PRELIMINARY DRAINAGE REPORT
LUMINA (PTS 555609)
CITY OF SAN DIEGO, CA
August 15, 2018

Prepared For:

COLRICH
444 West Beech Street, Suite 300
San Diego, CA 92101

Prepared By:

PROJECT DESIGN CONSULTANTS
Planning I Landscape Architecture I Engineering I Survey

701 B Street. Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

PDC Job No. 2357.35

REGISTERED PROFESSIONAL ENGINEER
DEBBY SUE REECE
No. C56148
EXP. 12-31-18
CIVIL
STATE OF CALIFORNIA

Prepared by: C. Pack, P.E.
Under the supervision of

Debby Reece, PE RCE 56148
Registration Expires 12/31/18

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1. INTRODUCTION

This report describes the existing and proposed storm water drainage improvements for the Lumina Tentative Map (TM) submittal. The Lumina project is owned by Colrich, and represents a portion of the Otay Mesa Central Village Specific Plan (CVSP) area. The TM development proposes development consistent with the land use designations of the recently approved Specific Plan. The overall drainage criteria for the project was identified in the technical report for the Specific Plan, entitled *Preliminary Drainage and Water Quality Summary for the Otay Mesa Central Village Specific Plan* (PTS 408329), which was prepared by Project Design Consultants and is dated January 22, 2016. The Specific Plan designated land uses within the proposed village area to accommodate future development consistent with the Otay Mesa Community Plan Update. Consistent with the land use designations applied to the site by the CVSP, the TM proposes development of Medium High Density Mixed-Use, Medium Density Multi-Family, Low Density Multi-Family, Public School Facilities, Recreation, and Open Space land uses.

This TM report builds upon the programmatic level drainage analysis in the Specific Plan and addresses the project-specific level analysis required for the Colrich parcels currently proposed per the Lumina TM. The project proposes a TM application for a 93.43-acre site located north of Siempre Viva Road and west of Cactus Road in the Otay Mesa community of the City of San Diego within the CVSP area. See Figure 1 for a Vicinity Map. The project proposes to impact small drainages in the canyons of the northern and southern project limits. We have mapped jurisdictional non-wetland Waters of the US (WUS) in these drainages. As such, we're anticipating needing agency permits (Corps 404, CDFW 1602, and RWQCB 401). We've got this in our scope and will be doing the fieldwork soon to update the delineation mapping.

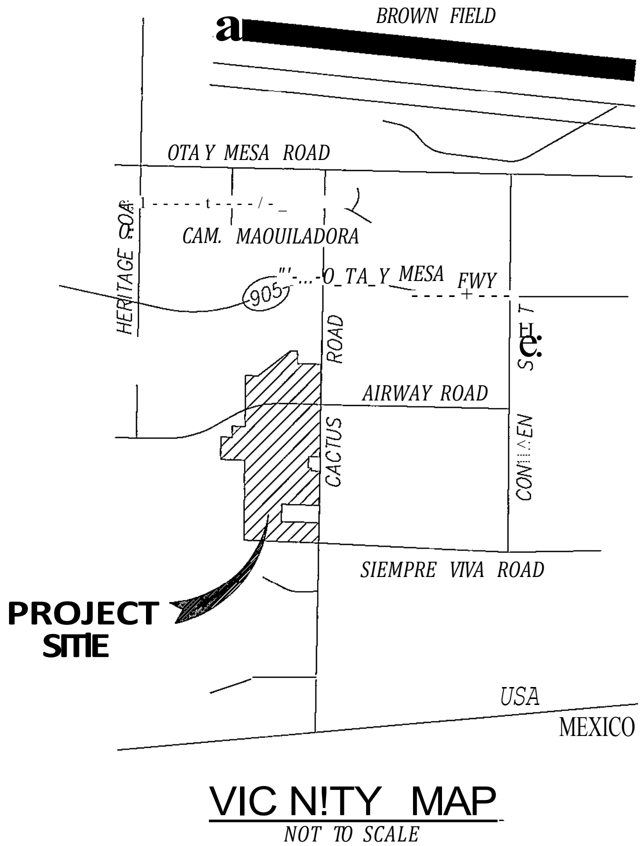

Figure 1: Vicinity Map

2. PROJECT BACKGROUND & RELATION TO PREVIOUS STUDIES

This report builds on the work done previously for the CVSP. The work done for the CVSP was based on the Otay Mesa Community Plan Update (CPU) and its associated EIR. Specifically, the Otay Mesa CPU Drainage Study that was part of the EIR outlined the drainage and water quality requirements for future development within Otay Mesa and identified some of the regional drainage and flooding issues within the area. The report is titled *Drainage Studyfor the Otay Mesa Community Plan Update,* and was prepared by Kimley-Hom and Associates in April 2007. Included in that report is as a companion study entitled *Review of Otay Mesa Drainage*

Studies, prepared by Tetratech. For a copy of this previously approved CPU Drainage report, refer to Appendix 4.

The report outlines the history and drainage challenges associated with the development of the Otay Mesa Community Plan Area. For example, for most of its early history, Otay Mesa was used for agriculture and farming. As industrial and commercial development started taking place in the 1960s, the City of San Diego recognized the need for a comprehensive drainage Master Plan for the Mesa. The topography of the majority of the area is mostly flat and some of the areas experience flooding during moderate storm events, particularly within the East Watershed (per the Watershed Map in the CPU Drainage Study). There was concern that the new development would increase the stormwater runoff crossing the border into Mexico. In 1987, the City Council approved a contract to prepare the Otay Mesa Master Drainage Plan and published a Notice to "All Private Engineers" that established drainage requirements for development within the East Watershed of Otay Mesa. (Refer to page 2 of the CPU Drainage Study). The Notice required no increase in the rate of stormwater runoff from the property after development, by construction of stormwater detention basins. Most of the drainage analysis associated with the CPU Drainage Study focused on the East Watershed, but the CPU Drainage Study also addressed the other areas within the CPU boundary. The Central Village Specific Plan is within the West Watershed, which is less developed than the East Watershed but still has some of the same drainage challenges. Per Section VII of the CPU Drainage report, the following describes the recommended drainage design criteria for future development within the West Watershed (which includes the Specific Plan Area):

> The West Watershed consists of smaller Mesa-top watersheds that drain into the tributary canyons of Spring Canyon. All of the flow from the watershed flows into Mexico at the Spring Canyon concentration point. Detention basins will be required to reduce the post-development peak flows to predevelopment levels for the 50-year and 100-year storm. If the detention basins concentrate flows at the upper edge of canyons, care must be taken to ensure that erosion potential is not increased downstream.

Therefore, the requirements of the West and East watersheds are different. While developments in the East watershed requires conformance with the Notice to "All Private Engineers", the West watershed is not subject to the same requirements, but it is subject to the 50-year and 100-year storm detention requirement, as outlined in the above paragraph.

Subsequent to the preparation of the previous Otay Mesa Drainage Studies, Caltrans has built the new State Route 905 and there have been other changes and development within the watershed. Some of the regional drainage improvements proposed in the original studies and master plans to alleviate regional flooding issues have still not been resolved. Therefore, this report follows the the guidance for future development established with the Specific Plan, specifically the requirement for detention. The guidance will require compliance with the overall goals of the CPU (reduce post-development peak flows) and will also require compliance with the applicable stormwater quality regulations.

3. EXISTING AND PROPOSED DRAINAGE PATTERNS AND IMPROVEMENTS

The following sections provide descriptions of the existing and proposed drainage patterns and improvements for the project.

3.1 Floodplains

The project is located within an area of the non-printed FEMA Firm Panel 06073C2200G. Per the FIRM index sheet, the panel is not printed is because there are no special flood hazard areas within the panel sheet. Therefore, there are no FEMA special flood hazard areas within the project. However, although there is no FEMA special flood hazard areas, there may be areas of localized flooding in the canyon and other drainage concentration points.

3.2 Existing Drainage Patterns

The site is currently used for agricultural uses, and there are a few residences and buildings scattered through the site. Topography within the project site is characterized by mostly gently sloping areas, with portions of the perimeter of the property within steep canyon areas. There are currently minimal drainage improvements within the project boundary. The majority of the project drains to the south to a steep finger canyon (Wruck Creek) located to the west of the existing Cactus Road/Siempre Viva Road intersection. Two of the finger canyons drain to sump areas that are collected and drained to the west and discharged downstream within the canyon via an existing RCP storm drain per City Drawing 23871-21-D. A large portion of the project area drains to the northwest to a canyon (North tributary of Spring Canyon) on the north side of the proposed Airway Road. A small portion of the project area (Cactus Road north of Airway Road) drains to the north along Cactus Road and drains into a culvert underneath Cactus Road. After crossing Cactus Road, the runoff commingles with other runoff draining from upstream areas including Caltrans right-of-way and then drains to the upstream point of the North Canyon.

See Exhibit A in Appendix 5 for the existing condition hydrology maps. Onsite drainage is divided generally into two main drainage areas, North and South. The Southern systems include Systems 100 and 200, and the Northern systems include Systems 300 and 500. They include the following areas:

> System 100: System 100 represents the area that drains to the south towards the finger canyon near the southerly property line near the existing eastern headwall per Drawing 23871-21-D.
>
> System 200: System 200 represents the area that drains to the south towards the existing steep finger canyon that flows in a southerly direction and enters the western headwall per Drawing 23871-21-D.
>
> System 300: System 300 represents the area that drains to the northwest towards the north tributary of Spring Canyon.
>
> System 500: System 500 represents the area that drains to the north along Cactus Road and eventually drains to the culvert that crosses underneath Cactus Road approximately 600 feet to the north of the site.

In order to adequately compare existing flows to proposed flows at each of the project outfalls and to provide a valid comparison, the downstream limits of the existing drainage boundaries match the limits of the proposed drainage boundaries. This was needed because of the large number of drainage outfalls, and lack of concentration points in the pre-developed condition.

3.3 Proposed Drainage Improvements

The proposed drainage patterns and drainage improvements have been designed to mlmlc existing drainage patterns. The proposed project will include a storm drain system consisting of inlets, pipes, brow ditches, roof drains, and water quality features/detention basins. Development of the site includes development of the backbone public streets with the associated utilities and the mass grading of the lots for future development. The lots will be developed with a range of land uses, including parks, residential, mixed use, and educational uses.

The proposed drainage improvements include public storm drain infrastructure serving the proposed public streets, and private storm drain improvements serving the private development lots. The backbone storm drain system will provide storm drain stubs to serve the proposed developable lots. The lots will be developed in phases.

Refer to Exhibit B for the proposed conditions hydrology map. The Southern systems include Systems 1000 and 2000, and the Northern systems include Systems 3000, 4000, and 5000. They include the following areas:

System 1000: System 1000 represents the area that drains to the south and into proposed Basin 1 (combined biofiltration/hydromodification/detention). The outlet of Basin 1 drains towards the existing eastern headwall per Drawing 23871-21-D.

System 2000: System 2000 represents the runon area draining onto the site from upstream areas to the west of the property. It also collects the portion of the future Trails Park. The drainage area drains towards the existing western headwall per Drawing 23871-21-D.

System 3000: System 3000 represents the drainage area that drains to the northerly canyon, but bypasses Basin 4. The drainage area includes a portion of Airway Road.

Airway Road will be extended to the west in the future by others with subsequent developments to the west.

System 4000: System 4000 represents the drainage area that drains to the northwest to Basin 4 and then outlets to the proposed storm drain outfall to the northerly canyon. Basin 4 is a combined biofiltration/hydromodification/detention basin. Note that a portion of existing Airway Road east of Cactus Road drains to the basin, so the ultimate width is used for the sizing calculations, even though the project's proposed widening will be widened to an interim width.

System 5000: System 5000 represents the Cactus Road drainage area that drains to the north along Cactus Road towards the existing culvert located north of the project approximately 600 feet to the north of the site.

4. HYDROLOGY CRITERIA, METHODOLOGY, AND RESULTS

The site was modeled for existing and proposed conditions to prevent any downstream impacts or increase in flow rates. Site hydrology was assessed to generate hydrographs to route through the basins being designed in concert with hydromodification criteria. Please see the Preliminary Hydromodification Management Study by Project Design Consultants for additional information regarding basin and outflow structure design.

4.1 Hydrology Criteria

Table 1 summarizes the key hydrology assumptions and criteria used for the hydrologic modeling.

Table 1: Hydrology Criteria

Existing and Proposed Hydrology:	100-year storm frequency
Soil Type:	Hydrologic Soil Group D

Land Use/ Runoff Coefficients:	Assigned for each drainage area based on estimated percent imperviousness (C values range from C=0.45 to C=0.95).
Rainfall intensity:	Based on intensity duration frequency relationships presented in the 1984 City of San Diego Drainage Design Manual

4.2 Hydrologic Methodology

The Rational Method was used to determine the onsite 100-year storm flow for the design of the Project storm drainpipe improvements. The goal of this analysis was to:

- Determine the design flows for the sizing of storm drainpipe improvements.
- Determine project flows that will be conveyed by the storm drainpipe systems within the project.
- Determine the differences in the drainage conditions between existing and proposed conditions for sizing of detention facilities.

The Rational Method was used to calculate onsite and offsite runoff for the 100-year storm. CivilD hydrologic computer software was used to model the onsite and offsite drainage basins. Per the *City of San Diego Drainage Design Manual,* hydrologic soil type D was utilized for all calculations. The runoff coefficients were assigned based on the percent imperviousness proposed for each lot.

4.3 Description of Hydrologic Modeling Software

The Civil-D Rational Method Program was used to perform the Rational Method hydrologic calculations. This section provides a brief explanation of the computational procedure used in the computer model.

The Civil-D Modified Rational Method Hydrology Program is a computer-aided design program where the user develops a node link model of the watershed. Developing independent node link models for each interior watershed and linking these sub-models together at confluence points creates the node link model. The intensity-duration-frequency relationships are applied to each of the drainage areas in the model to get the peak flow rates at each point of interest.

The peak flows at the inlets to the basins were used to generate inflow hydrographs utilizing the RickRatHydro program. This program artificially generates a program based on time of concentration and an expected 2/3rds storm distribution as provided in Figure 6-2 of the Hydrology Manual. These hydrographs could them be routed through the basins to produce the final proposed peak flow. The EPA's Stormwater Management Model (SWMM) was used to route these hydrographs through the basins. For more information on this modeling effort see the Preliminary Hydromodofication Management Report for the project. With these routing efforts it was demonstrated that the appropriate reduction could be achieved. For future submittal SWMM will need to be utilized to demonstrate the 100 year storm is appropriately attenuated as only SWMM is capable representing the hybrid biofiltration system with above and below ground storage.

4.4 Hydrology Results

The proposed detention basins will mitigate peak flows to effectively reduce the post-developed runoff from the site due to the development, consistent with the drainage criteria outlined in the CPU Drainage Study. The basins will have a large subsurface detention area below the biofiltration, such that the combination of surface and subsurface storage will mitigate for peak-flow and hydromodification management. Detention routing will be performed for subsequent submittals. Table 2 below summarizes the Rational Method results for the key areas of interest.

Table 2: Hydrology Results

	EXISTING CONDITIONS			PROPOSED CONDITIONS		
Outfall of Interest	***System***	***Q100 (cfs)***	***Contrib. Area (acres)***	***System***	***Q100(cfs)***	***Contrib. Area (acres)***
North	System 300	37.7	30.1	System 3000	3.9	0.9
	System 500	11.7	7.7	System 4000	105.6 undetained 13.4 detained	33.9
				System 5000	6.9	1.9
	Subtotal:	**49.4**	**37.8**	**Subtotal:**	**24.2**	**36.7**
South	System 100	28.4	20.7	System 1000	151.6 undetained 36.2 detained	63.4
	System 200	54.0	49.3	System 2000	10.2	8.2
	Subtotal:	**82.4**	**70.0**	**Subtotal:**	**46.4**	**71.6**
	Total:	**131.8**	**107.8**	**Total:**	**70.6**	**108.3**

5. HYDRAULIC CRITERIA, METHODOLOGY, AND RESULTS

Hydraulic calculations will be performed during final engineering. The preliminary design for each basin includes additional depth for freeboard.

6. CONCLUSIONP

Proposed project development complies with detention criteria outlined in previous studies, and therefore, should not adversely affect downstream drainage conditions. The proposed onsite storm drain infrastructure will be adequate to convey the design flows. The storm drain detention facilities are designed as combined facilities for hydrornodification and water quality purposes in addition to peak flow detention.

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APPENDIX 1

Intensity Duration Frequency Curve and Runoff Coefficients

TABLE2

RUNOFF COEFFICIENTS (RATIONAL METHOD)

DEVELOPED AREAS (URBAN)

Land Use	Coefficient{ C Soil Type 1)
Residential:	**D**
Single Family	.55
Multi-Units	.70
Mobile Homes	.65
Rural Oots greater than I/2 acre)	.45
Commercial (2) 8096 Impervious	.85
Indus trial (2) 9096 Impervious	.95

NOTES:

(1) Type D soil to be used for all areas.

(2) Where actual conditions deviate significantly from the tabulated imperviousness values of 8096 or 9096, the values given for coefficient C, may be revised by multiplying 8096 or 9096 by the ratio of actual imperviousness to the tabulated imperviousness. However, in no case shall the final coefficient be less than 0.50. For example: Consider commercial property on D soil.

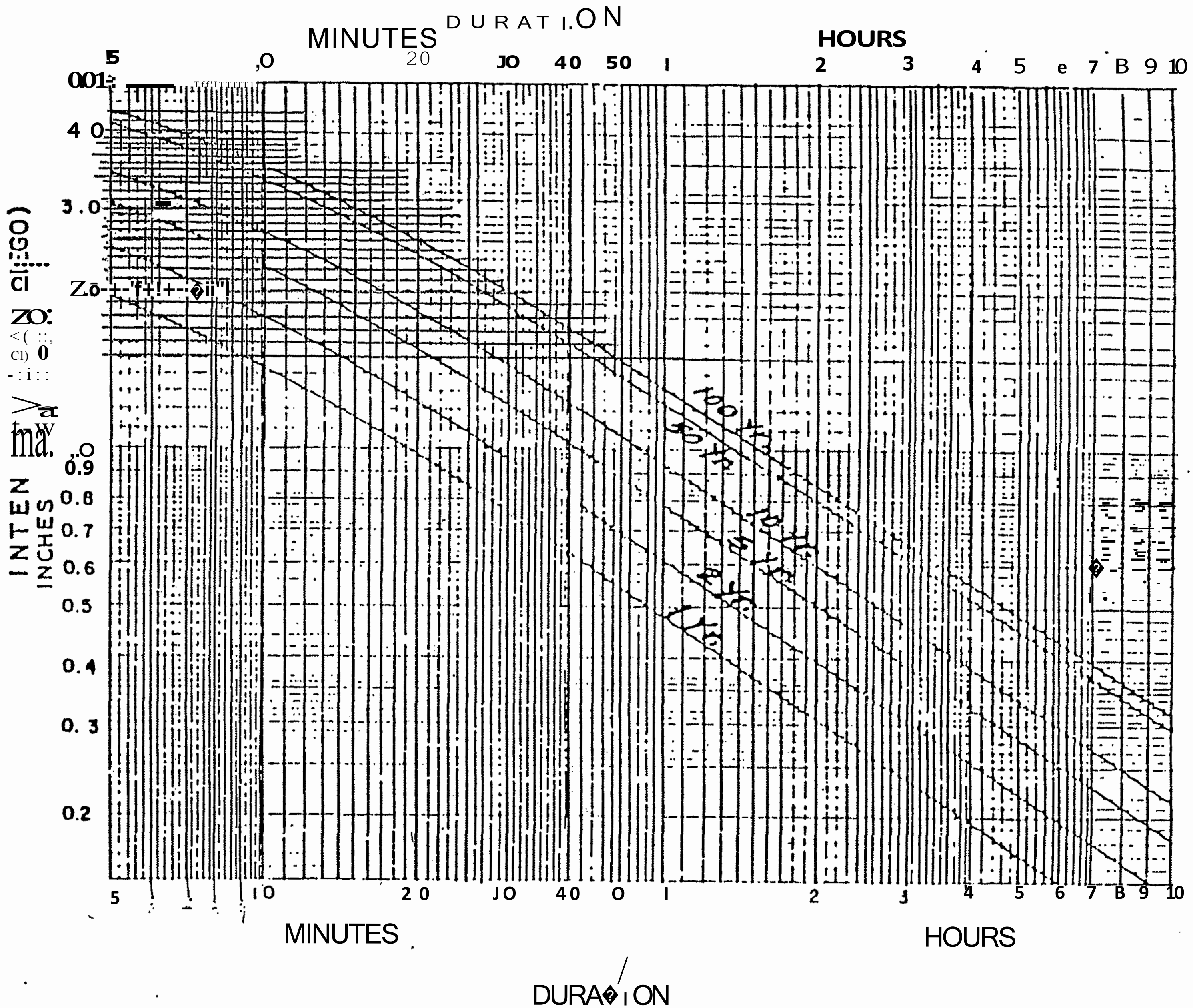
Actual imperviousness = .5096

Tabulated imperviousness = 8096

Revised C = $\frac{50}{80}$ x 0.8.5 = 0•53

ELEV.	FACTOR
0-1500	1.00
1500-3000	1.25
3000-4000	1.42
4000-5000	1.60
5	1.10
DESERT	1.25

To obtain correct intensity, multiply intensity on chart by factor for design elevation.



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APPEND1X2

Existing Conditions Rational Method Computer Output

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                San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
      Rational Hydrology Study        Date: 05/20/17
------------------------------------------------------------------------
2357.50 ILLUMINA
EXISTING CONDITIONS
100-YEAR
FILE:S100E100
------------------------------------------------------------------------
 *********   Hydrology Study Control Information**********

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Program License Serial Number 4049

------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used
English (in) rainfall data used

Standard intensity of Appendix I-Bused for year and
Elevation 0 - 1500 feet
Factor (to multiply* intensity)  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual 'C' values used
Runoff coefficients by rational method


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      100.000 to Point/Station      101.000
**** INITIAL AREA EVALUATION****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Initial subarea flow distance  =  103.000(Ft.)
Highest elevation =  512.000(Ft.)
Lowest elevation =  510.000(Ft.)
Elevation difference =    2.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C)  =     9.52 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4500)*( 103.000^.5)/( 1.942^(1/3))=   9.52
Rainfall intensity (I) =      3.435(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.450
Subarea runoff=      0.232(CFS)
Total initial stream area =        0.150 (Ac.)


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Process from Point/Station      101.000 to Point/Station      102.000
**** IMPROVED CHANNEL TRAVEL TIME****
______________________________________________________________________
Upstream point elevation =   510.000(Ft.)
Downstream point elevation =   462.000(Ft.)
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Channel length thru subarea  =  2096.000(Ft.)
Channel base width  =   10.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     13. 703 (CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =   2.000(Ft.)
Flow(q) thru subarea =     13.703(CFS)
Depth of flow =   0.300(Ft.), Average velocity =   3.508(Ft/s)
Channel flow top width =   16.008(Ft.)
Flow Velocity =    3.51(Ft/s)
Travel time  =    9.96 min.
Time of concentration =   19.48 min.
Critical depth =      0.344(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Rainfall intensity =      2.611(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =     20.478(CFS) for   17.430(Ac.)
Total runoff =     20.709(CFS)    Total area =       17.58(Ac.)


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Process from Point/Station      102.000 to Point/Station      105.000
**** IMPROVED CHANNEL TRAVEL TIME****

Upstream point elevation =   462.000(Ft.)
Downstream point elevation =    425.000(Ft.)
Channel length thru subarea  =   234.000(Ft.)
Channel base width  =    5.000(Ft.)
Slope or 'Z' of left channel bank =   5.000
Slope or 'Z' of right channel bank =   5.000
Manning's 'N'    = 0.025
Maximum depth of channel  =   2.000(Ft.)
Flow(q) thru subarea =     20.709(CFS)
Depth of flow=   0.325(Ft.), Average velocity =   9.608(Ft/s)
Channel flow top width =    8.253(Ft.)
Flow Velocity =    9.61(Ft/s)
Travel time  =   0.41 min.
Time of concentration =   19.88 min.
Critical depth=      0.648(Ft.)


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Process from Point/Station      103.000 to Point/Station      105.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1. 000
 [INDUSTRIAL area type                         ]
Time of concentration =    19.88 min.
Rainfall intensity =      2.587(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA,  C = 0.950
Subarea runoff =      7.718(CFS) for    3.140(Ac.)
Total runoff =     28. 427 (CFS)    Total area =       20.72(Ac.)
End of computations, total study area =         20.720  (Ac.)
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              San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
       Rational Hydrology Study        Date: 05/20/17
------------------------------------------------------------------------
2357.50 ILLUMINA
EXISTING CONDITIONS
SYSTEM 200, FILE: S200E100

------------------------------------------------------------------------
 *********   Hydrology Study Control Information**********

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


Program License Serial Number 4049

------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used
English (in) rainfall data used

Standard intensity of Appendix I-Bused for year and
Elevation O - 1500 feet
Factor (to multiply* intensity)  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual 'C' values used
Runoff coefficients by rational method


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      200.000 to Point/Station      201.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
 [RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Initial subarea flow distance  =  228.000(Ft.)
Highest elevation =  514.000(Ft.)
Lowest elevation =  510.000(Ft.)
Elevation difference =    4.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C)  =    14.65 min.
TC= [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC= [1.8*(1.1-0.4500)*( 228.000^.5)/( 1.754^(1/3)]=  14.65
Rainfall intensity (I) =      2.932(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.450
Subarea runoff =      1.148(CFS)
Total initial stream area=        0.870(Ac.)


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Process from Point/Station      201.000 to Point/Station      202.000
**** IMPROVED CHANNEL TRAVEL TIME****

Upstream point elevation=   510.000(Ft.)
Downstream point elevation =   490.000(Ft.)
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Channel length thru subarea  =  1131.000(Ft.)
Channel base width  =   10.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     11.055(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =   2.000(Ft.)
Flow(q) thru subarea =     11.055(CFS)
Depth of flow =   0.286(Ft.), Average velocity =   3.000(Ft/s)
Channel flow top width =   15.729(Ft.)
Flow Velocity =    3.00(Ft/s)
Travel time  =   6.28 min.
Time of concentration =   20.93 min.
Critical depth =     0.301(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
 [RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Rainfall intensity =     2.528(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =     17.0BB(CFS) for   15.020(Ac.)
Total runoff =     18.236(CFS)    Total area =       15.89(Ac.)


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Process from Point/Station      202.000 to Point/Station      203.000
**** IMPROVED CHANNEL TRAVEL TIME****
____________________________________________________________________
Upstream point elevation =   490.000(Ft.)
Downstream point elevation =   414.000(Ft.)
Channel length thru subarea  =  1266.000(Ft.)
Channel base width  =   10.000(Ft.)
Slope or 'Z' of left channel bank =   5.000
Slope or 'Z' of right channel bank =   5.000
Estimated mean flow rate at midpoint of channel =     36.695(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =   2.000(Ft.)
Flow(q) thru subarea =     36.695(CFS)
Depth of flow =   0.417(Ft.), Average velocity =   7.282(Ft/s)
Channel flow top width =   14.170(Ft.)
Flow Velocity =    7.28(Ft/s)
Travel time  =   2.90 min.
Time of concentration =   23.83 min.
Critical depth =     0.664(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
 [RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Rainfall intensity =     2.377(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =     34.410(CFS) for   32.170(Ac.)
Total runoff =     52.646(CFS)    Total area =       48.06(Ac.)


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Process from Point/Station      203.000 to Point/Station      205.000
**** IMPROVED CHANNEL TRAVEL TIME****
____________________________________________________________________
Upstream point elevation =   414.000(Ft.)
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Downstream point elevation =    404.000(Ft.)
Channel length thru subarea  =    162.000(Ft.)
Channel base width  =    10.000(Ft.)
Slope or 'Z' of left channel bank=    5.000
Slope or 'Z' of right channel bank=    5.000
Manning's 'N'     = 0.025
Maximum depth of channel  =    2.000(Ft.)
Flow(q) thru subarea =     52.646(CFS)
Depth of flow=   0.508(Ft.), Average velocity =   8.273(Ft/s)
Channel flow top width =   15.075(Ft.)
Flow Velocity =    8.27(Ft/s)
Travel time  =    0.33 min.
Time of concentration =   24.15 min.
Critical depth=      0.820(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      205.000
**** SUBAREA FLOW ADDITION****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Time of concentration =    24.15 min.
Rainfall intensity =      2.361(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =      1.349(CFS)  for    1.270(Ac.)
Total runoff=     53.995(CFS)    Total area =       49.33(Ac.)
End of computations, total study area =          49.330  (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology program based on
San Diego County Flood Control Division 1985 hydrology manual
Rational Hydrology Study Date: 05/20/17

2357.30 ILLUMINA
EXISTING CONDITIONS
SYSTEM 300, FILE: S300E100

********* Hydrology Study Control Information**********

Program License Serial Number 4049

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used
English (in) rainfall data used

Standard intensity of Appendix I-Bused for year and
Elevation O - 1500 feet
Factor (to multiply* intensity) = 1.000
Only used if inside City of San Diego
San Diego hydrology manual 'C' values used
Runoff coefficients by rational method

++
Process from Point/Station 301.000 to Point/Station 302.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Initial subarea flow distance = 194.000(Ft.)
Highest elevation = 514.000(Ft.)
Lowest elevation= 510.000(Ft.)
Elevation difference= 4.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) = 12.80 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4500)*(194.000^.5)/(2.062^(1/3)]= 12.80
Rainfall intensity (I) = 3.084(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.450
Subarea runoff= 0.999(CFS)
Total initial stream area = 0.720(Ac.)

++
Process from Point/Station 302.000 to Point/Station 304.000
**** IMPROVED CHANNEL TRAVEL TIME****

Upstream point elevation = 510.000(Ft.)
Downstream point elevation = 488.000(Ft.)

```
Channel length thru subarea  =   675.000(Ft.)
Channel base width  =   10.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      6.890(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    2.000(Ft.)
Flow(q) thru subarea =      6.890(CFS)
Depth of flow =   0.184(Ft.), Average velocity =   3.154(Ft/s)
Channel flow top width =   13.688(Ft.)
Flow Velocity =    3.15(Ft/s)
Travel time  =    3.57 min.
Time of concentration=   16.37 min.
Critical depth =      0.227(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Rainfall intensity =      2.807(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =     10.724(CFS)  for    8.490(Ac.)
Total runoff=     11.723(CFS)    Total area=        9.21(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      303.000 to Point/Station      304.000
**** SUBAREA FLOW ADDITION****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                            ]
Time of concentration =    16.37 min.
Rainfall intensity =      2.807(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      0.427(CFS)  for    0.160(Ac.)
Total runoff =     12.150(CFS)    Total area=        9.37 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      304.000 to Point/Station      310.000
**** IMPROVED CHANNEL TRAVEL TIME****
______________________________________________________________________
Upstream point elevation=   488.000(Ft.)
Downstream point elevation =   439.000(Ft.)
Channel length thru subarea  =   420.000(Ft.)
Channel base width  =   10.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =     21.136 (CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    2.000(Ft.)
Flow(q) thru subarea =     21.136(CFS)
Depth of flow =   0.243(Ft.), Average velocity =   7.007(Ft/s)
Channel flow top width =   14.855(Ft.)
Flow Velocity=    7.01(Ft/s)
Travel time  =    1.00 min.
Time of concentration =   17.37 min.
Critical depth =      0.445(Ft.)
 Adding area flow to channel
```

```
Decimal  fraction  soil  group  A = 0.000
Decimal  fraction  soil  group  B = 0.000
Decimal  fraction  soil  group  C = 0.000
Decimal  fraction  soil  group  D = 1.000
 [RURAL(greater  than  0.5  Ac,  0.2  ha)  area  type]
Rainfall  intensity =      2.740(In/Hr)  for  a   100.0  year  storm
Runoff  coefficient  used  for  sub-area,  Rational  method,Q=KCIA,  C = 0.450
Subarea  runoff =     17.092(CFS)  for   13.860(Ac.)
Total  runoff =     29.241  (CFS)    Total  area =       23.23  (Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process  from  Point/Station      305.000  to  Point/Station      310.000
****  SUBAREA  FLOW  ADDITION****

Decimal  fraction  soil  group  A = 0.000
Decimal  fraction  soil  group  B = 0.000
Decimal  fraction  soil  group  C = 0.000
Decimal  fraction  soil  group  D = 1.000
 [RURAL(greater  than  0.5  Ac,  0.2  ha)  area  type]
Time  of  concentration =    17.37  min.
Rainfall  intensity =      2.740(In/Hr)  for  a   100.0  year  storm
Runoff  coefficient  used  for  sub-area,  Rational  method,Q=KCIA,  C = 0.450
Subarea  runoff =      7.633(CFS)  for    6.190(Ac.)
Total  runoff =     36.875(CFS)    Total  area =       29.42(Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process  from  Point/Station      308.000  to  Point/Station      310.000
****  SUBAREA  FLOW  ADDITION****

Decimal  fraction  soil  group  A = 0.000
Decimal  fraction  soil  group  B = 0.000
Decimal  fraction  soil  group  C = 0.000
Decimal  fraction  soil  group  D = 1.000
 [RURAL(greater  than  0.5  Ac,  0.2  ha)  area  type]
Time  of  concentration =    17.37  min.
Rainfall  intensity =      2.740(In/Hr)  for  a   100.0  year  storm
Runoff  coefficient  used  for  sub-area,  Rational  method,Q=KCIA,  C = 0.450
Subarea  runoff=      0.802(CFS)  for    0.650(Ac.)
Total  runoff =     37. 676  (CFS)    Total  area =       30.07(Ac.)
End  of  computations,  total  study  area=         30.070  (Ac.)
```

```
                San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
         Rational Hydrology Study          Date: 06/01/17
------------------------------------------------------------------------
2357.50 LUMINA
EXISTING CONDITIONS
SYSTEM 500,  FILE:  S500E100

------------------------------------------------------------------------
 *********   Hydrology Study Control Information**********

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


Program License Serial Number 4049

------------------------------------------------------------------------
Rational hydrology study storm event year is    100.0
English  (in-lb)  input data Units used
English  (in)  rainfall data used

Standard intensity of Appendix I-Bused for year and
Elevation O - 1500  feet
Factor  (to multiply* intensity)   =  1.000
Only used if inside City of San Diego
San Diego hydrology manual  'C'  values used
Runoff coefficients by rational method


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      500.000 to Point/Station      501.000
**** INITIAL AREA EVALUATION****

Decimal  fraction soil group A = 0.000
Decimal  fraction soil group B = 0.000
Decimal  fraction soil group C = 0.000
Decimal  fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac,  0.2 ha)  area type]
Initial  subarea flow distance   =    90.000(Ft.)
Highest  elevation =  516.500(Ft.)
Lowest  elevation=  515.000(Ft.)
Elevation difference =     1.500(Ft.)
Time of concentration calculated by the urban
areas overland flow method  (App X-C)  =      9.36 min.
TC  =  [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC  =  [1.8*(1.1-0.4500)*(   90.000^.5)/( 1.667^(1/3)]=    9.36
Rainfall intensity  (I)  =       3.456(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area  (Q=KCIA) is C = 0.450
Subarea runoff=       0.653(CFS)
Total initial stream area =         0.420 (Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      501.000 to Point/Station      502.000
**** IMPROVED CHANNEL TRAVEL TIME****

Upstream point elevation =    515.000(Ft.)
Downstream point elevation =    509.000(Ft.)
```

```
Channel length thru subarea  =   505.000(Ft.)
Channel base width  =   10.000(Ft.)
Slope or 'Z' of left channel bank =  10.000
Slope or 'Z' of right channel bank =  10.000
Estimated mean flow rate at midpoint of channel =      4.502(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    2.000(Ft.)
Flow(q) thru subarea =      4.502(CFS)
Depth of flow =   0.193(Ft.), Average velocity =   1.956(Ft/s)
Channel flow top width=   13.859(Ft.)
Flow Velocity =    1.96(Ft/s)
Travel time  =   4.30 min.
Time of concentration =   13.67 min.
Critical depth=     0.174(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
 [RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Rainfall intensity =      3.010(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =      6.704(CFS) for    4.950(Ac.)
Total runoff=      7.358(CFS)    Total area=       5.37(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      502.000 to Point/Station      504.000
**** IMPROVED CHANNEL TRAVEL TIME****
______________________________________________________________________
Upstream point elevation=   509.000(Ft.)
Downstream point elevation =   507.900(Ft.)
Channel length thru subarea  =   147.000(Ft.)
Channel base width  =    1.000(Ft.)
Slope or 'Z' of left channel bank =  50.000
Slope or 'Z' of right channel bank =  50.000
Estimated mean flow rate at midpoint of channel =      8.002(CFS)
Manning's 'N'    = 0.018
Maximum depth of channel  =    2.000(Ft.)
Flow(q) thru subarea =      8.002(CFS)
Depth of flow =   0.276(Ft.), Average velocity =   1.953 (Ft/s)
Channel flow top width=   28.643(Ft.)
Flow Velocity=    1.95(Ft/s)
Travel time  =   1.25 min.
Time of concentration =   14.92 min.
Critical depth =     0.266(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
 [INDUSTRIAL area type                     ]
Rainfall intensity =      2.911(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.600(CFS) for    0.940(Ac.)
Total runoff =      9.957 (CFS)    Total area =       6.31(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      503.000 to Point/Station      504.000
**** SUBAREA FLOW ADDITION****
______________________________________________________________________
Decimal fraction soil group A=  0.000
```

Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Time of concentration = 14.92 min.
Rainfall intensity = 2.911(In/Hr) for a 100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff = 1.244(CFS) for 0.950(Ac.)
Total runoff = 11.202 (CFS) Total area = 7.26 (Ac.)

++
Process from Point/Station 504.000 to Point/Station 510.000
**** STREET FLOW TRAVEL TIME+ SUBAREA FLOW ADDITION****

Top of street segment elevation = 507.900(Ft.)
End of street segment elevation = 501.000(Ft.)
Length of street segment = 523.000(Ft.)
Height of curb above gutter flowline = 6.0(In.)
Width of half street (curb to crown) = 18.500(Ft.)
Distance from crown to crossfall grade break = 10.000(Ft.)
Slope from gutter to grade break (v/hz) = 0.020
Slope from grade break to crown (v/hz) = 0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line = 10.000(Ft.)
Slope from curb to property line (v/hz) = 0.020
Gutter width = 1.500(Ft.)
Gutter hike from flowline = 1.500(In.)
Manning's N in gutter = 0.0150
Manning's N from gutter to grade break = 0.0180
Manning's N from grade break to crown = 0.0180
Estimated mean flow rate at midpoint of street = 11.541(CFS)
Depth of flow = 0.472(Ft.), Average velocity = 3.191(Ft/s)
Note: depth of flow exceeds top of street crown.
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width = 18.500(Ft.)
Flow velocity = 3.19(Ft/s)
Travel time = 2.73 min. TC = 17.65 min.
Adding area flow to street
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Rainfall intensity = 2.722(In/Hr) for a 100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff = 0.539(CFS) for 0.440(Ac.)
Total runoff = 11.741(CFS) Total area = 7.70(Ac.)
Street flow at end of street = 11.741(CFS)
Half street flow at end of street = 11.741(CFS)
Depth of flow = 0.474(Ft.), Average velocity = 3.213(Ft/s)
Note: depth of flow exceeds top of street crown.
Flow width (from curb towards crown) = 18.500(Ft.)
End of computations, total study area = 7.700 (Ac.)

3

APPENDIX3

Proposed Conditions Rational Method Computer Output

```
San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control· Division 1985 hydrology manual
       Rational Hydrology Study        Date: 08/02/18
------------------------------------------------------------------------
2357.50 ILLUMINA
PROPOSED CONDITIONS
SYSTEM 100,  FILE: 1000P100
------------------------------------------------------------------------
 *********   Hydrology Study Control Information**********
------------------------------------------------------------------------


Program License Serial Number 4049
------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English  (in-lb)  input data Units used
English  (in)  rainfall data used

Standard intensity of Appendix I-Bused for year and
Elevation 0 - 1500  feet
Factor  (to multiply* intensity)  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual  'C' values used
Runoff coefficients by rational method


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1000.000 to Point/Station     1001.000
**** INITIAL AREA EVALUATION****
______________________________________________________________________
Decimal  fraction  soil  group A =  0.000
Decimal  fraction  soil  group B = 0.000
Decimal  fraction  soil  group C = 0.000
Decimal  fraction  soil  group D = 1.000
 [INDUSTRIAL area type                    ]
Initial  subarea flow distance  =  343.000(Ft.)
Highest elevation =  497.900(Ft.)
Lowest elevation=  492.100(Ft.)
Elevation difference=    5.800(Ft.)
Time of concentration·calculated by the urban
areas overland flow method  (App X-C)  =     4.20 min.
TC = [1.8*(1.1-C)*distance(Ft.)'.5)/(% slope'(1/3)]
TC = [1.8*(1.1-0.9500)*( 343.000'.5)/(   1.691'(1/3)]=   4.20
Setting time of concentration to 5 minutes
Rainfall intensity (I) =        4.389(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area  (Q=KCIA) is C = 0.950
Subarea runoff =       1.209(CFS)
Total initial stream area =         0.290 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1001.000 to Point/Station     1003.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****
______________________________________________________________________
Upstream point/station elevation =   488.500(Ft.)
Downstream point/station elevation =    488.300(Ft.)
```



```
Pipe length  =    18.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     1.209(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     1.209(CFS)
Normal flow depth in pipe =     5.51(In.)
Flow top width inside pipe =     8.77(In.)
Critical Depth =     6.07(In.)
Pipe flow velocity =       4.26(Ft/s)
Travel time through pipe =    0.07 min.
Time of concentration (TC) =      5.07 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1002.000 to Point/Station     1003.000
**** SUBAREA FLOW ADDITION****
______________________________________________________________________
Decimal  fraction  soil  group A = 0.000
Decimal  fraction  soil  group B = 0.000
Decimal  fraction  soil  group C = 0.000
Decimal  fraction  soil  group D = 1.000
 [INDUSTRIAL area type                    ]
Time of concentration =      5.07 min.
Rainfall intensity =      4.364(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.073(CFS)  for    0.500(Ac.)
Total runoff =      3.282(CFS)   Total area =         0.79 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1003.000 to Point/Station     1007.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****
______________________________________________________________________
Upstream point/station elevation =   488.300(Ft.)
Downstream point/station elevation =   483.100(Ft.)
Pipe length  =    411.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.282(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     3.282(CFS)
Normal flow depth in pipe =     8.26(In.)
Flow top width inside pipe =    11.11(In.)
Critical Depth =     9.31(In.)
Pipe flow velocity=       5.69(Ft/s)
Travel time through pipe =    1.20 min.
Time of concentration (TC) =      6.27 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1003.000 to Point/Station     1007.000
**** CONFLUENCE OF MINOR STREAMS****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.790(Ac.)
Runoff from this stream =       3.282(CFS)
Time of concentration =     6.27 min.
Rainfall intensity =     4.011(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1004.000 to Point/Station     1005.000
**** INITIAL AREA EVALUATION****
______________________________________________________________________
Decimal  fraction  soil  group A =  0.000
Decimal  fraction  soil  group B = 0.000
Decimal  fraction  soil  group C = 0.000
```

```
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                  ]
Initial subarea flow distance  =   80.000 (Ft.)
Highest elevation =  502.500(Ft.)
Lowest elevation =  501.700(Ft.)
Elevation difference =    0.800(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =     6.44 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.7000)*( 80.000^.5)/( 1.000^(1/3)]=   6.44
Rainfall intensity (I) =      3.970(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.700
Subarea runoff =      1.195(CFS)
Total initial stream area =       0.430(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1005.000 to Point/Station     1006.000
**** IMPROVED CHANNEL TRAVEL TIME****

Upstream point elevation =   501.700(Ft.)
Downstream point elevation =   496.500(Ft.)
Channel length thru subarea  =   532.000(Ft.)
Channel base width      =     2.000(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =      8.421 (CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    2.000(Ft.)
Flow(q) thru subarea =      8.421(CFS)
Depth of flow =    0.537(Ft.), Average velocity =   5.096(Ft/s)
Channel flow top width =    4.150(Ft.)
Flow Velocity =    5.10(Ft/s)
Travel time  =    1.74 min.
Time of concentration =    8.18 min.
Critical depth =      0.656(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                 ]
Rainfall intensity =      3.630(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.700
Subarea runoff =      13.213(CFS)  for    5.200(Ac.)
Total runoff =     14.408(CFS)   Total area =        5.63 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1006.000 to Point/Station     1009.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation=   483.700(Ft.)
Downstream point/station elevation =   483.400(Ft.)
Pipe length  =    31.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    14.408(CFS)
Nearest computed pipe diameter   =     21.00(In.)
Calculated individual pipe flow  =     14.408(CFS)
Normal flow depth in pipe =   15.94(In.)
Flow top width inside pipe =   17.96(In.)
Critical Depth =    16.91(In.)
Pipe flow velocity =      7.36(Ft/s)
Travel time through pipe =    0.07 min.
Time of concentration (TC) =     8.25 min.
```



```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1009.000 to Point/Station     1009.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                 ]
Time of concentration =     8.25 min.
Rainfall intensity =      3.619(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.750(CFS)  for    0.800(Ac.)
Total runoff =     17.158(CFS)   Total area=        6.43 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1009.000 to Point/Station     1007.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   483.300(Ft.)
Downstream point/station elevation =   483.100(Ft.)
Pipe length  =    22.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    17.158(CFS)
Nearest computed pipe diameter   =     24.00(In.)
Calculated individual pipe flow  =    17.158(CFS)
Normal flow depth in pipe=   16.17(In.)
Flow top width inside pipe =   22.50 (In.)
Critical Depth=    17.91(In.)
Pipe flow velocity =      7.62(Ft/s)
Travel time through pipe =    0.05 min.
Time of concentration (TC) =     8.30 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1008.000 to Point/Station     1007.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                 ]
Time of concentration =     8.30 min.
Rainfall intensity =      3.611(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.813(CFS)  for    0.820(Ac.)
Total runoff =     19.971(CFS)   Total area =        7.25 (Ac.)


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Process from Point/Station     1008.000 to Point/Station     1007.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 1 in normal stream number 2
Stream flow area =      7.250(Ac.)
Runoff from this stream =     19.971(CFS)
Time of concentration =    8.30 min.
Rainfall intensity =     3.611(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
```

```
No.          (CFS)          (min)                        (In/Hr)

1        3.282       6.27                       4.011
2       19.971       8.30                       3.611
Qmax(1) =
          1.000 *    1.000 *     3.282) +
          1.000 *    0.756*     19.971) + =       18.381
Qmax(2) =
          0.900 *    1.000 *     3.282) +
          1.000 *    1.000 *    19.971) + =       22.926

Total of 2 streams to confluence:
Flow rates before confluence point:
      3.282      19.971
Maximum flow rates at confluence using above data:
      18.381      22.926
Area of streams before confluence:
       0.790        7.250
Results of confluence:
Total flow rate =     22.926(CFS)
Time of concentration =      8.298 min.
Effective stream area after confluence =      8.040(Ac.)


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Process from Point/Station      1007.000 to Point/Station      1027.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   483.100(Ft.)
Downstream point/station elevation =   481.450(Ft.)
Pipe length =   109.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    22.926(CFS)
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    22.926(CFS)
Normal flow depth in pipe =   16.59(In.)
Flow top width inside pipe =   22.17(In.)
Critical Depth =   20.46(In.)
Pipe flow velocity =      9.89(Ft/s)
Travel time through pipe=    0.18 min.
Time of concentration (TC) =     8.48 min.


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Process from Point/Station      1007.000 to Point/Station      1027.000
**** CONFLUENCE OF MAIN STREAMS****

The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =      8.040(Ac.)
Runoff from this stream =     22.926(CFS)
Time of concentration=    8.48 min.
Rainfall intensity =     3.582(In/Hr)
Program is now starting with Main Stream No. 2


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Process from Point/Station      1010.000 to Point/Station      1011.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
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[INDUSTRIAL area type                    ]
Initial subarea flow distance  =  120.000(Ft.)
Highest elevation =  515.000(Ft.)
Lowest elevation=  513.100(Ft.)
Elevation difference =     1.900(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =      2.54 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.9500)*( 120.000^.5)/(  1.583^(1/3)]=   2.54
Setting time of concentration to 5 minutes
Rainfall intensity (I) =      4.389(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.950
Subarea runoff=      0.792(CFS)
Total initial stream area=        0.190(Ac.)


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Process from Point/Station      1011.000 to Point/Station      1013.000
**** STREET FLOW TRAVEL TIME+ SUBAREA FLOW ADDITION****

Top of street segment elevation =   513.100(Ft.)
End of street segment elevation =   495.400(Ft.)
Length of street segment  =   772.000(Ft.)
Height of curb above gutter flowline  =     6.0(In.)
Width of half street (curb to crown)  =  23.000(Ft.)
Distance from crown to crossfall grade break  =  18.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  12.000(Ft.)
Slope from curb to property line (v/hz)  =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =   0.0150
 Manning's N from gutter to grade break =  0.0150
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street=      2.731(CFS)
Depth of flow =   0.281(Ft.), Average velocity=   2.909(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =   9.315(Ft.)
Flow velocity =   2.91(Ft/s)
Travel time =     4.42 min.     TC =     9.42  min.
 Adding area flow to street
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Rainfall intensity =      3.447(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      3.046(CFS) for    0.930(Ac.)
Total runoff =      3.838(CFS)  Total area =         1.12 (Ac.)
Street flow at end of street=     3.838(CFS)
Half street flow at end of street =      3.838(CFS)
Depth of flow =   0.310(Ft.), Average velocity=   3.124(Ft/s)
Flow width (from curb towards crown)=  10.758(Ft.)


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Process from Point/Station      1012.000 to Point/Station      1013.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
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Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                              ]
Time of concentration =      9.42 min.
Rainfall intensity =      3.447(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.700
Subarea runoff =      7.481(CFS)  for    3.100(Ac.)
Total runoff =     11.319(CFS)   Total area=        4.22 (Ac.)


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Process from Point/Station     1013.000 to Point/Station     1015.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   491.800(Ft.)
Downstream point/station elevation =   488.200(Ft.)
Pipe length  =    13.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    11.319(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =    11.319(CFS)
Normal flow depth in pipe =    6.73(In.)
Flow top width inside pipe=   11.91(In.)
Critical depth could not be calculated.
Pipe flow velocity =     24.99(Ft/s)
Travel time through pipe =    0.01 min.
Time of concentration (TC) =     9.43 min.


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Process from Point/Station     1013.000 to Point/Station     1015.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                                 ]
Time of concentration =      9.43 min.
Rainfall intensity =      3.446(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      1.506(CFS)  for    0.460(Ac.)
Total runoff=     12.825(CFS)   Total area =        4. 68 (Ac.)


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Process from Point/Station     1015.000 to Point/Station     1023.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   488.200(Ft.)
Downstream point/station elevation =   483.200(Ft.)
Pipe length  =   444.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    12.825(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    12.825(CFS)
Normal flow depth in pipe =   13.73(In.)
Flow top width inside pipe =   19.98(In.)
Critical Depth =    16.00(In.)
Pipe flow velocity=      7.70(Ft/s)
Travel time through pipe =    0.96 min.
Time of concentration (TC) =     10.39 min.


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Process from Point/Station     1015.000 to Point/Station     1023.000
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**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 2 in normal stream number 1
Stream flow area =      4.680(Ac.)
Runoff from this stream =     12.825(CFS)
Time of concentration =   10.39 min.
Rainfall intensity =     3.327(In/Hr)


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Process from Point/Station     1018.000 to Point/Station     1021.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                              ]
Initial subarea flow distance  =  371.000 (Ft.)
Highest elevation =  494.000(Ft.)
Lowest elevation =  486.700(Ft.)
Elevation difference =    7.300(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =     4.15 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.9500)*( 371.000^.5)/(  1.968^(1/3)]=   4.15
Setting time of concentration to 5 minutes
Rainfall intensity (I) =      4.389(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.950
Subarea runoff =      3.002(CFS)
Total initial stream area =        0. 720 (Ac.)


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Process from Point/Station     1020.000 to Point/Station     1021.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Time of concentration =      5.00 min.
Rainfall intensity =      4.389(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =      5.905(CFS)  for    2.990(Ac.)
Total runoff =      8.908(CFS)   Total area =        3.71(Ac.)


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Process from Point/Station     1021.000 to Point/Station     1023.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   483.300(Ft.)
Downstream point/station elevation =   483.200(Ft.)
Pipe length  =    15.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     8.908(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =     8.908(CFS)
Normal flow depth in pipe =   12.80(In.)
Flow top width inside pipe =   20.49(In.)
Critical Depth =   13.31(In.)
Pipe flow velocity =      5.80(Ft/s)
Travel time through pipe =    0.04 min.
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Time of concentration (TC) =     5.04 min.


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Process from Point/Station     1022.000 to Point/Station     1023.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =     5.04 min.
Rainfall intensity =      4.374(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      3.116(CFS) for    0.750(Ac.)
Total runoff=     12.024(CFS)  Total area=        4.46 (Ac.)


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Process from Point/Station     1022.000 to Point/Station     1023.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 2 in normal stream number 2
Stream flow area=      4.460(Ac.)
Runoff from this stream =     12.024(CFS)
Time of concentration=    5.04 min.
Rainfall intensity=     4.374(In/Hr)
Summary of stream data:

Stream   Flow rate      TC             Rainfall Intensity
 No.       (CFS)       (min)                  (In/Hr)


1       12.825     10.39                 3.327
2       12.024      5.04                 4.374
Qmax(1)  =
           1.000 *    1.000 *    12.825) +
           0.761 *    1.000 *    12.024) + =      21.973
Qmax(2)  =
           1.000 *    0.485 *    12.825) +
           1.000 *    1.000 *    12.024) + =      18.247

Total of 2 streams to confluence:
Flow rates before confluence point:
      12.825      12.024
Maximum flow rates at confluence using above data:
       21.973       18.247
Area of streams before confluence:
        4.680        4.460
Results of confluence:
Total flow rate=     21.973(CFS)
Time of concentration =     10.393 min.
Effective stream area after confluence =      9.140(Ac.)


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Process from Point/Station     1023.000 to Point/Station     1027.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation=   482.900(Ft.)
Downstream point/station elevation =   481.500(Ft.)
Pipe length  =   158.00(Ft.)   Manning's N = 0.013
No. of pipes= 1  Required pipe flow  =    21.973(CFS)
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Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    21.973(CFS)
Normal flow depth in pipe=   20.44(In.)
Flow top width inside pipe=    17.07(In.)
Critical Depth=   20.08(In.)
Pipe flow velocity=      7.71(Ft/s)
Travel time through pipe=    0.34 min.
Time of concentration (TC) =    10.73 min.


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Process from Point/Station     1023.000 to Point/Station     1027.000
**** CONFLUENCE OF MAIN STREAMS****

The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area=      9.140(Ac.)
Runoff from this stream =     21.973(CFS)
Time of concentration=   10.73 min.
Rainfall intensity=     3.289(In/Hr)
Summary of stream data:

Stream   Flow rate      TC             Rainfall Intensity
 No.       (CFS)       (min)                  (In/Hr)


1       22.926      8.48                 3.582
2       21.973  .  10.73                 3.289
Qmax(1)  =
           1.000 *    1.000 *    22.926) +
           1.000 *    0.790 *    21.973) + =      40.287
Qmax(2)  =
           0.918 *    1.000 *    22.926) +
           1.000 *    1.000 *    21.973) + =      43.021

Total of 2 main streams to confluence:
Flow rates before confluence point:
      22.926      21.973
Maximum flow rates at confluence using above data:
       40.287       43.021
Area of streams before confluence:
        8.040        9.140


Results of confluence:
Total flow rate=     43.021(CFS)
Time of concentration =     10.735 min.
Effective stream area after confluence  =     17.180 (Ac.)


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Process from Point/Station     1024.000 to Point/Station     1027.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =     10.73 min.
Rainfall intensity =      3.289(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.281(CFS) for    0.730(Ac.)
Total runoff=     45.302(CFS)  Total area=       17.91 (Ac.)
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Process from Point/Station     1025.000 to Point/Station     1027.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =    10.73 min.
Rainfall intensity =      3.289(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.406(CFS)  for    0.770(Ac.)
Total runoff=     47.707(CFS)   Total area =       18.68 (Ac.)


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Process from Point/Station     1027.000 to Point/Station     1030.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =   481.500(Ft.)
Downstream point/station elevation =   478.900(Ft.)
Pipe length  =   389.00(Ft.)    Manning's N = 0.013
No. of pipes= 1  Required pipe flow  =    47.707(CFS)
Nearest computed pipe diameter  =     36.00(In.)
Calculated individual pipe flow  =    47.707(CFS)
Normal flow depth in pipe =   26.09(In.)
Flow top width inside pipe =   32.16(In.)
Critical Depth =   26.97(In.)
Pipe flow velocity =       8.70(Ft/s)
Travel time through pipe =    0.75 min.
Time of concentration (TC) =    11.48 min.


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Process from Point/Station     1027.000 to Point/Station     1030.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =    11.48 min.
Rainfall intensity =      3.210(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      0.945(CFS)  for    0.310(Ac.)
Total runoff =     48.653(CFS)   Total area =       18.99 (Ac.)


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Process from Point/Station     1029.000 to Point/Station     1030.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =    11.48 min.
Rainfall intensity =      3.210(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
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Subarea runoff =      1.037(CFS)  for    0.340(Ac.)
Total runoff =     49.689(CFS)   Total area=       19.33(Ac.)


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Process from Point/Station     1030.000 to Point/Station     1033.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =   478.900(Ft.)
Downstream point/station elevation =   476.200(Ft.)
Pipe length  =   447.00(Ft.)    Manning's N = 0.013
No. of pipes= 1  Required pipe flow  =    49.689(CFS)
Nearest computed pipe diameter  =     36.00(In.)
Calculated individual pipe flow  =    49.689(CFS)
Normal flow depth in pipe=   28.27(In.)
Flow top width inside pipe =   29.57 (In. )
Critical Depth =   27.53(In.)
Pipe flow velocity=      8.35(Ft/s)
Travel time through pipe =    0.89 min.
Time of concentration (TC) =    12.37 min.


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Process from Point/Station     1030.000 to Point/Station     1033.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 1 in normal stream number 1
Stream flow area =     19.330(Ac.)
Runoff from this stream =     49.689(CFS)
Time of concentration =   12.37 min.
Rainfall intensity=     3.123(In/Hr)


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Process from Point/Station     1042.000 to Point/Station     1043.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                 J
Initial subarea flow distance  =  211.000 (Ft.)
Highest elevation =  502.000(Ft.)
Lowest elevation =  496.500(Ft.)
Elevation difference =    5.500(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =     7.60 min.
TC = [1.8*(1.1-C)*distance(Ft.)'.5)/(% slope'(1/3)]
TC = [1.8*(1.1-0.7000)*( 211.000'.5)/( 2.607'(1/3)]=   7.60
Rainfall intensity (I) =      3.730(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.700
Subarea runoff =      0.809(CFS)
Total initial stream area =        0.310(Ac.)


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Process from Point/Station     1041.000 to Point/Station     1043.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
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 [RURAL(greater than 0.5 Ac, 0.2 ha) area type]
 Time of concentration =     7.60 min.
 Rainfall intensity =      3.730(In/Hr) for a   100.0 year storm
 Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
 Subarea runoff =      1.225(CFS) for    0.730(Ac.)
 Total runoff =      2.035(CFS)  Total area =       1.04 (Ac.)


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 Process from Point/Station     1043.000 to Point/Station     1044.000
 **** IMPROVED CHANNEL TRAVEL TIME****

______________________________________________________________________
 Upstream point elevation =   496.500(Ft.)
 Downstream point elevation =   487.000(Ft.)
 Channel length thru subarea  =  1040.000(Ft.)
 Channel base width       =     2.000(Ft.)
 Slope or 'Z' of left channel bank =   2.000
 Slope or 'Z' of right channel bank =   2.000
 Estimated mean flow rate at midpoint of channel =     18.449(CFS)
 Manning's 'N'    = 0.015
 Maximum depth of channel  =    2.000(Ft.)
 Flow(q) thru subarea =     18.449(CFS)
 Depth of flow=   0.820(Ft.), Average velocity =   6.177 (Ft/s)
 Channel flow top width =     5.282(Ft.)
 Flow Velocity =    6.18(Ft/s)
 Travel time  =    2.81 min.
 Time of concentration =    10.41 min.
 Critical depth =      1.000(Ft.)
  Adding area flow to channel
 Decimal fraction soil group A = 0.000
 Decimal fraction soil group B = 0.000
 Decimal fraction soil group C = 0.000
 Decimal fraction soil group D = 1.000
 [MULTI - UNITS area type                    ]
 Rainfall intensity =      3.326(In/Hr) for a   100.0 year storm
 Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.700
 Subarea runoff =     39.067(CFS) for    16.780(Ac.)
 Total runoff =     41.101(CFS)  Total area =       17.82 (Ac.)


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 Process from Point/Station     1044.000 to Point/Station     1032.000
 **** PIPEFLOW TRAVEL TIME (Program estimated size) ****

______________________________________________________________________
 Upstream point/station elevation=   482.000(Ft.)
 Downstream point/station elevation =   476.500(Ft.)
 Pipe length  =    24.00(Ft.)   Manning's N = 0.013
 No. of pipes= 1  Required pipe flow  =     41.101(CFS)
 Nearest computed pipe diameter  =     18.00(In.)
 Calculated individual pipe flow  =     41.101(CFS)
 Normal flow depth in pipe =   12.38(In.)
 Flow top width inside pipe=   16.69(In.)
 Critical depth could not be calculated.
 Pipe flow velocity =     31.74(Ft/s)
 Travel time through pipe=    0.01 min.
 Time of concentration (TC) =    10.42 min.


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 Process from Point/Station     1032.000 to Point/Station     1032.000
 **** SUBAREA FLOW ADDITION****

______________________________________________________________________
 Decimal fraction soil group A = 0.000
 Decimal fraction soil group B = 0.000
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 Decimal fraction soil group C = 0.000
 Decimal fraction soil group D = 1.000
 [INDUSTRIAL area type                      ]
 Time of concentration =    10.42 min.
 Rainfall intensity =      3.324(In/Hr) for a   100.0 year storm
 Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
 Subarea runoff =      2.053(CFS) for    0.650(Ac.)
 Total runoff =     43.154(CFS)  Total area =       18.47 (Ac.)


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 Process from Point/Station     1032.000 to Point/Station     1033.000
 **** PIPEFLOW TRAVEL TIME (Program estimated size) ****

______________________________________________________________________
 Upstream point/station elevation =   476.400(Ft.)
 Downstream point/station elevation =   476.200(Ft.)
 Pipe length  =    20.00(Ft.)   Manning's N = 0.013
 No. of pipes = 1  Required pipe flow  =     43.154(CFS)
 Nearest computed pipe diameter  =     30.00(In.)
 Calculated individual pipe flow  =     43.154(CFS)
 Normal flow depth in pipe =   26.34(In.)
 Flow top width inside pipe =   19.63(In.)
 Critical Depth =   26.32(In.)
 Pipe flow velocity =      9.46(Ft/s)
 Travel time through pipe =    0.04 min.
 Time of concentration (TC) =    10.45 min.


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 Process from Point/Station     1031.000 to Point/Station     1033.000
 **** SUBAREA FLOW ADDITION****

______________________________________________________________________
 Decimal fraction soil group A = 0.000
 Decimal fraction soil group B = 0.000
 Decimal fraction soil group C = 0.000
 Decimal fraction soil group D = 1.000
 [INDUSTRIAL area type                      ]
 Time of concentration =    10.45 min.
 Rainfall intensity =      3.320(In/Hr) for a   100.0 year storm
 Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
 Subarea runoff =      1.419(CFS) for    0.450(Ac.)
 Total runoff =     44.574(CFS)  Total area=       18.92 (Ac.)


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 Process from Point/Station     1031.000 to Point/Station     1033.000
 **** CONFLUENCE OF MINOR STREAMS****

______________________________________________________________________
 Along Main Stream number: 1 in normal stream number 2
 Stream flow area =     18.920(Ac.)
 Runoff from this stream =     44.574(CFS)
 Time of concentration =   10.45 min.
 Rainfall intensity =     3.320(In/Hr)
 Summary of stream data:

 Stream  Flow rate     TC            Rainfall Intensity
  No.      (CFS)      (min)                (In/Hr)


 1       49.689     12.37                 3.123
 2       44.574     10.45                 3.320
 Qmax (1)  =
           1.000 *    1.000 *    49.689)  +
           0.941 *    1.000 *    44.574)  + =      91.612
```

```
Qmax(2) =
          1.000 *    0.845 *    49.689) +
          1.000 *    1.000 *    44.574) + =      86.557

Total of 2 streams to confluence:
Flow rates before confluence point:
     49.689      44.574
Maximum flow rates at confluence using above data:
      91.612      86.557
Area of streams before confluence:
      19.330      18.920
Results of confluence:
Total flow rate =      91.612(CFS)
Time of concentration =     12.372 min.
Effective stream area after confluence =     38.250 (Ac.)


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Process from Point/Station     1033.000 to Point/Station     1040.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =    476.200(Ft.)
Downstream point/station elevation =    475.600(Ft.)
Pipe length  =    87.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     91.612(CFS)
Nearest computed pipe diameter  =      45.00(In.)
Calculated individual pipe flow  =     91.612(CFS)
Normal flow depth in pipe =    33.75(In.)
Flow top width inside pipe =    38.97(In.)
Critical Depth=    35.33(In.)
Pipe flow velocity=      10.31(Ft/s)
Travel time through pipe =     0.14 min.
Time of concentration  (TC)  =     12.51 min.


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Process from Point/Station     1033.000 to Point/Station     1040.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 1 in normal stream number 1
Stream flow area =      38.250(Ac.)
Runoff from this stream =      91.612(CFS)
Time of concentration =    12.51 min.
Rainfall intensity =      3.110(In/Hr)


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Process from Point/Station     1034.000 to Point/Station     1035.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                             1
Initial subarea flow distance  =  100.000 (Ft..)
Highest elevation =  498.000(Ft.)
Lowest elevation =  493.000(Ft.)
Elevation difference =     5.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =      4.21 min.
TC = [1.8*(1.1-C)*distance(Ft.)'.5)/(% slope'(1/3)]
TC = [1.8*(1.1-0.7000)*( 100.000'.5)/(    5.000'(1/3)] =    4.21
Setting time of concentration to 5 minutes
```



```
Rainfall intensity (I) =      4.389(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area  (Q=KCIA) is C = 0.700
Subarea runoff =      1.075(CFS)
Total initial stream area =        0.350(Ac.)


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Process from Point/Station     1035.000 to Point/Station     1036.000
**** IMPROVED CHANNEL TRAVEL TIME****

Upstream point elevation =    493.000(Ft.)
Downstream point elevation =    476.500(Ft.)
Channel length thru subarea  =  1050.000(Ft.)
Channel base width      =    2.000(Ft.)
Slope or 'Z' of left channel bank=   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =      9.294 (CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    2.000(Ft.)
Flow(q) thru subarea =      9.294(CFS)
Depth of flow =   0.499(Ft.), Average velocity =   6.210(Ft/s)
Channel flow top width =    3.997(Ft.)
Flow Velocity =     6.211Ft/s)
Travel time  =    2.82 min.
Time of concentration =     7.82 min.
Critical depth =      0.688(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                             ]
Rainfall intensity =      3.691(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.700
Subarea runoff =     13.822(CFS)  for    5.350(Ac.)
Total runoff =     14.898(CFS)   Total area =         5.70(Ac.)


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Process from Point/Station     1036.000 to Point/Station     1037.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =    476.500(Ft.)
Downstream point/station elevation =    476.340(Ft.)
Pipe length  =    14.00(Ft.)    Manning's N = 0.013
No. of pipes= 1  Required pipe flow  =     14.898(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    14.898(CFS)
Normal flow depth in pipe =    15.28(In.)
Flow top width inside pipe =    18.70(In.)
Critical Depth =    17.16(In.)
Pipe flow velocity=      7.95(Ft/s)
Travel time through pipe =     0.03 min.
Time of concentration  (TC)  =     7.85 min.


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Process from Point/Station     1037.000 to Point/Station     1039.000
**** PIPE,LOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =    476.340(Ft.)
Downstream point/station elevation =    476.280(Ft.)
Pipe length  =     6.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    14.898(CFS)
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Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    14.898(CFS)
Normal flow depth in pipe =   16.17(In.)
Flow top width inside pipe =   17.67(In.)
Critical Depth =   17.16(In.)
Pipe flow velocity =      7.49(Ft/s)
Travel time through pipe =    0.01 min.
Time of concentration (TC) =     7.86 min.

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Process from Point/Station     1037.000 to Point/Station     1039.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                         ]
Time of concentration=      7.86 min.
Rainfall intensity =      3.683(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.700
Subarea runoff =      0.464(CFS)  for    0.180(Ac.)
Total runoff =     15.362(CFS)   Total area =        5.88(Ac.)

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Process from Point/Station     1038.000 to Point/Station     1039.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                         ]
Time of concentration =      7.86 min.
Rainfall intensity =      3.683(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.700
Subarea runoff =      0.464(CFS)  for    0.180(Ac.)
Total runoff=     15.826(CFS)   Total area=        6.06 (Ac.)

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Process from Point/Station     1039.000 to Point/Station     1040.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   476.180(Ft.)
Downstream point/station elevation =   475.600(Ft.)
Pipe length  =    66.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     15.826(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    15.826(CFS)
Normal flow depth in pipe =   18.90(In.)
Flow top width inside pipe =   12.60(In.)
Critical Depth =   17.62(In.)
Pipe flow velocity =      6.94(Ft/s)
Travel time through pipe =    0.16 min.
Time of concentration (TC) =     8.02 min.

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Process from Point/Station     1039.000 to Point/Station     1040.000
**** CONFLUENCE OF MINOR STREAMS****
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Along Main Stream number: 1 in normal stream number 2
Stream flow area =     6.060(Ac.)
Runoff from this stream =     15.826 (CFS)
Time of concentration=    8.02 min.
Rainfall intensity =    3.656(In/Hr)
Summary of stream data:

Stream   Flow rate      TC              Rainfall Intensity
 No.       (CFS)       (min)                   (In/Hr)


1        91.612     12.51                   3.110
2        15.826      8.02                   3.656
Qmax(1)  =
             1.000 *    1.000 *    91.612)  +
             0.851 *    1.000 *    15.826)  + =     105.073
Qmax(2)  =
             1.000 *    0.641 *    91.612)  +
             1.000 *    1.000 *    15.826)  + =      74.537

Total of 2 streams to confluence:
Flow rates before confluence point:
      91.612      15.826
Maximum flow rates at confluence using above data:
      105.073      74.537
Area of streams before confluence:
       38.250        6.060
Results of confluence:
Total flow rate =    105.073 (CFS)
Time of concentration =    12.513 min.
Effective stream area after confluence =     44.310(Ac.)

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Process from Point/Station     1040.000 to Point/Station     1052.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   475.500(Ft.)
Downstream point/station elevation =   474.950(Ft.)
Pipe length  =    91.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    105.073(CFS)
Nearest computed pipe diameter  =     48.00(In.)
Calculated individual pipe flow  =    105.073(CFS)
Normal flow depth in pipe=   37.03(In.)
Flow top width inside pipe =   40.31(In.)
Critical Depth =   37.24(In.)
Pipe flow velocity =     10.11(Ft/s)
Travel time through pipe =    0.15 min.
Time of concentration (TC) =    12.66 min.

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Process from Point/Station     1050.000 to Point/Station     1052.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                              ]
Time of concentration =    12.66 min.
Rainfall intensity =      3.096(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.030(CFS)  for    0.690 (Ac.)
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Total runoff =     107.102(CFS)   Total area =        45.00 (Ac.)


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Process from Point/Station     1051.000 to Point/Station     1052.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =     12.66 min.
Rainfall intensity =      3.096(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      1.265(CFS)  for    0.430(Ac.)
Total runoff =    108.367(CFS)   Total area =        45.43(Ac.)


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Process from Point/Station     1052.000 to Point/Station     1049.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation=   474.850(Ft.)
Downstream point/station elevation =     0.000(Ft.)
Pipe length  =   236.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   108.367(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =   108.367(CFS)
Normal flow depth in pipe =   11.39(In.)
Flow top width inside pipe =   17.35(In.)
Critical depth could not be calculated.
Pipe flow velocity =     91.97(Ft/s)
Travel time through pipe =    0.04 min.
Time of concentration (TC) =    12.71 min.


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Process from Point/Station     1052.000 to Point/Station     1049.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 1 in normal stream number 1
Stream flow area =     45.430(Ac.)
Runoff from this stream =    108.367(CFS)
Time of concentration =   12.71 min.
Rainfall intensity =     3.092(In/Hr)


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Process from Point/Station     1060.000 to Point/Station     1045.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Initial subarea flow distance  =  152.000 (Ft.)
Highest elevation=  494.000(Ft.)
Lowest elevation =  487.000(Ft.)
Elevation difference=    7.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =     2.00 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
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```
TC = [1.8*(1.1-0.9500)*( 152.000^.5)/(   4.605^(1/3)]=   2.00
Setting time of concentration to 5 minutes
Rainfall intensity (I) =       4.389(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.950
Subarea runoff =      1.251(CFS)
Total initial stream area =        0.300(Ac.)


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Process from Point/Station     1045.000 to Point/Station     1047.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =  483.300(Ft.)
Downstream point/station elevation =  482.900(Ft.)
Pipe length  =     6.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     1.251(CFS)
Nearest computed pipe diameter  =     6.00(In.)
Calculated individual pipe flow  =     1.251(CFS)
Normal flow depth in pipe =    4.30(In.)
Flow top width inside pipe =    5.41(In.)
Critical depth could not be calculated.
Pipe flow velocity =      8.30(Ft/s)
Travel time through pipe =    0.01 min.
Time of concentration (TC) =     5.01 min.


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Process from Point/Station     1046.000 to Point/Station     1047.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =     5.01 min.
Rainfall intensity =      4.385(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      0.833(CFS)  for    0.200(Ac.)
Total runoff =      2.084(CFS)   Total area =        0.50 (Ac.)


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Process from Point/Station     1047.000 to Point/Station     1049.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =  482.530(Ft.)
Downstream point/station elevation =  473.500(Ft.)
Pipe length  =   260.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.084(CFS)
Nearest computed pipe diameter  =     9.00(In.)
Calculated individual pipe flow  =     2.084(CFS)
Normal flow depth in pipe =    5.42(In.)
Flow top width inside pipe=    8.Sl(In.)
Critical Depth =    7.83(In.)
Pipe flow velocity =      7.49(Ft/s)
Travel time through pipe =    0.58 min.
Time of concentration (TC) =     5.59 min.


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Process from Point/Station     1047.000 to Point/Station     1049.000
**** CONFLUENCE OF MINOR STREAMS****
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Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.500(Ac.)
Runoff from this stream =      2.084(CFS)
Time of concentration =    5.59 min.
Rainfall intensity =     4.196(In/Hr)
Summary of stream data:

Stream   Flow rate      TC              Rainfall Intensity
No.        (CFS)        (min)                   (In/Hr)


1      108.367     12.71                  3.092
2        2.084      5.59                  4.196
Qmax(1) =
          1.000 *    1.000 *   108.367) +
          0.737 *    1.000 *     2.084) + =      109.903
Qmax(2) =
          1.000 *    0.440 *   108.367) +
          1.000 *    1.000 *     2.084) + =       49.763

Total of 2 streams to confluence:
Flow rates before confluence point:
    108.367       2.084
Maximum flow rates at confluence using above data:
     109.903       49.763
Area of streams before confluence:
      45.430        0.500
Results of confluence:
Total flow rate =    109.903(CFS)
Time of concentration =    12.706 min.
Effective stream area after confluence =      45.930(Ac.)


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Process from Point/Station     1049.000 to Point/Station     1066.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   473.330(Ft.)
Downstream point/station elevation =   467.000(Ft.)
Pipe length  =    516.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    109.903(CFS)
Nearest computed pipe diameter  =      42.00(In.)
Calculated individual pipe flow  =    109.903(CFS)
Normal flow depth in pipe =    33.94(In.)
Flow top width inside pipe =    33.08(In.)
Critical Depth =    38.03(In.)
Pipe flow velocity =      13.20(Ft/s)
Travel time through pipe =    0.65 min.
Time of concentration (TC) =    13.36 min.


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Process from Point/Station     1064.000 to Point/Station     1066.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MULTI - UNITS area type                            ]
Time of concentration =    13.36 min.
Rainfall intensity =      3.036(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.700
Subarea runoff =      26.902(CFS)  for   12.660(Ac.)
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Total runoff =    136.805(CFS)  Total area =       58.59 (Ac.)


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Process from Point/Station     1049.000 to Point/Station     1066.000
**** CONFLUENCE OF MAIN STREAMS****

The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =      58.590(Ac.)
Runoff from this stream =     136.805(CFS)
Time of concentration =    13.36 min.
Rainfall intensity =     3.036(In/Hr)
Program is now starting with Main Stream No. 2


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Process from Point/Station     1067.000 to Point/Station     1055.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                            ]
Initial subarea flow distance  =  300.000(Ft.)
Highest elevation =   508.000(Ft.)
Lowest elevation =  504.000(Ft.)
Elevation difference =    4.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =      4.25 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.9500)*( 300.000^.5)/(   1.333^(1/3)]=    4.25
Setting time of concentration to 5 minutes
Rainfall intensity (I) =       4.389(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.950
Subarea runoff=      1.876(CFS)
Total initial stream area =         0.450(Ac.)


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Process from Point/Station     1055.000 to Point/Station     1057.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   499.000(Ft.)
Downstream point/station elevation =   498.900(Ft.)
Pipe length  =       9.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =      1.876(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =      1.876(CFS)
Normal flow depth in pipe =    6.00(In.)
Flow top width inside pipe =   12.00(In.)
Critical Depth =    7.00(In.)
Pipe flow velocity =      4.78(Ft/s)
Travel time through pipe =    0.03 min.
Time of concentration (TC) =     5.03 min.


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Process from Point/Station     1056.000 to Point/Station     1057.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
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Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                  ]
Time of concentration =      5.03 min.
Rainfall intensity =      4.378(In/Hr)  for a   100.0  year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      4.201(CFS)  for    1.010(Ac.)
Total runoff =      6.077(CFS)   Total area=        1.46 (Ac.)


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Process from Point/Station     1057.000 to Point/Station     1058.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =    498.600(Ft.)
Downstream point/station elevation =    488.800(Ft.)
Pipe length  =   477.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     6.077(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     6.077(CFS)
Normal flow depth in pipe =    8.86(In.)
Flow top width inside pipe=   14.75(In.)
Critical Depth =   11.95(In.)
Pipe flow velocity =      8.05(Ft/s)
Travel time through pipe =    0.99 min.
Time of concentration (TC) =      6.02 min.


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Process from Point/Station     1057.000 to Point/Station     1058.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                  ]
Time of concentration =      6.02 min.
Rainfall intensity =      4.076(In/Hr)  for a   100.0  year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.788(CFS)  for    0.720(Ac.)
Total runoff =      8.865(CFS)   Total area=        2.18 (Ac.)


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Process from Point/Station     1059.000 to Point/Station     1058.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                  ]
Time of concentration =      6.02 min.
Rainfall intensity =      4.076(In/Hr)  for a   100.0  year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.362(CFS)  for    0.610(Ac.)
Total runoff =     11.226(CFS)   Total area =        2.79 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1058.000 to Point/Station     1063.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
```



```
Upstream point/station elevation =    488.360(Ft.)
Downstream point/station elevation =    470.560(Ft.)
Pipe length  =   693.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    11.226(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =    11.226(CFS)
Normal flow depth in pipe =   10.75(In.)
Flow top width inside pipe =   17.66(In.)
Critical Depth =   15.37(In.)
Pipe flow velocity =     10.20(Ft/s)
Travel time through pipe =    1.13 min.
Time of concentration (TC) =      7.15 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1062.000 to Point/Station     1063.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                  ]
Time of concentration =      7.15 min.
Rainfall intensity =      3.815(In/Hr)  for a   100.0  year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      3.371(CFS)  for    0.930(Ac.)
Total runoff =     14.597(CFS)   Total area =        3.72 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1063.000 to Point/Station     1061.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =    470.230(Ft.)
Downstream point/station elevation =    470.000(Ft.)
Pipe length  =    19.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    14.597(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    14.597(CFS)
Normal flow depth in pipe =   14.?0(In.)
Flow top width inside pipe =   19.25(In.)
Critical Depth =   17.01(In.)
Pipe flow velocity=      8.12(Ft/s)
Travel time through pipe =    0.04 min.
Time of concentration (TC) =      7.19 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1060.000 to Point/Station     1061.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                  ]
Time of concentration =      7.19 min.
Rainfall intensity =      3.808(In/Hr)  for a   100.0  year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      3.907(CFS)  for    1.080(Ac.)
Total runoff =     18.504(CFS)   Total area =        4.80 (Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      1061.000 to Point/Station      1066.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =    469.710(Ft.)
Downstream point/station elevation =    467.000(Ft.)
Pipe length  =     52.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     18.504(CFS)
Nearest computed pipe diameter  =      18.00(In.)
Calculated individual pipe flow  =     18.504(CFS)
Normal flow depth in pipe =    11.86(In.)
Flow top width inside pipe =    17.07(In.)
Critical depth could not be calculated.
Pipe flow velocity =      14.97(Ft/s)
Travel time through pipe =    0.06 min.
Time of concentration (TC) =      7.25 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      1061.000 to Point/Station      1066.000
**** CONFLUENCE OF MAIN STREAMS****

The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =       4.800(Ac.)
Runoff from this stream =      18.504(CFS)
Time of concentration =     7.25 min.
Rainfall intensity =      3.796(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1      136.805     13.36                  3.036
2       18.504      7.25                  3.796
Qmax(1) =
            1.000 *    1.000 *   136.805) +
            0.800 *    1.000 *    18.504) + =     151.601
Qmax(2) =
            1.000 *    0.543 *   136.805) +
            1.000 *    1.000 *    18.504) + =      92.743

Total of 2 main streams to confluence:
Flow rates before confluence point:
     136.805       18.504
Maximum flow rates at confluence using above data:
      151.601       92.743
Area of streams before confluence:
       58.590        4.800


Results of confluence:
Total flow rate =    151.601(CFS)
Time of concentration =    13.357 min.
Effective stream area after confluence  =      63.390(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      1066.000 to Point/Station      1066.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
```



```
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Time of concentration =     13.36 min.
Rainfall intensity =      3.036(In/Hr)  for a    100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =      0.000(CFS)  for    0.000(Ac.)
Total runoff =    151.601(CFS)   Total area =       63.39(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      1066.000 to Point/Station      1068.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =    465.500(Ft.)
Downstream point/station elevation =    430.000(Ft.)
Pipe length  =    264.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    151.601(CFS)
Nearest computed pipe diameter  =      30.00(In.)
Calculated individual pipe flow  =    151.601(CFS)
Normal flow depth in pipe =    24.80(In.)
Flow top width inside pipe =    22.72(In.)
Critical depth could not be calculated.
Pipe flow velocity =      34.92(Ft/s)
Travel time through pipe =    0.13 min.
Time of concentration (TC) =    13.48 min.
End of computations, total study area =          63.390  (Ac.)
```

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              San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
       Rational Hydrology Study        Date: 08/02/18
------------------------------------------------------------------------
2357.50 ILLUMINA
PROPOSED CONDITIONS
SYSTEM 200,  FILE: 2000P100

------------------------------------------------------------------------
 *********   Hydrology Study Control Information**********

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


Program License Serial Number 4049

------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English  (in-lb)  input data Units used
English  (in)  rainfall data used

Standard intensity of Appendix I-Bused for year and
Elevation 0 - 1500  feet
Factor  (to multiply* intensity)  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual  'C' values used
Runoff coefficients by rational method


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     2000.000 to Point/Station     2001.000
**** INITIAL AREA EVALUATION****

Decimal  fraction  soil  group  A = 0.000
Decimal  fraction  soil  group  B = 0.000
Decimal  fraction  soil  group  C = 0.000
Decimal  fraction  soil  group  D = 1.000
 [RURAL(greater than 0.5 Ac,  0.2 ha)  area type]
Initial  subarea  flow  distance  =  306.000(Ft.)
Highest elevation =  498.000(Ft.)
Lowest elevation =  490.000(Ft.)
Elevation difference =    8.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method  (App X-C)  =     14.86 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4500)*( 306,000^.5)/( 2.614^(1/3)]=  14.86
Rainfall intensity  (I) =       2.916(In/Hr)  for a    100.0 year storm
Effective runoff coefficient used for area  (Q=KCIA) is C = 0.450
Subarea runoff =       2.257(CFS)
Total initial stream area =        1.720 (Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     2001.000 to Point/Station     2003.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =   489.000(Ft.)
Downstream point/station elevation =    473.700(Ft.)
Pipe length  =    420.00(Ft.)    Manning's N = 0.013
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No. of pipes = 1  Required pipe flow  =     2.257(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     2.257(CFS)
Normal flow depth in pipe=     5.63(In.)
Flow top width inside pipe=    8.71(In.)
Critical Depth =    8.06(In.)
Pipe flow velocity =        7.77(Ft/s)
Travel time through pipe =    0.90 min.
Time of concentration (TC) =    15.76 min.


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     2002.000 to Point/Station     2003.000
**** SUBAREA FLOW ADDITION****

Decimal  fraction  soil  group  A = 0.000
Decimal  fraction  soil  group  B = 0.000
Decimal  fraction  soil  group  C = 0.000
Decimal  fraction  soil  group  D = 1.000
 [RURAL(greater than 0.5 Ac,  0.2 ha)  area type]
Time of concentration=    15.76 min.
Rainfall intensity =      2.850(In/Hr)  for a    100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =      3.680(CFS)  for    2.870(Ac.)
Total runoff =      5.937(CFS)   Total area =        4.59(Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     2003.000 to Point/Station     2004.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =   473.400(Ft.)
Downstream point/station elevation =   471.900(Ft.)
Pipe length  =   152.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     5.937(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     5.937(CFS)
Normal flow depth in pipe =   11.39(In.)
Flow top width inside pipe=   12.82(In.)
Critical Depth =   11.82(In.)
Pipe flow velocity =       5.94(Ft/s)
Travel time through pipe =    0.43 min.
Time of concentration (TC) =    16.18 min.


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     2004.000 to Point/Station     2005.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =   471.600(Ft.)
Downstream point/station elevation =   460.000(Ft.)
Pipe length  =    950.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     5.937(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     5.937(CFS)
Normal flow depth in pipe =   10.45(In.)
Flow top width inside pipe=   13.79(In.)
Critical Depth =   11.82(In.)
Pipe flow velocity=      6.51(Ft/s)
Travel time through pipe =    2.43 min.
Time of concentration (TC) =    18.62 min.


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Process from Point/Station     2006.000 to Point/Station     2005.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac, 0.2 ha) area type]
Time of concentration =    18.62 min.
Rainfall intensity =      2.662(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =      4.288(CFS)  for    3.580(Ac.)
Total runoff =     10.226(CFS)   Total area =        8.17(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     2005.000 to Point/Station     2008.000
**** PIPEFLOW TRAVEL TIME (Program estimated size)  ****

Upstream point/station elevation =    463.430(Ft.)
Downstream point/station elevation =    406.500(Ft.)
Pipe length  =   135.00(Ft.)    Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     10.226(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =    10.226(CFS)
Normal flow depth in pipe =    7.02(In.)
Flow top width inside pipe =    7.46(In.)
Critical depth could not be calculated.
Pipe flow velocity =     27.68(Ft/s)
Travel time through pipe =    0.08 min.
Time of concentration (TC) =    18.70 min.
End of computations, total study area =           8.170  (Ac.)
```

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                San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
        Rational Hydrology Study        Date:  10/13/17
-------------------------------------------------------------------------
2357.50 ILLUMINA
PROPOSED CONDITIONS
SYSTEM 300,  FILE:  3000P100

-------------------------------------------------------------------------
 *********     Hydrology Study Control Information**********

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


Program License Serial Number 4049

-------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English  (in-lb} input data Units used
English  (in} rainfall data used

Standard intensity of Appendix ,I-Bused for year and
Elevation O - 1500 feet
Factor  (to multiply* intensity}  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual  'C' values used
Runoff coefficients by rational method


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     3000.000  to Point/Station     3002.000
**** INITIAL AREA EVALUATION****
_________________________________________________________________________
Decimal  fraction  soil  group A = 0.000
Decimal  fraction  soil  group B = 0.000
Decimal  fraction  soil  group C = 0.000
Decimal  fraction  soil  group D = 1.000
 [INDUSTRIAL area type                          l
Initial  subarea  flow  distance   =   130.000(Ft.}
Highest elevation =  499.000(Ft.}
Lowest elevation =  496.200(Ft.}
Elevation difference =    2.BOO(Ft.}
Time of concentration calculated by the urban
areas overland flow method  (App X-C}  =     2.38 min.
TC = [1.8*(1.1-C}*distance(Ft.}^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.9500)*( 130.000^.5}/(   2.154^(1/3}]=   2.38
Setting time of concentration to 5 minutes
Rainfall intensity (I} =      4.389(In/Hr}  for a   100.0  year storm
Effective runoff coefficient used for area  (Q=KCIA} is C = 0.950
Subarea runoff=      1.25l(CFS}
Total initial stream area =        0.300(Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     3001.000  to Point/Station     3002.000
**** SUBAREA FLOW ADDITION****
_________________________________________________________________________
Decimal  fraction  soil  group A = 0.000
Decimal  fraction  soil  group B = 0.000
```



```
Decimal  fraction  soil  group C = 0.000
Decimal  fraction  soil  group D = 1. 000
 [INDUSTRIAL area type                        ]
Time of concentration =      5.00 min.
Rainfall intensity =      4.389(In/Hr}  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA,  C = 0.950
Subarea runoff =       2.669(CFS)  for    0.640(Ac.)
Total runoff =      3.919(CFS)   Total area=        0. 94 (Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     3002.000  to Point/Station     3003.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****
_________________________________________________________________________
Upstream point/station elevation =   490.520(Ft.)
Downstream point/station elevation =   488.400(Ft.)
Pipe length  =   310.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.919(CFS)
Nearest computed pipe diameter  =     15.00(In.}
Calculated individual pipe flow  =     3.919(CFS)
Normal flow depth in pipe =     9.55(In.}
Flow top width inside pipe =   14.43(In.}
Critical Depth =     9.6l(In.}
Pipe flow velocity =       4.76(Ft/s}
Travel time through pipe=    1.09 min.
Time of concentration '(TC} =      6.09 min.
End of computations, total study area =          0.940  (Ac.}
```

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            San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
      Rational Hydrology Study        Date: 07/31/18
------------------------------------------------------------------------
2357.50 ILLUMINA
PROPOSED CONDITIONS
SYSTEM 4000,  FILE:  4000P100

------------------------------------------------------------------------
 *********   Hydrology Study Control Information**********

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


Program License Serial Number 4049

------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English  (in-lb) input data Units used
English  (in) rainfall data used

Standard intensity of Appendix I-Bused for year and
Elevation 0 - 1500  feet
Factor  (to multiply* intensity)  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual  'C' values used
Runoff coefficients by rational method


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4019.000 to Point/Station     4010.000
**** INITIAL AREA EVALUATION****

Decimal  fraction  soil  group A = 0.000
Decimal  fraction  soil  group B = 0.000
Decimal  fraction  soil  group C = 0.000
Decimal  fraction  soil  group D = 1.000
[INDUSTRIAL area type                      ]
Initial  subarea  flow distance  =  880.000 (Ft.)
Highest elevation =  515.000(Ft.)
Lowest elevation=  502.000(Ft.)
Elevation difference =   13.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method  (App X-C)  =     7.03 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/ (% slope^(1/3)]
TC = [1.8*(1.1-0.9500)*( 880.000^.5)/( 1.477^(1/3)]=   7.03
Rainfall intensity  (I)  =      3.840(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area  (Q=KCIA) is C = 0.950
Subarea runoff=      6.967(CFS)
Total initial stream area =        1.910 (Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4010.000 to Point/Station     4011.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation=   498.100(Ft.)
Downstream point/station elevation =   497.300(Ft.)
Pipe length  =    80.00(Ft.)    Manning's N = 0.013
```


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```
No. of pipes = 1  Required pipe flow  =     6.967(CFS)
Nearest computed pipe diameter  =    18.00(In.)
Calculated individual pipe  now  =     6.967 (CFS)
Normal flow depth in pipe =   10.71(In.)
Flow top width inside pipe =   17.67(In.)
Critical Depth =   12.26(In.)
Pipe flow velocity =      6.36(Ft/s)
Travel time through pipe =    0.21 min.
Time of concentration  (TC) =     7.24 min.


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4009.000 to Point/Station     4011.000
**** SUBAREA FLOW ADDITION****

Decimal  fraction  soil  group A = 0.000
Decimal  fraction  soil  group B = 0.000
Decimal  fraction  soil  group C = 0.000
Decimal  fraction  soil  group D = 1.000
[INDUSTRIAL area type                      ]
Time of concentration =     7.24 min.
Rainfall intensity =      3.797(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.778(CFS)  for    0.770(Ac.)
Total runoff =      9.745(CFS)  Total area =        2.68 (Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4009.000 to Point/Station     4011.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 1 in normal stream number 1
Stream flow area=      2.680(Ac.)
Runoff from this stream =      9.745(CFS)
Time of concentration =    7.24 min.
Rainfall intensity =     3.797(In/Hr)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4003.000 to Point/Station     4005.000
**** INITIAL AREA EVALUATION****

Decimal  fraction  soil  group A = 0.000
Decimal  fraction  soil  group B = 0.000
Decimal  fraction  soil  group C = 0.000
Decimal  fraction  soil  group D = 1.000
[INDUSTRIAL area type                      ]
Initial  subarea  flow distance  =  632.000 (Ft.)
Highest elevation =  515.000(Ft.)
Lowest elevation =  508.300(Ft.)
Elevation difference=    6.700(Ft.)
Time of concentration calculated by the urban
areas overland flow method  (App X-C)  =     6.66 min.
TC= [1.8*(1.1-C)*distance(Ft.)^.5)/ (% slope^(1/3)]
TC= [1.8*(1.1-0.9500)*( 632.000^.5)/( 1.060^(1/3)]=   6.66
Rainfall intensity  (I)  =      3.920(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area  (Q=KCIA) is C = 0.950
Subarea runoff =      4.842(CFS)
Total initial stream area =        1.300 (Ac.)


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Process from Point/Station     4005.000 to Point/Station     4008.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****
```

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Upstream point/station elevation =    502.000(Ft.)
Downstream point/station elevation =    501.730(Ft.)
Pipe length  =    13.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =      4.842(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     4.842(CFS)
Normal flow depth in pipe =     9.27(In.)
Flow top width inside pipe =   10.06(In.)
Critical Depth =   10.90(In.)
Pipe flow velocity =       7.43(Ft/s)
Travel time through pipe =    0.03 min.
Time of concentration  (TC) =     6.69 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4004.000 to Point/Station     4008.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                        ]
Time of concentration =      6.69 min.
Rainfall intensity =      3.914(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      6.953(CFS)  for     1.870(Ac.)
Total runoff =     11.795(CFS)   Total area =        3.17 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4018.000 to Point/Station     4008.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[RURAL(greater than 0.5 Ac,  0.2 ha) area type]
Time of concentration =      6.69 min.
Rainfall intensity =      3.914(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.450
Subarea runoff =      7.010(CFS)  for     3.980(Ac.)
Total runoff =     18.804(CFS)   Total area =        7.15(Ac.)


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Process from Point/Station     4008.000 to Point/Station     4011.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation=    501.400(Ft.)
Downstream point/station elevation =    493.360(Ft.)
Pipe length  =    766.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    18.804(CFS)
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    18.804(CFS)
Normal flow depth in pipe =    16.41(In.)
Flow top width inside pipe=   22.32(In.)
Critical Depth =   18.73(In.)
Pipe flow velocity =       8.22(Ft/s)
Travel time through pipe =    1.55 min.
Time of concentration  (TC) =     8.24 min.
```



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++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4008.000 to Point/Station     4011.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 1 in normal stream number 2
Stream flow area =      7.150(Ac.)
Runoff from this stream =     18.804(CFS)
Time of concentration =     8.24 min.
Rainfall intensity =     3.620(In/Hr)
Summary of stream data:

Stream   Flow rate      TC              Rainfall  Intensity
 No.       (CFS)       (min)                   (In/Hr)


1        9.745      7.24                  3.797
2       18.804      8.24                  3.620
Qmax(1)  =
          1.000  *    1.000  *      9.745)  +
          1.000  *    0.879  *     18.804)  + =      26.273
Qmax(2)  =
          0.953  *    1.000  *      9.745)  +
          1.000  *    1.000  *     18.804)  + =      28.094

Total of 2 streams to confluence:
Flow rates before confluence point:
      9.745       18.804
Maximum flow rates at confluence using above data:
     26.273       28.094
Area of streams before confluence:
      2.680        7.150
Results of confluence:
Total flow rate =     28.094(CFS)
Time of concentration =     8.240 min.
Effective stream area after confluence =      9.830(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4011.000 to Point/Station     4017.000
**** PIPEFLOW TRAVEL TIME  (Program estimated size)  ****

Upstream point/station elevation =    496.800(Ft.)
Downstream point/station elevation =    492.560(Ft.)
Pipe length  =    421.78(Ft.)   Manning's N = 0.013
No. of pipes= 1  Required pipe flow  =    28.094(CFS)
Nearest computed pipe diameter  =     27.00(In.)
Calculated individual pipe flow  =    28.094(CFS)
Normal flow depth in pipe=   20.11(In.)
Flow top width inside pipe=   23.54(In.)
Critical Depth =   22.13(In.)
Pipe flow velocity=      8.84(Ft/s)
Travel time through pipe =    0.79 min.
Time of concentration  (TC) =     9.03 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4011.000 to Point/Station     4017.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 1 in normal stream number 1
Stream flow area =      9.830(Ac.)
Runoff from this stream =     28.094(CFS)
Time of concentration =     9.03 min.
```

```
Rainfall intensity =      3.501(In/Hr)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4012.000 to Point/Station     4013.000
**** INITIAL AREA EVALUATION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Note: user entry of impervious value, Ap = 0.850
Initial subarea flow distance  =  180.000(Ft.)
Highest elevation=  506.000(Ft.)
Lowest elevation=  504.200(Ft.)
Elevation difference =     1.800(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =      4.90 min.
TC = [1.8*(1.1-C)*distance(Ft.)'.5)/(% slope'(1/3)]
TC = [1.8*(1.1-0.8972)*( 180.000'.5)/(   1.000'(1/3)] =   4.90
Setting time of concentration to 5 minutes
Rainfall intensity (I) =       4.389(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.897
Subarea runoff =      4.056(CFS)
Total initial stream area =        1.030 (Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4013.000 to Point/Station     4014.000
**** IMPROVED CHANNEL TRAVEL TIME****

Upstream point elevation=   504.200(Ft.)
Downstream point elevation =   496.000(Ft.)
Channel length thru subarea  =   840.000(Ft.)
Channel base width      =   3.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank=   4.000
Estimated mean flow rate at midpoint of channel =      23.608(CFS)
Manning's 'N'     = 0.015
Maximum depth of channel  =    2.000(Ft.)
Flow(q) thru subarea =     23.608(CFS)
Depth of flow =    0.698(Ft.), Average velocity =   5.845(Ft/s)
Channel flow top width =    8.580(Ft.)
Flow Velocity =    5.85(Ft/s)
Travel time  =    2.40 min.
Time of concentration =     7.40 min.
Critical depth =      0.859(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Rainfall intensity =      3.768(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =     35.545(CFS) for    9.930(Ac.)
Total runoff =     39.601(CFS)  Total area =       10. 96 (Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4014.000 to Point/Station     4015.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
```



```
Upstream point/station elevation =   494.780(Ft.)
Downstream point/station elevation =   494.620(Ft.)
Pipe length  =    27.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    39.601(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    39.601(CFS)
Normal flow depth in pipe =   26.25(In.)
Flow top width inside pipe =   26.62(In.)
Critical Depth =   25.14(In.)
Pipe flow velocity =      7.81(Ft/s)
Travel time through pipe =    0.06 min.
Time of concentration (TC) =     7.45 min.


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4010.000 to Point/Station     4015.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =     7.45 min.
Rainfall intensity =      3.757(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      3.284(CFS) for    0.920(Ac.)
Total runoff =     42.884(CFS)  Total area =       11.88(Ac.)


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4015.000 to Point/Station     4016.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   494.520(Ft.)
Downstream point/station elevation =   494.150(Ft.)
Pipe length  =    63.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    42.884(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    42.884(CFS)
Normal flow depth in pipe =   29.25(In.)
Flow top width inside pipe =   20.95(In.)
Critical Depth =   26.09(In.)
Pipe flow velocity =      7.71(Ft/s)
Travel time through pipe =    0.14 min.
Time of concentration (TC) =     7.59 min.


+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4009.000 to Point/Station     4016.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                    ]
Time of concentration =     7.59 min.
Rainfall intensity =      3.732(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      2.233(CFS) for    0.630(Ac.)
Total runoff =     45.118(CFS)  Total area =       12.51(Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4016.000 to Point/Station     4017.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   494.050(Ft.)
Downstream point/station elevation =   492.560(Ft.)
Pipe length  =   219.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    45.118(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    45.118(CFS)
Normal flow depth in pipe =   28.22(In.)
Flow top width inside pipe =   23.23(In.)
Critical Depth =   26.71(In.)
Pipe flow velocity=      8.35(Ft/s)
Travel time through pipe =    0.44 min.
Time of concentration (TC) =     8.03 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4016.000 to Point/Station     4017.000
**** CONFLUENCE OF MINOR STREAMS****

Along Main Stream number: 1 in normal stream number 2
Stream flow area =     12.510(Ac.)
Runoff from this stream =     45.118(CFS)
Time of concentration=    8.03 min.
Rainfall intensity=     3.655(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       28.094      9.03                    3.501
2       45 .118     8.03                    3.655
Qmax(1) =
            1.000 *    1.000 *    28.094) +
            0.958 *    1.000 *    45.118) + =       71.302
Qmax(2) =
            1.000 *    0.888 *    28.094) +
            1.000 *    1.000 *    45.118) + =       70.076

Total of 2 streams to confluence:
Flow rates before confluence point:
      28.094       45.118
Maximum flow rates at confluence using above data:
       71.302       70.076
Area of streams before confluence:
        9.830       12.510
Results of confluence:
Total flow rate =     71.302(CFS)
Time of concentration =     9.035 min.
Effective stream area after confluence =     22.340(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4017.000 to Point/Station     4020.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   492.460(Ft.)
Downstream point/station elevation =   492.000(Ft.)
Pipe length  =    78.00(Ft.)   Manning's N = 0.013
No. of pipes= 1  Required pipe flow  =    71.302(CFS)
Nearest computed pipe diameter  =     42.00(In.)
```



```
Calculated individual pipe flow  =    71.302(CFS)
Normal flow depth in pipe =   31.83(In.)
Flow top width inside pipe =   35.99(In.)
Critical Depth =   31.73(In.)
Pipe flow velocity =      9.11(Ft/s)
Travel time through pipe =    0.14 min.
Time of concentration (TC) =     9.18 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4000.000 to Point/Station     4020.000
**** SUBAREA FLOW ADDITION****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[COMMERCIAL area type                        ]
Time of concentration =     9.18 min.
Rainfall intensity =     3.481(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.850
Subarea runoff =     34.260(CFS)  for   11.580(Ac.)
Total runoff =    105.562(CFS)   Total area =       33.92 (Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     4020.000 to Point/Station     4025.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   484.500(Ft.)
Downstream point/station elevation -   482.900(Ft.)
Pipe length  =    80.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   105.562(CFS)
Nearest computed pipe diameter  =     39.00(In.)
Calculated individual pipe flow  =   105.562(CFS)
Normal flow depth in pipe =   29.02(In.)
Flow top width inside pipe =   34.04(In.)
Critical Depth =   36.70(In.)
Pipe flow velocity =     15.94(Ft/s)
Travel time through pipe =    0.08 min.
Time of concentration (TC) =     9.26 min.
End of computations, total study area =          33.920 (Ac.)
```

```
San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
       Rational Hydrology Study        Date: 07/31/18
------------------------------------------------------------------------
2357.50 ILLUMINA
PROPOSED CONDITIONS
SYSTEM 500, FILE: 5000P100
------------------------------------------------------------------------
 *********  Hydrology Study Control Information**********
------------------------------------------------------------------------

Program License Serial Number 4049
------------------------------------------------------------------------
Rational hydrology study storm event year is  100.0
English (in-lb) input data Units used
English (in) rainfall data used

Standard intensity of Appendix I-Bused for year and
Elevation 0 - 1500 feet
Factor (to multiply* intensity)  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual 'C' values used
Runoff coefficients by rational method

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     5000.000 to Point/Station     5003.000
**** INITIAL AREA EVALUATION****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                       ]
Initial subarea flow distance  =  470.000(Ft.)
Highest elevation=  510.000(Ft.)
Lowest elevation =  502.000(Ft.)
Elevation difference =    8.000(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =     4.90 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.9500)*( 470.000^.5)/(   1.702^(1/3)]=    4.90
Setting time of concentration to 5 minutes
Rainfall intensity (I) =       4.389(In/Hr)  for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.950
Subarea runoff =       1.501(CFS)
Total initial stream area=        0.360 (Ac.)

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     5003.000 to Point/Station     5008.000
**** STREET FLOW TRAVEL TIME+ SUBAREA FLOW ADDITION****
______________________________________________________________________
Top of street segment elevation =   502.000 (Ft.)
End of street segment elevation =   497.500 (Ft.)
```



```
Length of street segment  =   320.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  26.000(Ft.)
Distance from crown to crossfall grade break  =  10.000(Ft.)
Slope from gutter to grade break (v/hz)  =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  15.000(Ft.)
Slope from curb to property line (v/hz)  =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =       1.918(CFS)
Depth of flow =   0.278(Ft.), Average velocity=   2.117(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width=   9.136(Ft.)
Flow velocity =   2.12(Ft/s)
Travel time=    2.52 min.     TC =    7.52  min.
 Adding area flow to street
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                       ]
Rainfall intensity =      3.745(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      0.711(CFS)  for    0.200(Ac.)
Total runoff=      2.213(CFS)  Total area=        0.56 (Ac.)
Street flow at end of street=      2.213(CFS)
Half street flow at end of street =       2.213(CFS)
Depth of flow =   0.289(Ft.), Average velocity=   2.187(Ft/s)
Flow width (from curb towards crown)=   9.697(Ft.)

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     5002.000 to Point/Station     5008.000
**** SUBAREA FLOW ADDITION****
______________________________________________________________________
Decimal fraction soil group A =  0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                       ]
Time of concentration =     7.52 min.
Rainfall intensity =      3.745(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
Subarea runoff =      4.304(CFS)  for    1.210(Ac.)
Total runoff=      6.517(CFS)  Total area=        1.77 (Ac.)

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     5005.000 to Point/Station     5008.000
**** SUBAREA FLOW ADDITION****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[INDUSTRIAL area type                       ]
Time of concentration =     7.52 min.
Rainfall intensity =      3.745(In/Hr)  for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.950
```

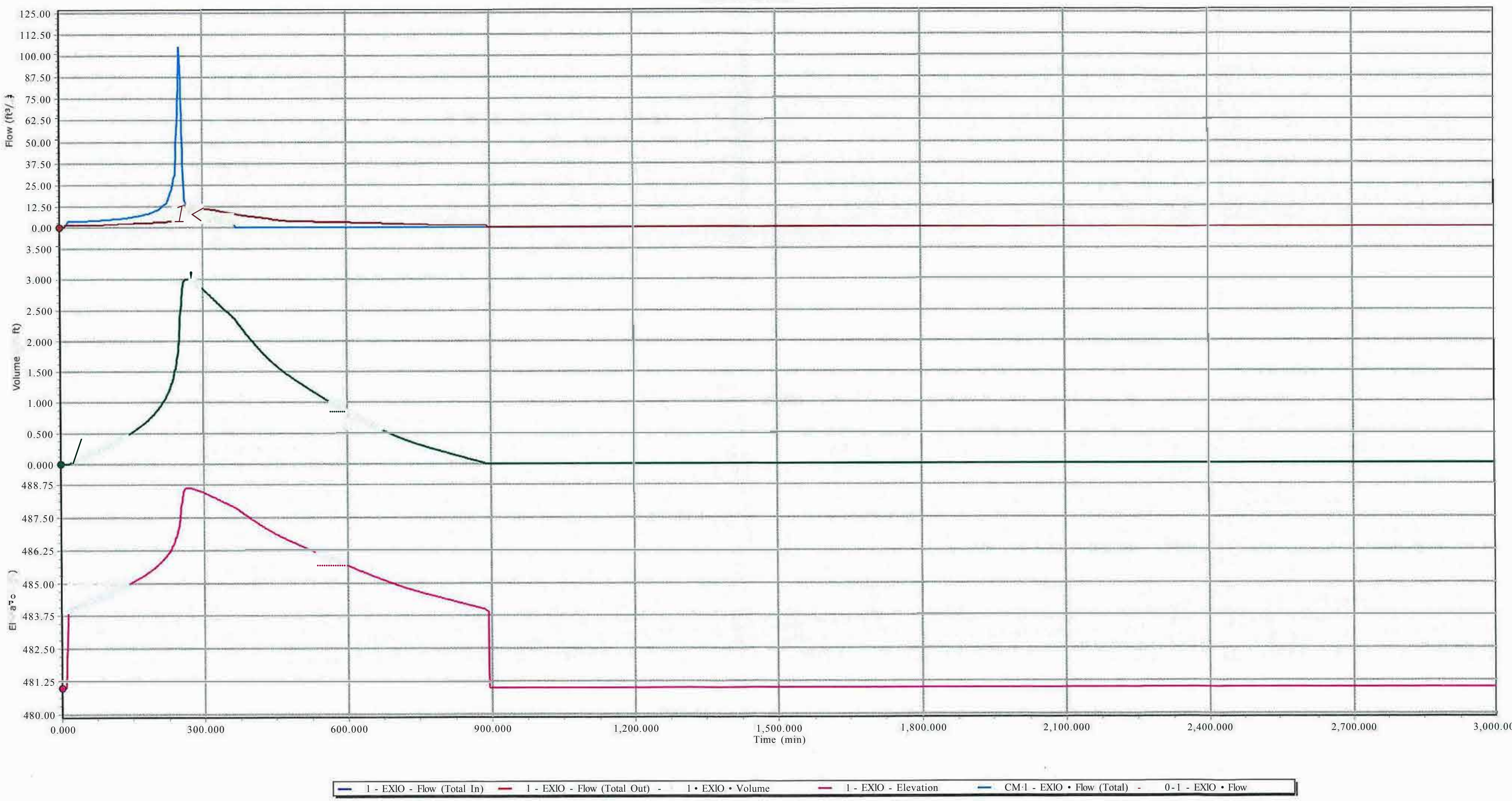
```
Subarea runoff=      0.391(CFS)  for    0.110(Ac.)
Total runoff=      6.908(CFS)   Total area =        1.88(Ac.)
End of computations, total study area =           1.880  (Ac.)
```

4

APPEND1X4

Preliminary Detention Calculations

North Basin



125.00
112.50
100.00
87.50
75.00
62.50
50.00
37.50
25.00
12.50
0.00
Flow (ft³/s)
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
Volume (ft)
488.75
487.50
486.25
485.00
483.75
482.50
481.25
480.00
0.000
300.000
600.000
900.000
1,200.000
1,500.000
1,800.000
2,100.000
2,400.000
2,700.000
3,000.000
Time (min)
1 - EXIO - Flow (Total In)
1 - EXIO - Flow (Total Out)
1 • EXIO • Volume
1 - EXIO - Elevation
CM·1 - EXIO • Flow (Total)
0-1 - EXIO • Flow

North Basin

Project Summary	
Title	System 4000- North Basin
Engineer	PDC
Company	PDC
Date	7/23/2018

Notes

North Basin

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft³/s)
, ♦M-1	EX10	0	4.893	2s2.000	105.60

Node Summary

Label	Scenario	J. R,etorii\ :Eyent<:> •:(years)/:>	.Hydrograph ;yolume! (aq:/t/::;:.	:time tC'Peak .<(foq)X:.?.. ' _♦x ,,,,. ,, >♦♦♦. <♦ >	Peak Flow (ft³/s)
0-1	EX10	0	4.893	267.000	13.35

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft³/s)	M♦i<imum; :,\iJatei'.;[; <Surface EfevaiJaW :: ·tctJ:t::rt·	,M;:ixi111u:m ':Pond Stora.ge (ac-ft)
1 (IN)	EX10	0	4.893	252.000	105.60	(N/A)	(N/A)
1 (OUT)	EX10	0	4.893	267.000	13.35	488.63	3.009

North Basin

Subsection: Read Hydrograph
Label: CM-1

Return Event: 100 years
Storm Event:

Peak Discharge	105.60 ft.3/s
Time to Peak	252.000 min
Hydrograph Volume	4.893 ac-ft.

