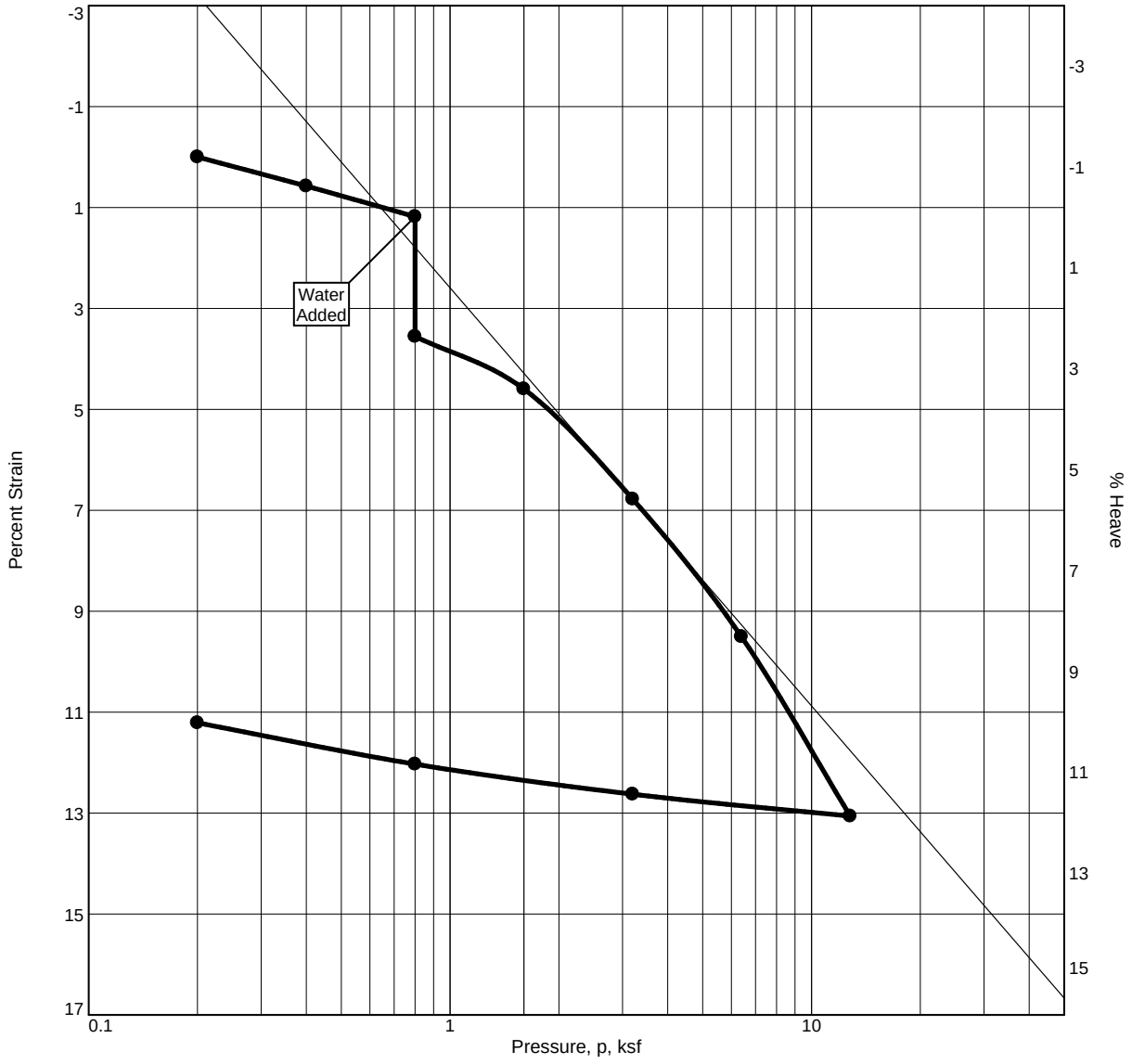
LABORATORY DATA SUMMARY*													
Boring Number	Sample Depth (ft)	Soil Description	Max. Dry Density [1] (pcf)	Optimum Moisture[1] (%)	Expansion Index[2]	USCS Soil Classification[3]	Atterberg Limits[4]			Sulfate Content[5] (%)	Chloride Content[6] (mg/L)	pH[7]	Minimum Resistivity[7] (ohm-cm)
							LL	PL	PI				
B-1	0-5	Silty Sand	132.5	8.0	6	SM	--	--	--	--	--	--	--
B-3	0-5	Silty Sand	--	--	--	SM	--	--	--	0.0102	420	7.3	4,800