HYDROGRAPH ORDINATES (ft3 /s)
Output Time Increment = 9.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.000	0.00	0.00	3.60	3.70	3.80
45.000	3.90	4.00	4.10	4.30	4.40
90.000	4.60	4.70	5.00	5.10	5.40
135.000	5.60	6.00	6.30	6.80	7.10
180.000	7.90	8.40	9.60	10.40	12.70
225.000	14.50	21.30	32.00	105.60	17.10
270.000	11.40	8.90	7.50	6.50	5.80
315.000	5.30	4.90	4.50	4.20	4.00
360.000	3.80	0.00	(N/A)	(N/A)	(N/A)

North Basin

Subsection: Elevation-Area Volume Curve | Return Event: 100 years
Label: 1 | Storm Event:

Elevation (ft)	Planimeter (ft^2)	Area (ft^2)	A1+A2+sqr (A1*A2) (ft^2)	Volume (ac-ft)	Volume (Total) (ac-ft)
481.00	0.0	10.000	0.000	0.000	0.000
483.90	0.0	10.000	30.000	0.001	0.001
484.00	0.0	18,816.000	19,259.774	0.015	0.015
490.00	0.0	45,867.000	94,060.431	4.319	4.334

North Basin

Subsection: Volume Equations | Return Event: 100 years
Label: 1 | Storm Event:

Pond Volume Equations

***Incremental volume computed by the Conic Method for Reservoir Volumes.**

Volume = (1/3) * (Ell - Ell) * (Areal + Areal + sqr(Area1 * Areal))

where:	Ell, EL2	Lower and upper elevations of the increment
	Areal, Area2	Areas computed for Ell, EL2, respectively
	Volume	Incremental volume between Ell and EL2

North Basin

Subsection: Outlet Input Data | Return Event: 100 years
Label: Outlet#l | Storm Event:

Requested Pond Water Surface Elevations	
Minimum (Headwater)	481.00 ft
Increment (Headwater)	0.10 ft
Maximum (Headwater)	490.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Circular	1-Lowflow orifice	Forward	TW	484.50	490.00
Orifice-Circular	2-Midflow orifice	Forward	TW	486.50	490.00
Orifice-Circular	3-Highflow orifice	Forward	TW	487.50	490.00
Stand Pipe	Riser - 1	Forward	TW	488.50	490.00
Orifice-Circular	0-Underdrain orifice	Forward	TW	481.25	490.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

North Basin

Subsection: Outlet Input Data — Return Event: 100 years
Label: Outlet#l — Storm Event:

Structure ID: 0-Underdrain orifice Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	481.25 ft
Orifice Diameter	6.0 in
Orifice Coefficient	0.600

Structure ID: 2-Midflow orifice Structure Type: Orifice-Circular	
Number of Openings	3
Elevation	486.50 ft
Orifice Diameter	6.0 in
Orifice Coefficient	0.600

Structure ID: 3-Highflow orifice Structure Type: Orifice-Circular	
Number of Openings	2
Elevation	487.50 ft
Orifice Diameter	8.0 in
Orifice Coefficient	0.600

Structure ID: Riser - 1 Structure Type: Stand Pipe	
Number of Openings	1
Elevation	488.50 ft
Diameter	36.0 in
Orifice Area	7.1 ft^2
Orifice Coefficient	Q.600
Weir Length	9.42 ft
Weir Coefficient	3.00 (ft^0.5)/S
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	True

Structure ID: 1-Lowflow orifice Structure Type: Orifice-Circular	
Number of Openings	3
Elevation	484.50 ft
Orifice Diameter	4.0 in
Orifice Coefficient	0.600

North Basin

Subsection: Outlet Input Data | Return Event: 100 years
Label: Outlet#l | Storm Event:

Structure ID: TW
Structure Type: TW Setup, DS Channel

Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft3/s
Flow Tolerance (Maximum)	10.000 ft3/s

North Basin

Subsection: Composite Rating Curve
Label: Outlet#l

Return Event: 100 years
Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
481.00	0.00	(N/A)	0.00
481.10	0.00	(N/A)	0.00
481.20	0.00	(N/A)	0.00
481.25	0.00	(N/A)	0.00
481.30	0.01	(N/A)	0.00
481.40	0.05	(N/A)	0.00
481.50	0.13	(N/A)	0.00
481.60	0.25	(N/A)	0.00
481.70	0.38	(N/A)	0.00
481.80	0.52	(N/A)	0.00
481.90	0.60	(N/A)	0.00
482.00	0.67	(N/A)	0.00
482.10	0.73	(N/A)	0.00
482.20	0.79	(N/A)	0.00
482.30	0.85	(N/A)	0.00
482.40	0.90	(N/A)	0.00
482.50	0.95	(N/A)	0.00
482.60	0.99	(N/A)	0.00
482.70	1.04	(N/A)	0.00
482.80	1.08	(N/A)	0.00
482.90	1.12	(N/A)	0.00
483.00	1.16	(N/A)	0.00
483.10	1.20	(N/A)	0.00
483.20	1.23	(N/A)	0.00
483.30	1.27	(N/A)	0.00
483.40	1.30	(N/A)	0.00
483.50	1.34	(N/A)	0.00
483.60	1.37	(N/A)	0.00
483.70	1.40	(N/A)	0.00
483.80	1.43	(N/A)	0.00
483.90	1.46	(N/A)	0.00
484.00	1.49	(N/A)	0.00
484.10	1.52	(N/A)	0.00
484.20	1.55	(N/A)	0.00
484.30	1.58	(N/A)	0.00
484.40	1.61	(N/A)	0.00
484.50	1.64	(N/A)	0.00
484.60	1.72	(N/A)	0.00
484.70	1.90	(N/A)	0.00
484.80	2.13	(N/A)	0.00
484.90	2.35	(N/A)	0.00
485.00	2.50	(N/A)	0.00
485.10	2.62	(N/A)	0.00

North Basin

Subsection: Composite Rating Curve
Label: Outlet#l

Return Event: 100 years
Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
485.20	2.74	(N/A)	0.00
485.30	2.84	(N/A)	0.00
485.40	2.95	(N/A)	0.00
485.50	3.04	(N/A)	0.00
485.60	3.13	(N/A)	0.00
485.70	3.22	(N/A)	0.00
485.80	3.30	(N/A)	0.00
485.90	3.38	(N/A)	0.00
486.00	3.46	(N/A)	0.00
486.10	3.54	(N/A)	0.00
486.20	3.61	(N/A)	0.00
486.30	3.68	(N/A)	0.00
486.40	3.75	(N/A)	0.00
486.50	3.82	(N/A)	0.00
486.60	3.96	(N/A)	0.00
486.70	4.22	(N/A)	0.00
486.80	4.58	(N/A)	0.00
486.90	5.02	(N/A)	0.00
487.00	5.56	(N/A)	0.00
487.10	5.88	(N/A)	0.00
487.20	6.16	(N/A)	0.00
487.30	6.42	(N/A)	0.00
487.40	6.66	(N/A)	0.00
487.50	6.89	(N/A)	0.00
487.60	7.16	(N/A)	0.00
487.70	7.52	(N/A)	0.00
487.80	7.96	(N/A)	0.00
487.90	8.47	(N/A)	0.00
488.00	9.03	(N/A)	0.00
488.10	9.63	(N/A)	0.00
488.20	10.26	(N/A)	0.00
488.30	10.69	(N/A)	0.00
488.40	11.09	(N/A)	0.00
488.50	11.46	(N/A)	0.00
488.60	12.71	(N/A)	0.00
488.70	14.68	(N/A)	0.00
488.80	17.12	(N/A)	0.00
488.90	19.94	(N/A)	0.00
489.00	23.09	(N/A)	0.00
489.10	26.53	(N/A)	0.00
489.20	30.23	(N/A)	0.00
489.30	34.18	(N/A)	0.00
489.40	38.36	(N/A)	0.00

North Basin

Subsection: Composite Rating Curve — Return Event: 100 years

Label: Outlet#l — Storm Event:

Composite Outflow Summary

water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
489.50	42.76	(N/A)	0.00
489.60	47.36	(N/A)	0.00
489.70	52.16	(N/A)	0.00
489.80	54.03	(N/A)	0.00
489.90	55.74	(N/A)	0.00
490.00	57.39	(N/A)	0.00

Contributing Structures
None Contributing
None Contributing
None Contributing
None Contributing
0-Underdrain orifice
0-Underdrain orifice
0-Underdrain orifice
0-Underdrain orifice
0-Underdrain orifice
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0-Underdrain orifice
0-Underdrain orifice

North Basin

Subsection: Composite Rating Curve — Return Event: 100 years
Label: Outlet#1 — Storm Event:

Composite Outflow Summary

Contributing Structures
0-Underdrain orifice
0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
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1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 0-Underdrain orifice
1-Lowflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice

North Basin

Subsection: Composite Rating Curve — Return Event: 100 years

Label: Outlet#l — Storm Event:

Composite Outflow Summary

}C:d6ti\bufipg ?tr.I.let res
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice

North Basin

Subsection: Composite Rating Curve | Return Event: 100 years
Label: Outlet#l | Storm Event:

Composite Outflow Summary

Contributing structures
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 3-Highflow orifice + Riser - 1 + 0-Underdrain orifice

North Basin

Subsection: Elevation-Volume-Flow Table (Pond) | Return Event: 100 years
Label: 1 | Storm Event:

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	481.00 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	1.000 min

Elevation (ft)	Outflow (ft³/s)	Storage (ac-ft)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
481.00	0.00	0.000	10.000	0.00	0.00	0.00
481.10	0.00	0.000	10.000	0.00	0.00	0.03
481.20	0.00	0.000	10.000	0.00	0.00	0.07
481.25	0.00	0.000	10.000	0.00	0.00	0.08
481.30	0.01	0.000	10.000	0.00	0.01	0.11
481.40	0.05	0.000	10.000	0.00	0.05	0.19
481.50	0.13	0.000	10.000	0.00	0.13	0.30
481.60	0.25	0.000	10.000	0.00	0.25	0.45
481.70	0.38	0.000	10.000	0.00	0.38	0.62
481.80	0.52	0.000	10.000	0.00	0.52	0.78
481.90	0.60	0.000	10.000	0.00	0.60	0.90
482.00	0.67	0.000	10.000	0.00	0.67	1.00
482.10	0.73	0.000	10.000	0.00	0.73	1.10
482.20	0.79	0.000	10.000	0.00	0.79	1.19
482.30	0.85	0.000	10.000	0.00	0.85	1.28
482.40	0.90	0.000	10.000	0.00	0.90	1.36
482.50	0.95	0.000	10.000	0.00	0.95	1.45
482.60	0.99	0.000	10.000	0.00	0.99	1.52
482.70	1.04	0.000	10.000	0.00	1.04	1.60
482.80	1.08	0.000	10.000	0.00	1.08	1.68
482.90	1.12	0.000	10.000	0.00	1.12	1.75
483.00	1.16	0.000	10.000	0.00	1.16	1.82
483.10	1.20	0.000	10.000	0.00	1.20	1.90
483.20	1.23	0.001	10.000	0.00	1.23	1.97
483.30	1.27	0.001	10.000	0.00	1.27	2.03
483.40	1.30	0.001	10.000	0.00	1.30	2.10
483.50	1.34	0.001	10.000	0.00	1.34	2.17
483.60	1.37	0.001	10.000	0.00	1.37	2.24
483.70	1.40	0.001	10;000	0.00	1.40	2.30

North Basin

Subsection: Elevation-Volume-Flow Table (Pond)   Return Event: 100 years
Label: 1   Storm Event:

Elevation (ft)	Outflow (ft^3/s)	Storage (ac-ft)	Area (ft^2)	Infiltration (ft^3/s)	Flow (Total) (ft^3/s)	2S/t + O (ft^3/s)
483.80	1.43	0.001	10.000	0.00	1.43	2.37
483.90	1.46	0.001	10.000	0.00	1.46	2.43
484.00	1.49	0.015	18,816.000	0.00	1.49	23.86
484.10	1.52	0.059	19,169.694	0.00	1.52	87.20
484.20	1.55	0.103	19,526.682	0.00	1.55	151.72
484.30	1.58	0.149	19,886.963	0.00	1.58	217.44
484.40	1.61	0.195	20,250.538	0.00	1.61	284.36
484.50	1.64	0.242	20,617.406	0.00	1.64	352.50
484.60	1.72	0.289	20,987.568	0.00	1.72	421.92
484.70	1.90	0.338	21,361.023	0.00	1.90	492.68
484.80	2.13	0.387	21,737.771	0.00	2.13	564.75
484.90	2.35	0.438	22,117.812	0.00	2.35	638.06
485.00	2.50	0.489	22,501.148	0.00	2.50	712.57
485.10	2.62	0.541	22,887.776	0.00	2.62	788.34
485.20	2.74	0.594	23,277.698	0.00	2.74	865.40
485.30	2.84	0.648	23,670.913	0.00	2.84	943.75
485.40	2.95	0.703	24,067.422	0.00	2.95	1,023.41
485.50	3.04	0.759	24,467.224	0.00	3.04	1,104.40
485.60	3.13	0.815	24,870.320	0.00	3.13	1,186.72
485.70	3.22	0.873	25,276.709	0.00	3.22	1,270.38
485.80	3.30	0.931	25,686.391	0.00	3.30	1,355.40
485.90	3.38	0.991	26,099.367	0.00	3.38	1,441.79
486.00	3.46	1.051	26,515.636	0.00	3.46	1,529.56
486.10	3.54	1.112	26,935.199	0.00	3.54	1,618.72
486.20	3.61	1.175	27,358.055	0.00	3.61	1,709.28
486.30	3.68	1.238	27,784.204	0.00	3.68	1,801.26
486.40	3.75	1.302	28,213.647	0.00	3.75	1,894.66
486.50	3.82	1.368	28,646.383	0.00	3.82	1,989.49
486.60	3.96	1.434	29,082.413	0.00	3.96	2,085.84
486.70	4.22	1.501	29,521.736	0.00	4.22	2,183.78
486.80	4.58	1.569	29,964.352	0.00	4.58	2,283.28
486.90	5.02	1.639	30,410.262	0.00	5.02	2,384.34
487.00	5.56	1.709	30,859.466	0.00	5.56	2,487.00
487.10	5.88	1.780	31,311.962	0.00	5.88	2,590.94
487.20	6.16	1.853	31,767.752	0.00	6.16	2,696.35
487.30	6.42	1.926	32,226.836	0.00	6.42	2,803.27
487.40	6.66	2.001	32,689.213	0.00	6.66	2,911.70
487.50	6.89	2.076	33,154.883	0.00	6.89	3,021.67
487.60	7.16	2.153	33,623.847	0.00	7.16	3,133.24
487.70	7.52	2.231	34,096.104	0.00	7.52	3,246.46
487.80	7.96	2.309	34,571.655	0.00	7.96	3,361.35
487.90	8.47	2.389	35,050.499	0.00	8.47	3,477.89
488.00	9.03	2.470	35,532.636	0.00	9.03	3,596.09

North Basin

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years
Label: 1 Storm Event:

Elevation (ft)	Outflow (ft3/s)	Storage (ac-ft)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
488.10	9.63	2.553	36,018.067	0.00	9.63	3,715.94
488.20	10.26	2.636	36,506.791	0.00	10.26	3,837.45
488.30	10.69	2.720	36,998.809	0.00	10.69	3,960.38
488.40	11.09	2.806	37,494.120	0.00	11.09	4,084.93
488.50	11.46	2.892	37,992.724	0.00	11.46	4,211.12
488.60	12.71	2.980	38,494.622	0.00	12.71	4,339.84
488.70	14.68	3.069	38,999.813	0.00	14.68	4,470.97
488.80	17.12	3.159	39,508.298	0.00	17.12	4,604.26
488.90	19.94	3.250	40,020.076	0.00	19.94	4,739.63
489.00	23.09	3.343	40,535.148	0.00	23.09	4,877.03
489.10	26.53	3.437	41,053.512	0.00	26.53	5,016.45
489.20	30.23	3.531	41,575.171	0.00	30.23	5,157.86
489.30	34.18	3.627	42,100.123	0.00	34.18	5,301.27
489.40	38.36	3.725	42,628.368	0.00	38.36	5,446.67
489.50	42.76	3.823	43,159.906	0.00	42.76	5,594.04
489.60	47.36	3.923	43,694.738	0.00	47.36	5,743.40
489.70	52.16	4.024	44,232.863	0.00	52.16	5,894.75
489.80	54.03	4.126	44,774.282	0.00	54.03	6,044.96
489.90	55.74	4.229	45,318.994	0.00	55.74	6,196.82
490.00	57.39	4.334	45,867.000	0.00	57.39	6,350.45

North Basin

Subsection: Pond Inflow Summary
Label: 1 (IN)

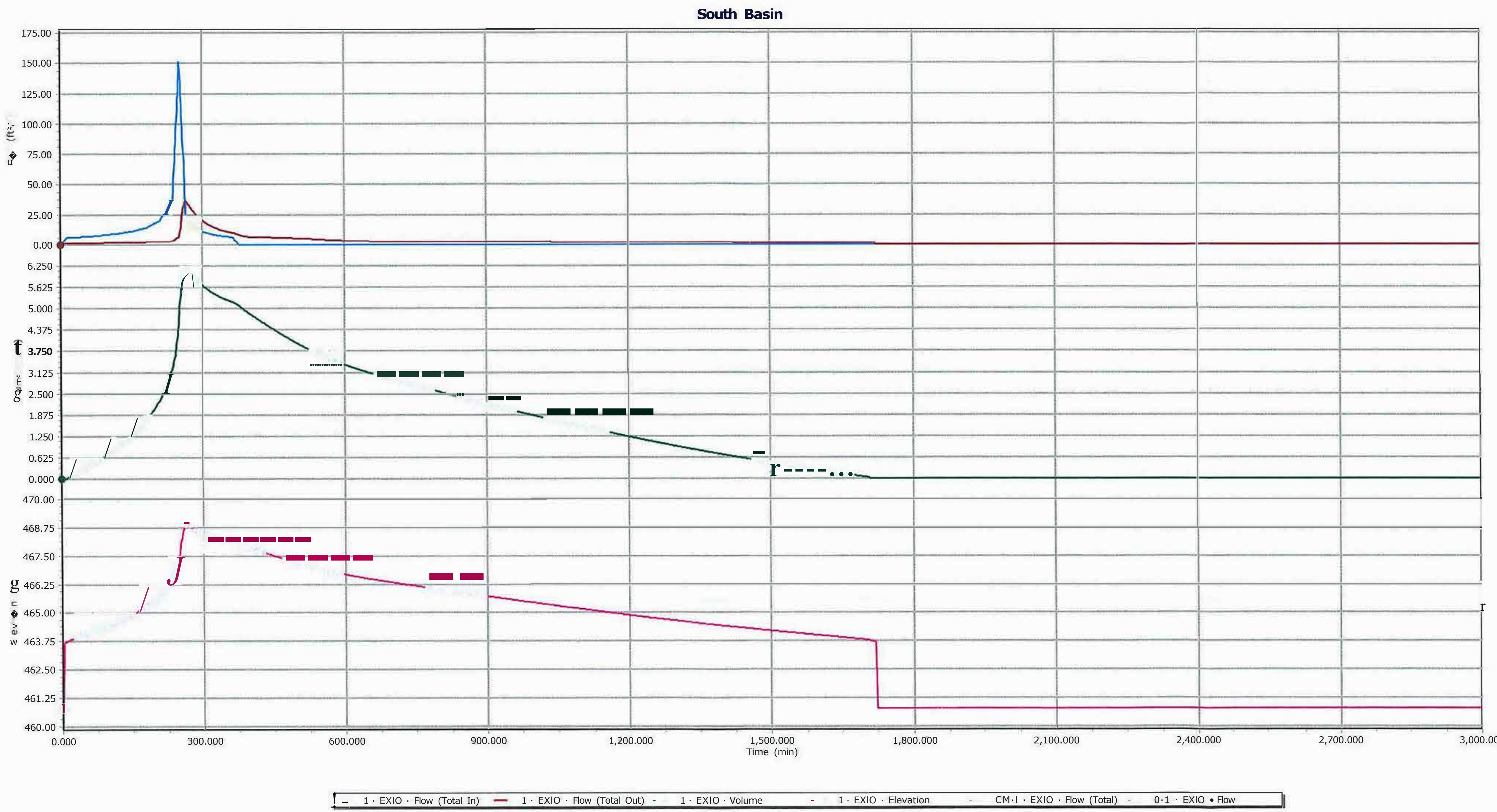
Return Event: 100 years
Storm Event:

Summary for Hydrograph Addition at '1'

[illegible]	Upstream Node
<Catchment to Outflow Node>	CM-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (min)	Flow (Peak) (ft3/s)
Flow (From)	CM-1	4.893	252.000	105.60
Flow (In)	1	4.893	252.000	105.60



South Basin
175.00
150.00
125.00
100.00
75.00
50.00
25.00
0.00
6.250
5.625
5.000
4.375
3.750
3.125
2.500
1.875
1.250
0.625
0.000
470.00
468.75
467.50
466.25
465.00
463.75
462.50
461.25
460.00
0.000
300.000
600.000
900.000
1,200.000
1,500.000
1,800.000
2,100.000
2,400.000
2,700.000
3,000.000
Time (min)
1 · EXIO · Flow (Total In)
1 · EXIO · Flow (Total Out)
1 · EXIO · Volume
1 · EXIO · Elevation
CM·I · EXIO · Flow (Total)
0·1 · EXIO • Flow

South Basin

Project Summary	
Title	South Basin
Engineer	PDC
Company	PDC
Date	8/15/2018

Notes

South Basin

Subsection: Master Network Summary

Catchments Summary

Label	:sc barip	Return .Event :cvears)	Hydrograph volume< (?<At)	Time to Peak (min)	Peak Flow (ft³/s)
CM-1	EX10	a	9.069	252.000	151.60

Node Summary

Label	Scenario	Return Eve nt (year!i)	Hydrograph Volume (ac-ft)	Time to Peak (min)	Peak Flow (ft³/s)
0-1	EX10	a	9.0691	265.000	36.24

Pond Summary

Label	$cenarici	Return Event (years)	Hydrogra'ph Volume (ac:ft)	Time to Peak (min)	Peak Flow (ft3/s)	Maximum OOat r S rface Elevation (ft)"	Maximum Ponci Storage: (ac-ft)
1 (IN)	EX10	a	9.069	252.000	151.60	(N/A)	(N/A)
1 (OUT)	EX10	a	9.069	265.000	36.24	468.88	6.242

South Basin

Subsection: Read Hydrograph | Return Event: 100 years
Label: CM-1 | Storm Event:

Peak Discharge	151.60 ft^3/s
Time to Peak	252.000 min
Hydrograph Volume	9.069 ac-ft.

HYDROGRAPH ORDINATES (ft3 /s)
Output Time Increment = 14.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)
0.000	0.00	6.50	6.90	7.00	7.50
70.000	7.70	8.30	8.60	9.40	9.80
140.000	10.90	11.50	13.20	14.30	17.50
210.000	19.90	29.30	37.60	151.60	23.50
280.000	15.70	12.30	10.30	9.00	8.00
350.000	7.30	6.70	0.00	(N/A)	(N/A)

South Basin

Subsection: Elevation-Area Volume Curve | Return Event: 100 years
Label: 1 | Storm Event:

Elevation. (ft)	Planimeter (ft²)	Area (ft²)	A1+A2+sqr (Al*A2) (ft2)	volu11le xac:tt)	Volume (Total) (ac-ft)
460.80	0.0	10.000	0.000	0.000	0.000
463.70	0.0	10.000	30.000	0.001	0.001
463.80	0.0	46,285.000	46,975.331	0.036	0.037
474.00	0.0	76,427.000	182,188.245	14.220	14.257

South Basin

Subsection: Volume Equations | Return Event: 100 years
Label: 1 | Storm Event:

Pond Volume Equations

***Incremental volume computed by the Conic Method for Reservoir Volumes.**

Volume = {1/3) * {EL2 - Ell) * (Areal + Area2 + sqr(Areal * Area2))

where:	Ell, EL2	Lower and upper elevations of the increment
	Areal, Area2	Areas computed for Ell, EL2, respectively
	Volume	Incremental volume between Ell and EL2

South Basin

Subsection: Outlet Input Data — Return Event: 100 years
Label: Outlet#l — Storm Event:

Requested Pond Water Surface Elevations	
Minimum (Headwater)	460.80 ft
Increment (Headwater)	0.10 ft
Maximum (Headwater)	474.00 ft

Outlet Connectivity

Structure Type	Oufiet ID	Direction	Outfall	El (ft)	E2 (ft)
Orifice-Circular	1-Lowflow orifice	Forward	TW	464.30	474.00
Orifice-Circular	2-Midflow orifice	Forward	TW	466.30	474.00
Stand Pipe	Riser - 1	Forward	TW	467.90	474.00
Orifice-Circular	0-Underdrain orifice	Forward	TW	461.05	474.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

South Basin

Subsection: Outlet Input Data — Return Event: 100 years
Label: Outlet#1 — Storm Event:

Structure ID: 0-Underdrain orifice Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	461.05 ft
Orifice Diameter	6.0 in
Orifice Coefficient	Q.600

Structure ID: 2-Midflow orifice Structure Type: Orifice-Circular	
Number of Openings	2
Elevation	466.30 ft
Orifice Diameter	8.0 in
Orifice Coefficient	0.600

Structure ID: Riser - 1 Structure Type: Stand Pipe	
Number of Openings	1
Elevation	467.90 ft
Diameter	36.0 in
Orifice Area	7.1 ft2
Orifice Coefficient	0.600
Weir Length	9.42 ft
Weir Coefficient	3.00 (ft^0.5)/S
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	True

Structure ID: 1-Lowflow orifice Structure Type: Orifice-Circular	
Number of Openings	2
Elevation	464.30 ft
Orifice Diameter	3.0 in
Orifice Coefficient	0.600

Structure ID: TW Structure Type: TW Setup, OS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30

South Basin

Subsection: Outlet Input Data | Return Event: 100 years
Label: Outlet#l | Storm Event:

Convergence Tolerances	
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft3/s
Flow Tolerance (Maximum)	10.000 ft3/s

South Basin

Subsection: Composite Rating Curve
Label: Outlet#l

Return Event: 100 years
Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	TaiJwate(Elevation (ft)	Convergence Error (ft)
460.80	0.00	(N/A)	0.00
460.90	0.00	(N/A)	0.00
461.00	0.00	(N/A)	0.00
461.05	0.00	(N/A)	0.00
461.10	0.01	(N/A)	0.00
461.20	0.05	(N/A)	0.00
461.30	0.13	(N/A)	0.00
461.40	0.25	(N/A)	0.00
461.50	0.38	(N/A)	0.00
461.60	0.52	(N/A)	0.00
461.70	0.60	(N/A)	0.00
461.80	0.67	(N/A)	0.00
461.90	0.73	(N/A)	0.00
462.00	0.79	(N/A)	0.00
462.10	0.85	(N/A)	0.00
462.20	0.90	(N/A)	0.00
462.30	0.95	(N/A)	0.00
462.40	0.99	(N/A)	0.00
462.50	1.04	(N/A)	0.00
462.60	1.08	(N/A)	0.00
462.70	1.12	(N/A)	0.00
462.80	1.16	(N/A)	0.00
462.90	1.20	(N/A)	0.00
463.00	1.23	(N/A)	0.00
463.10	1.27	(N/A)	0.00
463.20	1.30	(N/A)	0.00
463.30	1.34	(N/A)	0.00
463.40	1.37	(N/A)	0.00
463.50	1.40	(N/A)	0.00
463.60	1.43	(N/A)	0.00
463.70	1.46	(N/A)	0.00
463.80	1.49	(N/A)	0.00
463.90	1.52	(N/A)	0.00
464.00	1.55	(N/A)	0.00
464.10	1.58	(N/A)	0.00
464.20	1.61	(N/A)	0.00
464.30	1.64	(N/A)	0.00
464.40	1.70	(N/A)	0.00
464.50	1.80	(N/A)	0.00
464.60	1.91	(N/A)	0.00
464.70	1.99	(N/A)	0.00
464.80	2.06	(N/A)	0.00
464.90	2.12	(N/A)	0.00

South Basin

Subsection: Composite Rating Curve | Return Event: 100 years

Label: Outlet#l | Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
465.00	2.18	(N/A)	0.00
465.10	2.23	(N/A)	0.00
465.20	2.28	(N/A)	0.00
465.30	2.33	(N/A)	0.00
465.40	2.38	(N/A)	0.00
465.50	2.43	(N/A)	0.00
465.60	2.47	(N/A)	0.00
465.70	2.52	(N/A)	0.00
465.80	2.56	(N/A)	0.00
465.90	2.60	(N/A)	0.00
466.00	2.64	(N/A)	0.00
466.10	2.68	(N/A)	0.00
466.20	2.72	(N/A)	0.00
466.30	2.76	(N/A)	0.00
466.40	2.85	(N/A)	0.00
466.50	3.05	(N/A)	0.00
466.60	3.33	(N/A)	0.00
466.70	3.68	(N/A)	0.00
466.80	4.10	(N/A)	0.00
466.90	4.56	(N/A)	0.00
467.00	5.05	(N/A)	0.00
467.10	5.34	(N/A)	0.00
467.20	5.61	(N/A)	0.00
467.30	5.86	(N/A)	0.00
467.40	6.09	(N/A)	0.00
467.50	6.31	(N/A)	0.00
467.60	6.52	(N/A)	0.00
467.70	6.72	(N/A)	0.00
467.80	6.91	(N/A)	0.00
467.90	7.09	(N/A)	0.00
468.00	8.16	(N/A)	0.00
468.10	9.97	(N/A)	0.00
468.20	12.25	(N/A)	0.00
468.30	14.92	(N/A)	0.00
468.40	17.92	(N/A)	0.00
468.50	21.22	(N/A)	0.00
468.60	24.79	(N/A)	0.00
468.70	28.61	(N/A)	0.00
468.80	32.66	(N/A)	0.00
468.90	36.94	(N/A)	0.00
469.00	41.42	(N/A)	0.00
469.10	46.11	(N/A)	0.00
469.20	47.86	(N/A)	0.00

South Basin

Subsection: Composite Rating Curve | Return Event: 100 years
Label: Outlet#l | Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
469.30	49.46	(N/A)	0.00
469.40	51.00	(N/A)	0.00
469.50	52.49	(N/A)	0.00
469.60	53.94	(N/A)	0.00
469.70	55.35	(N/A)	0.00
469.80	56.73	(N/A)	0.00
469.90	58.06	(N/A)	0.00
470.00	59.37	(N/A)	0.00
470.10	60.65	(N/A)	0.00
470.20	61.90	(N/A)	0.00
470.30	63.12	(N/A)	0.00
470.40	64.32	(N/A)	0.00
470.50	65.50	(N/A)	0.00
470.60	66.65	(N/A)	0.00
470.70	67.79	(N/A)	0.00
470.80	68.90	(N/A)	0.00
470.90	70.00	(N/A)	0.00
471.00	71.08	(N/A)	0.00
471.10	72.14	(N/A)	0.00
471.20	73.19	(N/A)	0.00
471.30	74.22	(N/A)	0.00
471.40	75.24	(N/A)	0.00
471.50	76.24	(N/A)	0.00
471.60	77.23	(N/A)	0.00
471.70	78.21	(N/A)	0.00
471.80	79.17	(N/A)	0.00
471.90	80.12	(N/A)	0.00
472.00	81.06	(N/A)	0.00
472.10	81.99	(N/A)	0.00
472.20	82.91	(N/A)	0.00
472.30	83.82	(N/A)	0.00
472.40	84.72	(N/A)	0.00
472.50	85.61	(N/A)	0.00
472.60	86.49	(N/A)	0.00
472.70	87.36	(N/A)	0.00
472.80	88.23	(N/A)	0.00
472.90	89.08	(N/A)	0.00
473.00	89.93	(N/A)	0.00
473.10	90.76	(N/A)	0.00
473.20	91.59	(N/A)	0.00
473.30	92.42	(N/A)	0.00
473.40	93.23	(N/A)	0.00
473.50	94.04	(N/A)	0.00

South Basin

Subsection: Composite Rating Curve | Return Event: 100 years
Label: Outlet#l | Storm Event:

Composite Outflow Summary

<Watet Surface Elevation (ft)	Flow (ft3/)	Tailwater Elevation @	Convergence Error (ft)
473.60	94.84	(N/A)	0.00
473.70	95.63	(N/A)	0.00
473.80	96.42	(N/A)	0.00
473.90	97.20	(N/A)	0.00
474.00	97.98	(N/A)	0.00

Contributing Structures
None Contributing
None Contributing
None Contributing
None Contributing
0-Underdrain orifice
0-Underdrain orifice
0-Underdrain orifice
0-Underdrain orifice
0-Underdrain orifice
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South Basin

Subsection: Composite Rating Curve | Return Event: 100 years
Label: Outlet#l | Storm Event:

Composite Outflow Summary

Contributing Structures
0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
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1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice

Composite Outflow Summary

Contributing Structures
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice

South Basin

Subsection: Composite Rating Curve | Return Event: 100 years
Label: Outlet#l | Storm Event:

Composite Outflow Summary

Contributing Structures
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice

South Basin

Subsection: Composite Rating Curve | Return Event: 100 years
Label: Outlet#l | Storm Event:

Composite Outflow Summary

Contributing Structures
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice

South Basin

Subsection: Composite Rating Curve | Return Event: 100 years
Label: Outlet#l | Storm Event:

Composite Outflow Summary

C(irifributing structures
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice+ 2-Midflow orifice+ Riser - 1 + 0-Underdrain orifice
1-Lowflow orifice + 2-Midflow orifice + Riser - 1 + 0-Underdrain orifice

South Basin

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years
Label: 1 Storm Event:

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	460.80 ft
Volume (Initial)	0.000 ac-ft
Flow (Initial Outlet)	0.00 ft3/s
Flow (Initial Infiltration)	0.00 ft3/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	1.000 min

Elevation (ft)	Outflow (ft3/s)	Storage (ac-ft)	Area (ft2)	Infiltration (ft3/s)	Flow (Total) (ft3/s)	2S/t + O (ft3/s)
460.80	0.00	0.000	10.000	0.00	0.00	0.00
460.90	0.00	0.000	10.000	0.00	0.00	0.03
461.00	0.00	0.000	10.000	0.00	0.00	0.07
461.05	0.00	0.000	10.000	0.00	0.00	0.08
461.10	0.01	0.000	10.000	0.00	0.01	0.11
461.20	0.05	0.000	10.000	0.00	0.05	0.19
461.30	0.13	0.000	10.000	0.00	0.13	0.30
461.40	0.25	0.000	10.000	0.00	0.25	0.45
461.50	0.38	0.000	10.000	0.00	0.38	0.62
461.60	0.52	0.000	10.000	0.00	0.52	0.78
461.70	0.60	0.000	10.000	0.00	0.60	0.90
461.80	0.67	0.000	10.000	0.00	0.67	1.00
461.90	0.73	0.000	10.000	0.00	0.73	1.10
462.00	0.79	0.000	10.000	0.00	0.79	1.19
462.10	0.85	0.000	10.000	0.00	0.85	1.28
462.20	0.90	0.000	10.000	0.00	0.90	1.36
462.30	0.95	0.000	10.000	0.00	0.95	1.45
462.40	0.99	0.000	10.000	0.00	0.99	1.52
462.50	1.04	0.000	10.000	0.00	1.04	1.60
462.60	1.08	0.000	10.000	0.00	1.08	1.68
462.70	1.12	0.000	10.000	0.00	1.12	1.75
462.80	1.16	0.000	10.000	0.00	1.16	1.82
462.90	1.20	0.000	10.000	0.00	1.20	1.90
463.00	1.23	0.001	10.000	0.00	1.23	1.97
463.10	1.27	0.001	10.000	0.00	1.27	2.03
463.20	1.30	0.001	10.000	0.00	1.30	2.10
463.30	1.34	0.001	10.000	0.00	1.34	2.17
463.40	1.37	0.001	10.000	0.00	1.37	2.24
463.50	1.40	0.001	10.000	0.00	1.40	2.30

South Basin

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years

Label: 1 Storm Event:

Elevation (ft)	Outflow (ctt:3/s)	Storage (ca. fl:L)	Area (2)	trim) on	Flow (fotal) Ctr. M<	25/ff.0 (ft3/sf
463.60	1.43	0.001	10.000	0.00	1.43	2.37
463.70	1.46	0.001	10.000	0.00	1.46	2.43
463.80	1.49	0.037	46,285.000	0.00	1.49	54.66
463.90	1.52	0.143	46,544.013	0.00	1.52	209.40
464.00	1.55	0.250	46,803.749	0.00	1.55	365.01
464.10	1.58	0.358	47,064.208	0.00	1.58	521.48
464.20	1.61	0.466	47,325.389	0.00	1.61	678.83
464.30	1.64	0.575	47,587.293	0.00	1.64	837.04
464.40	1.70	0.685	47,849.920	0.00	1.70	996.16
464.50	1.80	0.795	48,113.269	0.00	1.80	1,156.21
464.60	1.91	0.906	48,377.341	0.00	1.91	1,317.14
464.70	1.99	1.017	48,642.136	0.00	1.99	1,478.91
464.80	2.06	1.129	48,907.654	0.00	2.06	1,641.56
464.90	2.12	1.242	49,173.894	0.00	2.12	1,805.09
465.00	2.18	1.355	49,440.857	0.00	2.18	1,969.51
465.10	2.23	1.469	49,708.543	0.00	2.23	2,134.81
465.20	2.28	1.583	49,976.951	0.00	2.28	2,301.01
465.30	2.33	1.698	50,246.082	0.00	2.33	2,468.09
465.40	2.38	1.814	50,515.936	0.00	2.38	2,636.08
465.50	2.43	1.930	50,786.512	0.00	2.43	2,804.96
465.60	2.47	2.047	51,057.812	0.00	2.47	2,974.75
465.70	2.52	2.165	51,329.834	0.00	2.52	3,145.44
465.80	2.56	2.283	51,602.578	0.00	2.56	3,317.03
465.90	2.60	2.401	51,876.045	0.00	2.60	3,489.54
466.00	2.64	2.521	52,150.235	0.00	2.64	3,662.96
466.10	2.68	2.641	52,425.148	0.00	2.68	3,837.29
466.20	2.72	2.762	52,700.784	0.00	2.72	4,012.54
466.30	2.76	2.883	52,977.142	0.00	2.76	4,188.71
466.40	2.85	3.005	53,254.223	0.00	2.85	4,365.85
466.50	3.05	3.127	53,532.026	0.00	3.05	4,544.02
466.60	3.33	3.251	53,810.552	0.00	3.33	4,723.21
466.70	3.68	3.374	54,089.801	0.00	3.68	4,903.40
466.80	4.10	3.499	54,369.773	0.00	4.10	5,084.58
466.90	4.56	3.624	54,650.467	0.00	4.56	5,266.74
467.00	5.05	3.750	54,931.884	0.00	5.05	5,449.87
467.10	5.34	3.876	55,214.024	0.00	5.34	5,633.74
467.20	5.61	4.003	55,496.887	0.00	5.61	5,818.52
467.30	5.86	4.131	55,780.472	0.00	5.86	6,004.23
467.40	6.09	4.259	56,064.780	0.00	6.09	6,190.87
467.50	6.31	4.389	56,349.810	0.00	6.31	6,378.45
467.60	6.52	4.518	56,635.564	0.00	6.52	6,566.97
467.70	6.72	4.649	56,922.039	0.00	6.72	6,756.43
467.80	6.91	4.780	57,209.238	0.00	6.91	6,946.84

South Basin

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years

Label: 1 Storm Event:

Elevation (ft)	Outflow (ft3/s)	Storage (ac-ft)	Area (ft2)	Infiltration (ft3/s)	Flow (Total) (ft3/s)	2S/t+O (ft3/s)
467.90	7.09	4.911	57,497.160	0.00	7.09	7,138.20
468.00	8.16	5.044	57,785.804	0.00	8.16	7,331.41
468.10	9.97	5.177	58,075.171	0.00	9.97	7,526.31
468.20	12.25	5.310	58,365.260	0.00	12.25	7,722.67
468.30	14.92	5.445	58,656.072	0.00	14.92	7,920.37
468.40	17.92	5.580	58,947.607	0.00	17.92	8,119.38
468.50	21.22	5.715	59,239.865	0.00	21.22	8,319.65
468.60	24.79	5.852	59,532.845	0.00	24.79	8,521.18
468.70	28.61	5.989	59,826.548	0.00	28.61	8,723.93
468.80	32.66	6.126	60,120.974	0.00	32.66	8,927.90
468.90	36.94	6.265	60,416.122	0.00	36.94	9,133.07
469.00	41.42	6.404	60,711.994	0.00	41.42	9,339.43
469.10	46.11	6.543	61,008.587	0.00	46.11	9,546.98
469.20	47.86	6.684	61,305.904	0.00	47.86	9,752.59
469.30	49.46	6.825	61,603.943	0.00	49.46	9,959.04
469.40	51.00	6.967	61,902.705	0.00	51.00	10,166.43
469.50	52.49	7.109	62,202.190	0.00	52.49	10,374.76
469.60	53.94	7.252	62,502.397	0.00	53.94	10,584.05
469.70	55.35	7.396	62,803.327	0.00	55.35	10,794.30
469.80	56.73	7.540	63,104.980	0.00	56.73	11,005.52
469.90	58.06	7.686	63,407.356	0.00	58.06	11,217.71
470.00	59.37	7.832	63,710.454	0.00	59.37	11,430.88
470.10	60.65	7.978	64,014.275	0.00	60.65	11,645.04
470.20	61.90	8.126	64,318.818	0.00	61.90	11,860.17
470.30	63.12	8.274	64,624.085	0.00	63.12	12,076.30
470.40	64.32	8.422	64,930.074	0.00	64.32	12,293.42
470.50	65.50	8.572	65,236.785	0.00	65.50	12,511.55
470.60	66.65	8.722	65,544.220	0.00	66.65	12,730.67
470.70	67.79	8.873	65,852.377	0.00	67.79	12,950.80
470.80	68.90	9.024	66,161.257	0.00	68.90	13,171.93
470.90	70.00	9.176	66,470.859	0.00	70.00	13,394.08
471.00	71.08	9.329	66,781.185	0.00	71.08	13,617.25
471.10	72.14	9.483	67,092.233	0.00	72.14	13,841.44
471.20	73.19	9.637	67,404.003	0.00	73.19	14,066.64
471.30	74.22	9.792	67,716.497	0.00	74.22	14,292.87
471.40	75.24	9.948	68,029.713	0.00	75.24	14,520.14
471.50	76.24	10.105	68,343.652	0.00	76.24	14,748.43
471.60	77.23	10.262	68,658.313	0.00	77.23	14,977.75
471.70	78.21	10.420	68,973.697	0.00	78.21	15,208.12
471.80	79.17	10.579	69,289.804	0.00	79.17	15,439.52
471.90	80.12	10.738	69,606.634	0.00	80.12	15,671.97
472.00	81.06	10.898	69,924.186	0.00	81.06	15,905.46
472.10	81.99	11.059	70,242.461	0.00	81.99	16,140.00

South Basin

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years
Label: 1 Storm Event:

Elevation (ft)	Outflow (ft³/s)	Storage (ac-ft)	Area (ft2)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
472.20	82.91	11.221	70,561.459	0.00	82.91	16,375.59
472.30	83.82	11.383	70,881.179	0.00	83.82	16,612.24
472.40	84.72	11.546	71,201.622	0.00	84.72	16,849.94
472.50	85.61	11.710	71,522.788	0.00	85.61	17,088.71
472.60	86.49	11.875	71,844.677	0.00	86.49	17,328.53
472.70	87.36	12.040	72,167.288	0.00	87.36	17,569.42
472.80	88.23	12.206	72,490.622	0.00	88.23	17,811.38
472.90	89.08	12.373	72,814.678	0.00	89.08	18,054.41
473.00	89.93	12.540	73,139.458	0.00	89.93	18,298.51
473.10	90.76	12.709	73,464.960	0.00	90.76	18,543.69
473.20	91.59	12.878	73,791.185	0.00	91.59	18,789.95
473.30	92.42	13.047	74,118.132	0.00	92.42	19,037.29
473.40	93.23	13.218	74,445.802	0.00	93.23	19,285.71
473.50	94.04	13.389	74,774.195	0.00	94.04	19,535.22
473.60	94.84	13.561	75,103.311	0.00	94.84	19,785.81
473.70	95.63	13.734	75,433.149	0.00	95.63	20,037.50
473.80	96.42	13.908	75,763.710	0.00	96.42	20,290.28
473.90	97.20	14.082	76,094.994	0.00	97.20	20,544.16
474.00	97.98	14.257	76,427.000	0.00	97.98	20,799.14

South Basin

Subsection: Pond Inflow Summary — Return Event: 100 years
Label: 1 (IN) — Storm Event:

Summary for Hydrograph Addition at '1'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	CM-1

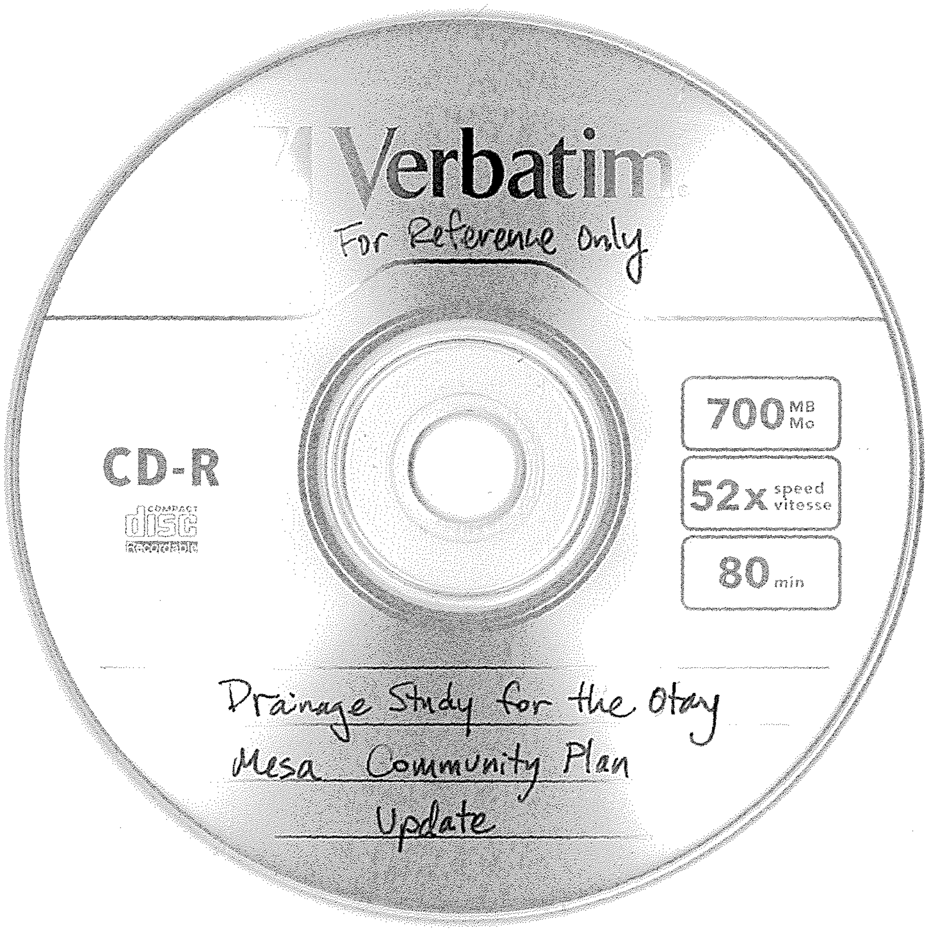
Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	CM-1	9.069	252.000	151.60
Flow (In)	1	9.069	252.000	151.60

5

APPENDIX5

Drainage Study for the Otay Mesa Community Plan Update
(For Reference Only)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For Reference Only
CD-R
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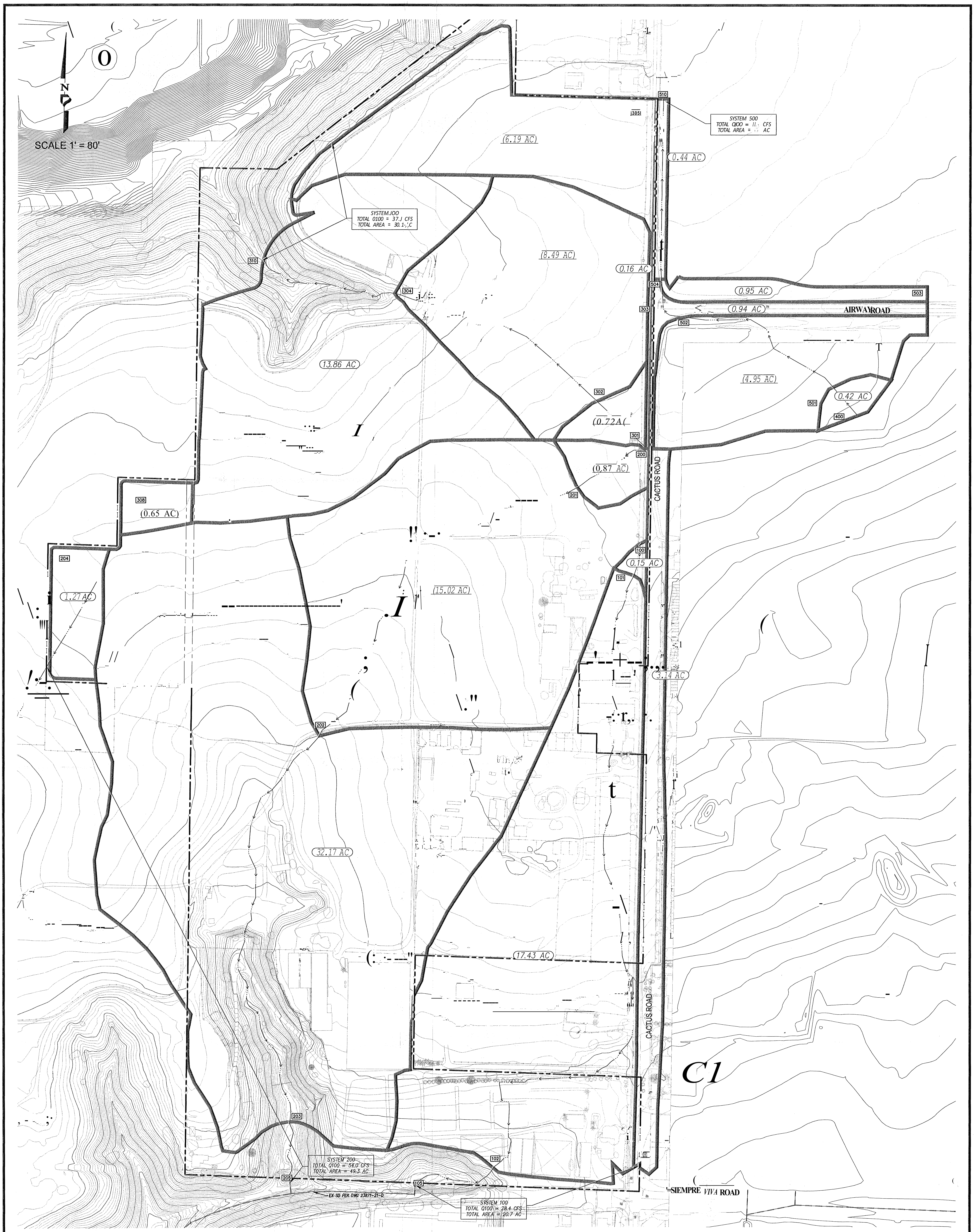
Drainage Study for the Otay
Mesa Community Plan
Update

6

APPEND1X6

Drainage Exhibits



LEGEND

PROPERTY BOUNDARY	HYDROLOGY NODE [I]
DRAINAGE SUBAREA	AREA FROM UPSTREAM TO DOWNSTREAM NODE (X.XX AC)
FLOW DIRECTION	

NOTE: SUPPLEMENTAL TOPOGRAPY IS 2-FT CONTOURS FROM SANGIS (1997, BEFORE SR 905 WAS BUILT)

SCALE: 1"=80'.

JOB # 235ZJ5

CREATED: 5/01/17

PREPARED BY:

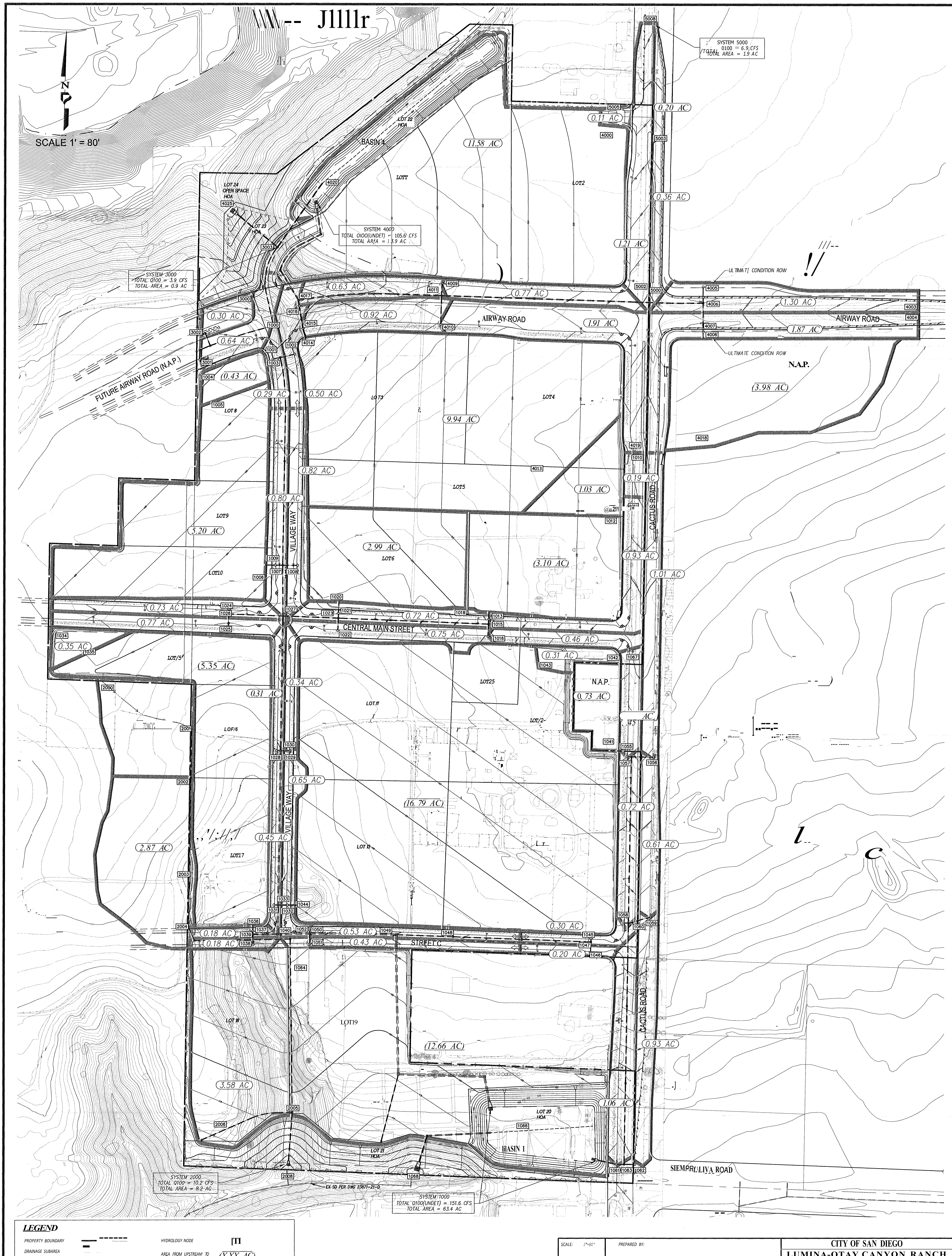
PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey

701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

CITY OF SAN DIEGO

LUMINA@OTAY CANYON RANCH

DRAINAGE MAP
EXISTING CONDITIONS
EXHIBIT A



LEGEND

PROPERTY BOUNDARY		HYDROLOGY NODE	
DRAINAGE SUBAREA		AREA FROM UPSTREAM TO DOWNSTREAM NODE	(X.XX AC)
FLOW DIRECTION			

NOTE: SUPPLEMENTAL TOPOGRAPHY IS 2-FT CONTOURS FROM SANGIS (1997, BEFORE SR 905 WAS BUILT)

SCALE: 1"=80'
JOB #: 2357.35
CREATED: 8/7/18

PREPARED BY:
PROJECT DESIGN CONSULTANTS

CITY OF SAN DIEGO
LUMINA-OTAY CANYON RANCH
DRAINAGE MAP
PROPOSED CONDITIONS
EXHIBIT B

Preliminary Hydromodification Management Study

LUMINA

Tentative Map

PTS #555609

City of San Diego, CA
August 16, 2018

Prepared for:

COLRICH
444 West Beech Street, Suite 300
San Diego, CA 92101

Prepared By:

PROJECT DESIGN CONSULTANTS

Planning | Landscape Architecture | Engineering | Survey

701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

Job# 2357.35

REGISTERED PROFESSIONAL ENGINEER
DEBBY SUE REECE
No. C56148
EXP. 12-31-18
CIVIL
STATE OF CALIFORNIA

Under the supervision of

Debby Reece, PE RCE 56148
Registration Expires 12/31/18

1. INTRODUCTION

This report summarizes the modeling effort to design the storage components and outflow controls for the two biofiltration basins meet hydromodification control requirements for the Lumina housing development. This is likely to include some additional flow control per Critical Coarse Sediment Yield Area management regulations to ensure no-net-impact to the receiving stream and the basins have been oversized at this point to ensure adequate storage is available. The basins will be relatively deep and the project will rely on the storage volume above ground to provide much of the required flow attenuation. This study has considered the effect of the two biofiltration portion of these BMPs as well. As these biofiltration BMPs will be implemented with dead storage per retention and pollutant control requirements, it is expected that they will contribute to flow attenuation and thus help reduce the size of the required storage volume. The existing and proposed conditions were modeled in PCSWMM to determine the storage vault size and orifice configurations that in combination with pollutant control BMPs would ensure compliance with the Hydromodification Management Plan (HMP) requirements from the San Diego Regional Water Quality Control Board (SDRWQCB). The results of this study show that the basins as presently sized will more than adequately meeting flow control requirements for hydromodication, including to ensure no-net-impact is achieved with respect to critical coarse sediment yield

1. 1 Project Description

The Lumina project will propose a mixed-use development complex composed of variable density multi-family housing and mixed-use commercial/residential buildings, on a 93.42 ac site in the southern extents of the Otay Lakes region of San Diego. Presently the site is partially utilized for agriculture while much of the area stand vacant. Runoff from the site currently sheet flows off-site to between two major drainage divides to the north and south that lead into Spring Canyon and Wruck Canyon, respectively. No existing public strom drain exists and the project will propose one outfall to each canyon and these will be the points of compliance for hydromodication control.

2. HYDROMODIFICATION MODELING OVERVIEW

The project will comply with flow requirements through the implementation of deepened biofiltration basins with underground arch-chamber storage for each of the two major drainage divides. This has been demonstrated and documented herein. With substantial storage volumes both above ground, as well as some below, these basins will also meet peak flow detention, as well as pollutant treatment and volume retention requirements.

Street tree wells will provide additional storage volumes assisting in lower flow attenuation, in addition to reductions in pollutant control and requirements of the biofiltration sizing. The proposed drainage divides were modeled for existing and proposed land covers to size the biofiltration basins. This was done using PCSWMM. The following is an overview of that process.

2. 1 Model Description

PCSWMM is a proprietary software which utilizes the EPA's Stormwater Management Model (SWMM) as its computational engine, while providing added processing and analytical capabilities to streamline design. PCSWMM is essentially a user-friendly shell for SWMM that allows rapid development and analysis of SWMM models.

PCSWMM was employed for this study based on the ability to efficiently create, edit and compare models, perform detention routing with the same software, and moreover, due to the tendency for SWMM to produce results that have been found to more accurately represent San Diego area watersheds than the alternative San Diego Hydrology Model (SDHM).

SWMM is a semi-distributed hydrologic and hydraulic modeling software that simulates the rainfall-runoff response of a watershed based on linear-reservoir overland flow routing. This overland flow routine accounts the connectedness ofpervious, impervious and Low Impact Development (LID) BMPs to the drainage system. LID BMPs are represented with a module in SWMM that simulates the water balance through standard LID BMP components, accounting for soil percolation, evapotranspiration, underdrain outflow, various media layer storage and subgrade infiltration. These controls provide a wide range of customizability between the various associated parameters and the ability to route underdrain or overflow to other SWMM elements, like storages nodes and conduits to represent most any conceivable LID system.

The outflow from these LID controls, storage components or watersheds is translated into the hydraulic component of the model that utilizes energy and momentum principles to determine flow through conduits, orifices and other structures. The hydraulics may be computed based on either the kinematic or dynamic-wave equations. In this study the former was used because there was no need to take downstream hydraulic grade line effects into consideration.

2.2 Hydromodification Criteria

The San Diego Regional Water Quality Control Board (SDRWQCB) requires the exceedance duration of post-developed flow rates be maintained to within 10% of the pre-developed flow durations. This must occur for flow frequencies ranging from a fraction of the 2-year flow (Q2) to the 0-year flow (QO). These flow frequency values may be calculated directly from SWMM statistics or estimated based on accepted USGS regression equations. These equations estimate flows based on a correlation with watershed area and the mean annual rainfall developed for the region. For this project the SWMM output was used because of the exceedingly small values calculated by regression equations, which were developed with data from significantly larger watersheds.

The fraction of the Q2 that must be controlled is dependent on the relative erodibility of the channel being discharged to, categorized as either High, Medium or Low susceptibility. By default it is assumed that all channels have a High susceptibility, and that therefore 0.1 of the Q2 must be controlled. A Geomorphic Assessment of Receiving Channels may be performed to indicate whether the channel erosion susceptibility can be categorized as Medium or Low, allowing control to 0.3 or 0.5 of the Q2, respectively.

2.3 Model Development

The inputs required for a SWMM model include rainfall, evapotranspiration rates, watershed characteristics and BMP configurations. The sources for some of these parameters are provided in Table 1 below.

Table 1: Hydrology Criteria

Raingage	'Bonita' - from Project Clean Water website (utilized per
Evapotranspiration	Daily E-T Rates taken from Table G.1-1 in the City of San Diego BMP Design Manual based on location in Zone 6 of California irrigation Management Information System "Reference Evapotranspiration Zones"
Overland Flow Path Length	Based on apparent flow path for existing conditions and recomended basin width to length ratio for proposed conditions per limit recommendation by Guo, J., Application of Kinematic Wave Cascading Plan to Irregular Watershed
Soils/Green-Amp! Parameters	Values for Hydrologic Soil Group 'D' taken from Table G.1-4 in the City of San Diego BMP Design Manual .
Overland Flow Coefficients - 'n'	Values for 'Grass' taken from SD BMP Design Manual Table G.1-4

The drainage area to the point of compliance was delineated with the project boundary, plus small fragments of adjacent land that drain through the site for both existing and proposed conditions. For the proposed model this drainage area has been broken up into the contributing drainage management (DMA) areas that drain to BMPs, plus one self-mitigating DMA. See the Storm Water Quality Management Plan (SWQMP) for more information regarding the pollutant control strategy and DMAs.

The overland flow path lengths were derived from idealized drainage lengths representing a hybrid of actual overland flow to an area drain system, as well as pipe flow and losses. This method is generally conservative compared to published guidance that suggests using the maximum flow length. The percent imperviousness was calculated based on the known coverages in the site plan to develop the same values used to calculate the Design Capture Volume, provided in Attachment 1e of the SWQMP. An electronic copy of the model is provided in Attachment 2 of this report.

3. Modeling for Hydromodification Compliance

The pre-developed conditions for the site were modelled based on the existing topography and landcover with zero imperviousness. For the post-developed condition the proposed site footprint was represented as an equivalent imperviousness and a short overland flow path length typical of urban drainage systems. The biofiltration basins, one lined and one unlined, were modelled by coupling the bioretention LID component to properly represent the media and underdrain, with the storage component to represent the basin. The parameters utilized for the biofiltration parameters were in line with the published values in the SD BMP management plan. These North and South Basins outlet to two separate proposed storm drains that quickly discharge to the adjacent Spring and Wruck Canyons, respectively. The deep biofiltration were modelled continuously to find the outlet control and storage volume that would ensure compliance could be met for both pollutant and flow control. It was determined that this suite of BMPs would be sufficient to provide flow control with the storage depths and outlet size provided herein based on the SWMM modeling results. The Status Report SWMM output file for the existing condition is provided in Attachment 3 and the proposed condition is provided in Attachment 4.

3.1 Flow Frequency Analysis

A Geomorphic Assessment of Receiving Channels, often referred to as a SCCWRP analysis, was performed by Chang Consultants for the Points of Compliance along Spring Canyon and Wruck Canyon. It was determined that both channels had a low susceptibility to erosion meaning that a 0.5 factor could be used as to calculate the low flow threshold from the flow rate of the 2-year recurrence interval.

The SWMM statistics calculator was used to determine the pre-developed and post developed flow rates for the 2, 5 and IO-year recurrence intervals. These are provided below with the resultant low flow threshold based on the geomorphic assessment. The SWMM output used to calculate these values is provided in Attachment 5.

Based on these values it is apparent that the basins function well within the required metrics and may be able to be reduced.

Table 2 - Pre-Developed and Post-Mitigated Flows for the North Basin

Return Period	Pre-project Qpeak (cfs)	Post-project - Mitigated Q (cfs)
LF = 0.5xQ2	4.321	2.016
2-year	8.642	4.032
5-year	11.804	4.598
10-year	14.502	6.635

Table 3 - Pre-Developed and Post-Mitigated Flows for the South Basin

Return Period	Pre-project Qpeak (cfs)	Post-project - Mitigated Q (cfs)
LF = 0.5xQ2	5.886	2.241
2-year	11.772	4.482
5-year	18.052	11.162
10-year	21.327	14.182

3.2 Biofiltration Basins

The basins are composed of both above and below ground storage as well as biofiltration media in between. These components were represented as a LID in series with a storage node as simulated in SWMM. The module allows the user to represent the various stages of a biofiltration basin including ponding, media, and gravel storage above and below the underdrain and accounts for losses and various infiltration rates. These layer depths were assigned per the design developed for pollutant control as shown in Table 3 on the next page and the parameter values were assigned with the standard values taken from Table G.1-7 in the BMP Design Manual but may be refined. Both the underdrain outflow and the overflow are routed into the underground storage vault. The underdrain is not offset within the gravel below but the perforated underdrain will be capped with an orifice to restrict flow. Thus the flow coefficient has been set has to ensure that both the above and below ground storage are utilized simultaneously.

Table 3 - Biofiltration LID Module parameters summary

Biofiltration Basin	surface Area (sf)	Layer Depth			Drain Coefficient
		Ponding (in)	Media (in)	Gravel Storage (in)	
NORTH	18,816	6	21	15	0.255
SOUTH	46,285	6	21	15	0.627
Media and storage parameters taken from Table G.1-7 in BMP Design Manual, underground storage volume based on assumed average CONTECH Chambermaxx porosity.					

3.2.1 Hydromodification Storage

The bioretention basins will be significantly depressed into the terrain providing for above ground ponding storage. The basins have been represented using the LID component which drains to the outfall and overflows into a storage unit. The drain coefficient utilized to represent this restriction is provided in Table 3 above.

3.2.2 Modeling Schematic

A complex of SWMM model components were implemented in order to capture all the storage components of the system. As depicted below, the North Basin (NB) receives all the inflow directed to the basin. From the basin overflow is sent to the above ground storage, ie. the ponding depth (NB_STOR_AG) while in the LID control editor, the underdrain flow has been routed directly to the outfall (POC 1). This schematic produces a continuity error of approximately 1% for both hydromodification and peak flow simulation runs, which in concert with the LID water balance accounting produced by the model, suggests that the schematic is appropriately replicating the array of storages and conveyance elements accurately. South basin has been modeled similarly. This also allowed for the 100 year peak flow hydrograph, indicating that peak flow reduction requirements can be met as well.

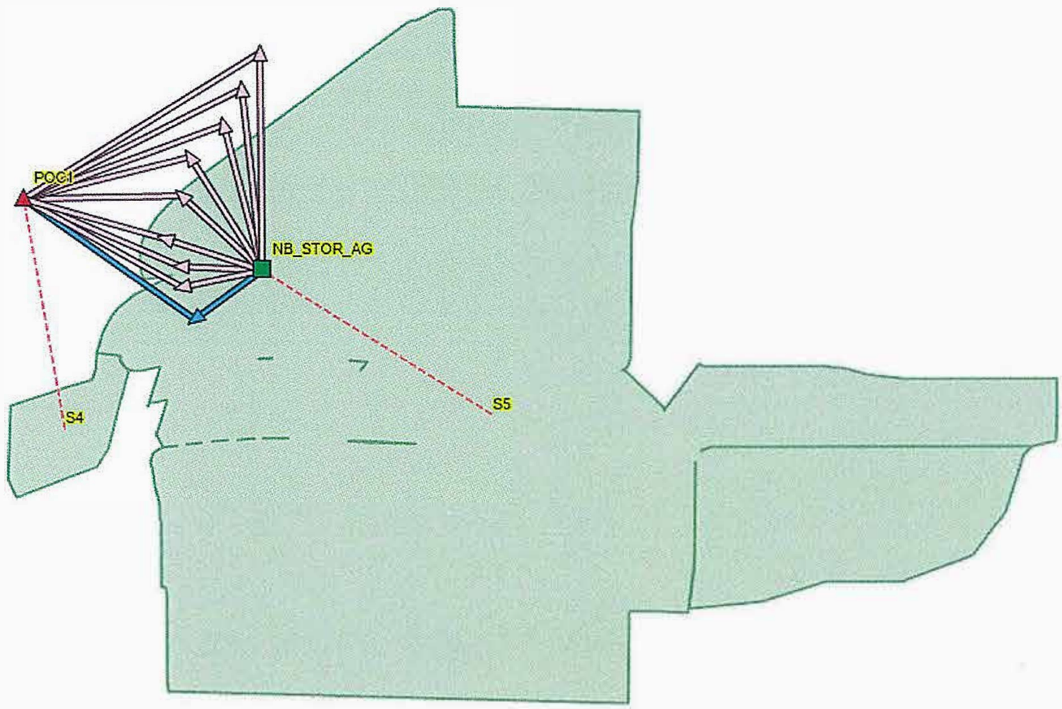


Figure 2 - Modeling schematic of multi-function biojiltration basin to simultaneously utilize both above and below ground storage

3.5 Flow Duration Curves for Hydromodification Compliance

The pre and post developed flow duration exceedance curves were developed for the hourly flow data using an automatic partial duration series calculator in PCSWMM. These curves are graphed over the flow ranges listed in Table 1 and are provided in Attachment 6. In all cases the duration of post developed flows are brought to well within that of the pre developed flows for half the two year flow to the ten year flow, indicating that the suite of BMPs will provide the flow attenuation required for compliance.

3.6 Drawdown

Drawdown graphs have been provided in Attachment 6. These graphs were produced by setting the storage basins in SWMM to full depth and letting the model run. All basins will drawdown within the required 96 hours.

4.0 SUMMARY

The predeveloped conditions of the Lumina site were modelled in SWMM to determine a baseline of flow durations that would need to be controlled in the post-developed conditions. The proposed development was also modelled in SWMM with two biofiltration basins with significant storage above ground as well as some gravel storage below. Based on the SWMM model results for this study it is determined that the combination of LID BMPs, including two biofiltration basins with partial retention storage, will be able to satisfy the hydromodification criteria. The basins demonstrate significant excess capacity and this is anticipated to be used to mitigate for critical coarse sediment yield are conservation requirements. This study is intended to demonstrate that these controls as sized are capable of providing hydromodification compliance and a full outlet design will be performed during final engineering.

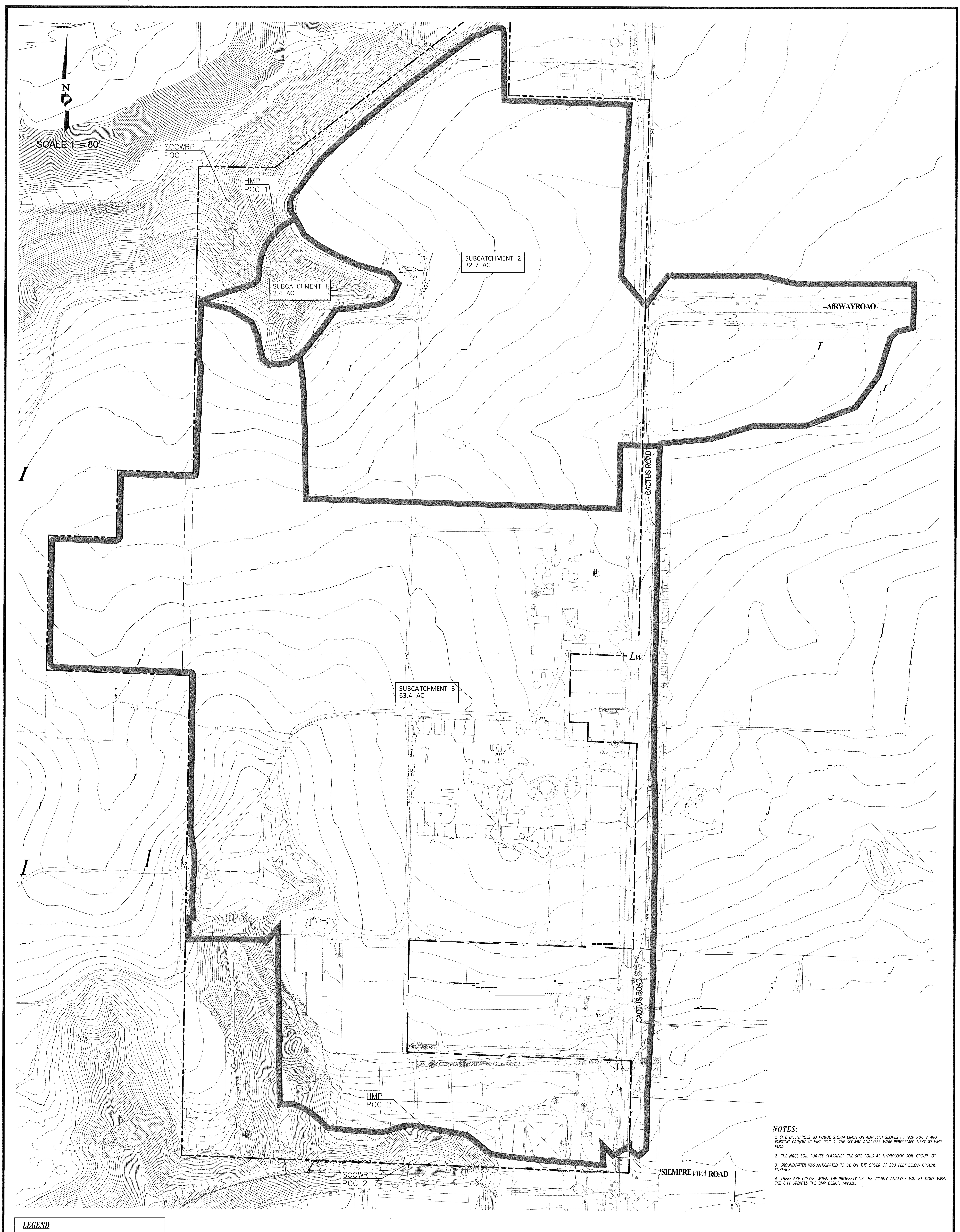
Attachments

1 - Hydromodification Management Exhibit
2 - SWMM Model w/ Subcatchment Schematics
3 - SWMM Output - Existing Condition
4 - SWMM Output - Proposed Conditions
5 - Flow Duration Curves
6 - Drawdown Graph

1

ATTACHMENT 1

Hydromodification Management Exhibit



NOTES:

1. SITE DISCHARGES TO PUBUC STORM DRA1N ON ADJACENT SLOPES AT HMP POC 2 ANO EXISTING CAI{(ON AT HMP POC 1. THE SCCWRP ANALYSES WERE PERFORMED NEXT TO HMP POCS.

2. THE NRCS SOIL SURVEY CLASSIFIES THE SITE SOILS AS HYDROLOCIC SOIL GROUP 'O"

3. GROUNDWATER WAS ANTICIPATED TO BE ON THE ORDER OF 200 FEET BELOW GROUND SURFACE

4. THERE ARE CCSYAs WITHIN THE PROPERTY OR THE VICINITY. ANALYSIS WILL BE DONE WHEN THE CITY UPDATES THE BMP DESIGN MANUAL.

LEGEND

SUBCATCHMENT BOUNDARY

NOTE: SUPPLEMENTAL TOPOGRAPY IS 2-FT CONTOURS FROM SANGIS (1997, BEFORE SR 905 WAS BUILT)

SCALE: 1"=80'
JOB#: 2357.35
CREATED: 6/01/11

PREPARED BY:
PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey
701 B Street, Suite 800
San Diego, CA 92101
619.236.1471 Tel
619.234.0349 Fax

CITY OF SAN DIEGO
LUMINA-OTAY CANYON RANCH
HYDROMODIFICATION MAP
EXISTING CONDITIONS
EXHIBIT 2A

2

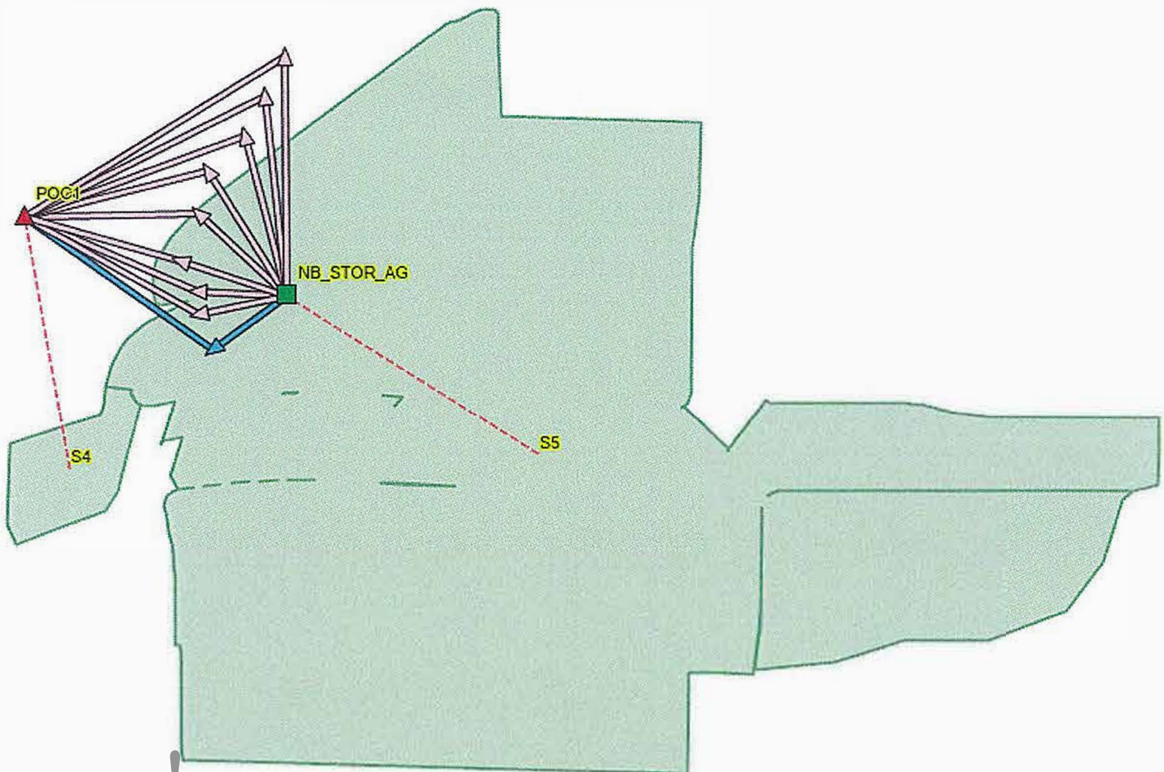
ATTACHMENT 2

SWMM Model with

Sub-catchment Parameters and Schematic

Proposed Conditions

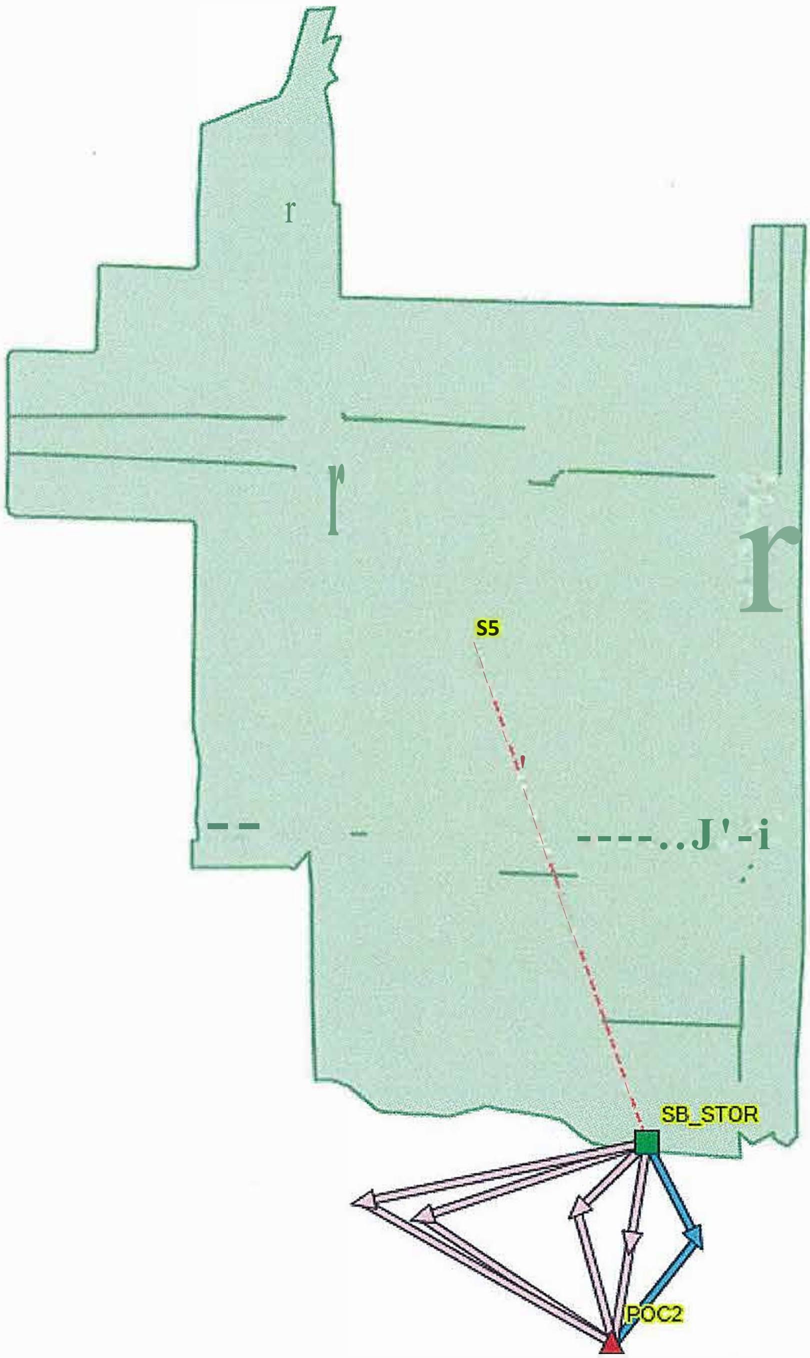
North Basin



Rain Gage		Area	Width	Flow	Slope	Imperv.	N		Dstore Imperv (in)	Dstore Perv (in)	Zero Imper. (%)	Suction Head (in)		Initial Deficit (frac.)
Bonita	POCl	0.95!	275.ssi	150	1	0 1 2		0.1	0.05	0.1	25	9	0.019	0.3
Boni•	NB_STOR_AGI	34.12'	1179.0941	1260.516	1.098	68.657	0.012	0.1	0.05	0.1	25	9	0.019	0.3

Proposed Conditions

South Basin



Name	Rain Gage	Outlet	Area (ac)	Width (ft)	Flow Length (ft)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (in)	Dstore Perv (in)	Zero Imperv (%)	Suction Head (in)	Conductivity (in/hr)	Initial Deficit (frac.)
S5	Bonita	SB_STOR	63.36	1272.309	2169.254	1.329	70.439	0.012	0.1	0.05	0.1	25	9	0.019	0.3

SWMM Model Flow Coefficient Calculation

BMP1 South

PARAMETER	ABBREV.	Bio-Retention Cell LID BMP	
Ponding Depth	PD	6	in
Bioretention Soil Layer	S	21	in
Gravel Layer	G	15	in
TOTAL		3.5	ft
		42	in
Orifice Coefficient	Cg	0.6	–
Low Flow Orifice Diameter	D	6	in
Drain exponent	n	0.5	–
Flow Rate (volumetric)	Q	1.704	cfs
Ponding Depth Surface Area	APD	47762.55	ft^2
Bioretention Surface Area	As.AG	46285	ft2
	As.AG	1.0626	ac
Flow Rate (per unit area)	q	1.591	in/hr
Effective Ponding Depth	PD,ff	**6.10**	in
Flow Coefficient	C	**0.2547**	–

SWMM Model Flow Coefficient Calculation

BMP4 North

PARAMETER	ABBREV.	Bio-Retention Cell LID BMP	
Ponding Depth	PD	6	in
Bioretention Soil Layer	S	21	in
Gravel Layer	G	15	in
TOTAL		3.5	ft
		42	in
Orifice Coefficient	Cg	0.6	–
Low Flow Orifice Diameter	D	6	in
Drain exponent	n	0.5	–
Flow Rate (volumetric)	Q	1.704	cfs
Ponding Depth Surface Area	A,o	21070.25	ft2
Bioretention Surface Area	As,AG	18816	ft2
	As.AG	0.4320	ac
Flow Rate (per unit area)	q	3.913	in/hr
Effective Ponding Depth	PD,ff	**6.36**	in
Flow Coefficient	C	**0.6266**	--


Verbati
CD-R
700 MB Mo
52x speed vitesse
80 min
LUMINA SWMM FILES
8/15/18

Attachment 3

SWMM Output - Existing Conditions

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

****
NOTE: The summary statistics displayed in this report are based on results found at every computational time step, not just on results from each reporting time step.
****

****
Analysis Options
****

```
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
  Water Quality .......... NO
Infiltration Method ...... GREEN AMPT
Starting Date ............ 10/03/1970 00:00:00
Ending Date .............. 05/25/2008 23:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 01:00:00
```

************************** Runoff Quantity Continuity **************************	Volume acre-feet	Depth inches
Total Precipitation	2783.528	339.110
Evaporation Loss	97.238	11.846
Infiltration Loss	2377.474	289.641
Surface Runoff	324.421	39.523
Final Storage	0.000	0.000
Continuity Error (%)	-0.561	

************************** Flow Routing Continuity **************************	Volume acre-feet	Volume 10" 6 gal
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	324.421	105.717
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	324.421	105.717
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10"6 gal	Peak Runoff CFS	Runoff Coeff
NB_FL	339.11	0.00	11.77	287.86	41.38	36.74	29.69	0.122
NB_ST	339.11	0.00	10.64	278.10	52.47	3.42	2.59	0.155
SB_FL	339.11	0.00	11.93	291.00	38.08	65.55	48.72	0.112

```
Analysis begun on:  Tue Aug 07 14:03:25 2018
Analysis ended on:  Tue Aug 07 14:03:33 2018
Total elapsed time: 00:00:08
```

4

Attachment 4

SWMM Ontput - Proposed Conditions

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------

Inital Post Condition Scenario for SOHM comparison - 82% impervious

WARNING 06: dry weather time step increased to the wet weather time step

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... KINWAVE
Starting Date ............ 10/03/1970 05:00:00
Ending Date .............. 05/25/2008 22:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 00:15:00
Routing Time Step ........ 60.00 sec

**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Initial LID Storage ......         0.076         0.026
Total Precipitation ......       990.961       339.080
Evaporation Loss .........       176.214        60.296
Infiltration Loss ........       240.836        82.408
Surface Runoff ...........       129.770        44.404
LID Drainage .............       449.667       153.864
Final Storage ............         0.076         0.026
Continuity Error (%) .....        -0.557

**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......       579.436       188.818
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         5.293         1.725
External Outflow .........       584.668       190.523
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.011

********************************
Highest Flow Instability Indexes
********************************
All links are stable.

*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     60.00 sec
Average Time Step           :     60.00 sec
Maximum Time Step           :     60.00 sec
Percent in Steady State     :      0.00
Average Iterations per Step :      1.00
```

Percent Not Converging : 0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10"6 gal	Peak Runoff CFS	Runoff Coeff
S4	339.08	0.00	55.74	41.46	247.09	6.37	1.05	0. 729
S5	339.08	0.00	60.42	83.55	196.91	182.43	34. 79	0.581

****
LID Performance Summary
****

Subcatchment:	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error
S5	LID	14832. 92	661. 77	0.00	1679.13	12492.48	2.10	2.10	-0.00

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
POC1	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
NB_STOR_AG	STORAGE	0.00	4.89	4.89	13709 00:29	4.89

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10"6 gal	Total Inflow Volume 10" 6 gal	Flow Balance Error Percent
POC1	OUTFALL	2.69	14. 03	13709 00:29	153	191	0.000
NB_STOR_AG	STORAGE	104.20	104. 20	13709 00:13	37.6	37.6	0.053

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
NB_STOR_AG	0. 097	0	0	0	156.852	85	13709 00:28	14 .03

****
Outfall Loading Summary

****

Outfall Node	Flow Freq Pent	Avg Flow CFS	Max Flow CFS	Total Volume 10"6 gal
POCl	5.51	0.39	14.03	190.509
System	5.51	0.39	14.03	190.509

****
Link Flow Summary
****

Link	Type	Maximum IFlowl CFS	Time of Max Occurrence days hr:min	Maximum]Velocl ft/sec	Max/ Full Flow	Max/ Full Depth
OR2	ORIFICE	0.89	13709 00:29			0.00
OR3	ORIFICE	1.54	13709 00:29			0.00
OR4	ORIFICE	0.89	13709 00:29			0.00
OR6	ORIFICE	1. 54	13709 00:29			0.00
OR7	ORIFICE	1.54	13709 00:29			0.00
ORB	ORTF'TCE	2.12	13709 00:29			0.00
OR9	ORIFICE	2.12	13709 00:29			0.00
RISER	ORIFICE	0.89	13709 00:29			0.00
ORl	WEIR	2.51	13709 00:29			0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Wed Aug 08 09:47:08 2018
Analysis ended on: Wed Aug 08 09:47:32 2018
Total elapsed time: 00:00:24

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------

Inital Post Condition Scenario for SOHM comparison - 82% impervious

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... KINWAVE
Starting Date ............ 10/03/1970 05:00:00
Ending Date .............. 05/25/2008 22:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 01:00:00
Routing Time Step ........ 60.00 sec

**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Initial LID Storage ......         0.186         0.035
Total Precipitation ......      1790.290       339.070
Evaporation Loss .........       313.255        59.329
Infiltration Loss ........       423.502        80.209
Surface Runoff ...........      1060.715       200.893
Final Storage ............         0.186         0.035
Continuity Error (%) .....        -0.401

**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10"6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......      1060.715       345.650
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........       770.838       251.189
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........       289.759        94.422
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.011

*******************************
Highest Flow Instability Indexes
*******************************
All links are stable.

*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     60.00 sec
Average Time Step           :     60.00 sec
Maximum Time Step           :     60.00 sec
Percent in Steady State     :      0.00
Average Iterations per Step :      1.00
Percent Not Converging      :      0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10" 6 gal	Peak Runoff CFS	Runoff Coeff
S5	339.07	0.00	59.33	80.21	200.89	345.62	64.32	0.592

****
LID Performance Sununary
****

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
S5	**LID**	339.07	276.23	62.84	0.00	0.00	2.10	2.10	0.00

****
Node Depth Sununary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
POC2	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
SB_STOR	STORAGE	0.05	4.34	4.34	4532 12:34	4.27

****
Node Inflow Sununary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10"6 **gal**	Total Inflow Volume 10"6 gal	Flow Balance Error Percent
POC2	OUTFALL	0.00	23.59	4532 12:34	0	251	0.000
SB_STOR	STORAGE	64.32	64.32	4532 12:01	346	346	0.011

****
Node Flooding Sununary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pent Full	Evap Pent Loss	Exfil Pent Loss	Maximum Volume 1000 ft3	**Max** Pent Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
SB_STOR	2. 623	0	0	27	234.846	39	4532 12:33	23.73

****
Outfall Loading Surmnary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
POC2	8.14	0.35	23.59	251.170
System	8.14	0.35	23.59	251.170

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min		Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
14	ORIFICE	0.48	4532	12:34			0.00
18	ORIFICE	0.48	4532	12:34			0.00
OR2	ORIFICE	2.40	4532	12:34			0.00
OR3	ORIFICE	2.40	4532	12:34			0.00
9	WEIR	17.82	4532	12:34			0.00

****
Conduit Surcharge Summary
****

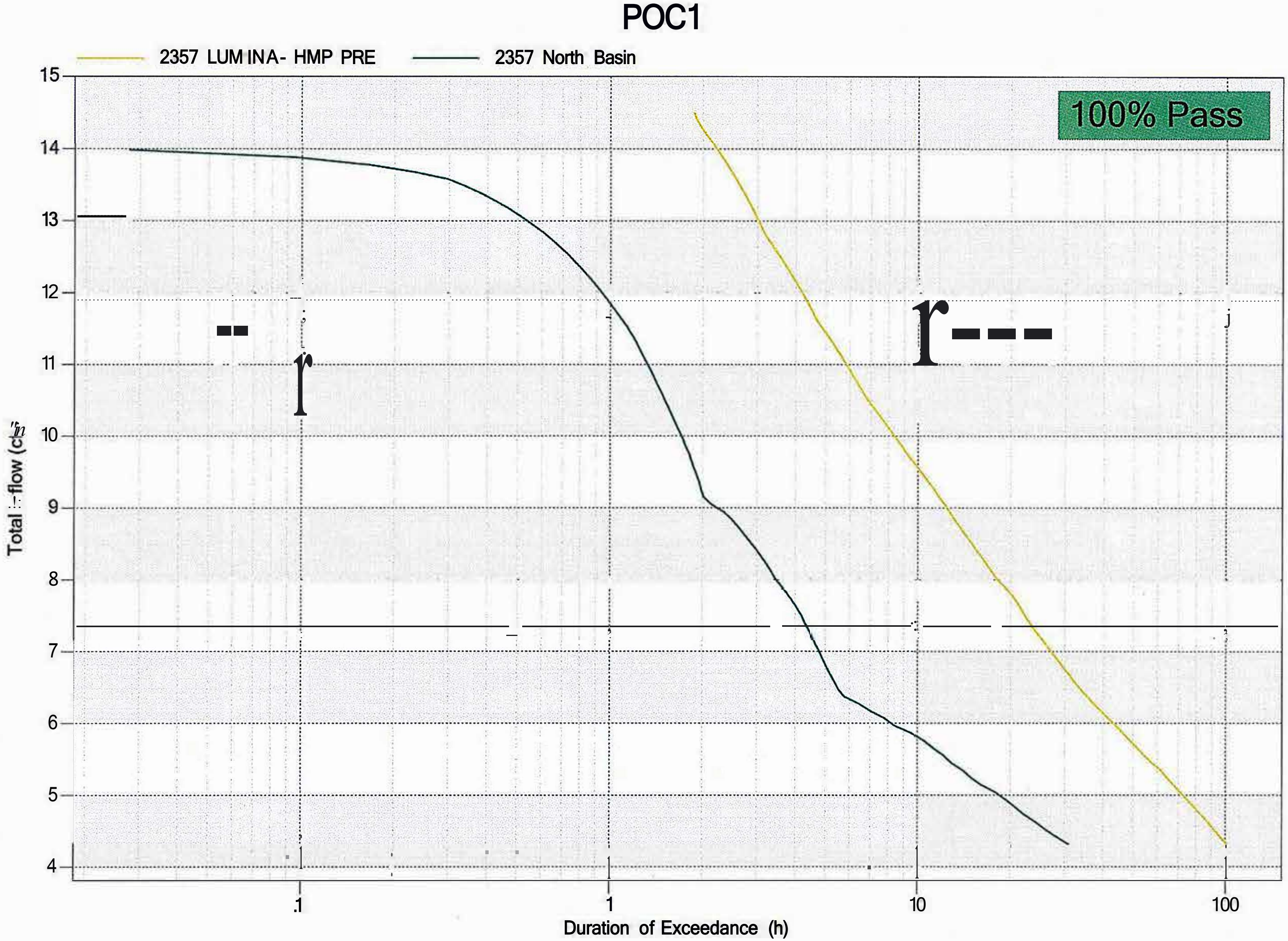
No conduits were surcharged.

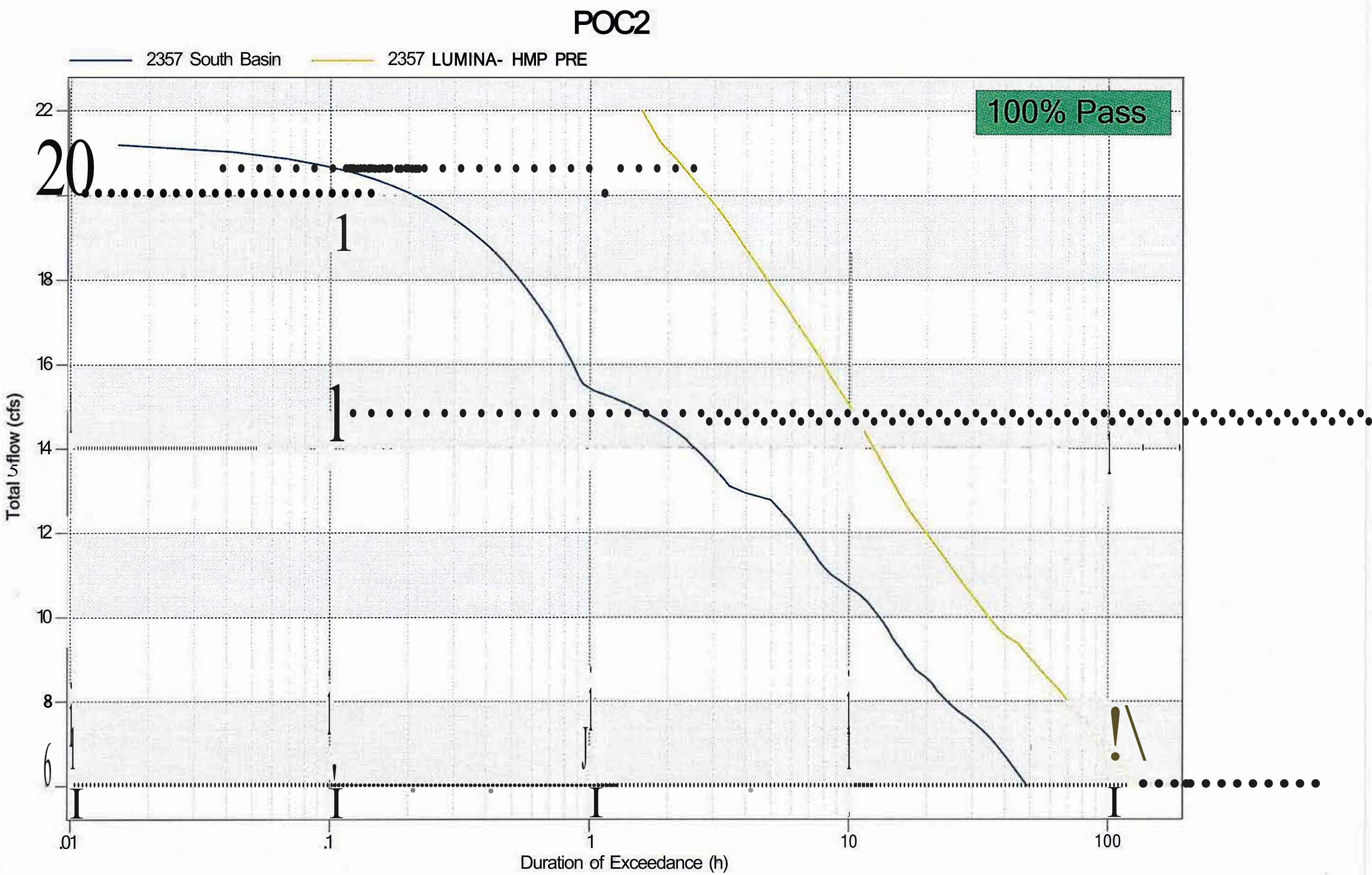
Analysis begun on: Tue Aug 14 16:38:02 2018
Analysis ended on: Tue Aug 14 16:38:16 2018
Total elapsed time: 00:00:14

5

Attachment 5

Flow Duration Comparison Curve


POC1
2357 LUMINA- HMP PRE
2357 North Basin
100% Pass
15
14
13
12
11
10
9
8
7
6
5
4
Total flow (cfs)
.1
1
10
100
Duration of Exceedance (h)


POC2
2357 South Basin
2357 LUMINA- HMP PRE
100% Pass
Total flow (cfs)
22
20
18
16
14
12
10
8
6
.01
.1
1
10
100
Duration of Exceedance (h)

Pre-proiect Flow Frequency - Long-term Simulation

Statistics - Node POC1 Total Inflow

Rank	Start Date	Event Duration (hours)	Event Peak (CFS)	Exceedance Frequency (percent)	Return Period (years)
1	3/1/1983	70	32.151	0.51	39
2	11/11/1972	4	16.511	1.02	19.5
3	3/24/1983	5	15.815	1.52	13
4	12/19/1970	57	14.393	2.03	9.75
5	1/11/2005	8	14.327	2.54	7.8
6	2/22/2004	17	12.839	3.05	6.5
7	11/25/1985	17	12.695	3.55	5.57
8	2/21/2005	10	11.616	4.06	- 4.88
9	1/16/1978	9	11.518	4.57	4.33
10	1/3/2005	28	10.653	5.08	3.9
11	12/4/1992	2	10.54	5.58	3.55
12	12/7/1992	6	10.436	6.09	3.25
13	10/19/2004	33	10.144	6.6	3
14	3/26/1991	32	9.766	7.11	2.79
15	1/31/1979	17	9.702	7.61	2.6
16	3/2/1992	20	9.248	8.12	2.44
17	3/20/1973	3	8.963	8.63	2.29
18	8/14/1983	2	8.786	9.14	2.17
19	4/1/1982	7	8.671	9.64	2.05
20	11/12/1976	3	8.613	10.15	1.95
21	2/22/2005	10	8.374	10.66	1.86
22	2/28/1991	29	7.962	11.17	1.77
23	11/20/1983	24	7.798	11.68	1.7
24	10/30/1998	2	7.762	12.18	1.63
25	1/29/1980	25	7.585	12.69	1.56
26	11/29/1970	5	7.214	13.2	1.5
27	3/18/1983	24	7.18	13.71	1.44
28	3/1/1981	14	6.874	14.21	1.39
29	12/25/1988	4	6.858	14.72	1.34
30	1/15/1993	27	6.795	15.23	1.3
31	2/27/1978	39	6.56	15.74	1.26
32	2/6/1992	6	6.531	16.24	1.22
33	1/4/1995	7	6.337	16.75	1.18
34	2/19/1993	4	6.315	17.26	1.15
35	3/10/1975	30	6.229	17.77	1.11
36	4/20/1983	6	6.132	18.27	1.08
37	3/6/1980	9	6.086	18.78	1.05
38	10/27/2004	6	5.924	19.29	1.03
39	3/21/1983	2	5.889	19.8	1

10-year Q:	14.502	cfs
5-year Q:	11.804	cfs
2-year Q:	8.642	cfs

Lower Flow Threshold:j)i! %i«la !j

o.sxQ2 : 4.321 cfs

Post-project Flow Frequency - Long-term Simulation

Statistics - Node POCI Total Inflow

Rank	Start Date	Event Duration (hours)	Event Peak (CFS)	Exceedance Frequency (percent)	Return Period (years)
1	4/15/2008	33.8	14.028	0.18	39
2	2/26/1983	150.8	9.098	0.37	19.5
3	1/30/1979	81.3	6.392	0.55	13
4	12/7/1992	34	6.183	0.74	9.75
5	11/24/1985	52.8	5.956	0.92	7.8
6	10/18/2004	76	5.555	1.11	6.5
7	2/21/2004	54.5	5.441	1.29	5.57
8	1/7/2005	118.8	5.109	1.48	4.88
9	2/6/1992	37.8	5.104	1.66	4.33
10	2/18/2005	137	4.344	1.85	3.9
11	2/27/1991	67.3	4.313	2.03	3.55
12	11/12/1976	28.5	4.254	2.21	3.25
13	12/17/1970	131.5	4.042	2.4	3
14	3/6/1980	29.5	3.982	2.58	2.79
15	1/3/2005	42	3.939	2.77	2.6
16	12/28/2004	43.5	3.903	2.95	2.44
.17	10/27/2004	35.5	3.893	3.14	2.29
18	3/2/1992	34.3	3.848	3.32	2.17
19	1/3/1995	55.5	3.816	3.51	2.05
20	1/28/1980	67.8	3.807	3.69	1.95
21	3/24/1983	24.8	3.76	3.87	1.86
22	11/10/1972	36.8	3.735	4.06	1.77
23	11/11/1985	40.3	3.732	4.24	1.7
24	3/4/2005	30.8	3.723	4.43	1.63
25	1/11/1993	178.8	3.722	4.61	1.56
26	1/14/1978	131.8	3.708	4.8	1.5
27	8/14/1983	25.3	3.704	4.98	1.44
28	3/20/1973	47	3.69	5.17	1.39
29	2/2/1988	33.8	3.662	5.35	1.34
30	11/29/1970	26	3.642	5.54	1.3
31	2/15/1986	27.5	3.631	5.72	1.26
32	3/16/1982	55.8	3.622	5.9	1.22
33	3/25/1991	66.3	3.594	6.09	1.18
34	8/16/1977	30.5	3.548	6.27	1.15
35	12/10/1984	41.8	3.503	6.46	1.11
36	12/3/1992	37.3	3.477	6.64	1.08
37	2/13/1995	34.3	3.471	6.83	1.05
38	3/10/1980	24.5	3.464	7.01	1.03
39	3/10/1975	40.5	3.44	7.2	1

10-year Q:	6.635	**cfs**
5-year Q:	4.598	cfs
2-year Q:	4.032	cfs
Lower Flow Threshold:	50%	
0.5xQ2 (Pre):	2.016	cfs

Pre-project Flow Frequency- Long-term Simulation

Statistics - Node POC2 Total Inflow

Rank	Start Date	Event Duration (hours)	Event Peak (CFS)	Exceedance Frequency (percent)	Return Period (years)
1	3/1/1983	72	48.407	0.52	39
2	11/11/1972	5	22.267	1.03	19.5
3	12/19/1970	57	21.983	1.55	13
4	1/11/2005	9	21.272	2.06	9.75
5	3/24/1983	6	21.25	2.58	7.8
6	2/22/2004	17	20.292	3.09	6.5
7	2/21/2005	11	18.815	3.61	5.57
8	12/7/1992	7	17.891	4.12	4.88
9	11/25/1985	18	16.937	4.64	4.33
10	1/16/1978	10	16.936	5.15	3.9
11	1/31/1979	18	15.629	5.67	3.55
12	1/3/2005	29	15.453	6.19	3.25
13	3/2/1992	20	14.406	6.7	3
14	3/26/1991	36	13.988	7.22	2.79
15	12/4/1992	2	13.163	7.73	2.6
16	10/19/2004	33	12.878	8.25	2.44
17	2/22/2005	11	12.166	8.76	2.29
18	1/29/1980	25	12.039	9.28	2.17
19	2/28/1991	15	11.79	9.79	2.05
20	3/20/1973	4	11.754	10.31	1.95
21	1/15/1993	28	11.422	10.82	1.86
22	4/i/1982	8	10.999	11.34	1.77
23	11/29/1970	6	10.825	11.86	1.7
24	2/6/1992	6	10.684	12.37	1.63
25	11/12/1976	3	10.601	12.89	1.56
26	3/10/1975	31	10.124	13.4	1.5
27	8/14/1983	3	10.087	13.92	1.44
28	1/4/1995	8	9.742	14.43	1.39
29	3/6/1980	9	9.521	14.95	1.34
30	11/20/1983	24	9.481	15.46	1.3
31	3/1/1981	15	9.479	15.98	1.26
32	2/27/1978	40	9.451	16.49	1.22
33	10/27/2004	7	9.24	17.01	1.18
34	10/30/1998	2	9.143	17.$3	1.15
35	12/28/2004	14	8.902	18.04	1.11
36	3/18/1983	25	8.684	18.56	1.08
37	12/25/1988	5	8.648	19.07	1.05
38	1/14/1978	18	8.236	19.59	1.03
39	2/15/1986	8	7.82	20.1	1

10-year Q:!	21.327	lets
5-year Q:	18.052	cfs
2-year Q:	11.772	ets

Lower Flow Threshold:!! 50%

0.5xQ2 : 5.886 lets

Post-project Flow Frequency - Long-term Simulation

Inital Post Condition Scenario for SDHM comparison - 82% impervious
Statistics- Node POC2 Total Inflow

Rank	Start Date	Event Duration (hours)	Event Peak (CFS)	Exceedance Frequency (percent)	Return Period (years)
1	2/24/1983	263	21.285	0.22	39
2	1/31/1979	124	15.446	0.43	19.S
3	12/3/1992	162	14.372	0.65	13
4	2/27/1991	113	14.166	0.86	9.75
5	10/18/2004	127	13.071	1.08	7.8
6	11/24/1985	97	13.007	1.3	6.5
7	12/17/1970	175	11.265	1.51	5.57
8	12/28/2004	112	11.14	1.73	4.88
9	2/22/2004	82	9.476	1.94	4.33
10	1/28/1980	115	8.812	2.16	3.9
11	1/7/2005	163	8.137	2.38	3.55
12	2/18/2005	189	8.026	2.59	3.25
13	2/6/1992	142	7.854	2.81	3
14	1/3/1995	146	7.447	3.02	2.79
15	1/14/1978	157	5.878	3.24	2.6
16	3/14/1982	156	5.396	3.46	2.44
17	12/27/1984	96	5.338	3.67	2.29
18	1/12/1993	211	4.546	3.89	2.17
19	3/4/2005	78	4.544	4.1	2.05
20	3/6/1980	77	4.419	4.32	1.95
21	11/11/1985	90	4.389	4.54	1.86
22	3/25/1991	118	4.347	4.75	1.77
23	2/27/1978	203	4.329	4.97	1.7
24	1/6/1993	128	4.273	5.18	1.63
25	3/2/1992	86	4.233	5.4	1.56
26	10/27/2004	84	4.202	5.62	1.5
27	11/10/1972	100	3.99	5.83	1.44
28	2/15/1986	79	3.961	6.05	1.39
29	2/28/1981	95	3.861	6.26	1.34
30	2/14/1995	84	3.765	6.48	1.3
31	11/21/1996	80	3.718	6.7	1.26
32	8/16/1977	83	3.702	6.91	1.22
33	2/3/1976	231	3.675.	7.13	1.18
34	3/5/1995	83	3.655	7.34	1.15
35	12/10/1984	89	3.653	7.56	1.11
36	11/12/1976	71	3.604	7.78	1.08
37	2/2/1988	82	3.479	7.99	1.05
38	1/25/1999	108	3.367	8.21	1.03
39	3/15/2003	95	3.362	8.42	1

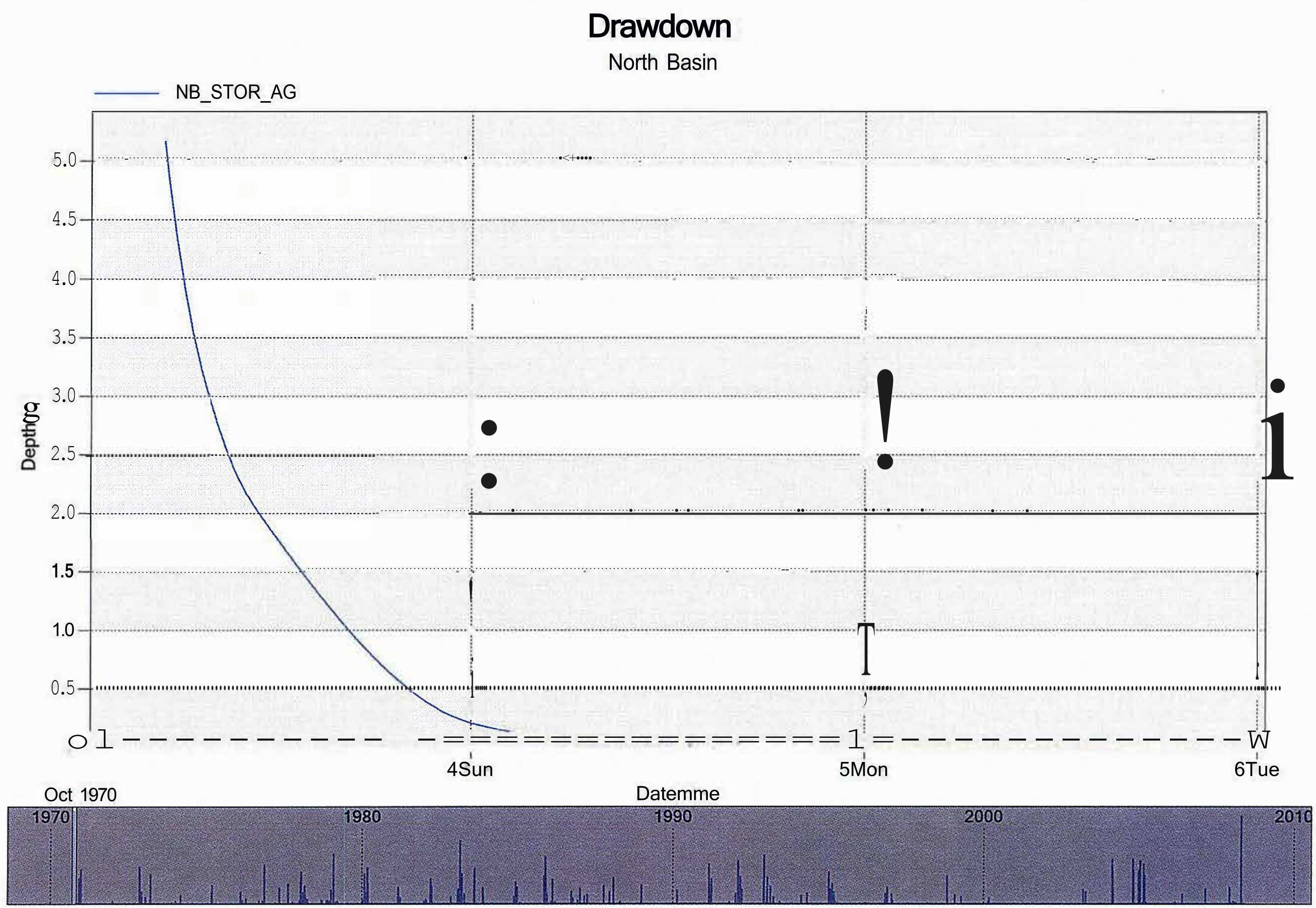
10-year Q:	14.182	cfs
5-year Q:	11.162	cfs
2-year Q:	4.482	cfs
Lower Flow Threshold:	50%	
0.5xQ2 :	2.241	crs

6

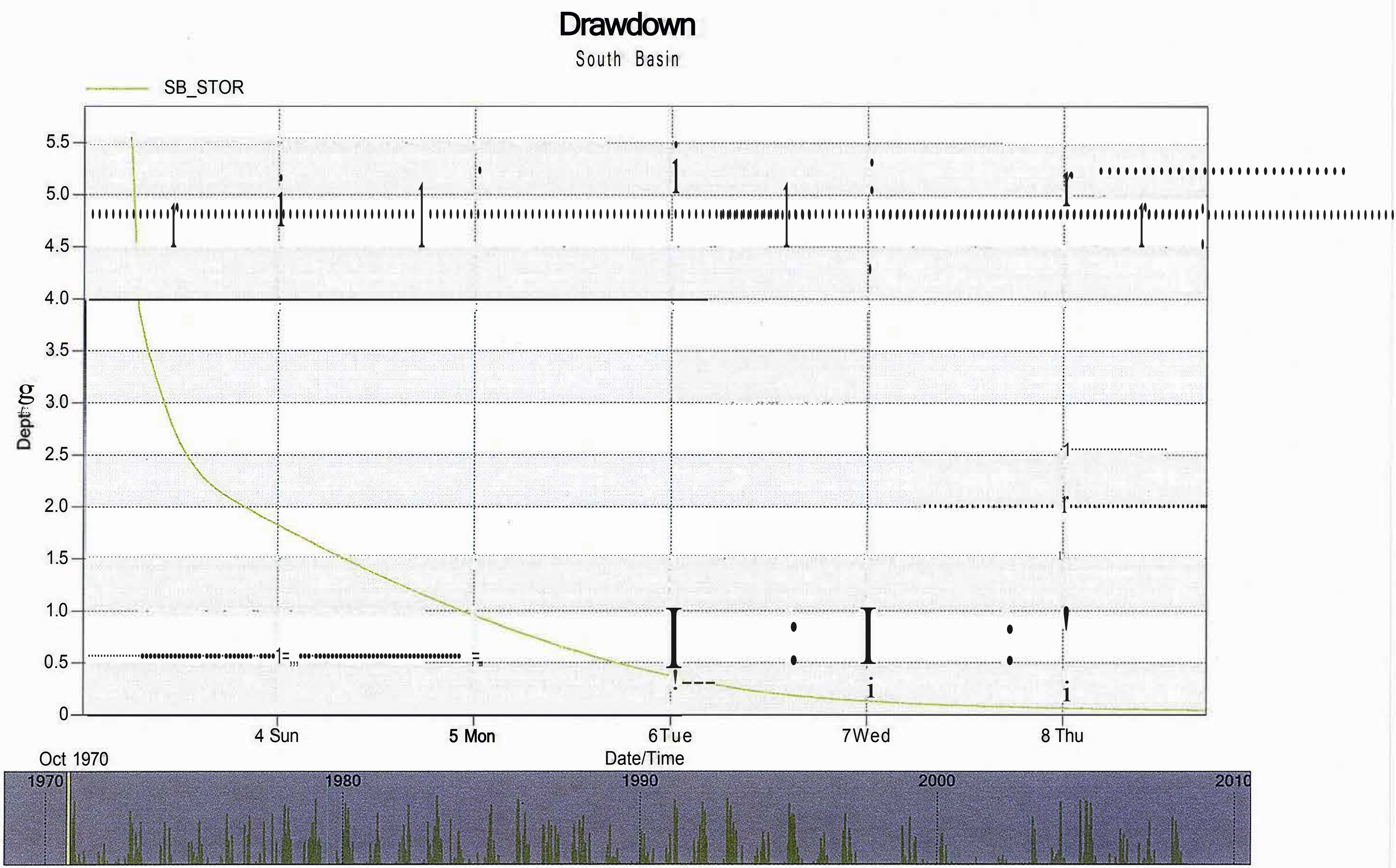
Attachment 6

Hydromodification Storage

Drawdown Graph



Drawdown
North Basin
NB_STOR_AG
Depth
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
4Sun
5Mon
6Tue
Datemme
Oct 1970
1970
1980
1990
2000
2010



Drawdown
South Basin
SB_STOR
Depth
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
4 Sun
5 Mon
6 Tue
7 Wed
8 Thu
Date/Time
Oct 1970
1970
1980
1990
2000
2010

Project Name: LUMINA

The City of San Diego

PRIORITY DEVELOPMENT PROJECT (PDP) STORM WATER QUALITY MANAGEMENT PLAN (SWQMP) FOR

LUMINA
TENTATIVE MAP PTS# 555609

ENGINEER OF WORK:

REGISTERED PROFESSIONAL ENGINEER
DEBBY SUE REECE
No. C56148
EXP. 12-31-18
CIVIL
STATE OF CALIFORNIA

Debby Reece, PE
RCE 56148, REGISTRATION EXPIRES 12/31/18

PREPARED FOR:
COLRICH
444 West Beech Street, Suite 300
San Diego, CA 92101

PREPARED BY:

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey

701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

DATE OF SWQMP:
August 10, 2018

Job No. 2357.35

Approved by: City of San Diego Date

Project Name: LUMINA

TABLE OF CONTENTS

Project Name: LUMINA

ACRONYMS

APN	Assessor's Parcel Number
ASBS	Area of Special Biological Significance
BMP	Best Management Practice
CEQA	California Environmental Quality Act
CGP	Construction General Permit
DCV	Design Capture Volume
DMA	Drainage Management Areas
ESA	Environmentally Sensitive Area
GLU	Geomorphic Landscape Unit
GW	Ground Water
HMP	Hydromodification Management Plan
HSG	Hydrologic Soil Group
HU	Harvest and Use
INF	Infiltration
LID	Low Impact Development
LUP	Linear Underground/Overhead Projects
MS4	Municipal Separate Storm Sewer System
N/A	Not Applicable
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PDP	Priority Development Project
PE	Professional Engineer
POC	Pollutant of Concern
SC	Source Control
SD	Site Design
SDRWQCB	San Diego Regional Water Quality Control Board
SIC	Standard Industrial Classification
SWPPP	Stormwater Pollutant Protection Plan
SWQMP	Storm Water Quality Management Plan
TMDL	Total Maximum Daily Load
WMAA	Watershed Management Area Analysis
WPCP	Water Pollution Control Program
WQIP	Water Quality Improvement Plan

Project Name: LUMINA

CERTIFICATION PAGE

Project Name: Lumina
Permit Application Number: 555609

I hereby declare that I am the Engineer in Responsible Charge of design of storm water BMPs for this project, and that I have exercised responsible charge over the design of the project as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with the requirements of the Storm Water Standards, which is based on the requirements of SDRWQCB Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100 (MS4 Permit).

I have read and understand that the City Engineer has adopted minimum requirements for managing urban runoff, including storm water, from land development activities, as described in the Storm Water Standards. I certify that this PDP SWQMP has been completed to the best of my ability and accurately reflects the project being proposed and the applicable source control and site design BMPs proposed to minimize the potentially negative impacts of this project's land development activities on water quality. I understand and acknowledge that the plan check review of this PDP SWQMP by the City Engineer is confined to a review and does not relieve me, as the Engineer in Responsible Charge of design of storm water BMPs for this project, of my responsibilities for project design.

____
Debby Reece, PE, RCE 56148, Registration Expires 12/31/18

Debby Reece
Print Name

Project Design Consultants
Company

____
Date

Project Name: LUMINA

SUBMITTAL RECORD

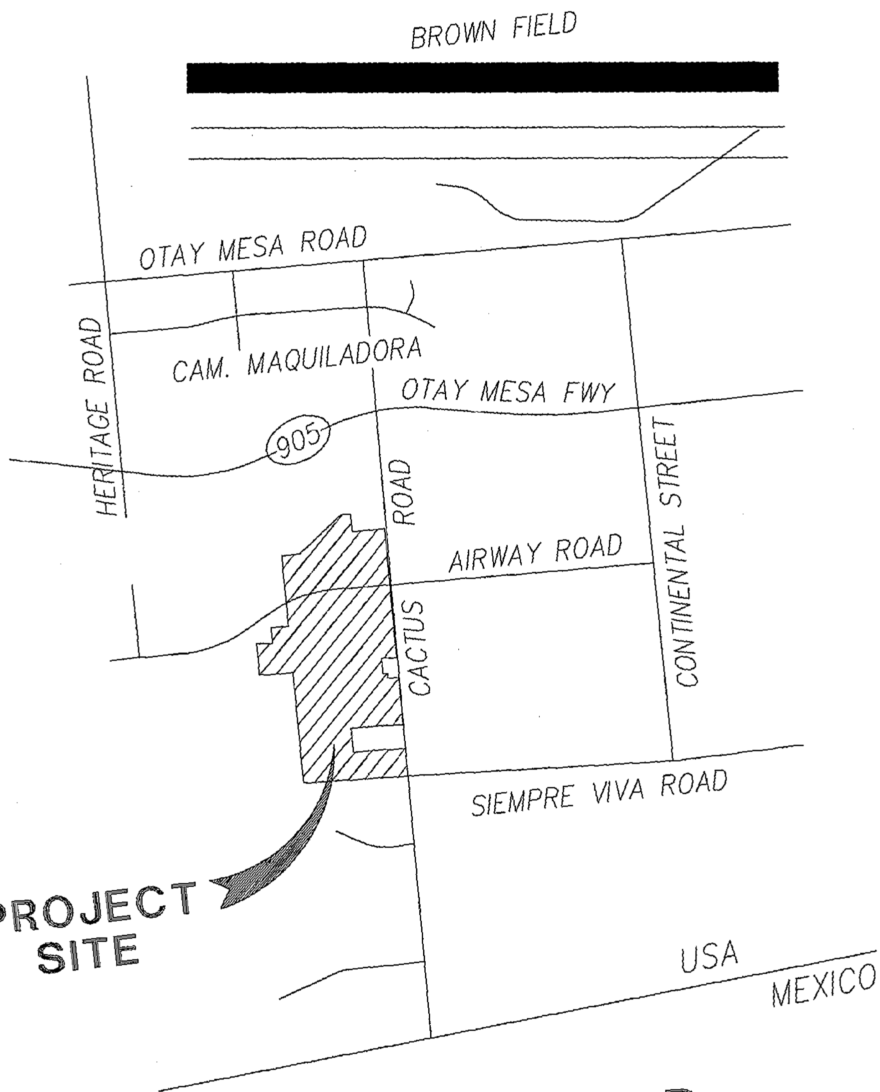
Use this Table to keep a record of submittals of this PDP SWQMP. Each time the PDP SWQMP is re-submitted, provide the date and status of the project. In last column indicate changes that have been made or indicate if response to plancheck comments is included. When applicable, insert response to plancheck comments.

Submittal Number	Date	Project Status	Summary of Changes
1	6/1/17	☒ Preliminary Design / Planning / CEQA ☐ Final Design	Initial Submittal
2	10/13/17	☒ Preliminary Design / Planning / CEQA ☐ Final Design	2nd Submittal
3	1/12/18	☒ Preliminary Design / Planning / CEQA ☐ Final Design	3rd Submittal
4	2/23/18	☒ Preliminary Design / Planning / CEQA ☐ Final Design	4th Submittal
5	8/15/18	☒ Preliminary Design / Planning / CEQA ☐ Final Design	5th Submittal

Project Name: LUMINA

PROJECT VICINITY MAP

Project Name: Lumina
Permit Application Number: 555609



VICINITY MAP
NOT TO SCALE

Project Name: LUMINA

THE CITY OF SAN DIEGO

City of San Diego
Development Services
1222 First Ave., MD-302
San Diego, CA 92101
(619) 446-5000

Storm Water Requirements Applicability Checklist

FORM **DS-560** February 2016

Project Address: Click here to enter project address.	Project Number *(for the City Use Only)*: Click here to enter project number

SECTION 1. Construction Storm Water BMP Requirements:

All construction sites are required to implement construction BMPs in accordance with the performance standards in the Storm Water Standards Manual. Some sites are additionally required to obtain coverage under the State Construction General Permit (CGP)[1], which is administrated by the State Water Resources Control Board.

For all projects complete PART A: If project is required to submit a SWPPP or WPCP, continue to PART B.

PART A: Determine Construction Phase Storm Water Requirements.

1. Is the project subject to California's statewide General NPDES permit for Storm Water Discharges Associated with construction activities, also known as the State Construction General Permit (CGP)? (Typically projects with land disturbance greater than or equal to 1 acre.)

   ◉ Yes; SWPPP required, skip questions 2-4 ○ No; next question

2. Does the project propose construction or demolition activity, including but not limited to, clearing, grading, grubbing, excavation, or any other activity that results in ground disturbance and contact with storm water runoff?

   ○ Yes; WPCP required, skip questions 3-4 ◉ No; next question

3. Does the project propose routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility? (projects such as pipeline/utility replacement)

   ○ Yes; WPCP required, skip questions 4 ◉ No; next question

4. Does the project only include the following Permit types listed below?
   - Electrical Permit, Fire Alarm Permit, Fire Sprinkler Permit, Plumbing Permit, Sign Permit, Mechanical Permit, Spa Permit.
   - Individual Right of Way Permits that exclusively include one of the following activities and associated curb/ sidewalk repair: water services, sewer lateral, storm drain lateral, or dry utility service.
   - Right of Way Permits with a project footprint less than 150 linear feet that exclusively include only ONE of the following activities: curb ramp, sidewalk and driveway apron replacement, curb and gutter replacement, and retaining wall encroachments.

   ☐ Yes; no document required

Check one of the boxes to the right, and continue to PART B:

☒ If you checked "Yes" for question 1,
a SWPPP is REQUIRED. Continue to PART B

☐ If you checked "No" for question 1, and checked "Yes" for question 2 or 3,
a WPCP is REQUIRED. If the project processes less than 5,000 square feet of ground disturbance AND has less than a 5-foot elevation change over the entire project area, a Minor WPCP may be required instead. **Continue to PART B.**

☐ If you checked "No" for all question 1-3, and checked "Yes" for question 4
PART B **does not apply and no document is required. Continue to Section 2.**

More information on the City's construction BMP requirements as well as CGP requirements can be found at: www.sandiego.gov/stormwater/regulations/swguide/constructing.shtml

Project Name: LUMINA

PART B: Determine Construction Site Priority.
This prioritization must be completed within this form, noted on the plans, and included in the SWPPP or WPCP. The city reserves the right to adjust the priority of projects both before and after construction. Construction projects are assigned an inspection frequency based on if the project has a "high threat to water quality." The City has aligned the local definition of "high threat to water quality" to the risk. Determination approach of the Stat e Construction General Permit (CGP). The CGP determines risk level based on project specific sediment risk and receiving water risk. Additional inspection is required for projects within the Areas of Special Biological Significance (ASBS) watershed. **NOTE:** The construction priority does **NOT** change construction BMP requirements that apply to projects; rather, it determines the frequency of inspections that will be conducted by city staff.

Complete PART B and continued to Section 2

1. ☐ **ASBS**

a. Projects located in the ASBS watershed. A map of the ASBS watershed can he found here *<placeholder for ASBS map link>*

2. ☒ **High Priority**

a. Projects 1 acre or more determined to be Risk Level 2 or Risk Level 3 per the Construction General Permit and not located in the ASBS watershed.

b. Projects 1 acre or more determined to be LUP Type 2 or LUP Type 3 per the Construction General Permit and not located in the ASBS watershed.

3. ☐ **Medium Priority**

a. Projects 1 acre or more but not subject to an ASBS or high priority designation.

b. Projects determined to be Risk Level 1 or LUP Type 1 per the Construction General Permit and not located in the ASBS watershed.

4. ☐ **Low Priority**

a. Projects not subject to ASBS, high or medium priority designation.

SECTION 2. Permanent Storm Water BMP Requirements.

Additional information for determining the requirements is found in the Storm Water Standards Manual.

PART C: Determine if Not Subject to Permanent Storm Water Requirements.
Projects that are considered maintenance, or otherwise not categorized as "new development projects" or "redevelopment projects" according to the Storm Water Standards Manual are not subject to Permanent Storm Water
BMPs.

If "yes" is checked for any number in Part C, proceed to Part F and check "Not Subject to Permanent Storm Water BMP Requirements".

If "no" is checked for all of the numbers in Part C continue to Part D.

1.	Does the project only include interior remodels and/or is the project entirely within an existing enclosed structure and does not have the potential to contact storm water?	○ Yes ◉ No
2.	Does the project only include the construction of overhead or underground utilities without creating new impervious surfaces?	○ Yes ◉ No

Project Name: LUMINA

3.	Does the project fall under routine maintenance? Examples include, but are not limited to: roof or exterior structure surface replacement, resurfacing or reconfiguring surface parking lots or existing roadways without expanding the impervious footprint, and routine replacement of damaged pavement (grinding, overlay, and pothole repair).	Yes No

PART D: PDP Exempt Requirements.

PDP Exempt projects are required to implement site design and source control BMPs.

If "yes" was checked for any questions in Part D, continue to Part F and check the box labeled "PDP Exempt."
If "no" was checked for all questions in Part D, continue to Part E.

1. Does the project ONLY include new or retrofit sidewalks, bicycle lanes, or trails that:

   • Are designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas? Or;
   • Are designed and constructed to be hydraulically disconnected from paved streets and roads? Or;
   • Are designed and constructed with permeable pavements or surfaces in accordance with the Green Streets guidance in the City's Storm Water Standards manual?

   Yes; PDP exempt requirements apply   No; next question

2. Does the project ONLY include retrofitting or redeveloping existing paved alleys, streets or roads designed and constructed in accordance with the Green Streets guidance in the City's Storm Water Standards Manual?

   Yes; PDP exempt requirements apply   No; PDP not exempt. PDP requirements apply.

PART E: Determine if Project is a Priority Development Project (PDP). Projects that match one of the definitions below are subject to additional requirements including preparation of a Storm Water Quality Management Plan (SWQMP).

If "yes" is checked for any number in PART E, continue to PART F and check the box labeled "Priority Development Project".
If "no" is checked for every number in PART E, continue to PART F and check the box labeled "Standard Project".

1.	**New Development that creates 10,000 square feet or more of impervious surfaces collectively over the project site.** This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.	Yes No
2.	**Redevelopment project that creates and/or replaces 5,000 square feet or more of impervious surfaces on an existing site of 10,000 square feet or more of impervious surfaces.** This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.	Yes No
3.	**New development or redevelopment of a restaurant.** Facilities that sell prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC 5812), and where the land development creates and/or replace 5,000 square feet or more of impervious surface.	Yes No
4.	**New development or redevelopment on a hillside.** The project creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site) and where the development will grade on any natural slope that is twenty-five percent or greater.	Yes No

Project Name: LUMINA

5.	**New development or redevelopment of a parking lot that creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site).**	◉ Yes ○ No
6.	**New development or redevelopment of streets, roads, highways, freeways, and driveways.** The project creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site).	◉ Yes ○ No
7.	**New development or redevelopment discharging directly to an Environmentally Sensitive Area.** The project creates and/or replaces 2,500 square feet of impervious surface (collectively over project site), and discharges directly to an Environmentally Sensitive Area (ESA). "Discharging- directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands).	○ Yes ◉ No
8.	**New development or redevelopment projects of a retail gasoline outlet that creates and/or replaces 5,000 square feet of impervious surface.** The development project meets the following criteria: (a) 5,000 square feet or more or (b) has a projected Average Daily Traffic of 100 or more vehicles per day.	○ Yes ◉ No
9.	**New development or redevelopment projects of an automotive repair shops that creates and/or replaces 5,000 square feet or more of impervious surfaces.** Development projects categorized in any one of Standard Industrial Classification (SIC) codes 5013, 5014, 5541, 7532-7534, or 7536-7539.	○ Yes ◉ No
10.	**Other Pollutant Generating Project.** The project is not covered in the categories above, results in the disturbance of one or more acres of land and is expected to generate pollutants post construction, such as fertilizers and pesticides. This does not include projects creating less than 5,000 sf of impervious surface and where added landscaping does not require regular use of pesticides and fertilizers, such as slope stabilization using native plants. Calculation of the square footage of impervious surface need not include linear pathways that are for infrequent vehicle use, such as emergency maintenance access or bicycle pedestrian use, if they are built with pervious surfaces of if they sheet flow to surrounding pervious surfaces.	○ Yes ◉ No

PART F: Select the appropriate category based on the outcomes of PART C through PART E.

1.	The project is **NOT SUBJECT TO STORM WATER REQUIREMENTS.**	☐
2.	The project is a **STANDARD PROJECT**. Site design and source control BMP requirements apply. See the Storm Water Standards Manual for guidance.	☐
3.	The project is **PDP EXEMPT**. Site design and source control BMP requirements apply. See the Storm Water Standards Manual for guidance.	☐
4.	The project is a **PRIORITY DEVELOPMENT PROJECT**. Site design, source control, and structural pollutant control BMP requirements apply. See the Storm Water Standards Manual for guidance on determining if project requires hydromodification management.	☒

Name of Owner or Agent *(Please Print):* Click here to enter name.	Title: Click here to enter title
Signature:	Date: Insert Date

Applicability of Permanent, Post-Construction Storm Water BMP Requirements (Storm Water Intake Form for all Development Permit Applications)	Form I-1
Project Identification	
Project Name: **Lumina**	
Permit Application Number: **555609**	Date: 08/14/2018
Determination of Requirements	
The purpose of this form is to identify permanent, post-construction requirements that apply to the project. This form serves as a short <u>summary</u> of applicable requirements, in some cases referencing separate forms that will serve as the backup for the determination of requirements. Answer each step below, starting with Step 1 and progressing through each step until reaching "Stop". Refer to Part 1 of Storm Water Standards sections and/or separate forms referenced in each step below.	

Step	Answer	Progression
Step 1: Is the project a "development project"? See Section 1.3 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☒ Yes	Go to Step 2.
	☐ No	Stop. Permanent BMP requirements do not apply. No SWQMP will be required. Provide discussion below.
Discussion / justification if the project is <u>not</u> a "development project" (e.g., the project includes *only* interior remodels within an existing building):		
Step 2: Is the project a Standard Project, Priority Development Project (PDP), or exception to PDP definitions? To answer this item, see Section 1.4 of the BMP Design Manual (Part 1 of Storm Water Standards) <u>in its entirety</u> for guidance, AND complete Storm Water Requirements Applicability Checklist.	☐ Standard Project	Stop. Standard Project requirements apply.
	☒ PDP	PDP requirements apply, including PDP SWQMP. Go to Step 3.
	☐ PDP Exempt	Stop. <u>Standard Project</u> requirements apply. Provide discussion and list any additional requirements below.

Project Name: LUMINA

Form I-1		
[Step 2 Continued from Page 1] Discussion / justification, and additional requirements for exceptions to PDP definitions, if applicable:		
Step 3: Is the project subject to earlier PDP requirements due to a prior lawful approval? See Section 1.10 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☐Yes	Consult the City Engineer to determine requirements. Provide discussion and identify requirements below. Go to Step 4.
	☒No	BMP Design Manual PDP requirements apply. Go to Step 4.
Discussion / justification of prior lawful approval, and identify requirements (*not required if prior lawful approval does not apply*):		
Step 4: Do hydromodification control requirements apply? See Section 1.6 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☒Yes	PDP structural BMPs required for pollutant control (Chapter 5) and hydromodification control (Chapter 6). Go to Step 5.
	☐No	Stop. PDP structural BMPs required for pollutant control (Chapter 5) only. Provide brief discussion of exemption to hydromodification control below.
Discussion / justification if hydromodification control requirements do <u>not</u> apply:		
Step 5: Does protection of critical coarse sediment yield areas apply? See Section 6.2 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☒Yes	Management measures required for protection of critical coarse sediment yield areas (Chapter 6.2). Stop.
	☐N/A	Management measures not required for protection of critical coarse sediment yield areas. Provide brief discussion below. Stop.
Discussion / justification if protection of critical coarse sediment yield areas does <u>not</u> apply:		

Site Information Checklist For PDPs	Form I-3B
Project Summary Information	
Project Name	Lumina
Project Address	Cactus Road and Siempre Viva Road San Diego, CA 92154
Assessor's Parcel Number(s) (APN(s))	646-100-17, 18, 20, 21, 38, 71, 76; 646-093-07, 09, 10, 11 & 12
Permit Application Number	555609
Project Watershed	Select One: ☐San Dieguito ☐Penasquitos ☐Mission Bay ☐San Diego River ☐San Diego Bay ☒Tijuana River
Hydrologic subarea name with Numeric Identifier up to two decimal places (9XX.XX)	Spring Canyon and Wruck Canyon 911.12
Parcel Area (total area of Assessor's Parcel(s) associated with the project)	93.44 Acres (40,704,333 Square Feet)
Area to be Disturbed by the Project (Project Area)	101.76 Acres (42,799,665 Square Feet)
Project Proposed Impervious Area (subset of Project Area)	76.94 Acres (33,784,596 Square Feet)
Project Proposed Pervious Area (subset of Project Area)	24.82 Acres (6,919,737 Square Feet)
Note: Proposed Impervious Area + Proposed Pervious Area = Area to be Disturbed by the Project. This may be less than the Parcel Area.	
The proposed increase or decrease in impervious area in the proposed condition as compared to the pre-project condition	No pre-project imperviousness available

Project Name: LUMINA

Form I-3B
Description of Existing Site Condition
Current Status of the Site (select all that apply): ☒ Existing development ☐ Previously graded but not built out ☐ Demolition completed without new construction ☒ Agricultural or other non-impervious use ☐ Vacant, undeveloped/natural Description / Additional Information: Presently the site is used for agriculture uses and some scattered residences.
Existing Land Cover Includes (select all that apply): ☒ Vegetative Cover ☒ Non-Vegetated Pervious Areas ☒ Impervious Areas Description / Additional Information: The site was is currently used for agricultural with a few residences and buildings scattered in the vicinity
Underlying Soil belongs to Hydrologic Soil Group (select all that apply): ☐ NRCS Type A ☐ NRCS Type B ☐ NRCS Type C ☒ NRCS Type D
Approximate Depth to Groundwater (GW): ☐ GW Depth < 5 feet ☐ 5 feet < GW Depth < 10 feet ☐ 10 feet < GW Depth < 20 feet ☒ GW Depth > 20 feet
Existing Natural Hydrologic Features (select all that apply): ☐ Watercourses ☐ Seeps ☐ Springs ☐ Wetlands ☒ None Description / Additional Information:

Form I-3B
Description of Existing Site Drainage Patterns

How is storm water runoff conveyed from the site? At a minimum, this description should answer:

1. *Whether existing drainage conveyance is natural or urban;*
2. *If runoff from offsite is conveyed through the site? If yes, quantification of all offsite drainage areas, design flows, and locations where offsite flows enter the project site and summarize how such flows are conveyed through the site;*
3. *Provide details regarding existing project site drainage conveyance network, including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, and natural and constructed channels;*
4. *Identify all discharge locations from the existing project along with a summary of the conveyance system size and capacity for each of the discharge locations. Provide summary of the pre-project drainage areas and design flows to each of the existing runoff discharge locations.*

Description/ Additional Information:

1. The existing drainage conveyance is mostly natural with minimal drainage improvements.
2. There are about 4.5 acres of runon areas draining onto the site from upstream areas to the west of project site towards the existing western headwall near the southerly property line. There are about 4 acres of offsite runoff from southeast corner of Cactus Road and Airway Road draining onto the site towards Spring Canyon on the north side of Airway Road.
3. There are currently minimal drainage improvements within the project boundary.
4. The majority of the project drains to the south to a steep finger canyon (Wruck Creek) located to the west of the existing Cactus Road/Siempre Viva Road intersection. Two of the finger canyons drain to sump areas that are collected and drained to the west and discharged downstream within the canyon via an existing RCP storm drain per City Drawing 23871-21-D. A large portion of the project area drains to the northwest to a canyon (North tributary of Spring Canyon) on the north side of the proposed Airway Road. A small portion of the project area (Cactus Road north of Airway Road) drains in an unimproved roadside swale to the north and drains into a culvert underneath Cactus Road. After crossing Cactus Road, the runoff commingles with other runoff draining from upstream areas including Caltrans right-of-way and then drains to the upstream point of the North Canyon.

Form I-3B
Description of Proposed Site Development
Project Description / Proposed Land Use and/or Activities: The Lumina project represents a portion of the Otay Mesa Central Village Specific Plan, and proposes development of Medium High Density Mixed-Use, Medium Density Multi-Family, Low Density Multi-Family, Public School Facilities, Recreation, and Open Space land uses.
List/describe proposed impervious features of the project (e.g., buildings, roadways, parking lots, courtyards, athletic courts, other impervious features): The impervious features of the project consist of building roofs, driveways, streets, parking lots, and concrete sidewalks. The impervious areas will also include hardscape in park areas and other miscellaneous improvements.
List/describe proposed pervious features of the project (e.g., landscape areas): The pervious features of the project consist of landscaping areas, undeveloped open space, and two proposed parks.
Does the project include grading and changes to site topography? ☒ Yes ☐ No Description / Additional Information: The site will be mass graded to regrade and flatten much of the site.

Form I-3B
Description of Proposed Site Drainage Patterns
Does the project include changes to site drainage (e.g., installation of new storm water conveyance systems)? ☒ Yes ☐ No If yes, provide details regarding the proposed project site drainage conveyance network, including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural and constructed channels, and the method for conveying offsite flows through or around the proposed project site. Identify all discharge locations from the proposed project site along with a summary of the conveyance system size and capacity for each of the discharge locations. Provide a summary of pre and post-project drainage areas and design flows to each of the runoff discharge locations. Reference the drainage study for detailed calculations. *Describe proposed site drainage patterns:* The project site will include a storm drain system consisting of roof drains, inlets, pipes, brow ditches, and water quality features/detention basins. The proposed drainage improvements include public storm drain infrastructure serving the proposed public streets, and private storm drain improvements serving the private development lots. The backbone storm drain system will provide storm drain stubs to serve the proposed developable lots. The lots will be developed in phases. The site generally maintains the natural drainage divide, while shifting only small fragments between the two major divides that go to the north and south due to mass grading.

Form I-3B
Identify whether any of the following features, activities, and/or pollutant source areas will be present (select all that apply): ☒ On-site storm drain inlets ☒ Interior floor drains and elevator shaft sump pumps ☐ Interior parking garages ☒ Need for future indoor & structural pest control ☒ Landscape/Outdoor Pesticide Use ☒ Pools, spas, ponds, decorative fountains, and other water features ☐ Food service ☒ Refuse areas ☐ Industrial processes ☐ Outdoor storage of equipment or materials ☐ Vehicle and Equipment Cleaning ☐ Vehicle/Equipment Repair and Maintenance ☐ Fuel Dispensing Areas ☐ Loading Docks ☒ Fire Sprinkler Test Water ☒ Miscellaneous Drain or Wash Water ☒ Plazas, sidewalks, and parking lots ☐ Large Trash Generating Facilities ☐ Animal Facilities ☐ Plant Nurseries and Garden Centers ☐ Automotive-related Uses Description / Additional Information: The project will have features typical of proposed land uses including parks, residential, mixed use and educational uses with landscaped areas, sidewalks, parking lots, refuse areas with the need for pesticides and pest control.

Project Name: LUMINA

Form I-3B
Identification and Narrative of Receiving Water
Narrative describing flow path from discharge location(s), through urban storm conveyance system, to receiving creeks, rivers, and lagoons and ultimate discharge location to Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable)
Provide a summary of all beneficial uses of receiving waters downstream of the project discharge locations. The majority of the project drains to the south to Wruck Canyon located to the west of the existing Cactus Road/Siempre Viva Road intersection. Two of the finger canyons drain to sump areas that are collected and drained to the west and discharged downstream within the canyon via an existing RCP storm drain per City Drawing 23871-21-D. A large portion of the project area drains to the northwest to North tributary of Spring Canyon on the north side of the proposed Airway Road. Wruck Canyon and Spring Canyon confluence with Tijuana River, and travel southwesterly entering Pacific Ocean close to US Mexico boundary. Per the basin plan, Spring Canyon and Wruck Canyon have the following beneficial uses: agricultural, rec 2, warm, and wild.
Identify all ASBS (areas of special biological significance) receiving waters downstream of the project discharge locations. There are no ASBS receiving waters downstream of the projects.
Provide distance from project outfall location to impaired or sensitive receiving waters. The project is located approximately 2 miles upstream of Tijuana River, which is on the 303(d) list of impaired waterbodies for the following contaminants: Eutrophic, Indicator Bacteria, Low Dissolved Oxygen, Pesticides, Phosphorus, Sedimentation/Siltation, Selenium, Solids, Surfactants (MBAS), Synthetic Organics, Total Nitrogen as N, Toxicity, Trace Elements and Trash.
Summarize information regarding the proximity of the permanent, post-construction storm water BMPs to the City's Multi-Habitat Planning Area and environmentally sensitive lands. Proposed BMPs will be located out of ESL areas.

Form I-3B		
Identification of Receiving Water Pollutants of Concern		
List any 303(d) impaired water bodies within the path of storm water from the project site to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable), identify the pollutant(s)/stressor(s) causing impairment, and identify any TMDLs and/or Highest Priority Pollutants from the WQIP for the impaired water bodies:		
303(d) Impaired Water Body	**Pollutant(s)/Stressor(s)**	**TMDLs / WQIP Highest Priority Pollutant**

Tijuana River	Eutrophic, Indicator Bacteria, Low Dissolved Oxygen, Pesticides, Phosphorus, Sedimentation/Siltation, Selenium, Solids, Surfactants (MBAS), Synthetic Organics, Total Nitrogen as N, Toxicity, Trace Elements and Trash	Eutrophic, Indicator Bacteria, Low Dissolved Oxygen, Pesticides, Phosphorus, Sedimentation/Siltation, Selenium, Solids, Surfactants (MBAS), Synthetic Organics, Total Nitrogen as N, Toxicity, Trace Elements and Trash
Tijuana River Estuary	Eutrophic, Indicator Bacteria, Lead, Low Dissolved Oxygen, Nickel, Pesticides, Thallium, Trash and Turbidity	Eutrophic, Indicator Bacteria, Lead, Low Dissolved Oxygen, Nickel, Pesticides, Thallium, Trash and Turbidity

Identification of Project Site Pollutants*

*Identification of project site pollutants is only required if flow-thru treatment BMPs are implemented onsite in lieu of retention or biofiltration BMPs (note the project must also participate in an alternative compliance program unless prior lawful approval to meet earlier PDP requirements is demonstrated)

Identify pollutants anticipated from the project site based on all proposed use(s) of the site (see BMP Design Manual (Part 1 of Storm Water Standards) Appendix B.6):

Pollutant	Not Applicable to the Project Site	Expected from the Project Site	Also a Receiving Water Pollutant of Concern
Sediment			
Nutrients			
Heavy Metals			
Organic Compounds			
Trash & Debris			
Oxygen Demanding Substances			
Oil & Grease			
Bacteria & Viruses			
Pesticides			

Form I-3B

Hydromodification Management Requirements

Do hydromodification management requirements apply (see Section 1.6 of the BMP Design Manual)?

- ⦿ Yes, hydromodification management flow control structural BMPs required.
- ○ No, the project will discharge runoff directly to existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.
- ○ No, the project will discharge runoff directly to conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.
- ○ No, the project will discharge runoff directly to an area identified as appropriate for an exemption by the WMAA for the watershed in which the project resides.

Description / Additional Information (to be provided if a 'No' answer has been selected above):

Critical Coarse Sediment Yield Areas*

***This Section only required if hydromodification management requirements apply**

Based on Section 6.2 and Appendix H does CCSYA exist on the project footprint or in the upstream area draining through the project footprint?

- ⦿ Yes
- ○ No, No critical coarse sediment yield areas to be protected based on WMAA maps

Discussion / Additional Information:

See attachment 2b for CCSYA documentation and No Net Impact Analysis.

Form I-3B

Flow Control for Post-Project Runoff*

***This Section only required if hydromodification management requirements apply**

List and describe point(s) of compliance (POCs) for flow control for hydromodification management (see Section 6.3.1). For each POC, provide a POC identification name or number correlating to the project's HMP Exhibit and a receiving channel identification name or number correlating to the project's HMP Exhibit.

POC 1 – Outlet of Southern Systems to Spring Canyon after entering public park storm drain system.

POC 3 – Outlet of Northern Systems to Wruck Canyon after entering public park storm drain system.

Refer to Hydromodification Study for further details.

Project Name: LUMINA

Has a geomorphic assessment been performed for the receiving channel(s)?

☐ No, the low flow threshold is 0.1Q2 (default low flow threshold)

☐ Yes, the result is the low flow threshold is 0.1Q2

☐ Yes, the result is the low flow threshold is 0.3Q2

☒ Yes, the result is the low flow threshold is 0.5Q2

If a geomorphic assessment has been performed, provide title, date, and preparer:

A Geomorphic Assessment of Receiving Channels was performed by Chang Consultants for the Points of Compliance.

This report is still being finalized and will be provided with the subsequent submittal.

Discussion / Additional Information: (optional)

It was determined that channel had a low susceptibility to erosion meaning that a 0.5 factor could be used as to calculate the low flow threshold from the flow rate of the 2-year recurrence interval.

Form I-3B
Other Site Requirements and Constraints
When applicable, list other site requirements or constraints that will influence storm water management design, such as zoning requirements including setbacks and open space, or local codes governing minimum street width, sidewalk construction, allowable pavement types, and drainage requirements.
Optional Additional Information or Continuation of Previous Sections As Needed
This space provided for additional information or continuation of information from previous sections as needed.

Source Control BMP Checklist for All Development Projects (Standard Projects and Priority Development Projects)			Form I-4
Project Identification			
Project Name: Lumina			
Permit Application Number: 555609			
Source Control BMPs			
All development projects must implement source control BMPs SC-1 through SC-6 where applicable and feasible. See Chapter 4 and Appendix E of the Model BMP Design Manual for information to implement source control BMPs shown in this checklist. Answer each category below pursuant to the following. • "Yes" means the project will implement the source control BMP as described in Chapter 4 and/or Appendix E of the Model BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project has no outdoor materials storage areas). Discussion / justification may be provided.			
Source Control Requirement	**Applied?**		
SC-1 Prevention of Illicit Discharges into the MS4	☒ Yes	☐ No	☐ N/A
Discussion / justification if SC-1 not implemented:			
SC-2 Storm Drain Stenciling or Signage	☒ Yes	☐ No	☐ N/A
Discussion / justification if SC-2 not implemented:			
SC-3 Protect Outdoor Materials Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐ Yes	☐ No	☒ N/A
Discussion / justification if SC-3 not implemented: No outdoor material storage areas planned.			
SC-4 Protect Materials Stored in Outdoor Work Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐ Yes	☐ No	☒ N/A
Discussion / justification if SC-4 not implemented: No outdoor work areas planned.			

Project Name: LUMINA

Form I-4			
Source Control Requirement	**Applied?**		
SC-5 Protect Trash Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☒ Yes	☐ No	☐ N/A
Discussion / justification if SC-5 not implemented:			
SC-6 Additional BMPs Based on Potential Sources of Runoff Pollutants (must answer for each source listed below)			
On-site storm drain inlets	☒ Yes	☐ No	☐ N/A
Interior floor drains and elevator shaft sump pumps	☒ Yes	☐ No	☐ N/A
Interior parking garages	☐ Yes	☐ No	☒ N/A
Need for future indoor & structural pest control	☒ Yes	☐ No	☐ N/A
Landscape/Outdoor Pesticide Use	☒ Yes	☐ No	☐ N/A
Pools, spas, ponds, decorative fountains, and other water features	☒ Yes	☐ No	☐ N/A
Food service	☐ Yes	☐ No	☒ N/A
Refuse Areas	☒ Yes	☐ No	☐ N/A
Industrial processes	☐ Yes	☐ No	☒ N/A
Outdoor storage of equipment or materials	☐ Yes	☐ No	☒ N/A
Vehicle/Equipment Repair and Maintenance	☐ Yes	☐ No	☒ N/A
Fuel Dispensing Areas	☐ Yes	☐ No	☒ N/A
Loading Docks	☐ Yes	☐ No	☒ N/A
Fire Sprinkler Test Water	☒ Yes	☐ No	☐ N/A
Miscellaneous Drain or Wash Water	☒ Yes	☐ No	☐ N/A
Plazas, sidewalks, and parking lots	☒ Yes	☐ No	☐ N/A
SC-6A: Large Trash Generating Facilities	☐ Yes	☐ No	☒ N/A
SC-6B: Animal Facilities	☐ Yes	☐ No	☒ N/A
SC-6C: Plant Nurseries and Garden Centers	☐ Yes	☐ No	☒ N/A
SC-6D: Automotive-related Uses	☐ Yes	☐ No	☒ N/A
Discussion / justification if SC-6 not implemented. Clearly identify which sources of runoff pollutants are discussed. Justification must be provided for <u>all</u> "No" answers shown above.			

Site Design BMP Checklist for All Development Projects (Standard Projects and Priority Development Projects)				Form I-5
Project Identification				
Project Name: Lumina				
Permit Application Number: 555609				
Site Design BMPs				
All development projects must implement site design BMPs SD-1 through SD-8 where applicable and feasible. See Chapter 4 and Appendix E of the BMP Design Manual (Part 1 of Storm Water Standards) for information to implement site design BMPs shown in this checklist. Answer each category below pursuant to the following. • "Yes" means the project will implement the site design BMP as described in Chapter 4 and/or Appendix E of the BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion / justification may be provided. A site map with implemented site design BMPs must be included at the end of this checklist.				

Site Design Requirement		Applied?		
SD-1 Maintain Natural Drainage Pathways and Hydrologic Features		☒Yes	☐ No	☐ N/A
Discussion / justification if SD-1 not implemented:				
1-1	Are existing natural drainage pathways and hydrologic features mapped on the site map?	☐Yes	☐ No	☒ N/A
1-2	Are street trees implemented? If yes, are they shown on the site map?	☒Yes	☐ No	☐ N/A
1-3	Implemented street trees meet the design criteria in SD-1 Fact Sheet (e.g. soil volume, maximum credit, etc.)?	☒Yes	☐ No	☐ N/A
1-4	Is street tree credit volume calculated using Appendix B.2.2.1 and SD-1 Fact Sheet in Appendix E?	☒Yes	☐ No	☐ N/A
SD-2 Have natural areas, soils and vegetation been conserved?		☒Yes	☐ No	☐ N/A
Discussion / justification if SD-2 not implemented:				
SD-3 Minimize Impervious Area		☒Yes	☐ No	☐ N/A
Discussion / justification if SD-3 not implemented:				
SD-4 Minimize Soil Compaction		☒ Yes	☐ No	☐ N/A
Discussion / justification if SD-4 not implemented:				
SD-5 Impervious Area Dispersion		☒ Yes	☐ No	☐ N/A
Discussion / justification if SD-5 not implemented: Runoff from the concrete sidewalks will be directed onto the landscaping.				

Project Name: LUMINA

Form I-5				
Site Design Requirement		**Applied?**		
SD-6 Runoff Collection		☐Yes	☐ No	☒ N/A
Discussion / justification if SD-6 not implemented:				
6a-1	Are green roofs implemented in accordance with design criteria in SD-6A Fact Sheet? If yes, are they shown on the site map?	☐Yes	☐ No	☒ N/A
6a-2	Is green roof credit volume calculated using Appendix B.2.1.2 and SD-6A Fact Sheet in Appendix E?	☐Yes	☐ No	☒ N/A
6b-1	Are permeable pavements implemented in accordance with design criteria in SD-6B Fact Sheet? If yes, are they shown on the site map?	☐Yes	☐ No	☒ N/A
6b-2	Is permeable pavement credit volume calculated using Appendix B.2.1.3 and SD-6B Fact Sheet in Appendix E?	☐Yes	☐ No	☒ N/A
SD-7 Landscaping with Native or Drought Tolerant Species		☒Yes	☐ No	☐ N/A
Discussion / justification if SD-7 not implemented:				
SD-8 Harvesting and Using Precipitation		☐ Yes	☒ No	☐ N/A
Discussion / justification if SD-8 not implemented: Harvest & Reuse was not triggered by the Feasibility Screening Worksheet.				
8-1	Are rain barrels implemented in accordance with design criteria in SD-8 Fact Sheet? If yes, are they shown on the site map?	☐ Yes	☐ No	☒ N/A
8-2	Is rain barrel credit volume calculated using Appendix B.2.2.2 and SD-8 Fact Sheet in Appendix E?	☐ Yes	☐ No	☒ N/A
Insert Site Map with all site design BMPs identified:				
Refer to Attachment 1A for site design BMP notes on the BMP map.				

Summary of PDP Structural BMPs	Form I-6 (PDPs)
Project Identification	
Project Name: Lumina	
Permit Application Number: 555609	
PDP Structural BMPs	
All PDPs must implement structural BMPs for storm water pollutant control (see Chapter 5 of the BMP Design Manual, Part 1 of Storm Water Standards). Selection of PDP structural BMPs for storm water pollutant control must be based on the selection process described in Chapter 5. PDPs subject to hydromodification management requirements must also implement structural BMPs for flow control for hydromodification management (see Chapter 6 of the BMP Design Manual). Both storm water pollutant control and flow control for hydromodification management can be achieved within the same structural BMP(s). PDP structural BMPs must be verified by the City at the completion of construction. This includes requiring the project owner or project owner's representative to certify construction of the structural BMPs (complete Form DS-563). PDP structural BMPs must be maintained into perpetuity (see Chapter 7 of the BMP Design Manual). Use this form to provide narrative description of the general strategy for structural BMP implementation at the project site in the box below. Then complete the PDP structural BMP summary information sheet (page 3 of this form) for each structural BMP within the project (copy the BMP summary information page as many times as needed to provide summary information for each individual structural BMP).	

Describe the general strategy for structural BMP implementation at the site. This information must describe how the steps for selecting and designing storm water pollutant control BMPs presented in Section 5.1 of the BMP Design Manual were followed, and the results (type of BMPs selected). For projects requiring hydromodification flow control BMPs, indicate whether pollutant control and flow control BMPs are integrated or separate.

Two deep biofiltration basins, referred herein as the North and South Basins, will take a majority of the runoff corresponding to two major north and south drainage divides. They will act as integrated pollutant control/hydromod/detention BMPs that can be simply described as a detention pond on top of a biofiltration basin. Two small portions to the north of the site will be served by a Modular Wetland and small biofiltration basin, while a portion of the southern part of the site will be a park designed as a self-retaining area. The park has yet to be designed but it will be ensured that the appropriate considerations regarding self-retaining areas with respect to impervious area ratios as outlined in the San Diego BMP Design Manual will be met. Some slopes to the southern perimeter will be graded and drain directly off site without any imperviousness and will therefore be treated as self-mitigating.

The south and north hybrid basins will individually meet pollutant treatment requirements for their respective drainage areas. Street trees will also contribute to volume retention beyond the necessary requirements, while providing various other benefits. Namely DCV reduction and attenuation of lower hydromodification flows, while also helping to make up for some very local limitations to infiltration despite the overcompensation in retention by the South Basin. A Modular Wetland (BMP #2) and a small non-standard biofiltration (BMP #3) will be utilized around the northwest extents of the project to treat a small part of the northern drainage divide that cannot be routed into the North Basin (Basin 4). Given the continual grade drop in the profile of Airway Road, to route this water into the North Basin would have required significant deepening of the surface. The outflows from the Modular Wetland unit will be treated as bypass for hydromodification and confluence with the outflow from Basin 4 to POC #3 towards Spring Canyon. For more details, see Street Tree Design and Justification write up in Attachment 1e-1.

Street trees have been sited continuously throughout the site and these will be leveraged to reduce the DCV, provide additional infiltration, and also hydromodification storage for low flow attenuation. This will largely entail sizeable structural soil wells to provide significant retention, as well as standard tree wells to capture incidental infiltration along the drip line and immediate vicinity, that may be difficult to route to the tree wells. The street tree approach is detailed in the preliminary sizing calculations of Attachment 1e and reflected in the hydromodification report.

Geotechnical testing indicated that rates within the site had potential for partial-retention along both the north and south drainage divides, and thus the South Basin (Basin #1) will not be lined at the bottom of the storage to allow for infiltration. Given the precipitous depths of Spring Canyon immediately adjacent to much of the northern drainage area, including a canyon finger projecting 40-60' vertically into the site that will undergo significant fill, infiltration near the slope presents significant issues. In addition, historically contaminated soils have been approved for burial near the North Basin. In addition to other constraints relating to the alignment of the extension of Airway Road and the site plan, the geotechnical engineer did not find it appropriate to allow infiltration in the North Basin. Although the geotechnical engineer recommended a no-infiltration condition for the North Basin, the project has elected to infiltrate through the structural soil tree wells to comply with partial infiltration requirements where the soil management consultant and geotechnical engineer have both indicated it is safe. Refer to Attachment 6 for the Infiltration Assessment Study and Attachment 1d for the infiltration feasibility checklist.

Offsite undeveloped, landscaped areas along the southwest border of the project site, and the proposed future park area at southwest corner, will be managed as self-mitigating areas, given that they will contain little imperviousness which will be directed onto sizeable swaths of vegetated landscape.

During final engineering, it is anticipated that the required parkway and street widening adjacent to the project will be permitted with a separate public improvement plan. Due to the shallow existing storm drain and the significant amount of upstream runoff, it is proposed that the offsite street widening project be addressed as a PDP exempt project by using Green Streets Guidance. Street Trees and/or vegetated swales will be incorporated as the Green Street feature. Refer to Attachment 1e-1 for a copy of Form J-1 for the PDP Green Streets exemption justification for managing the street widening.

Project Name: LUMINA

Form I-6	
Structural BMP Summary Information **(Copy this page as needed to provide information for each individual proposed structural BMP)**	
Structural BMP ID No. Basin 1 (South Basin)	
Construction Plan Sheet No.	
Type of structural BMP: ☐ Retention by harvest and use (HU-1) ☐ Retention by infiltration basin (INF-1) ☐ Retention by bioretention (INF-2) ☐ Retention by permeable pavement (INF-3) ☒ Partial retention by biofiltration with partial retention (PR-1) ☐ Biofiltration (BF-1) ☐ Proprietary Biofiltration (BF-3) meeting all requirements of Appendix F ☐ Flow-thru treatment control with prior lawful approval to meet earlier PDP requirements (provide BMP type/description in discussion section below) ☐ Flow-thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below) ☐ Flow-thru treatment control with alternative compliance (provide BMP type/description in discussion section below) ☐ Detention pond or vault for hydromodification management ☐ Other (describe in discussion section below)	
Purpose: ☐ Pollutant control only ☐ Hydromodification control only ☒ Combined pollutant control and hydromodification control ☐ Pre-treatment/forebay for another structural BMP ☐ Other (describe in discussion section below)	
Who will certify construction of this BMP? Provide name and contact information for the party responsible to sign BMP verification forms if required by the City Engineer (See Section 1.12 of the BMP Design Manual)	Project Design Consultants 619-235-6471
Who will be the final owner of this BMP?	HOA
Who will maintain this BMP into perpetuity?	HOA
What is the funding mechanism for maintenance?	Revenue from property

Project Name: LUMINA

Form I-6	
Structural BMP Summary Information **(Copy this page as needed to provide information for each individual proposed structural BMP)**	
Structural BMP ID No. Basin 4 (North Basin)	
Construction Plan Sheet No.	
Type of structural BMP: ☐ Retention by harvest and use (HU-1) ☐ Retention by infiltration basin (INF-1) ☐ Retention by bioretention (INF-2) ☐ Retention by permeable pavement (INF-3) ☐ Partial retention by biofiltration with partial retention (PR-1) ☒ Biofiltration (BF-1) ☐ Proprietary Biofiltration (BF-3) meeting all requirements of Appendix F ☐ Flow-thru treatment control with prior lawful approval to meet earlier PDP requirements (provide BMP type/description in discussion section below) ☐ Flow-thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below) ☐ Flow-thru treatment control with alternative compliance (provide BMP type/description in discussion section below) ☐ Detention pond or vault for hydromodification management ☐ Other (describe in discussion section below)	
Purpose: ☐ Pollutant control only ☐ Hydromodification control only ☒ Combined pollutant control and hydromodification control ☐ Pre-treatment/forebay for another structural BMP ☐ Other (describe in discussion section below)	
Who will certify construction of this BMP? Provide name and contact information for the party responsible to sign BMP verification forms if required by the City Engineer (See Section 1.12 of the BMP Design Manual)	Project Design Consultants 619-235-6471
Who will be the final owner of this BMP?	HOA
Who will maintain this BMP into perpetuity?	HOA
What is the funding mechanism for maintenance?	Revenue from property

Form I-6	
Structural BMP Summary Information **(Copy this page as needed to provide information for each individual proposed structural BMP)**	
Structural BMP ID No. BMP #2	
Construction Plan Sheet No.	
Type of structural BMP: ☐ Retention by harvest and use (HU-1) ☐ Retention by infiltration basin (INF-1) ☐ Retention by bioretention (INF-2) ☐ Retention by permeable pavement (INF-3) ☐ Partial retention by biofiltration with partial retention (PR-1) ☐ Biofiltration (BF-1) ☒ Proprietary Biofiltration (BF-3) meeting all requirements of Appendix F ☐ Flow-thru treatment control with prior lawful approval to meet earlier PDP requirements (provide BMP type/description in discussion section below) ☐ Flow-thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below) ☐ Flow-thru treatment control with alternative compliance (provide BMP type/description in discussion section below) ☐ Detention pond or vault for hydromodification management ☐ Other (describe in discussion section below)	
Purpose: ☒ Pollutant control only ☐ Hydromodification control only ☐ Combined pollutant control and hydromodification control ☐ Pre-treatment/forebay for another structural BMP ☐ Other (describe in discussion section below)	
Who will certify construction of this BMP? Provide name and contact information for the party responsible to sign BMP verification forms if required by the City Engineer (See Section 1.12 of the BMP Design Manual)	Project Design Consultants 619-235-6471
Who will be the final owner of this BMP?	HOA
Who will maintain this BMP into perpetuity?	HOA
What is the funding mechanism for maintenance?	Revenue from property

Project Name: LUMINA

Form I-6	
Structural BMP Summary Information **(Copy this page as needed to provide information for each individual proposed structural BMP)**	
Structural BMP ID No. BMP #3	
Construction Plan Sheet No.	
Type of structural BMP: ☐ Retention by harvest and use (HU-1) ☐ Retention by infiltration basin (INF-1) ☐ Retention by bioretention (INF-2) ☐ Retention by permeable pavement (INF-3) ☐ Partial retention by biofiltration with partial retention (PR-1) ☒ Biofiltration (BF-1) ☐ Proprietary Biofiltration (BF-3) meeting all requirements of Appendix F ☐ Flow-thru treatment control with prior lawful approval to meet earlier PDP requirements (provide BMP type/description in discussion section below) ☐ Flow-thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below) ☐ Flow-thru treatment control with alternative compliance (provide BMP type/description in discussion section below) ☐ Detention pond or vault for hydromodification management ☐ Other (describe in discussion section below)	
Purpose: ☒ Pollutant control only ☐ Hydromodification control only ☐ Combined pollutant control and hydromodification control ☐ Pre-treatment/forebay for another structural BMP ☐ Other (describe in discussion section below)	
Who will certify construction of this BMP? Provide name and contact information for the party responsible to sign BMP verification forms if required by the City Engineer (See Section 1.12 of the BMP Design Manual)	Project Design Consultants 619-235-6471
Who will be the final owner of this BMP?	HOA
Who will maintain this BMP into perpetuity?	HOA
What is the funding mechanism for maintenance?	Revenue from property

THE CITY OF SAN DIEGO

City of San Diego
Development Services
1222 First Ave., MD-302
San Diego, CA 92101
(619) 446-5000

Permenant BMP Construction

Self Certification Form

FORM
DS-563
January 2016

Date Prepared: Click here to enter text.	Project No.: Click here to enter text.
Project Applicant: Click here to enter text.	Phone: Click here to enter text.
Project Address: Click here to enter text.	
Project Engineer: Click here to enter text.	Phone: Click here to enter text.

The purpose of this form is to verify that the site improvements for the project, identified above, have been constructed in conformance with the approved Storm Water Quality Management Plan (SWQMP) documents and drawings.

This form must be completed by the engineer and submitted prior to final inspection of the construction permit. Completion and submittal of this form is required for all new development and redevelopment projects in order to comply with the City's Storm Water ordinances and NDPES Permit Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100. Final inspection for occupancy and/or release of grading or public improvement bonds may be delayed if this form is not submitted and approved by the City of San Diego.

CERTIFICATION:

As the professional in responsible charge for the design of the above project, I certify that I have inspected all constructed Low Impact Development (LID) site design, source control and structural BMP's required per the approved SWQMP and Construction Permit No. Click here to enter text.; and that said BMP's have been constructed in compliance with the approved plans and all applicable specifications, permits, ordinances and Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100 of the San Diego Regional Water Quality Control Board.

I understand that this BMP certification statement does not constitute an operation and maintenance verification.

Signature: ______________________________

Date of Signature: _ Insert Date ___

Printed Name: Click here to enter text.

Title: Click here to enter text.

Phone No. Click here to enter text.

Engineer's

1

ATTACHMENT 1

BACKUP FOR PDP POLLUTANT CONTROL BMPS

This is the cover sheet for Attachment 1.

Project Name: LUMINA

Indicate which Items are Included:

Attachment Sequence	Contents	Checklist
Attachment 1a	DMA Exhibit (Required) See DMA Exhibit Checklist.	☒ Included
Attachment 1b	Tabular Summary of DMAs Showing DMA ID matching DMA Exhibit, DMA Area, and DMA Type (Required)* *Provide table in this Attachment OR on DMA Exhibit in Attachment 1a	☒ Included on DMA Exhibit in Attachment 1a ☐ Included as Attachment 1b, separate from DMA Exhibit
Attachment 1c	Form I-7, Harvest and Use Feasibility Screening Checklist (Required unless the entire project will use infiltration BMPs) Refer to Appendix B.3-1 of the BMP Design Manual to complete Form I-7.	☒ Included ☐ Not included because the entire project will use infiltration BMPs
Attachment 1d	Form I-8, Categorization of Infiltration Feasibility Condition (Required unless the project will use harvest and use BMPs) Refer to Appendices C and D of the BMP Design Manual to complete Form I-8.	☒ Included ☐ Not included because the entire project will use harvest and use BMPs
Attachment 1e	Pollutant Control BMP Design Worksheets / Calculations (Required) Refer to Appendices B and E of the BMP Design Manual for structural pollutant control BMP design guidelines and site design credit calculations	☒ Included

Project Name: LUMINA

ATTACHMENT 1a-b

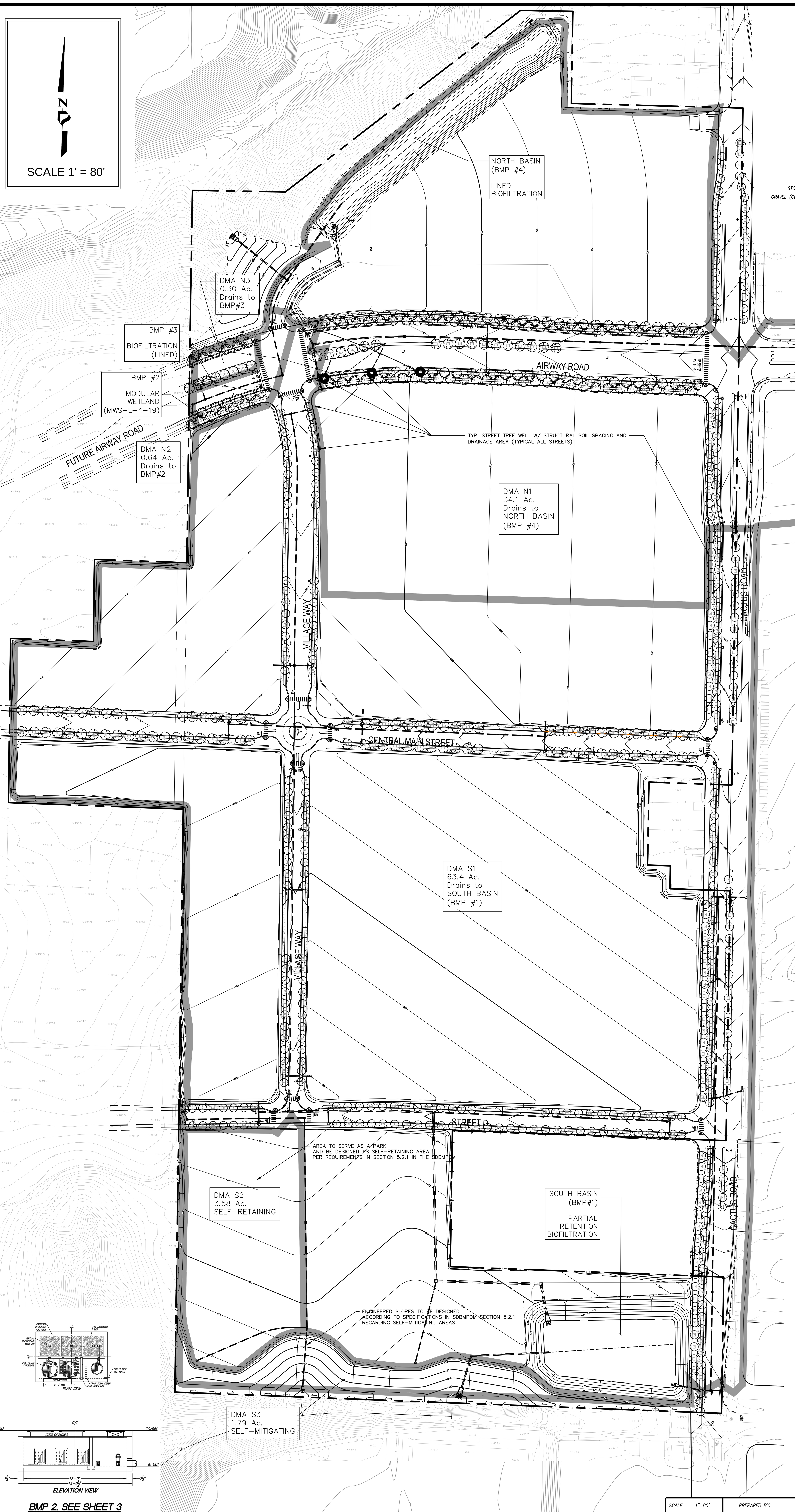
DMA Exhibit

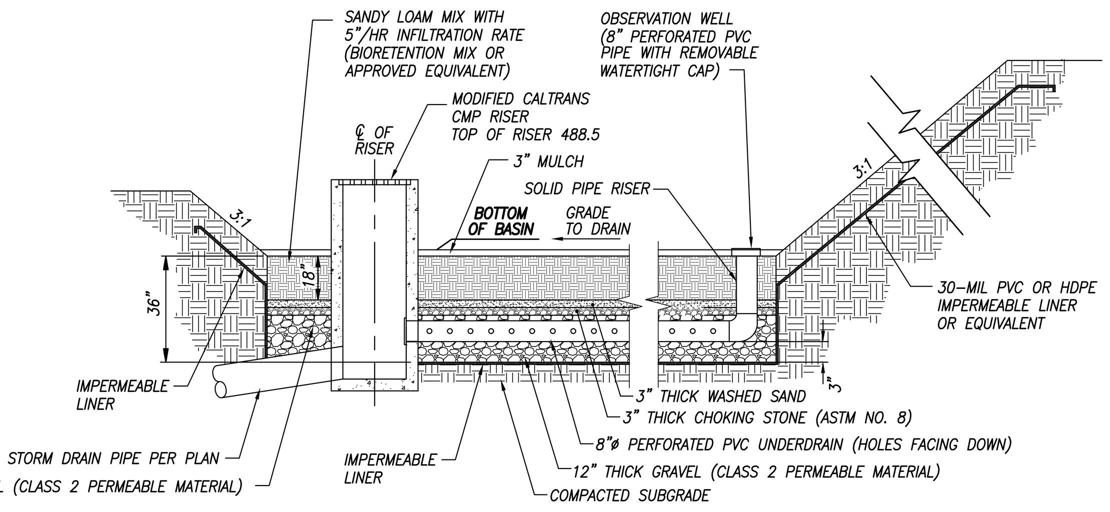
Project Name: LUMINA

Use this checklist to ensure the required information has been included on the DMA Exhibit:

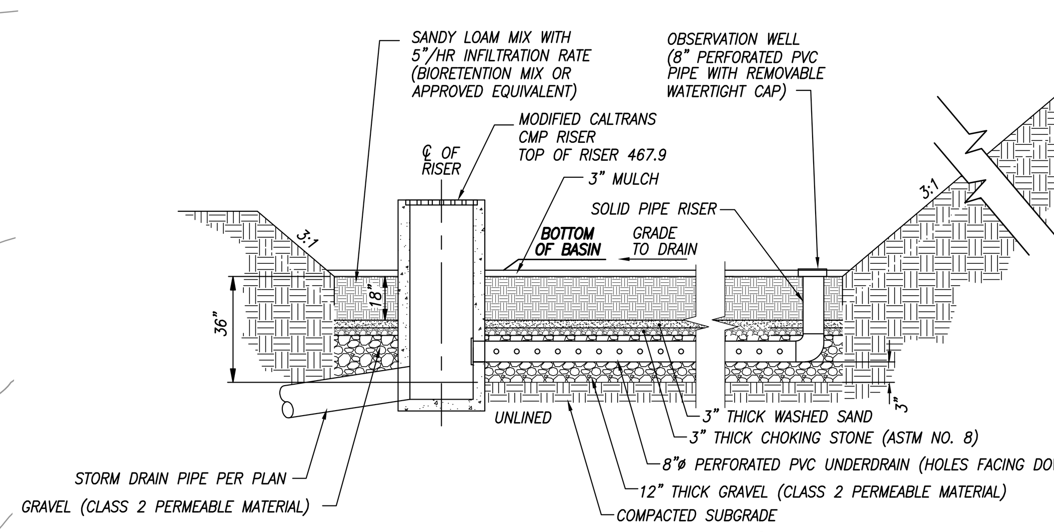
The DMA Exhibit must identify:

☒ Underlying hydrologic soil group
☒ Approximate depth to groundwater
☒ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
☒ Critical coarse sediment yield areas to be protected
☒ Existing topography and impervious areas
☒ Existing and proposed site drainage network and connections to drainage offsite
☒ Proposed demolition
☒ Proposed grading
☒ Proposed impervious features
☒ Proposed design features and surface treatments used to minimize imperviousness
☒ Drainage management area (DMA) boundaries, DMA ID numbers, and DMA areas (square footage or acreage), and DMA type (i.e., drains to BMP, self-retaining, or self-mitigating)
☒ Potential pollutant source areas and corresponding required source controls (see Chapter 4, Appendix E.1, and Form I-3B)
☒ Structural BMPs (identify location, type of BMP, and size/detail)





SECTION A-A: BIOFILTRATION BASIN (NORTH)
BMP 3 AND 4, SEE SHEET 3
NOT TO SCALE



SECTION A-A: BIOFILTRATION BASIN (SOUTH)
BMP 1
NOT TO SCALE

DMA SUMMARY

DMA #	DMA TYPE	DRAINAGE AREA (Ac)	BMP TYPE	BMP SIZE (SQFT)
N1	Drains to BMP 4	34.10	BIOFILTRATION (LINED)	18,816
N2	Drains to BMP 2	0.64	MODULAR WETLAND	4X19
N3	Drains to BMP 3	0.30	BIOFILTRATION (LINED)	250
S1	Drains to BMP 1	63.40	PARTIAL RETENTION BIOFILTRATION	46,285
S2	SELF-RETAINING	3.58	N/A	N/A
S3	SELF-MITIGATING	1.79	N/A	N/A

LEGEND

DMA BOUNDARY

PROPERTY BOUNDARY

BMP NOTES:

1. SITE DESIGN BMPS INCLUDE:
   - MINIMIZATION OF IMPERVIOUS FOOTPRINT
   - IMPERVIOUS DISPERSION
   - STREET TREES

   1A. STREET TREES WILL BE SYSTEMATICALLY IMPLEMENTED THROUGH MOST OF THE SITE WITH STRUCTURAL SOIL WELLS IN ORDER TO RETAIN STREET RUNOFF WITHIN THE TRIBUTARY AREA (EXAMPLE DEPICTED).

   1B. WELLS WILL BE APPROXIMATELY 4-5' IN DEPTH WITH A TOTAL SOIL VOLUME OF 700-1000 CF, PER REQUIREMENTS IN SD BMP DESIGN MANUAL FOR REDUCING THE TRIBUTARY DCV TO ZERO GIVEN TYPICAL STREET PROFILES

   (SEE APPENDIX 1C OF THE SWQMP FOR DETAILS AND JUSTIFICATION)

2. SOURCE CONTROL BMPs FOR PROJECT INCLUDE:
   - INTEGRATED PEST MANAGEMENT PRINCIPLES
   - EFFICIENT LANDSCAPE AND IRRIGATION DESIGN
   - STORMDRAIN STENCILING
   - PROTECTION OF TRASH STORAGE AREAS
   - BUILDING MANAGEMENT PRACTICES (MANAGEMENT OF FIRE SPRINKLER SYSTEM DISCHARGES, AIR CONDITIONING CONDENSATE DISCHARGES, AND THE USE OF NON-TOXIC ROOFING MATERIALS.)

3. THE TREATMENT BMPS SELECTED FOR THIS PROJECT ARE (2) LINED BIOFILTRATION BASINS (1) UNLINED BIOFILTRATION BASIN WITH UNDERGROUND STORAGE-AND (1) MODULAR WETLAND UNIT.

4. PROJECT IS SUBJECT TO HYDROMODIFICATION REQUIREMENTS AND WILL RELY ON STORAGE BOTH ABOVE AND BELOW THE BIOFILTRATION BMPS TO PROVIDE HYDROMOD CONTROL AND PEAK FLOW DETENTION

5. THE NRCS SOIL SURVEY CLASSIFIES THE SITE SOILS AS HYDROLOGIC SOIL GROUP 'D'

6. GROUNDWATER WAS NOT ENCOUNTERED WITHIN 20' AND IS EXPECTED AT DEPTHS > 200'

7. PROJECT TO IMPLEMENT GREEN STREETS ELEMENTS FOR STREET IMPROVEMENTS NOT HEREIN DELINEATED AS A DMA (SEE FORM J1 IN APPENDIX A OF SWQMP)

NOTE: SUPPLEMENTAL TOPOGRAPHY IS 2-FT CONTOURS FROM SANGIS (1997, BEFORE SR 905 WAS BUILT)

SCALE: 1"=80'
JOB #: 2357.35
CREATED: 8/14/18

PREPARED BY:

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey
701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

CITY OF SAN DIEGO

OTAY CANYON RANCH

SWQMP - DMA Exhibit
Attachment 1a-b

Project Name: LUMINA

ATTACHMENT 1c

Harvest & Use Feasibility

Worksheet B.3-1. Harvest and Use Feasibility Screening

Harvest and Use Feasibility Screening		Worsksheet B.3-1
1. Is there a demand for harvested water (check all that apply) at the project site that is reliably present during the wet season? ☐ Toilet and urinal flushing Indoor water use not allowed per city codes ☒ Landscape irrigation ☐ Other:______________		
2. If there is a demand; estimate the anticipated average wet season demand over a period of 36 hours. Guidance for planning level demand calculations for toilet/urinal flushing and landscape irrigation is provided in Section B.3.2. Assume moderate plant water use [Provide a summary of calculations here] Max 36 hr demand for landscape irrigation = 15.88 Ac × 1470 gal/ac × CF/7.48 gal = 3120.8 CF ≈ 3121 CF		
3. Calculate the DCV using worksheet B-2.1. [Provide a results here] DCV ≈ 90,000 CF		
3a. Is the 36-hour demand greater than or equal to the DCV? Yes / No ⇨ ⇩	3b. Is the 36-hour demand greater than 0.25DCV but less than the full DCV? Yes / No ⇨ ⇩	3c. Is the 36-hour demand less than 0.25DCV? Yes ⇩
Harvest and use appears to be feasible. Conduct more detailed evaluation and sizing calculations to confirm that DCV can be used at an adequate rate to meet drawdown criteria.	Harvest and use may be feasible. Conduct more detailed evaluation and sizing calculations to determine feasibility. Harvest and use may only be able to be used for a portion of the site, or (optionally) the storage may need to be upsized to meet long term capture targets while draining in longer than 36 hours.	Harvest and use is considered to be infeasible.

B.3.2 Harvested Water Demand Calculation

The following sections provide technical references and guidance for estimating the harvested water demand of a project. These references are intended to be used for the planning phase of a project for feasibility screening purposes.

B.3.2.1 Toilet and Urinal Flushing Demand Calculations

The following guidelines should be followed for computing harvested water demand from toilet and urinal flushing:

- If reclaimed water is planned for use for toilet and urinal flushing, then the demand for harvested storm water is equivalent to the total demand minus the reclaimed water supplied, and should be reduced by the amount of reclaimed water that is available during the wet season.
- Demand calculations for toilet and urinal flushing should be based on the average rate of use during the wet season for a typical year.
- Demand calculations should include changes in occupancy over weekends and around holidays and changes in attendance/enrollment over school vacation periods.
- For facilities with generally high demand, but periodic shut downs (e.g., for vacations, maintenance, or other reasons), a project specific analysis should be conducted to determine whether the long term storm water capture performance of the system can be maintained despite shut downs.
- Such an analysis should consider the statistical distributions of precipitation and demand, most importantly the relationship of demand to the wet seasons of the year.

Table B.3-1 provides planning level demand estimates for toilet and urinal flushing per resident, or employee, for a variety of project types. The per capita use per day is based on daily employee or resident usage. For non-residential types of development, the "visitor factor" and "student factor" (for schools) should be multiplied by the employee use to account for toilet and urinal usage for non-employees using facilities.

Table B.3-1: Toilet and Urinal Water Usage per Resident or Employee

Land Use Type	Toilet User Unit of Normalization	Per Capita Use per Day		Visitor Factor[4]	Water Efficiency Factor	Total Use per Resident or Employee
		Toilet Flushing[1,2]	Urinals[3]			
Residential	Resident	18.5	NA	NA	0.5	9.3
Office	Employee (non-visitor)	9.0	2.27	1.1	0.5	7 (avg)
Retail	Employee (non-visitor)	9.0	2.11	1.4	0.5	
Schools	Employee (non-student)	6.7	3.5	6.4	0.5	33
Various Industrial Uses (excludes process water)	Employee (non-visitor)	9.0	2	1	0.5	5.5

[1]Based on American Waterworks Association Research Foundation, 1999. Residential End Uses of Water. Denver, CO: AWWARF

[2]Based on use of 3.45 gallons per flush and average number of per employee flushes per subsector, Table D-1 for MWD (Pacific Institute, 2003)

[3]Based on use of 1.6 gallons per flush, Table D-4 and average number of per employee flushes per subsector, Appendix D (Pacific Institute, 2003)

[4]Multiplied by the demand for toilet and urinal flushing for the project to account for visitors. Based on proportion of annual use allocated to visitors and others (includes students for schools; about 5 students per employee) for each subsector in Table D-1 and D-4 (Pacific Institute, 2003)

[5]Accounts for requirements to use ultra-low flush toilets in new development projects; assumed that requirements will reduce toilet and urinal flushing demand by half on average compared to literature estimates. Ultra low flush toilets are required in all new construction in California as of January 1, 1992. Ultra low flush toilets must use no more than 1.6 gallons per flush and Ultra low flush urinals must use no more than 1 gallon per flush. Note: If zero flush urinals are being used, adjust accordingly.

B.3.2.2 General Requirements for Irrigation Demand Calculations

The following guidelines should be followed for computing harvested water demand from landscape irrigation:

- If reclaimed water is planned for use for landscape irrigation, then the demand for harvested storm water should be reduced by the amount of reclaimed water that is available during the wet season.
- Irrigation rates should be based on the irrigation demand exerted by the types of landscaping that are proposed for the project, with consideration for water conservation requirements.
- Irrigation rates should be estimated to reflect the average wet season rates (defined as November through April) accounting for the effect of storm events in offsetting harvested water demand. In the absence of a detailed demand study, it should be assumed that irrigation demand is not present during days with greater than 0.1 inches of rain and the subsequent 3-day period. This irrigation shutdown period is consistent with standard practice in land application of wastewater and is applicable to storm water to prevent irrigation from resulting in dry weather runoff. Based on a statistical analysis of San Diego County rainfall patterns, approximately 30 percent of wet season days would not have a demand for irrigation.

- If land application of storm water is proposed (irrigation in excess of agronomic demand), then this BMP must be considered to be an infiltration BMP and feasibility screening for infiltration must be conducted. In addition, it must be demonstrated that land application would not result in greater quantities of runoff as a result of saturated soils at the beginning of storm events. Agronomic demand refers to the rate at which plants use water.

The following sections describe methods that should be used to calculate harvested water irrigation demand. While these methods are simplified, they provide a reasonable estimate of potential harvested water demand that is appropriate for feasibility analysis and project planning. These methods may be replaced by a more rigorous project-specific analysis that meets the intent of the criteria above.

Demand Calculation Method

This method is based on the San Diego Municipal Code Land Development Code Landscape Standards Appendix E which includes a formula for estimating a project's annual estimated total water use based on reference evaporation, plant factor, and irrigation efficiency.

For the purpose of calculating harvested water irrigation demand applicable to the sizing of harvest and use systems, the estimated total water use has been modified to reflect typical wet-season irrigation demand. This method assumes that the wet season is defined as November through April. This method further assumes that no irrigation water will be applied during days with precipitation totals greater than 0.1 inches or within the 3 days following such an event. Based on these assumptions and an analysis of Lake Wohlford, Lindbergh and Oceanside precipitation patterns, irrigation would not be applied during approximately 30 percent of days from November through April.

The following equation is used to calculate the Modified Estimated Total Water Usage.

Equation B.3-1: Modified Estimated Total Water Usage

$$\text{Modified ETWU} = ETo_{Wet} \times [[\Sigma(PF \times HA)/IE] + SLA] \times 0.015$$

where:

Modified ETWU	=	Estimated daily average water usage during wet season
ETo_{Wet}	=	Average reference evapotranspiration from November through April (use 2.7 inches per month, using CIMS Zone 4 from Table G.1-1)
PF	=	Plant Factor
HA	=	Hydrozone Area (sq-ft); A section or zone of the landscaped area having plants with similar water needs. $\Sigma(PF \times HA)$ = The sum of PF x HA for each individual Hydrozone (accounts for different landscaping zones).
IE	=	Irrigation Efficiency (assume 90 percent for demand calculations)
SLA	=	Special Landscape Area (sq-ft); Areas used for active and passive recreation areas, areas solely dedicated to the production of fruits and vegetables, and areas irrigated with reclaimed water.

Table B.3-2: Planning Level Plant Factor Recommendations

Plant Water Use	Plant Factor	Also Includes
Low	< 0.1 – 0.2	Artificial Turf
Moderate	0.3 – 0.7	
High	0.8 and greater	Water features
Special Landscape Area	1.0	

In this equation, the coefficient (0.015) accounts for unit conversions and shut down of irrigation during and for the three days following a significant precipitation event:

0.015 = (1 mo/30 days)×(1 ft/12 in)×(7.48 gal/cu-ft)×(approximately 7 out of 10 days with irrigation demand from November through April)

Planning Level Irrigation Demands

To simplify the planning process, the method described above has been used to develop daily average wet season demands for a one-acre irrigated area based on the plant/landscape type. These demand estimates can be used to calculate the drawdown of harvest and use systems for the purpose of LID BMP sizing calculations.

Table B.3-3: Planning Level Irrigation Demand by Plant Factor and Landscape Type

General Landscape Type	36-Hour Planning Level Irrigation Demand (gallons per irrigated acre per 36 hour period)
Hydrozone – Low Plant Water Use	390
Hydrozone – Moderate Plant Water Use	1,470
Hydrozone – High Plant Water Use	2,640
Special Landscape Area	2,640

B.3.2.3 Calculating Other Harvested Water Demands

Calculations of other harvested water demands should be based on the knowledge of land uses, industrial processes, and other factors that are project-specific. Demand should be calculated based on the following guidelines:

- Demand calculations should represent actual demand that is anticipated during the wet season (November through April).
- Sources of demand should only be included if they are reliably and consistently present during the wet season.
- Where demands are substantial but irregular, a more detailed analysis should be conducted based on a statistical analysis of anticipated demand and precipitation patterns.

Project Name: LUMINA

ATTACHMENT 1d

Infiltration Feasibility

Categorization of Infiltration Feasibility Condition	Worksheet C.4-1

Part 1 - Full Infiltration Feasibility Screening Criteria

Would infiltration of the full design volume be feasible from a physical perspective without any undesirable consequences that cannot be reasonably mitigated?

Criteria	Screening Question	Yes	No
1	Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.	☐	☒

Provide basis:

Five (5) borehole percolation tests were performed. Three tests were performed in proximity to the proposed BMP basin located in the northerly portion of the site and two tests were performed in proximity to the proposed basin in the southerly portion of the site. Testing was performed in general conformance with Appendix D, Section D.3.3.2 of the 2016 BMP Design Manual. The stabilized percolation rates were then converted to infiltration rates based on the "Porchet Method". Using a factor of safety of 2 for feasibility screening purposes, the infiltration rates in the northerly portion of the site ranged between 0.20 and 0.38 inches/hour, and between 0.08 and 0.22 in the southerly portion of the site, all of which are less than 0.5 inches/hour. A more detailed discussion of the testing and findings are presented the referenced Preliminary Infiltration Feasibility Study for Otay Canyon Ranch, Lumina Project, Otay Mesa Area, City of San Diego, California, Report No. 1304-04-B-4, dated May 26, 2017.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.

Criteria	Screening Question	Yes	No
2	Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.	☐	☒

Provide basis:

Tested infiltration rates at the project site are less than 0.5 inches/hour. Infiltration at a rate greater than 0.5 inches/hour is not feasible for this project. As such, this screening question does not control the feasibility of infiltration at the project site and is not applicable.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.