(--) Tests Not Performed

Test Procedures:

[1] Per ASTM Test Method D 1557
[2] Per ASTM Test Method D 4829
[3] Per ASTM Test Method D 2487
[4] Per ASTM Test Method D 4318
[5] Per Caltrans Test Method 417
[6] Per Caltrans Test Method 422
[7] Per Caltrans Test Method 643

CONSOLIDATION TEST REPORT



SUMMARY OF TEST RESULTS

	DRY DENSITY (pcf)	MOISTURE CONTENT, (%)	SATURATION (%)	VOID RATIO	SPECIFIC GRAVITY	OVERBURDEN (ksf)	P_C (ksf)	C_C	SWELL PRESS. (ksf)
INITIAL	97.8	7.2	32.2	0.590	2.65	.21	1.8	0.13	
FINAL		15.8	100.0	0.411					

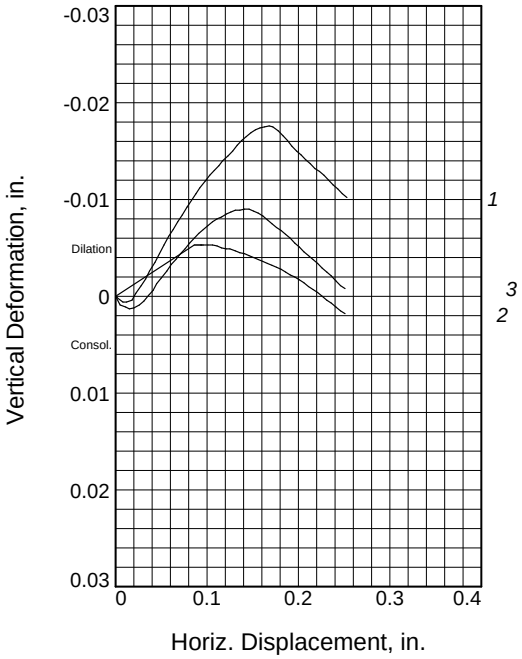
Source of Sample: B-4 **Depth:** 2
Material Description: Dark yellowish brown, Silty fine to coarse Sand **USCS:** SM **AASHTO:**
Remarks: Oversize found within sample

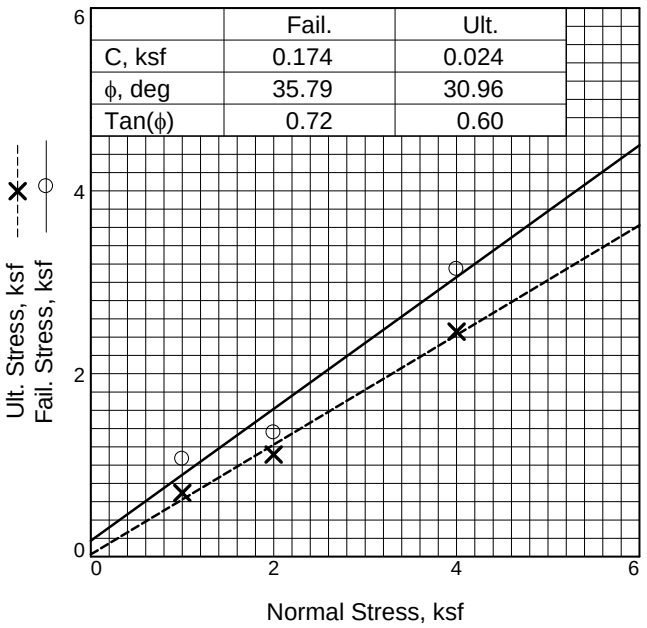
Laboratory:
1251 West Pomona Road, Unit #103, Corona, Ca 92882 Phone #. 714.549.8921

PETRA GEOSCIENCES INC.