Criteria	Screening Question	Yes	No
3	Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, storm water pollutants or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	☐	☒

Provide basis:

Tested infiltration rates at the project site are less than 0.5 inches/hour. Infiltration at a rate greater than 0.5 inches/hour is not feasible for this project. As such, this screening question does not control the feasibility of infiltration at the project site and is not applicable.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.

Criteria	Screening Question	Yes	No
4	Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	☐	☒

Provide basis:

The tested infiltration rates at the project site are less than 0.5 inches/hour. Infiltration at a rate greater than 0.5 inches/hour is not feasible for this project. As such, this screening question does not control the feasibility of infiltration at the project site. Per Section C.4.4 of the BMP Design Manual, final determination should be made by the project design engineer.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.

Part 1 Result*	If all answers to rows 1-4 are "Yes" a full infiltration design is potentially feasible. The feasibility screening category is Full Infiltration If any answer from row 1-4 is "No", infiltration may be possible to some extent but would not generally be feasible or desirable to achieve a "full infiltration" design. Proceed to Part 2	No, Full Infiltration Not Feasible. Go to Part 2

***To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by the City Engineer to substantiate findings**

Worksheet C.4-1 Page 3 of 4

Part 2 – Partial Infiltration vs. No Infiltration Feasibility Screening Criteria

Would infiltration of water in any appreciable amount be physically feasible without any negative consequences that cannot be reasonably mitigated?

Criteria	Screening Question	Yes	No
5	Do soil and geologic conditions allow for infiltration in any appreciable rate or volume? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.	☒	☐

Provide basis:

As discussed in the referenced infiltration feasibility report and the response to Criteria 1, the infiltration rates in the northerly portion of the site ranged between 0.20 and 0.38 inches/hour, and between 0.08 and 0.22 in the southerly portion of the site when utilizing a Factor of Safety of 2. In accordance with the current interpretation of 'appreciable rate or volume', these rates are considered to be adequate to establish a 'Partial Infiltration' designation.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

6	Can Infiltration in any appreciable quantity be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.	☒	☐

Provide basis:

As discussed in the referenced Preliminary Infiltration Feasibility Study, partial infiltration in the proposed BMP basin in the southerly portion is feasible without increasing the risk of geotechnical hazards that cannot be mitigated to an acceptable level.

The proposed basin in the northerly portion of the site is currently planned across an area of deep fill, in close proximity to a steep descending slope, and in an area of highly to critically expansive soils. As such, there is a high likelihood that geotechnical issues related soil settlement, slope destabilization, and soil swelling/heave will occur. It is our opinion that these issues would have detrimental effects on future improvements and that they cannot be reasonably mitigated. It is recommended that the northerly basin as currently proposed be fully encapsulated with an impermeable liner.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

Worksheet C.4-1 Page 4 of 4			
Criteria	Screening Question	Yes	No
7	Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, storm water pollutants or other factors)? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	☒	☐

Provide basis:

The project site has been the subject of several environmental assessments since 2004 and was enrolled in the San Diego County Department of Environmental Health (SDCDEH) Voluntary Action Program in 2014 (Case #DEH2014-LSAM-000254). In 2015 SCS Engineers prepared a Phase II Soil Sampling report that identified the presence of organochlorine pesticide (OCP) impacted soils as well as other soil contaminants of concern and general non-hazardous refuse. In 2017, C Young Associates prepared a Soil Management Plan (SMP) that addresses the removal and onsite placement (burial) of OCP impacted soils. The plan for the re-use of OCP impacted soils onsite includes their placement in 'deep' fill areas (greater than 10 feet below finish pad elevations). The SMP was approved by SDCDEH on May 23, 2017. Specific areas identified in the SMP include the northwesterly portion of the site partially beneath the northerly proposed BMP basin and easterly subjacent to the basin. In consideration of the close proximity of the basin to contaminated soils, it is strongly recommended that active or passive infiltration in this basin not be allowed as it would likely contribute to the movement or dispersion of contaminants. We recommend the basin be encapsulated with an impermeable liner as currently proposed. The southerly basin should not be impacted and partial infiltration is feasible.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

8	Can infiltration be allowed without violating downstream water rights? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	☒	☐

Provide basis:

We do not anticipate that construction of the proposed BMP basins will violate downstream water rights. Per Section C.4.4 of the BMP Design Manual, final determination should be made by the project design engineer.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

Part 2 Result*	If all answers from row 5-8 are "Yes", then partial infiltration design is potentially feasible. The feasibility screening category is Partial Infiltration. If any answer from row 5-8 is "No", then infiltration of any volume is considered to be infeasible within the drainage area. The feasibility screening category is No Infiltration.	Yes, Partial Infiltration is Feasible

**To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by the City Engineer to substantiate findings*

Project Name: LUMINA

ATTACHMENT 1e

BMP Worksheets/Calculations

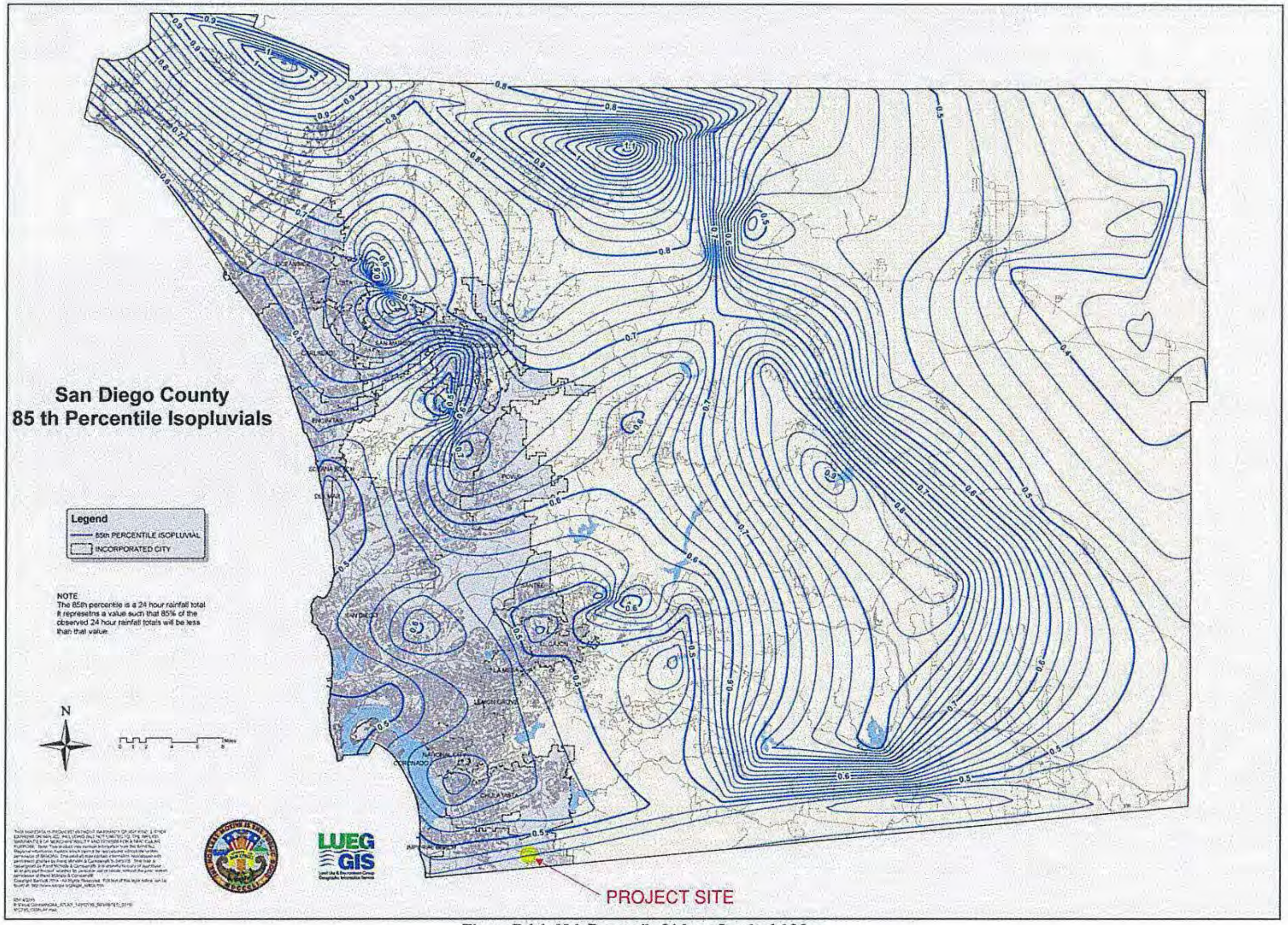


Figure B.1-1: 85th Percentile 24-hour Isopluvial Map

ATTACHMENT 1B: Worksheet B.2-1: DCV

85th percentile 24-hr storm depth from Figure B.1.= 0.46

DMA ID	TREE CREDIT ID	BMP ID	BMP Drainage Area (ac)	Impervious Area (ac)	Amended Soils (ac) (C=0.1)	Natural D Soils (ac) (C=0.3)	% Imp	Composite C[1]	Tree Credit Volume (cf)	Design Capture Volume (DCV) (CF)	LID adj. 'C'
N1		BMP#4	34.02	25.0909	8.9291	3.75	74%	0.72	4744	36333	0.639586
N2		BMP#2	0.64	0.576	0.064		90%	0.82	0	876	0.82
N3		BMP#3	0.3	0.27	0.03		90%	0.82	0	411	0.82
	North - Tree Credit Area	n/a	3.61	3.1	0.51		86%	0.79	0	4744	-
S1		BMP#1	63.22	52.4726	10.7474		83%	0.76	15502	65149	0.617148
S2		Self-Retaining	3.58	3.58			100%				-
S3		Self-Mitigating	1.79	1.79			100%				-
	South - Tree Credit Area	n/a	12.92	9.99	2.93		77%	0.72	0	15502	-

Notes:

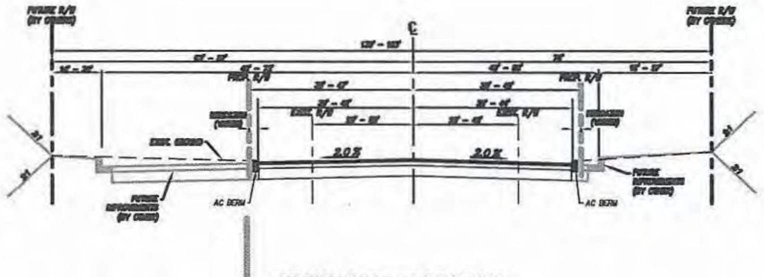
1) Equation for composite C factor = (0.9*Impervious Area +0.1*Pervious Area)/Total Area per BMP Design Manual.

C factors are from Table B.1-1 of Jan 2016 City BMP Design Manual.

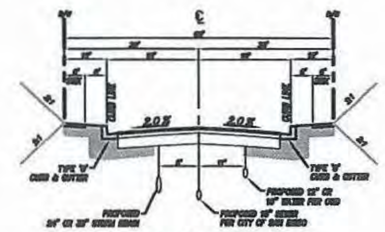
2) Tree credit areas are subset of their respective DMAs and include only tree lined streets where feasibile to drain and capture 100% of street runoff.

See Street Stree DVC Reduction Design and Justification Writeup included in Attatchment 1e for further details.

LUMINA
TENTATIVE MAP NO. 1972222



AIRWAY STREET SECTION (OFFSITE)
NOT TO SCALE



VILLAGE WAY SECTION
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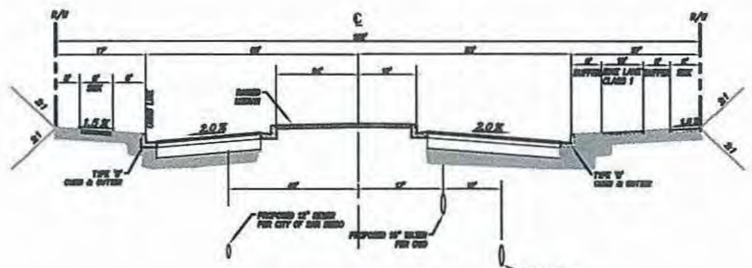

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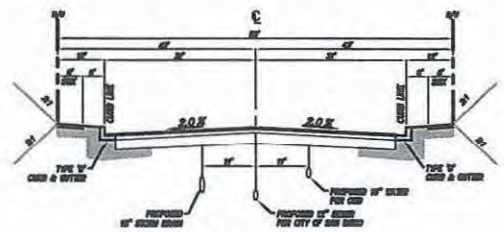

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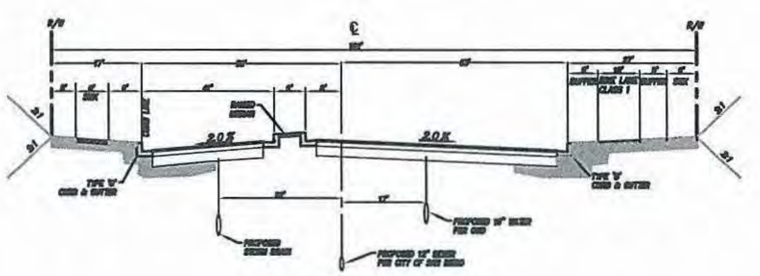

AIRWAY STREET SECTION
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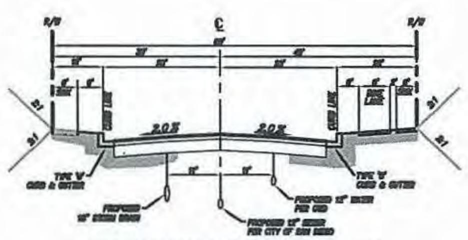

CENTRAL MAIN STREET SECTION
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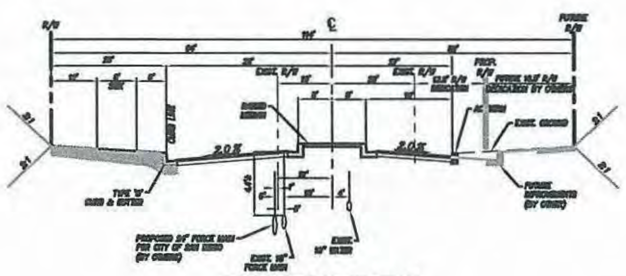

CACTUS ROAD SECTION
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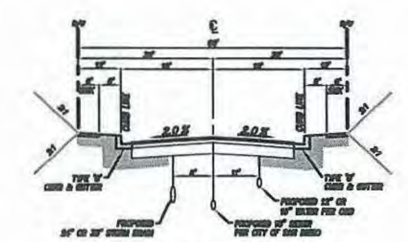
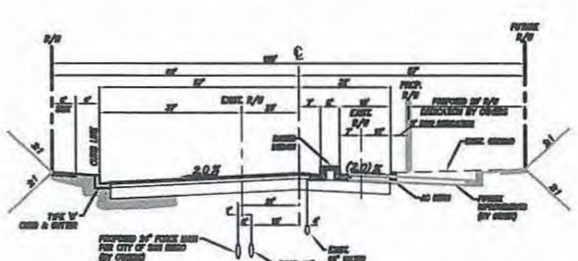


'C' STREET SECTION
NOT TO SCALE



CACTUS ROAD SECTION
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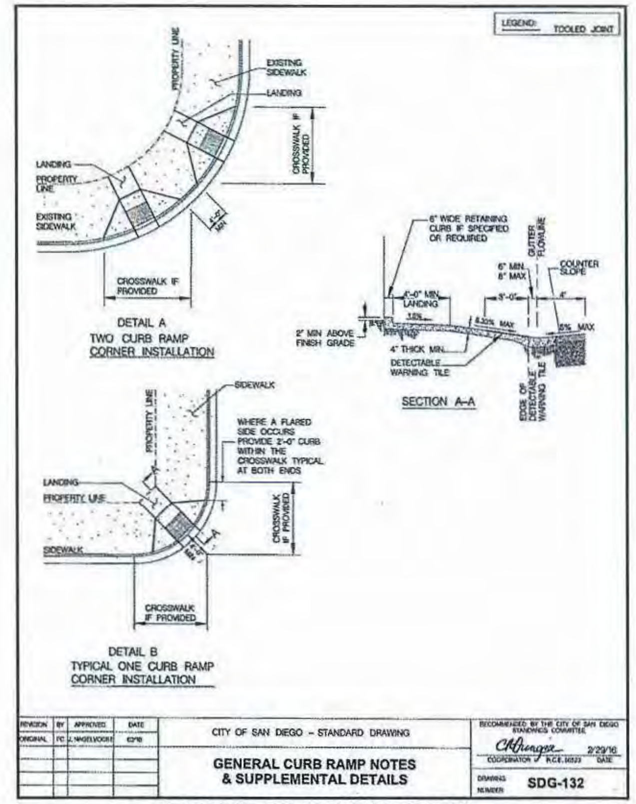
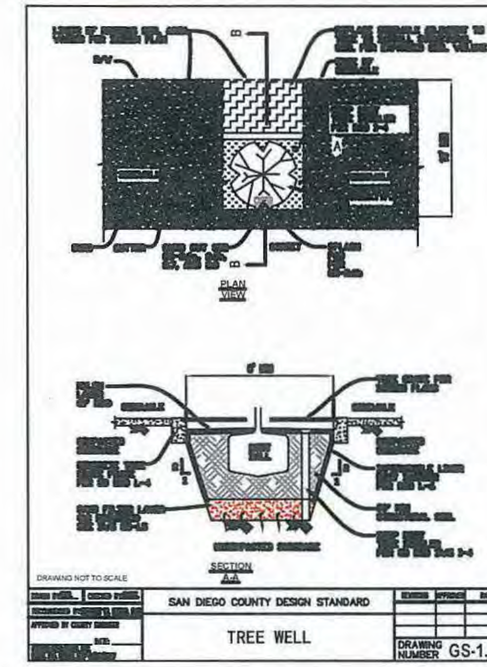
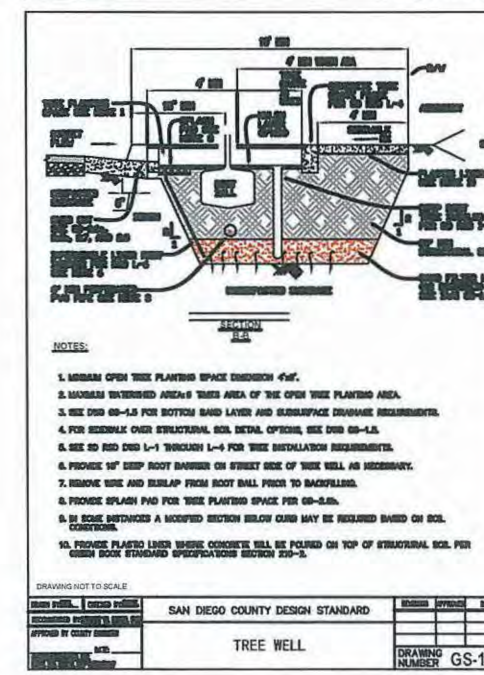


TYPICAL CURB RAMP DETAIL





PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey

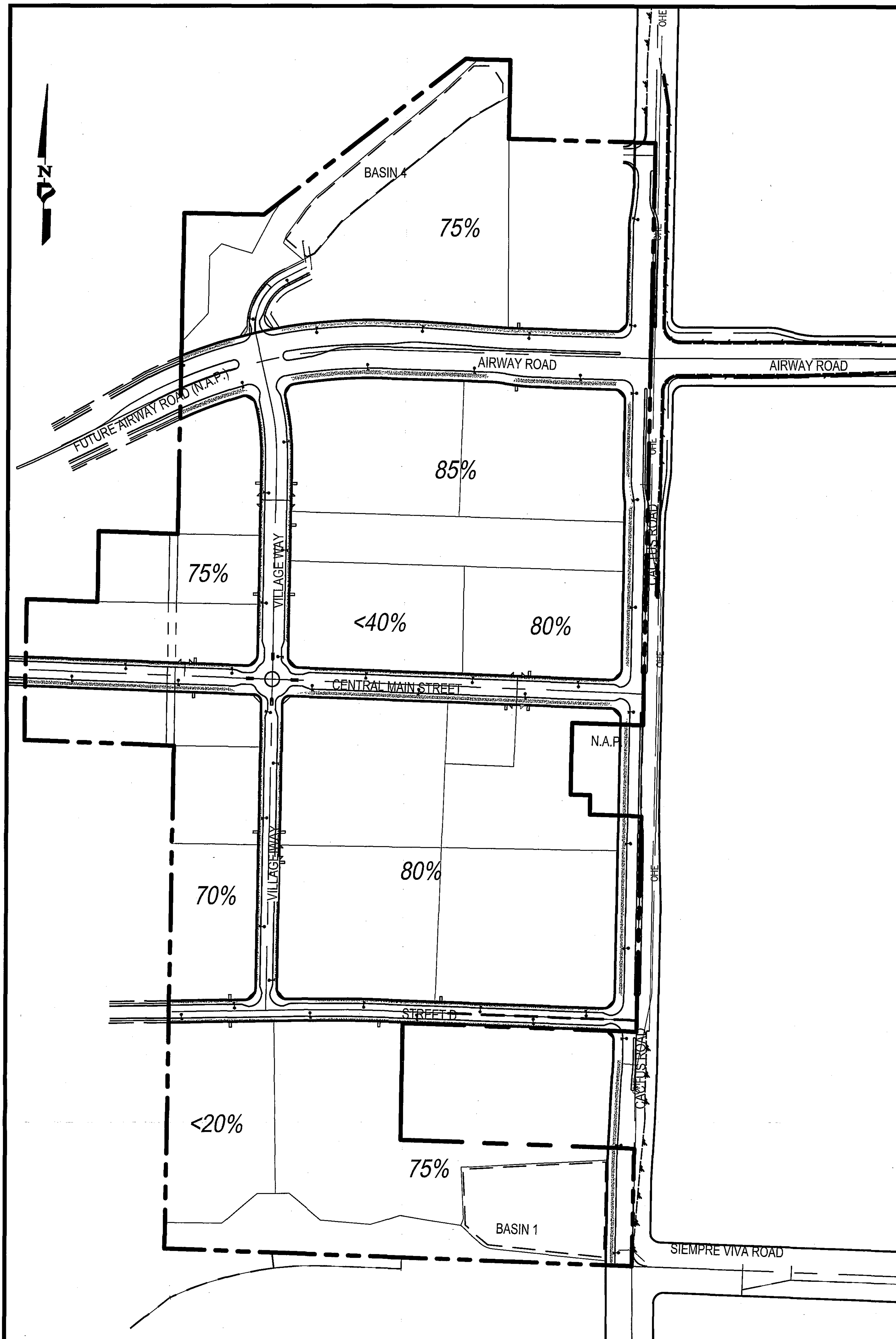
PREPARED BY:
NAME: PROJECT DESIGN CONSULTANTS
ADDRESS: 701 'B' STREET, SUITE 800
SAN DIEGO, CALIFORNIA 92101
PHONE #: (619) 235-6471

PROJECT ADDRESS:
SAN DIEGO, CALIFORNIA

PROJECT NAME:
LUMINA

SHEET TITLE:
STREET CROSS SECTIONS

REVISION 14:
REVISION 13:
REVISION 12:
REVISION 11:
REVISION 10:
REVISION 09:
REVISION 08:
REVISION 07:
REVISION 06:
REVISION 05:
REVISION 04:
REVISION 03:
REVISION 02: 08/17/2018
REVISION 01: 10/13/2017
ORIGINAL DATE: 08/01/2017
SHEET 2 OF 29
DEP #



SCALE: 1"=250'
JOB #: 2357.50
CREATED: 8/1/17

PREPARED BY:
PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey

CITY OF SAN DIEGO
LUMINA
IMPERVIOUS ASSUMPTIONS FOR FUTURE DEVELOPMENT PADS PROPOSED CONDITIONS

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The City of SAN DIEGO

	Project Name	Lumina	
	BMP ID	South Basin (BMP #1)	
Sizing Method for Pollutant Removal Criteria		**Worksheet B.5-1**	
1	Area draining to the BMP	2753863.2	sq. ft.
2	Adjusted runoff factor for drainage area (Refer to Appendix B.1 and B.2)	0.618	
3	85th percentile 24-hour rainfall depth	0.46	inches
4	Design capture volume [Line 1 x Line 2 x (Line 3/12)]	65466	cu. ft.
BMP Parameters			
5	Surface ponding [6 inch minimum, 12 inch maximum]	12	inches
6	Media thickness [18 inches minimum], also add mulch layer and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations	18	inches
7	Aggregate storage (also add ASTM No 8 stone) above underdrain invert (12 inches typical) – use 0 inches if the aggregate is not over the entire bottom surface area	2	inches
8	Aggregate storage below underdrain invert (3 inches minimum) – use 0 inches if the aggregate is not over the entire bottom surface area	8	inches
9	Freely drained pore storage of the media	0.2	in/in
10	Porosity of aggregate storage	0.4	in/in
11	Media filtration rate to be used for sizing (maximum filtration rate of 5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate (includes infiltration into the soil and flow rate through the outlet structure) which will be less than 5 in/hr.)	0.75	in/hr.
Baseline Calculations			
12	Allowable routing time for sizing	6	hours
13	Depth filtered during storm [Line 11 x Line 12]	4.5	inches
14	Depth of Detention Storage [Line 5 + (Line 6 x Line 9) + (Line 7 x Line 10) + (Line 8 x Line 10)]	19.6	inches
15	Total Depth Treated [Line 13 + Line 14]	24.1	inches
Option 1 – Biofilter 1.5 times the DCV			
16	Required biofiltered volume [1.5 x Line 4]	98199	cu. ft.
17	Required Footprint [Line 16/ Line 15] x 12	48896	sq. ft.
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
18	Required Storage (surface + pores) Volume [0.75 x Line 4]	49100	cu. ft.
19	Required Footprint [Line 18/ Line 14] x 12	30061	sq. ft.
Footprint of the BMP			
20	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Line 11 in Worksheet B.5-3)	0.015	
21	Minimum BMP Footprint [Line 1 x Line 2 x Line 20]	25617	sq. ft.
22	Footprint of the BMP = Maximum(Minimum(Line 17, Line 19), Line 21)	30061	sq. ft.
23	Provided BMP Footprint	46,285	sq. ft.
24	Is Line 23 > Line 22?	**Yes, Performance Standard is Met**	

The City of SAN DIEGO	Project Name	Lumina	
	BMP ID	South Basin - BMP#1	
Sizing Method for Volume Retention Criteria		**Worksheet B.5-2**	

1	Area draining to the BMP	2753863.2	sq. ft.
2	Adjusted runoff factor for drainage area (Refer to Appendix B.1 and B.2)	0.618	
3	85^{th} percentile 24-hour rainfall depth	0.46	inches
4	Design capture volume [Line 1 x Line 2 x (Line 3/12)]	65466	cu. ft.
BMP Parameters			
5	Footprint of the BMP	46,285	sq. ft.
6	Media thickness [18 inches minimum], also add mulch layer and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations	18	inches
7	Media retained pore space [50% of (FC-WP)]	0.05	in/in
8	Aggregate storage below underdrain invert (3 inches minimum) – use 0 inches if the aggregate is not over the entire bottom surface area	8	inches
9	Porosity of aggregate storage	0.4	in/in
Volume Retention Requirement			
10	Measured infiltration rate in the DMA	0.22	in/hr.
11	Factor of safety	2	
12	Reliable infiltration rate, for biofiltration BMP sizing [Line 10/ Line 11] Note: This worksheet is not applicable if Line 12 < 0.01 in/hr.	0.11	in/hr.
13	Average annual volume reduction target (Figure B.5-2) When Line 12 ≥ 0.01 in/hr. = Minimum (40, 166.9 x Line 12 +6.62)	25.0	%
14	Fraction of DCV to be retained (Figure B.5-3) 0.0000013 x Line 13^3 - 0.000057 x Line 13^2 + 0.0086 x Line 13 - 0.014	0.186	
15	Target volume retention [Line 14 x Line 4]	12177	cu. ft.
Evapotranspiration: Average Annual Volume Retention			
16	Effective evapotranspiration depth [Line 6 x Line 7]	0.9	inches
17	Retained Pore Volume [(Line 16 x Line 5)/12]	3471	cu. ft.
18	Fraction of DCV retained in pore spaces [Line 17/Line 4]	0.05	
19	Evapotranspiration average annual capture [ET nomographs in Figure B.5-5]	3.8	%
Infiltration: Average Annual Volume Retention			
20	Drawdown for infiltration storage [(Line 8 x Line 9)/Line 12]	29	hours
21	Equivalent DCV fraction from evapotranspiration (use Line 19 and Line 20 in Figure B.4-1; Refer to Appendix B.4.2.2)	0.02	
22	Infiltration volume storage [(Line 5 x Line 8 x Line 9)/12]	12343	cu. ft.
23	Infiltration Storage Fraction of DCV [Line 22/Line 4]	0.19	
24	Total Equivalent Fraction of DCV [Line 21 + Line 23]	0.21	
25	Biofiltration BMP average annual capture [use Line 24 and 20 in Figure B.4-1]	31.70	%
Volume retention required from site design and other BMPs			
26	Fraction of DCV retained (Figure B.5-3) 0.0000013 x Line 25^3 - 0.000057 x Line 25^2 + 0.0086 x Line 25 - 0.014	0.243	
27	Remaining target DCV retention [(Line 14 – Line 26) x Line 4] Note: If Line 27 is equal to or smaller than 0 then the BMP meets the volume retention performance standard. If Line 27 is greater than 0, the applicant must implement site design and/or other BMPs within the DMA that will retain DCV equivalent to or greater than Line 27 to meet the volume retention performance standard	-3732	cu. ft.

Volume Retention Performance Standard is Met

The City of SAN DIEGO

	Project Name	Lumina	
	BMP ID	South Basin (BMP #1)	
Alternative Minimum Footprint Sizing Factor		**Worksheet B.5-3**	
1	Area draining to the BMP	2753863.2	sq. ft.
2	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.618	
3	Load to Clog	2	lb/sq. ft.
4	Allowable Period to Accumulate Clogging Load (T_L)	10	years

Volume Weighted EMC Calculation

Land Use	**Fraction of Total DCV**	**TSS EMC (mg/L)**	**Product**
Single Family Residential		123	0
Commercial		128	0
Industrial		125	0
Education (Municipal)		132	0
Transportation		78	0
Multi-family Residential	1	40	40
Roof Runoff		14	0
Low Traffic Areas		50	0
Open Space		216	0
Other, specify:			0
Other, specify:			0
Other, specify:			0

5	Volume Weighted EMC (sum of all products)	40	mg/L
Sizing Factor for Clogging			
6	Adjustment for pretreatment measures Where: Line 6 = 0 if no pretreatment; Line 6 = 0.25 when pretreatment is included; Line 6 = 0.5 if the pretreatment has an active Washington State TAPE approval rating for "pre-treatment."	0.25	
7	Average Annual Precipitation [Provide documentation of the data source in the discussion box; SanGIS has a GIS layer for average annual precipitation]	12	inches
8	Calculate the Average Annual Runoff (Line 7 x Line 1/12) x Line2	1707810	cu-ft/yr
9	Calculate the Average Annual TSS Load (Line 8 x 62.4 x Line 5 x (1 – Line 6))/10^6	3197	lb/yr
10	Calculate the BMP Footprint Needed (Line 9 x Line 4)/Line 3	15985	sq. ft.
11	Calculate the Minimum Footprint Sizing Factor for Clogging [Line 10/ (Line 1 x Line 2)]	0.009	

Discussion:

See Attachment 1e-2.1 for imperviousness assumptions.

The City of SAN DIEGO

	Project Name	Lumina
	BMP ID	Airway Road Biofiltration (BMP #3)

Sizing Method for Pollutant Removal Criteria		**Worksheet B.5-1**	
1	Area draining to the BMP	13068	sq. ft.
2	Adjusted runoff factor for drainage area (Refer to Appendix B.1 and B.2)	0.82	
3	85th percentile 24-hour rainfall depth	0.46	inches
4	Design capture volume [Line 1 x Line 2 x (Line 3/12)]	411	cu. ft.
BMP Parameters			
5	Surface ponding [6 inch minimum, 12 inch maximum]	12	inches
6	Media thickness [18 inches minimum], also add mulch layer and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations	18	inches
7	Aggregate storage (also add ASTM No 8 stone) above underdrain invert (12 inches typical) – use 0 inches if the aggregate is not over the entire bottom surface area	12	inches
8	Aggregate storage below underdrain invert (3 inches minimum) – use 0 inches if the aggregate is not over the entire bottom surface area	6	inches
9	Freely drained pore storage of the media	0.2	in/in
10	Porosity of aggregate storage	0.4	in/in
11	Media filtration rate to be used for sizing (maximum filtration rate of 5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate (includes infiltration into the soil and flow rate through the outlet structure) which will be less than 5 in/hr.)	1.62	in/hr.
Baseline Calculations			
12	Allowable routing time for sizing	6	hours
13	Depth filtered during storm [Line 11 x Line 12]	9.72	inches
14	Depth of Detention Storage [Line 5 + (Line 6 x Line 9) + (Line 7 x Line 10) + (Line 8 x Line 10)]	22.8	inches
15	Total Depth Treated [Line 13 + Line 14]	32.52	inches
Option 1 – Biofilter 1.5 times the DCV			
16	Required biofiltered volume [1.5 x Line 4]	616	cu. ft.
17	Required Footprint [Line 16/ Line 15] x 12	227	sq. ft.
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
18	Required Storage (surface + pores) Volume [0.75 x Line 4]	308	cu. ft.
19	Required Footprint [Line 18/ Line 14] x 12	162	sq. ft.
Footprint of the BMP			
20	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Line 11 in Worksheet B.5-3)	0.024	
21	Minimum BMP Footprint [Line 1 x Line 2 x Line 20]	257	sq. ft.
22	Footprint of the BMP = Maximum(Minimum(Line 17, Line 19), Line 21)	257	sq. ft.
23	Provided BMP Footprint	250	sq. ft.
24	Is Line 23 > Line 22?	**Yes, Performance Standard is Met**	

The City of SAN DIEGO	Project Name	Lumina	
	BMP ID	Airway Road Biofiltration (BMP #3)	
Sizing Method for Volume Retention Criteria		Worksheet B.5-2	

1	Area draining to the BMP	13068	sq. ft.
2	Adjusted runoff factor for drainage area (Refer to Appendix B.1 and B.2)	0.82	
3	85^{th} percentile 24-hour rainfall depth	0.46	inches
4	Design capture volume [Line 1 x Line 2 x (Line 3/12)]	411	cu. ft.
BMP Parameters			
5	Footprint of the BMP	260	sq. ft.
6	Media thickness [18 inches minimum], also add mulch layer and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations	18	inches
7	Media retained pore space [50% of (FC-WP)]	0.05	in/in
8	Aggregate storage below underdrain invert (3 inches minimum) – use 0 inches if the aggregate is not over the entire bottom surface area	6	inches
9	Porosity of aggregate storage	0.4	in/in
Volume Retention Requirement			
10	Measured infiltration rate in the DMA	0.3	in/hr.
11	Factor of safety	2	
12	Reliable infiltration rate, for biofiltration BMP sizing [Line 10/ Line 11] Note: This worksheet is not applicable if Line 12 < 0.01 in/hr.	0.15	in/hr.
13	Average annual volume reduction target (Figure B.5-2) When Line 12 ≥ 0.01 in/hr. = Minimum (40, 166.9 x Line 12 +6.62)	31.7	%
14	Fraction of DCV to be retained (Figure B.5-3) $0.0000013 \times \text{Line } 13^3 - 0.000057 \times \text{Line } 13^2 + 0.0086 \times \text{Line } 13 - 0.014$	0.242	
15	Target volume retention [Line 14 x Line 4]	99	cu. ft.
Evapotranspiration: Average Annual Volume Retention			
16	Effective evapotranspiration depth [Line 6 x Line 7]	0.9	inches
17	Retained Pore Volume [(Line 16 x Line 5)/12]	20	cu. ft.
18	Fraction of DCV retained in pore spaces [Line 17/Line 4]	0.05	
19	Evapotranspiration average annual capture [ET nomographs in Figure B.5-5]	3.8	%
Infiltration: Average Annual Volume Retention			
20	Drawdown for infiltration storage [(Line 8 x Line 9)/Line 12]	16	hours
21	Equivalent DCV fraction from evapotranspiration (use Line 19 and Line 20 in Figure B.4-1; Refer to Appendix B.4.2.2)	0.02	
22	Infiltration volume storage [(Line 5 x Line 8 x Line 9)/12]	52	cu. ft.
23	Infiltration Storage Fraction of DCV [Line 22/Line 4]	0.13	
24	Total Equivalent Fraction of DCV [Line 21 + Line 23]	0.15	
25	Biofiltration BMP average annual capture [use Line 24 and 20 in Figure B.4-1]	30.86	%
Volume retention required from site design and other BMPs			
26	Fraction of DCV retained (Figure B.5-3) $0.0000013 \times \text{Line } 25^3 - 0.000057 \times \text{Line } 25^2 + 0.0086 \times \text{Line } 25 - 0.014$	0.235	
27	Remaining target DCV retention [(Line 14 – Line 26) x Line 4] Note: If Line 27 is equal to or smaller than 0 then the BMP meets the volume retention performance standard. If Line 27 is greater than 0, the applicant must implement site design and/or other BMPs within the DMA that will retain DCV equivalent to or greater than Line 27 to meet the volume retention performance standard	3	cu. ft.

Target Volume retention from site design and other BMPs = 3 cubic feet

The City of SAN DIEGO	Project Name	Lumina	
	BMP ID	North Biofiltration (BMP #3)	

Alternative Minimum Footprint Sizing Factor		Worksheet B.5-3	
1	Area draining to the BMP	13068	sq. ft.
2	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.82	
3	Load to Clog	2	lb/sq. ft.
4	Allowable Period to Accumulate Clogging Load (T_L)	10	years

Volume Weighted EMC Calculation

Land Use	Fraction of Total DCV	TSS EMC (mg/L)	Product
Single Family Residential		123	0
Commercial		128	0
Industrial		125	0
Education (Municipal)		132	0
Transportation	1	78	78
Multi-family Residential		40	0
Roof Runoff		14	0
Low Traffic Areas		50	0
Open Space		216	0
Other, specify:			0
Other, specify:			0
Other, specify:			0

5	Volume Weighted EMC (sum of all products)	78	mg/L

Sizing Factor for Clogging

6	Adjustment for pretreatment measures Where: Line 6 = 0 if no pretreatment; Line 6 = 0.25 when pretreatment is included; Line 6 = 0.5 if the pretreatment has an active Washington State TAPE approval rating for "pre-treatment."	0	
7	Average Annual Precipitation [Provide documentation of the data source in the discussion box; SanGIS has a GIS layer for average annual precipitation]	12	inches
8	Calculate the Average Annual Runoff (Line 7 x Line 1/12) x Line2	10716	cu-ft/yr
9	Calculate the Average Annual TSS Load (Line 8 x 62.4 x Line 5 x (1 – Line 6))/10^6	52	lb/yr
10	Calculate the BMP Footprint Needed (Line 9 x Line 4)/Line 3	261	sq. ft.
11	Calculate the Minimum Footprint Sizing Factor for Clogging [Line 10/ (Line 1 x Line 2)]	0.024	

Discussion:

See Attachment 1e-2.1 for imperviousness assumptions.

The City of SAN DIEGO	Project Name	Lumina	
	BMP ID	North Basin - BMP#4	

	Sizing Method for Pollutant Removal Criteria	Worksheet B.5-1	
1	Area draining to the BMP	1481911.2	sq. ft.
2	Adjusted runoff factor for drainage area (Refer to Appendix B.1 and B.2)	0.641	
3	85th percentile 24-hour rainfall depth	0.46	inches
4	Design capture volume [Line 1 x Line 2 x (Line 3/12)]	36820	cu. ft.
BMP Parameters			
5	Surface ponding [6 inch minimum, 12 inch maximum]	12	inches
6	Media thickness [18 inches minimum], also add mulch layer and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations	18	inches
7	Aggregate storage (also add ASTM No 8 stone) above underdrain invert (12 inches typical) – use 0 inches if the aggregate is not over the entire bottom surface area	10	inches
8	Aggregate storage below underdrain invert (3 inches minimum) – use 0 inches if the aggregate is not over the entire bottom surface area	3	inches
9	Freely drained pore storage of the media	0.2	in/in
10	Porosity of aggregate storage	0.4	in/in
11	Media filtration rate to be used for sizing (maximum filtration rate of 5 in/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate (includes infiltration into the soil and flow rate through the outlet structure) which will be less than 5 in/hr.)	3	in/hr.
Baseline Calculations			
12	Allowable routing time for sizing	6	hours
13	Depth filtered during storm [Line 11 x Line 12]	18	inches
14	Depth of Detention Storage [Line 5 + (Line 6 x Line 9) + (Line 7 x Line 10) + (Line 8 x Line 10)]	20.8	inches
15	Total Depth Treated [Line 13 + Line 14]	38.8	inches
Option 1 – Biofilter 1.5 times the DCV			
16	Required biofiltered volume [1.5 x Line 4]	55230	cu. ft.
17	Required Footprint [Line 16/ Line 15] x 12	17081	sq. ft.
Option 2 - Store 0.75 of remaining DCV in pores and ponding			
18	Required Storage (surface + pores) Volume [0.75 x Line 4]	27615	cu. ft.
19	Required Footprint [Line 18/ Line 14] x 12	15932	sq. ft.
Footprint of the BMP			
20	BMP Footprint Sizing Factor (Default 0.03 or an alternative minimum footprint sizing factor from Line 11 in Worksheet B.5-3)	0.012	
21	Minimum BMP Footprint [Line 1 x Line 2 x Line 20]	11526	sq. ft.
22	Footprint of the BMP = Maximum(Minimum(Line 17, Line 19), Line 21)	15932	sq. ft.
23	Provided BMP Footprint	18816	sq. ft.
24	Is Line 23 > Line 22?	**Yes, Performance Standard is Met**	

The City of SAN DIEGO	Project Name	Lumina	
	BMP ID	North Basin - BMP#4	
Sizing Method for Volume Retention Criteria		Worksheet B.5-2	

1	Area draining to the BMP	1481911.2	sq. ft.
2	Adjusted runoff factor for drainage area (Refer to Appendix B.1 and B.2)	0.641	
3	85th percentile 24-hour rainfall depth	0.46	inches
4	Design capture volume [Line 1 x Line 2 x (Line 3/12)]	36820	cu. ft.
BMP Parameters			
5	Footprint of the BMP	18816	sq. ft.
6	Media thickness [18 inches minimum], also add mulch layer and washed ASTM 33 fine aggregate sand thickness to this line for sizing calculations	18	inches
7	Media retained pore space [50% of (FC-WP)]	0.05	in/in
8	Aggregate storage below underdrain invert (3 inches minimum) – use 0 inches if the aggregate is not over the entire bottom surface area	3	inches
9	Porosity of aggregate storage	0.4	in/in
Volume Retention Requirement			
10	Measured infiltration rate in the DMA	0	in/hr.
11	Factor of safety	2	
12	Reliable infiltration rate, for biofiltration BMP sizing [Line 10/ Line 11] Note: This worksheet is not applicable if Line 12 < 0.01 in/hr.	0	in/hr.
13	Average annual volume reduction target (Figure B.5-2) When Line 12 ≥ 0.01 in/hr. = Minimum (40, 166.9 x Line 12 +6.62)	6.6	%
14	Fraction of DCV to be retained (Figure B.5-3) 0.0000013 x Line 13^3 - 0.000057 x Line 13^2 + 0.0086 x Line 13 - 0.014	0.041	
15	Target volume retention [Line 14 x Line 4]	1510	cu. ft.
Evapotranspiration: Average Annual Volume Retention			
16	Effective evapotranspiration depth [Line 6 x Line 7]	0.9	inches
17	Retained Pore Volume [(Line 16 x Line 5)/12]	1439	cu. ft.
18	Fraction of DCV retained in pore spaces [Line 17/Line 4]	0.04	
19	Evapotranspiration average annual capture [ET nomographs in Figure B.5-5]	3.1	%
Infiltration: Average Annual Volume Retention			
20	Drawdown for infiltration storage [(Line 8 x Line 9)/Line 12]	0	hours
21	Equivalent DCV fraction from evapotranspiration (use Line 19 and Line 20 in Figure B.4-1; Refer to Appendix B.4.2.2)	0.01	
22	Infiltration volume storage [(Line 5 x Line 8 x Line 9)/12]	1918	cu. ft.
23	Infiltration Storage Fraction of DCV [Line 22/Line 4]	0.05	
24	Total Equivalent Fraction of DCV [Line 21 + Line 23]	0.06	
25	Biofiltration BMP average annual capture [use Line 24 and 20 in Figure B.4-1]	21.12	%
Volume retention required from site design and other BMPs			
26	Fraction of DCV retained (Figure B.5-3) 0.0000013 x Line 25^3 - 0.000057 x Line 25^2 + 0.0086 x Line 25 - 0.014	0.154	
27	Remaining target DCV retention [(Line 14 – Line 26) x Line 4] Note: If Line 27 is equal to or smaller than 0 then the BMP meets the volume retention performance standard. If Line 27 is greater than 0, the applicant must implement site design and/or other BMPs within the DMA that will retain DCV equivalent to or greater than Line 27 to meet the volume retention performance standard	-4161	cu. ft.

Volume Retention Performance Standard is Met

The City of SAN DIEGO	Project Name	Lumina	
	BMP ID	North Basin (BMP #4)	
Alternative Minimum Footprint Sizing Factor		Worksheet B.5-3	

1	Area draining to the BMP	1481911.2	sq. ft.
2	Adjusted Runoff Factor for drainage area (Refer to Appendix B.1 and B.2)	0.641	
3	Load to Clog	2	lb/sq. ft.
4	Allowable Period to Accumulate Clogging Load (T_L)	10	years

Volume Weighted EMC Calculation

Land Use	Fraction of Total DCV	TSS EMC (mg/L)	Product
Single Family Residential		123	0
Commercial		128	0
Industrial		125	0
Education (Municipal)		132	0
Transportation		78	0
Multi-family Residential	1	40	40
Roof Runoff		14	0
Low Traffic Areas		50	0
Open Space		216	0
Other, specify:			0
Other, specify:			0
Other, specify:			0

5	Volume Weighted EMC (sum of all products)	40	mg/L

Sizing Factor for Clogging

6	Adjustment for pretreatment measures Where: Line 6 = 0 if no pretreatment; Line 6 = 0.25 when pretreatment is included; Line 6 = 0.5 if the pretreatment has an active Washington State TAPE approval rating for "pre-treatment."	0	
7	Average Annual Precipitation [Provide documentation of the data source in the discussion box; SanGIS has a GIS layer for average annual precipitation]	12	inches
8	Calculate the Average Annual Runoff (Line 7 x Line 1/12) x Line2	960515	cu-ft/yr
9	Calculate the Average Annual TSS Load (Line 8 x 62.4 x Line 5 x (1 – Line 6))/10^6	2397	lb/yr
10	Calculate the BMP Footprint Needed (Line 9 x Line 4)/Line 3	11987	sq. ft.
11	Calculate the Minimum Footprint Sizing Factor for Clogging [Line 10/ (Line 1 x Line 2)]	0.012	

Discussion:

See Attachment 1e-2.1 for imperviousness assumptions.

Attachment 1e

Modular Wetland Sizing Calculations

DMA-ID	A (sf)	Impervious (sf)	%IMP	C	1.5 x Q (cfs)	MWS Qdesign	MWS Model
N2	27878	25091	90%	0.8200	0.157	0.175	MWS-L-4-15

BMP #2

Onsite Proprietary Biofiltration BMP Checklist	Form I-10

A proprietary biofiltration BMP may satisfy the pollutant control requirements for a DMA onsite in some cases. This depends on the characteristics of the DMA and the performance certification/data of the proprietary biofiltration BMP. If the pollutant control requirements for a DMA are met onsite, then the DMA is not required to participate in an offsite alternative compliance program to meet its pollutant control obligations.

An applicant using a proprietary biofiltration BMP to meet the pollutant control requirements onsite must complete Section 1 of this form and include it in the PDP SWQMP. A separate form must be completed for each DMA. In instances where the City Engineer does not agree with the applicant's determination, Section 2 of this form will be completed by the City and returned to the applicant.

Section 1: Biofiltration Criteria Checklist (Appendix F)

Refer to Part 1 of the Storm Water Standards to complete this section. When separate forms/worksheets are referenced below, the applicant must also complete these separate forms/worksheets (as applicable) and include in the PDP SWQMP. The criteria numbers below correspond to the criteria numbers in Appendix F.

Criteria	Answer	Progression
Criteria 1 and 3: What is the infiltration condition of the DMA? Refer to Section 5.4.2 and Appendix C of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance. Complete and attach Worksheet C.4-1: Categorization of Infiltration Feasibility Condition to support the feasibility determination.	☐ Full Infiltration Condition	**Stop.** Proprietary biofiltration BMP is not allowed.
	☐ Partial Infiltration Condition	Proprietary biofiltration BMP is only allowed, if 40% (average annual capture) volume reduction is achieved within the BMP or downstream of the BMP. If the 40% volume reduction is achieved from within the BMP or downstream of the BMP **proceed to Criteria 2.** If the 40% of the volume reduction is not achieved, proprietary biofiltration BMP is not allowed. **Stop.**
	☐ No Infiltration Condition	Proprietary biofiltration BMP is allowed if one of the two criteria listed below are met: ☐ Documentation is provided to the satisfaction of the City Engineer that a larger footprint biofiltration BMP (i.e. minimum sizing factor calculated using worksheet B.5.2) is not feasible onsite; or ☐ Documentation is provided that volume reduction achieved by the larger footprint biofiltration BMP can be achieved through other measures (e.g., downstream site design BMPs, evapotranspiration from proprietary BMP, etc.) If one of the two criteria listed above is met **proceed to Criteria 2.** If neither criteria are met, proprietary biofiltration BMP is not allowed. **Stop.**

Onsite Proprietary Biofiltration BMP Checklist	Form I-10

Provide basis for Criteria 1 and 3:

Feasibility Analysis:
Summarize findings and attach Worksheet C.4-1

If Partial Infiltration Condition:
Provide documentation that 40% (average annual capture; or 0.375*DCV when using a 36-hour drawdown BMP) volume reduction is achieved within the BMP or downstream of the BMP. This could be achieved through downstream site design BMPs, downstream infiltration BMP, incidental retention by having an open bottom in the proprietary BMP or other similar measures.

If No Infiltration Condition:
Provide documentation that the alternative minimum sizing factor (attach Worksheet B.5-2) BMP is not feasible onsite or the volume reduction achieved by a non-proprietary BMP sized to the alternative minimum sizing factor can be achieved through downstream site design BMPs, downstream evapotranspiration BMPs, incidental evapotranspiration from the proprietary BMP or other similar measures.

Criteria	Answer	Progression
Criteria 2: Is the proprietary biofiltration BMP sized to meet the performance standard from the MS4 Permit? Refer to Appendix B.5 and Appendix F.2 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☑ Meets Flow based Criteria	Use guidance from Appendix F.2 to size the proprietary BMP to meet the flow based criteria. Include the calculations in the PDP SWQMP. Use parameters for sizing consistent with manufacturer guidelines and conditions of its third party certifications (i.e. a BMP certified at a loading rate of 1 gpm/sq. ft cannot be designed using a loading rate of 1.5 gpm/sq. ft) **Proceed to Criteria 4.**
	☐ Meets Volume based Criteria	Provide documentation that the proprietary biofiltration BMP has a total static (i.e. non-routed) storage volume, including pore-spaces and pre-filter detention volume (Refer to Appendix B.5 for a schematic) of at least 0.75 times the portion of the DCV not reliably retained onsite. **Proceed to Criteria 4.**
	☐ Does not Meet either criteria	**Stop.** Proprietary biofiltration BMP is not allowed.

Onsite Proprietary Biofiltration BMP Checklist	Form I-10

Provide basis for Criteria 2:

Provide documentation that the BMP meets the numeric criteria and is designed consistent with the manufacturer guidelines and conditions of its third-party certification (i.e., loading rate, etc., as applicable).

Criteria	Answer	Progression
Criteria 4: Does the proprietary biofiltration BMP meet the pollutant treatment performance standard for the projects most significant pollutants of concern? Refer to Appendix B.6 and Appendix F.1 of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☑ Yes, meets the TAPE certification.	Provide documentation that the proprietary BMP has an appropriate TAPE certification for the projects most significant pollutants of concern. **Proceed to Criteria 5.**
	☐ Yes, through other third-party documentation	Acceptance of third-party documentation is at the discretion of the City Engineer. The City engineer will consider, (a) the data submitted; (b) representativeness of the data submitted; and (c) consistency of the BMP performance claims with pollutant control objectives in Table F.1-2 and Table F.1-1 while making this determination. If a proprietary biofiltration BMP is not accepted, a written explanation/ reason will be provided in Section 2. **Proceed to Criteria 5.**
	☐ No	**Stop**. Proprietary biofiltration BMP is not allowed.

Provide basis for Criteria 4:

Provide documentation that identifies the projects most significant pollutants of concern and TAPE certification or other third party documentation that shows that the proprietary biofiltration BMP meets the pollutant treatment performance standard for the projects most significant pollutants of concern.

Onsite Proprietary Biofiltration BMP Checklist		Form I-10
Criteria	**Answer**	**Progression**
Criteria 5: Is the proprietary biofiltration BMP designed to promote appropriate biological activity to support and maintain treatment process? Refer to Appendix F of the BMP Design Manual (Part 1 of Storm Water Standards) for guidance.	☑ Yes	Provide documentation that the proprietary biofiltration BMP support appropriate biological activity. Refer to Appendix F for guidance. **Proceed to Criteria 6.**
	☐ No	**Stop.** Proprietary biofiltration BMP is not allowed.

Provide basis for Criteria 5:

Provide documentation that appropriate biological activity is supported by the proprietary biofiltration BMP to maintain treatment process.

Criteria	Answer	Progression
Criteria 6: Is the proprietary biofiltration BMP designed with a hydraulic loading rate to prevent erosion, scour and channeling within the BMP?	☑ Yes	Provide documentation that the proprietary biofiltration BMP is used in a manner consistent with manufacturer guidelines and conditions of its third-party certification. **Proceed to Criteria 7.**
	☐ No	**Stop.** Proprietary biofiltration BMP is not allowed.

Provide basis for Criteria 6:

Provide documentation that the BMP meets the numeric criteria and is designed consistent with the manufacturer guidelines and conditions of its third-party certification (i.e., maximum tributary area, maximum inflow velocities, etc., as applicable).

Onsite Proprietary Biofiltration BMP Checklist		Form I-10
Criteria	**Answer**	**Progression**
Criteria 7: Is the proprietary biofiltration BMP maintenance plan consistent with manufacturer guidelines and conditions of its third-party certification (i.e., maintenance activities, frequencies)?	☑ Yes, and the proprietary BMP is privately owned, operated and not in the public right of way.	Submit a maintenance agreement that will also include a statement that the BMP will be maintained in accordance with manufacturer guidelines and conditions of third-party certification. **Stop.** The proprietary biofiltration BMP meets the required criteria.
	☐ Yes, and the BMP is either owned or operated by the City or in the public right of way.	Approval is at the discretion of the City Engineer. The city engineer will consider maintenance requirements, cost of maintenance activities, relevant previous local experience with operation and maintenance of the BMP type, ability to continue to operate the system in event that the vending company is no longer operating as a business or other relevant factors while making the determination. **Stop.** Consult the City Engineer for a determination.
	☐ No	**Stop.** Proprietary biofiltration BMP is not allowed.

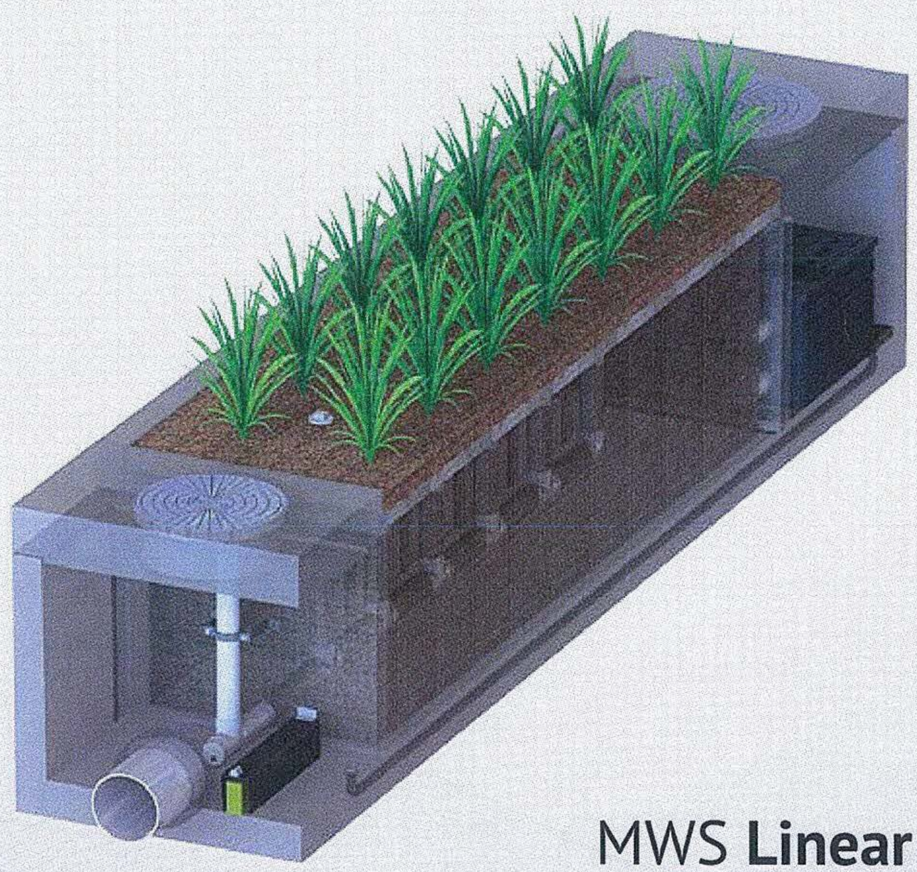
Provide basis for Criteria 7:

Include copy of manufacturer guidelines and conditions of third-party certification in the maintenance agreement. Attachment 3A of the PDP SWQMP must include a statement that the proprietary BMP will be maintained in accordance with manufacturer guidelines and conditions of third-party certification.

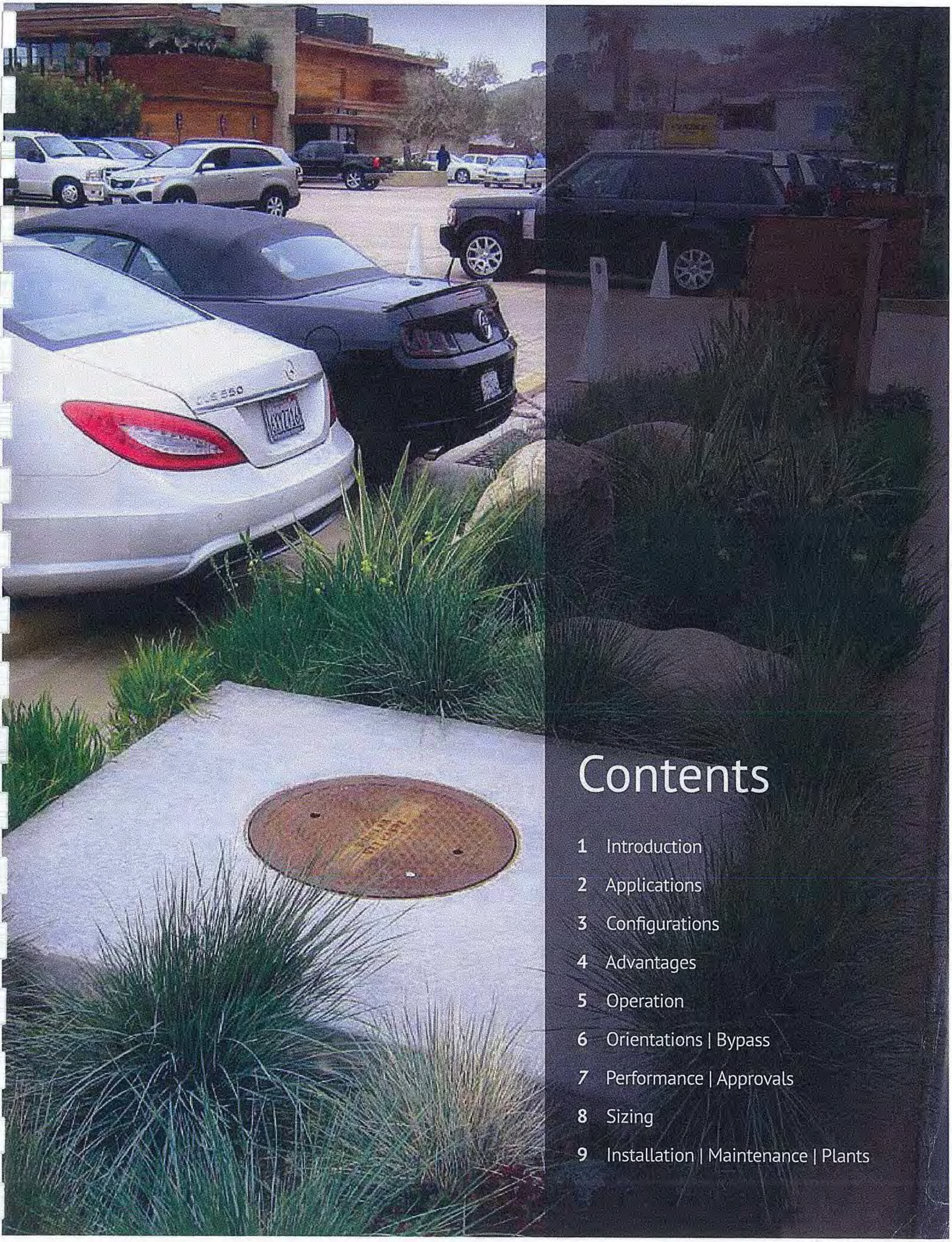
Onsite Proprietary Biofiltration BMP Checklist	Form I-10
Section 2: Verification (For City Use Only)	
Is the proposed proprietary BMP accepted by the City Engineer for onsite pollutant control compliance for the DMA?	☐ Yes ☐ No, See explanation below
Explanation/reason if the proprietary BMP is not accepted by the City for onsite pollutant control compliance:	

MODULAR WETLANDS™

Advanced ***Stormwater*** *Biofiltration*



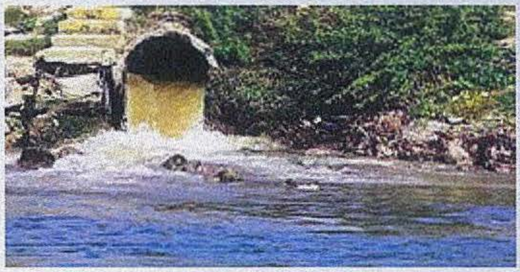
MWS **Linear**



Contents

The Urban Impact

For hundreds of years natural wetlands surrounding our shores have played an integral role as nature's stormwater treatment system. But as our cities grow and develop, these natural wetlands have perished under countless roads, rooftops, and parking lots.



Plant A Wetland

Without natural wetlands our cities are deprived of water purification, flood control, and land stability. Modular Wetlands and the MWS Linear re-establish nature's presence and rejuvenate water ways in urban areas.

MWS **Linear**

The Modular Wetland System Linear represents a pioneering breakthrough in stormwater technology as the only biofiltration system to utilize patented horizontal flow, allowing for a smaller footprint and higher treatment capacity. While most biofilters use little or no pre-treatment, the MWS Linear incorporates an advanced pre-treatment chamber that includes separation and pre-filter cartridges. In this chamber sediment and hydrocarbons are removed from runoff before it enters the biofiltration chamber, in turn reducing maintenance costs and improving performance.

Applications

The MWS Linear has been successfully used on numerous new construction and retrofit projects. The system's superior versatility makes it beneficial for a wide range of stormwater and waste water applications - treating rooftops, streetscapes, parking lots, and industrial sites.

Industrial

Many states enforce strict regulations for discharges from industrial sites. The MWS Linear has helped various sites meet difficult EPA mandated effluent limits for dissolved metals and other pollutants.

Residential

Low to high density developments can benefit from the versatile design of the MWS Linear. The system can be used in both decentralized LID design and cost-effective end-of-the-line configurations.

Streets

Street applications can be challenging due to limited space. The MWS Linear is very adaptable, and offers the smallest footprint to work around the constraints of existing utilities on retrofit projects.

Parking Lots

Parking lots are designed to maximize space and the MWS Linear's 4 ft. standard planter width allows for easy integration into parking lot islands and other landscape medians.

Commercial

Compared to bioretention systems, the MWS Linear can treat far more area in less space - meeting treatment and volume control requirements.

Mixed Use

The MWS Linear can be installed as a raised planter to treat runoff from rooftops or patios, making it perfect for sustainable "live-work" spaces.

More applications are available on our website: www.ModularWetlands.com/Applications

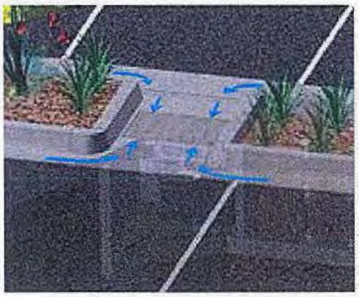
- Agriculture
- Reuse
- Low Impact Development
- Waste Water

Configurations

The MWS Linear is the preferred biofiltration system of Civil Engineers across the country due to its versatile design. This highly versatile system has available "pipe-in" options on most models, along with built-in curb or grated inlets for simple integration into your stormdrain design.

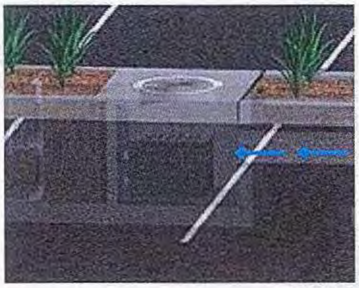
Curb Type

The *Curb Type* configuration accepts sheet flow through a curb opening and is commonly used along road ways and parking lots. It can be used in sump or flow by conditions. Length of curb opening varies based on model and size.



Grate Type

The *Grate Type* configuration offers the same features and benefits as the *Curb Type* but with a grated/drop inlet above the systems pre-treatment chamber. It has the added benefit of allowing for pedestrian access over the inlet. ADA compliant grates are available to assure easy and safe access. The *Grate Type* can also be used in scenarios where runoff needs to be intercepted on both sides of landscape islands.



Vault Type

The system's patented horizontal flow biofilter is able to accept inflow pipes directly into the pre-treatment chamber, meaning the MWS Linear can be used in end-of-the-line installations. This greatly improves feasibility over typical decentralized designs that are required with other biofiltration/bioretention systems. Another benefit of the "pipe in" design is the ability to install the system downstream of underground detention systems to meet water quality volume requirements.

Downspout Type

The *Downspout Type* is a variation of the *Vault Type* and is designed to accept a vertical downspout pipe from roof top and podium areas. Some models have the option of utilizing an internal bypass, simplifying the overall design. The system can be installed as a raised planter and the exterior can be stuccoed or covered with other finishes to match the look of adjacent buildings.

Advantages & Operation

The MWS Linear is the most efficient and versatile biofiltration system on the market, and the only system with horizontal flow which improves performance, reduces footprint, and minimizes maintenance. Figure-1 and Figure-2 illustrate the invaluable benefits of horizontal flow and the multiple treatment stages.

Featured Advantages

- Horizontal Flow Biofiltration
- Greater Filter Surface Area
- Pre-Treatment Chamber
- Patented Perimeter Void Area
- Flow Control
- No Depressed Planter Area

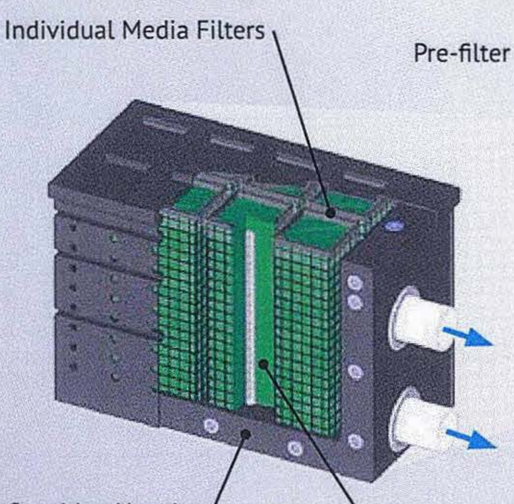
1 Pre-Treatment

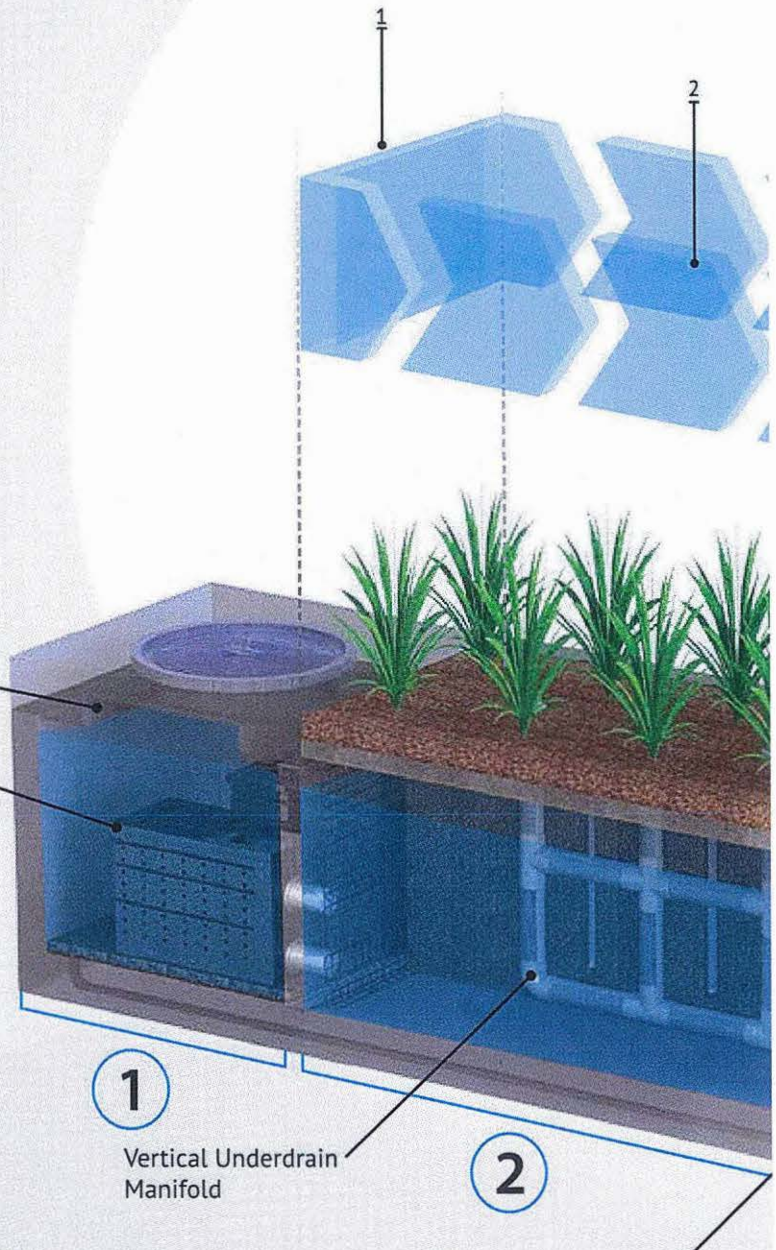
Separation

- Trash, sediment, and debris are separated before entering the pre-filter cartridges
- Designed for easy maintenance access

Pre-Filter Cartridges

- Over 25 ft^2 of surface area per cartridge
- Utilizes BioMediaGREEN filter material
- Removes over 80% of TSS & 90% of hydrocarbons
- Prevents pollutants that cause clogging from migrating to the biofiltration chamber





Wetland MEDIA™

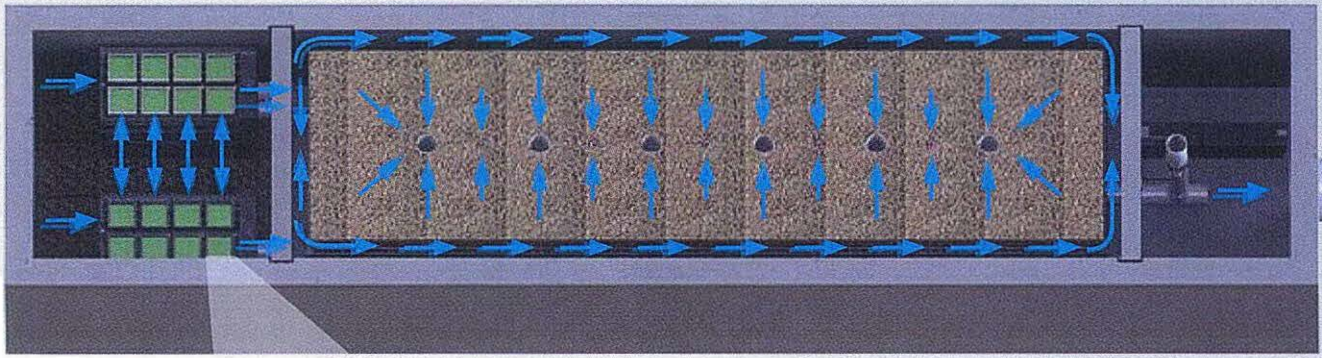
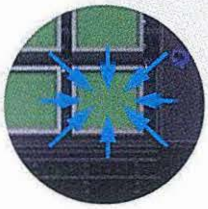


Fig. 2 - Top View

2x to 3x More Surface Area Than Traditional Downward Flow Bioretention Systems.



② Biofiltration

Horizontal Flow

- Less clogging than downward flow biofilters
- Water flow is subsurface
- Improves biological filtration

Patented Perimeter Void Area

- Vertically extends void area between the walls and the WetlandMEDIA on all four sides.
- Maximizes surface area of the media for higher treatment capacity

WetlandMEDIA

- Contains no organics and removes phosphorus
- Greater surface area and 48% void space
- Maximum evapotranspiration
- High ion exchange capacity and light weight

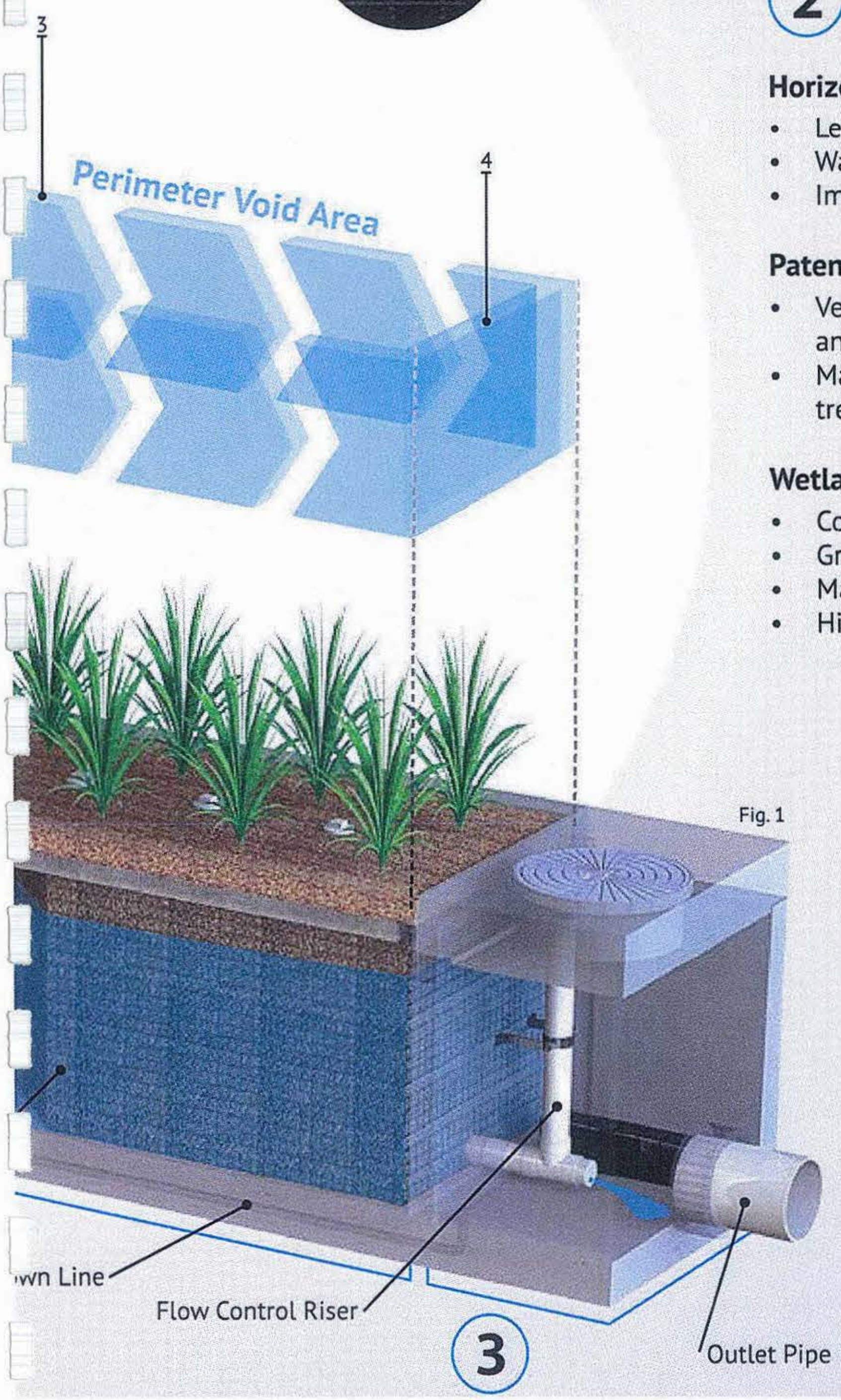


Fig. 1

③ Discharge

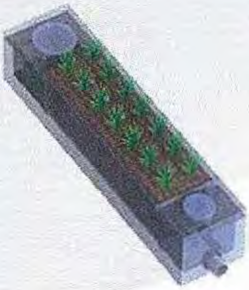
Flow Control

- Orifice plate controls flow of water through WetlandMEDIA to a level lower than the media's capacity.
- Extends the life of the media and improves performance

Drain-Down Filter

- The Drain-Down is an optional feature that completely drains the pre-treatment chamber
- Water that drains from the pre-treatment chamber between storm events will be treated

Orientations



Side-By-Side

The *Side-By-Side* orientation places the pre-treatment and discharge chamber adjacent to one another with the biofiltration chamber running parallel on either side. This minimizes the system length, providing a highly compact footprint. It has been proven useful in situations such as streets with directly adjacent sidewalks, as half of the system can be placed under that sidewalk. This orientation also offers internal bypass options as discussed below.

End-To-End

The *End-To-End* orientation places the pre-treatment and discharge chambers on opposite ends of the biofiltration chamber therefore minimizing the width of the system to 5 ft (outside dimension). This orientation is perfect for linear projects and street retrofits where existing utilities and sidewalks limit the amount of space available for installation. One limitation of this orientation is bypass must be external.

Bypass

Internal Bypass Weir (Side-by-Side Only)

The *Side-By-Side* orientation places the pre-treatment and discharge chambers adjacent to one another allowing for integration of internal bypass. The wall between these chambers can act as a bypass weir when flows exceed the system's treatment capacity, thus allowing bypass from the pre-treatment chamber directly to the discharge chamber.

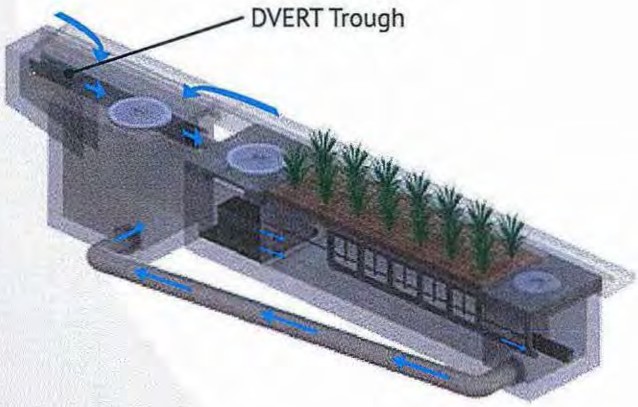
External Diversion Weir Structure

This traditional offline diversion method can be used with the MWS Linear in scenarios where runoff is being piped to the system. These simple and effective structures are generally configured with two outflow pipes. The first is a smaller pipe on the upstream side of the diversion weir - to divert low flows over to the MWS Linear for treatment. The second is the main pipe that receives water once the system has exceeded treatment capacity and water flows over the weir.

Flow By Design

This method is one in which the system is placed just upstream of a standard curb or grate inlet to intercept the first flush. Higher flows simply pass by the MWS Linear and into the standard inlet downstream.

DVERT Low Flow Diversion



This simple yet innovative diversion trough can be installed in existing or new curb and grate inlets to divert the first flush to the MWS Linear via pipe. It works similar to a rain gutter and is installed just below the opening into the inlet. It captures the low flows and channels them over to a connecting pipe exiting out the wall of the inlet and leading to the MWS Linear. The DVERT is perfect for retrofit and green street applications that allows the MWS Linear to be installed anywhere space is available.

Performance

The MWS Linear continues to outperform other treatment methods with superior pollutant removal for TSS, heavy metals, nutrients, hydrocarbons and bacteria. Since 2007 the MWS Linear has been field tested on numerous sites across the country. With it's advanced pre-treatment chamber and innovative horizontal flow biofilter, the system is able to effectively remove pollutants through a combination of physical, chemical, and biological filtration processes. With the same biological processes found in natural wetlands, the MWS Linear harnesses natures ability to process, transform, and remove even the most harmful pollutants.

Approvals

The MWS Linear has successfully met years of challenging technical reviews and testing from some of the most prestigious and demanding agencies in the nation, and perhaps the world.

State of Washington
TAPE
GULD
Basic
Enhanced/Metals
Phosphorus

Washington State TAPE Approved

The MWS Linear is approved for General Use Level Designation (GULD) for Basic, Enhanced, and Phosphorus treatment at 1 gpm/ft^2 loading rate. The highest performing BMP on the market for all main pollutant categories.

TSS	Total Phosphorus	Ortho Phosphorus	Nitrogen	Dissolved Zinc	Dissolved Copper	Total Zinc	Total Copper	Motor Oil
85%	64%	67%	45%	66%	38%	69%	50%	95%

VA

DEQ Assignment

The Virginia Department of Environmental Quality assigned the MWS Linear, the highest phosphorus removal rating for manufactured treatment devices to meet the new Virginia Stormwater Management Program (VSMP) Technical Criteria.

MD

Maryland Department Of The Environment Approved

Granted ESD (Environmental Site Design) status for new construction, redevelopment and retrofitting when designed in accordance with the Design Manual.

MA

MASTEP Evaluation

The University of Massachusetts at Amherst - Water Resources Research Center, issued a technical evaluation report noting removal rates up to 84% TSS, 70% Total Phosphorus, 68.5% Total Zinc, and more.

RI

Rhode Island DEM Approved

Approved as an authorized BMP and noted to achieve the following minimum removal efficiencies: 85% TSS, 60% Pathogens, 30% Total Phosphorus, and 30% Total Nitrogen.

Flow Based Sizing

The MWS Linear can be used in stand alone applications to meet treatment flow requirements. Since the MWS Linear is the only biofiltration system that can accept inflow pipes several feet below the surface it can be used not only in decentralized design applications but also as a large central end-of-the-line application for maximum feasibility.

Treatment Flow Sizing Table

Model #	Dimensions	WetlandMedia Surface Area	Treatment Flow Rate (cfs)
MWS-L-4-4	4' x 4'	23 ft^2	0.052
MWS-L-4-6	4' x 6'	32 ft^2	0.073
MWS-L-4-8	4' x 8'	50 ft^2	0.115
MWS-L-4-13	4' x 13'	63 ft^2	0.144
MWS-L-4-15	4' x 15'	76 ft^2	0.175
MWS-L-4-17	4' x 17'	90 ft^2	0.206
MWS-L-4-19	4' x 19'	103 ft^2	0.237
MWS-L-4-21	4' x 21'	117 ft^2	0.268
MWS-L-8-8	8' x 8'	100 ft^2	0.230
MWS-L-8-12	8' x 12'	151 ft^2	0.346
MWS-L-8-16	8' x 16'	201 ft^2	0.462

Volume Based Sizing

Many states require treatment of a water quality volume and do not offer the option of flow based design. The MWS Linear and its unique horizontal flow makes it the only biofilter that can be used in volume based design installed downstream of ponds, detention basins, and underground storage systems.

Treatment Volume Sizing Table

Model #	Treatment Capacity (cu. ft.) @ 24-Hour Drain Down	Treatment Capacity (cu. ft.) @ 48-Hour Drain Down
MWS-L-4-4	1140	2280
MWS-L-4-6	1600	3200
MWS-L-4-8	2518	5036
MWS-L-4-13	3131	6261
MWS-L-4-15	3811	7623
MWS-L-4-17	4492	8984
MWS-L-4-19	5172	10345
MWS-L-4-21	5853	11706
MWS-L-8-8	5036	10072
MWS-L-8-12	7554	15109
MWS-L-8-16	10073	20145

Installation

The MWS Linear is simple, easy to install, and has a space efficient design that offers lower excavation and installation costs compared to traditional tree-box type systems. The structure of the system resembles pre-cast catch basin or utility vaults and is installed in a similar fashion.

The system is delivered fully assembled for quick installation. Generally, the structure can be unloaded and set in place in 15 minutes. Our experienced team of field technicians are available to supervise installations and provide technical support.

Maintenance

Reduce your maintenance costs, man hours, and materials with the MWS Linear. Unlike other biofiltration systems that provide no pre-treatment, the MWS Linear is a self-contained treatment train which incorporates simple and effective pre-treatment.

Maintenance requirements for the biofilter itself are almost completely eliminated, as the pre-treatment chamber removes and isolates trash, sediments, and hydrocarbons. What's left is the simple maintenance of an easily accessible pre-treatment chamber that can be cleaned by hand or with a standard vac truck. Only periodic replacement of low-cost media in the pre-filter cartridges is required for long term operation and there is absolutely no need to replace expensive biofiltration media.

Plant Selection

Abundant plants, trees, and grasses bring value and an aesthetic benefit to any urban setting, but those in the MWS Linear do even more - they increase pollutant removal. What's not seen, but very important, is that below grade the stormwater runoff/flow is being subjected to nature's secret weapon: a dynamic physical, chemical, and biological process working to break down and remove non-point source pollutants. The flow rate is controlled in the MWS Linear, giving the plants more "contact time" so that pollutants are more successfully decomposed, volatilized and incorporated into the biomass of The MWS Linear's micro/macro flora and fauna.

A wide range of plants are suitable for use in the MWS Linear, but selections vary by location and climate. View suitable plants by selecting the list relative to your project location's hardy zone.

Please visit **www.ModularWetlands.com/Plants** for more information and various plant lists.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

April 2014

GENERAL USE LEVEL DESIGNATION FOR BASIC, ENHANCED, AND PHOSPHORUS TREATMENT

For the

MWS-Linear Modular Wetland

Ecology's Decision:

Based on Modular Wetland Systems, Inc. application submissions, including the Technical Evaluation Report, dated April 1, 2014, Ecology hereby issues the following use level designation:

1. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Basic treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.
2. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Phosphorus treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.
3. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Enhanced treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.
4. Ecology approves monitoring for the MWS - Linear Modular Wetland Stormwater Treatment System units for Basic, Phosphorus, and Enhanced treatment at the hydraulic

loading rate listed above. Designers shall calculate the water quality design flow rates using the following procedures:

- Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.
- Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
- Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.

5. These use level designations have no expiration date but may be revoked or amended by Ecology, and are subject to the conditions specified below.

Ecology's Conditions of Use:

Applicants shall comply with the following conditions:

1. Design, assemble, install, operate, and maintain the MWS – Linear Modular Wetland Stormwater Treatment System units, in accordance with Modular Wetland Systems, Inc. applicable manuals and documents and the Ecology Decision.
2. Each site plan must undergo Modular Wetland Systems, Inc. review and approval before site installation. This ensures that site grading and slope are appropriate for use of a MWS – Linear Modular Wetland Stormwater Treatment System unit.
3. MWS – Linear Modular Wetland Stormwater Treatment System media shall conform to the specifications submitted to, and approved by, Ecology.
4. Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.

- Typically, Modular Wetland Systems, Inc. designs MWS - Linear Modular Wetland systems for a target prefilter media life of 6 to 12 months.
- Indications of the need for maintenance include effluent flow decreasing to below the design flow rate or decrease in treatment below required levels.
- Owners/operators must inspect MWS - Linear Modular Wetland systems for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to SWMMEW, the wet season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.

- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.
- When inspections are performed, the following findings typically serve as maintenance triggers:
  - Standing water remains in the vault between rain events, or
  - Bypass occurs during storms smaller than the design storm.
  - If excessive floatables (trash and debris) are present (but no standing water or excessive sedimentation), perform a minor maintenance consisting of gross solids removal, not prefilter media replacement.
  - Additional data collection will be used to create a correlation between pretreatment chamber sediment depth and pre-filter clogging (see *Issues to be Addressed by the Company* section below)

6. Discharges from the MWS - Linear Modular Wetland Stormwater Treatment System units shall not cause or contribute to water quality standards violations in receiving waters.

Applicant:	Modular Wetland Systems, Inc.
Applicant's Address:	*PO. Box 869* *Oceanside, CA 92054*

Application Documents:

- *Original Application for Conditional Use Level Designation*, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., January 2011
- *Quality Assurance Project Plan*: Modular Wetland system – Linear Treatment System performance Monitoring Project, draft, January 2011.
- *Revised Application for Conditional Use Level Designation*, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., May 2011
- *Memorandum: Modular Wetland System-Linear GULD Application Supplementary Data, April 2014*
- *Technical Evaluation Report: Modular Wetland System Stormwater Treatment System Performance Monitoring, April 2014.*

Applicant's Use Level Request:

General use level designation as a Basic, Enhanced, and Phosphorus treatment device in accordance with Ecology's Guidance for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE) January 2011 Revision.

Applicant's Performance Claims:

- The MWS – Linear Modular wetland is capable of removing a minimum of 80-percent of TSS from stormwater with influent concentrations between 100 and 200 mg/l.

- The MWS – Linear Modular wetland is capable of removing a minimum of 50-percent of Total Phosphorus from stormwater with influent concentrations between 0.1 and 0.5 mg/l.
- The MWS – Linear Modular wetland is capable of removing a minimum of 30-percent of dissolved Copper from stormwater with influent concentrations between 0.005 and 0.020 mg/l.
- The MWS – Linear Modular wetland is capable of removing a minimum of 60-percent of dissolved Zinc from stormwater with influent concentrations between 0.02 and 0.30 mg/l.

Ecology Recommendations:

- Modular Wetland Systems, Inc. has shown Ecology, through laboratory and field-testing, that the MWS - Linear Modular Wetland Stormwater Treatment System filter system is capable of attaining Ecology's Basic, Total phosphorus, and Enhanced treatment goals.

Findings of Fact:

<u>Laboratory Testing</u>

The MWS-Linear Modular wetland has the:

- Capability to remove 99 percent of total suspended solids (using Sil-Co-Sil 106) in a quarter-scale model with influent concentrations of 270 mg/L.
- Capability to remove 91 percent of total suspended solids (using Sil-Co-Sil 106) in laboratory conditions with influent concentrations of 84.6 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 93 percent of dissolved Copper in a quarter-scale model with influent concentrations of 0.757 mg/L.
- Capability to remove 79 percent of dissolved Copper in laboratory conditions with influent concentrations of 0.567 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 80.5-percent of dissolved Zinc in a quarter-scale model with influent concentrations of 0.95 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 78-percent of dissolved Zinc in laboratory conditions with influent concentrations of 0.75 mg/L at a flow rate of 3.0 gpm per square foot of media.

<u>Field Testing</u>

- Modular Wetland Systems, Inc. conducted monitoring of an MWS-Linear (Model # MWS-L-4-13) from April 2012 through May 2013, at a transportation maintenance facility in Portland, Oregon. The manufacturer collected flow-weighted composite samples of the system's influent and effluent during 28 separate storm events. The system treated approximately 75 percent of the runoff from 53.5 inches of rainfall during the monitoring period. The applicant sized the system at 1 gpm/sq ft. (wetland media) and 3gpm/sq ft. (prefilter).

- Influent TSS concentrations for qualifying sampled storm events ranged from 20 to 339 mg/L. Average TSS removal for influent concentrations greater than 100 mg/L (n=7) averaged 85 percent. For influent concentrations in the range of 20-100 mg/L (n=18), the upper 95 percent confidence interval about the mean effluent concentration was 12.8 mg/L.
- Total phosphorus removal for 17 events with influent TP concentrations in the range of 0.1 to 0.5 mg/L averaged 65 percent. A bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean total phosphorus reduction was 58 percent.
- The lower 95 percent confidence limit of the mean percent removal was 60.5 percent for dissolved zinc for influent concentrations in the range of 0.02 to 0.3 mg/L (n=11). The lower 95 percent confidence limit of the mean percent removal was 32.5 percent for dissolved copper for influent concentrations in the range of 0.005 to 0.02 mg/L (n=14) at flow rates up to 28 gpm (design flow rate 41 gpm). Laboratory test data augmented the data set, showing dissolved copper removal at the design flow rate of 41 gpm (93 percent reduction in influent dissolved copper of 0.757 mg/L).

Issues to be addressed by the Company:

1. Modular Wetland Systems, Inc. should collect maintenance and inspection data for the first year on all installations in the Northwest in order to assess standard maintenance requirements for various land uses in the region. Modular Wetland Systems, Inc. should use these data to establish required maintenance cycles.
2. Modular Wetland Systems, Inc. should collect pre-treatment chamber sediment depth data for the first year of operation for all installations in the Northwest. Modular Wetland Systems, Inc. will use these data to create a correlation between sediment depth and pre-filter clogging.

Technology Description:
Download at http://www.modularwetlands.com/

Contact Information:

Applicant: Greg Kent
Modular Wetland Systems, Inc.
P.O. Box 869
Oceanside, CA 92054
gkent@biocleanenvironmental.net

Applicant website: http://www.modularwetlands.com/

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

Revision History

Date	Revision
June 2011	Original use-level-designation document
September 2012	Revised dates for TER and expiration
January 2013	Modified Design Storm Description, added Revision Table, added maintenance discussion, modified format in accordance with Ecology standard
December 2013	Updated name of Applicant
April 2014	Approved GULD designation for Basic, Phosphorus, and Enhanced treatment

Project Name: LUMINA

ATTACHMENT 1e-1

Supporting Design Documentation

Including:

Street Tree Design and Justification Write Up
Imperviousness Assumptions for Proposed Conditions
Street Cross Sections
Green Streets Form J-1

ATTACHMENT 1e

DCV Reduction, Hydromod Attenuation, Street Tree Preliminary Design and Approach Write-up

Overview

Street trees are sited continuously throughout the entire site to enhance the public space and will be utilized to help meet stormwater requirements. To maximize the capture potential, a number of trees will be planted within structural soil wells, which will significantly increase the storage capacity and thus the ability to reduce the design capture volume (DVC). The tree wells will be unlined to allow for infiltration and help meet volume retention requirements, while the storage volumes available in the soil porosity will also provide flow attenuation in order to meet hydromodification control requirements as well.

It is expected that within the drainage areas where these will be implemented 100% of the DCV will be captured. The figure below depicts a typical drainage area to a street tree with a structural soil well (both shown in green). While the green dashed line representing the tributary area to the first street tree well does not cover the entire drainage area between itself and the next street tree, it is apparent that the canopy coverage and soil volumes of the remaining trees will be sufficient to account for the remaining drainage area within the margins.

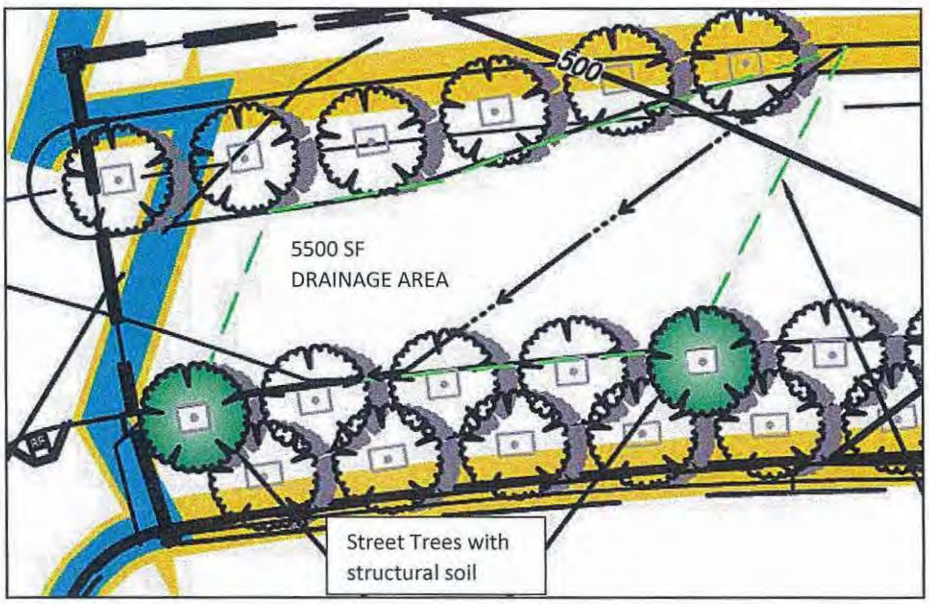


Figure 1 - Typical Street Tree with Structural Soil Showing Spacing and Drainage Area

Sizing

The street tree credit volume in the DCV calculation worksheet is based on Table B.2-2 (provided on the next page) from the City of San Diego BMP Design Manual. This is a conservative assumption as the table is based on 0.5 in rainfall depth, given that the 85th percentile storm at the project site is 0.46 in. Within the DCV Calculation Worksheet B.2-1, the DCV reductions have been determined by assuming that 100% of the expected DCV from street drainage areas that could be routed to the trees would be captured. These trees will take a majority of the drainage areas and a typical volume and spacing has been arrived at accordingly--with a little extra room to ensure the credit is not being overestimated.

Table B.2-2: Allowable Reduction in DCV

Tree Credit Volume (ft^3/tree)	Contributing Area (ft^2)	Soil Volume (ft^3)
10	267	33
50	1,333	167
100	2,667	333
150	4,000	500
200	5,333	667
300	8,000	1,000
400	10,667	1,333

While it is expected that the tree well design will be more thoroughly refined to account for different species, any significant variations in drainage areas, the landscape architecture of the site, and other concerns regarding constructability and efficiency in general, the figure on the previous page depicts a typical scenario.

Therefore, given a typical drainage area of approximately 5,500 square feet, and the knowledge that we want to provide the trees with at least 4 feet of depth for rich canopy growth, we are left with a necessary surface area of about 175 SF or about 13.25' x 13.25'. These dimensions can be fit within the available space between the curb and structures by utilizing the bearing capacity of structural soil to extend under the sidewalk. This is apparent by looking at the street cross sections found in Attachment 1e-3 which provides support for the various assumptions throughout this document.

DMA	Initial DCV (CF)	Tree Credit Volume (CF)	% of Initial DCV	# of Tree Wells	Soil Volume (CF)	Depth (ft)	Footprint (sf)
N1	41,600	4,750	11.4	25	17,500	4	175
S1	68,600	15,500	22.5	78	54,600	4	175

Table 2 – DCV credits and approximate soil volumes and dimensions.

As both the north and south basins will contain more than enough trees sited and proper space within the ROW to take all runoff received, we may attempt to route some downspouts into the soil volumes.

Volume Retention

Conclusion

The wide spread implementation of street trees on-site will be leveraged to help achieve volume retention, hydromodification control, and DCV reduction. This will be done primarily through structural soil tree wells, and these have been generally sized to ensure the credit taken at this point can easily be met, with the help of the expected canopy and soil volumes of standard trees to ensure all runoff can be captured. Future design submittals will further detail how this will be ensured to happen, but at this point we feel confident we are conservative in the credit that is being applied.

BMP Applicability and Selection for Green Street Exemption	Form J-1
Project Identification	
Project Name: Lumina	
Permit Application Number: 555609	Date: 8/15/2018
Project Characterization and Selection Synopsis	
The purpose of this form is to guide the selection of BMPs, given project specific constraints to meet the Green Streets exemption as defined in Appendix J.2 of the BMP Design Manual. In order to qualify for a PDP exemption, the project must incorporate all applicable Green Street BMP elements described in Appendix J.2, based on the applicability guidance provided in Appendix J.2. Complete the sections below providing detailed justification for each selection.	
Step 1: Does this project include retrofitting or redevelopment of an existing alley, street, or roadway criteria? Exemptions do not apply for projects that construct new alleys, streets, or roadways. See Appendix J for additional guidance on distinguishing between redevelopment of a street and new development. ☒ Yes ☐ No (if No is selected, the Green Street exemption is not applicable)	
Provide a brief overview of the project, key details, and site-specific opportunities and constraints: This project proposes development of mixed use area, medium and low density multi-family, public school facilities, recreation and open space land uses. The project may be responsible to widen existing streets such as Cactus Road and Airway Road, but since they are offsite, the interim street improvements are proposed to be dealt with as green-streets improvements.	
Step 2: Complete the BMP-specific applicability checklists on the following pages and attach them to this form. Complete forms for all BMPs, including those that were used and those that were not used.	
Step 3: Summarize the BMP(s) that were selected through the guidance process (Select all that apply):	

BMP Type	Applicable?	Used?	Summary of justification for Inclusion or Finding of Non-applicability
Vegetated Swales	☒	☐	Street trees (adjacent to project improvements) and swales (in offsite areas) have been chosen as the feature to be implemented based on the site constraints and the scale. The street design of Cactus Road north of Airway Road and Airway Road east of the site precludes the use of rain gardens, green gutters, curb extensions, or sidewalk planters from implementation. Permeable surfaces are not viable because of the poor infiltrating soils. Due to lack of available stormdrain, and the tight space constraints due to existing right-of-way widths, there are very limited opportunities for LID stormwater controls beyond street trees or swales.
Sidewalk Planters	☐	☐	
Curb Extensions	☐	☐	
Permeable Surfaces	☐	☐	
Green Gutters	☐	☐	
Rain Gardens	☐	☐	
Trees	☒	☐	
Other__________	☐	☐	

Form J-1 Page 2 of 8: Vegetated Swale			
Brief Description: Vegetated Swales are shallow, open channels that are designed to remove storm water pollutants by physically straining/filtering runoff through vegetation in the channel.			
Site Type (Check all that apply):	Street Type	Rating[12]	Present in Project?
	Residential Streets	◉	☐
	Commercial Street/ Business District	○	☐
	Collector Street	◉	☒
	Arterial and Boulevard	◉	☒
	Alleys	○	☐
	Parking Areas	◉	☐
Key Opportunities for Vegetated Swales (Check all that apply):	Parkway strips		☐
	Medians		☐
	Long, mostly continuous space		☒
	Other (must justify below)		☐
Site-Specific Factors (Check all that apply):	Favorable Conditions for Vegetated Swales		
	Slope > 1% and <3%		☐
	Conveying run-on to a site		☐
	Infiltration is partially feasible or not feasible		☒
	Long continuous segments available		☐
	More parkway width		☒
	Unfavorable Conditions for Vegetated Swales		
	Available width is < 8 feet		☐
	Frequent driveway interruption		☐
	ROW width too limited		☐
Summary of Findings:			
Were Vegetated Swales determined to be applicable as part of the Green Streets BMP plan? ☒ Yes ☐ No		If yes, were they used? ☒ Yes ☐ No	
Provide discussion/justifications for selections and decisions above: The street design of Cactus Road north of Airway Road and Airway Road at project site may be an opportunity for vegetated swales to be implemented.			

12 ● High applicability within this category, however may still be limited by site-specific factors

◉ Generally applicable in this category; largely dependent on site-specific factors

○ Limited applicability within this category; may still be applicable in some cases; should be considered

Form J-1 Page 3 of 8: Sidewalk Planters			
Brief Description: A planter imbedded in the sidewalk designed to manage storm water runoff from the adjacent roadway and sidewalk.			
Site Type (Check all that apply):	Street Type	Rating	Present in Project?
	Residential Streets	◉	☐
	Commercial Street/ Business District	◉	☐
	Collector Street	●	☒
	Arterial and Boulevard	●	☒
	Alleys	○	☐
	Parking Areas	◉	☐
Key Opportunities for Sidewalk Planters (Check all that apply):	Parkway strips		☐
	Medians		☐
	Between driveways		☐
	Other (must justify below)		☐
Site-Specific Factors (Check all that apply):	Favorable Conditions for Sidewalk Planters		
	Slope <4%		☐
	Wide sidewalks		☒
	More parkway width		☐
	Unfavorable Conditions for Sidewalk Planters		
	Conflicts with car egress		☐
	ROW width too limited		☐
Summary of Findings:			
Were Sidewalk Planters determined to be applicable as part of the Green Streets BMP plan? ☐ Yes ☒ No	If yes, were they used? ☐ Yes ☐ No		
Provide discussion/justifications for selections and decisions above: The project is not adjacent to the roadways proposed for green streets exemption, therefore, it is not feasible to implement full width improvements.			

Form J-1 Page 4 of 8: Curb Extensions			
Brief Description: Curb extensions expand the edge of the sidewalk into the roadway or parking area and allow storm water runoff to collect and infiltrate through a detention area of porous media.			
Site Type (Check all that apply):	Street Type	Rating	Present in Project?
	Residential Streets	●	☐
	Commercial Street/ Business District	●	☐
	Collector Street	◉	☒
	Arterial and Boulevard	◉	☒
	Alleys	○	☐
	Parking Areas	◉	☐
Key Opportunities for Curb Extensions (Check all that apply):	Intersections		☐
	Parking area		☐
	Other (must justify below)		☐
Site-Specific Factors (Check all that apply):	Favorable Conditions for Curb Extensions		
	Slope <4%		☐
	Traffic calming needed		☐
	Unfavorable Conditions for Curb Extensions		
	Conflicts with bike lanes		☐
	Site distance issues at intersection		☒
Summary of Findings:			
Were Curb Extensions determined to be applicable as part of the Green Streets BMP plan? ☐ Yes ☒ No	If yes, were they used? ☐ Yes ☐ No		
Provide discussion/justifications for selections and decisions above: Curb extensions can not be integrated with the street designs which are already set based on traffic design requirements.			

Form J-1 Page 5 of 8: Permeable Surfaces			
Brief Description: Permeable surfaces are pavement that allows for percolation through void spaces into subsurface layers.			
Site Type (Check all that apply):	Street Type	Rating	Present in Project?
	Residential Streets	●	☐
	Commercial Street/ Business District	●	☐
	Collector Street	◉	☒
	Arterial and Boulevard	◉	☒
	Alleys	●	☐
	Parking Areas	◉	☐
Key Opportunities for Permeable Surfaces (Check all that apply):	Sidewalks		☐
	Parking strips		☐
	Shoulders		☐
	Low traffic roadways		☐
	Other (must justify below)		☐
Site-Specific Factors (Check all that apply):	Favorable Conditions for Permeable Surfaces		
	Slope < 2-3%		☐
	Conveying limited run-on to a site		☐
	Low traffic area		☐
	Unfavorable Conditions for Permeable Surfaces		
	High traffic area		☒
	Run-on has high sediment load		☒
Summary of Findings:			
Were Permeable Surfaces determined to be applicable as part of the Green Streets BMP plan? ☐ Yes ☒ No		If yes, were they used? ☐ Yes ☒ No	
Provide discussion/justifications for selections and decisions above: Onsite soils are very low permeability.			

Form J-1 Page 6 of 8: Green Gutters			
Brief Description: Green Gutters are shallow and narrow strips of landscaping in a typical curb and gutter location with a lower elevation than the street gutter elevation to allow capture of storm water from the sidewalk and street.			
Site Type (Check all that apply):	Street Type	Rating	Present in Project?
	Residential Streets	○	☐
	Commercial Street/ Business District	◉	☐
	Collector Street	●	☒
	Arterial and Boulevard	●	☒
	Alleys	◉	☐
	Parking Areas	○	☐
Key Opportunities for Green Gutters (Check all that apply):	Parkway strips		☐
	Medians		☐
	Long, mostly continuous space		☒
	Other (must justify below)		☐
Site-Specific Factors (Check all that apply):	Favorable Conditions for Green Gutters		
	Slope > 1% and <3%		☐
	Conveying run-on to a site		☒
	Infiltration is partially feasible or not feasible		☒
	Long continuous segments available		☒
	Narrower spaces (as little as 2 to 3 feet)		☐
	Unfavorable Conditions for Green Gutters		
	Frequent driveway interruption		☐
	ROW width too limited		☐

Summary of Findings:

Were Green Gutters determined to be applicable as part of the Green Streets BMP plan? ☐ Yes ☒ No	If yes, were they used? ☐ Yes ☒ No

Provide discussion/justifications for selections and decisions above:

Green gutters can not be integrated with the street designs which are already set based on traffic design and planning needs and requirements.

Form J-1 Page 7 of 8: Rain Gardens			
Brief Description: Rain Gardens are shallow detention basins with vegetation that temporarily store water to allow for infiltration of the stored volume.			
Site Type (Check all that apply):	Street Type	Rating	Present in Project?
	Residential Streets	◉	☐
	Commercial Street/ Business District	◉	☐
	Collector Street	◉	☒
	Arterial and Boulevard	◉	☒
	Alleys	○	☐
	Parking Areas	●	☐
Key Opportunities for Rain Gardens (Check all that apply):	Irregularly shaped areas in ROW		☐
	Broad and flat areas		☒
	Other (must justify below)		☐
Site-Specific Factors (Check all that apply):	Favorable Conditions for Rain Gardens		
	Slope <2%		☒
	Infiltration is partially feasible or not feasible		☒
	Large area available		
	Unfavorable Conditions for Rain Gardens		
	Slope > 2%		☐
	ROW too limited		☐

Summary of Findings:

Were Rain Gardens determined to be applicable as part of the Green Streets BMP plan? ☐ Yes ☒ No	If yes, were they used? ☐ Yes ☒ No

Provide discussion/justifications for selections and decisions above:

The project is not adjacent to the roadways proposed for green streets exemption, therefore, it is not feasible to implement full width improvements.

Form J-1 Page 8 of 8: Trees			
Brief Description: Trees planted in the sidewalk right-of-way provide rainfall interception and infiltration benefits and typically supplements other storm water management tools.			
Site Type (Check all that apply):	Street Type	Rating[1]	Present in Project?
	Residential Streets	●	☐
	Commercial Street/ Business District	◉	☐
	Collector Street	◉	☒
	Arterial and Boulevard	◉	☒
	Alleys	◉	☐
	Parking Areas	●	☐
Key Opportunities for Trees (Check all that apply):	Parkway strips		☐
	Medians		☐
	Irregularly shaped areas		☐
	Extra ROW on back side of sidewalk		☒
	Other (must justify below)		☐
Site-Specific Factors (Check all that apply):	Favorable Conditions for Trees		
	Located outside of clear zone		☐
	Infiltration is feasible		☐
	ROW not limiting		
	Unfavorable Conditions for Trees		
	Limited space for root growth		☐
	Clear zone issues		☐

Summary of Findings:

Were Trees determined to be applicable as part of the Green Streets BMP plan? ☒ Yes ☐ No	If yes, were they used? ☒ Yes ☐ No

Provide discussion/justifications for selections and decisions above:

Street trees will fit in well in terms of architectural scale along wide Cactus Road adjacent to the project's frontage north of the intersection of Airway.

2

Project Name: LUMINA

ATTACHMENT 2
BACKUP FOR PDP HYDROMODIFICATION CONTROL MEASURES

This is the cover sheet for Attachment 2.

☐ Mark this box if this attachment is empty because the project is exempt from PDP hydromodification management requirements.

Project Name: LUMINA

Indicate which Items are Included:

Attachment Sequence	Contents	Checklist
Attachment 2a	Hydromodification Management Exhibit (Required)	☒ Included See Hydromodification Management Exhibit Checklist on the back of this Attachment cover sheet.
Attachment 2b	Management of Critical Coarse Sediment Yield Areas (WMAA Exhibit is required, additional analyses are optional) See Section 6.2 of the BMP Design Manual.	☒ Exhibit showing project drainage boundaries marked on WMAA Critical Coarse Sediment Yield Area Map (Required) Optional analyses for Critical Coarse Sediment Yield Area Determination ☐ 6.2.1 Verification of Geomorphic Landscape Units Onsite ☐ 6.2.2 Downstream Systems Sensitivity to Coarse Sediment ☒ 6.2.3 Optional Additional Analysis of Potential Critical Coarse Sediment Yield Areas Onsite
Attachment 2c	Geomorphic Assessment of Receiving Channels (Optional) See Section 6.3.4 of the BMP Design Manual.	☐ Not performed ☐ Included ☒ Submitted as separate stand-alone document
Attachment 2d	Flow Control Facility Design, including Structural BMP Drawdown Calculations and Overflow Design Summary (Required) See Chapter 6 and Appendix G of the BMP Design Manual	☐ Included ☒ Submitted as separate stand-alone document
Attachment 2e	Vector Control Plan (Required when structural BMPs will not drain in 96 hours)	☐ Included ☒ Not required because BMPs will drain in less than 96 hours

Project Name: LUMINA

ATTACHMENT 2a

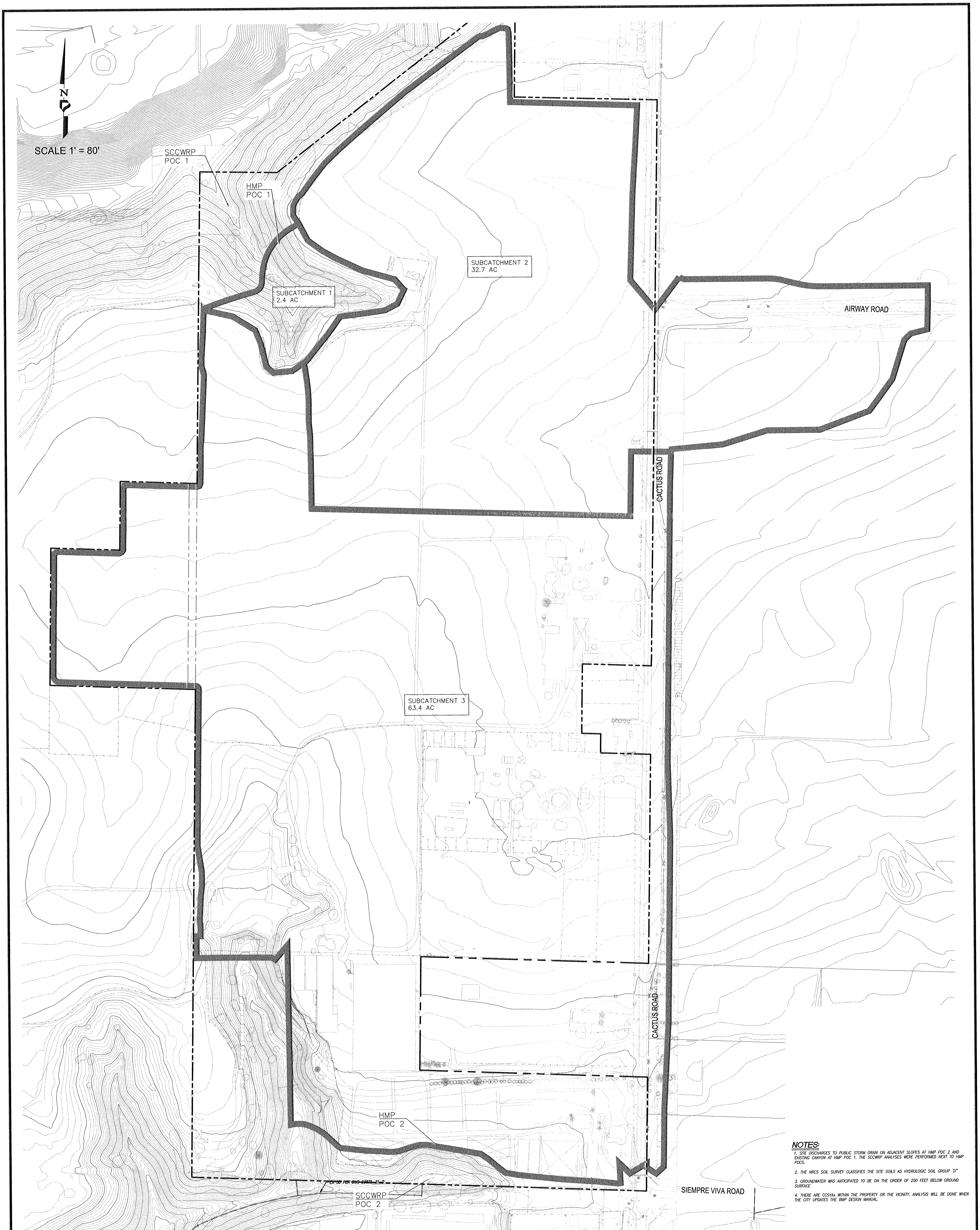
Hydromodification Exhibit

Project Name: LUMINA

Use this checklist to ensure the required information has been included on the Hydromodification Management Exhibit:

The Hydromodification Management Exhibit must identify:

☒ Underlying hydrologic soil group
☒ Approximate depth to groundwater
☒ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
☒ Critical coarse sediment yield areas to be protected
☒ Existing topography
☒ Existing and proposed site drainage network and connections to drainage offsite
☒ Proposed grading
☒ Proposed impervious features
☒ Proposed design features and surface treatments used to minimize imperviousness
☒ Point(s) of Compliance (POC) for Hydromodification Management
☒ Existing and proposed drainage boundary and drainage area to each POC (when necessary, create separate exhibits for pre-development and post-project conditions)
☒ Structural BMPs for hydromodification management (identify location, type of BMP, and size/detail)



NOTES:

1. SITE DISCHARGES TO PUBLIC STORM DRAIN ON ADJACENT SLOPES AT HMP POC 2 AND EXISTING CANYON AT HMP POC 1. THE SCCWRP ANALYSES WERE PERFORMED NEXT TO HMP POCS.

2. THE NRCS SOIL SURVEY CLASSIFIES THE SITE SOILS AS HYDROLOGIC SOIL GROUP 'D"

3. GROUNDWATER WAS ANTICIPATED TO BE ON THE ORDER OF 200 FEET BELOW GROUND SURFACE

4. THERE ARE CCSYAs WITHIN THE PROPERTY OR THE VICINITY. ANALYSIS WILL BE DONE WHEN THE CITY UPDATES THE BMP DESIGN MANUAL.

LEGEND

SUBCATCHMENT BOUNDARY

NOTE: SUPPLEMENTAL TOPOGRAPY IS 2-FT CONTOURS FROM SANGIS (1997, BEFORE SR 905 WAS BUILT)

SCALE: 1"=80'
JOB #: 2357.35
CREATED: 6/01/17

PREPARED BY:
PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey
701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

CITY OF SAN DIEGO

LUMINA-OTAY CANYON RANCH

HYDROMODIFICATION MAP
EXISTING CONDITIONS
EXHIBIT 2A

HMP NOTES:

1. HYDROMODIFICATION IMPACTS ARE MITIGATED IN TWO BASINS WITH ABOVE-GROUND AND BELOW-GROUND STORAGE.
2. REFER TO REPORT AND CALCULATIONS FOR DETAILED SUBCATCHMENT INFORMATION.

NOTE: SUPPLEMENTAL TOPOGRAPY IS 2-FT CONTOURS FROM SANGIS (1997, BEFORE SR 905 WAS BUILT)

SCALE: 1"=80'
JOB #: 2357.35
CREATED: 1/11/18

PREPARED BY:
PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey
701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

CITY OF SAN DIEGO
LUMINA
HYDROMODIFICATION EXHIBIT
PROPOSED CONDITIONS

Project Name: LUMINA

ATTACHMENT 2b

CCSYA Documentation

Preliminary PCCSYAs Study

LUMINA

Tentative Map
PTS #555609

City of San Diego, CA
August 16, 2018

Prepared for:
COLRICH
444 West Beech Street, Suite 300
San Diego, CA 92101

Prepared By:

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey
701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

Job # 2357.35

Under the supervision of

Debby Reece, PE RCE 56148
Registration Expires 12/31/18

SUMMARY

This technical memo summarizes the analysis f PCCSYAs for Lumina project. It is demonstrated that the Lumina project generates a No Net Impact in the Critical Coarse Sediment Yield (CCSY) for tributaries with 2 POCs. The methodology explained in Appendix H of the City of San Diego Storm Water Standards will be used to conclude that the Potential Critical Coarse Sediment Yield Areas (PCCSYAs) within the Lumina project are not significant (no-net-impact) and can be removed from CCSYA designation. Below are steps of CCSYAs identification and analyses in the City BMP Design Manual.

1: Identify CCSYAs

After examination of Regional Watershed Management Area Analysis PCCSYA maps provided in Appendix H.6. of City BMP Design Manual, it is determined that multiple slivers of CCSYAs fall within the Lumina project boundary.

2: Avoidance of Onsite CCSYAs (Storm Water Manual Appendix H.2)

Based on Appendix H.6 of City BMP Design Manual (Page H-17), the PCCSYAs may be removed from the CCSYA mapping without performing GLU analysis if the areas are under 10% slope or are paved.

As shown on the CCSYA exhibit, slivers of CCSYA areas are in steep slope areas, thus no CCSYA avoidance based on flat slopes with the pre-project conditions.

3: Bypass Onsite and Upstream CCSYAs (Storm Water Manual Appendix H.3)

Bypass CCSYAs from Hillslopes

The Lumina project cannot avoid the totality of the CCSYAs based on hillslope CCSYAs and De minimus upstream CCSYAs. Therefore, PCCSYAs draining to POC1 and POC2 are in fact CCSYAs, a no net impact analysis is needed for Lumina project.

4: No Net Impact (Storm Water Manual Appendix H.4)

This part of analysis is included to demonstrate that the post-project flows will comply with the no net impact requirements. For the purpose of demonstrating no net impact within the MS4-permited region of County of San Diego, Erosion Potential (Ep) is defined as the ratio of post-project/pre-development (natural) long-term transport capacity or work. Sediment Supply Potential (Sp) is defined as the ratio of post-project/pre-project (existing) long-term bed sediment supply. It is demonstrated that the NII management standard will be met with no net impact to the receiving waters:

$$NII = \frac{Ep}{Sp} \leq 1.1$$

4.1 Verification of Geomorphic Landscape Units (GLUs)

A site-specific GLU analysis is performed to demonstrate the original critical coarse sediment yield of the CCSYAs draining to POC1 and POC2. Appendix 3 shows the GIS results of the project site with a Geology Map. Note the

GLU nomenclature is presented in the following format: Geology-Land Cover-Slope Category (e.g., “CB-Agricultural/Grass-3” for a GLU consisting of coarse bedrock geology, agricultural/grass land cover, and 20% to 40% slope). See Appendix 1 for more detailed GLU analysis guidance from City BMP Manual. GLU types and areas can be seen in Table 1.

Table 1. GLU Units, Pre and Post-Development

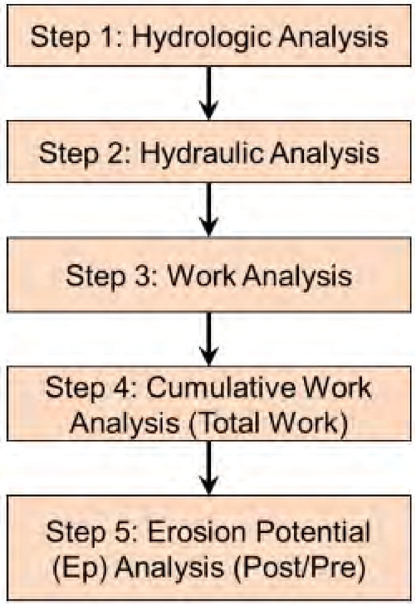
Pre-Developmet Conditions	
GLU	**Area (ft2)**
CSI-Agricultural/Grass-2	73236
CSI-Agricultural/Grass-3	20896
Post-Developmet Conditions	
GLU	**Area (ft2)**
CSI-Agricultural/Grass-2	0
CSI-Agricultural/Grass-3	0
CSI-Cut Slope (p=0.5)	0
CSI-Fill Slope (p=0.25)	72344

4.2 Ep Calculation

Ep is the work conveyed by a stream on its bed material to transport sediment. It is based on the shear stress experienced by the bed which is a function of the channel geometry, slope, and flow rates. To determine the erosion potential, an assessment will be necessary to characterize the channel in this manner, as well as the pre- and post-project flow rates and durations.

No Simplified Ep Method could be implemented in Lumina project since low flor threshold has been determined as 0.5Q2 for both POC1 and POC2 based on SWCCRP report provided by Wayne Chang (dated 06/01/2017). Pre- and post-project flow duration curves for No-Net Impact control are determined the same way that hydromodification flow duration curves are, i.e. through continuous simulation modeling. Once the channel characterization are determined, they will be used to develop a rating curve defining the shear stress at each flow rate (stage-stress curve).

Procedures in Appendix H, Section H.8.1.2 have been followed in this study to calculate Ep.



Step 1: PCSWMM has been used to simulate the hydrologic response of project site under predevelopment and post project conditions for a continuous period of record. Scale factor is 1 for this project as the area of watershed and portion of project are the same.

Step 2: Hydraulic parameters, such as stage, effective shear stress, and flow velocity, are computed for each designated flow bin using channel geometry and roughness data. Channel geometry and roughness data are based on data from Hydromodification Screening Report and added in Appendix 3 for reference.

Equation H.8-4: Effective Shear Stress

$$\tau = \gamma R S$$

Where:

- τ = Effective Shear Stress [lb/ft^2]
- γ = Unit Weight of Water [62.4 lb/ft^3]
- R= Hydraulic Radius [ft]
- S = Energy Gradient Assumed Equal to Longitudinal Slope [ft/ft].

Equation H.8-5: Manning's Equation

$$Q = \frac{1.49AR^{0.67}S^{0.5}}{n} \; or \; V = \frac{1.49R^{0.67}S^{0.5}}{n}$$

Where:

- Q = Peak Flowrate [cfs]
- V = Average Flow Velocity [ft/s]
- A = Cross-Section Flow Area [ft^2]
- R = Hydraulic Radius [ft] = A/P
- P = Wetted Perimeter [ft]
- S = Energy Gradient Assumed Equal to Longitudinal Slope [ft/ft]
- n = Manning Roughness [unit less]

Step 3: Work Analysis. Hydraulic results for each flow bin along with the critical bed/bank material strength parameters are input into a work or sediment transport function in order to produce a work or transport rating curve.

Equation H.8-6: Effective Work

$$W = (\tau - \tau_c)^{1.5} V$$

Where:

W = Work [dimensionless];

τ = Effective Shear Stress [lb/ft^2];

τ_c = Critical Shear Stress [lb/ft^2];

V = Mid-Channel Flow Velocity [ft/s]

Step 4: Cumulative Work Analysis. To calculate cumulative work, first multiply the work (from STEP 3) and duration associated with each flow bin (from STEP 1). Then, the total work is obtained by summing the cumulative for all flow bins (Qc to Q10 Equation H.8-7).

Equation H.8-7: Cumulative Work

$$W_t = \sum_{i=1}^{n} W_i \, \Delta t_i$$

Where:

W_t = Total Work [dimensionless]

W_i = Work per flow bin [dimensionless]

Δt = Duration per flow bin [hours]

n = number of flow bins

Step 5: Erosion Potential Analysis. Ep is calculated by simply dividing the total work of the post-project condition by that of the pre-development(natural) condition.

Equation H.8-8: Erosion Potential

$$E_p = W_{t,post} / W_{t,pre}$$

Where:

E_p = Erosion Potential [unitless]

$W_{t,post}$ = Total Work associated with the post-project condition [unitless]

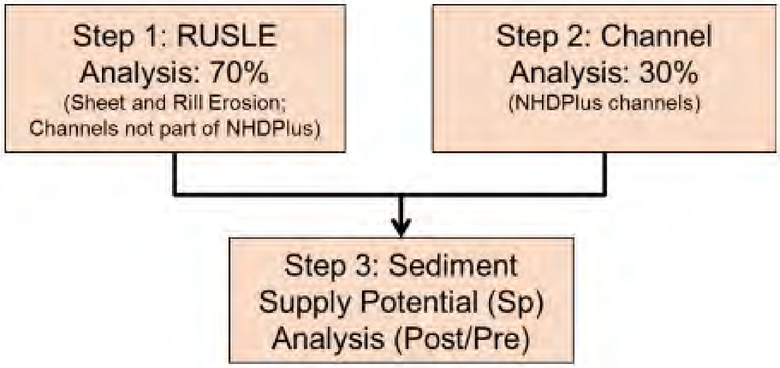
$W_{t,pre}$ = Total Work associated with the pre-development condition [unitless]

Detailed calculations have been included in Appendix 4. The overall Ep for POC 1 is 0.364, for POC 2 is 0.456.

4.3 Sp Calculation

Sediment Supply Potential (Sp) analysis is simplified to sediment production from hillslopes and channels. Sediment yield from hillslope processes can be estimated using the Revised Universal Soil Loss Equation (RUSLE) and a sediment delivery ratio. For channel processes, the best available regional datasets are the USGS National Hydrography Dataset (NHD) and the NHDPlus dataset from USEPA and USGS (http://www.horizon-systems.com/nhdplus/).

Procedures in Appendix H, Section H.8.2 have been followed in this study to calculate Sp.



Step 1: RUSLE analysis. RUSLE analysis is assumed to account for sediment yield from hillslope processes (sheet and rill erosion) and channels and gullies not part of the NHDPlus dataset.

Equation H.8-9: Sediment Yield (Hillslope)

$$SY_{HillSlope} = \frac{Post - Project \sum\{A \times K \times LS \times C\}}{Pre - Project \sum\{A \times K \times LS \times C\}}$$

Where:

A = Hillslope Area (acres)

K = Soil erodibility factor, this value can be obtained from regional K factor map from SWRCB or web soil survey or site-specific grain size analysis

LS = Slope length and steepness factor, this value can be obtained from the regional LS factor map from SWRCB or site-specific determination using look up tables based on slope and horizontal slope length from USDA Agriculture Handbook Number 703 (Renard et al., 1997) or other relevant sources

C= Cover management factor, use regional C factor map from USEPA or site-specific information; this is the reciprocal of the amount of surface cover on soil, whether it be vegetation, temporary mulch or other material. It is roughly the percentage of exposed soil, i.e., 95 percent cover yields a "C" value of 0.05. Use C=0 for areas where management actions are implemented (e.g. impervious areas) or where the project proposes any significant grading activities.

Step 2: Channel Analysis. As shown in the NHD Creek exhibit, there is no NHD+ mapped channels in the project range. Thus SYnhd= 1 for the calculations.

Equation H.8-10: Sediment Yield (NHD)

$$SY_{NHD} = \frac{L_{post}}{L_{pre}}$$

Where:

L_{post} = Length of NHDplus streams in the watershed contributing to bed sediment supply in the post-project condition [miles]

L_{pre} = Length of NHDplus streams in the watershed contributing to bed sediment supply in the pre-project existing condition [miles]

Step 3: Sediment Supply Potential Analysis. Sediment Supply Potential (Sp) is defined as the ratio of post-project/pre-project (existing) long-term bed sediment supply.

Equation H.8-11: Sediment Supply Potential

$$S_p = 0.7 \times SY_{RUSLE} + 0.3$$

Where:

S_p = Sediment Supply Potential [unitless]

$SY_{Hillslopes}$ = Change in bed sediment yield from hillslopes [unitless]

SY_{NHD} = Change in bed sediment yield from channels in NHDPlus dataset [unitless]

Detailed calculations have been included in Appendix 5. The overall Sp for POC 1 is 0.464, for POC 2 is 0.439.

4.4 Conclusions

Based on above calculations, Ep/Sp for POC 1 is 0.784; Ep/Sp for POC 2 is 1.039. Both are lower than threshold value of 1.1. No Net Impact is achieved for Lumina project with both Ep/Sp < 1.1. It is demonstrated that the proposed HMP BMPs provided for both north portion and south portion of Lumina Project are sufficient to meet the No Net Impact Criteria.

APPENDICES

Appendix 1

CCSYA Guidance from the City BMP Design Manual

Regional WMAA CCSYA Quantitative Analysis

Appendix 2

WMAA Map

Appendix 3

Pre and Post-Development GLU Areas

NHD-Plus Channel Map

Fill and Cut Map

Slope Map

Appendix 4

Ep Calculations

Appendix 5

Sp Calculations

Summary of Results

APPENDIX 1

CCSYA Guidance from the City BMP Design Manual

Regional WMAA CCSYA Quantitative Analysis

Appendix H

Guidance for Investigating Potential Critical Coarse Sediment Yield Areas

The following guidance provides methodologies for protecting CCSYAs:

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H.1 Step 1: Identify CCSYAs

A CCSYA is an active or potential source of bed sediment to downstream channel reaches. When a Priority Development Project (PDP) is constructed, it has the potential to negatively impact characteristics of sediment supply and delivery. In order to prevent these impacts, PDP applicants must examine the tributaries identified in their storm water management plans and identify sources of critical coarse sediment within the following areas:

- Onsite CCSYAs: CCSYAs identified within the project's property boundary as indicated in the SWQMP. Refer to **Section 1.3** for defining a project.
- Upstream CCSYAs: CCSYAs identified within the drainage area draining through the project's property boundary as indicated in the SWQMP. Refer to **Section 1.3** for defining a project.

Applicants must first identify potential critical coarse sediment yield areas (PCCSYAs) per any one of the methods presented in **Section H.1.1**. Once these PCCSYAs are identified, applicants may either accept the PCCSYA mapping as final, or may elect to further refine the results of the mapping through consideration of the refinement methods outlined in **Appendix H.1.2**. At the end of Step 1, applicants will have identified CCSYAs that must be avoided and bypassed by the project.

H.1.1 Identification Methods

Applicants must identify onsite and/or upstream sources of critical coarse sediment through examination of the Regional Watershed Management Area Analysis PCCSYA maps provided in **Appendix H.6**.

H.1.2 Refinement Options

After identifying PCCSYAs using the method above, the applicant may either accept the PCCSYA mapping as final, or may elect to further refine the results of the mapping through consideration of one or more of the refinement methods outlined below.

H.1.2.1 Depositional Analysis

Areas identified as PCCSYAs may be removed from consideration if it is demonstrated that these sources are deposited into existing systems prior to reaching the first downstream unlined water of the state. Systems resulting in deposition may include existing natural sinks, existing structural BMPs, existing hardened MS4 systems, or other existing similar features that produce a peak velocity from the discrete 2-year, 24-hour runoff event of less than three feet per second in the system being analyzed. Applicants electing to perform depositional analysis to refine PCCSYA mapping must refer to the detailed guidance provided in **Appendix H.7.1**.

H.1.2.2 Threshold Channel Analysis

Areas identified as PCCSYAs may be removed from consideration if they discharge to a "threshold channel" that does not exhibit characteristics associated with significant bed load movement during design flows. Applicants electing to perform threshold channel analysis to refine PCCSYA mapping must refer to the detailed guidance provided in **Appendix H.7.2**.

H.1.2.3 Coarse Sediment Source Area Verification

Areas identified as PCCSYAs may be removed from consideration if an applicant demonstrates that these areas actually consist of fine grained sediment. Applicants electing to perform coarse sediment source area verification to refine PCCSYA mapping must refer to the detailed guidance provided in **Appendix H.7.3**.

H.1.2.4 Verification of Geomorphic Landscape Units (GLUs)

Areas identified as PCCSYAs may be refined through verification of GLUs. If this method is used, applicants must refer to detailed guidance provided in **Appendix H.6.1**.

H.2 Step 2: Avoidance of Onsite CCSYAs

A key element of preserving the stability of receiving waters is to avoid changes in bed sediment supply by avoiding development on CCSYAs. Avoidance is best achieved through proper site design. The following are some potential strategies that should be considered while determining the site layout to avoid CCSYAs:

- The civil engineer shall designate onsite CCSYAs that are to be avoided (undisturbed) for the purpose of preserving coarse soil supply. When feasible, use and/or access restriction should be established for these areas.
- Minimize new impervious footprint. Refer to **Chapter 4** for guidance on minimizing impervious footprint.

If onsite CCSYAs are not avoided per the metrics defined below, the applicant must demonstrate no net impact to the receiving water using guidance in **Appendix H.4**.

H.2.1 Avoidance Metrics

If the applicant has identified onsite CCSYAs using the Regional Watershed Management Area Analysis PCCSYA maps provided in **Appendix H.6**, encroachments of up to 5% into the onsite CCSYAs may be permitted.

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H.3 Step 3: Bypass Onsite and Upstream CCSYAs

Another key element of preserving the stability of receiving waters is to maintain current bed sediment supply characteristics through effective bypass of onsite and upstream sediment sources. Upstream bed sediment sources may include overland flow from CCSYAs and/or concentrated channel flows. Applicants must ensure both onsite and upstream sources of bed sediment are effectively bypassed through their project. If onsite and/or upstream CCSYAs are not effectively bypassed per the criteria below, applicant must demonstrate no net impact to the receiving water per the guidance presented in **Appendix H.4**.

H.3.1 Bypass CCSYAs from Hillslopes

Both onsite and upstream hillslopes mapped as CCSYAs must be effectively bypassed through and/or around the proposed project site.

- Proposed hardened drainage systems (e.g. storm drains, drainage ditches) that convey the bed sediment from the hillslopes to the downstream waters of the state should maintain a peak velocity from the discrete 2-year, 24-hour runoff event greater than three feet per second.
    - When drainage ditches are proposed for bypass, this velocity may be achieved by designing to the minimum dimensions listed in the San Diego Regional Standard drawing D-75.
    - When an 18" concrete storm drain is proposed for bypass, this velocity may typically be achieved by maintaining a storm drain slope of ≥0.5%. In instances where 2-year, 24-hour peak flow rates associated with the storm drain are less than 1.1 cfs, applicants may refer to the table below for minimum slopes needed to maintain three feet per second. Applicants may interpolate the values from the table below, or may elect to perform more detailed cleansing velocity calculations presented in **Appendix H.7.1**.

2-Year, 24-Hour Peak Flow (cfs)	Minimum Slope for 18" Concrete Storm Drain
<0.25	n/a, this PCCSYA is considered de-minimis
0.25	2.0%
0.50	1.0%
1.10	0.5%

- Storm water runoff that contains the bed sediment from CCSYAs must not be routed through detention basins or other facilities with restricted outlets that will trap sediment. Bypass systems shall be designed as necessary so that the bed material is conveyed to the downstream receiving water. Structural BMPs (including most flow-thru BMPs) are likely to trap sediment.
- For scenarios where a BMP must be constructed to treat offsite drainage area and there are CCSYAs outside of the project footprint, it may be feasible to achieve mitigation by

construction of an outlet structure that can convey the bed load to the downstream receiving water and clear water through a bypass structure to a BMP.

- Proposed crossings (culverts, driveways, etc.) should not impede the transport of upstream critical coarse sediment. Crossings should be designed to avoid headwater conditions that would result in the trapping/settling of sediment.

H.3.2 Bypass CCSYAs from Channels

Projects that effectively avoid and bypass CCSYAs mapped in Step 1 (**i.e., Appendix H.1**) of this guidance are not required to take specific action to ensure bypass of channel flows. This guidance does not set forth channel bypass criteria for this scenario because it recognizes that existing regulator mechanisms (such as 401 certifications, site design requirements, etc.) are generally sufficient to preserve the sediment transport functions of onsite channels.

However, projects that do not effectively avoid and bypass the CCSYAs mapped in Step 1 (**i.e., Appendix H.1**), will be required to specifically account for bypass of channel flows as part of the demonstration of no net impact outlined in **Appendix H.4**.

H.3.3 De Minimis Upstream CCSYA

Applicants have an option to exclude de minimis upstream CCSYAs. De minimis upstream CCSYAs consist of coarse hillslope areas that are not significant contributors of bed sediment yield due to their small size, and are considered by the owner and the City Engineer as not practicable to bypass to the downstream waters of the state. In limited scenarios where all of the criteria below are satisfied, de minimis upstream CCSYAs may be omitted from consideration.

- De minimis upstream CCSYA is not disturbed through the proposed project activities.
- De minimis upstream CCSYA is not part of an upstream drainage contributing more than 0.31 total acres to the project site.
- Multiple de minimis upstream CCSYAs cannot be adjacent to each other and hydraulically connected.
- The SWQMP must document the reason why each de minimis upstream CCSYA could not be bypassed to the downstream waters of the state.

The 0.31-acre (13,500 square feet) de minimis threshold was established using 0.25 cfs as the cut off peak flow for the 2-year, 24-hour event, rational method equation and the following assumptions:

- C = 0.225 (average runoff coefficient (C) for soil type A and B);
- Average 6-hour, 2-year storm depth = 1.5 inches;
- Time of concentration = 6 minutes; and
- 2-year peak intensity = 3.51 in/hr. (based on procedures from the County Hydrology Manual).

The strategies for sediment bypass do not mitigate for the reduction of CCSYA that have been replaced by development onsite but can only mitigate scenarios where development hinders movement of bed sediment through the project footprint. When preservation of existing channels and/or implementation of sediment bypass measures is not feasible and/or not implemented, the applicant must demonstrate no net impact to the receiving water via the guidance presented in **Appendix H.4**.

H.4 Step 4: Demonstrate No Net Impact

When impacts to CCSYAs cannot be avoided or effectively bypassed, the applicant must demonstrate that their project generates no net impact to the receiving water per the performance metrics identified herein.

- **Appendix H.4.1** provides background on the state of the current science for predicting hydromodification impacts due to reductions in sediment supply;
- **Appendix H.4.2** defines the management standard that will be the basis for evaluating whether "no net impact to the receiving water" is achieved;
- **Appendix H.4.3** identifies the type of mitigation measures (i.e., additional flow control, and applicant proposed mitigation measures) that can be used to meet the management standard;
- **Appendix H.8** provides the methodology for calculation of Erosion Potential (Ep) and Sediment Supply Potential (Sp); and
- **Appendix H.9** provides fact sheets for implementation of the mitigation measures.

H.4.1 Background

Channel form, by definition, is composed of bed and bank material as well as channel geometry (in plan, cross-section, and profile); however, the dominant forces typically controlling channel form are discharge and sediment supply (notably bed material) since a stream's most basic function is to convey water and sediment (Knighton, 1998). The interaction between form and function is qualitatively described through Lane's relationship in Equation H.4-1:

Equation H.4-1: Lane's Relationship

$$Q_s \times d \propto Q_w \times S$$

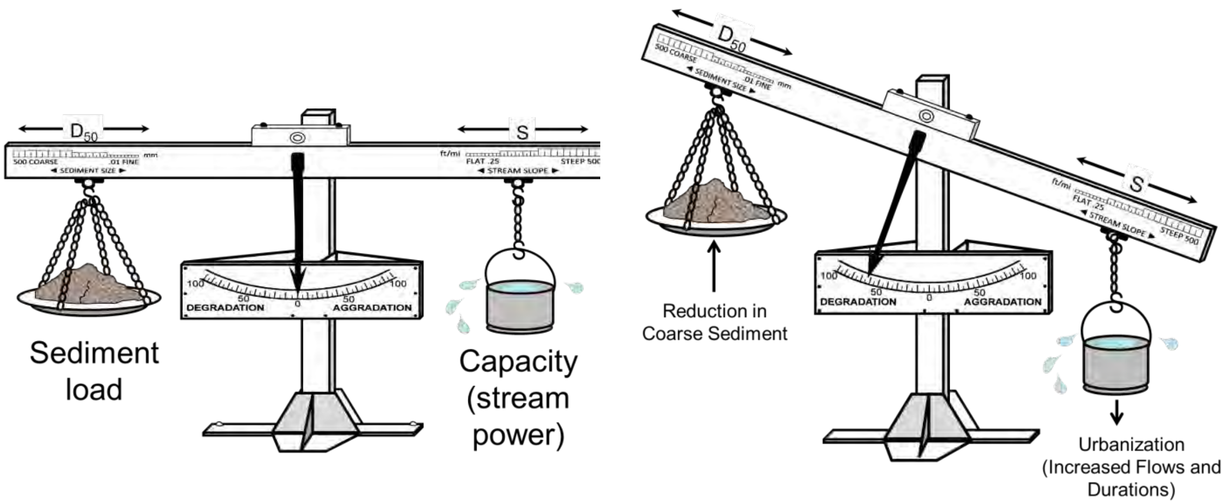
Where
Q_s = Sediment discharge
d = Particle diameter or size of sediment
Q_w = Streamflow
S = Stream slope

Lane's relationship qualitatively states that the sediment load (size and volume of sediment), which is the first half of the relationship, is proportional to the stream power (volume of runoff and slope) which is represented by the second half of the relationship. The sediment discharge (Q_s) in the relationship is the coarser part of sediment load, referred to as the "bed sediment", since this is the part of the load which largely molds the bed formation (Lane, 1955). Lane's relationship (Equation H.4.1) cannot be used for quantitative calculations since the proportionality is not necessarily linear.

For a stream at equilibrium, Lane's relationship states that if one of the variables changes and the other variables do not change proportionately, then the stream channel is no longer in equilibrium.

Sediment load and stream power can change considerably during and following new development, leading to changes in the equilibrium state of the receiving channel.

- Typically, sediment load increases during the construction period, due to the additional exposure of bare soil during the grading and construction process, and before landscaping vegetation has stabilized the soil. This is regulated through the construction-phase BMP requirements established by the Construction General Permit and/or the MS4 Permit.
- Following the construction period, sediment load typically decreases to below pre-development levels, as less sediment is available from areas that have been paved or stabilized by landscape vegetation. When this decrease is not regulated, the bed sediment supplied to the stream (first half of the relationship) is reduced and the sediment transport capacity (stream power) is increased due to increased flows and durations resulting from the addition of impervious areas (second half of the relationship). This may result in degradation of the stream system as illustrated in Figure H.4-1.



Stream in equilibrium

Post-construction condition with no flow control and/or sediment supply regulations

Schematics credit: SCCWRP

Figure H.4-1: Illustration of Lane's Relationship

Lane's relationship is useful for making qualitative predictions concerning channel impacts due to changes in runoff and/or sediment loads from the watershed. Although this qualitative assessment is useful for understanding how the watershed responds to development, quantitative predictions are valuable for determining the magnitude of response and they can inform the identification of locations where the greatest management attention should be invested.

Lane's relationship can be supplemented by the use of quantitative predictions which allow the evaluation of the stream under changing conditions. Quantitative predictions will include bed sediment supply calculations for the first half of the Lane relationship, and bed sediment transport capacity calculations for the second half of the Lane relationship. Imbalances between the bed sediment supply rate and transport capacity determines the rate of sediment deposition or erosion in the channel and the associated channel change (Wilcock et al., 2009).

The common practice is to use the Erosion Potential (Ep) metric to evaluate the changes in sediment transport capacity and the Sediment Supply Potential (Sp) metric to evaluate the changes in bed sediment supply for susceptible receiving channels of concern. In regards to Ep metric,

- SCCWRP Technical Report 667 (SCCWRP, 2012) states:

  "The underlying premise of the erosion potential approach advances the concept of flow duration control by addressing in-stream processes related to sediment transport. An erosion potential calculation combines flow parameters with stream geometry to assess long term (decadal) changes in the sediment transport capacity. The cumulative distribution of shear stress, specific stream power and sediment transport capacity across the entire range of relevant flows can be calculated and expressed using an erosion potential metric, Ep."

- SCCWRP Technical Report 753 (SCCWRP, 2013) states the following based on review of field measurements from 61 sites in Southern California:

  "Results indicate that channel enlargement is highly dependent on the ratio of post- to pre-urban sediment-transport capacity over cumulative duration simulations of 25 years (load ratio, a.k.a. erosion potential), which explained nearly 60% of the variance."

For the purposes of implementing mitigation measures within the MS4-permitted region of the County of San Diego: this manual defines Ep as the ratio of post-project/pre-development (natural) long-term transport capacity or work; and Sp as the ratio of post-project/pre-project (existing) long-term bed sediment supply. Guidance for calculating Ep and Sp are provided in **Appendix H.8**.

H.4.2 Management Standard

This guidance defines a sediment supply management standard through which no net impact to receiving water can be quantitatively indicated. This management standard is demonstrated through the Net Impact Index (NII), a dimensionless index that must be used by the applicant to evaluate if there is, or is not, a net impact to the receiving water. NII is defined in this manual as the ratio of Ep to Sp. Mitigation measures shall be designed to meet the NII management standard shown in Equation H.4-2 to achieve no net impact to the receiving water. The NII management standard is based on Lane's relationship (Ep is directly proportional to Sp) and an allowance of 10% (based on **Appendix H.4.2.1**). This represents the most appropriate current understanding of how to quantitatively account for sediment supply changes without replacing bed sediment sources (Palhegyi and Rathfelder, 2007 and Parra, 2015).

Equation H.4-2: Net Impact Index

$$NII = \frac{Ep}{Sp} \leq 1.1$$

Where

NII = Net Impact Index

E_p = Erosion Potential

S_p = Sediment Supply Potential

If NII ≤ 1.1, then the project produces no net impact to the receiving water in terms of coarse sediment yield, and no further analysis is required. If NII > 1.1, then the project generates an impact on the receiving water and the project is required to implement mitigation measures defined in **Appendix H.4.3** such that the NII is reduced to a compliant value (NII ≤ 1.1).

H.4.2.1 Allowance to the NII Management Standard

This manual establishes the NII defined in **Appendix H.4.2** as the management standard for coarse sediment supply. The 10% allowance to the management standard is supported by the following research studies or projects:

- The authors of the USACE report for channel design (USACE, 2001) state that, "achieving an optimum Capacity-Supply Ratio, within 10 percent of unity, should ensure dynamic stability while allowing the river itself to recover some of the fluvial detail that cannot be engineered."
- The authors of SCCWRP Technical Report 605 (SCCWRP, 2010), "anticipate that changes of less than 10% in either driver [discharge or sediment flux] are unlikely to instigate, on their own, significant channel changes. This value is a conservative estimate of the year-to-year variability in either discharge or sediment flux that can be accommodated by a channel system in a state of dynamic equilibrium."
- Sediment transport and supply measurements and calculations are inherently inexact. Discrepancies of up to 10% should not be a source of concern (PCR et al., 2002).

H.4.3 Types of Mitigation Measures

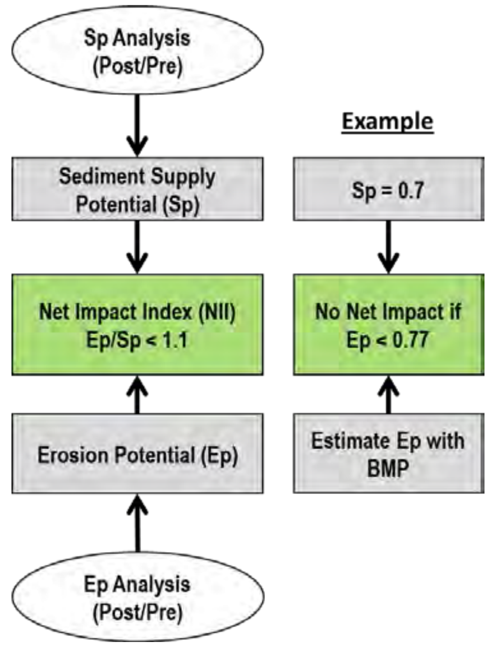
The following section discusses mitigation measures that may be used by the applicant to meet the NII management standard defined in **Appendix H.4.2**. These include:

- Additional Flow Control;
- Stream Rehabilitation; and
- Applicant Proposed Mitigation Measures

Appendix H.9 provides additional guidance for implementation of these mitigation measures.

H.4.3.1 Additional Flow Control

One option for managing bed sediment supply reductions is to provide additional detention and retention of site runoff to compensate for the reduction of bed sediment supply. This measure requires increasing flow attenuation by adding storage volume in structural BMPs. This management option accounts for changes in hydrology, channel geometry, and bed/bank material, but not sediment supply. For example, if there is a 30% reduction in bed-load due to proposed urbanization, then the sediment supply potential (Sp) equals 0.7. Assuming the appropriate range is +10%, hydromodification controls can be sized and situated such that the post-project effective in-stream work is lowered to less than 77% of the baseline pre-development condition.



Structural BMPs designed for hydromodification control utilize the following two basic principles:

- Detain runoff and release it in a controlled way that either mimics pre-development in-stream sediment transport capacity, mimics flow durations, or reduces flow durations to account for a reduction in bed sediment supply.
- Manage excess runoff volumes through one or more of the following pathways: (1) infiltration; (2) evapotranspiration; (3) storage and use; (4) discharge at a rate below the critical low flowrate; or (5) discharge downstream to a receiving water that is not susceptible to hydromodification impacts.

If desired, structural BMPs can be designed to support flood control and LID objectives in addition to hydromodification control. To the maximum extent possible, structural BMPs should be designed to receive flows from developed areas only. This facilitates design optimization as well as avoiding intercepting coarse sediments from open spaces that should ideally be passed through to the stream channel.

A fact sheet for additional flow control is provided in **Appendix H.9.1**.

H.4.3.2 Stream Rehabilitation

Hydromodification control can be achieved by stream rehabilitation projects including: drop structures, grade control structures, bed and bank reinforcement, increased channel sinuosity or meandering, increased channel width, and flow diversion. The objective of these in-stream controls, or stream restoration measures, is to reduce or maintain the overall Erosion Potential (Ep) of the receiving channel by modifying its hydraulic properties and/or bed/bank material resistance without fully replacing sediment supply or controlling increases in runoff. Stream rehabilitation is only an option where the receiving channel of concern is already impacted by erosive flows and shows evidence of excessive sediment, erosion, deposition, or is a hardened channel.

Stream rehabilitation projects are subject to the permitting requirements of the resource agencies. Stream rehabilitation projects may require the following permits:

- California Department of Fish and Wildlife – 1602 Streambed Alteration Agreement.
- US Fish and Wildlife Service – Authorization under the Endangered Species Act.
- US Army Corps of Engineers – Clean Water Act Section 404 Permit.
- Regional Water Quality Control Board – Clean Water Act Section 401 Water Quality Certification.
- Local Grading Permit

A fact sheet for stream rehabilitation is provided in **Appendix H.9.2**.

H.4.3.3 Applicant Proposed Mitigation Measures

The applicant may propose a mitigation measure not identified in this manual if it will achieve no net impact to the receiving water. Additional analysis may be requested by the City Engineer prior to approval of the mitigation measure to substantiate the finding of no net impact to the receiving water.

H.5 References

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H.5.1 Terms of Reference

The guidance described in **Appendix H** of this manual was developed by Geosyntec Consultants (Geosyntec) on behalf of the County of San Diego and the City of San Diego. **Appendix H** was specifically developed to provide PDP applicants guidance to meet the MS4 Permit Provision E.3.c.(2)(b) within the MS4-permitted region within the San Diego County. This guidance is not intended to be used for purposes, other than to meet this MS4 Permit requirement.

The guidance was developed with input from a Technical Advisory Committee (TAC) members through a series of meetings conducted in January 2016. The TAC input resulted in a streamlined guidance enhanced to provide applicants with simplified methods to determine impacts to coarse sediment delivery based on complex scientific principles. TAC participants included:

Bill Woolsey | Brian Haines | Charles Mohrlock | Chris Wolff | Dave Hammar | David Garcia | Emir Williams | Eric Mosolgo | Eric Stein | Erica Ryan | Howard Chang | Jon VanRhyn | Jonard Talamayan| Judd Goodman| Ken Susilo| Laura Henry| Luis Parra| Max Dugan | Rich Lucera | Sheri McPherson | Sumer Hasenin | Trevor Alsop | Venkat Gummadi | Wayne Chiu |

H.6 PCCSYAs: Regional WMAA Maps

PCCSYAs identified by the Regional WMAA were delineated using regional datasets for elevation, land cover, and geology. The methodology used to identify PCCSYAs from these datasets is based on Geomorphic Landscape Unit (GLU) methodology presented in the SCCWRP Technical Report 605. GLUs characterize the magnitude of sediment production from areas through three factors judged to exert the greatest influence on the variability on sediment-production rates: geology types, hillslope gradient, and land cover. The Regional WMAA document and the GIS layers for the map can be found on the Project Clean Water website at the following address:

http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=248&Itemid=219

The regional-level mapping is based on the following sources:

Dataset	Source	Year	Description
Elevation	USGS	2013	1/3rd Arc Second (~10 meter cells) digital elevation model for San Diego County
Land Cover	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
Geology	Kennedy, M.P., and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale.
	Kennedy, M.P., and Tan, S.S.	2008	Geologic Map of the San Diego 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 3, 1:100,000 scale.
	Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Areal Mapping Project, Open File Report 2004-1361, 1:100,000 scale.
	Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale

The regional data set is a function of the inherent data resolution of the macro-level data sets and may not conform to all site conditions, or does not reflect changes to particular areas that have occurred since the underlying data was developed. This means slopes, geology, or land cover at the project site can be mischaracterized in the regional data set. If an applicant feels the Regional WMAA analysis inaccurately mapped their project area, they may elect to perform a site-specific GLU analysis based on data collected from project-level investigations to refine the mapping as outlined below.

The following PCCSYAs may be removed from the mapping without performing the full GLU analysis described in Appendix H.6.1 a) areas under 10% slope, b) paved areas.

H.6.1 Site-Specific GLU Analysis

In order to perform a site-specific GLU analysis the applicant must first delineate the project boundary and any areas draining through the project boundary. The applicant must then determine appropriate slopes, geology, and land cover categories for this area as identified below.

There are four slope categories in the GLU analysis. Category numbers shown (1 to 4) were assigned for the purpose of GIS processing.

- 0% to 10% (1)
- 10% to 20% (2)
- 20% to 40% (3)
- >40% (4)

There are seven geology categories in the GLU analysis:

- Coarse bedrock (CB)
- Coarse sedimentary impermeable (CSI)
- Coarse sedimentary permeable (CSP)
- Fine bedrock (FB)
- Fine sedimentary impermeable (FSI)
- Fine sedimentary permeable (FSP)
- Other (O)

There are six land cover categories in the GLU analysis:

- Agriculture/grass
- Forest
- Developed
- Scrub/shrub
- Other
- Unknown

Project site slopes shall be classified into the categories based on project-level topography. Project site geology may be determined from geologic maps (may be the same as regional-level information) or classified in the field by a qualified geologist. Table H.6-1 provides information to classify geologic map units into each geology category. Project site land cover shall be determined from aerial photography and/or field visit. For reference, Table H.6-2 provides information to classify land cover categories from the SanGIS Ecology-Vegetation data set into land cover categories. The civil engineer shall not rely on the SanGIS Ecology-Vegetation data set to identify actual land cover at the project site (for project-level investigation land cover must be confirmed by aerial photo or field visit). Intersect the geologic categories, land cover categories, and slope categories within the project boundary to create GLUs. The GLUs listed in Table H.6-3 are considered to be PCCSYAs. Note the GLU nomenclature is presented in the following format: Geology – Land Cover – Slope Category (e.g., "CB-Agricultural/Grass-3" for a GLU consisting of coarse bedrock geology, agricultural/grass land cover, and 20% to 40% slope).

GLUs are created by intersecting the geologic categories, land cover categories, and slope categories. This is a similar procedure to intersecting land uses with soil types to determine runoff coefficients or runoff curve numbers for hydrologic studies, but there are three categories to consider for the GLU analysis (slope, geology, and land cover), and the GLUs are not to be composited into a single GLU. When GLUs have been created, determine whether any of the GLUs listed in Table H.6-3 are found within the project boundary. The GLUs listed in Table H.6-3 are considered to be PCCSYAs.

If none of the GLUs listed in Table H.6-3 are present within the project boundary and area draining through the project boundary, no measures for protection of critical coarse sediment yield areas are necessary. If one or more GLUs listed in Table H.6-3 are present within the project boundary, they shall be considered critical coarse sediment yield areas. Complete Worksheet H.6-1 to document verification of GLUs.

Table H.6-1: Geologic Grouping for Different Map Units

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
gr-m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
grMz	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Jcr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jhc	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jsp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ka	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kdl	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgbf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgdf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgh	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm1	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm2	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm3	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm4	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgu	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Khg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ki	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kis	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
Kjd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJem	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJld	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kjv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klb	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klh	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Km	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmgp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpa	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kqbd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kt	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kvc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwsr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Mzd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzq	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzs	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
sch	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Kp	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ql	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
QTf	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ec	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
K	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
Kccg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kcs	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kl	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ku	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
Qvof	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tp	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tpm	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
Tsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tscu	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsd	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdcg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsm	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tso	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tst	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tt	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tta	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmv	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsi	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa11	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa12	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa13	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoc	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop1	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop12	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop13	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop2	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop3	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop4	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop5	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop6	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
Tsa	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qof	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Q	Jennings; CA	Coarse	Sedimentary	Permeable	CSP
Qa	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qd	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qmb	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qw	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qt	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa1-2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa2-6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa5	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa7	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoc	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qc	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qu	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop2-4	San Diego 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop3	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop4	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop6	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qya	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyc	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Mzu	San Diego & Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
gb	Jennings; CA	Fine	Bedrock	Impermeable	FB
JTRm	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kat	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kc	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgb	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
KJvs	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kmv	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Ksp	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kvsp	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
Kwmt	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Qv	Jennings; CA	Fine	Bedrock	Impermeable	FB
Tba	San Diego 30' x 60'	Fine	Bedrock	Impermeable	FB
Tda	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tv	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tvsr	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgdfg	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Ta	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tcs	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Td	San Diego & Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Td+Tf	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qls	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tm	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tf	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tfr	El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
To	San Diego & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qpe	San Diego & Oceanside 30' x 60'	Fine	Sedimentary	Permeable	FSP
Mexico	San Diego 30' x 60'	NA	NA	Permeable	Other
Kuo	San Diego 30' x 60'	NA (Offshore)	NA	Permeable	Other
Teo	San Diego & Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Tmo	Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Qmo	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
QTso	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
af	San Diego & Oceanside 30' x 60'	Variable, dependent on source material	Sedimentary		Other

Table H.6-2: Land Cover Grouping for SanGIS Ecology-Vegetation Data Set

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
1	42000 Valley and Foothill Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
2	42100 Native Grassland		Agricultural/Grass
3	42110 Valley Needlegrass Grassland		Agricultural/Grass
4	42120 Valley Sacaton Grassland		Agricultural/Grass
5	42200 Non-Native Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
6	42300 Wildflower Field		Agriculture/Grass
7	42400 Foothill/Mountain Perennial Grassland		Agriculture/Grass
8	42470 Transmontane Dropseed Grassland		Agriculture/Grass
9	45000 Meadow and Seep		Agriculture/Grass
10	45100 Montane Meadow		Agriculture/Grass
11	45110 Wet Montane Meadow		Agriculture/Grass
12	45120 Dry Montane Meadows		Agriculture/Grass
13	45300 Alkali Meadows and Seeps		Agriculture/Grass
14	45320 Alkali Seep		Agriculture/Grass
15	45400 Freshwater Seep		Agriculture/Grass
16	46000 Alkali Playa Community		Agriculture/Grass
17	46100 Badlands/Mudhill Forbs		Agriculture/Grass
18	Non-Native Grassland		Agriculture/Grass
19	18000 General Agriculture	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Agriculture/Grass
20	18100 Orchards and Vineyards		Agriculture/Grass
21	18200 Intensive Agriculture		Agriculture/Grass
22	18200 Intensive Agriculture - Dairies, Nurseries, Chicken Ranches		Agriculture/Grass
23	18300 Extensive Agriculture - Field/Pasture, Row Crops		Agriculture/Grass
24	18310 Field/Pasture		Agriculture/Grass
25	18310 Pasture		Agriculture/Grass
26	18320 Row Crops		Agriculture/Grass
27	12000 Urban/Developed		Developed
28	12000 Urban/Develpoed		Developed
29	81100 Mixed Evergreen Forest	Forest	Forest
30	81300 Oak Forest		Forest
31	81310 Coast Live Oak Forest		Forest
32	81320 Canyon Live Oak Forest		Forest
33	81340 Black Oak Forest		Forest
34	83140 Torrey Pine Forest		Forest
35	83230 Southern Interior Cypress Forest		Forest
36	84000 Lower Montane Coniferous Forest		Forest
37	84100 Coast Range, Klamath and Peninsular Coniferous Forest		Forest
38	84140 Coulter Pine Forest	Forest	Forest
39	84150 Bigcone Spruce (Bigcone Douglas Fir)-Canyon Oak Forest		Forest
40	84230 Sierran Mixed Coniferous Forest		Forest
41	84500 Mixed Oak/Coniferous/Bigcone/Coulter		Forest
42	85100 Jeffrey Pine Forest		Forest
43	11100 Eucalyptus Woodland	Non-Native Vegetation, Developed Areas, or	Forest

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
		Unvegetated Habitat	
44	60000 RIPARIAN AND BOTTOMLAND HABITAT	Riparian and Bottomland Habitat	Forest
45	61000 Riparian Forests		Forest
46	61300 Southern Riparian Forest		Forest
47	61310 Southern Coast Live Oak Riparian Forest		Forest
48	61320 Southern Arroyo Willow Riparian Forest		Forest
49	61330 Southern Cottonwood-willow Riparian Forest		Forest
50	61510 White Alder Riparian Forest		Forest
51	61810 Sonoran Cottonwood-willow Riparian Forest		Forest
52	61820 Mesquite Bosque		Forest
53	62000 Riparian Woodlands		Forest
54	62200 Desert Dry Wash Woodland		Forest
55	62300 Desert Fan Palm Oasis Woodland		Forest
56	62400 Southern Sycamore-alder Riparian Woodland		Forest
57	70000 WOODLAND	Woodland	Forest
58	71000 Cismontane Woodland		Forest
59	71100 Oak Woodland		Forest
60	71120 Black Oak Woodland		Forest
61	71160 Coast Live Oak Woodland		Forest
62	71161 Open Coast Live Oak Woodland		Forest
63	71162 Dense Coast Live Oak Woodland		Forest
64	71162 Dense Coast Love Oak Woodland		Forest
65	71180 Engelmann Oak Woodland	Woodland	Forest
66	71181 Open Engelmann Oak Woodland		Forest
67	71182 Dense Engelmann Oak Woodland		Forest
68	72300 Peninsular Pinon and Juniper Woodlands		Forest
69	72310 Peninsular Pinon Woodland		Forest
70	72320 Peninsular Juniper Woodland and Scrub		Forest
71	75100 Elephant Tree Woodland		Forest
72	77000 Mixed Oak Woodland		Forest
73	78000 Undifferentiated Open Woodland		Forest
74	79000 Undifferentiated Dense Woodland		Forest
75	Engelmann Oak Woodland		Forest
76	52120 Southern Coastal Salt Marsh	Bog and Marsh	Other
77	52300 Alkali Marsh		Other
78	52310 Cismontane Alkali Marsh		Other
79	52400 Freshwater Marsh		Other
80	52410 Coastal and Valley Freshwater Marsh		Other
81	52420 Transmontane Freshwater Marsh		Other
82	52440 Emergent Wetland		Other
83	44000 Vernal Pool	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Other
84	44320 San Diego Mesa Vernal Pool		Other
85	44322 San Diego Mesa Claypan Vernal		Other

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
	Pool (southern mesas)		
86	13100 Open Water	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
87	13110 Marine		Other
88	13111 Subtidal		Other
89	13112 Intertidal		Other
90	13121 Deep Bay		Other
91	13122 Intermediate Bay		Other
92	13123 Shallow Bay		Other
93	13130 Estuarine		Other
94	13131 Subtidal		Other
95	13133 Brackishwater		Other
96	13140 Freshwater	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
97	13200 Non-Vegetated Channel, Floodway, Lakeshore Fringe		Other
98	13300 Saltpan/Mudflats		Other
99	13400 Beach		Other
100	21230 Southern Foredunes	Dune Community	Scrub/Shrub
101	22100 Active Desert Dunes		Scrub/Shrub
102	22300 Stabilized and Partially-Stabilized Desert Sand Field		Scrub/Shrub
103	24000 Stabilized Alkaline Dunes		Scrub/Shrub
104	29000 ACACIA SCRUB		Scrub/Shrub
105	63000 Riparian Scrubs	Riparian and Bottomland Habitat	Scrub/Shrub
106	63300 Southern Riparian Scrub		Scrub/Shrub
107	63310 Mule Fat Scrub		Scrub/Shrub
108	63310 Mulefat Scrub		Scrub/Shrub
109	63320 Southern Willow Scrub		Scrub/Shrub
110	63321 Arundo donnax Dominant/Southern Willow Scrub		Scrub/Shrub
111	63330 Southern Riparian Scrub		Scrub/Shrub
112	63400 Great Valley Scrub		Scrub/Shrub
113	63410 Great Valley Willow Scrub		Scrub/Shrub
114	63800 Colorado Riparian Scrub		Scrub/Shrub
115	63810 Tamarisk Scrub		Scrub/Shrub
116	63820 Arrowweed Scrub		Scrub/Shrub
117	31200 Southern Coastal Bluff Scrub	Scrub and Chaparral	Scrub/Shrub
118	32000 Coastal Scrub		Scrub/Shrub
119	32400 Maritime Succulent Scrub		Scrub/Shrub
120	32500 Diegan Coastal Sage Scrub		Scrub/Shrub
121	32510 Coastal form		Scrub/Shrub
122	32520 Inland form (> 1,000 ft. elevation)		Scrub/Shrub
123	32700 Riversidian Sage Scrub		Scrub/Shrub
124	32710 Riversidian Upland Sage Scrub		Scrub/Shrub
125	32720 Alluvial Fan Scrub		Scrub/Shrub
126	33000 Sonoran Desert Scrub		Scrub/Shrub
127	33100 Sonoran Creosote Bush Scrub		Scrub/Shrub
128	33200 Sonoran Desert Mixed Scrub		Scrub/Shrub
129	33210 Sonoran Mixed Woody Scrub		Scrub/Shrub
130	33220 Sonoran Mixed Woody and Succulent Scrub	Scrub and Chaparral	Scrub/Shrub
131	33230 Sonoran Wash Scrub		Scrub/Shrub
132	33300 Colorado Desert Wash Scrub		Scrub/Shrub

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
133	33600 Encelia Scrub		Scrub/Shrub
134	34000 Mojavean Desert Scrub		Scrub/Shrub
135	34300 Blackbush Scrub		Scrub/Shrub
136	35000 Great Basin Scrub		Scrub/Shrub
137	35200 Sagebrush Scrub		Scrub/Shrub
138	35210 Big Sagebrush Scrub		Scrub/Shrub
139	35210 Sagebrush Scrub		Scrub/Shrub
140	36110 Desert Saltbush Scrub		Scrub/Shrub
141	36120 Desert Sink Scrub		Scrub/Shrub
142	37000 Chaparral		Scrub/Shrub
143	37120 Southern Mixed Chaparral		Scrub/Shrub
144	37120 Southern Mixed Chapparal		Scrub/Shrub
145	37121 Granitic Southern Mixed Chaparral		Scrub/Shrub
146	37121 Southern Mixed Chaparral		Scrub/Shrub
147	37122 Mafic Southern Mixed Chaparral		Scrub/Shrub
148	37130 Northern Mixed Chaparral		Scrub/Shrub
149	37131 Granitic Northern Mixed Chaparral		Scrub/Shrub
150	37132 Mafic Northern Mixed Chaparral		Scrub/Shrub
151	37200 Chamise Chaparral		Scrub/Shrub
152	37210 Granitic Chamise Chaparral		Scrub/Shrub
153	37220 Mafic Chamise Chaparral		Scrub/Shrub
154	37300 Red Shank Chaparral		Scrub/Shrub
155	37400 Semi-Desert Chaparral		Scrub/Shrub
156	37500 Montane Chaparral		Scrub/Shrub
157	37510 Mixed Montane Chaparral		Scrub/Shrub
158	37520 Montane Manzanita Chaparral		Scrub/Shrub
159	37530 Montane Ceanothus Chaparral		Scrub/Shrub
160	37540 Montane Scrub Oak Chaparral		Scrub/Shrub
161	37800 Upper Sonoran Ceanothus Chaparral		Scrub/Shrub
162	37830 Ceanothus crassifolius Chaparral		Scrub/Shrub
163	37900 Scrub Oak Chaparral		Scrub/Shrub
164	37A00 Interior Live Oak Chaparral		Scrub/Shrub
165	37C30 Southern Maritime Chaparral	Scrub and Chaparral	Scrub/Shrub
166	37G00 Coastal Sage-Chaparral Scrub		Scrub/Shrub
167	37K00 Flat-topped Buckwheat		Scrub/Shrub
168	39000 Upper Sonoran Subshrub Scrub		Scrub/Shrub
169	Diegan Coastal Sage Scrub		Scrub/Shrub
170	Granitic Northern Mixed Chaparral		Scrub/Shrub
171	Southern Mixed Chaparral		Scrub/Shrub
172	11000 Non-Native Vegetation	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Unknown
173	11000 Non-Native VegetionVegetation		Unknown
174	11200 Disturbed Wetland		Unknown
175	11300 Disturbed Habitat		Unknown
176	13000 Unvegetated Habitat		Unknown
177	Disturbed Habitat		Unknown

Table H.6-3: Potential Critical Coarse Sediment Yield Areas

GLU	Geology	Land Cover	Slope (%)
CB-Agricultural/Grass-3	Coarse Bedrock	Agricultural/Grass	20% - 40%
CB-Agricultural/Grass-4	Coarse Bedrock	Agricultural/Grass	>40%
CB-Forest-2	Coarse Bedrock	Forest	10 – 20%
CB-Forest-3	Coarse Bedrock	Forest	20% - 40%
CB-Forest-4	Coarse Bedrock	Forest	>40%
CB-Scrub/Shrub-4	Coarse Bedrock	Scrub/Shrub	>40%
CB-Unknown-4	Coarse Bedrock	Unknown	>40%
CSI-Agricultural/Grass-2	Coarse Sedimentary Impermeable	Agricultural/Grass	10 – 20%
CSI-Agricultural/Grass-3	Coarse Sedimentary Impermeable	Agricultural/Grass	20% - 40%
CSI-Agricultural/Grass-4	Coarse Sedimentary Impermeable	Agricultural/Grass	>40%
CSP-Agricultural/Grass-4	Coarse Sedimentary Permeable	Agricultural/Grass	>40%
CSP-Forest-3	Coarse Sedimentary Permeable	Forest	20% - 40%
CSP-Forest-4	Coarse Sedimentary Permeable	Forest	>40%
CSP-Scrub/Shrub-4	Coarse Sedimentary Permeable	Scrub/Shrub	>40%

Worksheet H.6-1: Verification of GLUs

<table>
<tr><th colspan="2">Verification of GLUs</th><th>Worksheet H.6-1</th></tr>
<tr><td colspan="3">Detailed project-level review of GLUs may be performed to verify the presence or absence of potential critical coarse sediment yield areas within the project site and/or upstream areas. Use this form to document the evaluation of slope, geology, and land cover combined to determine the site-specific GLUs. Complete all sections of this form.</td></tr>
<tr><td colspan="3">Project Name:</td></tr>
<tr><td colspan="3">Project Tracking Number / Permit Application Number:</td></tr>
<tr><td>1</td><td>What are the pre-project slopes?</td><td>☐ 0% to 10% (1)
☐ 10% to 20% (2)
☐ 20% to 40% (3)
☐ >40% (4)</td></tr>
<tr><td>2</td><td>What is the underlying geology? Refer to Appendix H.6 to classify geologic categories into a geology grouping.

Note: site-specific geology may be determined in the field by a qualified geologist.</td><td>☐ Coarse bedrock (CB)
☐ Coarse sedimentary impermeable (CSI)
☐ Coarse sedimentary permeable (CSP)
☐ Fine bedrock (FB)
☐ Fine sedimentary impermeable (FSI)
☐ Fine sedimentary permeable (FSP)
☐ Other (O)</td></tr>
<tr><td>3</td><td>What is the pre-project land cover? Refer to Appendix H.6 for land cover category definitions.

Note: Land cover shall be determined from aerial photography and/or field visit.</td><td>☐ Agriculture/grass
☐ Forest
☐ Developed
☐ Scrub/shrub
☐ Other
☐ Unknown</td></tr>
<tr><td>4</td><td>List the GLU(s) within the project site and/or upstream areas.

Note the GLU nomenclature format is as follows: Geology – Land Cover – Slope Category (e.g. “CB-Agricultural/Grass-3” for a GLU consisting of coarse bedrock geology, agricultural/grass land cover, and 20% to 40% slope).</td><td></td></tr>
</table>

Worksheet H.6-1; Page 2 of 2			
5	Photo(s) Insert photos representative of the slopes, land cover, and geology.		
6	Are any of the GLUs found within the project boundary and/or upstream areas (listed in row 4) also listed in Table H.6-1?	☐ Yes	Go to 7
		☐ No	Go to 8
7	End – Provide management measures for preservation of coarse sediment supply as described in this guidance document, or the project applicant may elect to determine whether downstream systems would be sensitive to reduction of coarse sediment yield from the project site and/or perform site-specific method for mapping critical coarse sediment yield areas.		
8	End – Site-specific GLUs do not warrant preservation of coarse sediment supply, no measures for protection of critical coarse sediment yield areas onsite are necessary. Optional: use the note section below to provide justification for these findings.		
9	Notes		

H.6.2 Assumptions for Regional WMAA PCCSYA Maps

This appendix summarizes the assumptions used while developing Regional WMAA PCCSYA maps that are not listed in **Appendix H.6.1.1**:

- Critical coarse sediment would be generated from GLUs that are
  - composed of geologic units likely to generate coarse sediment (i.e. produces greater than 50% sand (0.074 mm; no. 200 sieve) by weight when weathered); **and**
  - have a potential for high relative sediment production (GLUs that produce soil loss greater than 8.4 tons/acre/year are assigned a high relative rating, this corresponds to 42% of the total coarse soil loss from the MS4-permitted region within the County of San Diego)
- Relative sediment production was assigned using RUSLE analysis of GLUs. It was assumed that this relative rating represents sediment production from sheet erosion, rill erosion, gullies and lower order channels, since these features are mostly on the hillslopes that are represented by the GLUs.
  - While performing the RUSLE analysis to assign the relative ranking, C factor from the regional maps from USEPA was adjusted to 0 for developed land covers to account for management actions implemented on developed sites (e.g. impervious surfaces).
- WMAA mapping does not account for sediment production from in-stream sediment supply (since these are mostly protected through other regulations) and sediment production from mass failures like landslides which are difficult to estimate on a regional scale without performing extensive field investigations.
- Regional WMAA map assumes that all receiving waters require coarse sediment and the map also does not account for potential existing impediments that may hinder delivery of coarse sediment to receiving waters.

For additional details refer to the Regional WMAA document on the Project Clean Water website at the following address:

http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=248&Itemid=219

H.6.3 Encroachment Allowance for Regional PCCSYA WMAA Map

When an applicant uses the regional PCCSYA map from WMAA to define onsite CCSYAs an encroachment allowance of up to 5% is allowed.

The following provides the supporting rational for 5% encroachment:

Step 1. Sp has to be greater than 0.5, based on current understanding of risks to receiving waters arising from changes in sediment production (SCCWRP Technical Report 605, 2010).

Step 2. Estimated Sp (Equation H.8.11) = $0.7*SY_{RUSLE}+0.3*SY_{NHD} = 0.7*0.42 + 0.3*1 = 0.59$

A. Based on RUSLE analysis conducted during Regional WMAA the GLUs mapped as PCCSYAs contribute 42% of the bed sediment yield (i.e. $SY_{RUSLE} = 0.42$)

B. Disturbance to NHDPlus channels are protected through 401 water quality certifications issued by the RWQCB, so it is assumed that $SY_{NHD} =1$

Step 3. Dividing the Sp estimate from Step 2 by the required Sp in Step 1 provides the factor of safety that is currently implicit in the regional WMAA PCCSYA map = 0.59/0.5 = 1.18 or 18% factor of safety

Step 4. The remaining factor of safety after accounting for the proposed encroachment of 5% = 18% - 5% = 13%

H.7 Downstream System Sensitivity to Coarse Sediment

If an applicant has identified onsite and/or upstream PCCSYAs and elects to perform additional optional analyses to refine the PCCSYA designation, the guidance presented below should be followed. Protection of critical coarse sediment yield areas is a necessary element of hydromodification management because coarse sediment supply is as much an issue for causing erosive conditions to receiving streams as are accelerated flows. However, not all downstream systems warrant preservation of coarse sediment supply nor all source areas need to be protected. The following guidance shall be used to refine PCCSYA designations:

- Depositional Analysis (**Appendix H.7.1**)
- Threshold Channel Analysis (**Appendix H.7.2**)
- Coarse Sediment Source Area Verification (**Appendix H.7.3**)

H.7.1 Depositional Analysis

Areas identified as PCCSYAs may be removed from consideration if it is demonstrated that these sources are deposited into existing systems prior to reaching the first downstream unlined water of the state. Systems resulting in deposition may include existing natural sinks, existing structural BMPs, existing hardened MS4 systems, or other existing similar features. Applicants electing to perform depositional analysis to refine PCCSYA mapping must meet the following criteria to qualify for exemption from CCSYA designation:

- The existing hardened MS4 system that is being analyzed should be upstream of the first downstream unlined waters of the state; **and**
- The peak velocity from the discrete 2-year, 24-hour runoff event for the existing hardened MS4 system that is being analyzed is less than three feet per second.

The three feet per second criteria is consistent with the recommended minimum velocity for storm and sanitary sewers in ASCE Manual of Engineering Practice No. 37 (ASCE, 1970).

In limited scenarios, applicant may have the option to establish site specific minimum self-cleansing velocity using Equation H.7-1 or other appropriate equations instead of using the default three feet per second criteria. This site specific analysis must be documented in the SWQMP and the City Engineer has the discretion to request additional analysis prior to approving a site specific minimum self-cleansing velocity. If an applicant chooses to establish a site specific minimum self-cleansing velocity for refinement, then the applicant must design any new bypass hardened conveyance systems proposed by the project to meet the site specific criteria.

Equation H.7-1: Minimum Self Cleansing Velocity

$$V = \frac{1.486}{n} R^{1/6} \left[B \left(s_g - 1 \right) D_g \right]^{1/2}$$

<u>Where:</u>

V = minimum self-cleansing velocity (ft/sec)
R = hydraulic radius (ft)
n = Manning's roughness coefficient (unitless)
B = constant equal to 0.04 for clean granular particles (unitless)
s_g = specific gravity of sediment particle (unitless): **Use 2.65**
D_g = sediment particle diameter (inches): **Use 0.20 in**

H.7.2 Threshold Channel Analysis

A threshold channel is a stream channel in which channel boundary material has no significant movement during the design flow. If there is no movement of bed load in the stream channel, then it is not anticipated that reductions in sediment supply will be detrimental to stream stability because the channel bed consists of the parent material and not coarse sediment supplied from upstream. In such a situation, changes in sediment supply are not considered a geomorphic condition of concern. SCCWRP Technical Report 562 (2008) states the following in regards to sand vs. gravel bed behavior/threshold vs. live-bed contrasts:

> "Sand and gravel systems are quite varied in their transport of sediment and their sensitivity to sediment supply. On the former, sand-bed channels typically have live beds, which transport sediment continuously even at relatively low flows. Conversely, gravel/cobble-bed channels generally transport the bulk of their bed sediment load more episodically, requiring higher flow events for bed mobility (i.e., threshold behavior)."

> "Sand-bed streams without vertical control are much more sensitive to perturbations in flow and sediment regimes than coarse-grain (gravel/cobble) threshold channels. This has clear implications in their respective management regarding hydromodification (i.e., sand systems being relatively more susceptible than coarser systems). This also has direct implications for the issue of sediment trapping by storm water practices in watersheds draining to sand-bed streams, as well as general loss of sediment supply following the conversion from undeveloped sparsely-vegetated to developed well-vegetated via irrigation."

The following provides guidance for evaluating whether a stream channel is a threshold channel or not. This determination is important because while accounting for changes in bed sediment supply is appropriate for quantifying geomorphic impacts in non-threshold stream channels, it is not considered appropriate for threshold channels. The domain of analysis for this evaluation shall be the same as that used to evaluate susceptibility, per SCCWRP Technical Report 606, Field Manual for Assessing Channel Susceptibility (2010). This domain is defined by the following upstream and downstream boundaries:

- From the point of compliance proceed downstream until reaching one of the following:
    - At least one reach downstream of the first grade-control point (preferably second downstream grade control location);
    - Tidal backwater/lentic (still water) waterbody;
    - Equal order tributary (Strahler 1952);
    - A 2-fold increase in drainage area.

  OR demonstrate sufficient flow attenuation through existing hydrologic modeling.
- From the point of compliance proceed upstream for 20 channel top widths OR to the first grade control in good condition, whichever comes first.

Applicant must complete Worksheet H.7-1 to document selection of the domain of analysis. If the entire domain of analysis is classified as a threshold channel, then the PDP can be exempt from the MS4 Permit requirement for sediment supply. The following definitions from the Natural Resources Conservation Service's (NRCS) National Engineering Handbook Part 654 - Stream Restoration Design (2007) are helpful in understanding what a threshold channel is.

- **Alluvial Channel**: Streams and channels that have bed and banks formed of material transported by the stream. There is an exchange of material between the inflowing sediment load and the bed and banks of an alluvial channel (NRCS, 2007).
- **Threshold Channel**: A channel in which channel boundary material has no significant movement during the design flow (NRCS, 2007).

The key factor for determining whether a channel is a threshold channel is the composition of its bed material. Larger bed sediment consisting primarily of cobbles and boulders are typically immobile, unless the channel is a large river with sufficient discharge to regularly transport such grain sizes as bed load. As a rule-of-thumb, channels with bed material that can withstand a 10-year peak discharge without incipient motion are considered threshold channels and not live-bed alluvial channels. Threshold channel beds typically consist of cobbles, boulders, bedrock, or very dense vegetation (e.g., a thicket). Threshold channels also includes channels that have existing grade control structures that protect the stream channels from hydromodification impacts.

For a project to be exempt from coarse sediment supply requirements, the applicant must submit the following for approval by the City Engineer:

- Photographic documentation and grain size analysis used to determine the d_{50} of the bed material; **and**
- Calculations that show that the receiving water of concern meets the specific stream power criteria defined below **or** a finding from a geomorphologist that the stream channel has existing grade control structures that protect the stream channel from hydromodification impacts.

Specific Stream Power

Specific (i.e., unit) stream power is the rate at which the energy of flowing water is expended on the bed and banks of a channel (refer to Equation H.7-2). SCCWRP studies have found that locating channels on a plot of Specific Stream Power at Q_{10} (as calculated by the Hawley et al. method optimized for Southern California watersheds – Figure H.7-1) versus median channel grain size is a good predictor of channel stability. The Q10 equation from SCCWRP TR 606 is presented as Equation H.7-3.

Equation H.7-2: Calculation of Specific Stream Power

$$Specific\ Stream\ Power = \frac{Total\ Stream\ Power}{Channel\ Width} = \frac{\gamma QS}{w}$$

Where:

- γ: Specific Weight of Water (9810 N/m^3)
- Q: Flow Rate (dominant discharge in many cases, m^3/sec)
- S: Slope of Channel
- w: Channel Width (meters)

Equation H.7-3: Calculation of Q_{10} using the Hawley et al. Method

$Q_{10cfs} = 18.2 * A^{0.87} * P^{0.77}$

Where:

- Q_{10cfs}: 10 year Flow Rate in cubic feet per second
- A: Drainage Area in sq. miles
- P: Mean Annual Precipitation in inches

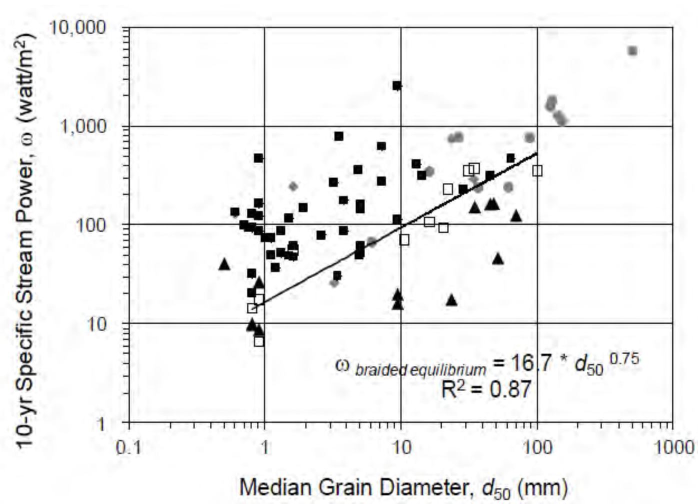

Figure H.7-1 : Threshold of stream instability based on specific stream power and channel sediment diameter

Since the SCCWRP TR 606 Q_{10} (Equation H.7-3) does not explicitly consider watershed imperviousness, adjustment factors (AF) shown in Figure H.7-2 were developed using the following Equation H.7-4 for Q_{10} from SCCWRP TR 654 to account for imperviousness while estimating Q_{10}.

Equation H.7-4: Calculation of Q_{10} using equation from SCCWRP TR 654

$$Q_{10} = e^{3.61} * A^{0.865} * DD^{0.804} * P_{224}^{0.778} * IMP^{0.096}$$

Where:

Q_{10}: 10 year Flow Rate
A: Drainage Area in sq. miles
DD: Drainage Density
P_{224}: 2-Year 24-Hour Precipitation in inches
IMP: Watershed Imperviousness

Adjustment factors were developed as part of this methodology by changing the watershed imperviousness in Equation H.7-4 and keeping the remaining terms constant. Adjustment factor for imperviousness of 3.6% was set to 1; since it is the mean imperviousness of the dataset used to develop the stability curve in Figure H.7-1. Updated Q_{10} equation with adjustment factor is presented as Equation H.7-5 below:

Equation H.7-5: Calculation of Q10 with Adjustment Factor for Watershed Imperviousness

$$Q_{10cfs} = AF * 18.2 * A^{0.87} * P^{0.77}$$

Where:

Q_{10cfs}: 10 year Flow Rate in cubic feet per second
AF: Adjustment Factor
A: Drainage Area in sq. miles
P: Mean Annual Precipitation in inches

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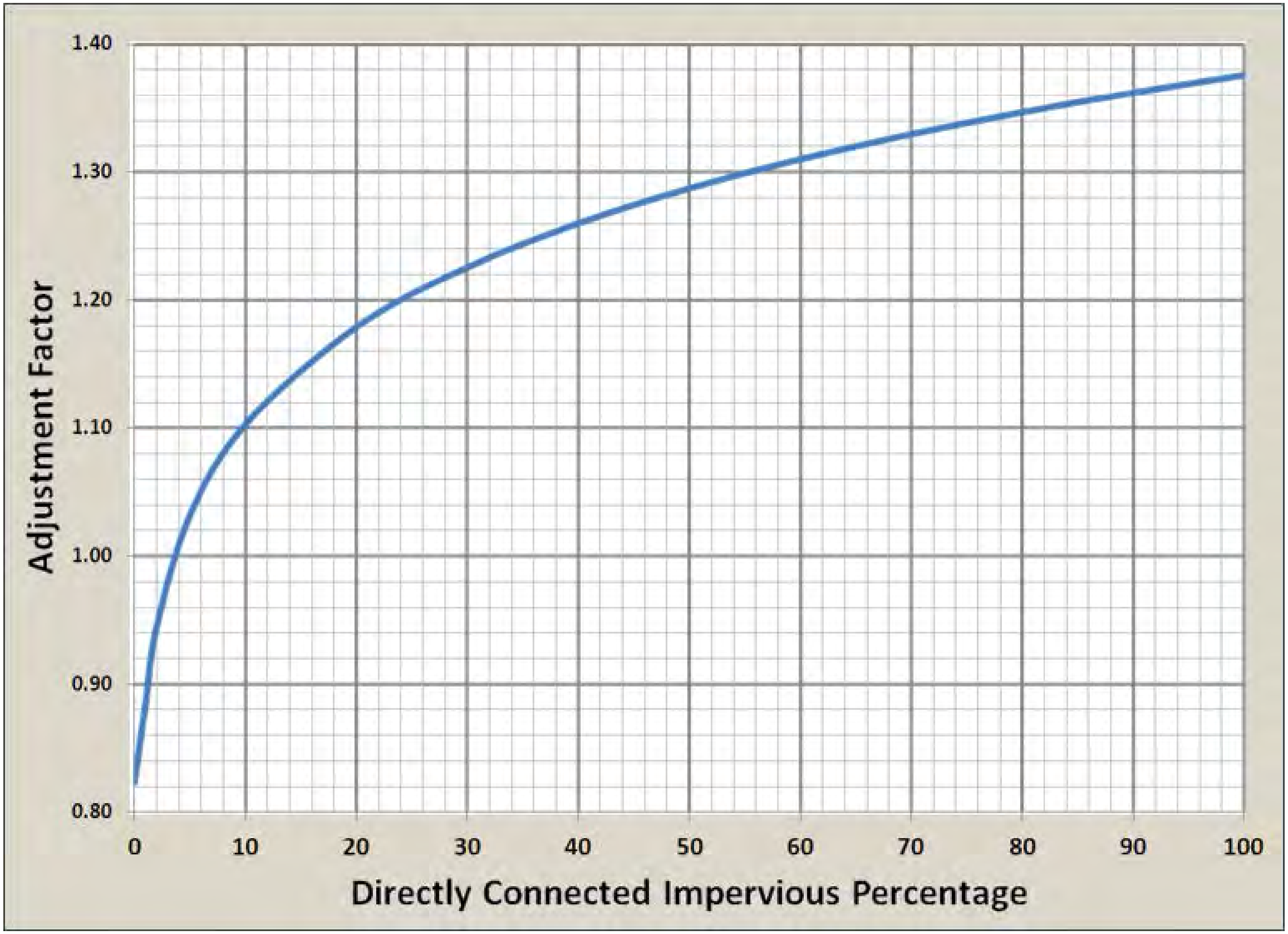

Figure H.7-2 : **Adjustment factor to account for imperviousness while estimating Q_{10}**

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Steps for evaluating the specific stream power criteria are presented below:

- **Step 1**: Calculate the specific stream power for the receiving water. Use Equation H.7-2, H.7-5 and Figure H.7-2. Directly connected imperviousness shall be estimated using guidance provided in the Water Quality Equivalency guidance document.
- **Step 2**: Determine the d_{50} of representative cross section within the domain of analysis.
- **Step 3**: Use results from Step 1 and Step 2; and Figure H.7-1 to determine if the receiving water meets the specific stream power criteria. Receiving water shall be considered meeting the specific stream power criteria when the point plotted based on results from Step 1 and Step 2 is below the solid line in Figure H.7-1.

H.7.3 Coarse Sediment Source Area Verification

When it has been determined that PCCSYAs are present, and it has been determined that downstream systems require protection, additional analysis may be performed that may refine the extents of actual CCSYAs to be protected onsite. The following analysis shall be performed to determine if the mapped PCCSYAs are a significant source of bed sediment supply to the receiving water, based on the coarse sediment proportion of the soil onsite

- Obtain a grain size distribution per ASTM D422 for the project's PCCSYA that is being evaluated.
- Identify whether the source material is a coarse grained or fine grained soil. Coarse grained is defined as over 50% by weight coarse than no. 200 sieve (i.e., d50 > 0.074 mm).
- By performing this analysis, the applicant can exclude PCCSYAs that are determined to be fine grained (i.e., d50 < 0.074 mm). Fine grained soils are not considered significant sources of bed sediment supply.
- Applicant shall include the following information in the SWQMP when this refinement option is performed:
  - Map with locations on where the grain size distribution analysis was performed;
  - Photographic documentation; and
  - Grain size distribution.
- Additional grain size distribution analysis may be requested at specific locations by the City Engineer prior to approval of this refinement.

Areas that are not expected to be a significant source of bed sediment supply (i.e. fine grained soils) to the receiving stream do not require protection and are not considered CCSYAs.

If it is determined that the PCCSYAs are producing sediment that is critical to receiving streams, or if the optional additional analysis presented above has not been performed, the project must provide management measures for protection of critical coarse sediment yield (refer to **Appendix H.2, H.3 and H.4**).

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Worksheet H.7-1: Domain of Analysis

Domain of Analysis		Worksheet H.7-1
Use this form to document the domain of analysis		
Project Name:		
Project Tracking Number / Permit Application Number:		
Part 1: Identify Domain of Analysis		
Project Location (at proposed storm water discharge point)		
1	Address:	
2	Latitude (decimal degrees):	
3	Longitude (decimal degrees):	
4	Watershed:	
Basis for determining downstream limit:		
Channel length from discharge point to downstream limit:		
Basis for determining upstream limit:		
Channel length from discharge point to upstream limit:		

Worksheet H.7-1; Page 2 of 2
Photo(s) Map or aerial photo of site. Include channel alignment and tributaries, project discharge point, upstream and downstream limits of analysis, ID number and boundaries of geomorphic channel units, and any other features used to determine limits (e.g. exempt water body, grade control).

H.8 Calculation Methodology for Ep and Sp

One method for quantifying hydromodification impacts to stream channels, which takes into account changes in the four factors in Lane's relationship (i.e., hydrology, channel geometry, bed and bank material, and sediment supply), is to compare long-term changes in sediment transport capacity, or in-stream work, to bed sediment supply. For the purposes of demonstrating no net impact within the MS4-permitted region of the County of San Diego, Erosion Potential (Ep) is defined as the ratio of post-project/pre-development (natural) long-term transport capacity or work. To calculate Ep, the hydrology, channel geometry, and bed/bank material factors mentioned above need to be characterized for both land use scenarios. Sediment Supply Potential (Sp) is defined as the ratio of post-project/pre-project (existing) long-term bed sediment supply. While evaluating changes in discharge and sediment supply is done primarily as a desktop analysis, geomorphic field assessment is often necessary to characterize channel geometry and bed/bank material, and to ground truth assumptions for the desktop analyses. This appendix provides methodologies for the following:

- Calculation of Ep, and
- Calculation of Sp.

H.8.1 Calculation of Ep

Erosion Potential (Ep) is defined as the ratio of post-project/pre-development (natural) long-term transport capacity or work. To calculate Ep, the hydrology, channel geometry, and bed/bank material factors mentioned above need to be characterized for both land use scenarios. Traditionally, Ep is calculated based on a watershed-scale analysis (using future built out conditions) of the area tributary to a given receiving channel of concern at the point of compliance. However, watershed-scale continuous hydrologic modeling might not be feasible for small projects, with this understanding specific simplification steps for project-scale modeling are provided in this appendix. The applicant shall perform Ep calculations using one of the following methods, as applicable:

- <u>Simplified Ep Method</u>: Applicable when the default low flow threshold of $0.1Q_2$ is used and no changes to the receiving water are proposed. Refer to **Appendix H.8.1.1**.
- <u>Standard Ep Method</u>: Applicable for all scenarios. Refer to **Appendix H.8.1.2**.

H.8.1.1 Simplified Ep Method

The simplified method is based on the relationships developed by Parra (2016) between the flow duration curve in the pre-development and post-project conditions and the standard simplified work equation. These relationships were developed using standard hydraulic equations and approximations that are applicable for channels of any lateral slope and the following geometrical cross sections: (a) wide rectangular sections; (b) relatively wide parabolic sections, and (c) triangular sections. The simplified Ep method is only applicable when the default low flow threshold of $0.1Q_2$ has been selected by the applicant for flow duration control and no changes to the receiving water geometry are proposed. Applicants shall follow Steps 1 through 3 to calculate Ep using the simplified methodology:

1. Perform continuous hydrologic simulation for the pre-development and post-project condition following guidelines in **Appendix G**. Generate flow bins and flow duration tables for the range of flows from $0.1Q_2$ to Q_{10}.

2. Calculate the total work in the pre-development and the post-project condition using Equation H.8-1

Equation H.8-1: Total Work (Simplified)

$$W_t = \sum_{j=1}^{n} \Delta t_j . \left(Q^{3m/2} - (0.1Q_2)^{3m/2}\right)^{1.5} \quad Q^m$$

Where:

W_t = Total Work [dimensionless]

Δt_j = Duration per flow bin

Q = Flow Rates estimated in STEP 1 [cfs] for a typical bin "j". Usually, in Flow Duration Curve (FDC) analyses, the number of bins is 100, so j = 1 to n (with n= 100). However, the number of bins can be as small as 20 (n = 20).

Q_2 = Pre-development 2-year peak flow [cfs]

m = Exponent based on the function of the receiving channels geometry.

- For narrow creek where the top width is 7 times or less the corresponding depth, m = 1/4.
- For intermediate creeks, where the top width is more than 7 times but less than 25 times the depth, m = 4/13.
- For wide creeks, where the top width is more than 25 times the depth, m = 2/5.

3. Ep is calculated by dividing the total work of the post-project condition by that of the pre-development (natural) condition (Equation H.8-2). Ep is expressed as:

Equation H.8-2: Ep (Simplified)

$$E_p = W_{t,post}/W_{t,pre}$$

Where:

E_p = Erosion Potential [unitless]

$W_{t,post}$ = Total Work associated with the post-project condition [unitless]

$W_{t,pre}$ = Total Work associated with the pre-development condition [unitless]

H.8.1.2 Standard Ep Method

While using the standard method, Ep calculation must be performed using the receiving water information from the point of compliance. Suggested steps for performing an Ep analysis are shown in the Figure H.8-1 below. This section describes each analysis step shown in Figure H.8-1, including the inputs and outputs of each step.

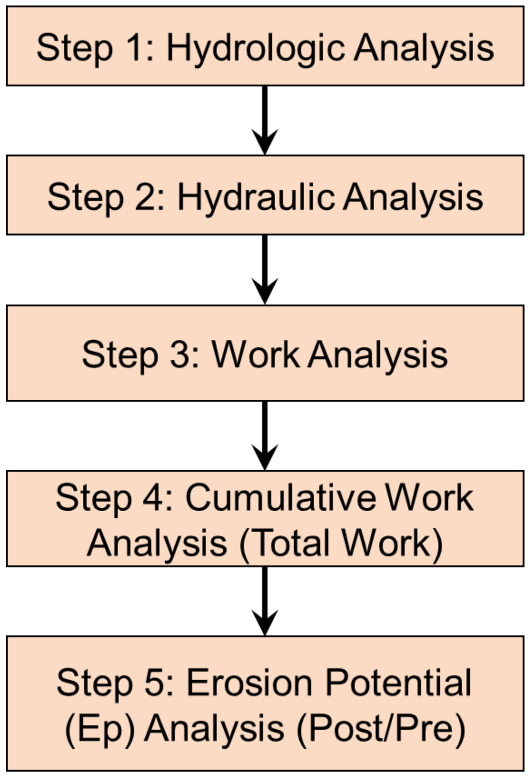

Figure H.8-1 : Erosion Potential Flow Chart

STEP 1: CONTINOUS HYDROLOGIC ANALYSIS

Hydrologic models are applied to simulate the hydrologic response of the watershed under pre-development and post-project conditions for a continuous period of record. Modeling software appropriate for this type of simulation includes USEPA's Storm Water Management Model (SWMM), Hydrological Simulation Program – Fortran (HSPF) developed by the USGS and USEPA, USACE's Hydrologic Modeling System (HEC-HMS), and the San Diego Hydrology Model (SDHM) developed by Clear Creek Solutions, Inc. SDHM uses an HSPF computational engine, long-term precipitation data, and is a visually-oriented interactive tool for automated modeling and facility sizing.

Input parameters for these continuous simulations are hourly precipitation data for a long-term (>30 years) record, sub-catchment delineation, impervious cover, soil type, vegetative cover, terrain steepness, lag time or flow path length, and monthly evapotranspiration rate. The primary output is a simulated discharge record associated with the receiving channel of concern. Flow routing through drainage conveyances is necessary for continuous hydrologic analysis at the watershed scale. **Appendix G** provides guidance for developing continuous simulation models.

Traditionally, a hydrograph (Figure H.8-2) is the primary means for graphically comparing discharge records; however, a hydrograph is not ideal because long-term flow records span several decades.

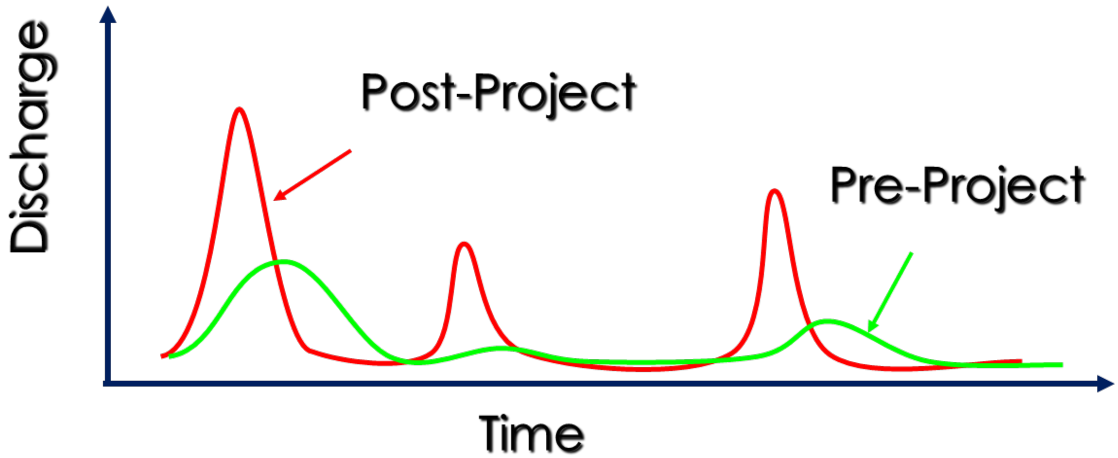

Figure H.8-2 : Example Hydrograph Comparison

Instead, a more effective means for comparing long-term continuous discharge records is to create a flow histogram, which differentiates the simulated flowrates into distinct "flow bins" so that the duration of flow for each bin can be tabulated. One method for establishing the distribution of flow bins is to increment the flow bins according to increments of flow stage using a hydraulic analysis, such as the normal depth equation. In this way, the hydraulic analysis step (Step 2) can be considered an input to the continuous hydrologic analysis step. While there is no established rule of thumb for how many flow bins are necessary, it is suggested that no less than 20 be used for an Ep analysis. An example of a flow histogram is provided on Figure H.8-3.

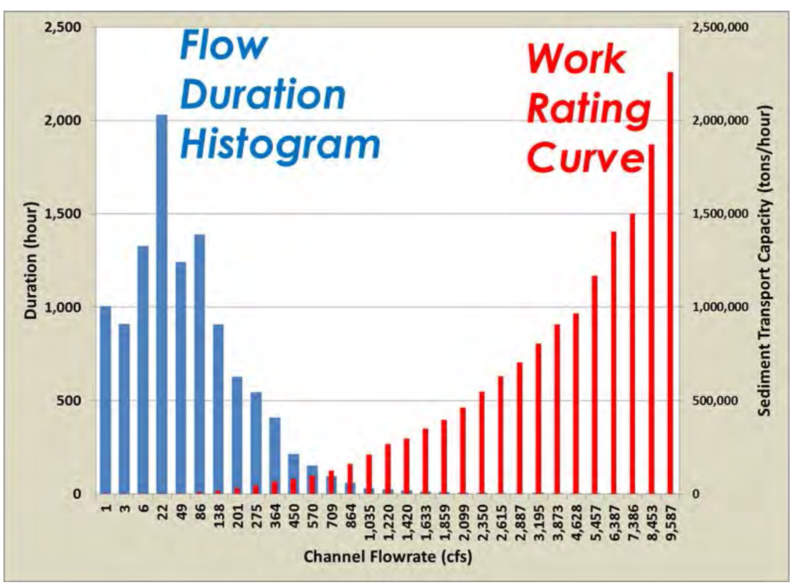

Figure H.8-3 : Example Flow Duration Histogram

Flow duration curves are another commonly used method for graphically interpreting long-term flow records. A flow duration curve is simply a plot of flowrate (y-axis) versus the cumulative duration, or percentage of time, that a flowrate is equaled or exceeded in the simulation record (x-axis). Figure H.8-4 provides an example flow duration curve comparison.

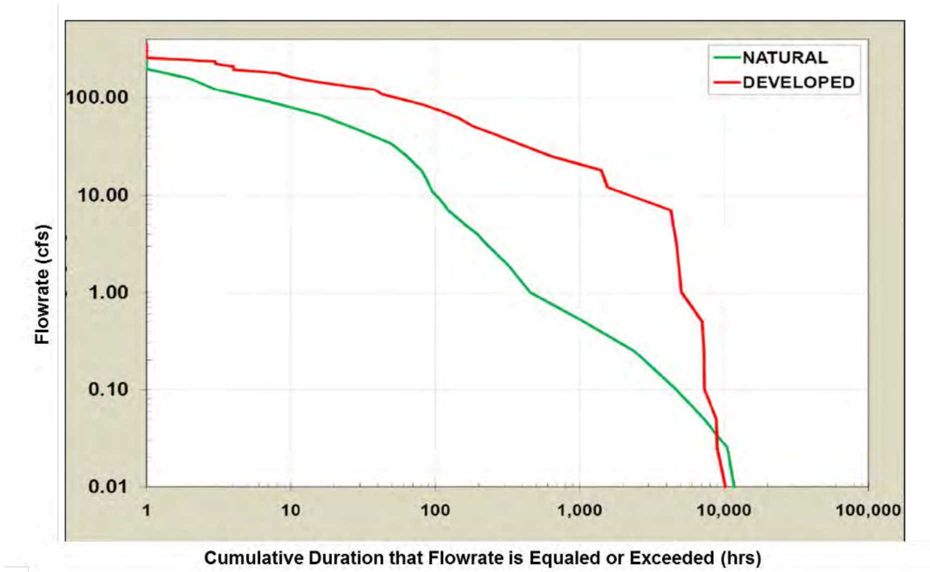

Figure H.8-4 : Example Flow Duration Curve

Scaling Factor for Project-Scale Modeling

Project-scale flow rates derived from continuous hydrologic simulation can be scaled using the ratio of the pre-development 2-year peak discharge for the watershed and project catchment (i.e., Q_2 watershed / Q_2 project catchment) so that hydraulic and effective work calculations can be performed at the point of compliance with a larger tributary watershed. This scaling translates the runoff from the project catchment to its contribution to erosivity in the down gradient receiving channel, without the need for a complex watershed-scale continuous hydrologic model.

Applicant can estimate the scaling factor using Equation H.8-3. The scaling factor equation was developed using the 2-year peak flow rate empirical equation from Hawley and Bledsoe (2011) and removing the terms (average annual precipitation and imperviousness (pre-development condition as required by the MS4 Permit) that are constant.

Equation H.8-3: Scaling Factor

$$Scaling\ Factor = \left(\frac{A_{watershed}}{A_{project}}\right)^{0.667}$$

Where:

$A_{watershed}$ =	total watershed drainage area at the point of compliance (mi^2)
$A_{project}$=	total project drainage area (mi^2)

STEP 2: HYDRAULIC ANALYSIS

Hydraulic parameters, such as stage, effective shear stress, and flow velocity, are computed for each designated flow bin using channel geometry and roughness data. Hydraulic calculations can be as simple as using the normal flow equation and obtaining results for the central channel or as complicated as using hydraulic models which account for backwater effects, such as HEC-RAS.

Using the formula for unit tractive force (Chow 1959), effective shear stress is expressed using Equation H.8-4

Equation H.8-4: Effective Shear Stress

$$\tau = \gamma RS$$

Where:

- τ = Effective Shear Stress [lb/ft^2]
- γ = Unit Weight of Water [62.4 lb/ft^3]
- R= Hydraulic Radius [ft]
- S = Energy Gradient Assumed Equal to Longitudinal Slope [ft/ft].

Normal depth can be estimated using Manning's equation (Equation H.8.5). Several sources provide lists of roughness coefficients for use in hydraulic analysis (Chow, 1959).

Equation H.8-5: Manning's Equation

$$Q = \frac{1.49AR^{0.67}S^{0.5}}{n} \quad or \quad V = \frac{1.49R^{0.67}S^{0.5}}{n}$$

Where:

- Q = Peak Flowrate [cfs]
- V = Average Flow Velocity [ft/s]
- A = Cross-Section Flow Area [ft^2]
- R = Hydraulic Radius [ft] = A/P
- P = Wetted Perimeter [ft]
- S = Energy Gradient Assumed Equal to Longitudinal Slope [ft/ft]
- n = Manning Roughness [unit less]