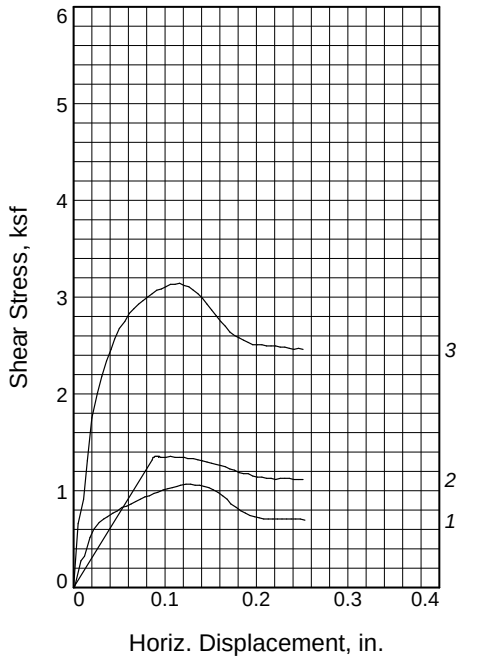
Client: Diversified Pacific
Project: West Palm ave. and Alvarado st.

Project No.: 18-430 **PLATE** B-2





	Fail.	Ult.
C, ksf	0.174	0.024
ϕ, deg	35.79	30.96
Tan(ϕ)	0.72	0.60



Sample No.		1	2	3
Initial	Water Content, %	8.2	8.2	8.2
	Dry Density, pcf	116.7	116.7	116.7
	Saturation, %	51.9	51.9	51.9
	Void Ratio	0.4179	0.4179	0.4179
	Diameter, in.	2.416	2.416	2.416
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	15.9	15.7	15.6
	Dry Density, pcf	116.7	116.7	116.7
	Saturation, %	100.6	99.6	99.2
	Void Ratio	0.4179	0.4179	0.4179
	Diameter, in.	2.416	2.416	2.416
	Height, in.	1.000	1.000	1.000
Normal Stress, ksf		1.000	2.000	4.000
Fail. Stress, ksf		1.068	1.356	3.144
Displacement, in.		0.128	0.089	0.116
Ult. Stress, ksf		0.696	1.116	2.460
Displacement, in.		0.253	0.251	0.251
Strain rate, in./min.		0.005	0.005	0.005

Sample Type: Remolded to 90% RC

Description: Reddish brown, Silty fine to coarse Sand

Assumed Specific Gravity= 2.65

Remarks:

PLATE B-3

Client: Diversified Pacific

Project: West Palm ave. and Alvarado st.

Source of Sample: B-1 **Depth:** 0-5

Proj. No.: 18-430 **Date Sampled:** 1-22-19

PETRA GEOSCIENCES INC.

Laboratory:
1251 West Pomona Road, Unit #103, Corona, Ca 92882 Phone #. 714.549.8921