Channel geometry inputs should be characterized by surveying cross-sections and longitudinal profiles of the active channel at strategic locations. Methods of collecting topographic survey data can range from traditional survey techniques (auto level, cloth tape, and survey rod), to conducting a detailed ground-based LiDAR survey.

STEP 3: WORK ANALYSIS

Hydraulic results for each flow bin along with the critical bed/bank material strength parameters are input into a work or sediment transport function in order to produce a work or transport rating curve. An example of such a rating curve is provided on Figure H.8-3. The work equations can range from simplistic indices, material-specific sediment transport equations, or more complex functions based on site-calibrated sediment transport rating curves.

- **Simplistic indices:** An acceptable equation for effective work, as stated in the Los Angeles Regional MS4 Permit (LARWQCB, 2012) is expressed using Equation H.8-6:

Equation H.8-6: Effective Work

$$W = (\tau - \tau_c)^{1.5} V$$

Where:

W = Work [dimensionless];

τ = Effective Shear Stress [lb/ft^2];

τ_c = Critical Shear Stress [lb/ft^2];

V = Mid-Channel Flow Velocity [ft/s]

- **Material-specific sediment transport equations**: Material specific sediment transport equations are allowed to estimate the sediment transport capacity in the post-project and pre-development condition.
- **Site-calibrated sediment transport curves**: Applicants may have an option to use site-calibrated sediment transport curves. In the future these may be available based on monitoring efforts being performed to support the County of San Diego's Hydromodification Management Plan.

The critical shear stress to be used in equation H.8.6 must be estimated using one of the following:

- Shear stress corresponding to the critical flow rate or low flow threshold (Qc). Qc is the flowrate that results in incipient motion of bed or bank material, whichever is least resistant. Qc is expressed as a fraction of the pre-development 2-year peak flow. The allowable low flow threshold Qc can be estimated as 10%, 30%, or 50% of the pre-development 2-year peak flow ($0.1Q_2$, $0.3Q_2$, or $0.5Q_2$) depending on the receiving stream susceptibility to erosion, per SCCWRP Technical Report 606, Field Manual for Assessing Channel Susceptibility (SCCWRP, 2010). If a channel susceptibility assessment is not performed, then the conservative default is a Qc equal to $0.1Q_2$.
- Bed and bank material can also be characterized through a geomorphic field assessment. For each stream location analyzed, a measure of critical shear stress can be obtained for the weakest bed or bank material prevalent in the channel. For non-cohesive material, a Wolman pebble count or sieve analysis can be used to obtain a grain size distribution, which can be converted to a critical shear stress using empirical relationships or published reference tables. For cohesive material, an in-situ jet test or reference tables are used. For banks reinforced with vegetation, reference tables are generally used. Appropriate references for critical shear stress values are provided in ASCE No.77 (1992) and Fischenich (2001). To account for the effects of vegetation density and channel irregularities, the applied shear stress can be partitioned into channel form and bed/bank roughness components. SCCWRP Technical Report 667 also has guidance for estimating critical shear stress.

STEP 4: CUMULATIVE WORK ANALYSIS

Cumulative work is a measure of the long-term total work or sediment transport capacity performed at a creek location. It incorporates the distribution of both discharge magnitude and duration for the flow rates simulated. The cumulative work analysis must be performed up to the maximum geomorphically significant flow of Q_{10}. To calculate cumulative work, first multiply the work (from STEP 3) and duration associated with each flow bin (from STEP 1). Then, the total work is obtained by summing the cumulative for all flow bins (Q_c to Q_{10} Equation H.8-7). This analysis can be expressed as:

Equation H.8-7: Cumulative Work

$$W_t = \sum_{i=1}^{n} W_i \, \Delta t_i$$

Where:

W_t = Total Work [dimensionless]

W_i = Work per flow bin [dimensionless]

Δt = Duration per flow bin [hours]

n = number of flow bins

The distribution of cumulative work, also referred to as a work curve (or work histogram), is helpful in understanding which flow rates are performing the most work on the channel of interest. An example work curve is provided in Figure H.8-5.

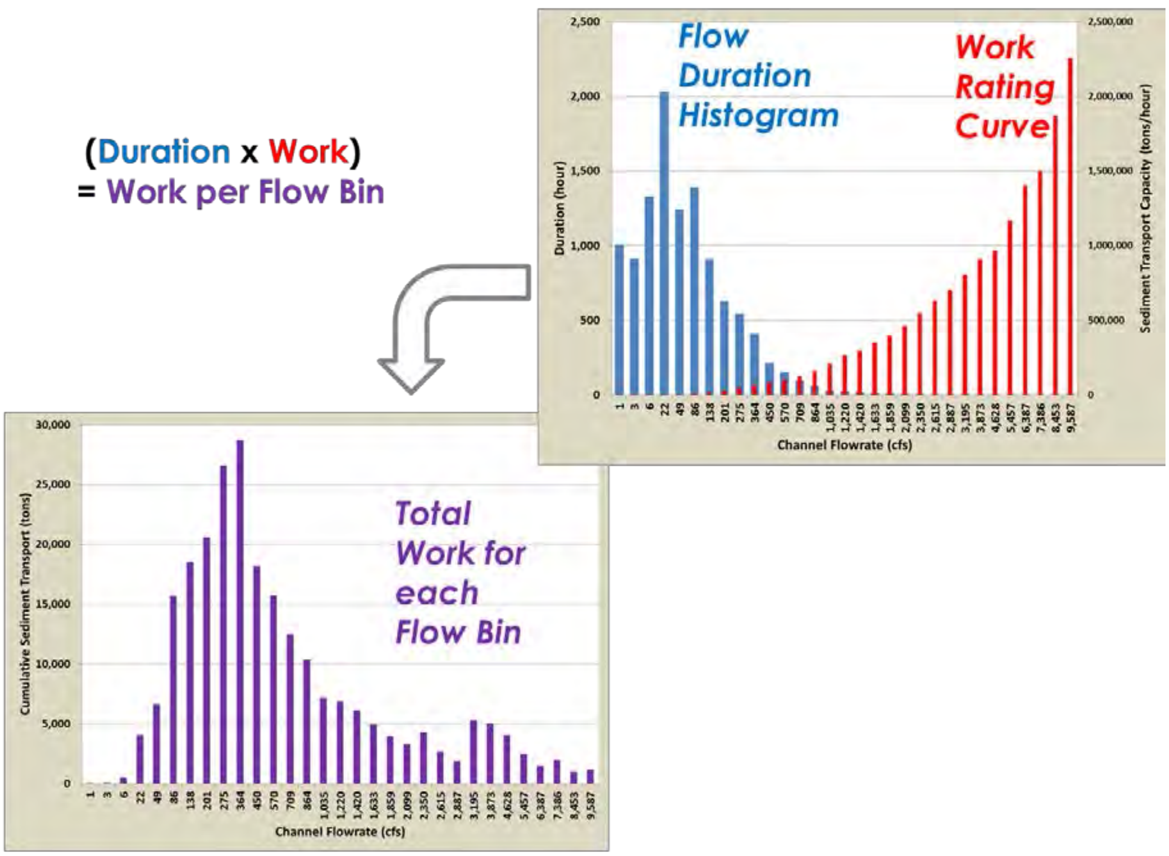

Figure H.8-5 : Example Work Curve

STEP 5: EROSION POTENTIAL ANALYSIS

Ep is calculated by simply dividing the total work of the post-project condition by that of the pre-development (natural) condition (Equation H.8-8). Ep is expressed as:

Equation H.8-8: Erosion Potential

$$E_p = W_{t,post} / W_{t,pre}$$

Where:

E_p = Erosion Potential [unitless]

$W_{t,post}$ = Total Work associated with the post-project condition [unitless]

$W_{t,pre}$ = Total Work associated with the pre-development condition [unitless]

As applicable, the applicant must use Worksheet H.8.1-1 and H.8.1-2 to document the Ep calculations for each point of compliance.

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Worksheet H.8-1: Erosion Potential (Ep) Analysis

Erosion Potential (Ep) Analysis		Worksheet H.8-1	
Background Information			
1	Low Flow Threshold: results of SCCWRP channel susceptibility analysis (Select 0.1*Q_2 if analysis has not been performed).	☐ 0.1*Q2 ☐ 0.3*Q2 ☐ 0.5*Q2	
2	Selected Ep Method	☐ Simplified Ep Method ☐ Standard Ep Method	
2	Hydrologic Analysis: Select hydrologic analysis method.	☐ Project-Scale ☐ Project-Scale and Watershed-Scale Continuous Simulation	
4	Number of Points of Compliance (Copy and complete worksheet for each Point of Compliance)		unitless
Step 1: Hydrologic Analysis (not applicable for Simplified Ep Method)			
5	Project-Scale Q_2 (from continuous simulation)		cfs
6	Project Area draining to the point of compliance		sq. miles
7	Watershed Area draining to the point of compliance		sq. miles
8	Scaling Factor for Flows (Line 7/Line 6)$^{0.667}$		unitless
9	Low flow threshold (factor from Line 1 x Line 6)		cfs
10	Watershed-Scale Q_{10} at Point of Compliance (from continuous simulation or Project Q_{10} * Line 8)		cfs
	Hydrologic analysis results (Attach results of continuous simulation including: full pre-development runoff time series at POC, full post-development runoff time series at POC, and flow duration histogram and/or cumulative flow duration curve for each POC).		☐ Yes ☐ No
Step 2: Hydraulic Analysis (not applicable for Simplified Ep Method)			
11	Provide details about the cross-section (width, depth, slope, roughness, etc.)		

Erosion Potential (Ep) Analysis		Worksheet H.8-1	
Step 3: Work Analysis (not applicable for Simplified Ep Method)			
12	Select work index, equation, or transport curve method for use in work analysis.	☐ Equation H.8.6 ☐ Sediment Transport Equation ☐ Sediment Transport Curve ☐ Other: ____________	
13	Describe/Justify selection in Line 12 above:		
14	Calculate work done for each flow bin under the pre-development and post-project condition using Worksheet H.8.1-2. Or similar documentation for sediment transport modeling or transport curve analysis.	☐ Yes ☐ No	
Step 4: Cumulative Work Analysis			
14	Cumulative pre-development work (Equation H.8.1 for Simplified Ep Method) (from Worksheet H.8.1-2 for Standard Ep Method)		
15	Cumulative post-project work (Equation H.8.1 for Simplified Ep Method) (from Worksheet H.8.1-2 for Standard Ep Method)		
Step 5: Erosion Potential Analysis			
16	Erosion Potential (Line 15 / Line 14)		unitless

Worksheet H.8-2: Work Calculations (Supplement to Worksheet 8-1)

Work Calculations (Supplement to Worksheet H.8-1)									Worksheet H.8-2	
1	Channel Slope								(ft/ft)	
2	Channel Roughness (n)								(unitless)	
3	Low Flow Threshold								cfs	
4	Critical Shear Stress								(lb/ft^2)	
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Bin	**Flow (cfs)**			**Duration (hours)**		**Hydraulic Radius (ft)**	**Average Velocity (ft/s)**	**Shear Stress (lb/ft^2)**	**Work (unitless)**	
	Lower Limit	**Upper Limit**	**Average**	**Pre-development**	**Post-Project**				**Pre-development**	**Post-Project**
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
n										
Sum (Bins 1 to n) =										

Worksheet H.8-2 Key

A Number of flow bins, add additional rows as needed

B Lower limit for the corresponding flow bin

C Upper limit for the corresponding flow bin

D Average flow for the corresponding flow bin; [(**B** + **C**)/2]

E Duration in hours for the corresponding flow bin in pre development condition

F Duration in hours for the corresponding flow bin in post project condition

G Hydraulic radius (in feet) associated with the average flow for the corresponding flow bin (from Manning's equation and/or hydraulic analysis)

H Average flow velocity (in fps) associated with the average flow for the corresponding flow bin (from Manning's equation and/or hydraulic analysis)

I Shear stress (lb/ft^2) associated with the average flow for the corresponding flow bin = γ * Hydraulic Radius*Slope = 62.4 * **G** * Line 1

J Pre-development work for associated flow bin

J = 0; If (**I** – Line 4) ≤ 0

J = **E** * (**I** – Line 4)$^{1.5}$ * **H**; If (**I** – Line 4) > 0

K Post-project work for associated flow bin

K = 0; If (**I** – Line 4) ≤ 0

K = **F** * (**I** – Line 4)$^{1.5}$ * **H**; If (**I** – Line 4) > 0

Note: If the receiving water dimensions are different in pre-development and post-project condition then Worksheet H.8.1-2 is not valid for work calculations.

H.8.2 Calculation of Sp

While there are many categories of erosion processes (e.g., landslides, debris flows, gullies, tree throw, animal burrows, sheetwash erosion, wind erosion, dry ravel, bank erosion), in this evaluation processes will be simplified to sediment production from hillslopes and channels. Under ideal circumstances, the total bed sediment supply rate (tons/year) would be calculated for both the post-project buildout condition and pre-project condition using a watershed-scale Geomorphic Landscape Unit (GLU) and Geomorphic Channel Unit (GCU) approach which:

1. identifies different sources of sediment supply based on categories of terrain slope, geology, land cover, and stream order;
2. estimates the base erosion rate of those sources (GLUs and GCUs);
3. approximates the sediment delivery ratio (SDR) to the receiving channel;
4. evaluates the coarse bed-load fraction of the sources; and
5. integrates these considerations into a bed-load yield rate for both the existing condition and proposed buildout condition.

However, calculation of sediment yield rates for each GLU (tons/mi^2-yr) and GCU (tons/mi-yr) using the available science is inherently inexact and requires extensive field calibration. Additionally, performing the geospatial calculations necessary for such a comprehensive GLU and GCU analysis may not be straightforward for some project applicants. Since the objective is to determine the fraction of reduction in bed sediment supply in the post-project condition compared to the pre-project condition, but not to determine the bed sediment yield in physical units (tons/year/acre, for example) the following simplifications are allowed. These simplifications take into consideration the regional sediment yield map shown in Figure H.8.6.

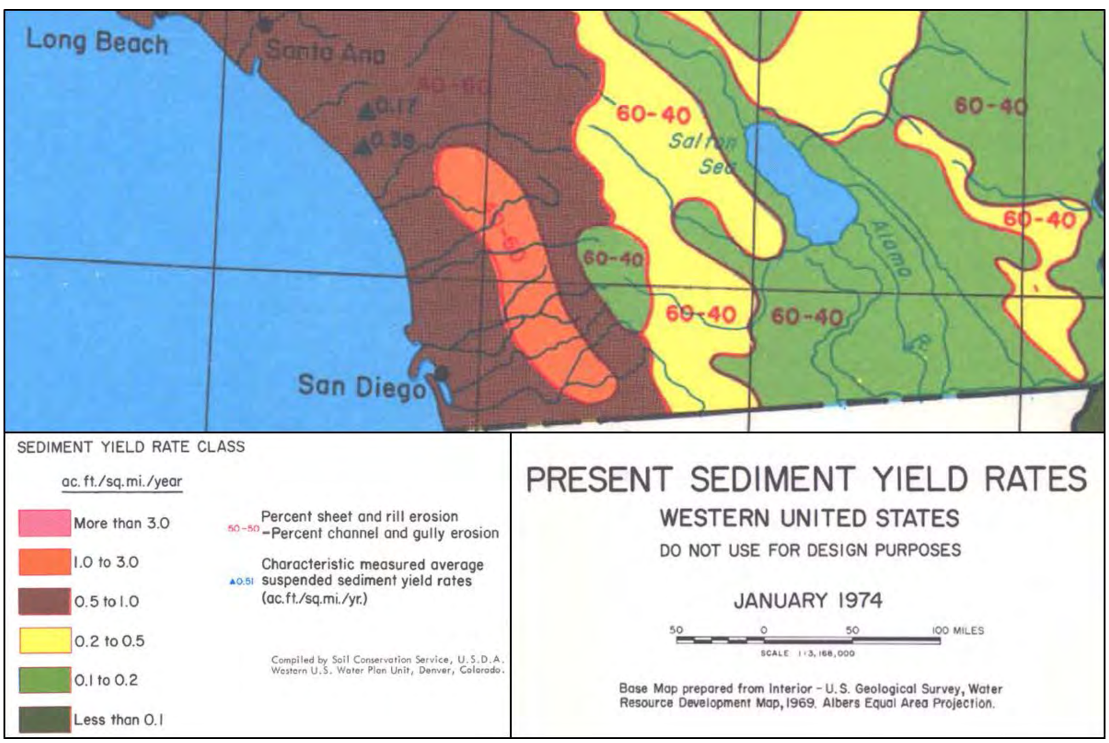

Figure H.8-6 : Regional Sediment Yield Map

According to a regional sediment yield map of the Western US (USDA, 1974), hillslope processes (sheet and rill erosion) account for approximately 40% of the sediment yield in the San Diego County region, while channel processes (in-stream and gully erosion) account for approximately 60% of the sediment yield. Figure H.8-7 shows the different erosion processes. Provision E.3.a.(3)(a) of the MS4 Permit requires, "maintenance or restoration of natural storage reservoirs and drainage corridors (including topographic depressions, areas of permeable soils, natural swales, and ephemeral and intermittent streams)", effectively making maintenance or restoration of channels and gullies within a project site a site design requirement.

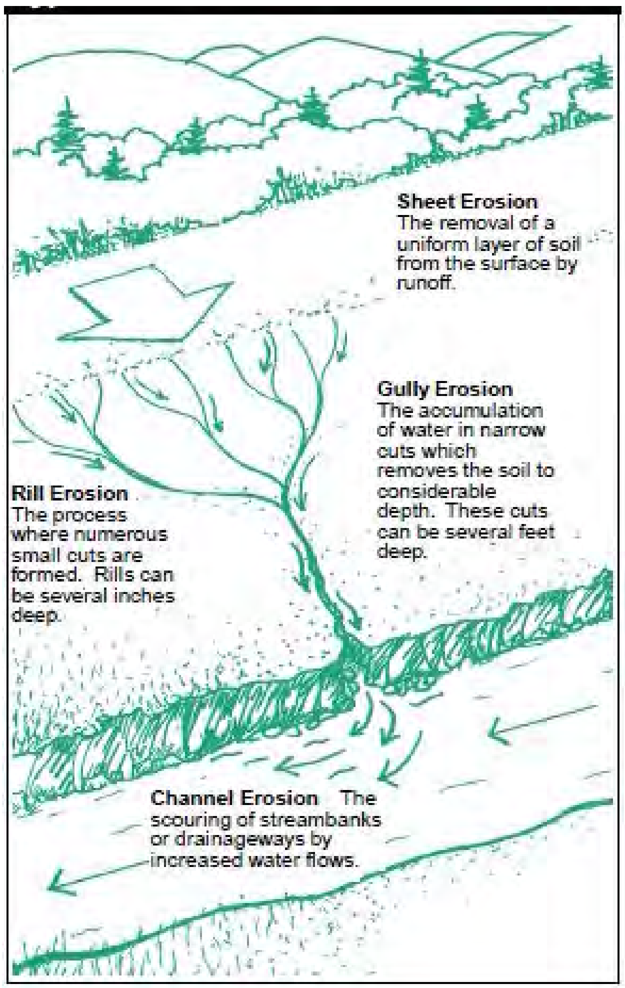

Figure H.8-7 : Different Erosion Processes that Contribute Sediment

Source: http://www.fairfaxcounty.gov/nvswcd/youyourland/soil.htm

Sediment yield from hillslope processes can be estimated using the Revised Universal Soil Loss Equation (RUSLE) and a sediment delivery ratio. For channel processes, the best available regional datasets are the USGS National Hydrography Dataset (NHD) and the NHDPlus dataset from USEPA and USGS (http://www.horizon-systems.com/nhdplus/). Both these datasets may not include the lowest order channels or gullies in the stream network, which can contribute a considerable amount of sediment produced from channel processes. Since the lower order channels and gullies originate and are mostly on the hillslopes, it is assumed for the Sp analysis that the sediment yield from lower order channels and gullies is proportional to the sediment yield from hill slopes. Based on feedback received during the TAC meetings (**Appendix H.5.1**) the following distribution is proposed for the calculation of Sp:

- 70% of bed sediment yield ratio from RUSLE analysis (assumed to account for sediment yield from hillslope processes (sheet and rill erosion) and channels and gullies not part of the NHDPlus dataset); and
- 30% of bed sediment yield ratio from channels in the NHDPlus dataset.

Note:

- If an applicant elects to map the waters of the state, the Sp distribution shall be revised to
    - 40% of bed sediment yield ratio from RUSLE analysis;
    - 30% of bed sediment yield ratio from waters of the state that are not part of NHDPlus dataset; and
    - 30% of bed sediment yield ratio from channels in the NHDPlus dataset.

SCALE OF ANALYSIS

The project applicant shall perform the Sp analysis at point (or points) where runoff leaves the project site.[24] The steps for performing an Sp analysis are shown in Figure H.8-8 and described below.

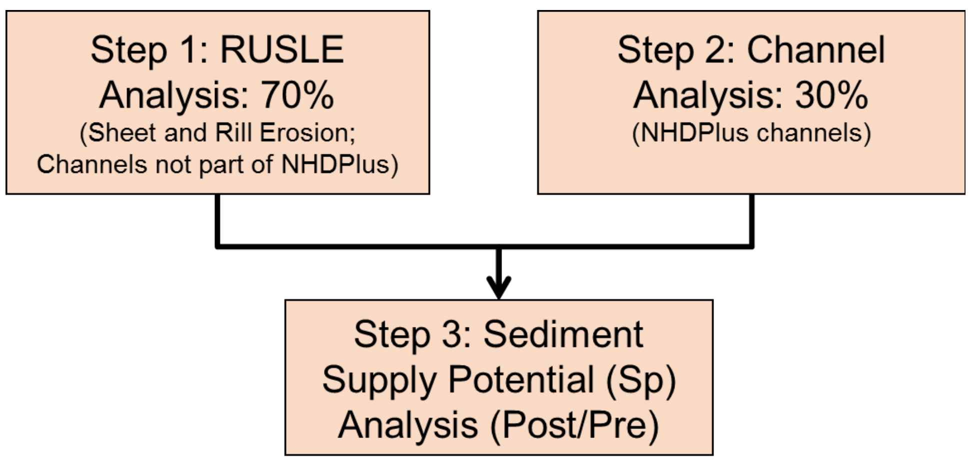

Figure H.8-8: Sediment Supply Potential Flow Chart

STEP 1: RUSLE ANALYSIS

RUSLE analysis is assumed to account for sediment yield from hillslope processes (sheet and rill erosion) and channels and gullies not part of the NHDPlus dataset. The change in bed sediment yield in the post-project condition compared to the pre-project condition using the RUSLE analysis must be

[24] The City Engineer has the discretion to allow for a watershed-scale Sp analysis to be performed at the point of compliance if the future built-out conditions of the watershed are used in the analysis.

estimated using Equation H.8-9. This equation is a modified form of the standard RUSLE equation. Only hillslopes that are anticipated to generate coarse sediment must be used in this analysis. Since Sp is a dimensionless index the terms that are relatively constant in the pre and post project condition, such as rainfall factor, have been removed.

Equation H.8-9: Sediment Yield (Hillslope)

$$SY_{HillSlope} = \frac{Post - Project\sum\{A \times K \times LS \times C\}}{Pre - Project\sum\{A \times K \times LS \times C\}}$$

Where:

A = Hillslope Area (acres)

K = Soil erodibility factor, this value can be obtained from regional K factor map from SWRCB or web soil survey or site-specific grain size analysis

LS = Slope length and steepness factor, this value can be obtained from the regional LS factor map from SWRCB or site-specific determination using look up tables based on slope and horizontal slope length from USDA Agriculture Handbook Number 703 (Renard et al., 1997) or other relevant sources

C= Cover management factor, use regional C factor map from USEPA or site-specific information; this is the reciprocal of the amount of surface cover on soil, whether it be vegetation, temporary mulch or other material. It is roughly the percentage of exposed soil, i.e., 95 percent cover yields a "C" value of 0.05. Use C=0 for areas where management actions are implemented (e.g. impervious areas) or where the project proposes any significant grading activities.

The applicant may be allowed to receive credit for bed sediment yield from engineered slopes on the project perimeter directly discharging to conveyance systems if **all** of the following criteria are met:

- The engineered slopes consist of coarse bed material. This is confirmed by performing grain size distribution per ASTM D422 for the engineered slope and verifying that the d_{50} is greater than no. 200 sieve (0.074 mm).
- Cover factor in the post project condition shall not be greater than the cover factor used in the pre project condition for the same area.
- A maximum practice factor of 0.25 is applied to proposed fill slopes. A maximum practice factor of 0.50 is applied to proposed cut slopes.
- A statement from the geotechnical engineer is included in the SWQMP certifying that the engineered slope will be stable even after accounting for bed sediment generation and the anticipated soil loss during the planned lifetime of the engineered slope is acceptable.

Additional analysis and/or documentation may be requested by the City Engineer prior to approval of the credit for bed sediment yield from engineered slopes.

STEP 2: CHANNEL ANALYSIS

If an NHDPlus mapped channel exists within the project property boundary, applicants must consider the sediment production from this existing channel system. The change is bed sediment yield in the post-project condition compared to the pre-project condition from channels in the NHDPlus dataset must be estimated using Equation H.8-10 (SY_{NHD}). This equation is based on screening-level GIS calculations of stream length that will be contributing sediment in the post-project condition in the watershed tributary to the point of compliance.

Equation H.8-10: Sediment Yield (NHD)

$$SY_{NHD} = \frac{L_{post}}{L_{pre}}$$

Where:

L_{post} = Length of NHDplus streams in the watershed contributing to bed sediment supply in the post-project condition [miles]

L_{pre} = Length of NHDplus streams in the watershed contributing to bed sediment supply in the pre-project existing condition [miles]

STEP 3: SEDIMENT SUPPLY POTENTIAL ANALYSIS

Sediment Supply Potential (Sp) is defined as the ratio of post-project/pre-project (existing) long-term bed sediment supply. Sp must be calculated using Equation H.8-11 presented below:

Equation H.8-11: Sediment Supply Potential

$$S_p = 0.7 \times SY_{RUSLE} + 0.3$$

Where:

S_p = Sediment Supply Potential [unitless]

$SY_{Hillslopes}$ = Change in bed sediment yield from hillslopes [unitless]

SY_{NHD} = Change in bed sediment yield from channels in NHDPlus dataset [unitless]

When estimating Sp the following additional conditions apply:

- Projects that do not have onsite NHDPlus channels shall omit consideration of SY_{NHD} and weighting factors depicted in Equation H.8-11. This simply results in Sp = SY_{RUSLE}.
- It must be assumed that the sediment yield from an area that drains to a structural BMP is zero. Consideration of sediment yield from an area draining to the structural BMP may be allowed if sediment bypass measures are implemented upstream of the structural BMP. However, additional analysis may be requested by the City Engineer to substantiate the sediment yield estimates proposed by the applicant from implementing sediment bypass measures.

- For scenarios where an upstream coarse sediment yield area drains through the project footprint and the project footprint cuts off conveyance of bed sediment generated upstream of the project footprint to the point of compliance, (e.g., via debris basins) the contribution from the upstream area shall be assumed to be zero.

As applicable, the applicant must use Worksheet H.8-3 to document the Sp calculations for each point of compliance.

Worksheet H.8-3: Sediment Supply Potential (Sp) Analysis

<table>
<tr><th colspan="12">Sediment Supply Potential (Sp) Analysis</th><th>Worksheet H.8-3</th></tr>
<tr><td>1</td><td colspan="6">Scale of Analysis</td><td colspan="6">☐ Project Scale
☐ Watershed Scale (built-out condition)</td></tr>
<tr><td colspan="12">Step 1: RUSLE Analysis</td></tr>
<tr><td rowspan="11">2</td><td rowspan="2">GLU</td><td colspan="5">Pre-Project</td><td colspan="5">Post-Project</td></tr>
<tr><td>A</td><td>K</td><td>LS</td><td>C</td><td>A*K*LS*C</td><td>A</td><td>K</td><td>LS</td><td>C</td><td>A*K*LS*C</td></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="11">Add additional rows as needed</td></tr>
<tr><td>3</td><td colspan="5">Sum Pre-Project</td><td></td><td colspan="4">Sum Post-Project</td><td></td></tr>
<tr><td>4</td><td colspan="8">SY_{RUSLE}: (Sum Post-Project/ Sum Pre-Project) (From Line 3)</td><td colspan="2"></td><td>unitless</td></tr>
<tr><td colspan="12">Step 2: Channel Analysis: NHDPlus Channels</td></tr>
<tr><td>5</td><td colspan="8">L_{pre} (from GIS analysis of pre-project existing condition)</td><td colspan="2"></td><td>miles</td></tr>
<tr><td>6</td><td colspan="8">L_{post} (from GIS analysis of post-project condition)</td><td colspan="2"></td><td>miles</td></tr>
<tr><td>7</td><td colspan="8">SY_{NHD}: (Line 6 / Line 5)</td><td colspan="2"></td><td>unitless</td></tr>
<tr><td colspan="12">Step 3: Sediment Supply Potential Analysis</td></tr>
<tr><td>8</td><td colspan="8">RUSLE Analysis Bed Sediment Yield Ratio Calculated (Line 4)</td><td colspan="2"></td><td>unitless</td></tr>
<tr><td>9</td><td colspan="8">Channel Bed Sediment Yield Ratio from NHDPlus dataset
(Line 7)</td><td colspan="2"></td><td>unitless</td></tr>
<tr><td>10</td><td colspan="8">Sediment Supply Potential Calculated using Equation H.8.11.
(0.7 x Line 8 + 0.3 x Line 9)</td><td colspan="2"></td><td>unitless</td></tr>
</table>

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H.9 Mitigation Measures Fact Sheets

The following fact sheets were developed to assist the project applicants with designing mitigation measures:

- Additional flow control
- Stream Rehabilitation

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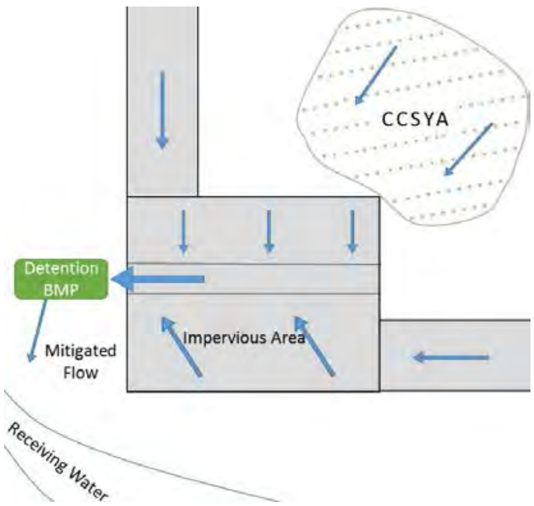
H.9.1 Additional Flow Control



Description

Additional flow control refers to the modification of post-development flow rates and durations beyond the levels required by standard HMP criteria (i.e. control of flow rates and durations from Q_c to Q_{10}). Additional flow control can mitigate the effect of decreased sediment delivery by equivalently limiting sediment transport capacity. BMPs providing additional flow control are detention/retention type BMPs and will typically be larger than those that meet HMP criteria only. The performance standard for additional flow control can be demonstrated through the NII management standard.

Management Standard and Sizing Approach

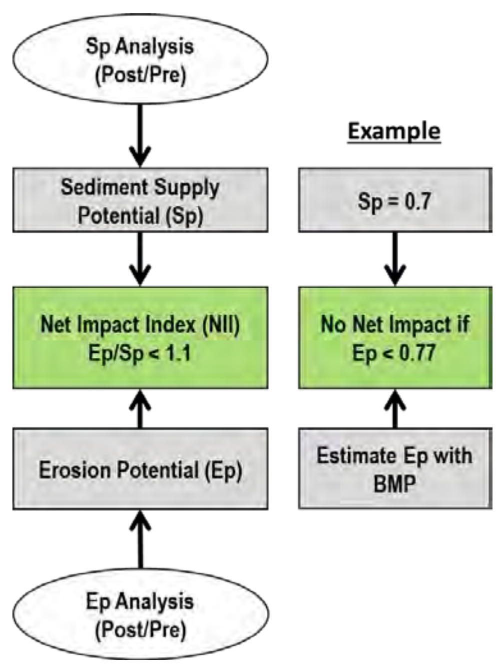
The management standard additional flow control BMPs need to meet to demonstrate that there is no net impact to the receiving waters is presented in the equation below:

$$NII = \frac{Ep}{Sp} \leq 1.1$$

Where:

Ep: is the ratio of post-project/pre-development sediment transport capacity

Sp: ratio of post-project/pre-project (existing) long-term bed sediment supply



Note: Redevelopment projects typically do not have critical coarse sediment yield areas onsite because management actions have been implemented onsite (e.g. impervious areas, stabilization, etc.). Refer to Appendix H.8 for methodologies to calculate Ep and Sp.

Project applicants must demonstrate that the NII management standard will be met under the post-project scenario through the following steps:

1. Calculate the Sp at the point of compliance using guidance in **Appendix H.8.2**.
2. Determine the Target Ep: EpTarget ≤ 1.1 * Sp

3. Calculate the pre-development sediment transport capacity or work (Ep denominator). Refer to **Section 6.3.3** for definition of pre-development and refer to **Appendix H.8.1** for guidance on calculating the sediment transport capacity or work.
4. Iteratively size additional flow control BMPs and calculate the post-project sediment transport capacity (Ep numerator) until the target Ep is reached.
5. Summarize the calculations performed to size the BMPs in the SWQMP.

In addition to the general approach outlined above, additional flow control BMPs must meet the design criteria presented in the Model BMP Design Manual (refer to **Appendix E** Fact Sheets). Deviations from these criteria may be approved at the discretion of the City Engineer if it is determined appropriate.

Design Adaption for Project Goals

NII management standard is met by additional flow control. Larger BMPs may be able to provide adequate additional flow control to meet the required performance standard. In this scenario no additional sediment BMPs are required.

For example, project that has an Sp = 0 (i.e. 100% of the bed sediment in the drainage area to the point of compliance is impacted by the project) can be mitigated by designing a BMP such that there is no discharge within the geomorphically significant flow range (i.e. Q_c to Q_{10}).

NII management standard is not fully met by additional flow control. Additional flow control alone may not be able to entirely meet the NII management standard due to site, or other, constraints. In scenarios where the target Ep cannot be met by additional flow control, additional BMPs that increase the supply of bed sediment or reduce the susceptibility of the receiving channel will be required.

Note: Additional flow control BMPs can be independent BMPs that provide flow control only or they can be integrated with storm water pollutant control BMPs.

Conceptual Design and Sizing Approach

The following steps detail an approach that can be used to appropriately size BMPs that provide additional flow control:

Step 1: Calculate the Sediment Supply Potential (Sp) based on pre- and post-project condition at the point of compliance.

- Refer to **Appendix H.8.2** for methodology to calculate Sp. Applicant must document this analysis using Worksheet H.8.2-1.

Step 2: Determine the Target Ep based on the results of Step 1.

- $Ep_{Target} \leq 1.1 * Sp$

Step 3: Perform continuous simulation modeling for pre-development condition.

- Perform continuous simulation (refer to **Appendix G**) for the pre-development condition.

- o Determine the flow durations for the pre-project scenario as described in **Appendix G.1.6.2**.

Step 4: Perform pre-development work analysis.

- o Calculate the cumulative work performed by the range of geomorphically significant flows for the pre-development scenario, (refer to Step 3 and Step 4 in **Appendix H.8.1** for calculation of work).

Step 5: Implement flow control BMPs and perform continuous simulation modeling for post-project scenario.

- o Appropriately size pollutant control and hydromodification management BMPs according to the procedures presented in this manual.
- o Perform continuous simulation (refer to **Appendix G**) for the post-project condition.
- o Determine the flow durations for the post-project scenario as described in **Appendix G.1.6.2**.
- o Typically, BMPs sized to satisfy the flow duration control will provide for some level of Sp reduction and will ensure that the minimum design standards and sizing requirements are met.

Step 6: Perform post-project work analysis.

- o Follow the steps presented in Step 4 to determine the post-project total work.

Step 7: Calculate Ep and determine if Target Ep has been met.

- o Divide the post-project total work by the pre-development total work and determine if the target Ep has been met.
- o If the target Ep is met by the standard BMPs, document results and compliance with hydrologic and sediment supply performance standards.
- o If the target Ep is not met, proceed to Step 8.

Step 8: Provide additional flow control storage and calculate Ep.

- o Following the procedures presented in the previous steps, iteratively calculate Ep for increasingly large BMPs until the target Ep is met.
- o Document results and compliance with hydrologic and NII management standard.

As applicable, the applicant must use Worksheet H.8.1-1, Worksheet H.8.2-1 and Worksheet H.9.1-1 to document sizing of the additional flow control mitigation measure.

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Worksheet H.9-1: Additional Flow Control Mitigation Measure

Additional Flow Control Mitigation Measure		Worksheet H.9-1	
1	Sediment Supply Potential (Line 16 of Worksheet H.8-3)		unitless
2	Attached completed Worksheet H.8-3 and associated documentation	☐ Yes ☐ No	
3	Target Ep ≤ 1.1 * Line 1		unitless
4	Erosion Potential (Line 16 of Worksheet H.8-1)		unitless
5	Attached completed Worksheet H.8-1 and associated documentation	☐ Yes ☐ No	
6	Is Line 4 ≤ Line 3? If Yes, NII management standard is met. If No, increase the size of the BMP and recalculate Line 4.	☐ Yes ☐ No	

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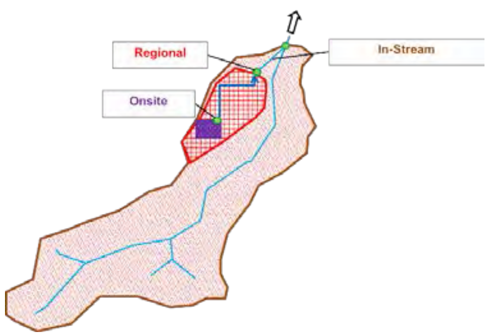
H.9.2 Stream Rehabilitation



Description

Hydromodification control can be achieved by stream rehabilitation projects including: drop structures, grade control structures, bed and bank reinforcement, increased channel sinuosity or meandering, increased channel width, and flow diversion. The objective of these in-stream controls, or stream restoration measures, is to reduce or maintain the overall Ep of the receiving channel. Stream rehabilitation option is only available when the receiving channel of concern is already impacted by erosive flows and shows evidence of excessive sediment, erosion, deposition, or is a hardened channel.

Management Standard and Sizing Approach

The management standard stream rehabilitation projects need to meet to demonstrate that there is no net impact to the receiving waters is presented in the equation below:

$$NII = \frac{Ep}{Sp} \leq 1.1$$

Where:

Ep: is the ratio of post-project/pre-development sediment transport capacity

Sp: ratio of post-project/pre-project (existing) long-term bed sediment supply

Note: Stream rehabilitation project reduce Ep by modifying the stream's hydraulic properties and/or bed/bank material resistance without fully replacing sediment supply or controlling increases in runoff. Refer to **Appendix H.8** for methodologies to calculate Ep and Sp.

Design Adaption for Project Goals

The following describes different types of stream rehabilitation projects that could be implemented to meet the NII management standard by reducing or maintaining the overall Ep:

Drop Structures: Drop structures are designed to reduce the average channel slope, thereby reducing the shear stresses generated by stream flows. These controls can be incorporated as natural looking rock structures with a step-pool design which allows drop energy to be dissipated into the pools while providing a reduced longitudinal slope between structures.

Grade Control Structures: Grade control structures are designed to maintain the existing channel slope while allowing for minor amounts of local scour. These control measures are often buried and entail a narrow trench across the width of the stream backfilled with concrete or similar material, as well as the creation of a "plunge pool" feature by placing boulders and vegetation on the downstream side of the sill. A grade control structure provides a reduced footprint and impact as compared to drop structures, which are designed to alter the channel slope.

Bed and Bank Reinforcement: Channel reinforcement serves to increase bed and bank resistance to instream erosion. A number of vegetated approaches are widely used. Such approaches include large woody debris, live crib walls, vegetated mechanically stabilized earth, live siltation, live brushlayering, willow posts and poles, live staking, live fascine, rootwad revetment, live brush mattresses, and vegetated reinforcement mats. These technologies provide erosion control that stabilizes bed and bank surfaces and allows for re-establishment of native plants, which serves to further increase channel stability.

Channel Sinuosity: Increasing channel sinuosity (meandering) can serve to reduce the channel slope, thereby reducing the shear stresses generated by stream flows. However, forcing a channel to be too sinuous is likely to lead to subsequent channel avulsion (cutting a new stream path) to a straighter course. Channel sinuosity needs to be supported by a geomorphic basis of design that shows the proposed form and gradient are appropriate for the valley slope, sediment, and water regime. This support may take the form of reference reaches in similar watersheds that have supported the proposed morphology over a significant period of time, or comparison between the proposed form and typical literature values.

Channel Widening: Increasing the width-to-depth ratio of a stream's cross section is meant to spread flows out over a wider cross section with lower depths, thereby reducing shear stress for a given flow rate. This approach can be a useful management strategy in incised creeks to restore them to equilibrium conditions once vertical incision has ceased. As with sinuosity, it is important to develop a robust geomorphic basis of design that shows the increase in width-to-depth ratio to be sustainable.

Flow Diversion: Flow diversions can be designed to divert the excess flows caused by development to an hydromodification management exempt water body so that the shear stresses do no increase in the susceptible receiving water. When diversions are proposed to a water body exempt through watershed management area analysis, the applicant is required to provide a supporting analysis that the excess flows diverted to the exempt water body do not invalidate the exemption.

Design Considerations

Each stream rehabilitation project is to some degree unique because of differences in geomorphic process, morphology and previous watershed history. For this reason, this fact sheet does not provide a prescriptive 'cookery book' approach for rehabilitating streams, but instead provides guidelines and recommendations. Shields (1996) provides a helpful overview of the analytical steps involved in stream restoration and Shields et al. (1999) provides examples of approaches used to rehabilitate incised channels. Applicant will need to provide geomorphic and engineering information to support their proposed project approach. It is recommended that multiple lines of technical evidence be used by applicants to develop creek restoration plans based on the preponderance of evidence for design criteria such as channel width, depth, slope and planform. It is also important to understand that all creek rehabilitation projects must comply with relevant Federal, State and local regulations and permits. These will likely include obtaining permits from the RWQCB, USACE and California DF&W, and may involve additional permits or consultation with USDF&W and FEMA, as well as permits from the local jurisdiction. The proposed design shall also meet local drainage design guidelines for channel design.

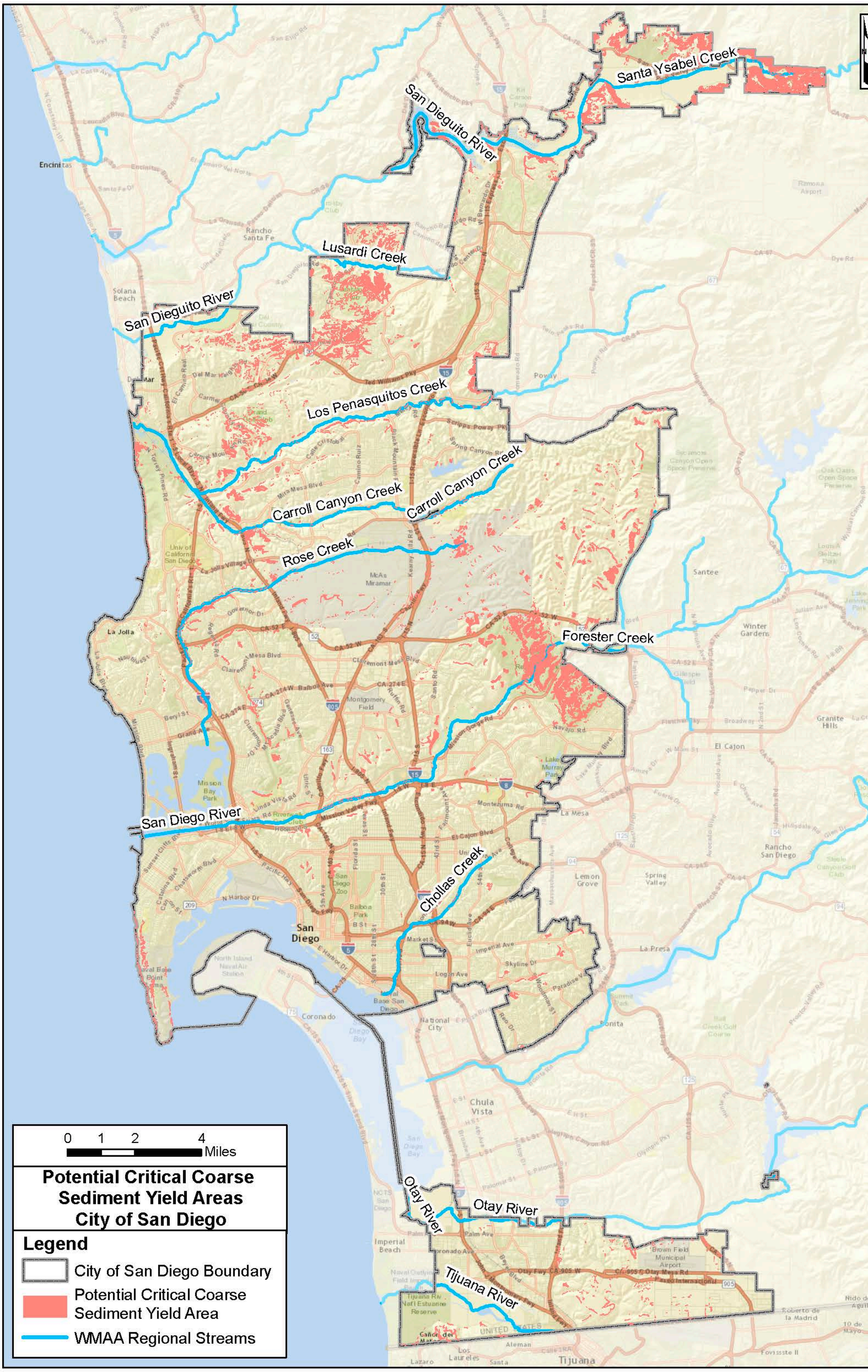


Figure H.9-1 : Potential Critical Coarse Sediment Yield Areas

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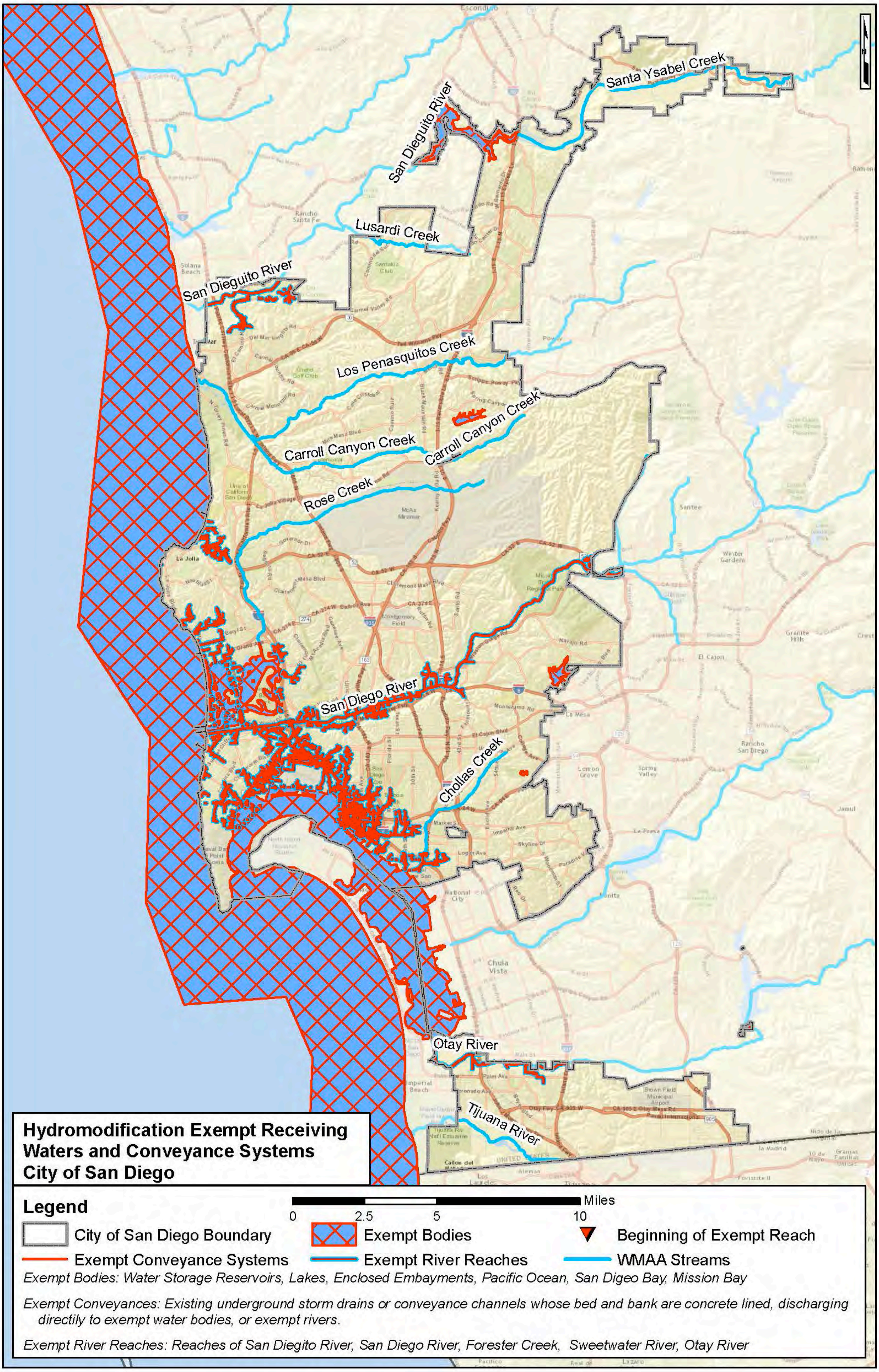

Figure H.9-2 : Hydromodification Exempt Areas

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A.4.2 Quantitative Analysis

Soil loss estimates for each Geomorphic Landscape Unit were estimated using the Revised Universal Soil Loss Equation (RUSLE; Renard et al. 1997) listed below:

$$A = R \times K \times LS \times C \times P$$

Where

A = estimated average soil loss in tons/acre/year

R = rainfall-runoff erosivity factor

K = soil erodibility factor

LS = slope length and steepness factor

C = cover-management factor

P = support practice factor; assumed 1 for this analysis

Regional datasets used to estimate the inputs required to estimate the soil loss from each GLU are listed in table below:

Dataset	Source	Download year	Description
RUSLE – R Factor	SWRCB	2014	Regional R factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_R_Factor/
RUSLE – K Factor	SWRCB	2014	Regional K factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_K_Factor/
RUSLE – LS Factor	SWRCB	2014	Regional LS factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_LS_Factor/
RUSLE – C Factor	USEPA	2014	Regional C factor map was downloaded from http://www.epa.gov/esd/land-sci/emap_west_browser/pages/wemap_mm_sl_rusle_c_qt.htm#mapnav

GIS analysis was used to calculate the area weighted estimate of R, K, LS and C factors using the regional datasets listed in the table above. For the developed land cover the C factor was then adjusted to 0 from the regional estimate to account for management actions implemented on developed sites (e.g. impervious surfaces). Soil loss estimates ranged from 0 to 15.2 tons/acre/year.

For evaluating the degree of relative risk to a stream solely arising from changes in sediment and/or water delivery SCCWRP Technical Report 605, 2010 states:

> *"The challenge in implementing this step is that presently we have insufficient basis to defensibly identify either low-risk or high-risk conditions using these metrics. For example, channels that are close to a threshold for geomorphic change may display significant morphological changes under nothing more than natural year-to-year variability in flow or sediment load.*

- *Acknowledging this caveat, we nonetheless anticipate that changes of less than 10% in either driver are unlikely to instigate, on their own, significant channel changes. This value is a conservative estimate of the year-to-year variability in either discharge or sediment flux that can be accommodated by a channel system in a state of dynamic equilibrium. It does not "guarantee," however, that channel change may not occur—either in response to yet modest alterations in water or sediment delivery, or because of other urbanization impacts (e.g., point discharge of runoff or the trapping of the upstream sediment flux; see Booth 1990) that are not represented with this analysis.*
- *In contrast, recognizing a condition of undisputed "high risk" must await broader collection of regionally relevant data. We note that >60% reductions in predicted sediment production have resulted in both minimal (McGonigle) and dramatic (Agua Hedionda) channel changes, indicating that "more data" may never provide absolute guidance. At present, we suggest using predicted watershed changes of 50% or more in either runoff (as indexed by change in impervious area) or sediment production as provisional criteria for requiring a more detailed evaluation of both the drivers and the resisting factors for channel change, regardless of other screening-level assessments. Clearly, however, only more experience with the application of such "thresholds," and the actual channel conditions that accompany them, will provide a defensible basis for setting numeric standards."*

The following criterion was developed using the suggestions listed above and then used to assign relative sediment production rating to each GLU:

- Low: Soil Loss < 5.6 tons/acre/year [GLUs that have a soil loss of 0 to 5.6 tons/acre/year produces around 10% of the total coarse sediment soil loss from the study area]
- Medium: 5.6 tons/acre/year < Soil Loss < 8.4 tons/acre/year
- High: > 8.4 tons/acre/year [GLUs that have a soil loss greater than 8.4 tons/acre/year produces around 42% of the total coarse sediment soil loss from the study area]

Results from the quantitative analysis are summarized in Table A.4.2.

Table A.4.2 Relative Sediment Production for different Geomorphic Landscape Units

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CB-Agricultural/Grass-1	52883	0.20	4.67	0.14	50	6.5	Medium	No
CB-Agricultural/Grass-2	40633	0.21	5.19	0.14	56	8.3	Medium	No
CB-Agricultural/Grass-3	32617	0.22	6.04	0.14	57	10.6	High	Yes
CB-Agricultural/Grass-4	11066	0.23	7.38	0.14	57	13.5	High	Yes
CB-Developed-1	39746	0.22	3.77	0	49	0	Low	No
CB-Developed-2	32614	0.22	4.28	0	50	0	Low	No
CB-Developed-3	15841	0.22	4.86	0	49	0	Low	No
CB-Developed-4	1805	0.22	5.63	0	48	0	Low	No
CB-Forest-1	32231	0.20	6.38	0.14	39	6.8	Medium	No
CB-Forest-2	38507	0.20	7.20	0.13	45	8.8	High	Yes
CB-Forest-3	55303	0.20	8.14	0.13	48	10.6	High	Yes
CB-Forest-4	38217	0.20	9.95	0.14	50	13.6	High	Yes
CB-Other-1	1036	0.20	5.52	0.13	45	6.5	Medium	No
CB-Other-2	317	0.20	6.46	0.13	45	7.9	Medium	No
CB-Other-3	296	0.20	6.96	0.14	43	8.3	Medium	No
CB-Other-4	111	0.21	6.84	0.14	41	8.2	Medium	No
CB-Scrub/Shrub-1	88135	0.20	5.66	0.14	33	5.3	Low	No
CB-Scrub/Shrub-2	143694	0.20	6.51	0.14	37	6.8	Medium	No
CB-Scrub/Shrub-3	246703	0.21	7.33	0.14	41	8.4	Medium	No
CB-Scrub/Shrub-4	191150	0.21	8.28	0.14	42	9.8	High	Yes
CB-Unknown-1	1727	0.21	5.32	0.13	44	6.3	Medium	No
CB-Unknown-2	1935	0.21	5.95	0.13	44	7.1	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CB-Unknown-3	1539	0.22	6.21	0.13	44	7.7	Medium	No
CB-Unknown-4	278	0.22	6.61	0.13	44	8.4	High	Yes
CSI-Agricultural/Grass-1	14609	0.34	2.72	0.14	39	4.8	Low	No
CSI-Agricultural/Grass-2	9059	0.37	3.61	0.14	47	8.7	High	Yes
CSI-Agricultural/Grass-3	10096	0.38	3.99	0.14	47	9.8	High	Yes
CSI-Agricultural/Grass-4	2498	0.37	4.33	0.14	47	10.5	High	Yes
CSI-Developed-1	82371	0.28	2.51	0	39	0	Low	No
CSI-Developed-2	22570	0.30	2.66	0	41	0	Low	No
CSI-Developed-3	13675	0.30	2.89	0	40	0	Low	No
CSI-Developed-4	3064	0.27	3.20	0	39	0	Low	No
CSI-Forest-1	449	0.27	4.26	0.13	43	6.6	Medium	No
CSI-Forest-2	611	0.25	5.11	0.13	44	7.5	Medium	No
CSI-Forest-3	716	0.29	4.43	0.13	44	7.4	Medium	No
CSI-Forest-4	348	0.30	4.49	0.13	43	7.6	Medium	No
CSI-Other-1	319	0.31	2.50	0.13	32	3.2	Low	No
CSI-Other-2	83	0.27	3.01	0.13	39	4.3	Low	No
CSI-Other-3	45	0.28	3.03	0.13	39	4.5	Low	No
CSI-Other-4	13	0.24	4.01	0.14	39	5.2	Low	No
CSI-Scrub/Shrub-1	9051	0.26	3.53	0.13	39	4.7	Low	No
CSI-Scrub/Shrub-2	10802	0.27	4.36	0.13	41	6.3	Medium	No
CSI-Scrub/Shrub-3	28220	0.26	4.82	0.13	41	6.7	Medium	No
CSI-Scrub/Shrub-4	20510	0.26	5.52	0.13	41	7.8	Medium	No
CSI-Unknown-1	5292	0.28	2.38	0.13	36	3.1	Low	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CSI-Unknown-2	2074	0.29	2.98	0.13	40	4.5	Low	No
CSI-Unknown-3	2171	0.27	3.04	0.13	39	4.2	Low	No
CSI-Unknown-4	676	0.26	3.04	0.13	38	3.8	Low	No
CSP-Agricultural/Grass-1	59327	0.22	3.01	0.14	44	4.0	Low	No
CSP-Agricultural/Grass-2	8426	0.23	3.81	0.14	42	5.2	Low	No
CSP-Agricultural/Grass-3	2377	0.24	4.05	0.14	41	5.6	Low	No
CSP-Agricultural/Grass-4	291	0.22	6.28	0.14	52	10.1	High	Yes
CSP-Developed-1	85283	0.27	2.10	0	42	0	Low	No
CSP-Developed-2	7513	0.26	2.77	0	42	0	Low	No
CSP-Developed-3	2317	0.27	2.70	0	40	0	Low	No
CSP-Developed-4	272	0.27	2.76	0	38	0	Low	No
CSP-Forest-1	14738	0.22	4.52	0.14	44	6.0	Medium	No
CSP-Forest-2	3737	0.22	5.99	0.14	45	8.2	Medium	No
CSP-Forest-3	1858	0.21	6.42	0.14	45	8.5	High	Yes
CSP-Forest-4	484	0.21	7.62	0.14	48	10.2	High	Yes
CSP-Other-1	7404	0.23	2.61	0.14	39	3.2	Low	No
CSP-Other-2	343	0.24	3.68	0.13	40	4.8	Low	No
CSP-Other-3	126	0.24	3.76	0.13	40	4.9	Low	No
CSP-Other-4	17	0.24	4.19	0.13	39	5.3	Low	No
CSP-Scrub/Shrub-1	22583	0.23	3.75	0.14	41	4.8	Low	No
CSP-Scrub/Shrub-2	8938	0.24	5.63	0.14	40	7.1	Medium	No
CSP-Scrub/Shrub-3	7186	0.23	6.15	0.13	39	7.5	Medium	No
CSP-Scrub/Shrub-4	2609	0.22	7.16	0.14	43	9.3	High	Yes

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CSP-Unknown-1	6186	0.25	2.63	0.13	40	3.4	Low	No
CSP-Unknown-2	744	0.27	3.49	0.13	39	4.8	Low	No
CSP-Unknown-3	350	0.28	3.32	0.13	38	4.5	Low	No
CSP-Unknown-4	78	0.28	3.26	0.13	40	4.5	Low	No
FB-Agricultural/Grass-1	6103	0.25	5.49	0.14	49	9.2	High	No
FB-Agricultural/Grass-2	7205	0.25	5.87	0.14	51	10.1	High	No
FB-Agricultural/Grass-3	6730	0.24	6.43	0.14	53	11.3	High	No
FB-Agricultural/Grass-4	2586	0.22	8.62	0.14	57	15.2	High	No
FB-Developed-1	10116	0.28	3.94	0	46	0	Low	No
FB-Developed-2	9075	0.28	4.41	0	45	0	Low	No
FB-Developed-3	5499	0.27	4.72	0	44	0	Low	No
FB-Developed-4	785	0.27	5.08	0	43	0	Low	No
FB-Forest-1	3780	0.21	7.24	0.13	39	8.0	Medium	No
FB-Forest-2	7059	0.21	7.53	0.13	43	8.8	High	No
FB-Forest-3	13753	0.22	8.02	0.13	43	9.7	High	No
FB-Forest-4	8899	0.26	9.63	0.13	35	11.5	High	No
FB-Other-1	172	0.26	5.72	0.13	44	8.6	High	No
FB-Other-2	75	0.26	5.97	0.13	38	7.7	Medium	No
FB-Other-3	76	0.28	6.27	0.13	34	7.6	Medium	No
FB-Other-4	36	0.31	6.70	0.13	33	8.6	High	No
FB-Scrub/Shrub-1	10297	0.24	6.94	0.14	36	8.3	Medium	No
FB-Scrub/Shrub-2	25150	0.25	7.24	0.14	38	9.0	High	No
FB-Scrub/Shrub-3	70895	0.25	7.89	0.13	38	10.0	High	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FB-Scrub/Shrub-4	70679	0.26	9.05	0.14	39	12.1	High	No
FB-Unknown-1	654	0.30	5.33	0.13	37	7.6	Medium	No
FB-Unknown-2	829	0.29	5.26	0.13	40	7.9	Medium	No
FB-Unknown-3	1062	0.29	5.54	0.13	39	8.2	Medium	No
FB-Unknown-4	299	0.28	6.02	0.13	38	8.4	High	No
FSI-Agricultural/Grass-1	8462	0.32	3.91	0.13	24	3.9	Low	No
FSI-Agricultural/Grass-2	4979	0.33	4.29	0.13	31	5.7	Medium	No
FSI-Agricultural/Grass-3	4808	0.34	4.26	0.13	34	6.3	Medium	No
FSI-Agricultural/Grass-4	1055	0.35	4.11	0.13	36	6.7	Medium	No
FSI-Developed-1	9953	0.29	3.09	0	34	0	Low	No
FSI-Developed-2	4972	0.31	3.22	0	37	0	Low	No
FSI-Developed-3	3350	0.29	3.30	0	36	0	Low	No
FSI-Developed-4	763	0.28	3.31	0	37	0	Low	No
FSI-Forest-1	186	0.33	4.62	0.13	37	7.2	Medium	No
FSI-Forest-2	217	0.35	4.47	0.13	39	7.9	Medium	No
FSI-Forest-3	262	0.37	4.71	0.13	40	9.2	High	No
FSI-Forest-4	111	0.36	4.73	0.13	40	9.2	High	No
FSI-Other-1	266	0.31	3.11	0.13	24	2.9	Low	No
FSI-Other-2	81	0.30	3.29	0.13	25	3.1	Low	No
FSI-Other-3	56	0.31	3.04	0.13	27	3.2	Low	No
FSI-Other-4	15	0.29	3.57	0.13	33	4.4	Low	No
FSI-Scrub/Shrub-1	2241	0.27	4.46	0.13	29	4.5	Low	No
FSI-Scrub/Shrub-2	3911	0.28	4.96	0.13	31	5.7	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FSI-Scrub/Shrub-3	7590	0.29	5.05	0.13	34	6.3	Medium	No
FSI-Scrub/Shrub-4	3502	0.30	5.14	0.13	37	7.5	Medium	No
FSI-Unknown-1	1117	0.29	2.83	0.13	27	3.0	Low	No
FSI-Unknown-2	780	0.30	3.44	0.13	32	4.3	Low	No
FSI-Unknown-3	855	0.29	3.41	0.13	31	4.0	Low	No
FSI-Unknown-4	285	0.28	3.21	0.13	32	3.7	Low	No
FSP-Agricultural/Grass-1	13	0.22	2.22	0.13	40	2.5	Low	No
FSP-Agricultural/Grass-2	3	0.22	2.59	0.13	40	3.0	Low	No
FSP-Agricultural/Grass-3	2	0.22	2.69	0.13	40	3.2	Low	No
FSP-Agricultural/Grass-4	0	0.20	2.94	0.12	40	2.9	Low	No
FSP-Developed-1	180	0.26	2.85	0	40	0	Low	No
FSP-Developed-2	13	0.25	2.69	0	40	0	Low	No
FSP-Developed-3	8	0.21	2.25	0	40	0	Low	No
FSP-Developed-4	0	0.21	2.29	0	40	0	Low	No
FSP-Forest-1	8	0.22	2.29	0.14	40	2.9	Low	No
FSP-Forest-2	5	0.20	2.22	0.14	40	2.5	Low	No
FSP-Forest-3	0	0.20	2.22	0.14	40	2.5	Low	No
FSP-Other-1	1307	0.20	2.38	0.14	40	2.7	Low	No
FSP-Other-2	34	0.21	2.36	0.14	40	2.7	Low	No
FSP-Other-3	8	0.22	2.56	0.13	40	3.0	Low	No
FSP-Other-4	0	0.43	4.35	0.12	40	9.3	High	No
FSP-Scrub/Shrub-1	147	0.23	2.68	0.14	40	3.3	Low	No
FSP-Scrub/Shrub-2	18	0.23	2.55	0.14	40	3.3	Low	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FSP-Scrub/Shrub-3	4	0.20	2.23	0.14	40	2.6	Low	No
FSP-Scrub/Shrub-4	0	0.20	1.70	0.12	40	1.7	Low	No
FSP-Unknown-1	40	0.20	1.87	0.13	40	1.9	Low	No
FSP-Unknown-2	5	0.20	1.99	0.12	40	2.0	Low	No
FSP-Unknown-3	1	0.20	2.39	0.12	40	2.4	Low	No
O-Agricultural/Grass-1	2433	0.20	2.93	0.14	34	2.8	Low	No
O-Agricultural/Grass-2	112	0.21	3.44	0.14	32	3.2	Low	No
O-Agricultural/Grass-3	30	0.23	3.89	0.13	32	3.8	Low	No
O-Agricultural/Grass-4	1	0.26	6.47	0.13	37	7.9	Medium	No
O-Developed-1	8327	0.27	1.37	0	39	0	Low	No
O-Developed-2	474	0.25	2.12	0	40	0	Low	No
O-Developed-3	157	0.26	3.07	0	41	0	Low	No
O-Developed-4	26	0.24	3.89	0	41	0	Low	No
O-Forest-1	235	0.22	6.15	0.13	43	7.6	Medium	No
O-Forest-2	67	0.21	5.07	0.13	45	6.6	Medium	No
O-Forest-3	45	0.21	5.43	0.13	47	7.3	Medium	No
O-Forest-4	20	0.20	5.95	0.13	59	9.0	High	No
O-Other-1	9362	0.25	3.86	0.13	36	4.3	Low	No
O-Other-2	344	0.24	3.32	0.13	35	3.5	Low	No
O-Other-3	120	0.23	4.86	0.13	35	5.0	Low	No
O-Other-4	37	0.22	5.64	0.13	39	6.6	Medium	No
O-Scrub/Shrub-1	688	0.22	4.83	0.13	40	5.7	Medium	No
O-Scrub/Shrub-2	224	0.22	5.80	0.13	36	6.3	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
O-Scrub/Shrub-3	209	0.22	6.47	0.13	41	7.5	Medium	No
O-Scrub/Shrub-4	96	0.22	6.62	0.13	44	8.2	Medium	No
O-Unknown-1	1236	0.28	1.60	0.12	26	1.5	Low	No
O-Unknown-2	62	0.27	1.48	0.13	36	1.8	Low	No
O-Unknown-3	15	0.29	3.52	0.13	38	4.9	Low	No
O-Unknown-4	7	0.34	3.87	0.12	40	6.6	Medium	No

GLU Nomenclature: Geology – Land Cover – Slope Category

Geology Categories:

CB Coarse Bedrock

CSI Coarse Sedimentary Impermeable

CSP Coarse Sedimentary Permeable

FB Fine Bedrock

FSI Fine Sedimentary Impermeable

FSP Fine Sedimentary Permeable

O Other

Slope Categories:

1 0%-10%

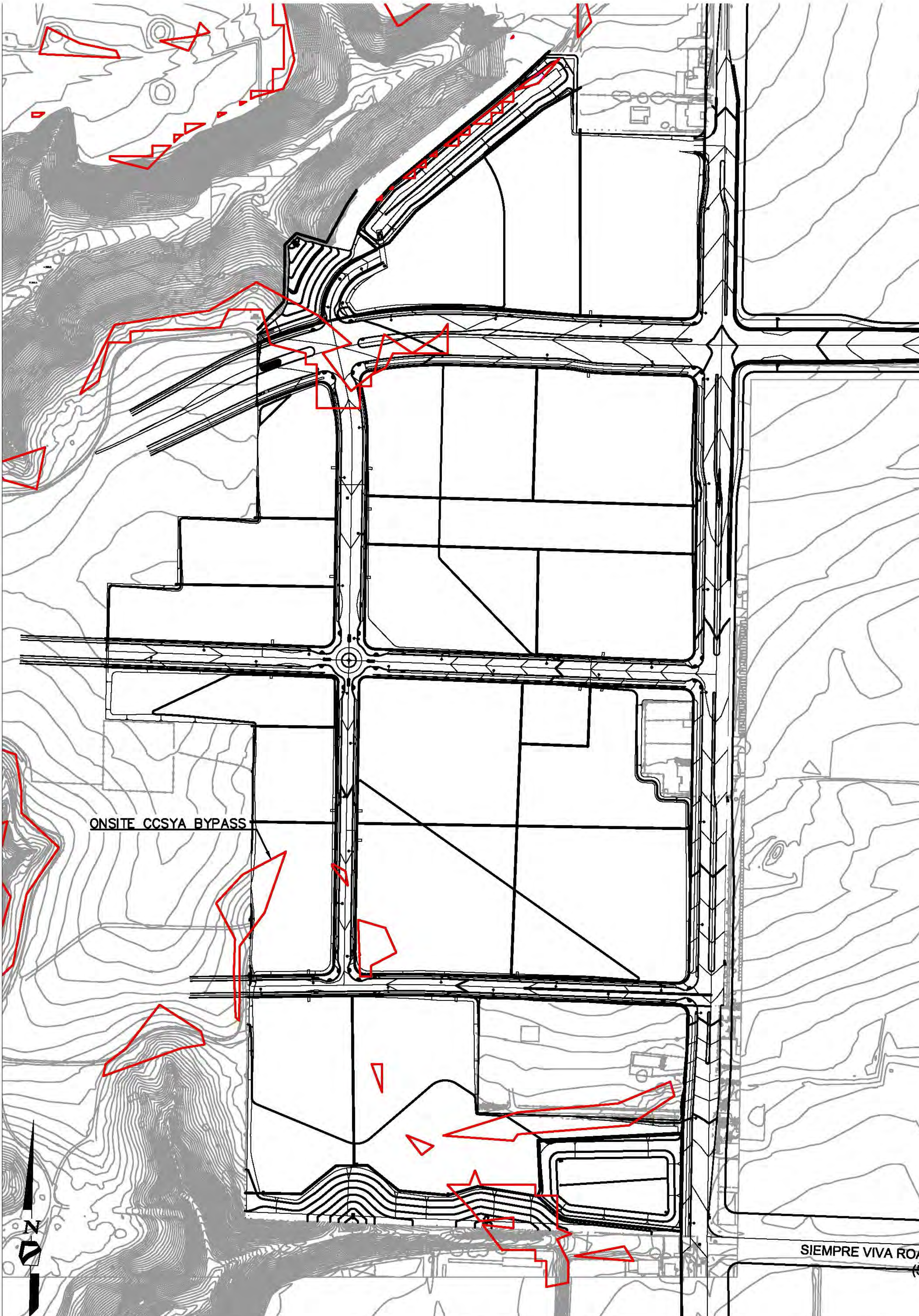
2 10% - 20%

3 20% - 40%

4 > 40%

APPENDIX 2

PCCSYA EXHIBIT



[redacted]

WMAA CCSYA

ONSITE CCSYA TO BE BYPASSED

PREPARED BY:

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey

701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

CITY OF SAN DIEGO

LUMINA

Attachment 2c
CCSYA VICINITY MAP

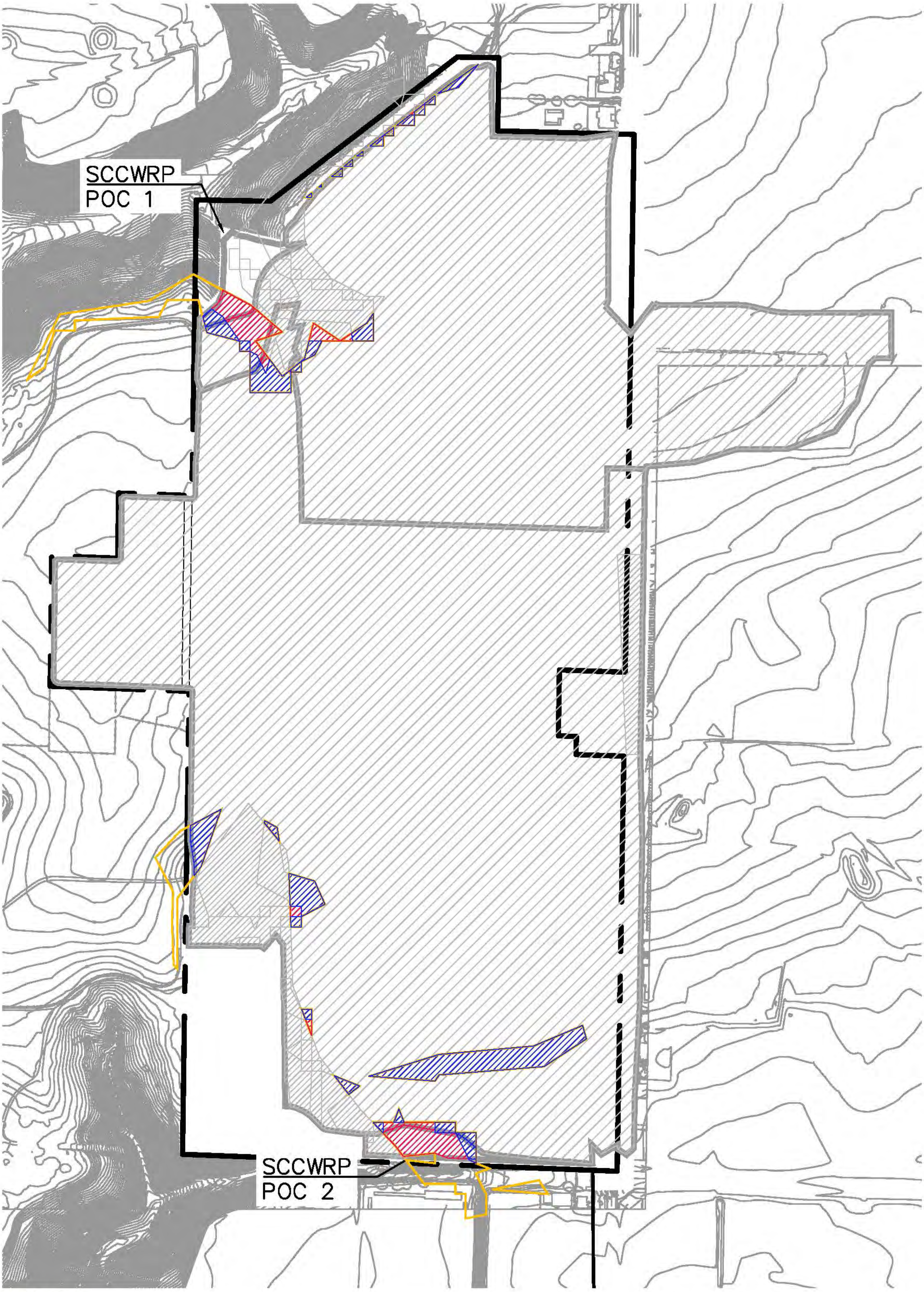
APPENDIX 3

Pre and Post-Development GLU Areas

NHD-Plus Channel Map

Fill and Cut Map

Slope Map



LEGEND

- CRITICAL COARSE SEDIMENT YIELD AREAS
- CSI AGRICULTURAL GRASS 2
- CSI AGRICULTURAL GRASS 3
- OTHER NON-CCSYA GLU
- PROJECT BOUNDARY

SCALE: 1"=300'	PREPARED BY: PROJECT DESIGN CONSULTANTS Planning | Landscape Architecture | Engineering | Survey — 701 B Street, Suite 800 San Diego, CA 92101 619.235.6471 Tel 619.234.0349 Fax	CITY OF SAN DIEGO
JOB #: 2357.35		LUMINA
CREATED: 8/8/18		SWQMP ATTACHMENT 2B PRE-DEVELOPMENT GLU EXHIBIT

P:\2357.35\Engr\Reports\Hydromod-TM\Attachments\2357.35-Attachment2C-CCSYA_GLUs_PRE.dwg 8/14/2018 2:15:46 PM

LEGEND

- CRITICAL COARSE SEDIMENT YIELD AREAS
- PROJECT BOUNDARY
- CUT AREA
- FILL AREA

SCALE: 1"=300'	PREPARED BY:	PROJECT DESIGN CONSULTANTS Planning | Landscape Architecture | Engineering | Survey	CITY OF SAN DIEGO
JOB #: 2357.35		701 B Street, Suite 800 San Diego, CA 92101 619.235.6471 Tel 619.234.0349 Fax	LUMINA
CREATED: 8/8/18			SWQMP ATTACHMENT 2B POST-DEVELOPMENT GLU EXHIBIT

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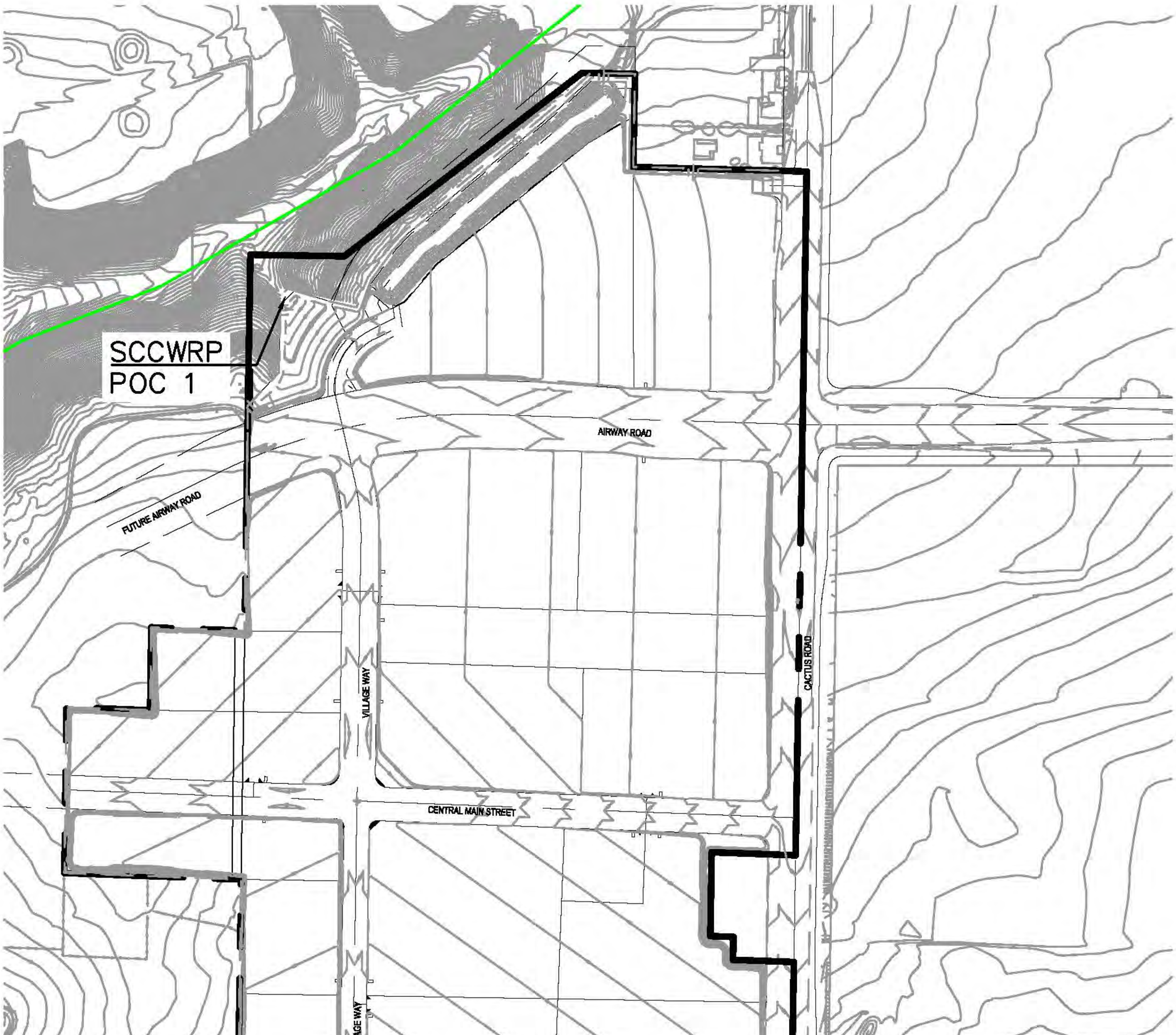


LEGEND

NHD CREEK

PROJECT BOUNDARY

SCALE: 1"=300'	PREPARED BY: PROJECT DESIGN CONSULTANTS Planning | Landscape Architecture | Engineering | Survey — 701 B Street, Suite 800 San Diego, CA 92101 619.235.6471 Tel 619.234.0349 Fax	CITY OF SAN DIEGO
JOB #: 2357.35		LUMINA
CREATED: 8/8/18		SWQMP ATTACHMENT 2B NHD CREEK EXHIBIT

\\projects\p_drive\2357.35\Engr\Reports\Hydromod-TM\Attachments\2357.35-Attachment2C-CCSYA_GLUs_NHD.dwg

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
EG-FG	**1.00**	**1.00**	4008095.51 Sq. Ft.	287545.77 Cu. Yd.	630729.26 Cu. Yd.	343183.49 Cu. Yd.<Fill>
Totals			4008095.51 Sq. Ft.	287545.77 Cu. Yd.	630729.26 Cu. Yd.	343183.49 Cu. Yd.<Fill>

Slopes Table					
Number	Minimum Slope	Maximum Slope	2D Area	3D Area	Color
1	0.00%	25.00%	3691916.42	3696441.03	
2	25.00%	3608.64%	377651.42	416447.69	

APPENDIX 4

Ep Calculations

POC1 Work Calculations, Pre-Developmet Conditions		
Channel Slope:	0.01	
Channel n:	0.045	
Low Flow Threshold:	4.32	cfs
Type of Flow:	50% of Q2	
Channel Type:	Trapezoidal	
Side Slope z:	2	
Bottom Width	10	ft
Normal Depth	0.29	ft
Hydraulic Radius	0.27	ft
Critical Shear Stress τ_c	0.168	
Unit Weight of Water	62.4	lb/ft3

SUM W_{PRE} **2.647**

Rank	Start Date	Duration (hours)	Peak (CFS)	h (ft)	A (ft2)	R (ft)	V (ft/s)	τ (lb/ft2)	W_{PRE}
1	3/1/1983	70	32.151	0.953	11.342	0.795	2.835	0.496	0.532
2	11/11/1972	4	16.511	0.647	7.303	0.566	2.261	0.353	0.180
3	3/24/1983	5	15.815	0.631	7.101	0.554	2.227	0.346	0.166
4	12/19/1970	57	14.393	0.597	6.679	0.527	2.155	0.329	0.139
5	1/11/2005	8	14.327	0.595	6.659	0.526	2.152	0.328	0.137
6	2/22/2004	17	12.839	0.558	6.202	0.496	2.070	0.310	0.110
7	11/25/1985	17	12.695	0.554	6.157	0.493	2.062	0.308	0.107
8	2/21/2005	10	11.616	0.526	5.814	0.471	1.998	0.294	0.089
9	1/16/1978	9	11.518	0.523	5.782	0.469	1.992	0.292	0.087
10	1/3/2005	28	10.653	0.500	5.499	0.449	1.937	0.280	0.073
11	12/4/1992	2	10.540	0.497	5.461	0.447	1.930	0.279	0.071
12	12/7/1992	6	10.436	0.494	5.426	0.444	1.923	0.277	0.069
13	10/19/2004	33	10.144	0.486	5.328	0.438	1.904	0.273	0.064
14	3/26/1991	32	9.766	0.475	5.200	0.429	1.878	0.268	0.059
15	1/31/1979	17	9.702	0.473	5.178	0.427	1.874	0.267	0.058
16	3/2/1992	20	9.248	0.460	5.022	0.416	1.842	0.260	0.051
17	3/20/1973	3	8.963	0.451	4.922	0.410	1.821	0.256	0.047
18	8/14/1983	2	8.786	0.446	4.860	0.405	1.808	0.253	0.044
19	4/1/1982	7	8.671	0.443	4.819	0.402	1.799	0.251	0.043
20	11/12/1976	3	8.613	0.441	4.798	0.401	1.795	0.250	0.042
21	2/22/2005	10	8.374	0.434	4.713	0.395	1.777	0.246	0.039
22	2/28/1991	29	7.962	0.421	4.563	0.384	1.745	0.240	0.033
23	11/20/1983	24	7.798	0.416	4.503	0.380	1.732	0.237	0.031
24	10/30/1998	2	7.762	0.415	4.490	0.379	1.729	0.236	0.031
25	1/29/1980	25	7.585	0.409	4.425	0.374	1.714	0.233	0.028
26	11/29/1970	5	7.214	0.397	4.286	0.364	1.683	0.227	0.024
27	3/18/1983	24	7.180	0.396	4.273	0.363	1.680	0.227	0.023
28	3/1/1981	14	6.874	0.386	4.156	0.354	1.654	0.221	0.020
29	12/25/1988	4	6.858	0.385	4.150	0.354	1.653	0.221	0.020
30	1/15/1993	27	6.795	0.383	4.126	0.352	1.647	0.220	0.019

31	2/27/1978	39	6.560	0.375	4.035	0.345	1.626	0.216	0.017
32	2/6/1992	6	6.531	0.374	4.023	0.345	1.623	0.215	0.016
33	1/4/1995	7	6.337	0.368	3.947	0.339	1.605	0.212	0.014
34	2/19/1993	4	6.315	0.367	3.939	0.338	1.603	0.211	0.014
35	3/10/1975	30	6.229	0.364	3.904	0.336	1.595	0.210	0.013
36	4/20/1983	6	6.132	0.361	3.866	0.333	1.586	0.208	0.012
37	3/6/1980	9	6.086	0.359	3.848	0.332	1.582	0.207	0.012
38	10/27/2004	6	5.924	0.353	3.782	0.327	1.566	0.204	0.010
39	3/21/1983	2	5.889	0.352	3.768	0.326	1.563	0.203	0.010
40	12/27/1984	25	5.850	0.351	3.752	0.324	1.559	0.202	0.010
41	3/20/1991	28	5.842	0.350	3.749	0.324	1.558	0.202	0.010
42	3/2/2004	3	5.807	0.349	3.735	0.323	1.555	0.202	0.009
43	12/28/2004	13	5.797	0.349	3.731	0.323	1.554	0.201	0.009
44	2/15/1986	8	5.636	0.343	3.665	0.318	1.538	0.198	0.008
45	11/22/1984	3	5.560	0.340	3.634	0.315	1.530	0.197	0.007
46	3/17/1982	31	5.281	0.330	3.518	0.307	1.501	0.191	0.005
47	3/4/2005	5	5.133	0.324	3.455	0.302	1.486	0.188	0.004
48	3/7/1974	6	5.122	0.324	3.451	0.301	1.484	0.188	0.004
49	2/10/1978	6	5.114	0.324	3.447	0.301	1.484	0.188	0.004
50	3/5/1981	10	5.098	0.323	3.440	0.301	1.482	0.188	0.004
51	1/14/1978	17	5.038	0.321	3.415	0.299	1.475	0.186	0.004
52	2/19/1980	30	4.999	0.319	3.398	0.297	1.471	0.186	0.003
53	1/25/1995	17	4.973	0.318	3.387	0.296	1.468	0.185	0.003
54	4/28/1994	5	4.838	0.313	3.329	0.292	1.453	0.182	0.002
55	12/11/1984	7	4.723	0.309	3.279	0.288	1.440	0.180	0.002
56	8/16/1977	8	4.656	0.306	3.250	0.286	1.433	0.178	0.001
57	10/11/1987	2	4.617	0.305	3.232	0.284	1.428	0.178	0.001
58	1/4/1974	6	4.596	0.304	3.223	0.284	1.426	0.177	0.001
59	3/5/2000	5	4.387	0.296	3.130	0.276	1.401	0.173	0.000
60	1/12/1993	11	4.359	0.294	3.118	0.275	1.398	0.172	0.000
61	2/2/1988	3	4.303	0.292	3.093	0.274	1.391	0.171	0.000

POC1 Work Calculations, Post-Developmet Conditions

Channel Slope:	0.01	
Channel n:	0.045	
Low Flow Threshold:	4.32	cfs
Type of Flow:	50% of Q2	
Channel Type:	Trapezoidal	
Side Slope z:	2	
Bottom Width	10	ft
Normal Depth	0.29	ft
Hydraulic Radius	0.27	ft
Critical Shear Stress τ_c	0.168	
Unit Weight of Water Υ	62.4	lb/ft3

SUM W_{POST} **0.241**

SYrusle=	0.091
SYnhd=	1
Ep=	0.364

Rank	Start Date	Duration (hours)	Peak (CFS)	h (ft)	A (ft2)	R (ft)	V (ft/s)	τ (lb/ft2)	W_{POST}
1	4/15/2008	33.8	14.028	0.588	6.568	0.520	2.136	0.325	0.132
2	2/26/1983	150.8	9.098	0.455	4.969	0.413	1.831	0.258	0.049
3	1/30/1979	81.3	6.392	0.370	3.969	0.341	1.611	0.213	0.015
4	12/7/1992	34	6.183	0.362	3.886	0.334	1.591	0.209	0.013
5	11/24/1985	52.8	5.956	0.354	3.795	0.328	1.569	0.204	0.011
6	10/18/2004	76	5.555	0.340	3.632	0.315	1.530	0.197	0.007
7	2/21/2004	54.5	5.441	0.336	3.585	0.312	1.518	0.194	0.006
8	1/7/2005	118.8	5.109	0.324	3.445	0.301	1.483	0.188	0.004
9	2/6/1992	37.8	5.104	0.323	3.443	0.301	1.482	0.188	0.004
10	2/18/2005	137	4.344	0.294	3.111	0.275	1.396	0.172	0.000
11	2/27/1991	67.3	4.313	0.293	3.097	0.274	1.393	0.171	0.000
12	11/12/1976	28.5	4.254	0.290	3.070	0.272	1.385	0.170	0.000

POC2 Work Calculations, Pre-Developmet Conditions		
Channel Slope:	0.0649	
Channel n:	0.06	
Low Flow Threshold:	5.886	cfs
Type of Flow:	50% of Q2	
Channel Type:	Trapezoidal	
Side Slope z:	3.25	
Bottom Width	4	ft
Normal Depth	0.39	ft
Hydraulic Radius	0.31	ft
Critical Shear Stress τ_c	1.255	
Unit Weight of Water `	62.4	lb/ft3

SUM

W_{PRE} 72.111

Rank	Start Date	Duration (hours)	Peak (CFS)	h (ft)	A (ft2)	R (ft)	V (ft/s)	τ (lb/ft2)	W_{PRE}
1	3/1/1983	72	48.407	1.173	9.169	0.765	5.279	3.100	13.220
2	11/11/1972	5	22.267	0.794	5.222	0.556	4.264	2.250	4.231
3	12/19/1970	57	21.983	0.788	5.174	0.553	4.249	2.238	4.139
4	1/11/2005	9	21.272	0.775	5.053	0.545	4.210	2.207	3.909
5	3/24/1983	6	21.250	0.775	5.049	0.545	4.209	2.206	3.902
6	2/22/2004	17	20.292	0.756	4.885	0.534	4.154	2.163	3.594
7	2/21/2005	11	18.815	0.727	4.628	0.517	4.066	2.095	3.128
8	12/7/1992	7	17.891	0.708	4.464	0.506	4.008	2.050	2.840
9	11/25/1985	18	16.937	0.688	4.293	0.495	3.946	2.003	2.548
10	1/16/1978	10	16.936	0.688	4.293	0.494	3.945	2.003	2.548
11	1/31/1979	18	15.629	0.660	4.054	0.478	3.855	1.934	2.157
12	1/3/2005	29	15.453	0.656	4.021	0.475	3.843	1.925	2.105
13	3/2/1992	20	14.406	0.632	3.826	0.461	3.766	1.867	1.802
14	3/26/1991	36	13.988	0.622	3.747	0.455	3.733	1.843	1.683
15	12/4/1992	2	13.163	0.602	3.589	0.443	3.668	1.795	1.454
16	10/19/2004	33	12.878	0.595	3.534	0.439	3.644	1.778	1.376
17	2/22/2005	11	12.166	0.578	3.394	0.428	3.584	1.734	1.186
18	1/29/1980	25	12.039	0.574	3.369	0.426	3.573	1.726	1.153
19	2/28/1991	15	11.790	0.568	3.320	0.422	3.551	1.710	1.089
20	3/20/1973	4	11.754	0.567	3.313	0.422	3.548	1.708	1.079
21	1/15/1993	28	11.422	0.558	3.247	0.416	3.518	1.686	0.995
22	4/1/1982	8	10.999	0.547	3.161	0.409	3.479	1.658	0.889
23	11/29/1970	6	10.825	0.542	3.126	0.407	3.463	1.647	0.847
24	2/6/1992	6	10.684	0.539	3.097	0.404	3.449	1.637	0.813
25	11/12/1976	3	10.601	0.536	3.081	0.403	3.441	1.631	0.793
26	3/10/1975	31	10.124	0.523	2.983	0.395	3.394	1.598	0.681
27	8/14/1983	3	10.087	0.522	2.975	0.394	3.391	1.595	0.672
28	1/4/1995	8	9.742	0.512	2.903	0.388	3.356	1.571	0.594
29	3/6/1980	9	9.521	0.506	2.857	0.384	3.333	1.555	0.546
30	11/20/1983	24	9.481	0.505	2.848	0.383	3.328	1.552	0.537

31	3/1/1981	15	9.479	0.505	2.848	0.383	3.328	1.552	0.536
32	2/27/1978	40	9.451	0.504	2.842	0.383	3.325	1.550	0.530
33	10/27/2004	7	9.240	0.498	2.798	0.379	3.303	1.534	0.485
34	10/30/1998	2	9.143	0.495	2.777	0.377	3.292	1.527	0.465
35	12/28/2004	14	8.902	0.488	2.726	0.372	3.266	1.508	0.415
36	3/18/1983	25	8.684	0.481	2.679	0.368	3.242	1.491	0.372
37	12/25/1988	5	8.648	0.480	2.671	0.368	3.238	1.489	0.365
38	1/14/1978	18	8.236	0.468	2.582	0.360	3.190	1.456	0.287
39	2/15/1986	8	7.820	0.455	2.490	0.351	3.140	1.422	0.214
40	12/11/1984	7	7.797	0.454	2.485	0.351	3.138	1.420	0.210
41	12/27/1984	26	7.790	0.454	2.484	0.351	3.137	1.420	0.209
42	2/10/1978	7	7.656	0.449	2.454	0.348	3.120	1.408	0.187
43	3/4/2005	6	7.651	0.449	2.453	0.348	3.119	1.408	0.186
44	3/17/1982	31	7.638	0.449	2.450	0.347	3.118	1.407	0.184
45	1/25/1995	17	7.569	0.447	2.434	0.346	3.109	1.401	0.173
46	2/19/1993	4	7.492	0.444	2.417	0.344	3.100	1.394	0.161
47	4/20/1983	6	7.250	0.436	2.363	0.339	3.069	1.374	0.125
48	3/5/1981	12	7.113	0.432	2.332	0.336	3.051	1.362	0.105
49	3/21/1983	3	6.882	0.424	2.279	0.331	3.020	1.341	0.076
50	3/20/1991	29	6.878	0.424	2.278	0.331	3.019	1.341	0.075
51	3/2/2004	3	6.767	0.420	2.252	0.329	3.004	1.331	0.062
52	1/12/1993	11	6.702	0.418	2.237	0.327	2.995	1.325	0.055
53	2/19/1980	31	6.674	0.417	2.231	0.326	2.991	1.322	0.052
54	11/22/1984	3	6.474	0.410	2.185	0.322	2.963	1.304	0.031
55	3/7/1974	7	6.379	0.406	2.162	0.320	2.950	1.295	0.023
56	3/10/1980	5	6.359	0.406	2.158	0.319	2.947	1.293	0.021

POC2 Work Calculations, Post-Developmet Conditions		
Channel Slope:	0.0649	
Channel n:	0.06	
Low Flow Threshold:	5.886	cfs
Type of Flow:	50% of Q2	
Channel Type:	Trapezoidal	
Side Slope z:	3.25	
Bottom Width	4	ft
Normal Depth	0.39	ft
Hydraulic Radius	0.31	ft
Critical Shear Stress τ_c	1.255	
Unit Weight of Water Y	62.4	lb/ft3

SUM W_{POST} **16.085**

SYrusle= 0.223

SYnhd= 1

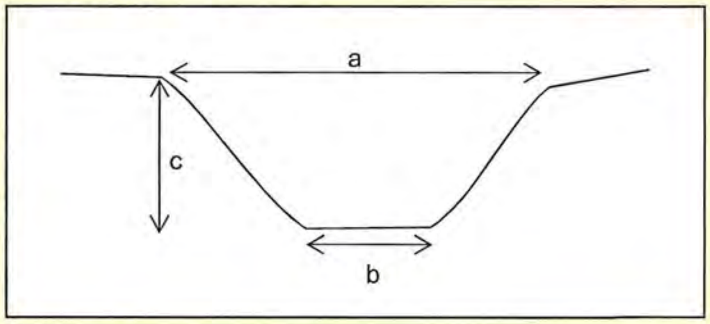
Ep= 0.456

Rank	Start Date	Duration (hours)	Peak (CFS)	h (ft)	A (ft2)	R (ft)	V (ft/s)	τ (lb/ft2)	W_{POST}
1	2/24/1983	263	21.285	0.775	5.055	0.545	4.211	2.208	3.913
2	1/31/1979	124	15.446	0.656	4.020	0.475	3.842	1.925	2.103
3	12/3/1992	162	14.372	0.631	3.819	0.461	3.763	1.865	1.792
4	2/27/1991	113	14.166	0.626	3.780	0.458	3.747	1.854	1.733
5	10/18/2004	127	13.071	0.600	3.571	0.442	3.660	1.790	1.429
6	11/24/1985	97	13.007	0.599	3.559	0.441	3.655	1.786	1.411
7	12/17/1970	175	11.265	0.554	3.215	0.414	3.504	1.676	0.955
8	12/28/2004	112	11.14	0.551	3.190	0.412	3.492	1.668	0.924
9	2/22/2004	82	9.476	0.505	2.847	0.383	3.328	1.551	0.536
10	1/28/1980	115	8.812	0.485	2.706	0.371	3.256	1.501	0.397
11	1/7/2005	163	8.137	0.465	2.560	0.358	3.178	1.448	0.269
12	2/18/2005	189	8.026	0.461	2.536	0.355	3.165	1.439	0.249
13	2/6/1992	142	7.854	0.456	2.498	0.352	3.144	1.425	0.219
14	1/3/1995	146	7.447	0.443	2.407	0.343	3.094	1.391	0.154

Critical Flow Calculator

Reach 1

enter all values in green cells
and drop down boxes



Inputs

a) Receiving channel width at top of bank (ft) - see figure on right	18.0
b) Channel width at bed (ft)	10.0
c) Bank height at top of bank (ft)	2.0
Channel gradient (ft/ft)	0.0100
Receiving channel roughness	Same as above, but some weeds and stones n=0.045

Channel materials (use weakest of bed or banks). If materials are varied use weakest material covering more than 20% of channel.

- unconsolidated sandy loam 0.035 lb/sq ft
- alluvial silt (non coloidal) 0.045 lb/sq ft
- medium gravel 0.12 lb/sq ft
- alluvial silt/clay 0.26 lb/sq ft
- 2.5 inch cobble 1.1 lb/sq ft
- enter own d50 (variable)
- vegetation (bed and banks) 0.6 lb/sq ft

Select method of calculating Q2

- Input own Q2
- Calculate Q2 using USGS regression

Receiving water watershed annual precip (inches)	9.73	Receiving water watershed area at PoC (sq mi)	0.102
Project watershed annual precipitation (inches)	9.73	Project watershed area draining to PoC (sq mi)	0.102

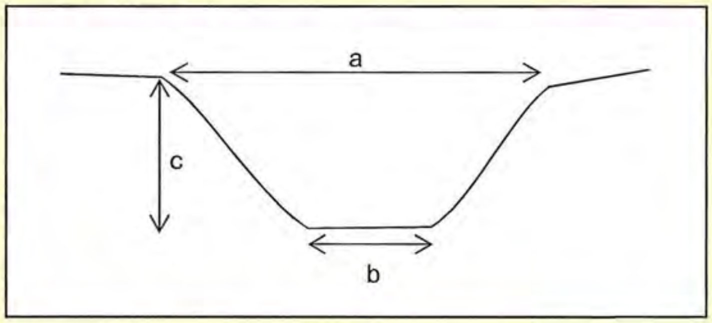
Outputs - Flow control range

Receiving water Q2	1.1	**Point of Compliance low flow rate (cfs)**	**0.5**
Project site Q2	1.1	**Low flow class**	**0.5Q2**
		Channel vulnerability	**Low**

Critical Flow Calculator

Reach 3

enter all values in green cells
and drop down boxes



Inputs

a) Receiving channel width at top of bank (ft) - see figure on right	30.0
b) Channel width at bed (ft)	4.0
c) Bank height at top of bank (ft)	4.0
Channel gradient (ft/ft)	0.0649
Receiving channel roughness	Light brush and trees, leaves not present n=0.06

Channel materials (use weakest of bed or banks). If materials are varied use weakest material covering more than 20% of channel.

- unconsolidated sandy loam 0.035 lb/sq ft
- alluvial silt (non coloidal) 0.045 lb/sq ft
- medium gravel 0.12 lb/sq ft
- alluvial silt/clay 0.26 lb/sq ft
- 2.5 inch cobble 1.1 lb/sq ft
- enter own d50 (variable)
- vegetation (bed and banks) 0.6 lb/sq ft

Select method of calculating Q2

- Input own Q2
- Calculate Q2 using USGS regression

Receiving water watershed annual precip (inches)	9.73	Receiving water watershed area at PoC (sq mi)	0.058
Project watershed annual precipitation (inches)	9.73	Project watershed area draining to PoC (sq mi)	0.058

Outputs - Flow control range

Receiving water Q2	0.7	**Point of Compliance low flow rate (cfs)**	**0.4**
Project site Q2	0.7	**Low flow class**	**0.5Q2**
		Channel vulnerability	**Low**

APPENDIX 5

Sp Calculations

Summary of Results

POC1 Pre-Developmet Conditions RUSLE			
GLU	Area (ft2)	$A_{soil\text{-}loss}$ (ton/ac/yr)	PRE_{rusle} (ton/yr)
CSI-Agricultural/Grass-2	23816	8.7	4.757
CSI-Agricultural/Grass-3	13456	9.8	3.027

Total PRE 7.784

POC1 Post-Developmet Conditions RUSLE			
GLU	**Area (ft2)**	**$A_{soil\text{-}loss}$ (ton/ac/yr)**	**$POST_{rusle}$ (ton/yr)**
CSI-Agricultural/Grass-2	0	8.7	0
CSI-Agricultural/Grass-3	0	9.8	0
CSI-Cut Slope (p=0.5)	0	4.625	0
CSI-Fill Slope (p=0.25)	34303	2.3125	1.821

Total POST 1.821

POC1 SUMMARY	
SYrusle=	0.234
SYnhd=	1
Sp=	0.464
Ep=	0.364
Ep/Sp=	0.784
	< 1.1
NO NET IMPACT	

POC2 Pre-Developmet Conditions RUSLE			
GLU	**Area (ft2)**	**$A_{soil\text{-}loss}$ (ton/ac/yr)**	**PRE_{rusle} (ton/yr)**
CSI-Agricultural/Grass-2	73236	8.7	14.627
CSI-Agricultural/Grass-3	20896	9.8	4.701

Total PRE 19.328

POC2 Post-Developmet Conditions RUSLE			
GLU	**Area (ft2)**	**$A_{soil-loss}$ (ton/ac/yr)**	**$POST_{rusle}$ (ton/yr)**
CSI-Agricultural/Grass-2	0	8.7	0
CSI-Agricultural/Grass-3	0	9.8	0
CSI-Cut Slope (p=0.5)	0	4.625	0
CSI-Fill Slope (p=0.25)	72344	2.3125	3.841

Total POST 3.841

POC2 SUMMARY	
SYrusle=	0.199
SYnhd=	1
Sp=	0.439
Ep=	0.456
Ep/Sp=	1.039
	< 1.1
NO NET IMPACT	

3

Project Name: LUMINA

ATTACHMENT 3

STRUCTURAL BMP MAINTENANCE INFORMATION

This is the cover sheet for Attachment 3.

Project Name: LUMINA

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	**Contents**	**Checklist**
Attachment 3a	Structural BMP Maintenance Thresholds and Actions (Required)	☒ Included See Structural BMP Maintenance Information Checklist.
Attachment 3b	Draft Maintenance Agreement (when applicable)	☐ Included ☐ Not Applicable

Project Name: LUMINA

Use this checklist to ensure the required information has been included in the Structural BMP Maintenance Information Attachment:

Preliminary Design / Planning / CEQA level submittal:

- Attachment 3a must identify:
  - ☐ Typical maintenance indicators and actions for proposed structural BMP(s) based on Section 7.7 of the BMP Design Manual
- Attachment 3b is not required for preliminary design / planning / CEQA level submittal.

Final Design level submittal:

Attachment 3a must identify:

- ☐ Specific maintenance indicators and actions for proposed structural BMP(s). This shall be based on Section 7.7 of the BMP Design Manual and enhanced to reflect actual proposed components of the structural BMP(s)
- ☐ How to access the structural BMP(s) to inspect and perform maintenance
- ☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
- ☐ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable
- ☐ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)
- ☐ When applicable, frequency of bioretention soil media replacement
- ☐ Recommended equipment to perform maintenance
- ☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

Attachment 3b: For private entity operation and maintenance, Attachment 3b must include a Storm Water Management and Discharge Control Maintenance Agreement (Form DS-3247). The following information must be included in the exhibits attached to the maintenance agreement:

- ☐ Vicinity map
- ☐ Site design BMPs for which DCV reduction is claimed for meeting the pollutant control obligations.
- ☐ BMP and HMP location and dimensions
- ☐ BMP and HMP specifications/cross section/model
- ☐ Maintenance recommendations and frequency
- ☐ LID features such as (permeable paver and LS location, dim, SF).

Project Name: LUMINA

THE CITY OF SAN DIEGO RECORDING REQUESTED BY: **THE CITY OF SAN DIEGO** AND WHEN RECORDED MAIL TO:	
Click or tap here to enter text. Click or tap here to enter text. Click or tap here to enter text.	(THIS SPACE IS FOR THE RECORDER'S USE ONLY)

STORM WATER MANAGEMENT AND DISCHARGE CONTROL MAINTENANCE AGREEMENT

APPROVAL NUMBER:	ASSESSOR'S PARCEL NUMBER:	PROJECT NUMBER:
Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.

This agreement is made by and between the City of San Diego, a municipal corporation [City] and Click or tap here to enter text.

the owner or duly authorized representative of the owner [Property Owner] of property located at:
Click or tap here to enter text.

(PROPERTY ADDRESS)

and more particularly described as: Click or tap here to enter text.

(LEGAL DESCRIPTION OF PROPERTY)

in the City of San Diego, County of San Diego, State of California.

Property Owner is required pursuant to the City of San Diego Municipal Code, Chapter 4, Article 3, Division 3, Chapter 14, Article 2, Division 2, and the Land Development Manual, Storm Water Standards to enter into a Storm Water Management and Discharge Control Maintenance Agreement [Maintenance Agreement] for the installation and maintenance of Permanent Storm Water Best Management Practices [Permanent Storm Water BMP's] prior to the issuance of construction permits. The Maintenance Agreement is intended to ensure the establishment and maintenance of Permanent Storm Water BMP's onsite, as described in the attached exhibit(s), the project's Storm Water Quality Management Plan [SWQMP] and Grading and/or Improvement Plan Drawing No(s), or Building Plan Project No(s): Click or tap here to enter text.

Property Owner wishes to obtain a building or engineering permit according to the Grading and/or Improvement Plan Drawing No(s) or Building Plan Project No(s): Click or tap here to enter text.

Continued on Page 2

Project Name: LUMINA

NOW, THEREFORE, the parties agree as follows:

1. Property Owner shall have prepared, or if qualified, shall prepare an Operation and Maintenance Procedure [OMP] for Permanent Storm Water BMP's, satisfactory to the City, according to the attached exhibit(s), consistent with the Grading and/or Improvement Plan Drawing No(s), or Building Plan Project No(s):Click or tap here to enter text..

2. Property Owner shall install, maintain and repair or replace all Permanent Storm Water BMP's within their property, according to the OMP guidelines as described in the attached exhibit(s), the project's WQTR and Grading and/or Improvement Plan Drawing No(s), or Building Plan Project No(s)Click or tap here to enter text..

3. Property Owner shall maintain operation and maintenance records for at least five (5) years. These records shall be made available to the City for inspection upon request at any time.

This Maintenance Agreement shall commence upon execution of this document by all parties named hereon, and shall run with the land.

Executed by the City of San Diego and by Property Owner in San Diego, California.

See Attached Exhibits(s):Click or tap here to enter text.

(Owner Signature)

Click or tap here to enter text.
(Print Name and Title)

Click or tap here to enter text.
(Company/Organization Name)

Click or tap to enter a date.
(Date)

THE CITY OF SAN DIEGO

APPROVED:

(City Control engineer Signature

(Print Name)

(Date)

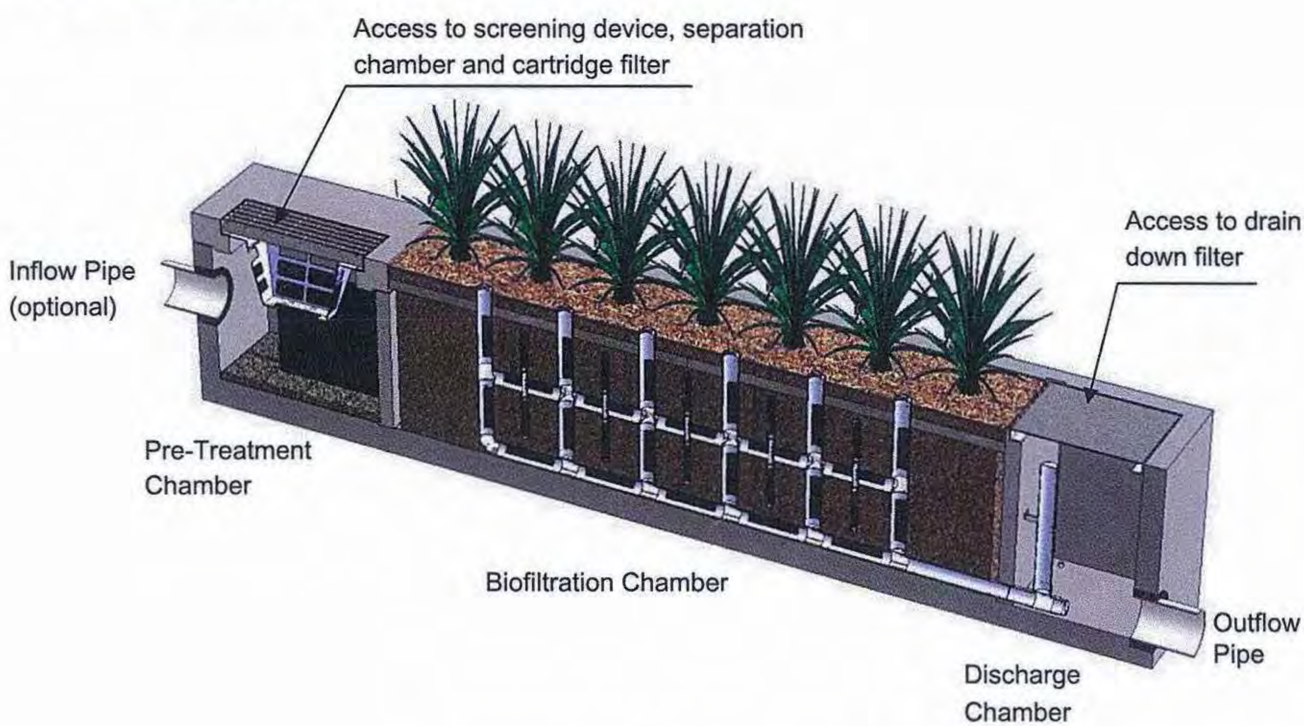
NOTE: ALL SIGNATURES MUST INCLUDE NOTARY ACKNOWLEDMENTS PER CIVIL CODE SEC. 1180 ET.SEQ

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

- Remove Trash from Screening Device – average maintenance interval is 6 to 12 months.
  - *(5 minute average service time).*
- Remove Sediment from Separation Chamber – average maintenance interval is 12 to 24 months.
  - *(10 minute average service time).*
- Replace Cartridge Filter Media – average maintenance interval 12 to 24 months.
  - *(10-15 minute per cartridge average service time).*
- Replace Drain Down Filter Media – average maintenance interval is 12 to 24 months.
  - *(5 minute average service time).*
- Trim Vegetation – average maintenance interval is 6 to 12 months.
  - *(Service time varies).*

System Diagram



MODULAR WETLANDS

Maintenance Procedures

Screening Device

1. Remove grate or manhole cover to gain access to the screening device in the Pre-Treatment Chamber. Vault type units do not have screening device. Maintenance can be performed without entry.
2. Remove all pollutants collected by the screening device. Removal can be done manually or with the use of a vacuum truck. The hose of the vacuum truck will not damage the screening device.
3. Screening device can easily be removed from the Pre-Treatment Chamber to gain access to separation chamber and media filters below. Replace grate or manhole cover when completed.

Separation Chamber

1. Perform maintenance procedures of screening device listed above before maintaining the separation chamber.
2. With a pressure washer spray down pollutants accumulated on walls and cartridge filters.
3. Vacuum out Separation Chamber and remove all accumulated pollutants. Replace screening device, grate or manhole cover when completed.

Cartridge Filters

1. Perform maintenance procedures on screening device and separation chamber before maintaining cartridge filters.
2. Enter separation chamber.
3. Unscrew the two bolts holding the lid on each cartridge filter and remove lid.
4. Remove each of 4 to 8 media cages holding the media in place.
5. Spray down the cartridge filter to remove any accumulated pollutants.
6. Vacuum out old media and accumulated pollutants.
7. Reinstall media cages and fill with new media from manufacturer or outside supplier. Manufacturer will provide specification of media and sources to purchase.
8. Replace the lid and tighten down bolts. Replace screening device, grate or manhole cover when completed.

Drain Down Filter

1. Remove hatch or manhole cover over discharge chamber and enter chamber.
2. Unlock and lift drain down filter housing and remove old media block. Replace with new media block. Lower drain down filter housing and lock into place.
3. Exit chamber and replace hatch or manhole cover.

MODULAR WETLANDS

Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.

2. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.

3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.

4. Entry into chambers may require confined space training based on state and local regulations.

5. No fertilizer shall be used in the Biofiltration Chamber.

6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

Maintenance Procedure Illustration

Screening Device

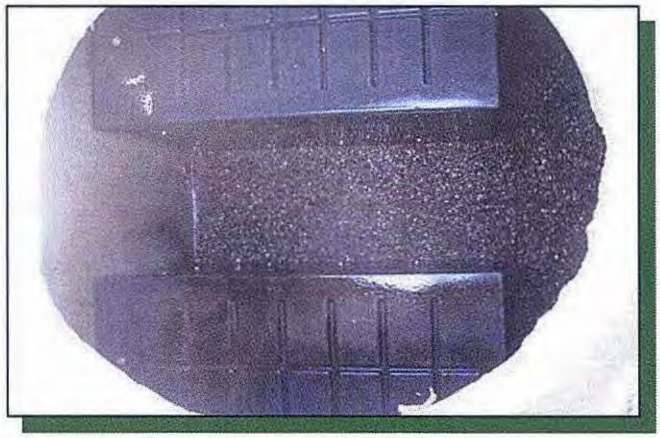
The screening device is located directly under the manhole or grate over the Pre-Treatment Chamber. It's mounted directly underneath for easy access and cleaning. Device can be cleaned by hand or with a vacuum truck.

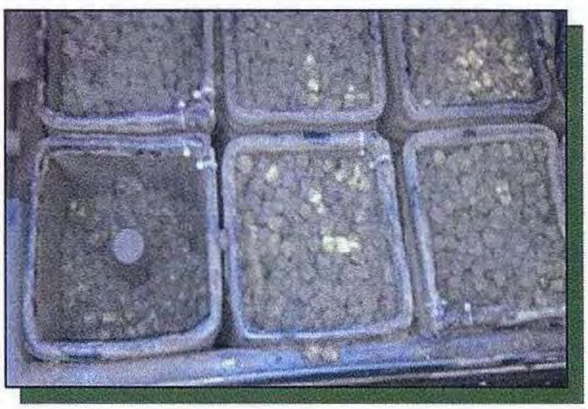
Separation Chamber

The separation chamber is located directly beneath the screening device. It can be quickly cleaned using a vacuum truck or by hand. A pressure washer is useful to assist in the cleaning process.

Cartridge Filters

The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.





Drain Down Filter

The drain down filter is located in the Discharge Chamber. The drain filter unlocks from the wall mount and hinges up. Remove filter block and replace with new block.

MODULAR WETLANDS

Trim Vegetation

Vegetation should be maintained in the same manner as surrounding vegetation and trimmed as needed. No fertilizer shall be used on the plants. Irrigation per the recommendation of the manufacturer and or landscape architect. Different types of vegetation requires different amounts of irrigation.

Inspection Form

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

BIO CLEAN ENVIRONMENTAL SERVICES, INC.

Inspection Report
Modular Wetlands System

MODULAR WETLANDS

Project Name ______________________________

Project Address ______________________________ (city) (Zip Code)

Owner / Management Company ______________________________

Contact ______________________ Phone ( ) –

Inspector Name ______________________ Date ___ / ___ / ______ Time ________ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition ______________________ Additional Notes ______________________

For Office Use Only
(Reviewed By)
(Date) Office personnel to complete section to the left.

Inspection Checklist

Modular Wetland System Type (Curb, Grate or UG Vault): ____________ Size (22', 14' or etc.): ____________

Structural Integrity:	Yes	No	Comments
Damage to pre-treatment access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Damage to discharge chamber access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Does the MWS unit show signs of structural deterioration (cracks in the wall, damage to frame)?			
Is the inlet/outlet pipe or drain down pipe damaged or otherwise not functioning properly?			
Working Condition:			
Is there evidence of illicit discharge or excessive oil, grease, or other automobile fluids entering and clogging the unit?			
Is there standing water in inappropriate areas after a dry period?			
Is the filter insert (if applicable) at capacity and/or is there an accumulation of debris/trash on the shelf system?			
Does the depth of sediment/trash/debris suggest a blockage of the inflow pipe, bypass or cartridge filter? If yes specify which one in the comments section. Note depth of accumulation in in pre-treatment chamber.			Depth:
Does the cartridge filter media need replacement in pre-treatment chamber and/or discharge chamber?			Chamber:
Any signs of improper functioning in the discharge chamber? Note issues in comments section.			
Other Inspection Items:			
Is there an accumulation of sediment/trash/debris in the wetland media (if applicable)?			
Is it evident that the plants are alive and healthy (if applicable)? Please note Plant Information below.			
Is there a septic or foul odor coming from inside the system?			

Waste:	Yes	No
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

Recommended Maintenance	
No Cleaning Needed	
Schedule Maintenance as Planned	
Needs Immediate Maintenance	

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: ______________________________

Maintenance Report

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

Cleaning and Maintenance Report
Modular Wetlands System

Project Name ______________________________

Project Address ______________________________ (city) (Zip Code)

Owner / Management Company ______________________________

Contact ______________________ Phone ( ) –

Inspector Name ______________________ Date ___/___/_____ Time __________ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition ______________________ Additional Notes ______________________

For Office Use Only
(Reviewed By)
(Date) Office personnel to complete section to the left.

Site Map #	GPS Coordinates of Insert	Manufacturer / Description / Sizing	Trash Accumulation	Foliage Accumulation	Sediment Accumulation	Total Debris Accumulation	Condition of Media 25/50/75/100 (will be changed @ 75%)	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:	MWS Catch Basins						
		MWS Sedimentation Basin						
		Media Filter Condition						
		Plant Condition						
		Drain Down Media Condition						
		Discharge Chamber Condition						
		Drain Down Pipe Condition						
		Inlet and Outlet Pipe Condition						

Comments:

4

Project Name: LUMINA

ATTACHMENT 4

COPY OF PLAN SHEETS SHOWING PERMANENT STORM WATER BMPS

This is the cover sheet for Attachment 4.

Project Name: LUMINA

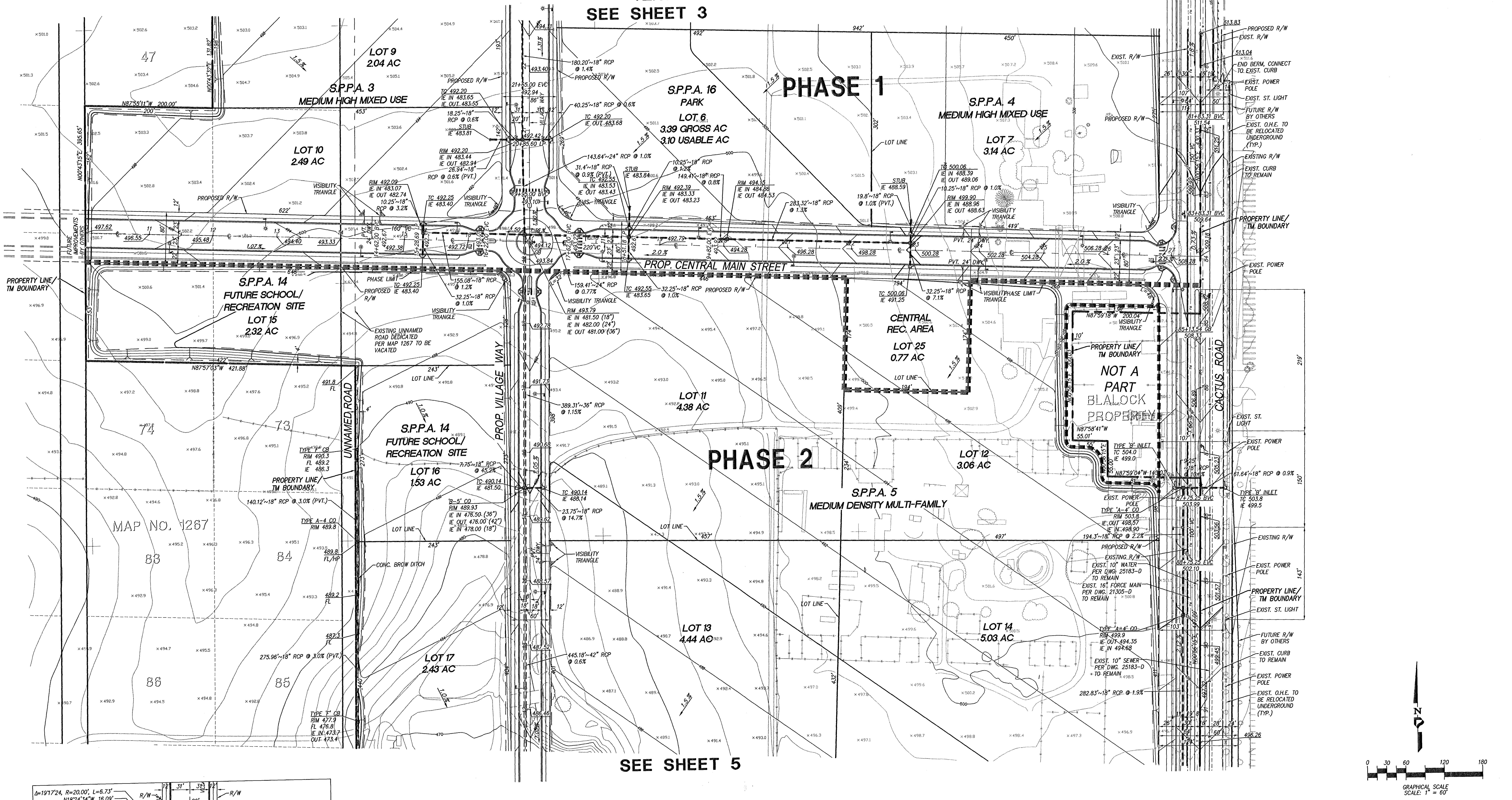
Use this checklist to ensure the required information has been included on the plans:

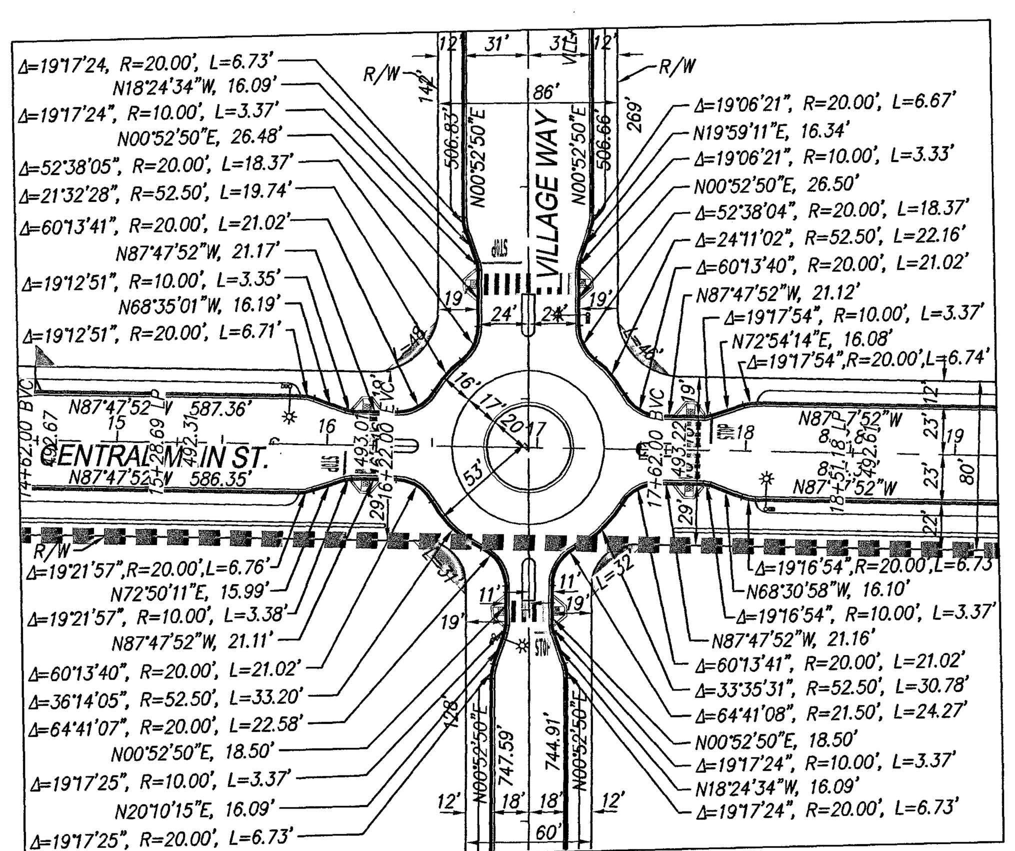
The plans must identify:

- ☒ Structural BMP(s) with ID numbers matching Form I-6 Summary of PDP Structural BMPs
- ☒ The grading and drainage design shown on the plans must be consistent with the delineation of DMAs shown on the DMA exhibit
- ☒ Details and specifications for construction of structural BMP(s)
- ☒ Signage indicating the location and boundary of structural BMP(s) as required by the City Engineer
- ☒ How to access the structural BMP(s) to inspect and perform maintenance
- ☒ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
- ☒ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable
- ☒ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)
- ☒ Recommended equipment to perform maintenance
- ☒ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management
- ☒ Include landscaping plan sheets showing vegetation requirements for vegetated structural BMP(s)
- ☒ All BMPs must be fully dimensioned on the plans
- ☒ When proprietery BMPs are used, site specific cross section with outflow, inflow and model number shall be provided. Broucher photocopies are not allowed.

LUMINA

TENTATIVE MAP NO. 1972222





CURB ROUNDABOUT DETAIL

SCALE: 1"=60'

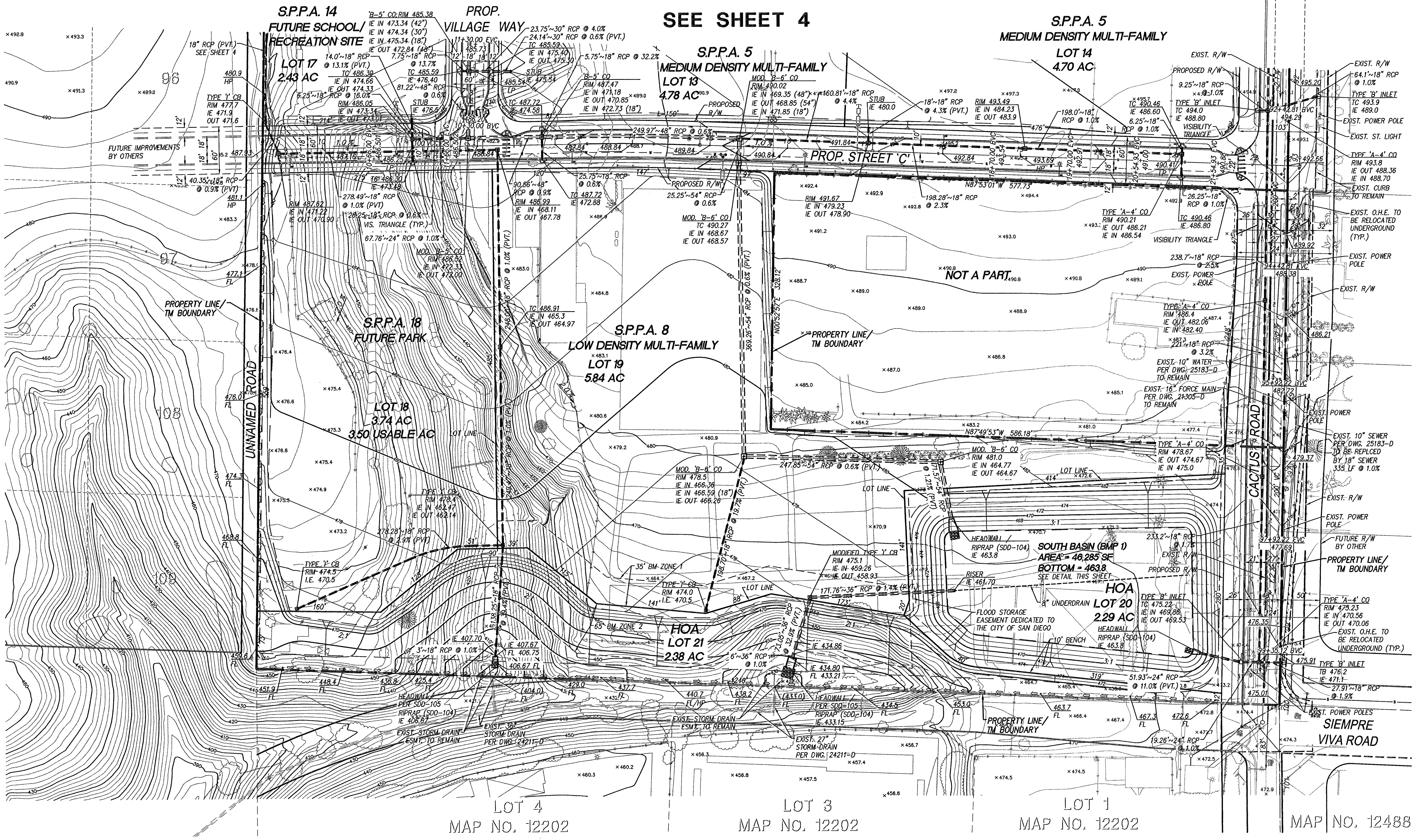
NOTE:

1. NO OBSTRUCTION INCLUDING SOLID WALLS IN THE VISIBILITY AREA SHALL EXCEED 3 FEET IN HEIGHT. PLANT MATERIAL, OTHER THAN TREES, WITHIN THE PUBLIC RIGHT-OF-WAY THAT IS LOCATED WITHIN VISIBILITY AREAS SHALL NOT EXCEED 24 INCHES IN HEIGHT, MEASURED FROM THE TOP OF THE ADJACENT CURB.
2. ACCESS FOR EACH LOT SUBJECT TO FUTURE NEIGHBORHOOD DEVELOPMENT PERMIT.
3. ALL PROPOSED WET AND DRY UTILITIES ARE TO BE UNDERGROUND.
4. EXISTING OVERHEAD ELECTRICAL FACILITIES WITHIN CACTUS ROAD TO BE RELOCATED UNDERGROUND.
5. ALL PROPOSED STREETS TO BE DEDICATED ON FINAL MAP.
6. FOR ALL PRIVATE UTILITIES ENCROACHING INTO A PUBLIC RIGHT-OF-WAY, EMRA WILL BE REQUIRED.
7. ALL STORM DRAIN SHOWN ON PLANS IS PUBLIC UNLESS OTHERWISE NOTED AT PRIVATE.

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey
701 B Street, Suite 800
San Diego, CA 92101
619.235.6471 Tel
619.234.0349 Fax

PREPARED BY:	REVISION 14:
NAME: PROJECT DESIGN CONSULTANTS	REVISION 13:
ADDRESS: 701 'B' STREET, SUITE 800	REVISION 12:
SAN DIEGO, CALIFORNIA 92101	REVISION 11:
PHONE #: (619) 235-6471	REVISION 10:
	REVISION 09:
PROJECT ADDRESS:	REVISION 08:
	REVISION 07:
SAN DIEGO, CALIFORNIA	REVISION 06:
	REVISION 05:
	REVISION 04:
PROJECT NAME:	REVISION 03:
LUMINA	REVISION 02: 08/17/2018
	REVISION 01: 10/13/2017
	ORIGINAL DATE: 06/01/2017
SHEET TITLE:	
GRADING AND STORM DRAIN PLANS	SHEET 4 OF 29
	DEP #

LUMINA
TENTATIVE MAP NO. 1972222



NOTE:

1. NO OBSTRUCTION INCLUDING SOLID WALLS IN THE VISIBILITY AREA SHALL EXCEED 3 FEET IN HEIGHT. PLANT MATERIAL, OTHER THAN TREES, WITHIN THE PUBLIC RIGHT-OF-WAY THAT IS LOCATED WITHIN VISIBILITY AREAS SHALL NOT EXCEED 24 INCHES IN HEIGHT, MEASURED FROM THE TOP OF THE ADJACENT CURB.
2. ACCESS FOR EACH LOT SUBJECT TO FUTURE NEIGHBORHOOD DEVELOPMENT PERMIT.
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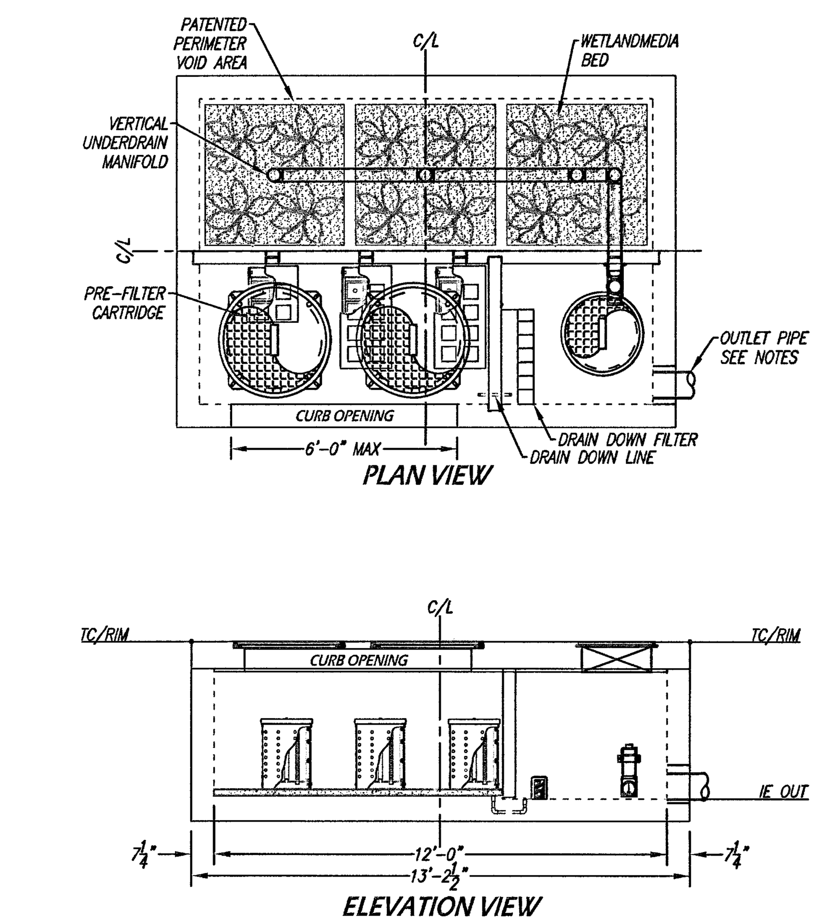
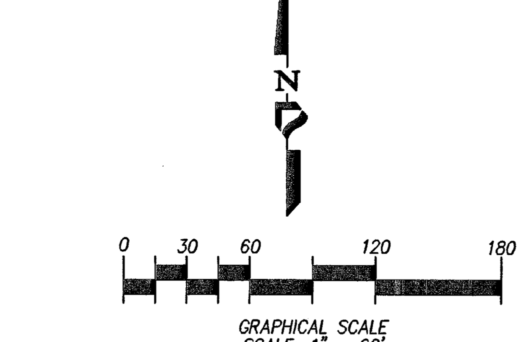
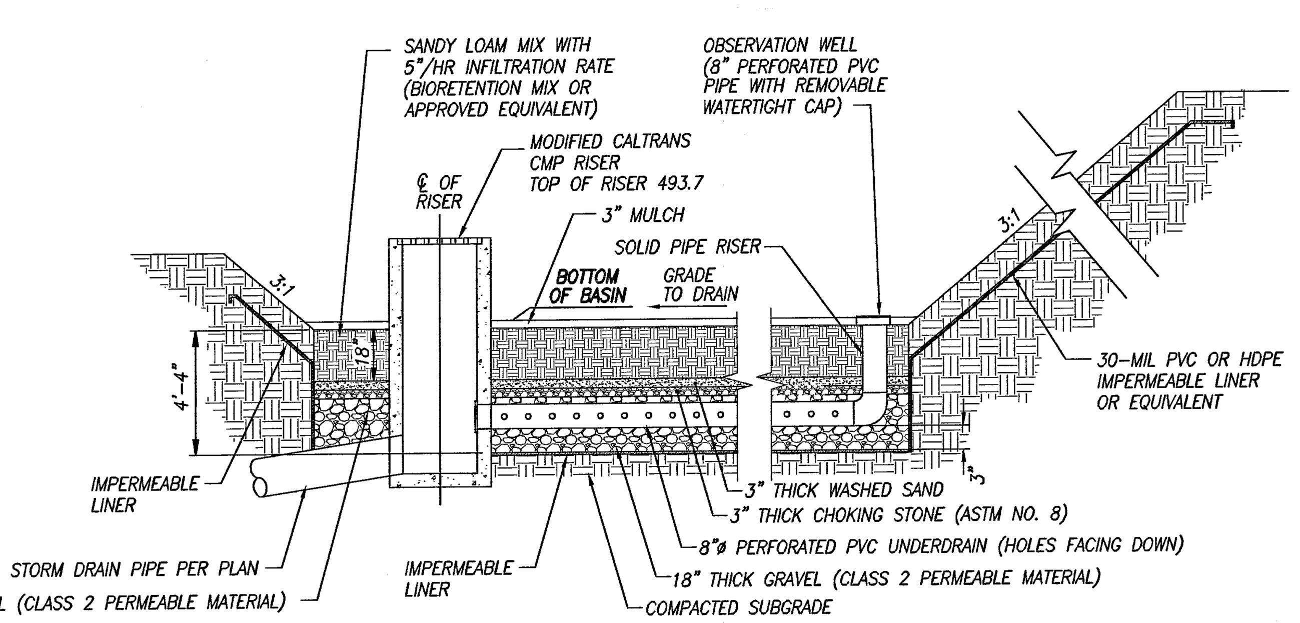
4. EXISTING OVERHEAD ELECTRICAL FACILITIES WITHIN CACTUS ROAD TO BE RELOCATED UNDERGROUND.
5. ALL PROPOSED STREETS TO BE DEDICATED ON FINAL MAP.
6. FOR ALL PRIVATE UTILITIES ENCROACHING INTO A PUBLIC RIGHT-OF-WAY, EMRA WILL BE REQUIRED.
7. ALL STORM DRAIN SHOWN ON PLANS IS PUBLIC UNLESS OTHERWISE NOTED AT PRIVATE.

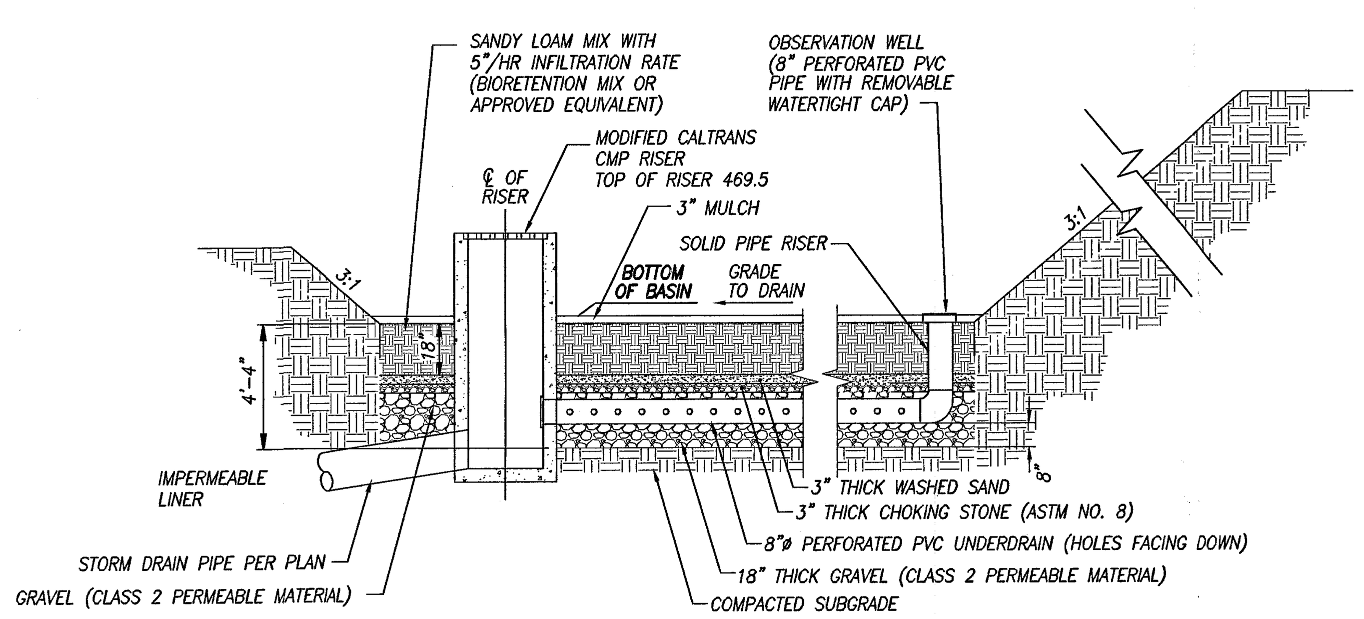


BMP 2, SEE SHEET 3





SECTION A-A: BIOFILTRATION BASIN (NORTH)
BMP 3 AND 4, SEE SHEET 3
NOT TO SCALE



SECTION A-A: BIOFILTRATION BASIN (SOUTH)
BMP 1
NOT TO SCALE

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey

PREPARED BY:	REVISION 14:
NAME: PROJECT DESIGN CONSULTANTS	REVISION 13:
ADDRESS: 701 'B' STREET, SUITE 800	REVISION 12:
SAN DIEGO, CALIFORNIA 92101	REVISION 11:
PHONE #: (619) 235-6471	REVISION 10:
	REVISION 09:
PROJECT ADDRESS:	REVISION 08:
	REVISION 07:
SAN DIEGO, CALIFORNIA	REVISION 06:
	REVISION 05:
	REVISION 04:
PROJECT NAME:	REVISION 03:
LUMINA	REVISION 02: 08/17/2018
	REVISION 01: 10/13/2017
	ORIGINAL DATE: 06/01/2017
SHEET TITLE:	
GRADING AND STORM DRAIN PLANS	SHEET 5 OF 29
	DEP #

5

Project Name: LUMINA

ATTACHMENT 5
DRAINAGE REPORT

Attach project's drainage report. Refer to Drainage Design Manual to determine the reporting requirements.

6

Project Name: LUMINA

ATTACHMENT 6
GEOTECHNICAL AND GROUNDWATER INVESTIGATION REPORT

Attach project's geotechnical and groundwater investigation report. Refer to Appendix C.4 to determine the reporting requirements.

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
485 Corporate Drive, Suite B
Escondido, CA 92029
Telephone: (619) 867-0487

ColRich
444 West Beech Street, Suite 300
San Diego, California 92101

May 26, 2017
P/W 1304-04
Report No. 1304-04-B-4

Attention: **Mr. Jason Shepard**

Subject: **Preliminary Infiltration Feasibility Study for Otay Canyon Ranch, Lumina Project, Otay Mesa Area, City of San Diego, California**

References: Attached

In accordance with your request, Advanced Geotechnical Solutions, Inc. (AGS) has prepared this Preliminary Infiltration Feasibility Study for Otay Canyon Ranch Project, Otay Mesa Area, City of San Diego, California. This report is intended to meet the preliminary infiltration testing requirements of the City of San Diego and provide an evaluation of the feasibility for storm water infiltration in accordance with the current Storm Water Standards – BMP Design Manual. A discussion of our field testing and findings are presented below. Worksheet Form C.4-1 and associated supporting worksheets and data are presented in Appendix 1.

Based on our review of the existing site conditions and proposed development, results of site specific subsurface exploration and infiltration testing, and our associated analyses it is our opinion that infiltration is feasible in portions of the site and not feasible in other portions of the site. Specifically, the northerly proposed basin should be designed for no infiltration and the southerly proposed basin can be designed for partial infiltration. In addition, use of smaller Low Impact Development (LID) infiltration devices or bioinfiltration type BMPs in interior portions of the site may be feasible provided adequate subsurface exploration and testing is performed at the proposed locations prior to approval or implementation.

1.0 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The irregular shaped site is comprised of 12 contiguous parcels located in the Otay Mesa area of San Diego, California. The overall site encompasses approximately 92 acres and is more specifically located westerly adjacent to Cactus Road and is bound to the north by Spring Canyon and an auto recycling facility, to the west by vacant land and a southwesterly-flowing drainage, and to the south a westerly flowing drainage and the future extension of Siempre Viva Road. In general, the site is relatively level to gently sloping except for two reentrant canyons on the northwest and southwest portions of the site. Elevations within the project limits range from elevation 404 msl (southwest corner) to 512 msl (northeast corner).

The southern portion of the site is currently occupied by an operational nursery which consists of an office building in the southeast corner; several barn, shed, and canopy type structures; and several growing areas. The remainder of the site is vacant land covered with a moderate growth of annual grasses and weeds with scattered trees adjacent to the canyons on the west and southern portions of the site. It appears that a portion of the site is currently being utilized for grazing.

At this time, AGS is unaware of specific septic system(s), water well(s) or utilities that may exist on the properties. However, it is likely that these improvements are onsite. If encountered, septic systems and water wells must be abandoned/mitigated in accordance with the specifications of the County of San Diego.

As depicted on the grading plan (Plates 1 through 3), the site will be graded into six (6) large sheet graded pads separated by interior roads. It is anticipated the pads will be developed to support multi-family and mixed-use residential structures. The overall project site is divided into two (2) drainage management areas (DMA), one for the northerly portion of the site and one for the southerly portion. A regional water quality basin is proposed for each DMA, one at the southeastern corner of the project and one in the northwestern portion.

2.0 SUBSURFACE EXPLORATION AND SITE GEOLOGY

As part of our infiltration feasibility study, seven (7) exploratory trenches were advanced with a rubber tire backhoe and logged at the site (PT-1 through PT-7). Prior to the infiltration study, several exploratory trenches were excavated, sampled, and logged as part of due diligence studies for individual parcels within the overall project site (AGS, 2013 & 2015). In addition, six separate limited geotechnical studies were performed by Geocon (Geocon, 2003 to 2005) for properties within the overall project site. In general, these studies consisted of limited mapping and the excavation, logging and sampling of a total of 21 backhoe test pits ranging from a few feet deep to a maximum depth of 16 feet.

The site is underlain to the depths explored by localized undocumented fill, alluvium, Lindavista Formation (terrace deposits) and San Diego Formation. Beneath the explored depths it is anticipated that Otay Formation unconformably underlies San Diego Formation. The approximate limits of these units are shown on the Plates 1 through 3.

2.1. <u>Undocumented Artificial Fill (Map Symbol afu)</u>

Undocumented artificial fill was encountered in the southern, western, and northern portions of the site. The more extensive undocumented fills appear to be related to previous canyon in-fills near the western and southern site boundaries. Some of the fill is also related to the backfill of former reservoir locations. The fill primarily consists of silty to clayey sands to sandy clay that are dry to moist, and very loose to moderately dense. Generally, colors vary from brown to reddish brown. The fill contains some gravel and cobbles, organic debris, trash and construction debris (e.g. concrete pieces). During the recent site subsurface investigation for this study the maximum depth of undocumented fill encountered was approximately nine (9) feet. Previously it was encountered to a depth of 13 feet. Based upon our observations isolated areas of undocumented fill could be as deep as 20 to 30 feet.

2.2. <u>Topsoil (No Map Symbol)</u>

A relatively thin veneer of topsoil blankets most of the upper mesa portion of the site. It typically consists of medium to dark brown sandy clay to clayey sand in a dry to slightly moist and loose condition. The topsoil commonly contains roots. During the recent site subsurface investigation the maximum depth of topsoil encountered ranged from 1 to 4 feet.

2.3. Alluvium (Map Symbol Qal)

Alluvial soils are present in the bottoms of the drainages onsite. The alluvium consists of brown, sandy to silty clay that is slightly moist to moist and loose. Occasional cobbles and small boulders were encountered. During previous subsurface investigations the depth of alluvium encountered ranged from 3 to 8 feet. Based upon our observations isolated areas of alluvium could be as deep as 12 to 15 feet.

2.4. Lindavista Formation (Map Symbol Ql)

Quaternary aged Lindavista Formation (Todd, 2004) caps most of the mesa portion of the site. This unit is commonly referred to as Terraced Deposits due to its depositional environment and has also been mapped as Very Old Alluvial Deposits (Tan and Kennedy, 2002) and Very Old Paralic Deposits (Kennedy and Tan, 2005). The Lindavista Formation generally ranges in color from brown to reddish brown to orange brown. As encountered during our recent explorations and previous subsurface investigations by Geocon, the Lindavista Formation varies from silty to sandy clay that is slightly moist to moist and firm to stiff to well graded sand with silt, gravel, and cobble that is slightly moist and moderately dense to dense.

2.5. San Diego Formation (Map Symbol Tsd)

It is anticipated that a majority of the site is underlain at depth by Pliocene aged San Diego Formation and is exposed beneath the Lindavista Formation in the lower portions of the onsite canyon walls. As encountered, the San Diego Formation generally consists of light gray to light olive brown silty fine-grained sandstone and clayey to sandy siltstone that is moderately hard to hard.

2.6. Otay Formation (Map Symbol To)

Although not encountered in our subsurface excavations, Oligocene aged Otay Formation unconformably underlies San Diego Formation and is exposed extensively in the project vicinity. The City of San Diego Seismic Safety Study (Grid Tile 3) identifies the lower portion of Spring Canyon on the north side of the project site as 'Slide-Prone Formations – Otay, Sweetwater, and others.'

3.0 TESTING METHODS AND PROCEDURES

To evaluate feasibility for infiltration of the proposed onsite water quality basins and to provide preliminary design infiltration rates, five (5) borehole percolation tests were performed in general conformance with Appendix D, Section D.3.3.2 of the current BMP Design Manual. One to two test borings were excavated in each basin location, with test locations chosen where the formational units were anticipated to be exposed nearer to the surface.

To provide representative continuous soil/geologic logs for the percolation test holes, the percolation test borings were continuously logged during excavation. Locations of the percolation test holes are shown on Plates 1 through 3, included herewith.

The percolation boreholes (P-1 through P-5) were excavated with a 6-inch diameter auger mounted to a CAT 420F rubber tire backhoe and extended to depths ranging from 36-inches to 72-inches below ground surface. Borings P-1 through P-3 extended through undocumented artificial fill to Lindavista Formation (terrace deposits) and boreholes P-4 and P-5 extended into artificial fill.

The resulting test holes were cleaned of loose debris then successively filled with several gallons of clean, potable water and allowed to pre-soak overnight. The following day the test holes were cleaned of sediment and the bottom was lined with approximately 2-inches of washed gravel prior to percolation testing. A series of falling head percolation tests were performed. The test holes were filled with clean, potable water to approximately 24 to 30 inches above infiltration surface and allowed to infiltrate. The water level was allowed to drop for a 30-minute period, the water level was then measured and the drop rate calculated in inches per hour. The test hole was then refilled with water as necessary and the test procedure was repeated over the course of 6 hours until a stabilized percolation rate was recorded. The stabilized percolation rate was then converted to an infiltration rate based on the "Porchet Method"

$$I_t = \frac{\Delta H \pi r^2 60}{\Delta t(\pi r^2 + 2\pi r H_{avg})} = \frac{\Delta H\, 60\, r}{\Delta t(r + 2H_{avg})}$$

Where:

I_t = tested infiltration rate, inches/hour
ΔH = change in head over the time interval, inches
Δt = time interval, minutes
$^*r$ = effective radius of test hole
H_{avg} = average head over the time interval, inches

utilizing the following equation:

Logs of the field testing and graphical representations of the test data presented as infiltration rate versus time interval are included in Appendix 2 as supporting documents for Worksheet C.4-1.

4.0 TEST RESULTS AND PRELIMINARY DESIGN VALUES

The results of our testing are summarized in Table 1 below.

TABLE 1 SUMMARY OF INFILTRATION/PERCOLATION TEST RESULTS					
Test Hole No.	Depth of Test Hole	Approximate Test Elevation	Geologic Unit	Description	Tested Infiltration Rate (inches/hour)
P-1	4'	485 msl	Ql	Cobbley Sand	0.73
P-2	5'	490 msl	Ql	Clayey Sand with Cobbles	0.77
P-3	6'	490 msl	Ql	Clayey Sand with Cobbles	0.40
P-4	4'	467 msl	afu	Clayey Sand with Cobbles	0.44
P-5	3'	467 msl	afu	Clay	0.17

In accordance with Appendix D, Section D.5. of the BMP Design Manual, a 'Factor of Safety' should be applied to the tested infiltration rates to determine the design infiltration rates. The factor of safety is determined by Worksheet D.5-1 and possesses a numerical value between 2 and 9. For the proposed project site, the factor of safety worksheet yielded a Combined Factor of Safety (S_{total}) of 4.5. However, for the purposes of feasibility screening, it is recommended that a Factor of Safety of 2.0 be utilized. Table 2 below summarizes the preliminary design infiltration rates for the subject test holes utilizing a factor of safety of 2.0.

TABLE 2 SUMMARY OF PRELIMINARY DESIGN INFILTRATION RATES			
Test Hole No.	Tested Infiltration Rate (in./hr.)	Factor of Safety	Preliminary Design Infiltration Rate (in./hr.)
P-1	0.73	2.0	**0.36**
P-2	0.77	2.0	**0.38**
P-3	0.40	2.0	**0.20**
P-4	0.44	2.0	**0.22**
P-5	0.17	2.0	**0.08**

5.0 DESIGN CONSIDERATIONS

5.1. Groundwater

No shallow groundwater was observed in the test borings nor in the test pits excavated onsite. Groundwater is anticipated to be on the order of 200 feet below ground surface and it is our opinion that the seasonal high groundwater elevation is greater than ten feet below the base of the proposed basin.

5.2. Geotechnical Hazards

5.2.1. Settlement and Volume Change

As currently proposed, the project will be sheet graded with cuts and fills generally on the order of 5 to 10 feet. Deeper fills up to 70 feet are proposed within onsite canyons and in areas of more extensive remedial grading where canyons and land depressions have been previously filled. The northerly proposed basin is partially situated over an area of deep fill. The anticipated fill depths beneath the westerly portion of the proposed basin are on the order 10 to 30 feet. Infiltration in deep fills is not recommended due to the increased potential for settlement. It may be possible to import or manufacture select permeable soils to be utilized beneath the basin as a 'conduit' to the native infiltration surface at depth; however, this option is highly cost prohibitive and not considered a reasonable mitigation.

Highly to critically expansive soils were encountered onsite during subsurface explorations by both Geocon and AGS, and are common within the project vicinity. Laboratory testing indicates the clay soils onsite typically have Expansion Indices (EI) greater than 90 (highly expansive) and locally greater than 130 (critically expansive). Expansive clays are capable of significant volume increases when exposed to water and can lead to heaving of overlying soils, structures, and other improvements. Infiltration BMPs should be avoided in areas where expansive soils will exist beneath or adjacent to the BMP. At a minimum, a 10-foot thick section of low expansive soils should overlay the underlying expansive soils in areas of proposed infiltration BMPs. Dependent upon the degree of expansion potential and the thickness of the expansive soil unit, the thickness of the low expansive soil cap may need to be increased to provide adequate confining pressure to mitigate the potential for heaving. Due to the broad distribution of expansive soils at the project site, it is recommended that the final locations of proposed infiltration BMPs be drilled and evaluated by the geotechnical consultant prior to approval or construction.

5.2.2. Slope Stability

Steep (>25 percent) natural slopes flank the north side of the site. After development, graded fill slopes and fill over natural slopes will be present in close proximity to the proposed northern basin. In addition the lower portion of the natural slope in the northerly portion of the site is identified as a 'Slide-Prone Formation – Otay, Sweetwater, and others' in the City of San Diego Seismic Safety Study. Infiltrating into more permeable fill over less permeable formational materials acts to concentrate subsurface water along that fill-bedrock contact rather than infiltrating vertically. Where slopes are subjacent to basins, there is a risk for infiltration of storm water to result in daylight seepage on slope faces and destabilization of slopes. If infiltration is permitted, there is a potential for water seepage and slope failure. For the proposed development, infiltration type BMPs should be set back from the top of slope a minimum distance of 1.5H, where H is the total slope height. If storm water BMPs cannot be located outside the recommended set back due to civil design constraints, the BMPs should be fully lined.

5.3. Soil and Groundwater Contamination

The project site has been the subject of several environmental assessments since 2004 and was enrolled in the San Diego County Department of Environmental Health Voluntary Action Program in 2014. In 2015 SCS Engineers prepared a Phase II Soil Sampling report that identified the presence of organochlorine pesticide (OCP) impacted soils as well as other soil contaminants of concern and general non-hazardous refuse. In 2017, C Young Associates prepared a Soil Management Plan (SMP) that addresses the removal and onsite placement (burial) of OCP impacted soils. The plan for the re-use of OCP impacted soils onsite includes their placement in 'deep' fill areas (greater than 10 feet below finish pad elevations). Specific areas identified in the SMP include the northwesterly portion of the site partially beneath the northerly proposed BMP basin and easterly adjacent to the basin. In consideration of the close proximity of the basin to contaminated soils, it is strongly recommended that active or passive infiltration in this basin not be allowed as it would likely contribute to the movement or dispersion of contaminants. If the proposed northerly BMP basin cannot be relocated due to civil design constraints, the BMP should be fully lined.

5.4. Pretreatment Prior to Infiltration

Details of the proposed BMP basins were not available for review at the time of this report; however it is anticipated that basins will have a filter course/choking layer above the infiltration surface.

5.5. Soil Characteristics and Anticipated Flow Paths

After the proposed grading is completed, the infiltration surfaces are anticipated be in compacted fill overlying Lindavista Formation. As encountered, the Lindavista Formation can generally be described as varying from silty to sandy clay, in a slightly moist to moist, and firm to stiff condition to well graded sand with silt, gravel, and cobbles in a slightly moist and moderately dense to dense condition. Infiltration rates within the Lindavista Formation are low. It is anticipated that the majority of stormwater will hit this contact and develop strong lateral flow rather than infiltrating vertically. This is of particular concern for the northerly proposed basin in consideration of its proximity to an approximately 90-foot high, steep (>25 percent) descending slope.

5.6. Proximity to Water Supply Wells

No water supply wells are known to exist within 100 feet of the proposed basins.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our preliminary infiltration testing, the onsite soils possess infiltration rates ranging between 0.17 and 0.77 inches/hour with preliminary design infiltration rates ranging between 0.08 and 0.38, utilizing a factor of safety of 2. The infiltration rates for the project site are low and full infiltration at the project site is not feasible. The preliminary infiltration rates do indicate that partial infiltration is feasible. Based on our feasibility evaluation, use of infiltration type BMPs in the southerly portion of the site as currently proposed is feasible. In addition, use of localized LID or proprietary infiltration devices or small bioinfiltration BMPs, such as modular wetlands, within the interior portion of the site is also considered feasible for the proposed development. However, the hazards associated with infiltrating stormwater in the northerly basin as currently planned cannot be reasonably mitigated and should be avoided.

Dependent upon the final type, size, and location of proposed BMPs, additional investigation and testing may be warranted.

Advanced Geotechnical Solutions, Inc. appreciates the opportunity to provide you with geotechnical consulting services and professional opinions. If you have any questions, please contact the undersigned at (619) 867-0487.

Respectfully Submitted,
Advanced Geotechnical Solutions, Inc.

Prepared by:

SHANE P. SMITH
Staff Engineer

Reviewed by:

JOHN J. DONOVAN
RCE 65051, RGE 2790, Reg. Exp. 6-30-17

REGISTERED PROFESSIONAL ENGINEER
JOHN J. DONOVAN
GE 2790
GEOTECHNICAL
STATE OF CALIFORNIA

PAUL J. DERISI, Vice President
CEG 2536, Reg. Exp. 5-31-17

PROFESSIONAL GEOLOGIST
PAUL J. DERISI
No. 2536
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

Distribution: (6) Addressee

Attachments:
Appendix 1- References
Appendix 2- Storm Water Standards BMP Design Manual - Worksheet Form C-4.1, Support Documents and Field Data
Appendix 3- Subsurface Logs
Enclosure: Plates 1-3

APPENDIX 1

References

Advanced Geotechnical Solutions, Inc. (2013). "Geotechnical/Geologic Due Diligence Evaluation of Otay Canyon Ranch Project, Otay Mesa Area, City of San Diego, California," dated May 24, 2013, Report No. 1304-04-B-2.

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Geocon, Inc. (2003a). "Preliminary Geotechnical Investigation, Centex South Otay – Kuta Property, San Diego, California," dated January 28, 2003.

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---. (2005b). "Soil and Geologic Reconnaissance, Watson Property, San Diego, California," dated February 17, 2005.

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Kennedy, M.P. and Tan, S.S. (2008). *Geologic Map of the San Diego 30' x 60' Quadrangle, California*, California Geological Survey, Regional Geologic Map, Scale 1:100,000

Todd, V.R. (2004). *Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle*, USGS OFR 2004-1361.

APPENDIX 2

STORM WATER STANDARDS BMP DESIGN MANUAL – WORKSHEET FORM C-4.1

SUPPORT DOCUMENTS AND FIELD DATA

PERCOLATION TEST DATA SHEET

Project: Otay Cyn. Ranch | Project No.: 1304-04 | Date: 10/13/2016

Test Hole No.: P-1 | Tested By: SS | Water Temp.: 68

Depth of Test Hole: 48 | USCS: SC | Air Temp.: 75

Test Hole Dimensions (Inches)

Length 48 | Width 6 | Diameter 6

Infiltration Test

Trial No.	Start Time (hr and min)	Stop Time (hr and min)	Time Interval (min.)	(Piezometric Surface in inches) Start Depth	End Depth	Depth Change	Average Water Column	Perc Rate (in./hr.)	Infiltration Rate* (in./hr.)
1	9:43	10:14	31	26.34	33.03	6.69	29.69	12.95	0.623
2	10:15	10:47	32	25.94	32.63	6.69	29.29	12.54	0.611
3	10:46	11:34	48	24.76	34.21	9.45	29.49	11.81	0.572
4	11:35	12:07	32	23.58	33.03	9.45	28.31	17.72	0.892
5	12:10	12:40	30	21.22	32.64	11.42	26.93	22.84	1.205
6	12:42	13:16	34	22.80	33.04	10.24	27.92	18.07	0.921
7	13:18	13:49	31	25.16	32.64	7.48	28.90	14.48	0.714
8	13:51	14:25	34	25.16	32.64	7.48	28.90	13.20	0.651
9	14:26	14:56	30	25.16	32.64	7.48	28.90	14.96	0.738
10	14:57	15:27	30	25.16	32.64	7.48	28.90	14.96	0.738
11	15:28	15:58	30	25.16	32.64	7.48	28.90	14.96	0.738
12	15:59	16:29	30	25.16	32.64	7.48	28.90	14.96	0.738
13									
14									
15									

*Calculated via Porchet Method

PERCOLATION TEST DATA SHEET

Project: Otay Cyn. Ranch | Project No.: 1304-04 | Date: 10/13/2016

Test Hole No.: P-2 | Tested By: SS | Water Temp.: 68

Depth of Test Hole: 72 | USCS: | Air Temp.: 75

Test Hole Dimensions (Inches)

Length 72 | Width 6 | Diameter 6

Infiltration Test

Trial No.	Start Time (hr and min)	Stop Time (hr and min)	Time Interval (min.)	(Piezometric Surface in inches) Start Depth	End Depth	Depth Change	Average Water Column	Perc Rate (in./hr.)	Infiltration Rate* (in./hr.)
1	9:34	11:27	113	25.00	36.02	11.02	30.51	5.85	0.274
2	11:31	12:01	30	23.50	32.16	8.66	27.83	17.32	0.886
3	12:03	12:34	31	22.50	31.16	8.66	26.83	16.76	0.887
4	12:37	13:11	34	21.25	31.88	10.63	26.57	18.76	1.003
5	13:13	13:43	30	20.50	28.37	7.87	24.44	15.74	0.910
6	13:45	14:15	30	22.50	29.98	7.48	26.24	14.96	0.809
7	14:18	14:48	30	22.25	29.73	7.48	25.99	14.96	0.816
8	14:49	15:19	30	22.00	29.48	7.48	25.74	14.96	0.824
9	15:20	15:50	30	24.25	31.67	7.42	27.96	14.84	0.756
10	15:51	16:21	30	24.00	31.42	7.42	27.71	14.84	0.762
11	16:22	16:52	30	23.75	31.17	7.42	27.46	14.84	0.769
12	16:53	17:23	30	23.50	30.92	7.42	27.21	14.84	0.775
13									
14									
15									

*Calculated via Porchet Method

PERCOLATION TEST DATA SHEET

Project: Otay Cyn. Ranch | Project No.: 1304-04 | Date: 10/13/2016

Test Hole No.: P-3 | Tested By: SS | Water Temp.: 68

Depth of Test Hole: 72 | USCS: | Air Temp.: 75

Test Hole Dimensions (Inches)

Length 72 Width 6 Diameter 6

Infiltration Test

Trial No.	Start Time (hr and min)	Stop Time (hr and min)	Time Interval (min.)	(Piezometric Surface in inches) Start Depth	End Depth	Depth Change	Average Water Column	Perc Rate (in./hr.)	Infiltration Rate* (in./hr.)
1	9:27	10:02	35	28.50	33.62	5.12	31.06	8.78	0.404
2	10:03	10:34	31	28.00	32.33	4.33	30.17	8.38	0.397
3	10:35	11:24	49	27.63	32.35	4.72	29.99	5.78	0.275
4	11:25	11:56	31	27.25	31.58	4.33	29.42	8.38	0.407
5	11:58	12:29	31	27.25	31.57	4.32	29.41	8.36	0.406
6	12:33	13:08	35	27.13	31.98	4.85	29.56	8.31	0.402
7	13:10	13:40	30	27.22	31.52	4.30	29.37	8.60	0.418
8	13:41	14:12	31	27.18	31.33	4.15	29.26	8.03	0.392
9	14:13	14:43	30	27.23	31.38	4.15	29.31	8.30	0.404
10	14:44	15:14	30	27.32	31.47	4.15	29.40	8.30	0.403
11	15:15	15:45	30	27.41	31.56	4.15	29.49	8.30	0.402
12	15:46	16:16	30	27.15	31.30	4.15	29.23	8.30	0.405
13									
14									
15									

*Calculated via Porchet Method

PERCOLATION TEST DATA SHEET

Project: Otay Cyn. Ranch | Project No.: 1304-04 | Date: 10/13/2016

Test Hole No.: P-4 | Tested By: SS | Water Temp.: 68

Depth of Test Hole: 48 | USCS: | Air Temp.: 75

Test Hole Dimensions (Inches)

Length 48 | Width 6 | Diameter 6

Infiltration Test

Trial No.	Start Time (hr and min)	Stop Time (hr and min)	Time Interval (min.)	(Piezometric Surface in inches) Start Depth	End Depth	Depth Change	Average Water Column	Perc Rate (in./hr.)	Infiltration Rate* (in./hr.)
1	9:17	9:55	38	33.46	39.37	5.91	36.42	9.32	0.369
2	9:57	10:27	30	33.07	38.98	5.91	36.02	11.81	0.472
3	10:28	10:59	31	32.28	38.19	5.91	35.24	11.43	0.467
4	11:02	11:49	47	32.68	40.55	7.87	36.61	10.05	0.396
5	11:52	12:22	30	31.65	37.80	6.14	34.72	12.29	0.509
6	12:23	12:53	30	33.46	38.19	4.72	35.83	9.45	0.380
7	12:54	13:27	33	32.68	38.19	5.51	35.43	10.02	0.407
8	13:30	14:03	33	33.07	38.58	5.51	35.83	10.02	0.403
9	14:05	14:35	30	33.07	38.58	5.51	35.83	11.02	0.443
10	14:35	15:05	30	33.07	38.58	5.51	35.83	11.02	0.443
11	15:06	15:36	30	33.07	38.58	5.51	35.83	11.02	0.443
12	15:37	16:07	30	33.07	38.58	5.51	35.83	11.02	0.443
13									
14									
15									

*Calculated via Porchet Method

PERCOLATION TEST DATA SHEET

Project: Otay Cyn. Ranch | Project No.: 1304-04 | Date: 10/13/2016

Test Hole No.: P-5 | Tested By: SS | Water Temp.: 68

Depth of Test Hole: 36 | USCS: | Air Temp.: 75

Test Hole Dimensions (Inches)

Length 36 | Width 6 | Diameter 6

Infiltration Test

Trial No.	Start Time	Stop Time	Time Interval	(Piezometric Surface in inches)			Average	Perc Rate	Infiltration Rate*
	(hr and min)	(hr and min)	(min.)	Start Depth	End Depth	Depth Change	Water Column	(in./hr.)	(in./hr.)
1	9:12	9:50	38	25.20	29.13	3.94	27.17	6.22	0.325
2	9:52	10:23	31	25.20	27.56	2.36	26.38	4.57	0.246
3	10:23	10:53	30	25.59	26.77	1.18	26.18	2.36	0.128
4	10:54	11:45	51	25.59	28.74	3.15	27.17	3.71	0.194
5	11:47	12:15	28	25.59	26.77	1.18	26.18	2.53	0.137
6	12:16	12:48	32	25.59	26.77	1.18	26.18	2.21	0.120
7	12:51	13:24	33	25.20	26.77	1.57	25.98	2.86	0.156
8	13:26	13:58	32	25.20	26.77	1.57	25.98	2.95	0.161
9	14:01	14:31	30	25.20	26.77	1.57	25.98	3.15	0.172
10	14:32	15:02	30	25.20	26.77	1.57	25.98	3.15	0.172
11	15:03	15:33	30	25.20	26.77	1.57	25.98	3.15	0.172
12	15:34	16:04	30	25.20	26.77	1.57	25.98	3.15	0.172
13									
14									
15									

*Calculated via Porchet Method

APPENDIX 3

BACKHOE TEST PITS (PT-1 THROUGH PT-7, AGS 2016)

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	Test Pit *PT-1* — MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
				Artificial Fill, Undocumented:				
			SP	At 0-1.0 feet, Cobbley Sand with Silt, fine to coarse grained brown to gray brown, dry, losse to moderately dense				
			SC	At 1.0 feet, Clayey Sand with Cobble, fine to coarse grained, olive brown to dark brown with iron oxide, slightly moist, medium dense to dense; sub angular to sub rounded,				
				Lindavista Formation:				
			SP	At 3.0 feet, Cobbley Sand with Silt Trace Clay, fine to coarse grained, olive brown to dark brown with iron oxied, slightly moist medium dense to dense; prodominately 6 inch minus with occassional plus 6-12 inch cobble				
5								
				At 6.0 feet, Gravely Sand with Cobble trace Clay, fine to coarse grianed, light orange brown to light brown, moist, dense				
10								
				At 12.0 feet, Gravely Clayey Sand with Cobble, fine to coarse grained, light orange brown to light brown, moist to wet, medium dense to dense				
				Total Depth = 13.5 No Water Encountered No Caving				
15								

LEGEND

Sample Type: R — Drive Sample; B — Bulk Sample; --Water Table

Laboratory Testing: AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis; SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-2*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SP	**Artificial Fill, Undocumented:** 0-2.0 feet, Gravely Clayey Sand with Cobbles, fine to coarse grained, brown to dark brown, slightly moist, dense				
5			SP	**Lindavista Formation:** At 2.0 feet, Gravely Clayey Sand to Silty Sand with Cobbles, fine to coarse grained, orange brown to light brown, moist, moderately dense				
				At 7.0 feet, Gravely Sand with Cobbles trace Clay, fine to coarse grained, orange brown to light brown, moist, moderately dense				
10				At 11.0 feet, Cemented Gravely Sand with Cobbles trace clay, fine to coarse grained, orange brown to light brown, moist, medium dense				
				At 13.0 feet, Clayey Sand with Cobbles, fine to coarse grained orange brown to light brown, moist to wet, moderately dense				
15				Total Depth = 14.0 feet No Water Encountered No Caving				

LEGEND

Sample Type: R — Drive Sample; B — Bulk Sample; --Water Table

Laboratory Testing: AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis; SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	Test Pit *PT-3* — MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SC	**Artificial Fill, Undocumented:** 0-2.0 feet, Clayey Sand with Cobbles, fine to coarse grained brown to dark brown, slightly moist, dense				
			SC	**Lindavista Formation:** At 2.0 feet, Clayey Sand to Silty Sand with Cobbles, fine to coarse grained, orange brown to light brown, slightly moist to moist, dense; cemented sand				
5			SP	At 5.5 feet, Gravely Sand with Cobbles, fine to coarse grained, light brown, slightly moist to moist, dense to very dense; calcium carbonate on fracture surfaces				
				Refusal at 6.5 feet No Water Encountered No Caving				
10								
15								

LEGEND

Sample Type: R — Drive Sample; B — Bulk Sample; --Water Table

Laboratory Testing: AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis; SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-4*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SC	**Artificial Fill, Undocumented:** At 0-0.5 feet, Clayey Sand with Cobbles, fine to coarse grained brown to dark brown, slightly moist, dense				
			CL	At 0.5-4.0 feet, Clay, fine grained, brown to dark brown, moist, stiff				
5			CL	At 4.0 feet, Sandy Clay with Cobbles, fine to coarse grianed brown, moist, stiff; calcium carbonate on fracture surfaces				
			SC	**Lindavista Formation:** At 5.5 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, moist, medium dense to dense; calcium carbonate on fracture surfaces At 8.0 feet, Clayey Sand with Cobbles, fine to coarse grianed, orange brown to brown, moist, dense to very dense				
10								
				Refusal at 11.5 feet No Water Encountered No Caving				
15								

LEGEND

Sample Type:	R — Drive Sample		B — Bulk Sample	—Water Table
Laboratory Testing:	AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
	SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-5*

Depth (ft)	Sample Type*	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SC	**Artificial Fill, Undocumented:** At 0-1.0 feet, Clayey Sand with Cobbles, fine to coarse grained brown, dry to slightly moist, medium dense				
			SC	**Lindavista Formation:** At 1.0 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, slightly moist, medium dense At 3.0 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, slightly moist, dense				
5								
			CL	At 6.0 feet, Clay with Cobbles, fine grained, light brown to gray brown, moist, very stiff				
10				Refusal at 9.5 feet No Water Encountered No Caving				
15								

LEGEND

Sample Type: R — Drive Sample; B — Bulk Sample; --Water Table

Laboratory Testing: AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis; SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/12/2016
LOCATION:	Chula Vista		

Test Pit *PT-6*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
				Artificial Fill, Undocumented:				
			CL	At 0-2.5 feet, Sandy Clay with Gravel, fine to coarse grained, gray brown to dark brown, moist, firm; 5-10% 1 inch gravel				
			SC	At 2.5 feet, Clayey Sand with Cobbles, fine to coarse grained, brown to red brown, moist, medium dense				
5				At 4.-0 feet Construction Debris, concrete, asphalt, metal stapping, trash				
10				Refusal at 9.5 feet No Water Encountered No Caving				
15								

LEGEND

Sample Type: R — Drive Sample B — Bulk Sample --Water Table

Laboratory Testing: AL = Atterberg Limits EI = Expansion Index MD = Maximum Density SA = Sieve Analysis SR = Sulfate/Resistivity Test DS = Shear Testing RV = R-Value Test CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/12/2016
LOCATION:	Chula Vista		

Test Pit *PT-7*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Saturation (percent)	Laboratory Testing: Others
			CL	**Artificial Fill, Undocumented:** At 0-3.0 feet, Sandy Clay, fine to coarse grained, gray brown to reddish brown, moist, firm				
5 10			CL	At 3.0 feet, Clay, fine grained, light green to gray, moist to wet, firm				
			SC	**Lindavista Formation:** At 12.0 feet, Clayey Sand with Cobbles, fine to coarse grained gray to light gray with orange brown, moist to wet, moderately dense; sub-rounded				
15				Refusal at 13.0 feet No Water Encountered No Caving				

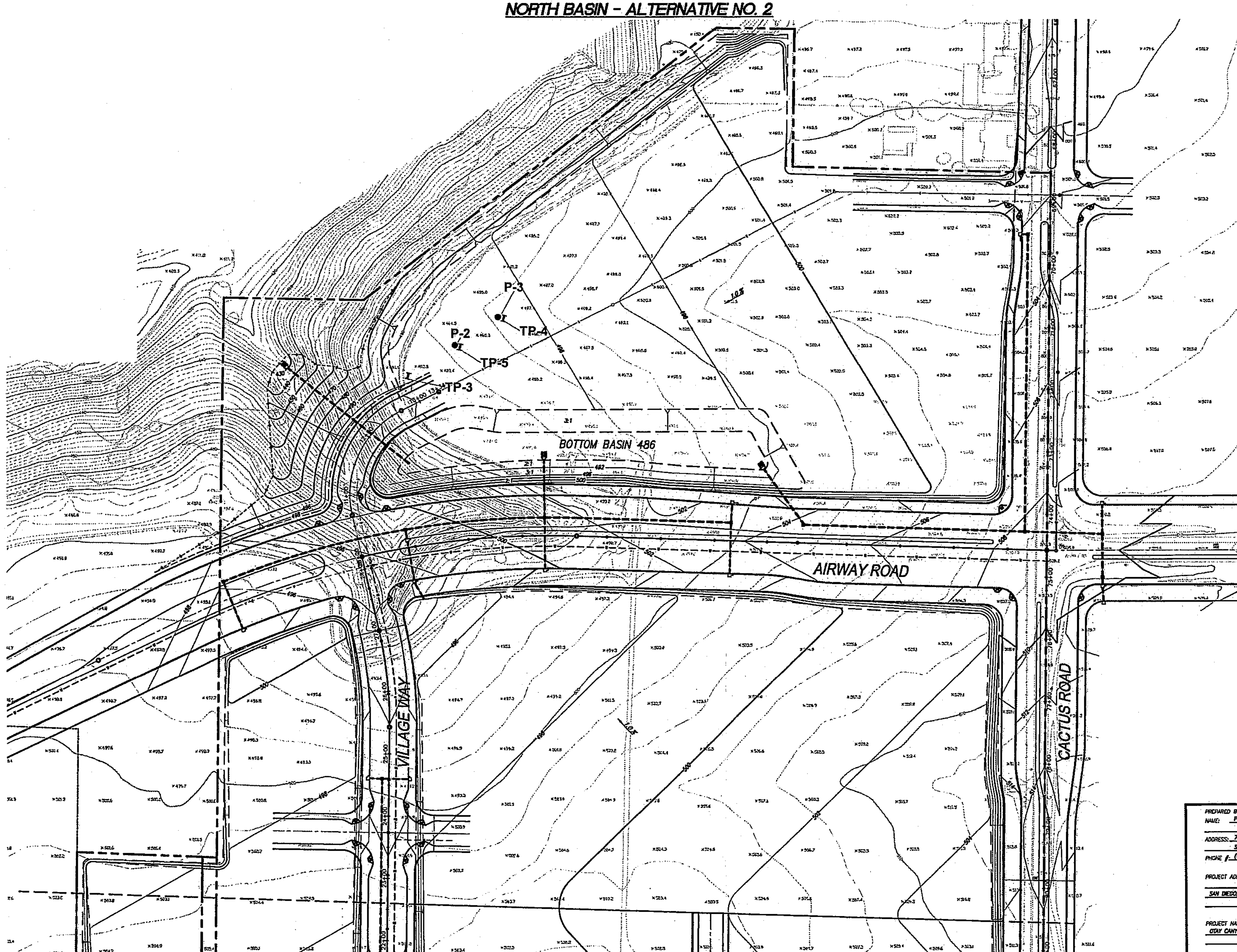
LEGEND

Sample Type:	R — Drive Sample		B — Bulk Sample	▽ --Water Table
Laboratory Testing:	AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
	SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

OTAY CANYON RANCH

TENTATIVE MAP NO. ________

NORTH BASIN - ALTERNATIVE NO. 2



LEGEND:

- P-1 — Approximate location of infiltration test (AGS, 2016)
- T-1 — Approximate location of exploratory test pits (AGS, 2016)

NORTH BASIN
DEPTH = 12.0'
TOP AREA = 74,000 SF
FOOTPRINT = 28,500 SF
= 3.0%

NORTH

0 30 60 120 180
(IN FEET)
1 inch = 60 ft.

PLATE 1

Infiltration Test Location Map

AGS
ADVANCED GEOTECHNICAL SOLUTIONS, INC.

Project:	Report:	Date:
P/W 1304-04	1304-04-B-4	May, 2017

PREPARED BY:
NAME: PROJECT DESIGN CONSULTANTS
ADDRESS: 701 "B" STREET, SUITE 800
SAN DIEGO, CALIFORNIA 92101
PHONE #: (619) 235-6471

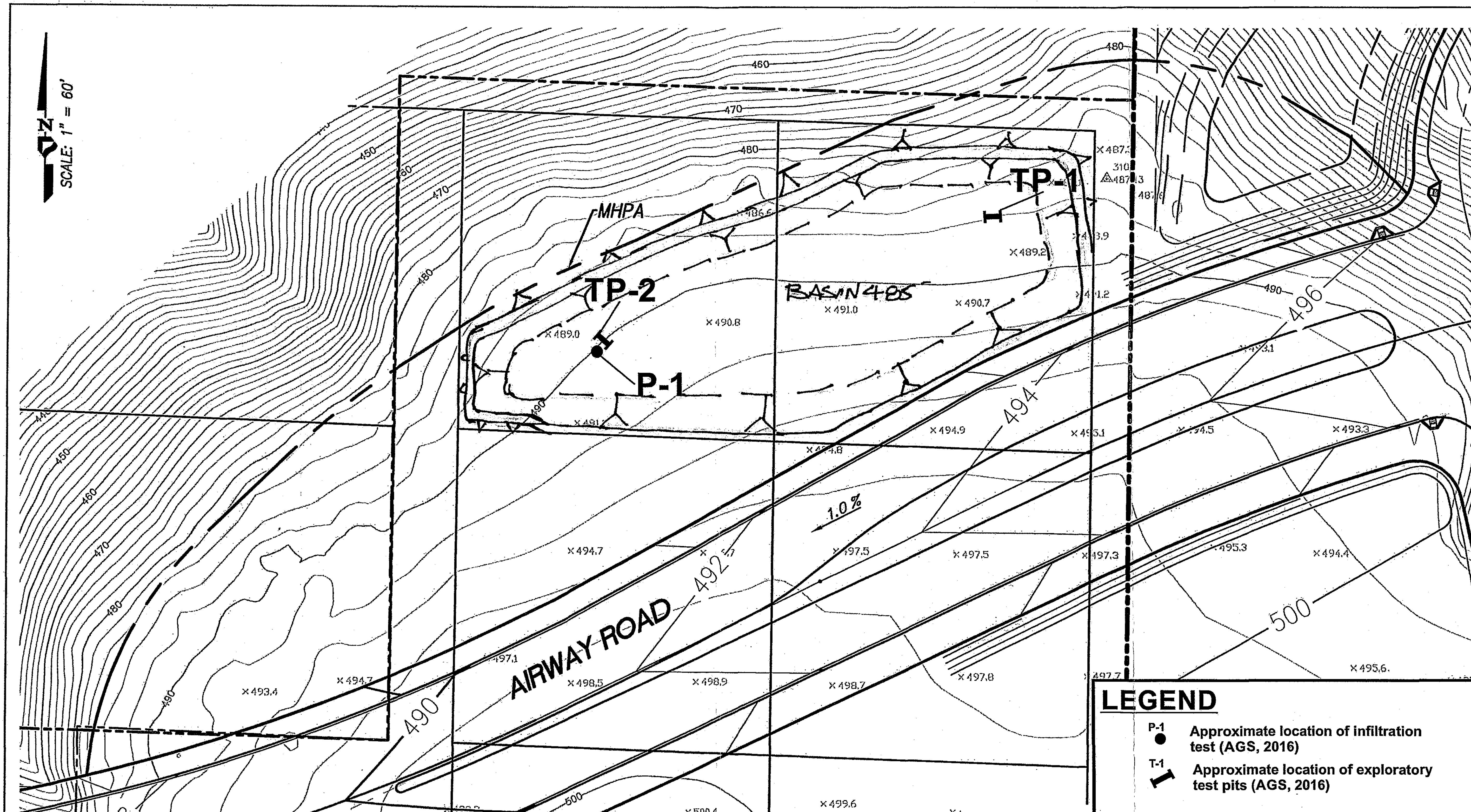
PROJECT ADDRESS:
SAN DIEGO, CALIFORNIA

PROJECT NAME:
OTAY CANYON RANCH

SHEET TITLE:

REVISION 14:
REVISION 13:
REVISION 12:
REVISION 11:
REVISION 10:
REVISION 09:
REVISION 08:
REVISION 07:
REVISION 06:
REVISION 05:
REVISION 04:
REVISION 03:
REVISION 02:
REVISION 01:
ORIGINAL DATE: 07/12/2016
SHEET ____ OF X
DEP # ____

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey

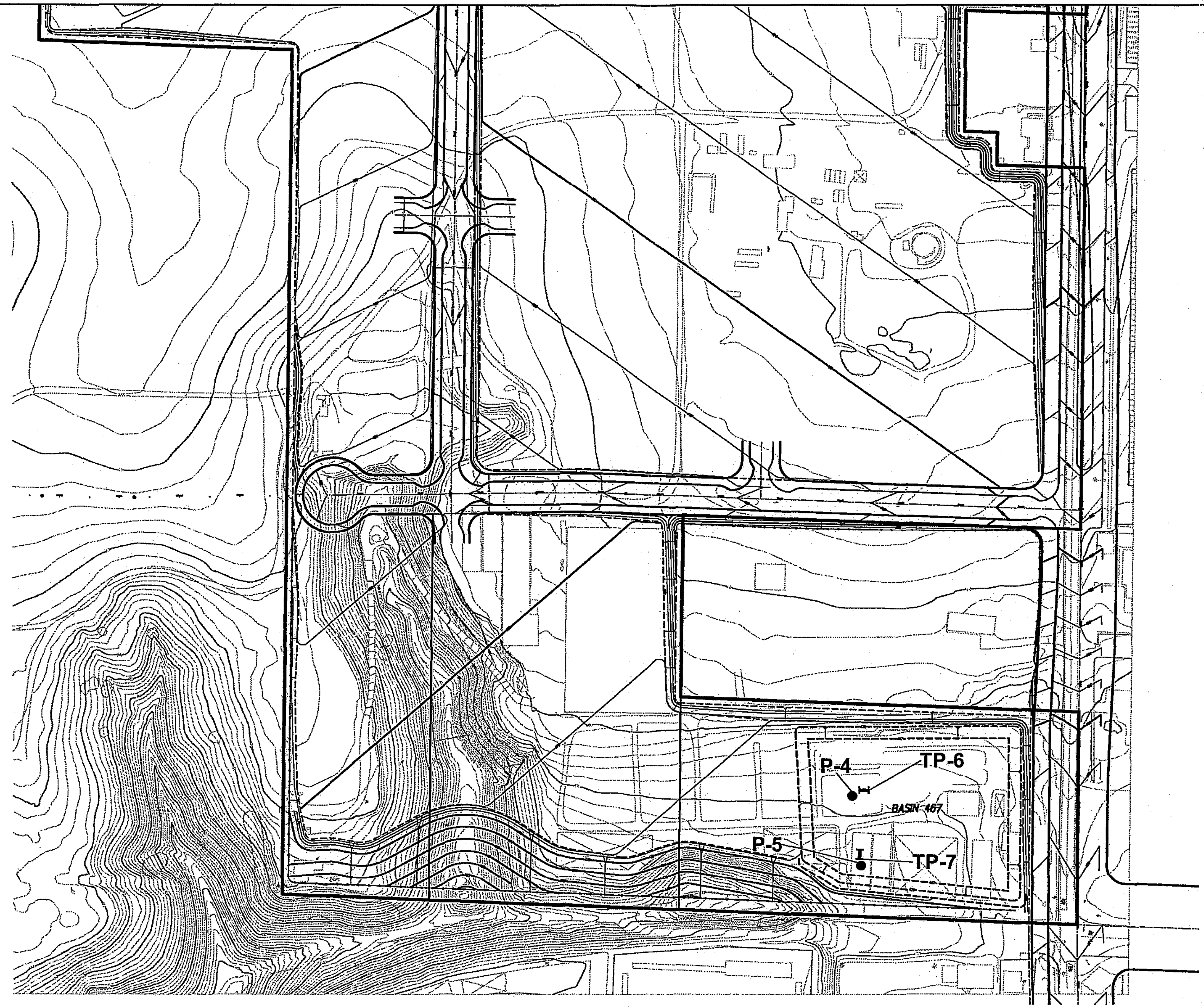


N

SCALE: 1 in. = 60ft.

PLATE 2

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
485 Corporate Drive, Suite B, Escondido Ca 92029
Telephone: (619) 726-1046 Fax: (714) 409-3287
P/W 1304-04 Report No. 1304-04-B-4



LEGEND:

P-1 ● Approximate location of infiltration test (AGS, 2016)

T-1 Approximate location of exploratory test pits (AGS, 2016)

NORTH

0 30 60 120 180

(IN FEET)

1 inch = 60 ft.

PLATE 3

Infiltration Test Location Map

AGS

ADVANCED GEOTECHNICAL SOLUTIONS, INC.

Project:	Report:	Date:
P/W 1304-04	1304-04-B-4	May, 2017

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
485 Corporate Drive, Suite B
Escondido, California 92029
Telephone: (619) 867-0487 Fax: (714) 409-3287

ColRich
444 West Beech Street, Suite 300
San Diego, California 92101

May 26, 2017
P/W 1304-04
Report No. 1304-04-B-6

Attention: **Mr. Jason Shepard**

Subject: **Geotechnical Review of Tentative Map, Otay Canyon Ranch, Otay Mesa Area, City of San Diego, California.**

References: See Appendix A

Gentleperson:

Pursuant to your request, presented herein are the results of Advanced Geotechnical Solutions, Inc.'s, (AGS) Geotechnical Review of Tentative Map for the proposed Otay Canyon Ranch project in the Otay Mesa area, City of San Diego, California. AGS has been retained by ColRich to provide geotechnical services supporting the Tentative Map approval process for this project.

The purpose of this geotechnical review is to evaluate the proposed grading plans relative to the near-site and on-site geologic and geotechnical conditions, and provide conclusions and recommendations to aid in the development of the project. The 60-scale grading plans prepared by Project Design Consultants were provided to AGS for preparation of this report. These grading plans are included in this document with appurtenant geologic and geotechnical data superimposed upon them.

Advanced Geotechnical Solutions, Inc., appreciates the opportunity to provide you with geotechnical consulting services and professional opinions. If you have any questions, please contact the undersigned at (619) 867-0487.

Respectfully Submitted,
Advanced Geotechnical Solutions, Inc.

JOHN J. DONOVAN
RCE 65051, RGE 2790, Reg. Exp. 6-30-17

PAUL J. DERISI, Vice President
CEG 2536, Reg. Exp. 5-31-17

REGISTERED PROFESSIONAL ENGINEER
JOHN J. DONOVAN
GE 2790
GEOTECHNICAL
STATE OF CALIFORNIA

PROFESSIONAL GEOLOGIST
PAUL J. DERISI
No. 2536
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

Distribution: (6) Addressee
(1) Project Design Consultants

TABLE OF CONTENTS

ATTACHMENTS:

Geotechnical Review of Tentative Map, Otay Canyon Ranch, Otay Mesa Area, City of San Diego, California

1.0 INTRODUCTION

1.1. Background and Purpose

The purpose of this report is to provide a Tentative Map (TM) level geotechnical study that may be utilized to support the submittal process for the proposed Otay Canyon Ranch Project located in the Otay Mesa area, City of San Diego, California. This report has been prepared to address the current design prepared by Project Design Consultants in a manner consistent with the City of San Diego geotechnical report guidelines and current standard of practice. Geotechnical conclusions and recommendations are presented herein, and the items addressed include: 1) unsuitable soil removals and remedial grading; 2) cut, fill and natural slope stability; 3) potential geologic hazards and general mitigation measures for these potential hazards; 4) buttress/stabilization fill criteria; 5) cut/fill pad overexcavation criteria; 6) remedial and design grading recommendations; 7) rippability of the onsite bedrock; and 8) general foundation design recommendations based upon anticipated as-graded soil conditions.

1.2. Scope of Study

This study provides geotechnical/geologic conclusions and recommendations for development of site as shown on the Tentative Map. The scope of this study included the following tasks:

- Review of pertinent published and unpublished geologic and geotechnical literature, maps, and aerial photographs readily available to this firm (Appendix A).
- Perform geologic field mapping within the proposed TM boundaries.
- Transfer selected geologic and geotechnical information generated from investigations at the project site, onto the 60-scale TM/Preliminary Grading Plan prepared by Project Design Consultants, included as Plates 1 through 3 (attached). These plans depict existing grades and proposed rough grading. AGS has added geologic and geotechnical information to the plans, including: the approximate limits of surficial geologic units and locations of exploratory excavations with abbreviated logs.
- Compile subsurface information generated from previous investigations at the site by AGS and others.
- Conduct preliminary percolation/infiltration testing in general conformance with the current City of San Diego BMP Design Manual.
- Compile laboratory testing of representative bulk samples obtained during the various investigations at the site (Appendix C).
- Prepare geologic/geotechnical cross-sections (A-A' thru I-I'), shown on Plate 4.
- Conduct a geotechnical engineering and geologic hazard analysis of the site.
- Conduct a limited seismicity analysis.

- Evaluate the stability of cut, fill, and natural slopes within the limits of the proposed development (Appendix D).
- Data analyses in relation to the site-specific proposed improvements.
- Limited evaluation of liquefaction potential based upon field investigation and familiarity with the onsite soils conditions.
- Discussion of pertinent geologic and geotechnical topics.
- Prepare general foundation design parameters which can be used for preliminary design.
- Prepare this geotechnical review report of the current tentative map-with the associated exhibits summarizing our findings. This report is suitable for preliminary design and regulatory review.

1.3. Geotechnical Study Limitations

The conclusions and recommendations in this report are professional opinions based on the data developed during this and previous investigations at the project site. The conclusions presented herein are based upon the current design as reflected on the included Tentative Map. Changes to the plan would necessitate further review.

The materials immediately adjacent to or beneath those observed may have different characteristics than those observed. No representations are made as to the quality or extent of materials not observed. Any evaluation regarding the presence or absence of hazardous materials is beyond the scope of this firm's services.

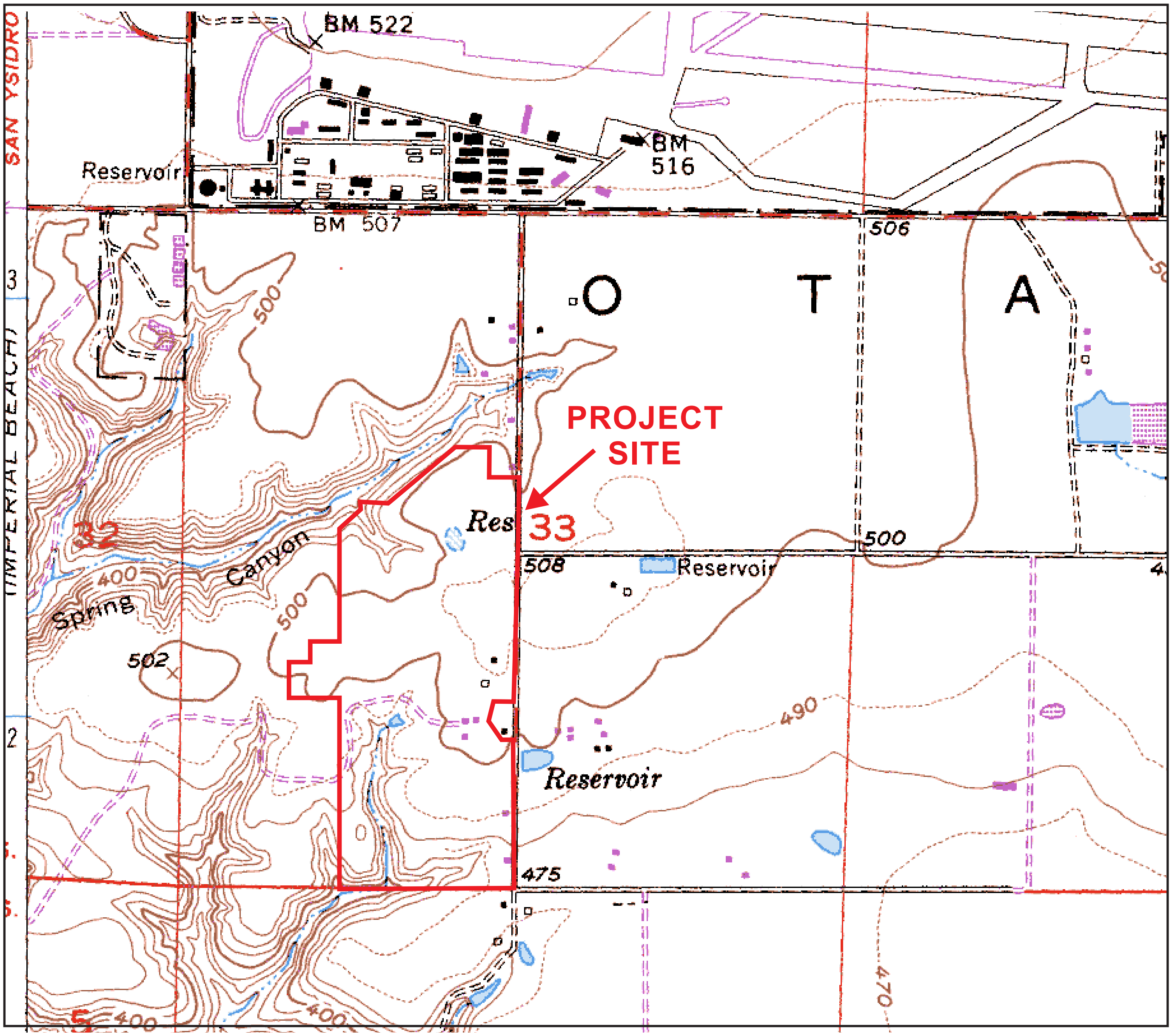
2.0 SITE LOCATION AND DESCRIPTION

2.1. Site Location and Description

The irregular shaped site is comprised of 12 contiguous parcels encompassing a total area of approximately 92 acres. The project site is located in the Otay Mesa area of San Diego, California. The site is more specifically located westerly adjacent to Cactus Road and is bound to the north by Spring Canyon and an auto recycling facility, to the west by vacant land and a southwesterly-flowing drainage, and to the south a westerly flowing drainage and the future extension of Siempre Viva Road. In general, the site is relatively level to gently sloping to the southwest. Two (2) reentrant canyons exist on the northwest and southwest portions of the site. Elevations within the project limits range from elevation 404 msl (drainage at southern boundary) to 512 msl (eastern boundary of site).

The southernmost portion of the site is currently occupied by an operational nursery which consists of an office building in the southeast corner; several barn, shed, and canopy type structures; and several growing areas. The remainder of the site is vacant land that is currently being utilized for agricultural purposes.

At this time, AGS is unaware of specific septic system(s), water well(s) or utilities that may exist on the properties. However, it is likely that these improvements are onsite. If encountered, septic



SITE LOCATION MAP
OTAY CANYON RANCH, LUMINA PROJECT
SAN DIEGO, CALIFORNIA

P/W 1304-04

FIGURE 1

SOURCE MAP - TOPOGRAPHIC MAP OF THE OTAY MESA 7.5 MINUTE QUADRANGLE, SAN DIEGO COUNTY, CALIFORNIA

AGS
ADVANCED GEOTECHNICAL SOLUTIONS, INC.
485 Corporate Drive, Suite B
Escondido, Ca 92029
Telephone: (619) 867-0487 Fax: (714) 409-3287

systems and water wells must be abandoned/mitigated in accordance with the specifications of the County of San Diego Department of Environmental Health.

2.2. Proposed Development

As depicted on the grading plans (Plates 1 through 3), the proposed development consists of six (6) large sheet graded pads separated by in-tract streets. Planned use includes multi-family residential, mixed-use residential and potential school site. Relatively lightly loaded structures are anticipated. Two large regional BMP basins are proposed at the northwestern and southeastern corners of the project. In addition, proposed widening and improvement of Cactus Road with associated utilities are also proposed.

It is anticipated that conventional cut and fill grading techniques will be utilized to develop the Proposed Project. Current 60-scale plans prepared by Project Design Consultants show maximum cuts and fills on the order of 11 and 60 feet, respectively. Proposed cut and fill slope are designed up to 10 and 74 feet, respectively, at slope ratios of 2:1 (H:V).

3.0 PREVIOUS INVESTIGATIONS

3.1. AGS Investigations

Previous investigations conducted at the subject site by AGS include a Due Diligence Investigation for the southern approximately two-thirds of the subject site (AGS 2013), which involved excavating, logging, and sampling of nine (9) rubber-tired backhoe tests pits with depths ranging from 6 to 12 feet. Logs of these excavations are presented in Appendix B-1.

A Due Diligence Investigation for the northern approximately one-third of the subject site (AGS 2015) was conducted by AGS in 2015 and included excavating, logging, and sampling of ten (10) backhoe test pits. Logs of these excavations are presented in Appendix B-1.

AGS conducted a preliminary infiltration feasibility study at the site in October of 2016. The study included the excavation of seven (7) test pits and five (5) percolation test boreholes. The results of that study are presented in Appendix E.

Selected bulk samples obtained during the three field investigations were transported to our laboratory or Soil Cor for testing and analysis; results of that testing are presented in Appendix C-1.

3.2. Investigations By Others

Six separate due diligence level geotechnical studies were prepared by Geocon (Geocon, 2003 to 2005). In general, these studies consisted of limited mapping and the excavation, logging and sampling of a total of 21 backhoe test pits ranging from a few feet deep to a maximum depth of 16 feet. Logs of these test pits are presented in Appendix B-2 with associated laboratory testing presented in Appendix C-2.

A Phase I environmental site assessment was conducted by SCS Engineers at the site, with the results reported in a report dated June 25, 2014 (SCS, 2014). A Soil Management Plan was prepared by C Young Associates in April 2017 and revised in May 2017.

4.0 ENGINEERING GEOLOGY

4.1. Geologic Analysis

4.1.1. Literature Review

AGS reviewed the referenced geologic documents in preparing this study, and where appropriate, that information was included in this document.

4.1.2. Aerial Photograph Review

AGS reviewed historic aerial photographs and satellite imagery during this investigation. The photographs AGS reviewed are presented in the References (Appendix A).

4.1.3. Field Mapping

The geologic contacts mapped on the TM are based on our observations of the site and subsurface data collected from our test pits, as well as test pits by others.

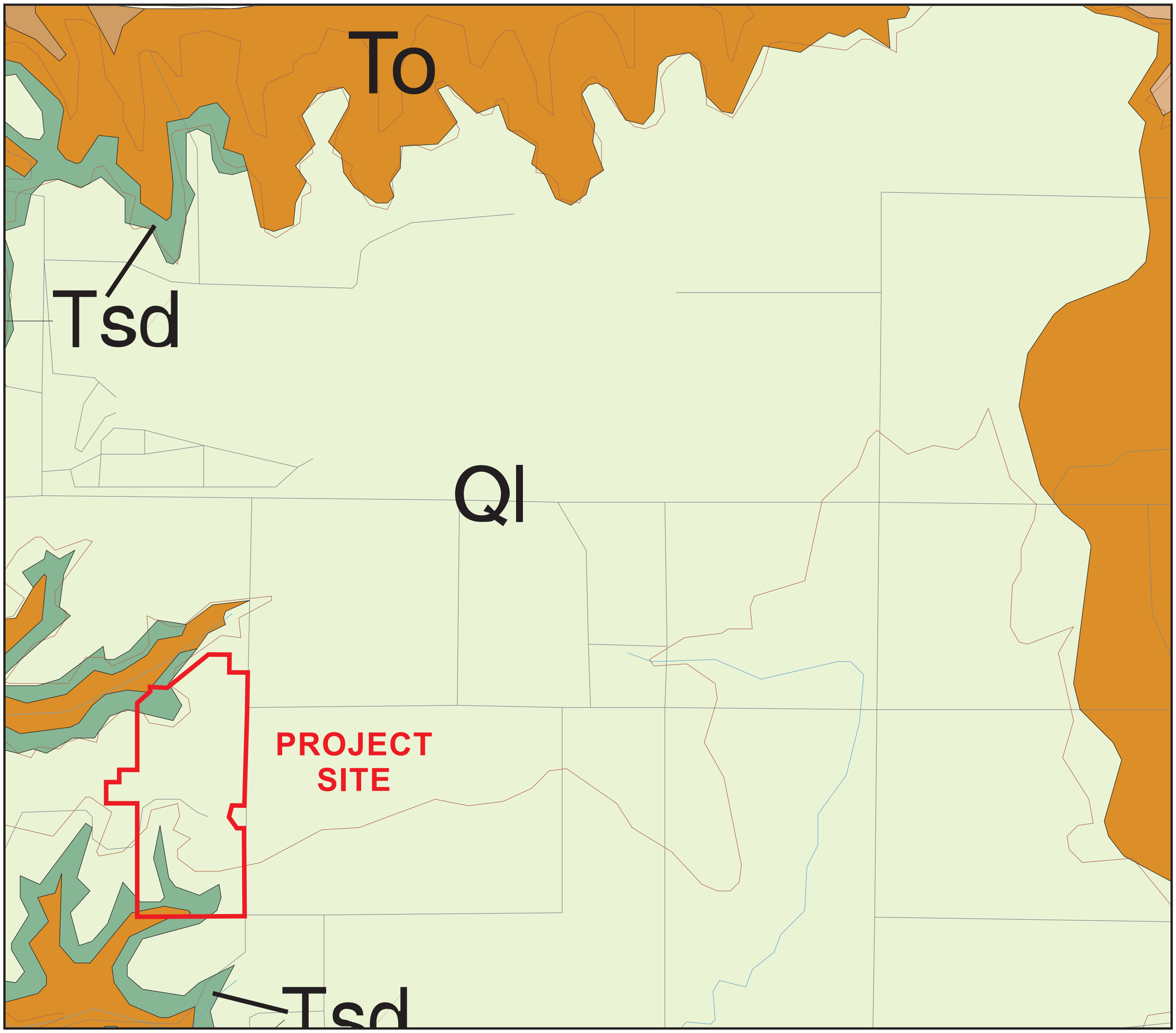
4.2. Geologic and Geomorphic Setting

The project is located in the lower Peninsular Range Region of San Diego County, a subset of the greater Peninsular Ranges Geomorphic Province of California. The Peninsular Ranges Geomorphic province is approximately bounded to the east by Elsinore Fault Zone, to the north by the Transverse Ranges, the south by Baja California, and to the west by the Pacific Ocean. This portion of the Peninsular Ranges is underlain by Jurassic and Cretaceous plutonic rocks of the Peninsular Ranges Batholith, which contains screens of variably metamorphosed Mesozoic rocks. Late Jurassic and Early Cretaceous volcanic and volcanic-clastic rocks exposed southwest of the Elsinore Fault Zone represent an older superjacent part of the Peninsular Ranges magmatic arc. These basement rocks are non-conformably overlain by a thick sequence of relatively undisturbed sedimentary rocks ranging from upper Cretaceous to Pleistocene in age.

Specifically, the project site is located near the coastal plain. Geologically, the site is underlain by two principle rock types, the Pleistocene-age Lindavista Formation underlain by the Pliocene age San Diego Formation. The Tertiary age Otay Formation is thought to unconformably underlie the San Diego Formation. Locally, undocumented artificial fill exists within former drainages at the site, and in some areas unconsolidated alluvium/topsoil of Holocene age was encountered below the artificial fill. A regional geology map is shown on Figure 2.

4.3. Stratigraphy

A brief description of the earth materials encountered on this site is presented in the following sections. More detailed descriptions of these materials are provided in the logs included in Appendix B. Based upon our investigation, the site is mantled by topsoil and undocumented artificial fill. Pleistocene-age terrace deposits assigned to the Lindavista Formation (Todd, 2004) exist below the topsoil and artificial fill at the site. The Lindavista Formation is underlain by the Pliocene age San Diego Formation. The Tertiary age Otay Formation has been mapped below the San Diego Formation at the site (Todd, 2004). The Otay Formation was not encountered during



REGIONAL GEOLOGIC MAP
OTAY CANYON RANCH, LUMINA PROJECT
SAN DIEGO, CALIFORNIA

LEGEND:

Ql - Lindavista Fromation
Tsd - San Diego Formation
To - Otay Formation

P/W 1304-04

FIGURE 2

SOURCE MAP - EL CAJON 30x60
QUADRANGLE, SOUTHERN CALIFORNIA

AGS
ADVANCED GEOTECHNICAL SOLUTIONS, INC.
485 Corporate Drive, Suite B
Escondido, Ca 92029
Telephone: (619) 867-0487 Fax: (714) 409-3287

subsurface investigations at the site. The approximate limits of these units are shown on Plates 1 through 3.

4.3.1. Undocumented Artificial Fill (Map Symbol afu)

Undocumented artificial fill was encountered in the southern, western, and northern portions of the site. The more extensive undocumented fills appear to be related to previous canyon in-fills near the western and southern site boundaries. Some of the fill is also related to the backfill of former reservoir locations. The fill primarily consists of silty to clayey sands to sandy clay that are dry to moist, and very loose to moderately dense. Generally, colors vary from brown to reddish brown. The fill contains some gravel and cobbles, organic debris, trash and construction debris (e.g. concrete pieces). During the our site subsurface investigations, AGS encountered artificial fill to depth of up to 12 feet, and Geocon encountered artificial fill to 13 feet, where refusal was reached on large concrete rubble. Isolated areas of undocumented fill could be as deep as 20 to 30 feet.

4.3.2. Topsoil (No Map Symbol)

A relatively thin veneer of topsoil blankets most of the upper mesa portion of the site. It typically consists of medium to dark brown sandy clay to clayey sand in a dry to slightly moist and loose condition. The topsoil commonly contains roots. During the recent site subsurface investigation the maximum depth of topsoil encountered ranged from 1 to 4 feet.

4.3.3. Alluvium (Map Symbol Qal)

Alluvial soils are present in the bottoms of the drainages onsite. The alluvium consists of brown, sandy to silty clay that is slightly moist to moist and loose/soft. Occasional cobbles and small boulders were encountered. The maximum depth of alluvium encountered 8 feet. Based upon our observations isolated areas of alluvium could be as deep 15 feet.

4.3.4. Lindavista Formation (Map Symbol Ql)

Pleistocene-age terrace deposits assigned to the Lindavista Formation cap the mesa portion of the site. This unit generally ranges in color from brown to reddish brown to orange brown. As encountered during our exploration and previous subsurface investigations by Geocon, these deposits vary from silty to sandy clay that is slightly moist to moist and firm to stiff, to well-graded sand with silt, gravel, and cobbles in a slightly moist and moderately dense to dense state.

4.3.5. San Diego Formation (Map Symbol Tsd)

It is anticipated that a majority of the site is underlain at depth by the Pliocene age San Diego Formation and is exposed in the lower portions of the onsite canyon walls. As encountered, the San Diego Formation generally consists of light gray to olive brown silty fine-grained sandstone and clayey to sandy siltstone that is moderately hard to hard.

The Tertiary age Otay Formation has been mapped as underlying the San Diego Formation (Todd, 2004), and may be exposed beneath alluvial/colluvial soils in the canyon bottoms westerly and northerly offsite. Bucket auger borings should be advanced at the site when access becomes available to determine the stability of the natural descending slopes at the site.

4.4. Geologic Structure and Tectonic Setting

4.4.1. Regional Faulting

The San Andreas Fault zone is the dominant and controlling tectonic stress regime of southern California. As the boundary between the Pacific and North American structural plates, this northwest trending right lateral, strike–slip, active fault has controlled the crustal structural regimes of southern California since Miocene time. Numerous related active fault zones with a regular spacing, including the Elsinore-Whittier-Chino, Newport-Inglewood-Rose Canyon, and San Jacinto fault zones characterize the stress regime and also trend to the northwest as do the Santa Ana Mountains and the Peninsular Ranges.

The Newport-Inglewood-Rose Canyon fault zone is the closest known active fault to the project and is located approximately 9 miles to the west of the site.

4.4.2. Local Faulting

No Alquist-Priolo Special Studies Fault Zones or San Diego County Fault Zones are located onsite. No faults have been mapped onsite, nor were any observed during this geologic study. The most influential geologic fault potentially affecting the property is the active Silver Strand section of the Newport-Inglewood-Rose Canyon fault zone.

4.4.3. Geologic Structure

The geologic structure within the sedimentary units below the site is characterized by regional westerly to southwesterly dipping beds with inclinations on the order of 3 to 7 degrees from horizontal.

4.5. Groundwater

Shallow groundwater was not observed during this study. Intermittent flows within the active primary and tributary drainages should be anticipated during rain events.

4.6. Non-seismic Geologic Hazards

4.6.1. Mass Wasting and Debris Flows

No landslides have been mapped within the subject site. Based on our site investigations, the vast majority of the site slopes shallowly to the southwest and is underlain by the essentially flat-lying Lindavista Formation and San Diego Formation. The Otay Formation has been mapped below the San Diego Formation at the site. Relatively deep borings should be advanced at the site to determine the structure, depth, and lithology of any Otay Formation that exists within the natural descending slopes at the northwestern and southwestern perimeters of the proposed development. The Otay Formation can be susceptible to mass wasting, due to the common bentonitic clay beds found in this unit. Based on the information that has been developed to date on the project, it is our opinion that the potential for landsliding is low to moderate in its current state. The potentially adverse effects of landsliding can be mitigated during development through the use of design avoidance or through typical remedial grading measures (removal and recompaction and/or construction of stabilization and buttress fills). Accordingly, it is our opinion that the susceptibility to landsliding onsite after development is considered to be less than significant; however, deep borings should be advanced at the site to help determine the risk of landsliding and evaluate potential mitigation measures, if warranted..

4.6.2. Flooding

Detailed FEMA flood maps are not currently available for the Proposed Project site. The San Diego County Hazard Mitigation plan indicates the site is located outside designated 100- and 500-year floodplain areas. The potential for flooding is considered to be low. Hydrology studies should be provided by the Civil Engineer.

4.6.3. Subsidence and Ground Fissuring

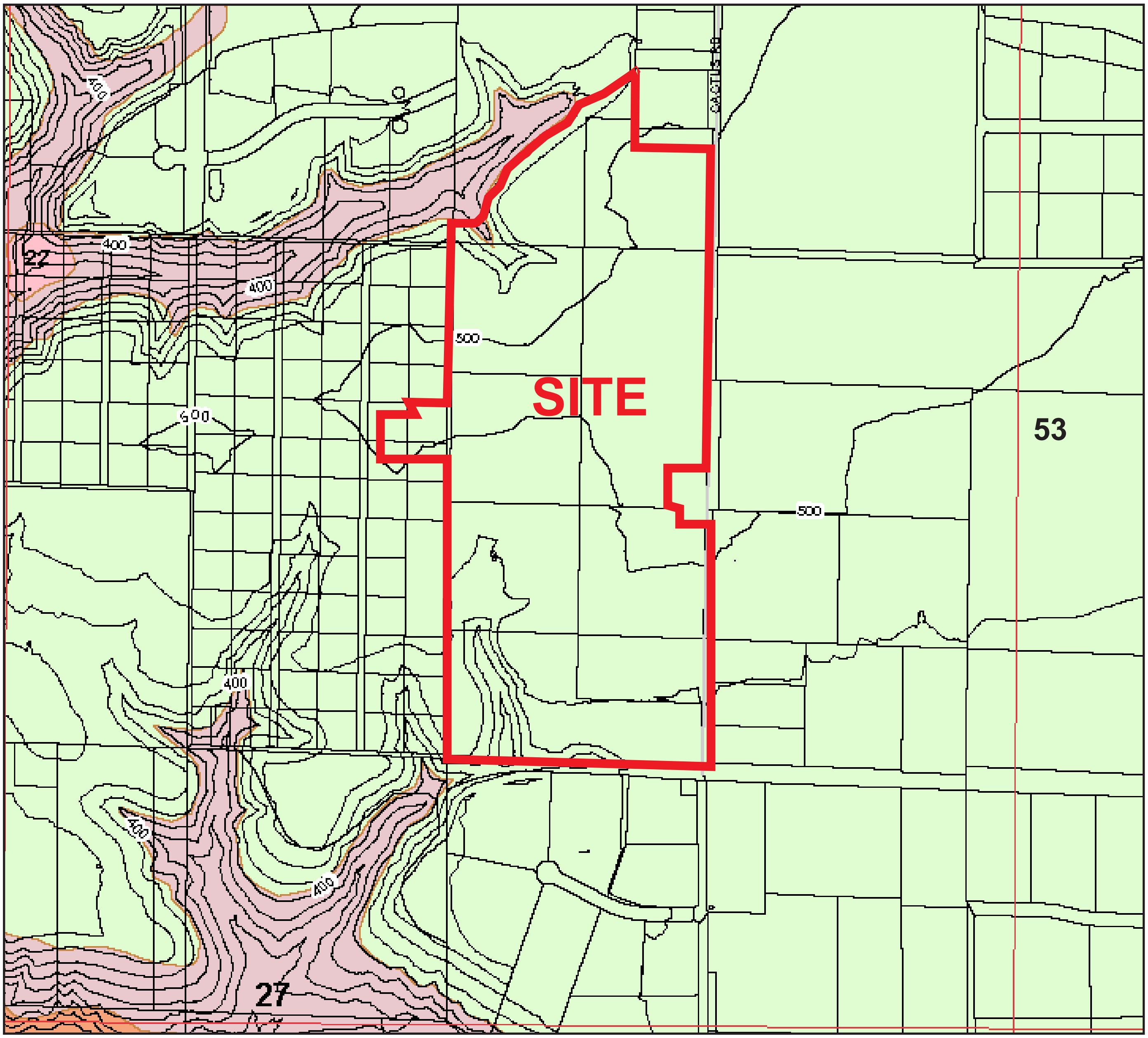
Owing to the presence of dense to moderately hard formational materials underlying the Proposed Project, subsidence and ground fissuring potential at the site is considered very low.

4.7. Seismic Hazards

The Proposed Project is located in the tectonically active Southern California area, and will therefore likely experience shaking effects from earthquakes. The type and severity of seismic hazards affecting the site are to a large degree dependent upon the distance to the causative fault, the intensity of the seismic event, the direction of propagation of the seismic wave and the underlying soil characteristics. The seismic hazard may be primary, such as surface rupture and/or ground shaking, or secondary, such as liquefaction, seismically induced slope failure or dynamic settlement. The following is a site-specific discussion of ground motion parameters, earthquake-induced landslide hazards, settlement, and liquefaction. The purpose of this analysis is to identify potential seismic hazards and propose mitigations, if necessary, to reduce the hazard to a less than significant level of risk. The following seismic hazards discussion is guided by the California Building Code (2016) and the City of San Diego Seismic Hazards Study, Geologic Hazards and Faults, 2008. A portion of this map is presented in Figure 3.

4.7.1. City of San Diego Seismic Safety Study

AGS has reviewed the 2008 City of San Diego Seismic Safety Study, Grid Tile 3 (Figure 3). The flat portion of the site is mapped as Unit 53 – Level or sloping terrain, unfavorable geologic structure, low to moderate risk. The northern portion of the



SEISMIC HAZARD ZONES
OTAY CANYON RANCH, LUMINA PROJECT
SAN DIEGO, CALIFORNIA

21 Confirmed, known, or highly suspected

27 Otay, Sweetwater, and others

53 Level or sloping terrain, unfavorable geologic structure, Low to moderate risk

FIGURE 3

SOURCE MAP(S):CITY OF SAND DIEGO SEISMIC SAFETY STUDY GEOLOGIC HAZARDS AND FAULTS, GRID TITLE 3

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
485 Corporate Drive, Suite B, Escondido CA 92029
Telephone: (714) 786-5661 Fax: (714) 409-3287

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property descending into Spring Canyon is mapped as Unit 27 – Landslide prone formations – Otay, Sweetwater, and others.

There are fault traces mapped approximately 0.85 miles west of the project site. The fault is presumed inactive, does not project into the project site, and will not be a design concern for the project.

4.7.2. Surface Fault Rupture

Surface rupture is a break in the ground surface during or as a consequence of seismic activity. In large part, research supports the conclusion that active faults tend to rupture at or near pre-existing fault planes. No faults have been mapped within or near the project. As such, it is appropriate to conclude that the potential for surface fault rupture is very low.

4.7.3. Ground Motions

As noted, the site is within the tectonically active southern California area, with segments of the Newport-Inglewood-Rose Canyon fault zone within 9 miles of the site. The potential exists for strong ground motion that may affect future improvements. As part of this assessment, AGS utilized the California Geologic Survey Probabilistic Seismic Hazards Seismic Hazards Ground Motion Interpolator Page. A site location with latitude of 32.55767˚N and longitude 116.99025˚W was utilized. Ground motions (10% probability of being exceeded in 50 years) are expressed as a fraction of the acceleration due to gravity (g). Three values of ground motion are shown, peak ground acceleration (Pga), spectral acceleration (Sa) at short (0.2 second) and moderately long (1.0 second) periods. Ground motion values are also modified by the local site soil conditions. Ground motion values are shown for two different site conditions: Soft Rock (site category C, V_s30=760m/s) and Stiff Soil (site category D, V_s30=270m/s).

TABLE 4.7.3
SELECTED GROUND MOTIONS*

	Soft Rock	**Stiff Soil**
Pga (g)	0.171g	0.220g
Sa 0.2 sec	0.398g	0.500g
Sa 1.0 sec.	0.140g	0.267g

*Ground Motion values were interpolated from a grid (0.05 degree spacing) of values calculated using the 2008 PSHA model. Interpolated ground motion may not equal values calculated for a specific site, therefore these values are not intended for design or analysis.

4.7.4. Liquefaction

Liquefaction is the phenomenon where seismic agitation of loose, saturated sands and silty sands can result in a buildup of pore pressures that, if sufficient to overcome overburden stresses, can produce a temporary quick condition. Localized, loose lenses/layers of sandy soils may be subject to liquefaction when a large, prolonged, seismic event affects the site. As the excess pore water pressure dissipates, the liquefied zones/lenses can consolidate causing settlement. Post liquefaction effects at a site can manifest in several ways and may include: 1) ground deformations; 2) loss of shear strength; 3) lateral spread; 4) dynamic settlement; and 5) flow failure.

In general, the more recently sediment has been deposited, the more likely it is to be susceptible to liquefaction. Further, liquefaction potential is greatest in loose, poorly graded sands and silty sands with mean grain size in the range of 0.1 to 0.2 mm. Other factors that must be considered are groundwater, confining stresses, relative density, intensity and duration of ground shaking.

The Proposed Project is not within an area zoned by the County of San Diego as a Potential Liquefaction Area.

In consideration of the recommended remedial grading, and dense nature of the formational materials and proposed fills within the limits of the Proposed Project, the potential for liquefaction or seismically induced settlement is considered remote.

4.7.5. Lateral Spreading

Liquefaction-induced lateral spreading is defined as the finite, lateral displacement of gently sloping ground as a result of pore pressure build-up or liquefaction in a shallow underlying deposit during an earthquake. Due to the presence of dense underlying formational materials, the potential for lateral spreading is considered to be very low.

4.7.6. Seismically Induced Dynamic Settlement

Seismically induced dynamic settlement occurs in response to seismic shaking of loose cohesionless sand soils. The source of settlement is volumetric strain associated with liquefaction of saturated soils strata, and/or, the rearrangement of sandy particles in dry, relatively loose layers of cohesionless sandy soils. These two sources of settlement potential are mutually exclusive. As a result, if the groundwater rises, the liquefaction potential and its adverse effects increase, while dry sand settlement potential decreases; and, vice-versa.

Due to the anticipated removals proposed herein, the density of the Lindavista Formation to be left in-place, and the relative hardness of the underlying San Diego Formation, the potential for seismically induced settlement is considered very low.

4.7.7. Seismically Induced Landsliding

Do to the relatively flat-lying sedimentary units beneath the site, seismically induced landsliding of engineered fill slopes is considered to be very low. The descending slopes near the northerly and southerly periphery of the project may be susceptible to seismically induced landsliding and will need to be evaluated in more detail using data developed through additional future subsurface exploration efforts. Pseudo-static slope stability analyses were performed using a horizontal destabilizing seismic coefficient (kh) of 0.15g. The analyzed slopes were determined to be grossly stable. A more detailed discussion of slope stability is presented in Section 6.2.

4.7.8. Earthquake Induced Flooding

Earthquake induced flooding can be caused by tsunamis, dam failures, or seiches. Also, earthquakes can cause landslides that dam rivers and streams, and flooding can occur upstream above the dam and also downstream when these dams are breached. A seiche is a free or standing-wave oscillation on the surface of water in an enclosed or semi-enclosed basin. The wave can be initiated by an earthquake and can vary in height from several centimeters to a few meters. Due to the lack of an up-gradient freestanding body of water nearby, the potential for a seiche impacting the site is considered to be non-existent.

Considering the lack of any dams or permanent water sources upstream, earthquake induced flooding caused by a dam failure is considered to be remote.

Considering the distance of the site from the coastline, the potential for flooding due to tsunamis is very low.

5.0 GEOTECHNICAL ENGINEERING

Presented herein is a general discussion of the geotechnical properties of the various soil types and the analytic methods used in this report.

5.1. Material Properties

5.1.1. Excavation Characteristics

The results of AGS's and others subsurface investigations, combined with grading experience in the area, indicate that the alluvium, topsoil, undocumented fill, Lindavista Formation, and the San Diego Formation are rippable with conventional grading equipment (i.e., scrapers). Deeper cuts (> 10 feet) in the gravelly/cobbly portions of the Lindavista Formation may be cemented, requiring heavy ripping to efficiently excavate this material.

Significant amounts of oversize rock (i.e., rocks > 12 inches) are not expected to be generated during grading at the site.

5.1.2. Oversized Materials

Oversized rock may be incorporated into the compacted fill section to within ten (10) feet of finish grade or within two (2) feet of the deepest utility (if utility is greater than ten (10) feet). Oversize rock is not to be placed within areas of proposed drainage structures and should be kept minimally five (5) feet outside and below proposed culverts, pipes, etc. Variances to the above rock hold-down must be approved by the owner, geotechnical consultant and governing agencies.

5.1.3. Compressibility

The onsite materials that are compressible include topsoil, undocumented fill, alluvium, colluvium, and highly weathered Lindavista Formation. Highly compressible materials will require removal from fill areas prior to placement of fill and where exposed at grade in cut areas.

5.1.4. Collapse Potential/Hydro-Consolidation

The hydro-consolidation process is a singular response to the introduction of water into collapse-prone sandy soils. Upon initial wetting, the soil structure and apparent strength are altered and a virtually immediate settlement response occurs. Recommended measures to mitigate potential for differential settlement due to hydro-collapse include removal/recompaction and/or foundation design, such as described in Sections 6.1 and 7.1 of this report. Typical mitigation measures consist of removal and recompaction of these soils where these soils are found within structural areas.

5.1.5. Expansion Potential

Based upon the sampling and associated laboratory testing conducted by AGS, the onsite soils are considered to exhibit “Very Low” to “Very High” expansion potential, with the majority of the onsite soils possessing “Low” to “High” expansion potential. Typical mitigation measures for expansive soils include: structural design; pre-saturation; and overexcavation where the higher expansion characteristics are present and replacement with lower expansive soils (selective grading).

5.1.6. Shear Strength

AGS has evaluated the shear strength of the materials onsite using the laboratory data presented in the referenced Geocon reports and our prior experience with the onsite materials. Direct shear tests were conducted on samples that were remolded to 90 percent of the maximum dry density, and the results of the tests can be used to evaluate the strength of fill derived from the onsite materials. The test results indicated that shear strength of fill could vary based on the type of material. A clayey sand that was tested exhibited a relatively low shear strength whereas a silty sand that was tested exhibited a high shear strength. An “average” value was used for design. Within the onsite geologic units, the in-situ shear strength is the most significant factors in cut slope and natural slope stability. Additional exploratory work is planned and samples of the underlying geologic units will be collected for testing. Based on our experience with nearby projects, the shear strength of the formational materials has been estimated and is shown in Table 5.1.6. These shear strength values assume that low strength beds within the formational units are not present.

TABLE 5.1.6 **RECOMMENDED SHEAR STRENGTHS FOR DESIGN**			
Material	**Cohesion (psf)**	**Friction Angle (degrees)**	**Density (pcf)**
Artificial Fill Compacted	350	27	125
Lindavista Formation (Ql)	200	32	130
San Diego Formation (Tsd)	50	30	125

5.1.7. Chemical and Resistivity Test Results

The initial test results from AGS's investigation in the general area indicate that the water soluble sulfate concentrations for the onsite soils tested ranged from 0.01% to 0.405% which corresponds to a S0 (not applicable) to S2 (severe) sulfate exposure class per ACI 318 Table 4.3.1. Some of the onsite soils are expected to be corrosive to concrete. Based upon the initial test results, higher strength concrete, low water to cement ratios (0.5 to 0.45) and specialized cement types (Type V) could be required to mitigate the adverse effects these aggressive soils could have on concrete.

Resistivity testing of the onsite soils ranged from 260 ohm-cm to 2,300 ohm-cm. These results indicate that some of the onsite soils are expected to be corrosive to ferrous metals. Additional testing should be completed during grading to verify whether the soils tested produce similar test results.

5.1.8. Earthwork Adjustments

The onsite soils are expected to undergo a volume change when excavated and utilized as a fill material. In an effort to balance earthwork quantities, the following volume adjustments can be utilized. These numbers are considered approximate and should be refined during grading when actual conditions are better defined. Contingencies should be made to adjust the earthwork balance during grading if these numbers are adjusted.

TABLE 5.1.8 **RECOMMENDED EARTHWORK ADJUSTMENTS**	
Geologic Unit	**Adjustment Factor**
Alluvium/Topsoil	Shrink 10 – 12%
Undocumented Artificial Fill	Shrink 8 – 15%
Lindavista Formation (Ql)	Bulk 2 – 5%
San Diego Formation (Tsd)	Bulk 5 – 8%

5.1.9. Permeability/Infiltration Potential

AGS conducted five (5) borehole percolation tests (P-1 through P-5) at preliminary locations for water quality control basins. In addition, backhoe test pits were excavated adjacent to each infiltration test location. The approximate locations of the percolation test holes are presented on the Geologic Map and Exploration Location Plan, Plates 1 through 3.

Infiltration testing was performed in accordance with the methods described in Appendix D of the 2016 County of San Diego BMP Design Manual. Field percolation rates were converted to infiltration rates using the using the Porchet method. Based on the results of our site specific subsurface investigation and percolation testing, it is anticipated that the onsite soils and bedrock possess low infiltration rates. Preliminary design infiltration rates ranged between 0.08 in/hr and 0.38 in/hr. A more detailed discussion of test methods and findings are presented in Appendix E – Infiltration Feasibility Study. Table 5.1.9 presents infiltration rates for the areas tested. Dependent upon proposed BMP type and location, additional evaluation and testing may be warranted.

TABLE 5.1.9
SUMMARY OF PRELIMINARY DESIGN INFILTRATION RATES

Test Hole No.	Tested Infiltration Rate (in./hr.)	Factor of Safety	Preliminary Design Infiltration Rate (in./hr.)
P-1	0.73	2.0	**0.36**
P-2	0.77	2.0	**0.38**
P-3	0.40	2.0	**0.20**
P-4	0.44	2.0	**0.22**
P-5	0.17	2.0	**0.08**

5.1.10. Pavement Support Characteristics

Compacted fill derived from onsite soils are expected to possess “poor” to “moderate” pavement support characteristics. Testing should be completed once subgrade elevations are reached for the onsite roadways. For preliminary planning purposes, AGS has used an R-Value of 20 for the preliminary design of roadway pavement sections.

5.2. Analytical Methods

5.2.1. Slope Stability Analysis

Stability analyses were performed for both static and seismic (pseudo-static) conditions using the GSTABL7 computer program. The Modified Bishop method was used to analyze circular type failures. The critical failure surface determined in the static analysis was used in the pseudo-static analysis. A horizontal destabilizing seismic coefficient (kh) of 0.15g was selected for the site and used in the pseudo-static analyses.

Surficial stability analyses were conducted using an infinite height slope method assuming seepage parallel to the slope surface.

5.2.2. Pavement Design

Asphalt concrete pavement sections have been designed using the recommendations and methods presented in the Caltrans Highway Design Manual.

5.2.3. Bearing Capacity and Lateral Pressure

Ultimate bearing capacity values were obtained using the graphs and formula presented in NAVFAC DM-7.1. Allowable bearing was determined by applying a factor of safety of at least 3 to the ultimate bearing capacity. Static lateral earth pressures were calculated using Rankine methods for active and passive cases.

6.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

Based on the information presented herein and our experience in the vicinity of the proposed project site, it is AGS's opinion that the proposed development of Otay Canyon Ranch is feasible, from a geotechnical point of view, provided that the constraints discussed in this report are addressed in the design and construction of the proposed project. Key issues related to site development are discussed and associated geotechnical recommendations for use in planning and design are presented in the following sections of this report.

All grading shall be accomplished under the observation and testing of the project Geotechnical Consultant in accordance with the recommendations contained herein, the current codes and practiced by the City of San Diego and this firm's Earthwork Specifications (Appendix F).

6.1. Site Preparation and Removals/Overexcavation

Guidelines to determine the depth of removals are presented below; however, the exact extent of the removals must be determined in the field during grading, when observation and evaluation in greater detail afforded by those exposures can be performed by the Geotechnical Consultant. In general, removed soils will be suitable for reuse as compacted fill when free of deleterious materials and after adequate moisture conditioning and mixing.

Removal of unsuitable soils typically should be established at a 1:1 projection to suitable materials outside the proposed engineered fills. Front cuts should be made no steeper than 1:1, except where constrained by other factors such as property lines and protected structures. Removals should be initiated at approximately twice the distance of the anticipated removal depth, outside the engineered fills. During grading, the bottoms of all removal areas should be observed, mapped, and approved by the Geotechnical Consultant prior to fill placement. It is recommended the bottoms of removals be surveyed and documented.

6.1.1. Site Preparation and Removals

Existing vegetation, trash, debris and other deleterious materials should be removed and wasted from the site prior to removal of unsuitable soils and placement of compacted fill. Artificial fill, topsoil/colluvium, alluvium, and highly weathered formational materials should be removed in areas planned to receive fill or where exposed at final grade. The resulting undercuts should be replaced with engineered fill. Estimated depths of removals based upon the geologic unit are presented in Table 6.1.1. It should be noted that local variations can be expected requiring an increase in the depth of removal for unsuitable and weathered deposits. The extent of removals can best be determined in the field during grading when observation and evaluation can be performed by the soil engineer and/or engineering geologist. Removals should expose competent formational materials and be observed and mapped by the engineering geologist prior to fill placement. In general, soils removed during remedial grading will be suitable for reuse in compacted fills provided they are properly moisture conditioned, mixed, and do not contain deleterious materials.

TABLE 6.1.1
ESTIMATED DEPTH OF REMOVALS

Geologic Unit	Estimated Removal Depth
Undocumented Artificial Fill	3 – 20+ feet
Topsoil/Colluvium (no map symbol)	2 – 5 feet
Alluvium (Qal)	4 – 10 feet
Lindavista Formation (Ql)	3 – 5 feet
San Diego Formation (Tsd)	1 – 3 feet

6.1.2. Overexcavation

6.1.2.1. Cut Lot Overexcavation

When structural sitings are made available, structural cut lots exposing the Lindavista Formation should be overexcavated such that a minimum of three feet of compacted fill is placed below the building pads. Deeper overexcavation may be considered for structures planned with deeper footings. The overexcavation should maintain a minimum one (1) percent gradient to the front of the lot. In addition, where steep cut/fill transitions are created, additional overexcavation and flattening of the transitions may be required.

6.1.2.2. Cut/Fill Transition Lot Overexcavation

Where design or remedial grading activities create a cut/fill transition on the "structural" lots, excavation of the cut and shallow fill portion should be performed such that a minimum of three (3) feet of compacted fill exists below pad grade. The undercut overexcavation should maintain a minimum one (1) percent gradient to the front of the lot. In addition, where steep cut/fill transitions are created, additional overexcavation and flattening of the transitions may be recommended.

6.1.3. Removals Along Grading Limits and Property Lines

Removals of unsuitable soils will be required prior to fill placement along the project grading limits. A 1:1 projection, from toe of slope or grading limit, outward to competent materials should be established, when possible.

6.2. Slope Stability and Remediation

The majority of the project site is underlain by the Lindavista Formation, overlain by topsoil and artificial fill. Below the Lindavista Formation, the San Diego Formation was observed. The Otay Formation has been mapped at the site below the San Diego Formation. It should be noted that weak and/or sheared zones can be found within claystone beds in the Otay Formation. The presence of these beds can impact the stability of the adjacent descending natural slopes if found to daylight on the slope face. Additional subsurface data should be collected prior to grading to evaluate the stability of the natural slopes surrounding the site. Deep borings are currently planned. If adverse geologic conditions are encountered during the subsurface investigation or grading operations in sloped areas, the construction of stabilization fill slopes may be required to provide adequate stability.

Based on current geologic information, it is generally anticipated that the proposed cut and fill slopes will be grossly and surficially stable as designed. AGS evaluated the global stability of the slopes shown on the geologic cross sections using GSTABL7. Based on the results of the analysis, proposed cut slope and fill slopes are expected to be grossly stable in both static conditions (slope stability Factor of Safety greater than 1.5) and seismic conditions (pseudo-static slope stability Factor of Safety greater than 1.1). The results of the analyses are provided in Appendix D.

6.2.1. Cut Slopes

Due to the site being located at the top of a mesa, the highest proposed cut slope is only approximately 12 feet at a slope ratio of 2:1 (horizontal: vertical). Based upon the currently available information, we anticipate that proposed cut slopes will be in the Lindavista Formation and will be grossly stable at slope ratios of 2:1 (horizontal: vertical) or flatter to maximum proposed height. If highly to moderately weathered Lindavista Formation is exposed within cut slopes, that portion of the cut slope should be removed and replaced with a stabilization fill.

Cut slopes should be observed by the Geotechnical Consultant during grading. Where cut slopes expose unfavorable geology, such as, daylighted joints, sheared zones, loose or raveling weathered bedrock, or where boulders may pose a rock fall hazard, replacement of the unsuitable portions of the cut with stabilization fill will be recommended.

6.2.2. Fill Slopes

Fill slopes on the project are designed at 2:1 ratios (horizontal to vertical) or flatter. The highest anticipated fill slope is approximately 73 feet at the northeastern site boundary. Fill slopes, when properly constructed with onsite materials, are expected to be grossly stable as designed. Stability calculations supporting this conclusion are presented in

Appendix D. Fill slopes will be subject to surficial erosion and should be landscaped as quickly as possible.

Keys should be constructed at the toe of all fill slopes “toeing” on existing or cut grade. Fill keys should have a minimum width equal to one-half the height of ascending slope, and not less than 15 feet. Unsuitable soil removals below the toe of proposed fill slopes should extend from the catch point of the design toe outward at a minimum 1:1 projection into approved material to establish the location of the key. Backcuts to establish that removal geometry should be cut no steeper than 1:1 or as recommended by the Geotechnical Consultant.

6.2.3. Skin Cut and Skin Fill Slopes

A review of the preliminary grading plans did not indicate any significant design skin fill and skin cut conditions, however, skin cut or thin fill sections may be created during grading. If these conditions occur, it is recommended that a backcut and keyway be established such that a minimum fill thickness equal to one-half the remaining slope height, and not less than 15 feet, is provided. Where the design cut is insufficient to remove all unsuitable materials, overexcavation and replacement with a stabilization fill will be required, as shown on Grading Detail 6 in Appendix F.

6.2.4. Fill Over Cut Slopes

Fill over cut slopes should be constructed such that the cut portion is excavated first for geologic mapping and stability determination. If deemed stable then a “tilt-back” keyway half the remaining slope height or minimally twenty (20) feet wide should be established. Drains will be required for this condition with the locations determined based upon exposed field conditions.

6.2.5. Surficial Stability

The surficial stability of proposed fill and cut slopes, constructed in accordance with the recommendations presented herein, have been analyzed, and the analyses presented in Appendix D indicates factors-of-safety in excess of code minimums. When fill and cut slopes are properly constructed and maintained, satisfactory performance can be anticipated although slopes will be subject to erosion, particularly before landscaping is fully established.

6.2.6. Natural Slopes

Significant descending natural slopes are present along the northerly and southerly boundaries of the project. Preliminary slope stability analyses have been conducted using the geologic information currently available and indicate that these slopes are grossly stable. Several landslides are present west of the project, and natural slopes in those areas are not considered stable. Additional subsurface work is planned, and the natural slopes surrounding the site should be re-analyzed based on the additional data collected.

6.2.7. Temporary Backcut Stability

During grading operations, temporary backcuts may occur due to grading logistics and during retaining wall construction. Backcuts should be made no steeper than 1:1 (horizontal to vertical) to heights of up to 20 feet, and 1½:1 (horizontal: vertical) for heights greater than 20 feet. Flatter backcuts may be necessary where geologic conditions dictate, and where minimum width dimensions are to be maintained.

In consideration of the inherent instability created by temporary construction of backcuts, it is imperative that grading schedules be coordinated to minimize the unsupported exposure time of these excavations. Once started these excavations and subsequent fill operations should be maintained to completion without intervening delays imposed by avoidable circumstances. In cases where five-day workweeks comprise a normal schedule, grading should be planned to avoid exposing at-grade or near-grade excavations through a non-work weekend. Where improvements may be affected by temporary instability, either on or offsite, further restrictions such as slot cutting, extending work days, implementing weekend schedules, and/or other requirements considered critical to serving specific circumstances, may be imposed.

6.2.8. Observation During Grading

All temporary slope excavations, including front, side and backcuts, and all cut slopes should be mapped to verify the geologic conditions that were modeled prior to grading.

6.3. Survey Control During Grading

Removal bottoms, fill keys, stabilization fill keys, and backdrains should be surveyed prior to final observation and approval by the geotechnical engineer/engineering geologist in order to verify locations and gradients.

6.4. Subsurface Drainage

Canyon subdrains should be constructed within the major drainages which will ultimately be filled as part of the mass grading of the site. Canyon subdrains will range in diameter from 6 to 8 inches in diameter and should be constructed in accordance with Grading Details 1 and 2. Final determination as to the location and the size of these subdrain systems will be dependent upon the final design grades and length of drain sections. Accordingly, once more detailed plans become available, site specific recommendations will be prepared regarding the size, location, and extent of the subdrain system for the project. Preliminary proposed canyon subdrain locations and sizes are shown on Plates 1 through 3. Actual subdrain locations will be determined in the field, after completion of remedial grading.

Backdrains, where required, should be constructed in accordance with Grading Detail 2. Drains should be installed behind all retaining walls.

6.5. Seepage

Seepage, if encountered during grading, should be evaluated by the Geotechnical Consultant. In general, seepage is not anticipated to adversely affect grading. If seepage is excessive, remedial measures such as horizontal drains or under drains may need to be installed.

6.6. Earthwork Considerations

6.6.1. Compaction Standards

All fills should be compacted at least 90 percent of the maximum dry density as determined by ASTM D1557. All loose and or deleterious soils should be removed to expose firm native soils or bedrock. Prior to the placement of fill, the upper 6 to 8 inches should be ripped, moisture conditioned to optimum moisture or slightly above optimum, and compacted to a minimum of 90 percent of the maximum dry density (ASTM D1557). Fill should be placed in thin (6 to 8-inch) lifts, moisture conditioned to optimum moisture or slightly above, and compacted to 90 percent of the maximum dry density (ASTM D1557) until the desired grade is achieved. For fills greater than 50 feet, AGS recommends a minimum compaction standard of 93 percent of the maximum dry density (ASTM D1557). For fills deeper than 75 feet, AGS recommends a minimum compaction standard of 95 percent of the maximum dry density (ASTM D1557).

Where the natural slope is steeper than 5-horizontal to 1-vertical and where determined by the Geotechnical Consultant, compacted fill material shall be keyed and benched into competent materials.

6.6.2. Mixing and Moisture Control

In order to prevent layering of different soil types and/or different moisture contents, mixing and moisture control of materials will be necessary. The preparation of the earth materials through mixing and moisture control should be accomplished prior to and as part of the compaction of each fill lift. Water trucks or other water delivery means may be necessary for moisture control. Discing may be required when either excessively dry or wet materials are encountered.

6.6.3. Haul Roads

All haul roads, ramp fills, and tailing areas shall be removed prior to engineered fill placement.

6.6.4. Import Soils

The project is proposed to balance on site. If this changes, the Geotechnical Consultant should be contacted.

6.6.5. Fill Slope Construction

Fill slopes may be constructed by preferably overbuilding and cutting back to the compacted core or by back-rolling and compacting the slope face. The following recommendations should be incorporated into construction of the proposed fill slopes.

Care should be taken to avoid spillage of loose materials down the face of any slopes during grading. Spill fill will require complete removal before compaction, shaping, and grid rolling.

Seeding and planting of the slopes should follow as soon as practical to inhibit erosion and deterioration of the slope surfaces. Proper moisture control will enhance the long-term stability of the finish slope surface.

6.6.5.1. Overbuilding Fill Slopes

Fill slopes should be overfilled as determined by the grading contractor, but not less than 2 feet measured perpendicular to the slope face, so that when trimmed back to the compacted core, compaction of the slope face meets the minimum project requirements for compaction.

Compaction of each lift should extend out to the temporary slope face. The slope should be back-rolled at fill intervals not exceeding 4 feet in height, unless a more extensive overfilling is undertaken.

6.6.5.2. Compacting the Slope Face

As an alternative to overbuilding the fill slopes, the slope faces may be back-rolled with a heavy-duty loaded sheepsfoot or vibratory roller at maximum 4-foot fill height intervals. Back-rolling at more frequent intervals may be required. Compaction of each fill lift should extend to the face of the slope. Upon completion, the slopes should be watered, shaped, and track-walked with a D-8 bulldozer or similar equipment until the compaction of the slope face meets the minimum project requirements. Multiple passes may be required.

6.6.6. Utility Trench Excavation and Backfill

All utility trenches should be shored or laid back in accordance with applicable OSHA standards. Excavations in bedrock areas should be made in consideration of underlying geologic structure, and the geotechnical consultant should be consulted on these issues during construction.