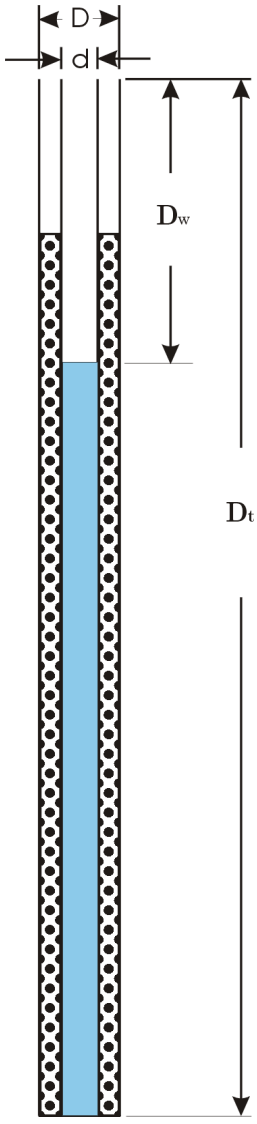
APPENDIX C

PERCOLATION FIELD TEST DATA

PERCOLATION TEST SUMMARY

Test Number: P-1

Job No. 18-430
Project Name: 301 W. Palm Ave. Redlands
Client: Diversified Pacific
Tested by: Levon Holmes
Date: January 21, 2018



Depth to Bottom,ft (D_t): 13
Diameter of Hole, in (D): 6
Diameter of Pipe, in (d): 3
Agg. Correction (% Voids): 45
Soil Description: fine to medium Silty SAND (SM)

Time Interval (min)	Depth to Water Surface Dw (ft)		Change in Head (in)	Perc Rate gal/day/ft^2
	1st Reading	2nd Reading		
30	6.00	6.50	6.0	1.9
30	6.00	6.25	3.0	0.9
30	6.00	6.27	3.2	1.0
30	6.00	6.22	2.6	0.8
30	5.95	6.22	3.2	1.0
30	6.00	6.21	2.5	0.8
30	6.00	6.25	3.0	0.9
30	6.00	6.23	2.8	0.9
30	5.97	6.20	2.8	0.9
30	6.00	6.20	2.4	0.8
30	5.97	6.18	2.5	0.8
30	5.95	6.16	2.5	0.8

Percolation Rate: **0.8 gal/day/ft^2**
Infiltration Rate: **0.05 inches/hour**

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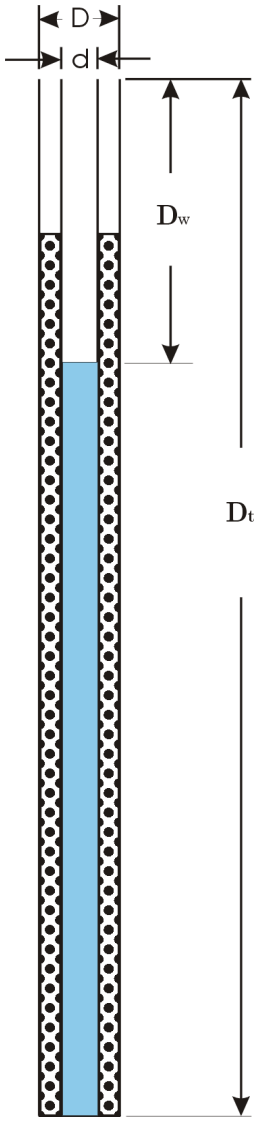
PERCOLATION TEST SUMMARY

Test Number: P-2

Job No. 18-430
Project Name: 301 W. Palm Ave. Redlands
Client: Diversified Pacific
Tested by: Levon Holmes
Date: January 21, 2018



Depth to Bottom,ft (D_t): 10
Diameter of Hole, in (D): 8
Diameter of Pipe, in (d): 3
Agg. Correction (% Voids): 45
Soil Description: fine to medium Silty SAND (SM)

Time Interval (min)	Depth to Water Surface Dw (ft)		Change in Head (in)	Perc Rate gal/day/ft^2
	1st Reading	2nd Reading		
30	5.00	5.65	7.8	4.2
30	5.00	5.53	6.4	3.4
10	5.00	5.20	2.4	3.7
10	5.00	5.15	1.8	2.8
10	5.00	5.15	1.8	2.8
10	5.00	5.12	1.4	2.2
10	5.00	5.12	1.4	2.2
10	5.00	5.12	1.4	2.2
			0.0	#DIV/0!
			0.0	#DIV/0!
			0.0	#DIV/0!
			0.0	#DIV/0!

Percolation Rate: **2.2 gal/day/ft^2**
Infiltration Rate: **0.15 inches/hour**

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