Mainline and lateral utility trench backfill should be compacted to at least 90 percent of maximum dry density as determined by ASTM D 1557. Onsite soils will not be suitable for use as bedding material but will be suitable for use in backfill, provided oversized materials are removed. No surcharge loads should be imposed above excavations. This includes spoil piles, lumber, concrete trucks, or other construction materials and equipment. Drainage above excavations should be directed away from the banks, and care should be taken to avoid saturation of the soils.

Compaction should be accomplished by mechanical means. Jetting of native soils will not be acceptable.

To reduce moisture penetration beneath the slab-on-grade areas, shallow utility trenches should be backfilled with lean concrete or concrete slurry where they intercept the foundation perimeter, or such excavations can be backfilled with native soils, moisture-conditioned to over optimum, and compacted to a minimum of 90 percent relative compaction.

7.0 DESIGN RECOMMENDATIONS

From a geotechnical perspective, the Proposed Project is feasible provided the following recommendations are incorporated into the design and construction. Preliminary design recommendations are presented herein and are based on some of the general soils conditions encountered during the recent investigation and described in the referenced geotechnical investigations. As such, recommendations provided herein are considered preliminary and subject to change based on the results of additional observation and testing that will occur during grading operations. Final design recommendations should be provided in a final rough/precise grading report.

7.1. Structural Design Recommendations

It is expected that for typical one to three story residential/commercial products and loading conditions (1 ksf to 6 ksf for spread and continuous footings), conventional or post-tensioned shallow slab-on-grade foundation systems can be utilized.

Upon the completion of rough grading, finish grade samples should be collected and tested to develop specific recommendations as they relate to final foundation design recommendations for individual lots. These test results and corresponding design recommendations should be presented in a Final Grading Report.

7.1.1. Foundation Design

Residential/Commercial structures can be supported on conventional shallow foundations and slab-on-grade or post-tensioned slab/foundation systems, as discussed above. The design of foundation systems should be based on as-graded conditions as determined after grading completion. The following values may be used in preliminary foundation design:

Allowable Bearing: 2000 psf.

Lateral Bearing: 250 psf per foot of depth to a maximum of 2000 psf for level conditions. Reduced values may be appropriate for descending slope conditions.

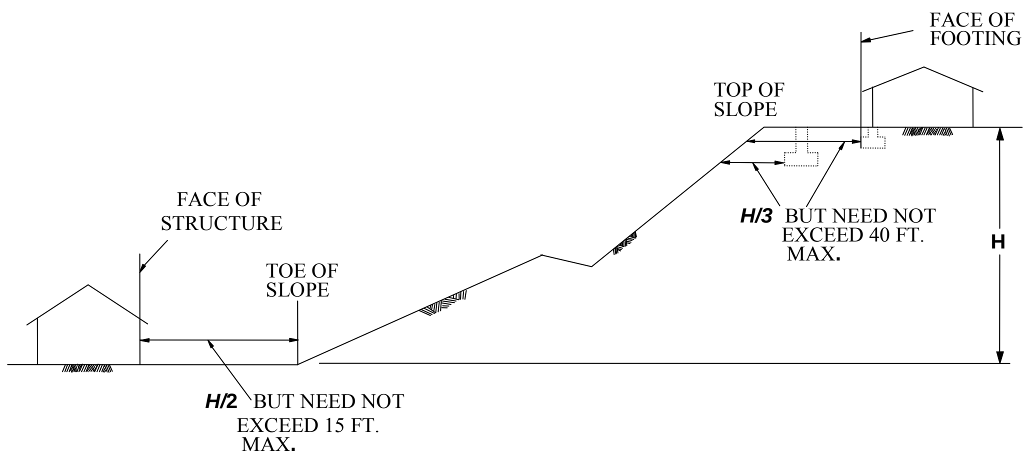
Sliding Coefficient: 0.30

The above values may be increased as allowed by Code to resist transient loads such as wind or seismic. Building code and structural design considerations may govern. Depth and reinforcement requirements and should be evaluated by a qualified engineer.

7.1.1.1. Deepened Footings and Setbacks

Improvements constructed in proximity to natural slopes or properly constructed, manufactured slopes can, over a period of time, be affected by natural processes including gravity forces, weathering of surficial soils and long-term (secondary) settlement. Most building codes, including the California Building Code, require that structures be set back or footings deepened where subject to the influence of these natural processes.

For the subject site, where foundations for residential structures are to exist in proximity to slopes, the footings should be embedded to satisfy the requirements



7.1.1.2. Moisture and Vapor Barrier

A moisture and vapor retarding system should be placed below the slabs-on-grade in portions of the structure considered to be moisture sensitive. The retarder should be of suitable composition, thickness, strength, and low permeance to effectively prevent the migration of water and reduce the transmission of water vapor to acceptable levels. Historically, a 10-mil plastic membrane, such as *Visqueen*, placed between one to four inches of clean sand, has been used for this purpose. More recently Stego® Wrap or similar underlayments have been used to lower permeance to effectively prevent the migration of water and reduce the transmission of water vapor to acceptable levels. The use of this system or other systems, materials, or techniques can be considered, at the discretion of the designer, provided the system reduces the vapor transmission rates to acceptable levels.

7.1.2. Retaining Wall Design

The foundations for retaining walls of appurtenant structures structurally separated from the building structure may bear on properly compacted fill. The foundations may be designed in accordance with the recommendations provided in Table 7.1.2, Conventional Foundation Design Parameters. When calculating the lateral resistance, the upper 12 inches of soil cover should be ignored in areas that are not covered with hardscape. Retaining wall footings should be designed to resist the lateral forces by passive soil resistance and/or base friction as recommended for foundation lateral resistance.

Retaining walls should be designed to resist earth pressures presented in the following table. These values assume that the retaining walls will be backfilled with select materials as shown in Detail RTW-A or native soils as shown in Detail RTW-B. The type of backfill ("select" or "native") should be specified by the wall designer and shown on the plans. Retaining walls should be designed to resist additional loads such as construction loads, temporary loads, and other surcharges as evaluated by the structural engineer.

TABLE 7.1.2
RETAINING WALL EARTH PRESSURES

"Native"* Backfill Materials (γ=125pcf, EI$\leq$50)

	Level Backfill		Sloping (2:1) Backfill	
	Rankine Coefficients	**Equivalent Fluid Pressure (psf / lineal foot)**	**Rankine Coefficients**	**Equivalent Fluid Pressure (psf / lineal foot)**
Active Pressure	$K_a = 0.36$	45	$K_a = 0.58$	73
Passive Pressure	$K_p = 2.77$	345	$K_p = 1.72$	200
At Rest Pressure	$K_o = 0.53$	66	$K_o = 0.77$	96

"Select"* Backfill Materials (γ=120pcf, EI$\leq$20, SE$\geq$20)

	Level Backfill		Sloping (2:1) Backfill	
	Rankine Coefficients	**Equivalent Fluid Pressure (psf / lineal foot)**	**Rankine Coefficients**	**Equivalent Fluid Pressure (psf / lineal foot)**
Active Pressure	$K_a = 0.28$	34	$K_a = 0.44$	53
Passive Pressure	$K_p = 3.54$	420	$K_p = 1.33$	160
At Rest Pressure	$K_o = 0.44$	53	$K_o = 0.75$	90

Notes: "Select" backfill materials should be granular, structural quality backfill with a Sand Equivalent of 20 or better and an Expansion Index of 20 or less. The "select" backfill must extend at least one-half the wall height behind the wall; otherwise, the values presented in the "Native" backfill materials columns must be used for the design. "Native" backfill materials should have an Expansion Index of 50 or less. The upper one-foot of backfill should be comprised of native on-site soils.

In addition to the above static pressures, unrestrained retaining walls should be designed to resist seismic loading as required by the 2016 CBC. The seismic load can be modeled as a thrust load applied at a point 0.6H above the base of the wall, where H is equal to the height of the wall. This seismic load (in pounds per lineal foot of wall) is represented by the following equation:

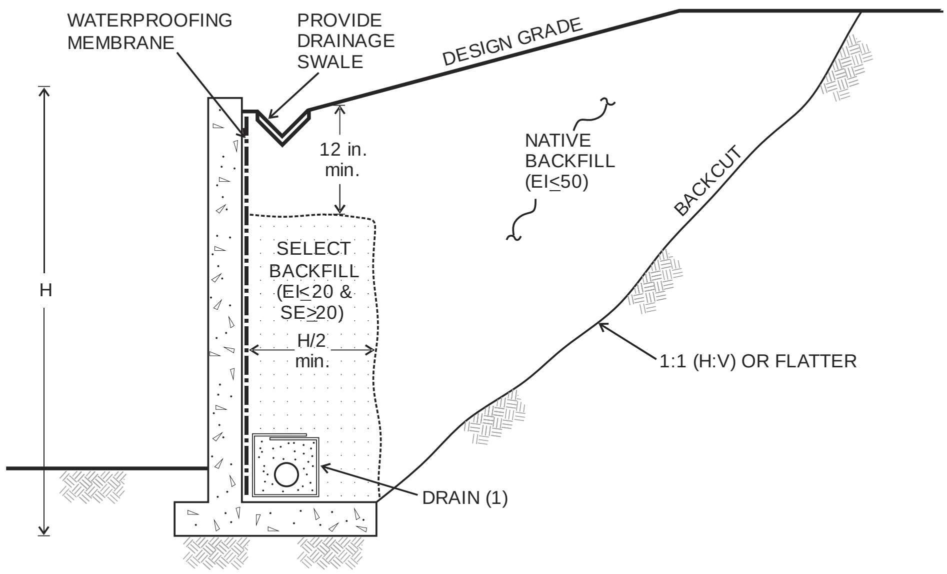
$$Pe = \tfrac{3}{8} * \gamma * H^2 * k_h$$

Where:
- Pe = Seismic thrust load
- H = Height of the wall (feet)
- γ = soil density = 125 pounds per cubic foot (pcf)
- k_h = seismic pseudostatic coefficient = 0.5 * peak horizontal ground acceleration / g

The peak horizontal ground accelerations are provided in Section 7.1.3. Walls should be designed to resist the combined effects of static pressures and the above seismic thrust load.

Retaining walls should be provided with a drainage system adequate to prevent the buildup of hydrostatic forces as shown in Details RTW-A and RTW-B. Otherwise, the retaining walls should be designed to resist hydrostatic forces. Proper drainage devices should be installed along the top of the wall backfill and should be properly sloped to prevent surface water ponding adjacent to the wall. In addition to the wall drainage system, for building perimeter walls extending below the finished grade, the wall should be waterproofed and/or damp-proofed to effectively seal the wall from moisture infiltration through the wall to the interior wall face.

The wall should be backfilled with granular soils placed in loose lifts no greater than 8-inches thick, at or near optimum moisture content, and mechanically compacted to a minimum 90 percent of the maximum dry density as determined by ASTM D1557. Flooding or jetting of backfill materials generally do not result in the required degree and uniformity of compaction and is not recommended. No backfill should be placed against concrete until minimum design strengths are achieved as verified by compression tests of cylinders. The geotechnical consultant should observe the retaining wall footings, back drain installation, and be present during placement of the backfill to confirm that the walls are properly backfilled and compacted.

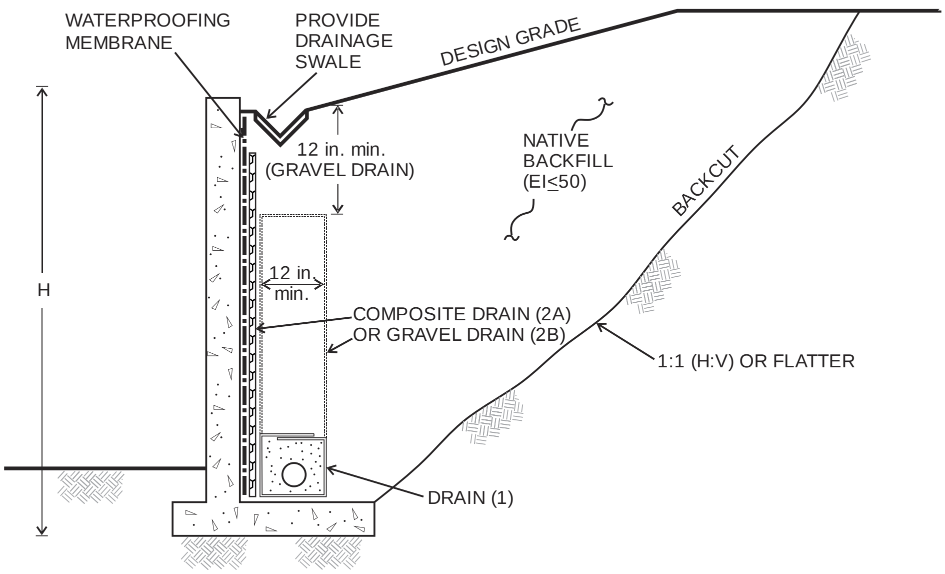


NOTES: (1) DRAIN: 4-INCH PERFORATED ABS OR PVC PIPE OR APPROVED EQUIVALENT SUBSTITUTE PLACED PERFORATIONS DOWN AND SURROUNDED BY A MINIMUM OF 1 CUBIC FEET OF 3/4 INCH ROCK OR APPROVED EQUIVALEN T SUBSTITUTE AND WRAPPED IN MIRAFI 140 FILTER FABRIC OR APPROVED EQUIVALENT SUBSTITUTE

VER 1.0

NTS

AGS ADVANCED GEOTECHNICAL SOLUTIONS, INC.	RETAINING WALL ALT. A - SELECT BACKFILL	DETAIL RTW-A



NOTES: (1) DRAIN: 4-INCH PERFORATED ABS OR PVC PIPE OR APPROVED EQUIVALENT SUBSTITUTE PLACED PERFORATIONS DOWN AND SURROUNDED BY A MINIMUM OF 1 CUBIC FEET OF 3/4 INCH ROCK OR APPROVED EQUIVALENT SUBSTITUTE AND WRAPPED IN MIRAFI 140 FILTER FABRIC OR APPROVED EQUIVALENT SUBSTITUTE

(2A) COMPOSITE DRAIN SYSTEM: MIRAFI G200N, DELTA DRAIN 2000/6000/6200 OR APPROVED EQUIVALENT SUBSTITUTE CONNECTED TO DRAIN (1)

(2B) GRAVEL DRAIN: MINIMUM 12-INCH WIDE 3/4-INCH GRAVEL BLANKET WRAPPED IN MIRAFI FILTER FABRIC (140 OR APPROVED EQUIVALENT SUBSTITUTE)

VER 1.0 NTS

AGS ADVANCED GEOTECHNICAL SOLUTIONS, INC.	RETAINING WALL ALT.B - NATIVE BACKFILL	DETAIL RTW-B

7.1.3. Seismic Design

The site has been identified to have multiple site classes (Site Class C and D) in accordance with CBC, 2016, Section 1613.3.2 and ASCE 7, Chapter 20. Utilizing this information, the United States Geological Survey (USGS) web tool (http://earthquake.usgs.gov/hazards/designmaps/) and ASCE 7 criterion, the mapped seismic acceleration parameters S_S, for 0.2 seconds and S_1, for 1.0 second period (CBC, 2016, 1613.3.1) for Risk-Targeted Maximum Considered Earthquake (MCE_R) can be determined. The mapped acceleration parameters are provided for Site Class "B". Adjustments for other Site Classes are made, as needed, by utilizing Site Coefficients F_a and F_v for determination of MCE_R spectral response acceleration parameters S_{MS} for short periods and S_{M1} for 1.0 second period (CBC, 2016 1613.3.3). Five-percent damped design spectral response acceleration parameters S_{DS} for short periods and S_{D1} for 1.0 second periods can be determined from the equations in CBC, 2016, Section 1613.3.4. Results are presented in Table 7.1.3.

Using the United States Geological Survey (USGS) web-based ground motion calculator, the site class modified PGAM (FPGA*PGA) was determined to be 0.356g. This value does not include near-source factors that may be applicable to the design of structures on site.

TABLE 7.1.3
SEISMIC DESIGN CRITERIA

PARAMETER	SITE CLASS C (Soft Rock-Tsd/Ql)	SITE CLASS D (Compacted Fill-afe)
Mapped Spectral Acceleration (0.2 sec Period), S_S	0.839g	0.839g
Mapped Spectral Acceleration (1.0 sec Period), S_1	0.319g	0.319g
Site Coefficient, F_a	1.064	1.164
Site Coefficient, F_v	1.481	1.761
MCE Spectral Response Acceleration (0.2 sec Period), SM_S	0.893g	0.977g
MCE Spectral Response Acceleration (1.0 sec Period), SM_1	0.473g	0.562g
Design Spectral Response Acceleration (0.2 sec Period), SD_S	0.596g	0.652g
Design Spectral Response Acceleration (1.0 sec Period), SD_1	0.315g	0.375g

7.2. Civil Design Recommendations

7.2.1. Rear and Side Yard Walls and Fences

Block wall footings should be founded a minimum of 24-inches below the lowest adjacent grade. To reduce the potential for uncontrolled, unsightly cracks, it is recommended that a construction joint be incorporated at regular intervals. For side yard walls situated perpendicular to the top of slopes a joint should be constructed at approximately 10 feet from the slope hinge point. Spacing of the joints should be between 10 and 20 feet.

7.2.2. Drainage

Final site grading should assure positive drainage away from structures. Planter areas should be provided with area drains to transmit irrigation and rain water away from structures. The use of gutters and down spouts to carry roof drainage well away from structures is recommended. Raised planters should be provided with a positive means to remove water through the face of the containment wall.

7.2.3. Water Quality/BMP Basins

AGS conducted site specific percolation/infiltration testing to evaluate feasibility for storm water infiltration at the project site and to determine preliminary infiltration rates for the proposed BMP basins. Testing was completed in general accordance with the 2016 City of San Diego BMP Design Manual. A copy of our site specific Infiltration Feasibility Study is included herewith in Appendix E.

Based on the results of our testing, Partial Infiltration design for the proposed BMPs is potentially feasible. This is dependent on final basin size and location, and verification of the soil/geologic conditions.

7.2.4. Pavement Design

Final pavement design will be determined based upon sampling and testing of post-grading conditions. For preliminary design and estimating purposes the pavement structural sections presented in Table 7.2.4 can be used for the range of likely traffic indices. The structural sections are based upon an assumed R - Value of 20 and the current City of San Diego Pavement Design Standards Schedule “J”.

TABLE 7.2.4
PRELIMINARY ASPHALT CONCRETE PAVEMENT SECTIONS

Traffic Index	Asphalt Concrete (inches)	Cement Treated Base (inches)
5.0	3.0	7.5
5.5	3.0	9.0
6.0	3.0	10.5
6.5	4.0	10.5
7.0	4.0	12.0
7.5	4.5	13.0
8.0	5.0	14.0

Pavement subgrade soils should be at or near optimum moisture content and should be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D1557. Aggregate base should be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D1557 and should conform with the specifications listed in Section 26 of the *Standard Specifications for the State of California Department of Transportation* (Caltrans) or Section 200-2 of the *Standard Specifications for Public Works Construction* (Green Book). The asphalt concrete should conform to Section 26 of the Caltrans *Standard Specifications* or Section 203-6 of the Green Book.

8.0 FUTURE STUDY NEEDS

This report represents a TM review of the Proposed Project. As the project design progresses, additional site specific geologic and geotechnical issues will need to be considered in the ultimate design and construction of the project. Consequently, future geotechnical studies and reviews are necessary, including the advancement of bucket auger borings to evaluate the natural descending slopes at the site. These future studies may include reviews of:

- Rough grading plans.
- Precise grading plans.
- Foundation plans.
- Retaining wall plans.

These plans should be forwarded to the project geotechnical engineer/geologist for evaluation and comment, as necessary.

9.0 CLOSURE

9.1. Geotechnical Review

As is the case in any grading project, multiple working hypotheses are established utilizing the available data, and the most probable model is used for the analysis. Information collected during the grading and construction operations is intended to evaluate the hypotheses, and some of the assumptions summarized herein may need to be changed as more information becomes available. Some modification of the grading and construction recommendations may become necessary, should the conditions encountered in the field differ significantly than those hypothesized to exist.

AGS should review the pertinent plans and sections of the project specifications, to evaluate conformance with the intent of the recommendations contained in this report.

If the project description or final design varies from that described in this report, AGS must be consulted regarding the applicability of, and the necessity for, any revisions to the recommendations presented herein. AGS accepts no liability for any use of its recommendations if the project description or final design varies and AGS is not consulted regarding the changes.

9.2. Limitations

This report is based on the project as described and the information obtained from the exploratory excavations at the locations indicated on the plan. The findings are based on the review of the field and laboratory data combined with an interpolation and extrapolation of conditions between and beyond the exploratory excavations. The results reflect an interpretation of the direct evidence obtained. Services performed by AGS have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, either expressed or implied, and no warranty or guarantee is included or intended.

The recommendations presented in this report are based on the assumption that additional exploration will be performed and an appropriate level of field review will be provided by geotechnical engineers and engineering geologists who are familiar with the design and site geologic conditions. That field review shall be sufficient to confirm that geotechnical and geologic conditions exposed during grading are consistent with the geologic representations and corresponding recommendations presented in this and future reports. AGS should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations of this report are applicable to the specific design of this project as discussed in this report. They have no applicability to any other project or to any other location, and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of AGS.

AGS has no responsibility for construction means, methods, techniques, sequences, or procedures, or for safety precautions or programs in connection with the construction, for the acts or omissions of the CONTRACTOR, or any other person performing any of the construction, or for the failure of any of them to carry out the construction in accordance with the final design drawings and specifications.

APPENDIX A

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Aerial Photographs Reviewed for Report			
Year	**Flight ID**	**Photo ID**	**Photo Scale**
1928	SD	69B- 1, 2, 3 69C- 1, 2, 3 69D- 1, 2, 3	1” = 1000’
1960-1970	SDCT2/T11	2- 74 14- 28, 29, 30	1” = 1000’
1968	AXN	3JJ- 101, 102, 175	1” = 2800’
1970	SDC	13- 7, 8	1” = 2000’
1971	GS-VCSQ	1- 5	1” = 2600’
1973-1975	SDPD	14- 11, 12, 13 15- 14	1” = 1000’
1974	SDC ORTHOS	Jamul Mtn.	1” = 2000’
1974	SDPD	2- 3,4	1” = 2000’
1976	SAN DIEGO	235, 236, 247, 248	1” = 2000’
1978-1979	SDCO (WEST)	33- F1,F2 34- D22, D23, D24	1” = 1000’
1983	C11109 (CAS)	139, 140	1” = 2000’
1989	WAC (WEST)	18- 49, 51	1” = 2640’

APPENDIX B

SUBSURFACE LOGS

APPENDIX B-1

SUBSURFACE LOGS-
AGS 2013, 2015, and 2016 (Current)

Project Otay Canyon Ranch
Date Excavated 4/23/13
Logged by PJD
Equipment Case 580M Extend-a-hoe w/24" bucket

TABLE I

LOG OF TEST PITS

Test Pit No.	Depth (ft.)	USCS	Description
TP-1	0.0 – 7.5	SM/SC	**ARTIFICIAL FILL - UNDOCUMENTED (Qafu)**: SILTY to CLAYEY SAND, fine- to medium-grained, brown, dry, loose; occasional gravels.
		ML	@ 1 ft. becomes CLAYEY SILT with sand, light grayish brown, slightly moist, firm. @ 3.5 ft. becomes dark brown; significant amount of trash and organic debris; strong odor.
	7.5 – 11.5	SC	**TERRACE DEPOSITS?** (Qt): CLAYEY SAND with COBBLES and GRAVEL, slightly moist, medium dense; stained appearance, bluish to greenish gray.
			TOTAL DEPTH 11.5 FT. NO WATER, NO CAVING
TP-2	0.0 – 2.0	SC/CL	**TOPSOIL** (No Map Symbol): CLAYEY SAND to SANDY CLAY, brown, slightly moist, loose.
	2.0 – 8.0		**SAN DIEGO FM.** (Tsd): SANDY SILTSTONE, fine-grained, completely weathered, slightly moist, soft; abundant carbonate development. @ 4.0 ft. becomes olive gray, moderately hard; tightly fractured, trace manganese oxide development. @ 5.5 ft. moderately weathered, hard. @ 7.0 ft. becomes very hard. @ 8.0 ft. practical refusal.
			TOTAL DEPTH 8.0 FT. NO WATER, NO CAVING

TABLE I continued

LOG OF TEST PITS

Test Pit No.	Depth (ft.)	USCS	Description
TP-9	0.0 – 3.0	CL	**TOPSOIL** (No Map Symbol): SANDY CLAY, fine- to medium-grained, dark brown, slightly moist, loose/firm. @ 1 ft. SILTY CLAY, dark brown to red brown, slightly moist, soft to firm; occasional small gravel.
	3.0 – 12.0	SC/CL	**TERRACE DEPOSITS** (Qt): CLAYEY SAND to SANDY CLAY, fine-grained, reddish brown, moist, medium dense; trace carbonate spotting.
		SC	@ 5.0 ft. CLAYEY SAND with gravel and cobbles, moist, medium dense. @ 8.0 ft. POORLY GRADED SAND, fine- to medium-grained, light brown, slightly moist to moist, medium dense; trace clay.
			TOTAL DEPTH 12.0 FT. NO WATER, NO CAVING

TABLE I continued

LOG OF TEST PITS

Test Pit No.	Depth (ft.)	USCS	Description
TP-7	0.0 – 5.0	CL	**ALLUVIUM** (Qal): SILTY to SANDY CLAY, brown, slightly moist to moist, loose/soft; occasional cobbles and small boulders.
	5.0 – 10.0	ML	**SAN DIEGO FM.** (Tsd): CLAYEY SILTSTONE with fine-grained sand, light grayish brown, slightly moist, moderately hard to hard.
			TOTAL DEPTH 10.0 FT. NO WATER, NO CAVING
TP-8	0.0 – 8.5	SC	**ARTIFICIAL FILL - UNDOCUMENTED (Qafu)**: CLAYEY SAND, fine- to coarse-grained, brown to dark brown, moist, loose to medium dense; occasional cobbles and small boulders, trash and organic debris.
		SC/CL	@ 2.5 ft. CLAYEY SAND to SANDY CLAY dark brown to black, moist, loose; abundant trash debris. @ 3.5 ft. abundant large cobbles and boulders.
	5.0 – 10.5	ML/CL	**SAN DIEGO FM.** (Tsd): CLAYEY SILTSTONE to SILTY CLAYSTONE with fine-grained sand, gray to light grayish brown, slightly moist to moist, highly weathered, soft; occasional gravel and small cobble, carbonate spotting, minor iron oxide development. @ 8.5 ft. moderately weathered, moderately hard; increased gravel content with occasional large cobble. @ 9.5 ft. hard
			TOTAL DEPTH 10.5 FT. NO WATER, NO CAVING

TABLE I continued

LOG OF TEST PITS

Test Pit No.	Depth (ft.)	USCS	Description
TP-5	0.0 – 6.0	SM	**ARTIFICIAL FILL - UNDOCUMENTED (Qafu)**: SILTY SAND, fine- to coarse-grained, brown, slightly moist, very loose; trash debris, perlite. @ 2 ft. large boulders and construction debris (concrete) @ 6 ft. refusal on concrete debris TOTAL DEPTH 6.0 FT. NO WATER, NO CAVING
TP-6	0.0 – 8.0	CL	**ALLUVIUM** (Qal): SILTY to SANDY CLAY, brown to gray brown, slightly moist, loose/soft; occasional cobbles and small boulders. @ 2 ft. moist
	8.0 – 11.5	ML	**SAN DIEGO FM.** (Tsd): CLAYEY SILTSTONE with fine-grained sand, gray to light grayish brown, slightly moist, moderately hard to hard. TOTAL DEPTH 11.5 FT. NO WATER, NO CAVING

TABLE I continued

LOG OF TEST PITS

Test Pit No.	Depth (ft.)	USCS	Description
TP-3	0.0 – 0.5	GP	**ARTIFICIAL FILL - UNDOCUMENTED (Qafu)**: SANDY GRAVEL, poorly graded, grayish brown, dry, loose to medium dense.
	0.5 – 10.5	CL	**TERRACE DEPOSITS** (Qt): SANDY CLAY with silt, fine-grained, reddish brown, slightly moist to moist, firm.
			TOTAL DEPTH 10.5 FT. NO WATER, NO CAVING
TP-4	0.0 – 8.5	SC	**ARTIFICIAL FILL - UNDOCUMENTED (Qafu)**: CLAYEY SAND, fine- to medium-grained, brown to dark reddish brown, moist, loose to medium dense.
		CL	@ 1 ft. SANDY CLAY with gravel and small cobbles, reddish brown, moist to wet, soft to firm. @ 7 ft. occasional large cobbles and boulders.
	8.5 – 12.0	SC	**TERRACE DEPOSITS** (Qt): CLAYEY SAND, orange brown to light reddish brown, moist, medium dense.
			TOTAL DEPTH 12.0 FT. NO WATER, NO CAVING

Project Jabir
Date Excavated 2/4/2015
Logged by PWM
Equipment Cat 420F

LOG OF TEST PITS

Test Pit No.	Depth (ft.)	USCS	Description
TP-1	0.0 – 3.0	CL	**Topsoil/Residual Soil:** SANDY CLAY, fine to coarse grained, brown, dry, soft; some gravel to 2" diameter; carbonate development; vugs. @2 ft. slightly moist, firm to stiff.
	3.0 – 12.0	SC	**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, light brown to orange brown, slightly moist, dense. @7 ft. cobble conglomerate, ~50-60% cobble, subrounded, <6" diameter. @7.5 ft. larger cobble, generally 8-10" diameter, a few small boulders
		CL	@9 ft. CLAY, greenish gray and brown, firm; with fine to coarse grained sand and small gravel and cobble. TOTAL DEPTH 12.0 FT. NO WATER, NO CAVING
TP-2	0.0 – 2.0	CL	**Topsoil/Residual Soil:** SANDY CLAY, fine to coarse grained, brown, dry, soft; some subrounded gravel to 2" diameter; carbonate development; root hairs to 1.5 ft.; vugs. @1 ft. slightly moist, firm.
	2.0 – 11.0	SC	**Terrace Deposits (Qt):** CLAYEY SAND with abundant gravel and cobble, fine to coarse grained, light brown to orange brown, slightly moist, dense; cobble to 6" diameter. @7 ft. cobble to 8" diameter. @9 ft. cobble to 12" diameter. TOTAL DEPTH 11.0 FT. NO WATER, NO CAVING

Test Pit No.	Depth (ft.)	USCS	Description
TP-3	0.0 – 4.0	CL	**Topsoil/Residual Soil:** SANDY CLAY, fine to coarse grained, brown, dry, soft; some subrounded gravel to 2" diameter; fine root hairs to 1.5 ft. bgs; vugs. @1 ft. firm; carbonate development. @1.5 ft. slightly moist. @4 ft. grayish brown.
	4.0 – 10.0	SC	**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, light brown to orange brown, slightly moist, dense. @5 ft. dense; cobble conglomerate, approx. 50% soil matrix – 50% cobble, subrounded, generally 4-6" diameter, up to 10" maximum. @8 ft. very dense.
			TOTAL DEPTH 10.0 FT. NO WATER, NO CAVING
TP-4	0.0 – 2.0		**Topsoil:** SANDY CLAY, fine to coarse grained, brown, dry, soft; some subrounded gravel to 2" diameter; root hairs to 1 ft. bgs; porous. @1 ft. carbonate development in soil; some cobble to 6" diameter.
	2.0 – 10.0		**Artificial Fill – Undocumented (Trash Debris):** CLAYEY SAND with abundant buried trash debris, dark brown to black, loose, moist. @5.0 ft. black; highly odorous.
	10.0 – 16.0		**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, bluish green, slightly moist, loose; cobble up to 10" diameter. @12 ft. orange brown with slight bluish green tint. @13 ft. orange brown to light brown, slightly moist. @14 ft. medium dense. @15 ft. dense.
			TOTAL DEPTH 16.0 FT. NO WATER, NO CAVING

Test Pit No.	Depth (ft.)	USCS	Description
TP-5	0.0 – 5.0	CL	**Topsoil/Residual Soil:** SANDY CLAY, fine to coarse grained, brown to grayish brown, slightly moist, soft; some subrounded gravel to 2” diameter; fine root hairs to 1.5 ft. bgs; porous. @1 ft. firm to stiff; carbonate development to 2 ft. bgs. @3 ft. stiff.
	5.0 – 13.0	SC	**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, light brown to orange brown, slightly moist, dense; with gravel and cobble to 6” diameter. @8 ft. dense; cobble conglomerate, 50% soil matrix – 50% cobble, subrounded, up to 10” diameter. @11 ft. very dense; 60% cobble. TOTAL DEPTH 13.0 FT. NO WATER, NO CAVING
TP-6	0.0 – 5.0	CL	**Topsoil/Residual Soil:** SANDY CLAY, fine to coarse grained, brown to grayish brown, dry, soft to firm; some subrounded gravel and cobble to 4” diameter; fine root hairs to 2 ft. bgs; porous. @2.5 ft. slightly moist, firm to stiff.
	4.0 – 11.5	SC	**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, light brown to orange brown, slightly moist, dense: gravel and cobble to 6” diameter; ~25% cobble. @7.5 ft. SANDY CLAY, brown and yellowish brown, firm. @8 ft. CLAYEY SAND, fine to coarse grained, light brown, moist, dense; cobble conglomerate, approx. 60% soil matrix – 40% cobble, subrounded, up to 6” diameter. @10 ft. cobble to 10” diameter. TOTAL DEPTH 11.5 FT. NO WATER, NO CAVING

Test Pit No.	Depth (ft.)	USCS	Description
TP-7	0.0 – 6.0	CL	**Topsoil/Residual Soil:** SANDY CLAY, fine to coarse grained, brown, dry, soft; some subrounded gravel to 3" diameter; fine root hairs to 2 ft. bgs; porous. @1 ft. firm; carbonate development to 2 ft. bgs. @2.5 ft. grayish brown, slightly moist, stiff; some small cobble to 4" diameter. @3.5 ft. moist.
	6.0 – 10.0	SC	**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, light brown to orange brown, slightly moist, dense; with gravel and cobble to 6" diameter; ~30% cobble. @7 ft. increased cobble content. @9 ft. cobble to 12" diameter; predominately 6-8" diameter; approx. 50% soil matrix - 50% cobble. TOTAL DEPTH 10.0 FT. NO WATER, NO CAVING
TP-8	0.0 – 2.0	CL	**Topsoil:** SANDY CLAY, fine to coarse grained, dry, soft; fine root hairs to 1 ft. bgs; porous. @1 ft. firm to stiff; slightly moist. @1.5 ft. carbonate development; some subrounded gravel to 3" diameter.
	2.0 – 10.5	SC	**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, light brown to orange brown, slightly moist, dense: gravel and cobble to 6" diameter; ~30% cobble. @5 ft. increased cobble content. @6 ft. approx. 50% soil matrix – 50% cobble; generally 3-6" diameter. @8 ft. cobble to 12" diameter. TOTAL DEPTH 10.5 FT. NO WATER, NO CAVING

Test Pit No.	Depth (ft.)	USCS	Description
TP-9	0.0 – 1.0	CL	**Topsoil:** SANDY CLAY, fine to coarse grained, brown, dry, soft to firm.
	1.0 – 9.5	SC	**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, light brown to orange brown, slightly moist, dense; carbonate development from 1-2 ft. bgs; 20% gravel and cobble to 6” diameter. @3 ft. increased cobble content; cobble to 10” diameter. @6.5 ft. light brown; 50% soil matrix - 50% cobble. TOTAL DEPTH 9.5 FT. NO WATER, NO CAVING
TP-10	0.0 – 2.5	CL	**Topsoil/Residual Soil:** SANDY CLAY, fine to coarse grained, brown, slightly moist, soft to firm; carbonate development from 1-2 ft. bgs.; with small cobble; occasional large cobble to 12” diameter
	2.5 – 10.0	SC	**Terrace Deposits (Qt):** CLAYEY SAND, fine to coarse grained, light brown to orange brown, slightly moist, dense: gravel and cobble to 4” diameter; ~20% cobble. @4 ft. increased cobble content. @6 ft. approx. 40% soil matrix – 60% cobble; up to 10” diameter. @7 ft. light brown. @8 ft. very dense. TOTAL DEPTH 10.0 FT. NO WATER, NO CAVING

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-1*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SP	**Artificial Fill, Undocumented:** At 0-1.0 feet, Cobbley Sand with Silt, fine to coarse grained brown to gray brown, dry, losse to moderately dense				
			SC	At 1.0 feet, Clayey Sand with Cobble, fine to coarse grained, olive brown to dark brown with iron oxide, slightly moist, medium dense to dense; sub angular to sub rounded,				
5			SP	**Lindavista Formation:** At 3.0 feet, Cobbley Sand with Silt Trace Clay, fine to coarse grained, olive brown to dark brown with iron oxied, slightly moist medium dense to dense; prodominately 6 inch minus with occassional plus 6-12 inch cobble At 6.0 feet, Gravely Sand with Cobble trace Clay, fine to coarse grianed, light orange brown to light brown, moist, dense				
10				At 12.0 feet, Gravely Clayey Sand with Cobble, fine to coarse grained, light orange brown to light brown, moist to wet, medium dense to dense				
15				Total Depth = 13.5 No Water Encountered No Caving				

LEGEND

Sample Type:	R --- Drive Sample		B --- Bulk Sample	--Water Table
Laboratory Testing:	AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
	SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-2*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Saturation (percent)	Laboratory Testing: Others
			SP	**Artificial Fill, Undocumented:** 0-2.0 feet, Gravely Clayey Sand with Cobbles, fine to coarse grained, brown to dark brown, slightly moist, dense				
			SP	**Lindavista Formation:** At 2.0 feet, Gravely Clayey Sand to Silty Sand with Cobbles, fine to coarse grained, orange brown to light brown, moist, moderately dense				
5								
				At 7.0 feet, Gravely Sand with Cobbles trace Clay, fine to coarse grained, orange brown to light brown, moist, moderately dense				
10								
				At 11.0 feet, Cemented Gravely Sand with Cobbles trace clay, fine to coarse grained, orange brown to light brown, moist, medium dense				
				At 13.0 feet, Clayey Sand with Cobbles, fine to coarse grained orange brown to light brown, moist to wet, moderately dense				
				Total Depth = 14.0 feet No Water Encountered No Caving				
15								

LEGEND

Sample Type:	R --- Drive Sample	B --- Bulk Sample	--Water Table	
Laboratory Testing:	AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
	SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-3*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Saturation (percent)	Laboratory Testing: Others
			SC	**Artificial Fill, Undocumented:** 0-2.0 feet, Clayey Sand with Cobbles, fine to coarse grained brown to dark brown, slightly moist, dense				
			SC	**Lindavista Formation:** At 2.0 feet, Clayey Sand to Silty Sand with Cobbles, fine to coarse grained, orange brown to light brown, slightly moist to moist, dense; cemented sand				
5			SP	At 5.5 feet, Gravely Sand with Cobbles, fine to coarse grained, light brown, slightly moist to moist, dense to very dense; calcium carbonate on fracture surfaces				
				Refusal at 6.5 feet No Water Encountered No Caving				
10								
15								

LEGEND

Sample Type: R --- Drive Sample B --- Bulk Sample --Water Table

Laboratory Testing: AL = Atterberg Limits EI = Expansion Index MD = Maximum Density SA = Sieve Analysis SR = Sulfate/Resistivity Test DS = Shear Testing RV = R-Value Test CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-4*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Saturation (percent)	Laboratory Testing: Others
			SC	**Artificial Fill, Undocumented:** At 0-0.5 feet, Clayey Sand with Cobbles, fine to coarse grained brown to dark brown, slightly moist, dense				
			CL	At 0.5-4.0 feet, Clay, fine grained, brown to dark brown, moist, stiff				
5			CL	At 4.0 feet, Sandy Clay with Cobbles, fine to coarse grianed brown, moist, stiff; calcium carbonate on fracture surfaces				
10			SC	**Lindavista Formation:** At 5.5 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, moist, medium dense to dense; calcium carbonate on fracture surfaces At 8.0 feet, Clayey Sand with Cobbles, fine to coarse grianed, orange brown to brown, moist, dense to very dense				
15				Refusal at 11.5 feet No Water Encountered No Caving				

LEGEND

Sample Type:	R --- Drive Sample	B --- Bulk Sample	--Water Table	
Laboratory Testing:	AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
	SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-5*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Saturation (percent)	Laboratory Testing: Others
			SC	**Artificial Fill, Undocumented:** At 0-1.0 feet, Clayey Sand with Cobbles, fine to coarse grained brown, dry to slightly moist, medium dense				
			SC	**Lindavista Formation:** At 1.0 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, slightly moist, medium dense At 3.0 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, slightly moist, dense				
5								
			CL	At 6.0 feet, Clay with Cobbles, fine grained, light brown to gray brown, moist, very stiff				
10				Refusal at 9.5 feet No Water Encountered No Caving				
15								

LEGEND

Sample Type: R --- Drive Sample; B --- Bulk Sample; --Water Table

Laboratory Testing:
AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis
SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/12/2016
LOCATION:	Chula Vista		

Test Pit *PT-6*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
				Artificial Fill, Undocumented:				
			CL	At 0-2.5 feet, Sandy Clay with Gravel, fine to coarse grained, gray brown to dark brown, moist, firm; 5-10% 1 inch gravel				
			SC	At 2.5 feet, Clayey Sand with Cobbles, fine to coarse grained, brown to red brown, moist, medium dense				
				At 4.-0 feet Construction Debris, concrete, asphalt, metal stapping, trash				
5								
10				Refusal at 9.5 feet No Water Encountered No Caving				
15								

LEGEND

Sample Type: R --- Drive Sample; B --- Bulk Sample; --Water Table

Laboratory Testing:
AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis
SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/12/2016
LOCATION:	Chula Vista		

Test Pit *PT-7*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			CL	**Artificial Fill, Undocumented:** At 0-3.0 feet, Sandy Clay, fine to coarse grained, gray brown to reddish brown, moist, firm				
5			CL	At 3.0 feet, Clay, fine grained, light green to gray, moist to wet, firm				
10								
			SC	**Lindavista Formation:** At 12.0 feet, Clayey Sand with Cobbles, fine to coarse grained gray to light gray with orange brown, moist to wet, moderately dense; sub-rounded				
15				Refusal at 13.0 feet No Water Encountered No Caving				

LEGEND

Sample Type: R --- Drive Sample; B --- Bulk Sample; --Water Table

Laboratory Testing:

AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

APPENDIX B-2

SUBSURFACE LOGS-
GEOCON

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 1B ELEV. (MSL.) 508 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0					**TERRACE DEPOSIT CLAY** Soft to stiff, moist, dark brown, Sandy CLAY; porous, with roots, shrinkage cracks			
2	T 1-1			CL				
4					- Irregular contact with cobble layer			
6	T 1-2				**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light yellow - brown, Gravelly, Silty medium to coarse SAND; with some clay			
8				SM	- Massive, with cleaner sand below 8 feet, trace gravel			
10					TRENCH TERMINATED AT 10 FEET			

Figure A-1,
Log of Trench T 1, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 2 G ELEV. (MSL.) 505 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 2				CL	**TOPSOIL** Stiff, damp, dark brown, Sandy CLAY; very porous, with shrinkage cracks, roots			
4 6				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light reddish to yellowish - brown, Gravelly Silty, coarse SAND - Massive to horizontal bedded			
					TRENCH TERMINATED AT 7.5 FEET			

Figure A-2,
Log of Trench T 2, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 1 G ELEV. (MSL.) 508 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 – 5.5	T 1-1 (at ~2-3 ft)			CL	**TERRACE DEPOSIT CLAY** Soft to stiff, moist, dark brown, Sandy CLAY; porous, with roots, shrinkage cracks - Irregular contact with cobble layer			
5.5 – 10	T 1-2 (at ~6-7 ft)			SM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light yellow - brown, Gravelly, Silty medium to coarse SAND; with some clay - Massive, with cleaner sand below 8 feet, trace gravel			
					TRENCH TERMINATED AT 10 FEET			

Depth scale: 0, 2, 4, 6, 8, 10

Figure A-1,
Log of Trench T 1, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-02

TRENCH T 7 F

ELEV. (MSL.) 488 DATE COMPLETED 12-29-2003

EQUIPMENT JD 510

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				CL	**TOPSOIL** Stiff, moist, dark brown, Gravelly to Sandy CLAY			
2 – 10				GM-SM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light reddish brown, Silty, very Sandy, fine to medium GRAVEL - Becomes very coarse, 18-inch diameter clasts			
12	T7-1 T7-2			SM	Dense, damp, light brown, Silty, fine to medium SANDSTONE; massive to horizontal bedding, trace, fine gravel		103.4	12.2
16					TRENCH TERMINATED AT 16 FEET			

Figure A-7,
Log of Trench T 7, Page 1 of 1

07147-42-02.GPJ

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-02

TRENCH T 6 F

ELEV. (MSL.) 494 DATE COMPLETED 12-29-2003

EQUIPMENT JD 510

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 6	T6-1 (at 2)			CL-SC	**TERRACE DEPOSIT CLAY** Soft, very moist, dark yellow to olive brown, Sandy CLAY; porous, with roots, pinhole pores - Becomes, very clayey, sand			
6 – 13.5				GM-SM	**TERRACE DEPOSIT GRAVEL** Medium dense to dense, moist, light brown to reddish brown, very Sandy, fine to medium GRAVEL to Gravelly, Silty, medium to coarse SAND; massive, grading to coarser with depth			
					TRENCH TERMINATED AT 13.5 FEET			

Figure A-6,
Log of Trench T 6, Page 1 of 1

07147-42-02.GPJ

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-02

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 5 F ELEV. (MSL.) 501 DATE COMPLETED 12-29-2003 EQUIPMENT JD 510	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 – 2				CL	**TOPSOIL** Soft, very moist, dark brown, Sandy CLAY; porous, with roots, pinhole voids			
4				SM-GM	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, medium to light yellow brown, Gravelly, Silty, coarse SAND			
6 – 14				SP-GP	Medium dense to dense, damp, light brown, very Gravelly, coarse SAND; massive to imbricated, with clean cohesionless sand lenses - Becomes much coarser, with 18-inch diameter cobble			
					TRENCH TERMINATED AT 15 FEET			

Figure A-5,
Log of Trench T 5, Page 1 of 1

07147-42-02.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-02

TRENCH T 4 F

ELEV. (MSL.) 494 DATE COMPLETED 12-29-2003

EQUIPMENT JD 510

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 3				CL	**TOPSOIL** Stiff, damp, dark brown, Sandy CLAY			
3 – 6				SC	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, medium reddish brown, Clayey, Gravelly, fine to medium SAND			
6 – 10				SM-GM	Medium dense, damp, light reddish brown, very Gravelly, Silty, medium to coarse SAND			
10 – 14				SP-GP	Medium dense to dense, light reddish brown, very Gravelly, medium to coarse SAND to Sandy, coarse GRAVEL; little cohesion, caving			

TRENCH TERMINATED AT 14 FEET (Caving)

Figure A-4,
Log of Trench T 4, Page 1 of 1

07147-42-02.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-02

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 3 F ELEV. (MSL.) 497 DATE COMPLETED 12-29-2003 EQUIPMENT JD 510 MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 4				CL	**TERRACE DEPOSIT CLAY** Soft to stiff, damp, dark brown, Sandy CLAY; porous, with pinhole pores and shrinkage cracks			
6 – 8				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, medium brown to reddish brown, Gravelly, Silty, fine to medium SAND; with some clay			
10				SM	Medium dense, moist, medium brown, Silty, fine to medium SAND; with some clay			
12 – 14				GM	Medium dense, to dense, reddish brown, very Sandy, coarse GRAVEL, with some Silt			
					TRENCH TERMINATED AT 15 FEET			

Figure A-3,
Log of Trench T 3, Page 1 of 1

07147-42-02.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-02

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 2 F ELEV. (MSL.) 502 DATE COMPLETED 12-29-2003 EQUIPMENT JD 510	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 – 4.5				CL	**TERRACE DEPOSIT CLAY** Soft, very moist, medium dark brown to olive, Silty to Sandy CLAY; porous, with roots, pinhole pores			
4.5 – 7				SC-CL	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, medium to light brown, very Clayey to Gravelly SAND			
7 – 10.5				SM	Medium dense, moist, light brown, Silty, medium to coarse SAND			
10.5 – 12				SC	Medium dense, moist, medium brown, Clayey, fine SAND			
12 – 16				SM-GM	Medium dense, moist, light brown to tan, Silty, coarse SAND to Sandy, medium GRAVEL - Becomes more dense, Gravelly; gravel clast 1-inch to 3-inches in diameter			
16					TRENCH TERMINATED AT 16 FEET			

Figure A-2,
Log of Trench T 2, Page 1 of 1

07147-42-02.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-02

TRENCH T 1F

ELEV. (MSL.) 503 DATE COMPLETED 12-29-2003

EQUIPMENT JD 510

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0–7	T1-1			CL-CH	**TERRACE DEPOSIT CLAY** Soft, very moist, dark to medium brown, Silty, Sandy CLAY; porous, with shrinkage cracks, pinhole pores			
7–12	T1-2 T1-3			CL-ML	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, medium olive to brown, Clayey SILT to Silty CLAY; with white mottling of calcium carbonate or calcium sulfate, with trace gravel		102.0	22.3
12–15				GM	Medium dense, damp to moist, light to medium brown, Sandy, fine to medium GRAVEL, with some Silt			

TRENCH TERMINATED AT 15 FEET

Figure A-1,
Log of Trench T 1, Page 1 of 1

07147-42-02.GPJ

SAMPLE SYMBOLS ... SAMPLING UNSUCCESSFUL ... STANDARD PENETRATION TEST ... DRIVE SAMPLE (UNDISTURBED) ... DISTURBED OR BAG SAMPLE ... CHUNK SAMPLE ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 12 4 E ELEV. (MSL.) 489 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 2 4				CL	**TERRACE DEPOSIT CLAY** Stiff, moist, dark brown, Sandy CLAY; porous, with roots, burrows			
6 8				SM	Medium dense, light to medium olive - brown, Silty, fine SAND - With discontinuous horizontal layers of calcium carbonate - sulfate			
10				SM-ML	**OTAY FORMATION** Dense, damp, light gray - olive, very Silty fine SANDSTONE - Horizontally laminated with some clay			
					TRENCH TERMINATED AT 11 FEET			

Figure A-12,
Log of Trench T 12, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

TRENCH T 103 E

ELEV. (MSL.) 500 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 2	T 10-1			CL	**TERRACE DEPOSIT CLAY** Stiff, damp, dark brown, Sandy CLAY			
4				SM	Medium dense, damp, light to medium olive - brown, Silty fine SAND; some clay, calcium carbonate - sulfate			
6				GM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light brown - whitish - tan, Sandy medium to coarse GRAVEL			
					TRENCH TERMINATED AT 7 FEET			

Figure A-10,
Log of Trench T 10, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS ... SAMPLING UNSUCCESSFUL ... STANDARD PENETRATION TEST ... DRIVE SAMPLE (UNDISTURBED) ... DISTURBED OR BAG SAMPLE ... CHUNK SAMPLE ... WATER TABLE OR SEEPAGE

PROJECT NO. 07147-42-01

TRENCH T [redacted] 2 E

ELEV. (MSL.) 505 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 2				CL	**TERRACE DEPOSIT CLAY** Stiff, damp, dark brown, Sandy CLAY; porous			
4 – 8				SM	Medium dense, humid, light to medium Olive - brown to brown, Silty fine SAND; with some clay - Horizontal beds, with discontinuous white 1 inch to 3 inch thick calcium carbonate - sulfate layers			
10				SM	**TERRACE DEPOSIT GRAVEL** Dense, damp, light olive Silty SANDSTONE			
12				SM-GM	Medium dense, damp to moist, medium to light reddish - brown, very Gravelly coarse SAND; with some silt (approx. 20 to 30 percent 2 inch to 6 inch cobble			
					TRENCH TERMINATED AT 13 FEET			

Figure A-11,
Log of Trench T 11, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-02

TRENCH T ~~1~~ E

ELEV. (MSL.) 502 DATE COMPLETED 12-29-2003

EQUIPMENT JD 510

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 4.5				CL	**TERRACE DEPOSIT CLAY** Soft, very moist, medium dark brown to olive, Silty to Sandy CLAY; porous, with roots, pinhole pores			
4.5 – 7				SC-CL	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, medium to light brown, very Clayey to Gravelly SAND			
7 – 10.5				SM	Medium dense, moist, light brown, Silty, medium to coarse SAND			
10.5 – 12				SC	Medium dense, moist, medium brown, Clayey, fine SAND			
12 – 16				SM-GM	Medium dense, moist, light brown to tan, Silty, coarse SAND to Sandy, medium GRAVEL - Becomes more dense, Gravelly; gravel clast 1-inch to 3-inches in diameter			
16					TRENCH TERMINATED AT 16 FEET			

Figure A-2,
Log of Trench T 2, Page 1 of 1

07147-42-02.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-06A

TRENCH T 7 D

ELEV. (MSL.) 505' DATE COMPLETED 08-02-2005

EQUIPMENT JD 510 RUBBER-TIRE BACKHOE 24" BUCKET

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0					**TERRACE DEPOSIT CLAY** Stiff, very moist, dark yellow brown, Sandy CLAY			
2								
4								
	T7-1			CL				
6					-Becomes medium brown, more silty			
8								
10					**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light brown, Silty, fine SAND; thin pebble gravel in clean sand (laminae) with thin micaceous silt layers			
12				SP				
14								
					TRENCH TERMINATED AT 15 FEET			

Figure A-7,
Log of Trench T 7, Page 1 of 1

07147-42-06A.GPJ

SAMPLE SYMBOLS			
	☐ ... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-06A

TRENCH T 6 D

ELEV. (MSL.) 504' DATE COMPLETED 08-02-2005

EQUIPMENT JD 510 RUBBER-TIRE BACKHOE 24" BUCKET

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 3				CL	**TERRACE DEPOSIT CLAY** Soft to stiff, very moist, dark brown, Sandy CLAY; porous			
3 – 7				SC-ML	Medium dense, very moist, medium light olive (mottled), Clayey, fine SAND to SILT			
7 – 12.5				GP	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light medium brown, (with gray coatings of manganese oxide?), Sandy, coarse GRAVEL			

TRENCH TERMINATED AT 12.5 FEET

Figure A-6,
Log of Trench T 6, Page 1 of 1

07147-42-06A.GPJ

SAMPLE SYMBOLS
- ☐ ... SAMPLING UNSUCCESSFUL
- ☒ ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-06A

TRENCH T 5 D

ELEV. (MSL.) 504' DATE COMPLETED 08-02-2005

EQUIPMENT JD 510 RUBBER-TIRE BACKHOE 24" BUCKET

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 3				CL	**TERRACE DEPOSIT CLAY** Soft, very moist, dark brown, Sandy CLAY			
3 – 5				SC-ML	Dense, humid to damp, light brown to white (mottled), Clayey Silt to Clayey, fine SAND; calcium carbonate, fracture fillings, "caliche"			
5 – 15	T5-1 (8 – 10)			SP	**TERRACE DEPOSIT GRAVEL** Medium dense to dense, damp, light yellow brown, Gravelly, fine to medium SAND; horizontal laminated with biotite mica laminae; noncohesive when disturbed; could represent marine beach-terrace deposit (?)			
					TRENCH TERMINATED AT 15 FEET			

Figure A-5,
Log of Trench T 5, Page 1 of 1

07147-42-06A.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-06A

TRENCH T 4 D

ELEV. (MSL.) 500' DATE COMPLETED 08-02-2005

EQUIPMENT JD 510 RUBBER-TIRE BACKHOE 24" BUCKET

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 8				CL	**TERRACE DEPOSIT CLAY** Soft to stiff, damp, dark brown, Sandy CLAY; porous with shrinkage cracks			
8 – 10.5				SM-ML	Medium dense, damp, medium brown, very Silty to Clayey, fine SAND with some clay			
10.5 – 12				SM	Medium dense, damp, light brown, Silty, medium to coarse SAND			
12 – 14				GM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light brown, very Sandy GRAVEL with some silt			
14					TRENCH TERMINATED AT 14 FEET			

Figure A-4,
Log of Trench T 4, Page 1 of 1

07147-42-06A.GPJ

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 3 D ELEV. (MSL.) 496' DATE COMPLETED 08-02-2005 EQUIPMENT JD 510 RUBBER-TIRE BACKHOE 24" BUCKET	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 – 5.5				CL	**TERRACE DEPOSIT CLAY** Soft, moist, dark brown (mottled with white), Sandy CLAY; porous; with shrinkage cracks, upper 1 to 2 feet			
5.5 – 7				SM	Medium dense, very moist, medium yellow and red brown, Gravelly, Silty SAND; angular scour contact			
7 – 11	T3-1			SC	Medium dense, moist, light olive brown, Clayey, fine SAND with some silt, micaceous			
11 – 14				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, medium orange brown, very Gravelly, Silty, coarse to medium SAND			
14					TRENCH TERMINATED AT 14 FEET			

Figure A-3,
Log of Trench T 3, Page 1 of 1

07147-42-06A.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-06A

TRENCH T 2 D

ELEV. (MSL.) **500'** DATE COMPLETED **08-02-2005**

EQUIPMENT **JD 510 RUBBER-TIRE BACKHOE 24" BUCKET**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				CL	**TOPSOIL** Stiff, humid, dark brown, Sandy CLAY; porous			
2 – 9				SM-GM	**TERRACE DEPOSIT GRAVEL** Medium dense, very moist, light brown, Gravelly, medium to coarse SAND; some silt			
9 – 12				GM	Dense, moist, medium dark brown, Silty, Sandy, medium to coarse GRAVEL; some oversize cobble (5% 8"-12" diameter)			
12					TRENCH TERMINATED AT 12 FEET			

Figure A-2,
Log of Trench T 2, Page 1 of 1

07147-42-06A.GPJ

SAMPLE SYMBOLS

- ☐ ... SAMPLING UNSUCCESSFUL
- ⊠ ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-06A

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 1 D ELEV. (MSL.) 498' DATE COMPLETED 08-02-2005 EQUIPMENT JD 510 RUBBER-TIRE BACKHOE 24" BUCKET	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 2	T1-1			CL	**TERRACE DEPOSIT CLAY** Soft to stiff, very moist, dark brown, Sandy CLAY; porous			
4 6				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, very moist, light brown, Gravelly, coarse SAND with some silt			
8 10 12	T1-2			GM	Medium dense, very moist, medium brown-mottled gray (manganese coatings), Silty, Sandy, medium to coarse GRAVEL			
					TRENCH TERMINATED AT 13 FEET			

Figure A-1,
Log of Trench T 1, Page 1 of 1

07147-42-06A.GPJ

SAMPLE SYMBOLS			
	☐ ... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-03

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 5 C ELEV. (MSL.) 494' DATE COMPLETED 12-30-03 EQUIPMENT JD 510	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0					**TERRACE DEPOSIT CLAY** Stiff, damp, dark brown, sandy CLAY			
2								
4	T5-1			CL				
6					Dense, damp, light medium reddish brown, sandy coarse GRAVEL			
8	T5-2							
10				GM				
12								
14								
					Medium dense to dense, damp, light reddish brown, gravelly coarse SAND			
16				SM				
					TRENCH TERMINATED AT 16.5 FEET			

Figure A-5,
Log of Trench T 5, Page 1 of 1

07147-42-03.GPJ

SAMPLE SYMBOLS
... SAMPLING UNSUCCESSFUL
... STANDARD PENETRATION TEST
... DRIVE SAMPLE (UNDISTURBED)
... DISTURBED OR BAG SAMPLE
... CHUNK SAMPLE
... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-03

TRENCH T 4 C

ELEV. (MSL.) 494' DATE COMPLETED 12-30-03

EQUIPMENT JD 510

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 3				CL	**TERRACE DEPOSIT CLAY** Stiff, damp, dark brown, Sandy CLAY			
3 – 8				SM-GM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, medium reddish to yellow brown, gravelly silty medium coarse SAND; trace clay			
8 – 10				GM	Dense, damp, light yellow brown, Sandy coarse GRAVEL with 2"-6" diameter cobbles			
10 – 13.5				SM-GM	Medium dense, damp, light reddish brown, very Gravelly Silty medium coarse SAND			
13.5 – 15				SM	Medium dense, damp, light reddish brown, silty coarse SAND			
					TRENCH TERMINATED AT 15 FEET			

Figure A-4,
Log of Trench T 4, Page 1 of 1

07147-42-03.GPJ

SAMPLE SYMBOLS
... SAMPLING UNSUCCESSFUL
... DISTURBED OR BAG SAMPLE
... STANDARD PENETRATION TEST
... CHUNK SAMPLE
... DRIVE SAMPLE (UNDISTURBED)
... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-03

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 3 C ELEV. (MSL.) 498' DATE COMPLETED 12-30-03 EQUIPMENT JD 510	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 – 5				CL	**TERRACE DEPOSIT CLAY** Stiff, damp-moist dark brown Sandy CLAY -Porous, with roots, shrinkage cracks, borrows, some silt			
5 – 10.5				SC	**TERRACE DEPOSIT GRAVEL** Medium dense to dense, damp, light yellow to reddish brown, very gravelly Clayey coarse SAND some silt			
10.5 – 13				ML	Medium dense, moist, medium light brown, Gravelly-Sandy SILT with some clay			
13 – 16				SM-GM	Medium dense to dense, moist, medium reddish brown, very gravelly silty coarse SAND			
16					TRENCH TERMINATED AT 16 FEET			

Figure A-3,
Log of Trench T 3, Page 1 of 1

07147-42-03.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-03

TRENCH T 2 C

ELEV. (MSL.) **506'** DATE COMPLETED **12-30-03**

EQUIPMENT **JD 510**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 3	T2-1			CL	**TERRACE DEPOSIT CLAY** Stiff, damp, dark brown Sandy CLAY -Porous, with shrinkage cracks, pinhole voids			
3 – 8	T2-2			SM	**TERRACE DEPOSIT GRAVEL** Medium dense, light yellow brown to reddish brown, Gravelly, Silty medium coarse SAND -Massive to horizontal bedding, trace clay			
8 – 13.5				SM-GM	Medium dense to dense, light yellow brown to reddish brown, very gravelly coarse SAND to sandy gravel; some silt			
13.5 – 15				SM-GM	Medium dense to dense, light yellow brown, very gravelly coarse SAND to sandy gravel with larger cobble 6"-8" max; some silt			

TRENCH TERMINATED AT 15 FEET

Figure A-2,
Log of Trench T 2, Page 1 of 1

07147-42-03.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-03

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 1 C ELEV. (MSL.) 501' DATE COMPLETED 12-29-03 EQUIPMENT JD 510	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0				CL	**TOPSOIL** Stiff, damp, dark brown, Sandy CLAY			
2 – 12	T1-1			GM-SM	**TERRACE DEPOSIT GRAVEL** Medium dense to dense, humid-damp, light yellowish brown, very Sandy coarse GRAVEL; -Massive to horizontally bedded, with cobbles of sobrounded volcanics, and some silt -Diesel fuel odor* -Becomes coarser, with 10"-18"cobble			
					TRENCH TERMINATED AT 12.5 FEET *NOTE: RINCON ENVIRONMENTAL SAMPLED THIS TRENCH			

Figure A-1,
Log of Trench T 1, Page 1 of 1

07147-42-03.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

TRENCH T 18 B

ELEV. (MSL.) 488 DATE COMPLETED 08-12-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 2				CL	**TERRACE DEPOSIT CLAY** Stiff, moist, dark brown, Sandy CLAY; porous, with roost, shrinkage cracks			
2 – 6	T 18-1			SM	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, light reddish - brown, Silty coarse SAND - Massive			
6					TRENCH TERMINATED AT 6 FEET			

Figure A-18,
Log of Trench T 18, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

TRENCH T 17B

ELEV. (MSL.) 480 DATE COMPLETED 08-12-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SC-CL	**TOPSOIL** Loose, damp, dark brown, very Clayey, fine SAND			
2				ML-CL	**OTAY FORMATION** Dense, moist, medium brown, Clayey SILTSTONE; horizontally laminated			
4	T 17-1 T 17-2						96.6	22.9
6								
8				SM-ML	Very dense, damp, light brown - gray, very Silty, fine SANDSTONE to Sandy SILTSTONE - Horizontally laminated, with biotite mica			

TRENCH TERMINATED AT 9 FEET

Figure A-17,
Log of Trench T 17, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 16 B ELEV. (MSL.) 467 DATE COMPLETED 08-12-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0					**UNDOCUMENTED FILL** Loose, dry to humid, dark to medium brown (mottled), very Gravelly, Silty medium SAND			
2								
4								
6				SM-GM	- Very porous, with wood, metal, asphalt concrete, plastic, and oversize concrete debris (approx. 50 + percent)			
8								
10								
12								
					TRENCH TERMINATED AT 13 FEET Refusal On Oversize Concrete			

Figure A-16,
Log of Trench T 16, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

TRENCH T 15 B

ELEV. (MSL.) 480 DATE COMPLETED 08-12-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 5				SC	**UNDOCUMENTED FILL** Loose, humid to damp, mottled dark brown to light brown, Clayey, Gravelly SAND - with some silt, porous, with glass, metal, wood debris, possible burn - ash			
5 – 13				GM	Very loose, humid, dark gray - brown, Sandy debris, and oversized concrete chunks 2 feet to 5 feet in diameter, and rebar, open voids - Open voids			

Depth scale: 0, 2, 4, 6, 8, 10, 12

TRENCH TERMINATED AT 13 FEET
Refusal On Oversize Concrete

Figure A-15,
Log of Trench T 15, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

TRENCH T 14B

ELEV. (MSL.) 492 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 2 – 4				CL	**TERRACE DEPOSIT CLAY** Soft to stiff, moist to very moist, dark olive - brown, Sandy CLAY; porous, with roots, burrows			
6				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, medium to light reddish - brown, Silty coarse SAND - Massive, with trace gravel			
					TRENCH TERMINATED AT 7.5 FEET			

Figure A-14,
Log of Trench T 14, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 13B ELEV. (MSL.) 490 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 – 3				CL	**UNDOCUMENTED FILL** Loose, moist, dark to medium brown (mottled), very Sandy CLAY; porous, with trash, wood			
3 – 7				CL	**TERRACE DEPOSIT CLAY** Soft, very moist to wet, olive - brown, Sandy CLAY			
7 – 10				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, very moist, dark gray, Silty coarse SAND; trace gravel			
10 – 12.5				SM-GM	Medium dense, very moist, reddish - brown, very Gravelly, Silty, coarse SAND - Oversize cobble (approx. 20 percent, 6 inches to 18 inches in diameter)			
					TRENCH TERMINATED AT 12.5 FEET			

Figure A-13,
Log of Trench T 13, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 12 B ELEV. (MSL.) 489 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0–4				CL	**TERRACE DEPOSIT CLAY** Stiff, moist, dark brown, Sandy CLAY; porous, with roots, burrows			
4–9				SM	Medium dense, light to medium olive - brown, Silty, fine SAND - With discontinuous horizontal layers of calcium carbonate - sulfate			
9–11				SM-ML	**OTAY FORMATION** Dense, damp, light gray - olive, very Silty fine SANDSTONE - Horizontally laminated with some clay			
					TRENCH TERMINATED AT 11 FEET			

Figure A-12,
Log of Trench T 12, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 11B ELEV. (MSL.) 505 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 2				CL	**TERRACE DEPOSIT CLAY** Stiff, damp, dark brown, Sandy CLAY; porous			
4 6 8				SM	Medium dense, humid, light to medium Olive - brown to brown, Silty fine SAND; with some clay - Horizontal beds, with discontinuous white 1 inch to 3 inch thick calcium carbonate - sulfate layers			
10				SM	**TERRACE DEPOSIT GRAVEL** Dense, damp, light olive Silty SANDSTONE			
12				SM-GM	Medium dense, damp to moist, medium to light reddish - brown, very Gravelly coarse SAND; with some silt (approx. 20 to 30 percent 2 inch to 6 inch cobble			
					TRENCH TERMINATED AT 13 FEET			

Figure A-11,
Log of Trench T 11, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	☐ ... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 10 B ELEV. (MSL.) 500 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 2	T 10-1			CL	**TERRACE DEPOSIT CLAY** Stiff, damp, dark brown, Sandy CLAY			
4				SM	Medium dense, damp, light to medium olive - brown, Silty fine SAND; some clay, calcium carbonate - sulfate			
6				GM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light brown - whitish - tan, Sandy medium to coarse GRAVEL			
					TRENCH TERMINATED AT 7 FEET			

Figure A-10,
Log of Trench T 10, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	☐ ... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 9 B ELEV. (MSL.) 499 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 – 7				CL	**TERRACE DEPOSIT CLAY** Soft to stiff, moist, dark brown - olive, Sandy CLAY; porous, with roots, burrows - Irregular contact inclined SE			
7 – 9				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light reddish - brown, Silty, medium to coarse Gravelly SAND			
					TRENCH TERMINATED AT 9 FEET			

Figure A-9,
Log of Trench T 9, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

TRENCH T 8B

ELEV. (MSL.) 513 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 3				CL	**TERRACE DEPOSIT CLAY** Stiff, damp to moist, sark gray - brown, Sandy CLAY			
3 – 8	T 8-1			SC	Medium dense, damp, olive - brown, very Clayey fine SAND; white calcium (sulfate - carbonate), mottled			
8 – 13.5	T 8-2			SM	**TERRACE DEPOSIT GRAVEL** Dense, humid, light tan - olive, Silty very fine to fine SANDSTONE		116.3	6.2
	T 8-3				- Massive to horizontal bedding			

TRENCH TERMINATED AT 13.5 FEET

Figure A-8,
Log of Trench T 8, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

TRENCH T 7B

ELEV. (MSL.) 506 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 6				CL	**TERRACE DEPOSIT CLAY** Soft to stiff, moist, dark olive - brown, Sandy CLAY; porous, with roots, shrinkage cracks			
6 – 9.5				ML-CL	Stiff, very moist, medium to light olive, very Clayey SILT			
9.5 – 11.5				SM-GM	**TERRACE DEPOSIT GRAVEL** Medium dense, very moist, light reddish - brown, Gravelly, Silty coarse SAND - Massive			

TRENCH TERMINATED AT 11.5 FEET

Figure A-7,
Log of Trench T 7, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	TRENCH T 6B ELEV. (MSL.) 495 DATE COMPLETED 08-11-2003 EQUIPMENT JD 510 RUBBERTIRE 24"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
0 – 4				SC-CL	**TERRACE DEPOSIT CLAY** Loose, damp to moist, dark yellow - brown, very Gravelly, Clayey medium SAND; porous, with roots, cobble to 10 inch diameter			
4 – 6				SM-GM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp to moist, medium to light reddish - brown to brown, Gravelly medium to very coarse SAND - Massive (approx. 20 percent cobble)			
					TRENCH TERMINATED AT 6 FEET			

Figure A-6,
Log of Trench T 6, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. 07147-42-01

TRENCH T 5B

ELEV. (MSL.) 504 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 4				CL	**TERRACE DEPOSIT CLAY** Stiff, damp to moist, dark gray - brown, Sandy CLAY; porous, with roots, shrinkage cracks			
4 – 11	T 5-1			CL	Soft to stiff, moist, medium olive - brown (mottled with white), Silty CLAY - Massive to horizontal beds, with calcium carbonate - sulfate lenses in upper portion			
11 – 12.5				SM-GM	**TERRACE DEPOSIT GRAVEL** Medium dense, moist, light brown, Gravelly, Silty coarse SAND - Massive, cobbles approx. 20 to 30 percent and 2 inches to 6 inches diameter			

TRENCH TERMINATED AT 12.5 FEET

Figure A-5,
Log of Trench T 5, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

TRENCH T 4B

ELEV. (MSL.) 505 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0					**TERRACE DEPOSIT CLAY** Stiff, moist, dark brown, Sandy CLAY; porous, with roots, shrinkage cracks			
2	T 4-1			CL				
4								
6				SC	Dense, damp, olive - brown, mottled, Clayey coarse SAND			
8				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light reddish - brown, Silty coarse SAND; trace gravel			
					TRENCH TERMINATED AT 9.5 FEET			

Figure A-4,
Log of Trench T 4, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	☐ ... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

TRENCH T 3 B

ELEV. (MSL.) 499 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 4				CL	**TERRACE DEPOSIT CLAY** Stiff, moist, dark brown, Sandy CLAY; porous			
4 – 10	T 3-1 T 3-3			SC	Medium to very dense, damp, olive - brown with white (mottled) Clayey, fine to medium SAND - Calcium - carbonate cemented, marginal rippablilty		103.2	17.8
10 – 11.5	T 3-2			GM	**TERRACE DEPOSIT GRAVEL** Dense, humid, damp, light brown, Silty, Sandy, coarse GRAVEL - Massive to horizontal, approx. 30 percent 2 inch to 8 inch cobble			

TRENCH TERMINATED AT 11.5 FEET

Figure A-3,
Log of Trench T 3, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

TRENCH T 2 B

ELEV. (MSL.) 505 DATE COMPLETED 08-11-2003

EQUIPMENT JD 510 RUBBERTIRE 24"

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0 – 2				CL	**TOPSOIL** Stiff, damp, dark brown, Sandy CLAY; very porous, with shrinkage cracks, roots			
2 – 7.5				SM	**TERRACE DEPOSIT GRAVEL** Medium dense, damp, light reddish to yellowish - brown, Gravelly Silty, coarse SAND - Massive to horizontal bedded			
					TRENCH TERMINATED AT 7.5 FEET			

Figure A-2,
Log of Trench T 2, Page 1 of 1

07147-42-01.GPJ

SAMPLE SYMBOLS	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

APPENDIX C

LABORATORY TEST RESULTS

APPENDIX C-1

LABORATORY TEST RESULTS-
AGS 2013, 2015, and 2016 (Current)

SoilCor
CORROSION & THERMAL SCIENCES
41765 Hawthorn Street
Murrieta, CA 92562
ph (951) 894-2682
fx (951) 894-2683

EXPANSION INDEX
ASTM D 4829, UBC 29-2

Work Order No.: 13E1258
Client: AGS, Inc.
Project: P/W 1304-04
Sample Identification: TP-3 @ 0-2'
Report Date: May 23, 2013

■ ASTM D 4829 ☐ UBC 29-2

MOLDING DATA		
Initial Moisture (%)	11.3	
Soil + Ring (g)	598.2	
Ring (g)	200.7	
Wet Soil (g)	397.5	
Dry Soil (g)	357.1	
Wet Density (pcf)	119.9	
Dry Density (pcf)	107.7	
Water Density (pcf)	12.17	
Volume of Solids (cf)	0.6394	
Volume of Voids (cf)	0.3606	
Degree of Saturation (%)	54.1	

MOISTURE DATA		
Moisture Can No.	5-L	6-L
Wet Soil + Tare (g)	755.6	747.9
Dry Soil + Tare (g)	735.2	720.2
Tare (g)	474.0	475.0
Moisture Content (%)	7.8	11.3

COARSE MATERIAL	
Plus No. 4 (%)	~ 2

TEST DATA			
	Height (in)	Time (h:m)	Date
Load	1.000	16:25	5/21/13
Inundate	1.000	16:35	5/21/13
Reading	1.080	16:10	5/22/13
Reading	1.080	16:10	5/22/13
Reading			
EI (measured)	80.0		

UBC REPORT RANGES	
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	High
>130	Very High

FINAL RESULTS	
Expansion Index (EI_{50})	84
EI Classification	Medium

SoilCor
CORROSION & THERMAL SCIENCES
41765 Hawthorn Street
Murrieta, CA 92562
ph (951) 894-2682
fx (951) 894-2683

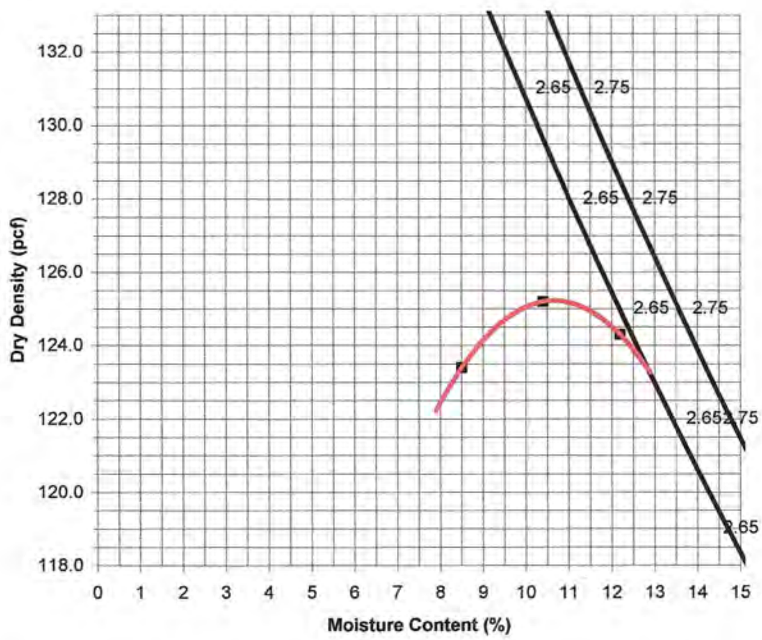
LABORATORY DENSITY
ASTM D 1557

Work Order No.: 13E1258
Client: AGS, Inc.
Project No.: P/W 1304-04
Project Name:
Sample Identification: TP-6 @ 4-6'
Report Date: May 23, 2013

Soil Description: (SC) Dark Brown, Clayey Fine-Coarse Sand w/ Gravel

Procedure: ❑ A (-No.4) ❑ B (-3/8") ■ C (-3/4")
Preparation: ■ Moist ❑ Dry
Rammer: ■ Manual ❑ Mechanical

Test No:	1	2	3	4	5	6
Wet Density (pcf):	133.8	138.3	139.4			
Dry Density (pcf):	123.4	125.2	124.3			
Moisture Content (%):	8.5	10.4	12.2			



Raw Curve Data (Without Oversize)	
As-Rec'd Oversize Content (%):	22.5
*Oversize Specific Gravity (Gs):	2.65
Maximum Dry Density (pcf):	125.3
Optimum Moisture Cont. (%):	10.7

*Specific Gravity assumed unless noted, 1.0% SSD moisture is default for oversize fraction

Rock Corrected Values (D 4718)		
Oversize (%)	Max Density (pcf)	Optimum (%)
5	127.0	10.0
10	128.5	9.5
15	130.0	9.0
20	131.5	9.0
25	133.5	8.5
30	135.0	8.0

Form No. 157R
Rev. 06/12

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SoilCor
CORROSION & THERMAL SCIENCES
41765 Hawthorn Street Murrieta, CA 92562
ph (951) 894-2682 • fx (951) 894-2683

Work Order No.: 13E1258
Client: AGS, Inc.
Project: P/W 1304-04
Report Date: May 23, 2013

Laboratory Test(s) Results Summary

The subject soil sample was processed in accordance with California Test Method CTM 643 and tested for pH / Minimum Resistivity (CTM 643), Sulfate Content (CTM 417) and Chloride Content (CTM 422). The test results follow:

Sample Identification	pH	Minimum Resistivity (ohm-cm)	Sulfate Content (mg/kg)	Sulfate Content (% by wgt)	Chloride Content (ppm)
TP-3 @ 0-2'	8.1	260	370	0.037	630

*ND=No Detection

We appreciate the opportunity to serve you. Please do not hesitate to contact us with any questions or clarifications regarding these results or procedures.

Ahmet K. Kaya, Laboratory Manager

ANAHEIM TEST LAB, INC

3008 ORANGE AVENUE
SANTA ANA, CALIFORNIA 92707
PHONE (714) 549-7267

DATE: 03/03/2015

AGS
2842 Walnut Avenue, Suite C-1
Tustin, CA 92780

P.O. NO.: Verbal

LAB NO.: B-8076

SPECIFICATION: CA-417/422/643

Attn: Sean Donovan

MATERIAL: Soil

J.N.: 1501-09
Project: Jabir
Location: Otay Canyon Ranch
Sample I.D.: TP-5 @ 5'-6'

ANALYTICAL REPORT

CORROSION SERIES
SUMMARY OF DATA

PH	SOLUBLE SULFATES per CA. 417 ppm	SOLUBLE CHLORIDES per CA. 422 ppm	MIN. RESISTIVITY per CA. 643 ohm-cm
6.9	111	673	2,300

RESPECTFULLY SUBMITTED

WES BRIDGER CHEMIST

ADVACED GEOTECHNICAL SOLUTIONS, INC .

EXPANSION INDEX TEST ASTM (D4829)

Project Name: JABIR- OTAY CYN RANCH
Location:
File No: 1501-09
Date:

Excavation: TP-3
Depth: 3-5 '
Description: Olive Sandy Clay
By:

SAMPLE PREPARATION

PARAMETER	FORMULA	UNITS	DATA		
Ring Volume	A	cf	0.007476		
Specific Surcharge		psf	144		
2-lb Sample Moist	B	%	15.0		
Wt. Ring	C	g	194.4		
Wt. Ring + Wet Soil	D	g	552.4		
Wt. Wet Soil	E = D - C	g	358		
Dry Density	F	pcf	91.72		
Initial Saturation	G = (A x 2.7 x F) / (2.7 x 62.4 - F)	%	48.4		

FINAL SAMPLE INFORMATION

Wt. Ring + Tare + Wet Soil	H	g	721.5		
Wt. Ring + Tare + Dry Soil	I	g	624.2		
Tare	J	no.	,160.0		
Wt. Tare	K	g	98.7		
Wt. Moisture Loss	L = H - I	g	97.3		
Wt. Dry Soil	M = I - C - K	g	331.1		
Final Moisture Content	N = 100 x (L / M)	%	29.4		
Final Saturation	O = (N x 2.7 x F) / (2.7 x 62.4 - F)	%	94.81		
Ring Volume After Test	P = (R - S + 1) x 0.08722 / 12	cf	0.00839		

TEST INFORMATION

PROPOSED READINGS		FORMULA	DATE	TIME	UNITS			
	LOAD APPLIED							
0 minute		Q	2/24/2015	2.30 PM		0.5192		
10 minute		R	2/24/2015	2.40 PM		0.5190		
11 minute	WATER ADDED							
		S	2/26/2015	12.30 PM		0.674		
EXPANSION INDEX		**EI = 1000 x (S - R)**				**155**		

INITIAL DRY DENSITY F (pcf)	INITIAL MOISTURE CONTENT B (%)	INITIAL SATURA-TION G (%)	SWELL (%) EI /10	EXPANSION INDEX (EI)		FINAL DRY DENSITY (E/P/454)/ (100+N)x100	FINAL MOISTURE CONTENT N (%)	FINAL SATURA-TION O (%)
91.72	15.0	48.4	15.5	155		72.60	29.4	94.8

ADVANCED GEOTECHNICAL SOLUTIONS, INC.

EXPANSION INDEX - ASTM D4829

Project Name:	Otay Canyon Ranch	Excavation/Tract:	TP-5
Location:	Otay Mesa	Depth/Lot:	6 ft.
P/W:	1304-04	Description:	Sandy Clay
Date:	10/23/16	By:	HM

Expansion Index - ASTM D4829	
Initial Dry Density (pcf):	94.3
Initial Moisture Content (%):	14.3
Initial Saturation (%):	49.1
Final Dry Density (pcf):	79.2
Final Moisture Content (%):	39.0
Final Saturation (%):	93.3
Expansion Index:	191
Potential Expansion:	Very High

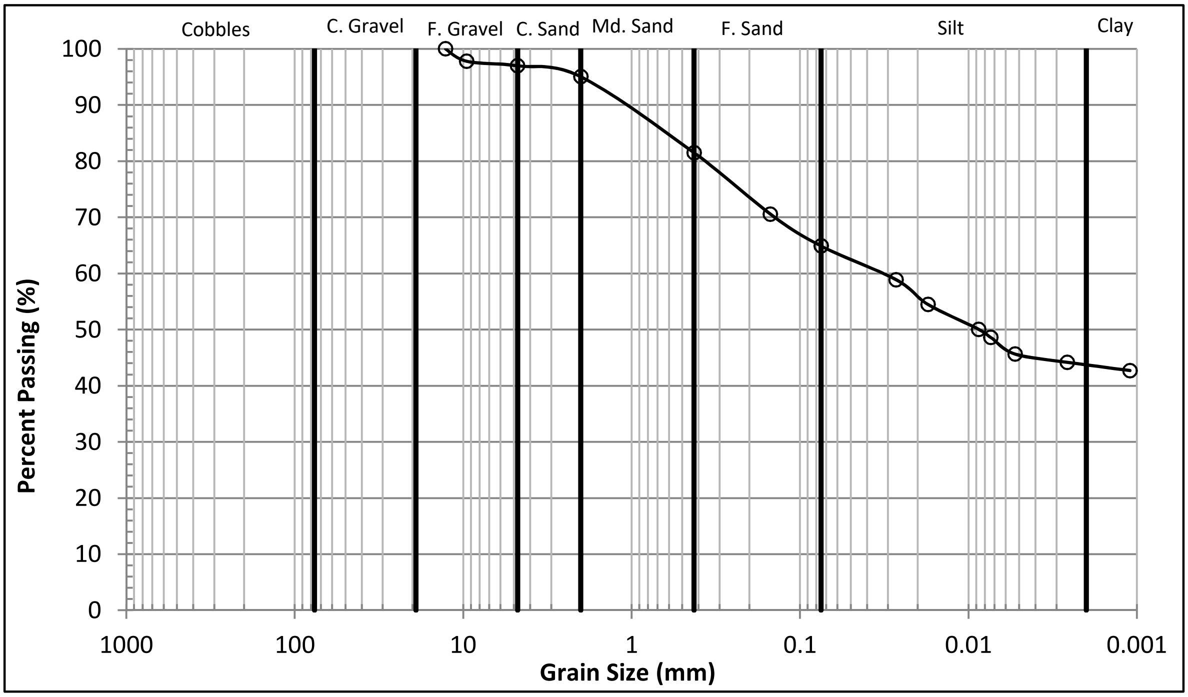
ASTM D4829 - Table 5.3	
Expansion Index	Potential Expansion
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	High
>130	Very High

ADVANCED GEOTECHNICAL SOLUTIONS, INC.

PARTICLE SIZE ANALYSIS - ASTM D422

Project Name: Otay Canyon Ranch
Location: Otay Mesa
Project No.: 1304-04
Date: 10/23/16

Excavation: TP-6
Depth: 0-2.5 '
By: H M



Grain Size (in/#)	Grain Size (mm)	Amount Passing (%)
3 "	75.00	
2 1/2 "	63.00	
2 "	50.00	
1 1/2 "	37.50	
1 "	25.00	
3/4 "	19.05	
1/2 "	12.70	100.00
3/8 "	9.53	97.79
# 4	4.75	97.00
# 10	2.00	95.05
# 20	0.85	#N/A
# 30	0.60	#N/A
# 40	0.425	81.50
# 50	0.30	#N/A
# 60	0.212	#N/A
# 100	0.15	70.56
# 200	0.075	64.89
Hydro	0.0269	58.89
Hydro	0.0174	54.48
Hydro	0.0087	50.06
Hydro	0.0074	48.59
Hydro	0.0053	45.64
Hydro	0.0026	44.17
Hydro	0.0011	42.70

Summary	
% Gravel =	3.0
% Sand =	32.1
% Silt =	21.5
% Clay =	43.4
Sum =	100.0

LL= ______
PL= ______
PI= ______

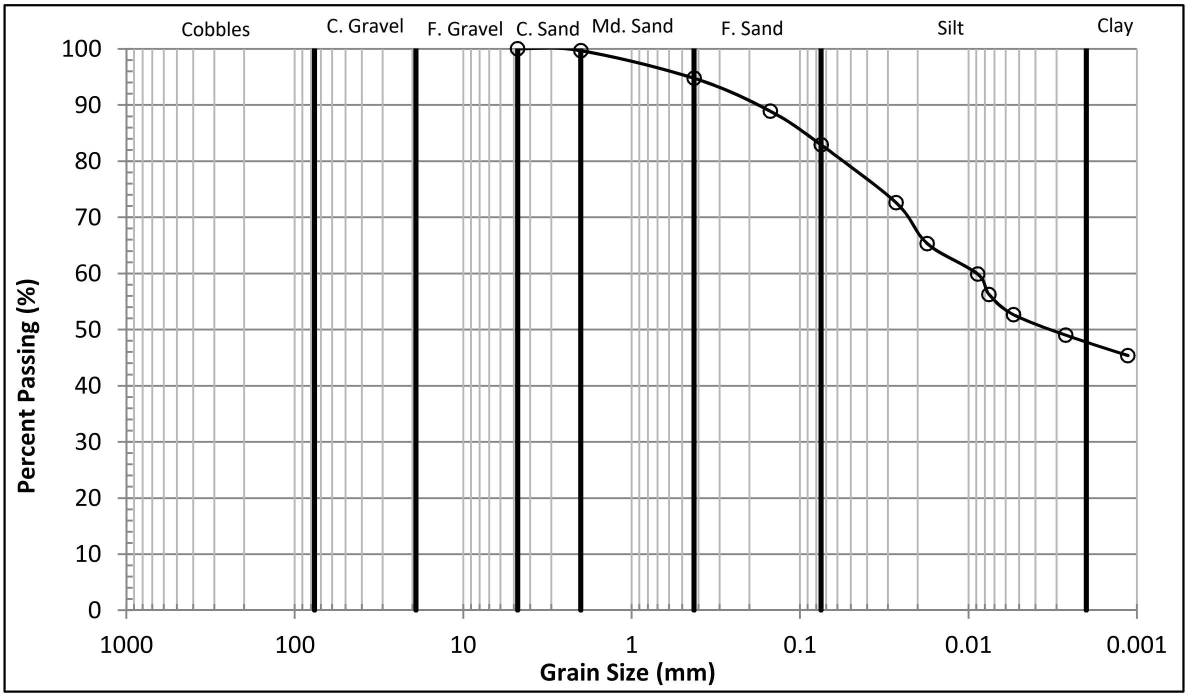
Soil Type: ______

ADVANCED GEOTECHNICAL SOLUTIONS, INC.

PARTICLE SIZE ANALYSIS - ASTM D422

Project Name: Otay Canyon Ranch
Location: Otay Mesa
Project No.: 1304-04
Date: 10/23/16

Excavation: Tp-5
Depth: 6 '
By: H M



Grain Size (in/#)	Grain Size (mm)	Amount Passing (%)
3 "	75.00	
2 1/2 "	63.00	
2 "	50.00	
1 1/2 "	37.50	
1 "	25.00	
3/4 "	19.05	
1/2 "	12.70	
3/8 "	9.53	
# 4	4.75	100.00
# 10	2.00	99.68
# 20	0.85	#N/A
# 30	0.60	#N/A
# 40	0.425	94.77
# 50	0.30	#N/A
# 60	0.212	#N/A
# 100	0.15	88.90
# 200	0.075	82.90
Hydro	0.0269	72.60
Hydro	0.0176	65.34
Hydro	0.0088	59.90
Hydro	0.0075	56.27
Hydro	0.0054	52.64
Hydro	0.0026	49.01
Hydro	0.0011	45.38

Summary	
% Gravel =	0.0
% Sand =	17.1
% Silt =	35.7
% Clay =	47.2
Sum =	100.0

LL= ______
PL= ______
PI= ______

Soil Type: ______

ADVANCED GEOTECHNICAL SOLUTIONS, INC.

EXPANSION INDEX - ASTM D4829

Project Name:	Otay Canyon Ranch	Excavation/Tract:	TP-6
Location:	Otay Mesa	Depth/Lot:	0 - 2.5 ft.
P/W:	1304-04	Description:	Clay
Date:	10/23/16	By:	HM

Expansion Index - ASTM D4829	
Initial Dry Density (pcf):	97.4
Initial Moisture Content (%):	13.5
Initial Saturation (%):	49.9
Final Dry Density (pcf):	86.6
Final Moisture Content (%):	33.1
Final Saturation (%):	94.4
Expansion Index:	125
Potential Expansion:	High

ASTM D4829 - Table 5.3

Expansion Index	Potential Expansion
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	High
>130	Very High

APPENDIX C-2

LABORATORY TEST RESULTS-
GEOCON

APPENDIX B

LABORATORY TESTING

Laboratory tests were performed in accordance with generally accepted test methods of the American Society for Testing and Materials (ASTM) or other suggested procedures. Selected samples were tested for their in-place dry density and moisture content, direct shear strength, compaction, expansion, and soluble-sulfate characteristics. The results of the tests are summarized in tabular and graphical form herewith. The in-place dry density and moisture content of the samples tested are presented on the boring logs in Appendix A.

TABLE B-I
SUMMARY OF LABORATORY MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT TEST RESULTS
ASTM D 1557

Sample No.	Description	Maximum Dry Density (pcf)	Optimum Moisture Content (% dry wt.)
T1-1	Dark brown, Sandy CLAY with trace gravel	124.9	10.6
T1-2	Light olive-brown, Clayey, fine to coarse SAND	125.8	9.8
T3-1	Dark gray-brown, Silty, fine to medium SAND	120.5	13.0
T8-3	Light brown, Silty, fine SAND with trace clay	113.5	14.9
T17-2	Gray-brown, Clayey SILT with little sand	108.7	16.8

TABLE B-II
SUMMARY OF DIRECT SHEAR TEST RESULTS

Sample No.	Dry Density (pcf)	Moisture Content (%)	Unit Cohesion (psf)	Angle of Shear Resistance (degrees)
T1-1*	112.5	10.5	500	25
T1-2*	112.3	10.7	650	16

* Sample remolded to approximately 90 percent of maximum laboratory dry density at near optimum moisture content.

TABLE B-III
SUMMARY OF LABORATORY EXPANSION INDEX TEST RESULTS

Sample No.	Moisture Content		Dry Density (pcf)	Expansion Index
	Before Test (%)	After Test (%)		
T1-1	14.5	34.7	95.8	99
T1-3	14.1	30.2	98.8	52
T6-1	12.9	32.2	96.2	78

TABLE B-IV
SUMMARY OF LABORATORY SOLUBLE-SULFATE TEST RESULTS

Sample No.	Sulfate (% SO_4)	Sulfate Exposure*
T1-3	0.030	Negligible

* Reference: 1997 Uniform Building Code Table 19-A-3.

APPENDIX B

LABORATORY TESTING

Laboratory tests were performed in accordance with generally accepted test methods of the American Society for Testing and Materials (ASTM) or other suggested procedures. Selected samples were tested for their in-place dry density and moisture content, direct shear strength, compaction, expansion, and soluble-sulfate characteristics. The results of the tests are summarized in tabular and graphical form herewith. The in-place dry density and moisture content of the samples tested are presented on the boring logs in Appendix A.

TABLE B-I
SUMMARY OF LABORATORY MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT TEST RESULTS
ASTM D 1557

Sample No.	Description	Maximum Dry Density (pcf)	Optimum Moisture Content (% dry wt.)
T1-1	Dark Reddish brown, very Sandy CLAY with trace gravel	118.8	13.8
T1-3	Olive-brown, Clayey, sandy SILT with trace gravel	113.1	13.9
T7-2	Light yellowish brown, Silty, fine to medium SAND with trace fine gravel	119.0	13.0

TABLE B-II
SUMMARY OF DIRECT SHEAR TEST RESULTS

Sample No.	Dry Density (pcf)	Moisture Content (%)	Unit Cohesion (psf)	Angle of Shear Resistance (degrees)
T1-1*	106.6	13.6	600	20

* Sample remolded to approximately 90 percent of maximum laboratory dry density at near optimum moisture content.

TABLE B-III
SUMMARY OF LABORATORY EXPANSION INDEX TEST RESULTS

Sample No.	Moisture Content		Dry Density (pcf)	Expansion Index
	Before Test (%)	After Test (%)		
T5-1	9.7	17.7	107.2	0
T7-1	13.0	30.3	100.9	130

TABLE B-IV
SUMMARY OF LABORATORY SOLUBLE-SULFATE TEST RESULTS

Sample No.	Sulfate (% SO_4)	Sulfate Exposure*
T3-1	0.360	Severe
T7-1	0.405	Severe
T1-2	0.013	Negligible

*Reference: 1997 Uniform Building Code Table 19-A-4.

TABLE B-V
SUMMARY OF LABORATORY POTENTIAL OF HYDROGEN (pH) AND RESISTIVITY TEST RESULTS CALIFORNIA TEST NO. 643

Sample No.	Ph	Resistivity (ohm centimeters)	Corrosive Rating
T7-1	6.7	280	Severely Corrosive

APPENDIX B

LABORATORY TESTING

Laboratory tests were performed in accordance with generally accepted test methods of the American Society for Testing and Materials (ASTM) or other suggested procedures. Selected samples were tested for their moisture content, direct shear strength, compaction, expansion, and soluble-sulfate characteristics. The results of the tests are summarized in tabular and graphical form herewith. The in-place dry density and moisture content of the samples tested are presented on the boring logs in Appendix A.

TABLE B-I
SUMMARY OF LABORATORY MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT TEST RESULTS
ASTM D 1557

Sample No.	Description	Maximum Dry Density (pcf)	Optimum Moisture Content (% dry wt.)
T3-1	Light Olive-brown, Silty SAND with little clay; micaceous	122.6	10.8
T5-1	Light yellowish-brown, fine to med. SAND, with gravel and thin mica laminae	128.0	9.1
T7-1	Dark reddish-brown, silty CLAY, with some sand	122.0	12.1

TABLE B-II
SUMMARY OF LABORATORY DIRECT SHEAR TEST RESULTS

Sample No.	Dry Density (pcf)	Moisture Content (%)	Unit Cohesion (psf)	Angle of Shear Resistance (degrees)
T5-1*	116.6	16.6	370	38
T7-1	115.4	30.3	225	14

*Sample remolded to approximately 90 percent of maximum laboratory dry density at near optimum moisture content.

TABLE B-III
SUMMARY OF LABORATORY EXPANSION INDEX TEST RESULTS

Sample No.	Moisture Content		Dry Density (pcf)	Expansion Index
	Before Test (%)	After Test (%)		
T2-1	13.8	32.2	97.4	111
T5-1	11.7	20.5	109.5	49

TABLE B-IV
SUMMARY OF LABORATORY SOLUBLE SULFATE TEST RESULTS

Sample No.	Sulfate (% SO_4)	Sulfate Exposure*
T1-1	0.09	Negligible
T5-1	0.06	Negligible

* Reference: 1997 Uniform Building Code Table 19-A-3.

APPENDIX B

LABORATORY TESTING

Laboratory tests were performed in accordance with generally accepted test methods of the American Society for Testing and Materials (ASTM) or other suggested procedures. Selected samples were tested for their in-place dry density and moisture content, direct shear strength, compaction, expansion, and soluble-sulfate characteristics. The results of the tests are summarized in tabular and graphical form herewith. The in-place dry density and moisture content of the samples tested are presented on the boring logs in Appendix A.

TABLE B-I
SUMMARY OF LABORATORY MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT TEST RESULTS ASTM D 1557

Sample No.	Description	Maximum Dry Density (pcf)	Optimum Moisture Content (% dry wt.)
T1-1	Yellowish brown, gravelly silty SAND with trace clay	124.2	10.1

TABLE B-II
SUMMARY OF DIRECT SHEAR TEST RESULTS

Sample No.	Dry Density (pcf)	Moisture Content (%)	Unit Cohesion (psf)	Angle of Shear Resistance (degrees)
T1-1*	111.7	9.5	403	37

* Sample remolded to approximately 90 percent of maximum laboratory dry density at near optimum moisture content.

TABLE B-III
SUMMARY OF LABORATORY EXPANSION INDEX TEST RESULTS

Sample No.	Moisture Content		Dry Density (pcf)	Expansion Index
	Before Test (%)	After Test (%)		
T1-1	10.0	29.7	110.3	25
T1-2	10.0	27.3	100.5	38
T3-1	10.9	30.9	109.2	41
T4-1	9.8	28.4	111.5	58
T8-3	14.3	26.8	100.6	7
T10-1	13.0	34.9	89.7	72
T17-2	14.5	43.8	97.2	139
T18-1	10.3	21.1	109.8	7

TABLE B-IV
SUMMARY OF LABORATORY SOLUBLE-SULFATE TEST RESULTS

Sample No.	Sulfate (% SO_4)	Sulfate Exposure*
T1-1	0.011	Negligible
T1-2	0.048	Negligible
T3-1	0.033	Negligible
T4-1	0.038	Negligible
T18-1	0.030	Negligible

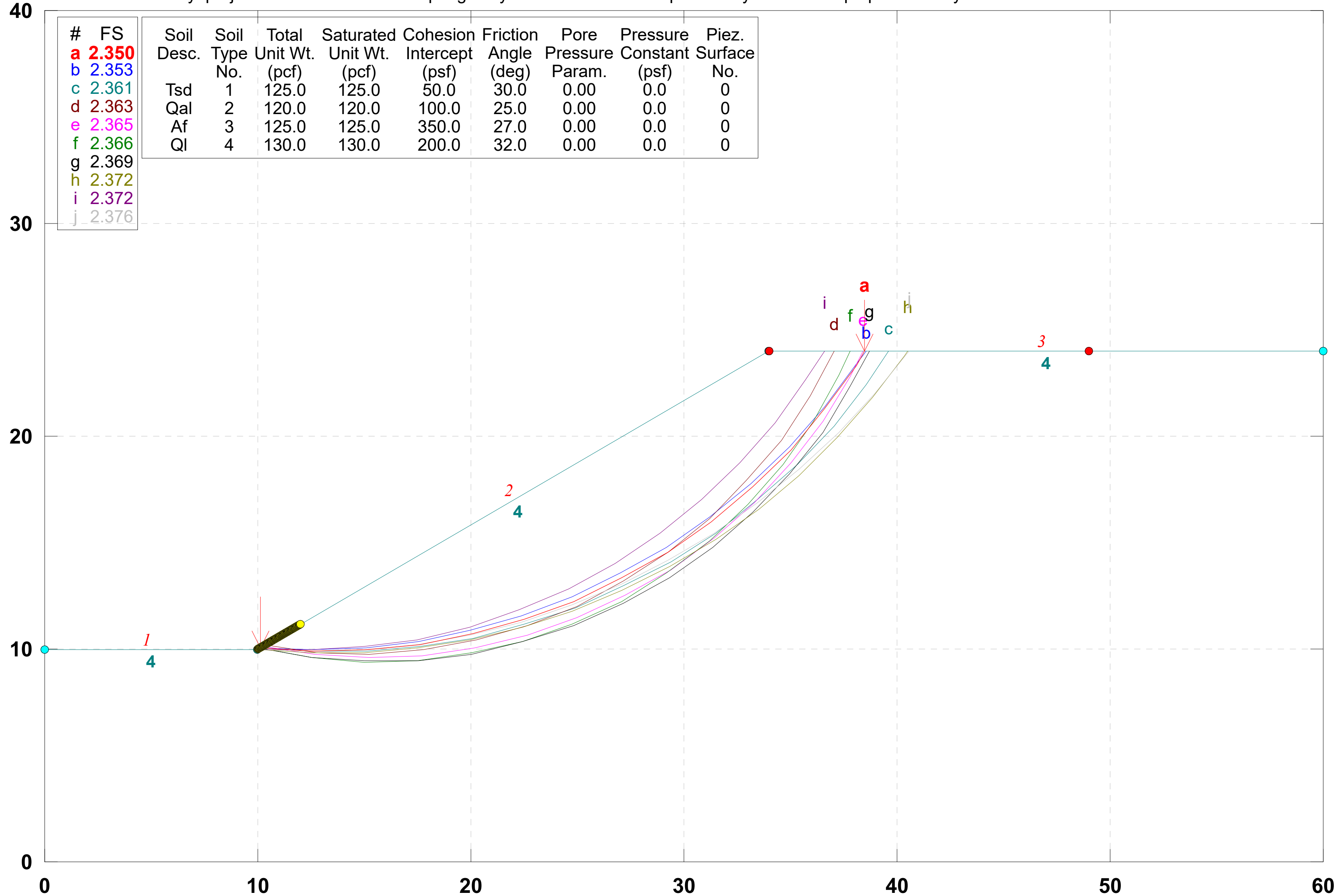
* Reference: 1997 Uniform Building Code Table 19-A-3.

APPENDIX D

SLOPE STABILITY ANALYSIS

1304-04 -Otay Canyon Ranch- Highest Cut Slope- 12-ft 2:1

y:\project files\1304-04 colrich spring canyon ranch\1304-04 slope stability\12-ft cut slope.pl2   Run By: AGS   5/26/2017   03:26PM



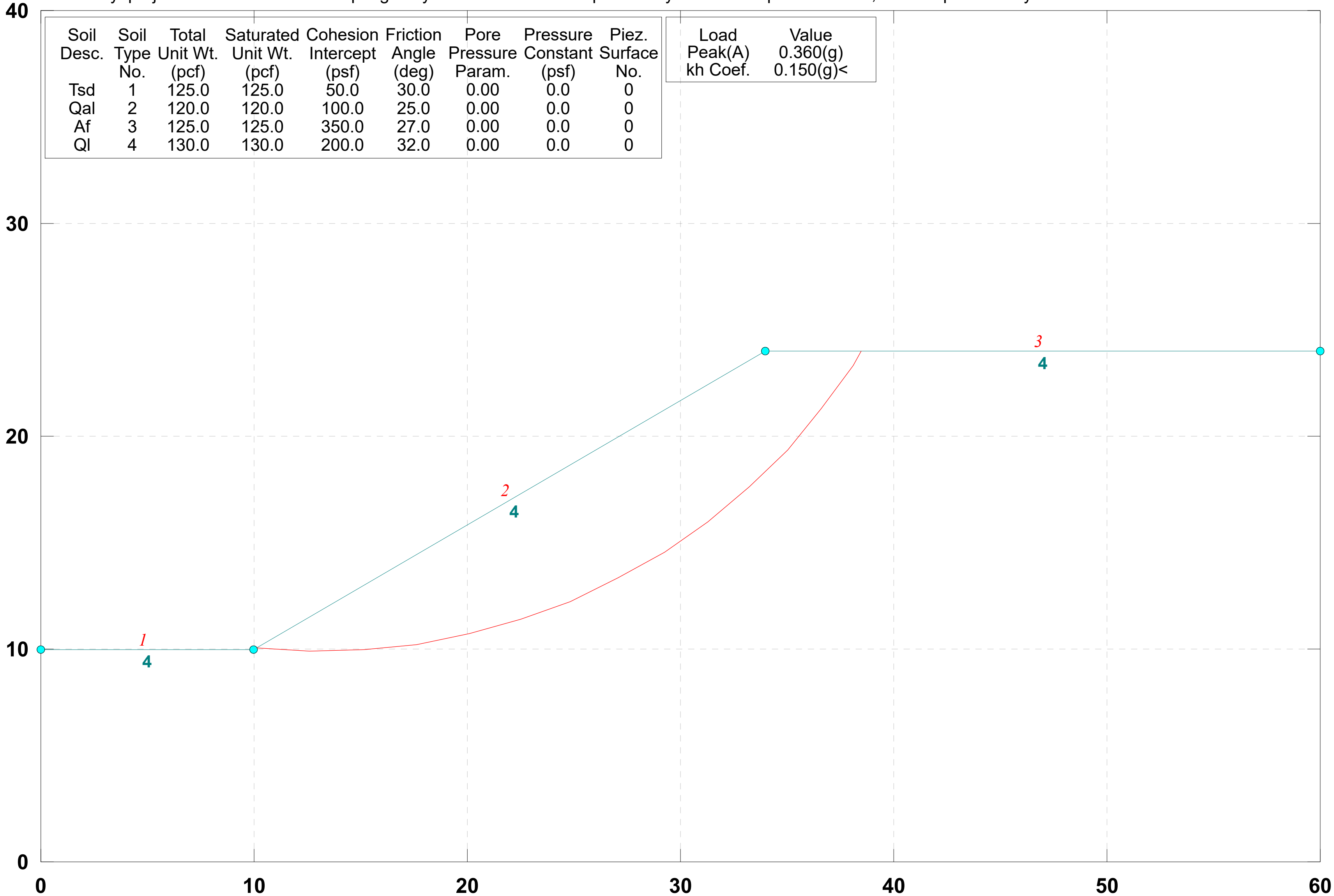
Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Tsd	1	125.0	125.0	50.0	30.0	0.00	0.0	0
Qal	2	120.0	120.0	100.0	25.0	0.00	0.0	0
Af	3	125.0	125.0	350.0	27.0	0.00	0.0	0
Ql	4	130.0	130.0	200.0	32.0	0.00	0.0	0

GSTABL7 v.2 FSmin=2.350

Safety Factors Are Calculated By The Modified Bishop Method

1304-04 -Otay Canyon Ranch- Highest Cut Slope- 12-ft 2:1, Pseudostatic

y:\project files\1304-04 colrich spring canyon ranch\1304-04 slope stability\12-ft cut slope surface #1, seismic.plt Run By: AGS 5/26/2017 03:56PM

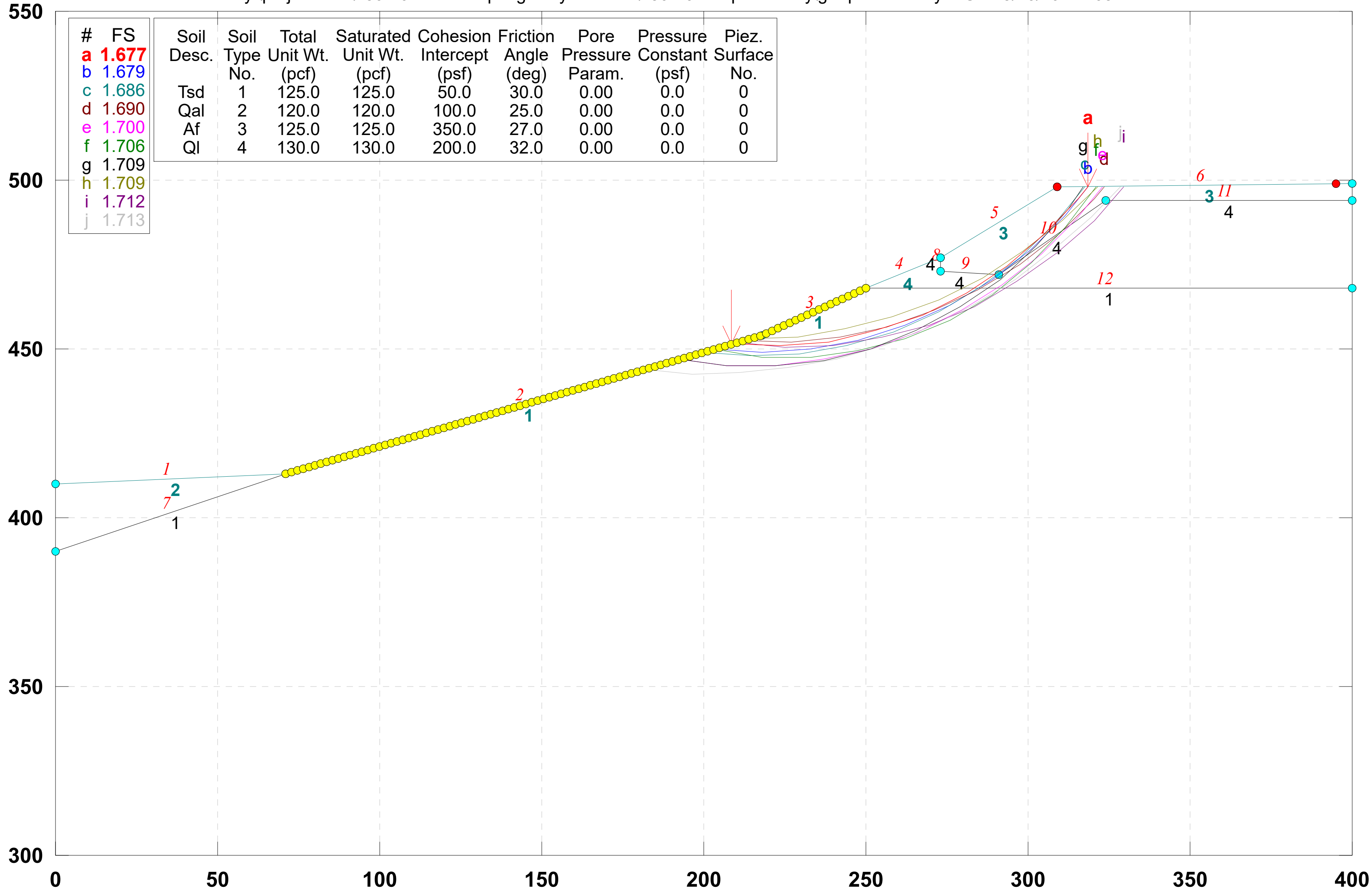


GSTABL7 v.2 FSmin=1.769

Factor Of Safety Is Calculated By The Modified Bishop Method

1304-04 -Otay Canyon Ranch-Section G-G' Fill over natural slope

y:\project files\1304-04 colrich spring canyon ranch\1304-04 slope stability\g-1.pl2 Run By: AGS 5/26/2017 03:24PM



#	FS
a	1.677
b	1.679
c	1.686
d	1.690
e	1.700
f	1.706
g	1.709
h	1.709
i	1.712
j	1.713

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Tsd	1	125.0	125.0	50.0	30.0	0.00	0.0	0
Qal	2	120.0	120.0	100.0	25.0	0.00	0.0	0
Af	3	125.0	125.0	350.0	27.0	0.00	0.0	0
Ql	4	130.0	130.0	200.0	32.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.677

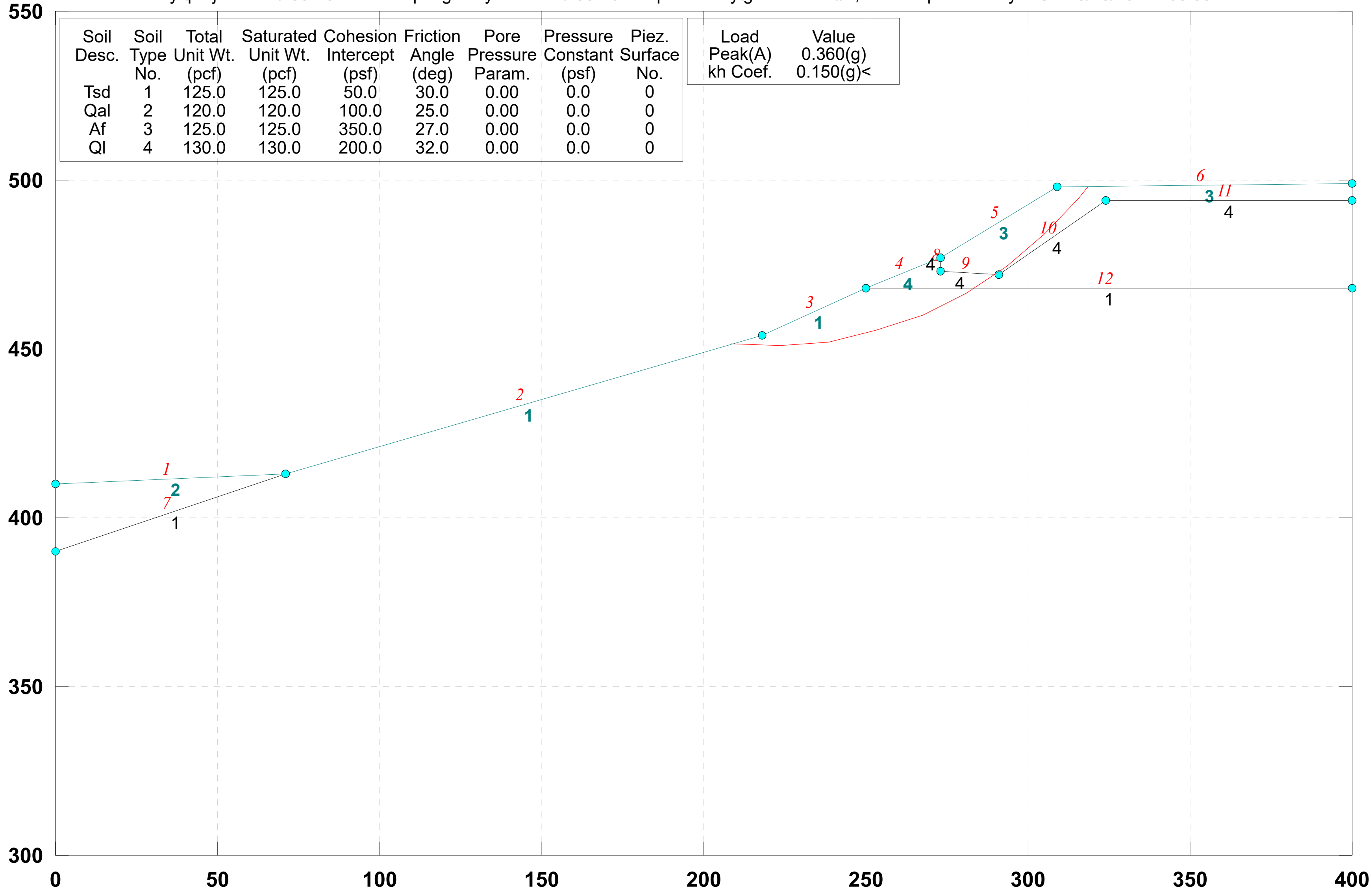
Safety Factors Are Calculated By The Modified Bishop Method

1304-04 -Otay Canyon Ranch-Section G-G' Fill over natural slope, Pseudostatic

y:\project files\1304-04 colrich spring canyon ranch\1304-04 slope stability\g-1 surface #1, seismic.plt   Run By: AGS   5/26/2017   03:53PM

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Tsd	1	125.0	125.0	50.0	30.0	0.00	0.0	0
Qal	2	120.0	120.0	100.0	25.0	0.00	0.0	0
Af	3	125.0	125.0	350.0	27.0	0.00	0.0	0
Ql	4	130.0	130.0	200.0	32.0	0.00	0.0	0

Load	Value
Peak(A)	0.360(g)
kh Coef.	0.150(g)<



GSTABL7 v.2 FSmin=1.204

Factor Of Safety Is Calculated By The Modified Bishop Method

1304-04 -Otay Canyon Ranch-Section H-H' Highest Fill Slope

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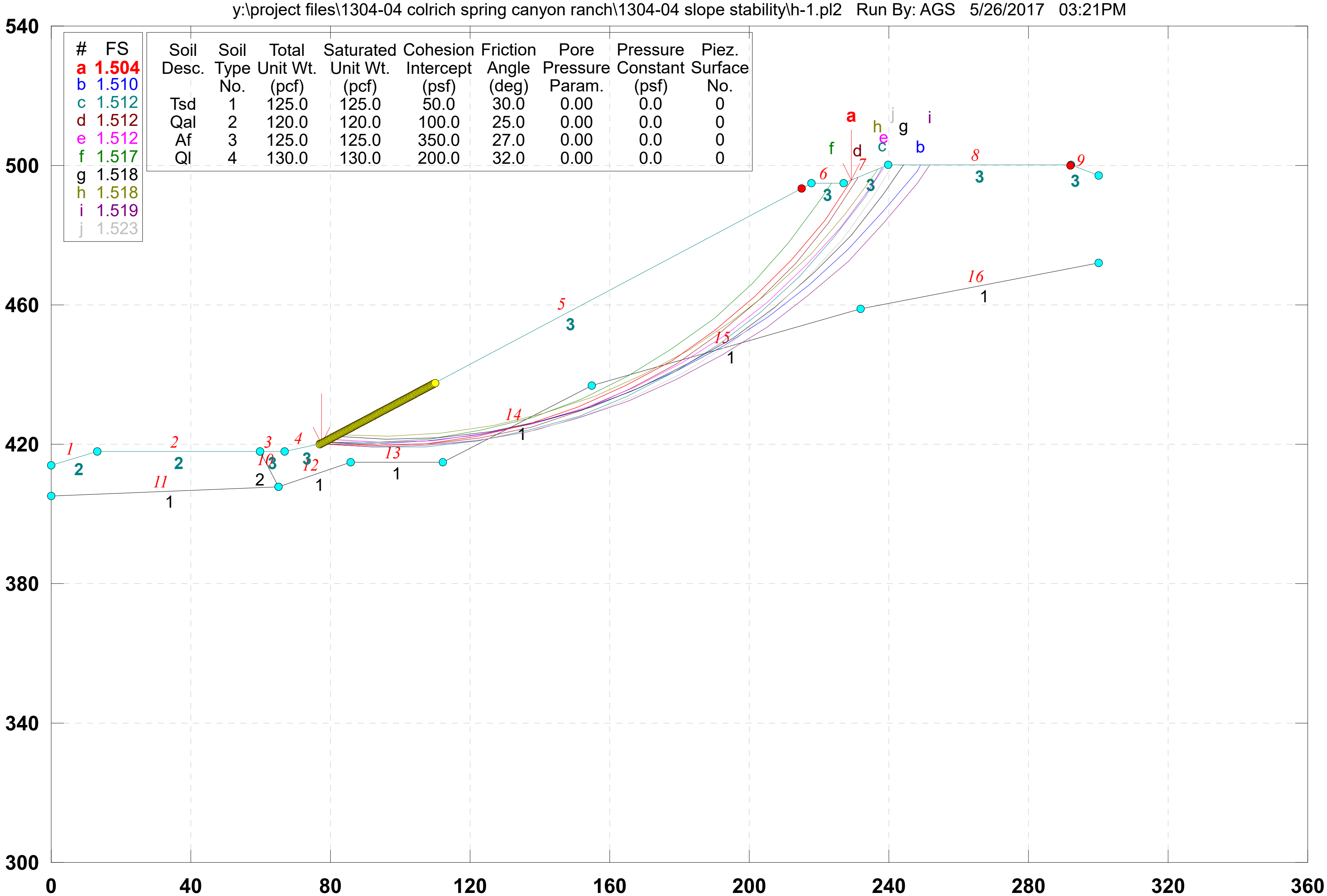

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Tsd	1	125.0	125.0	50.0	30.0	0.00	0.0	0
Qal	2	120.0	120.0	100.0	25.0	0.00	0.0	0
Af	3	125.0	125.0	350.0	27.0	0.00	0.0	0
Ql	4	130.0	130.0	200.0	32.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.504

Safety Factors Are Calculated By The Modified Bishop Method

1304-04 -Otay Canyon Ranch-Section H-H' Highest Fill Slope, Pseudostatic

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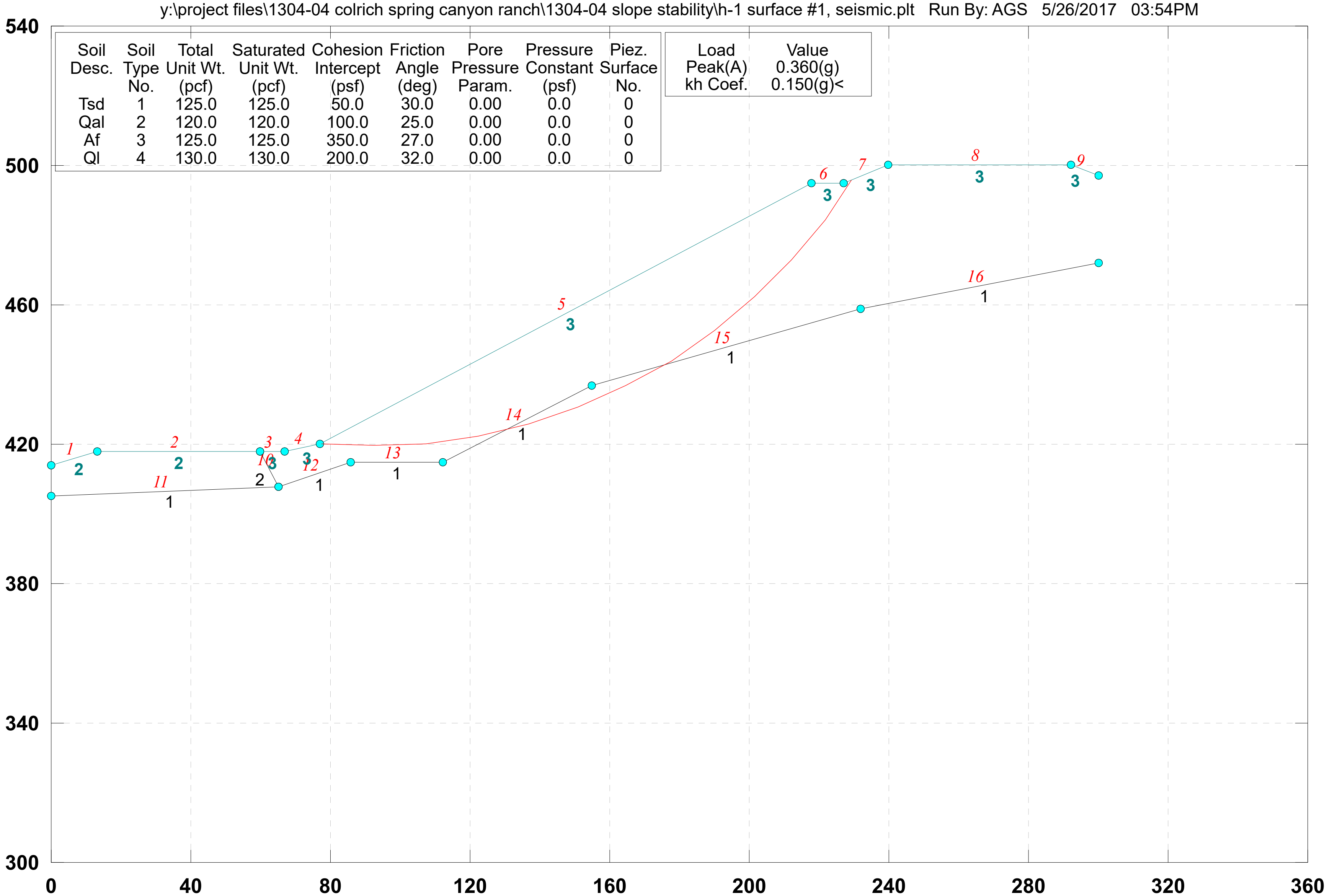


Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Tsd	1	125.0	125.0	50.0	30.0	0.00	0.0	0
Qal	2	120.0	120.0	100.0	25.0	0.00	0.0	0
Af	3	125.0	125.0	350.0	27.0	0.00	0.0	0
Ql	4	130.0	130.0	200.0	32.0	0.00	0.0	0

Load	Value
Peak(A)	0.360(g)
kh Coef.	0.150(g)<

GSTABL7 v.2 FSmin=1.111

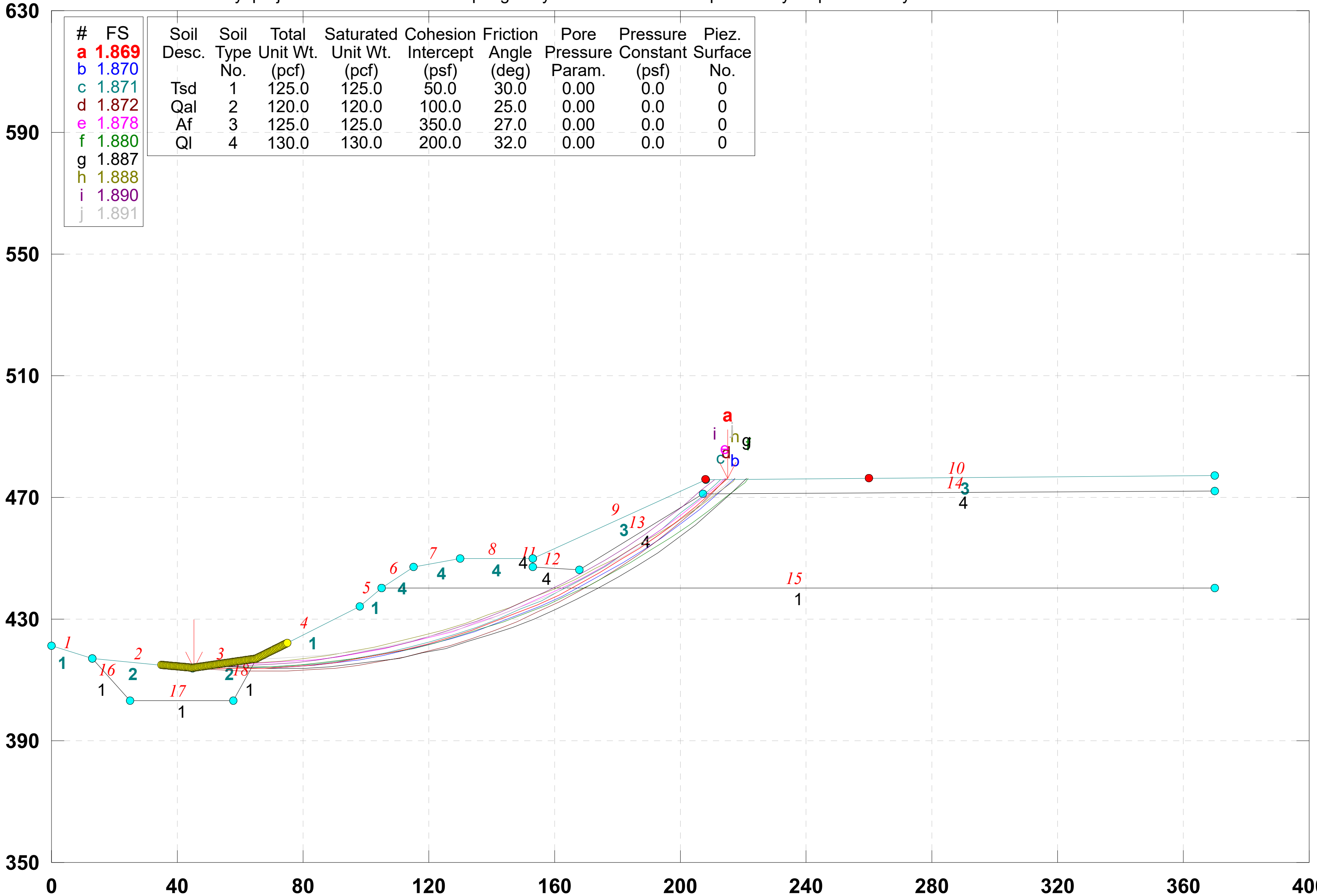
Factor Of Safety Is Calculated By The Modified Bishop Method

1304-04 -Otay Canyon Ranch- Section I-I'Fill over Cut over Natural

y:\project files\1304-04 colrich spring canyon ranch\1304-04 slope stability\i-1.pl2 Run By: AGS 5/26/2017 03:40PM

#	FS
a	1.869
b	1.870
c	1.871
d	1.872
e	1.878
f	1.880
g	1.887
h	1.888
i	1.890
j	1.891

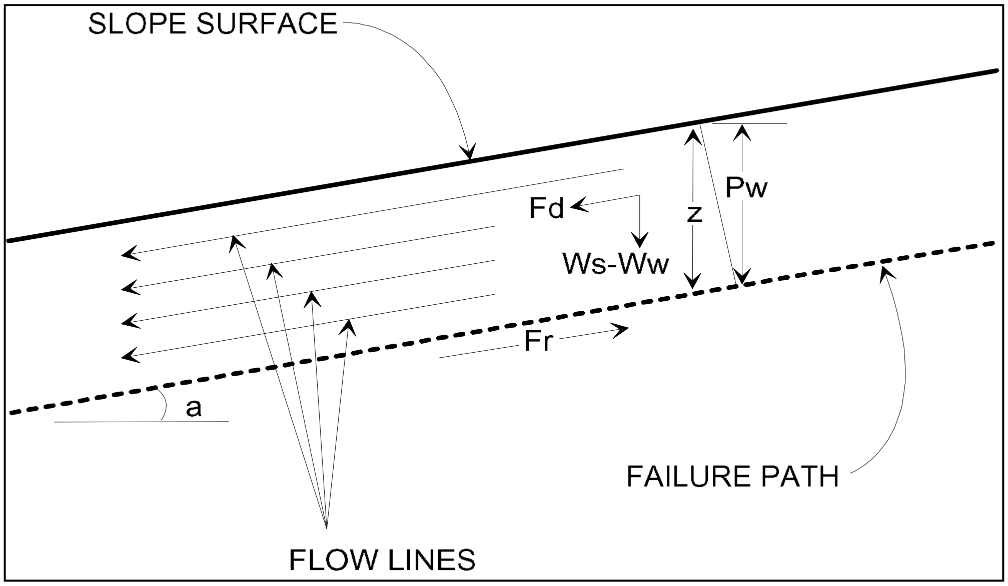
Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Tsd	1	125.0	125.0	50.0	30.0	0.00	0.0	0
Qal	2	120.0	120.0	100.0	25.0	0.00	0.0	0
Af	3	125.0	125.0	350.0	27.0	0.00	0.0	0
Ql	4	130.0	130.0	200.0	32.0	0.00	0.0	0



GSTABL7 v.2 FSmin=1.869

Safety Factors Are Calculated By The Modified Bishop Method

SURFICIAL STABILITY ANALYSIS



Assume: (1) Saturation To Slope Surface
(2) Sufficient Permeability To Establish Water Flow

Pw = Water Pressure Head=(z)(cos^2(a))
Ws = Saturated Soil Unit Weight
Ww = Unit Weight of Water (62.4 lb/cu.ft.)
u = Pore Water Pressure=(Ww)(z)(cos^2(a))
z = Layer Thickness
a = Angle of Slope
phi = Angle of Friction
c = Cohesion
Fd = (0.5)(z)(Ws)(sin(2a))
Fr = (z)(Ws-Ww)(cos^2(a))(tan(phi)) + c
Factor of Safety (FS) = Fr/Fd

2:1 COMPACTED FILL SLOPE

Given:

Ws (pcf)	z (ft)	a (degrees)	(radians)	phi (degrees)	(radians)	c (psf)
125	4	26.6	0.464258	27	0.471239	350

Calculations:

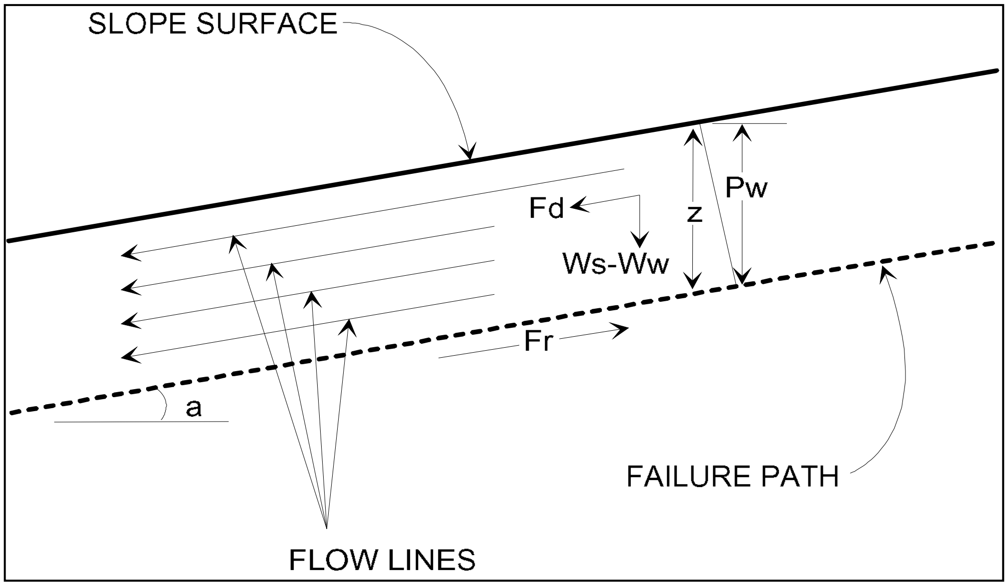
Pw	u	Fd	Fr	**FS**
3.20	199.56	200.18	452.01	**2.26**

Special Cases:

Saturated Sand: FS = (Ww/Ws)(tan(phi')/tan(a))
FS = 0.490615

Moist Clay FS = (c/Ws*z)(1/(cos^2(a)*tan(a))
FS = 1.748402

SURFICIAL STABILITY ANALYSIS



Assume: (1) Saturation To Slope Surface
(2) Sufficient Permeability To Establish Water Flow

Pw = Water Pressure Head=(z)(cos^2(a))
Ws = Saturated Soil Unit Weight
Ww = Unit Weight of Water (62.4 lb/cu.ft.)
u = Pore Water Pressure=(Ww)(z)(cos^2(a))
z = Layer Thickness
a = Angle of Slope
phi = Angle of Friction
c = Cohesion
Fd = (0.5)(z)(Ws)(sin(2a))
Fr = (z)(Ws-Ww)(cos^2(a))(tan(phi)) + c
Factor of Safety (FS) = Fr/Fd

2:1 CUT SLOPE IN LINDAVISTA

Given:

Ws	z	a		phi		c
(pcf)	(ft)	(degrees)	(radians)	(degrees)	(radians)	(psf)
130	4	26.6	0.464258	32	0.558505	200

Calculations:

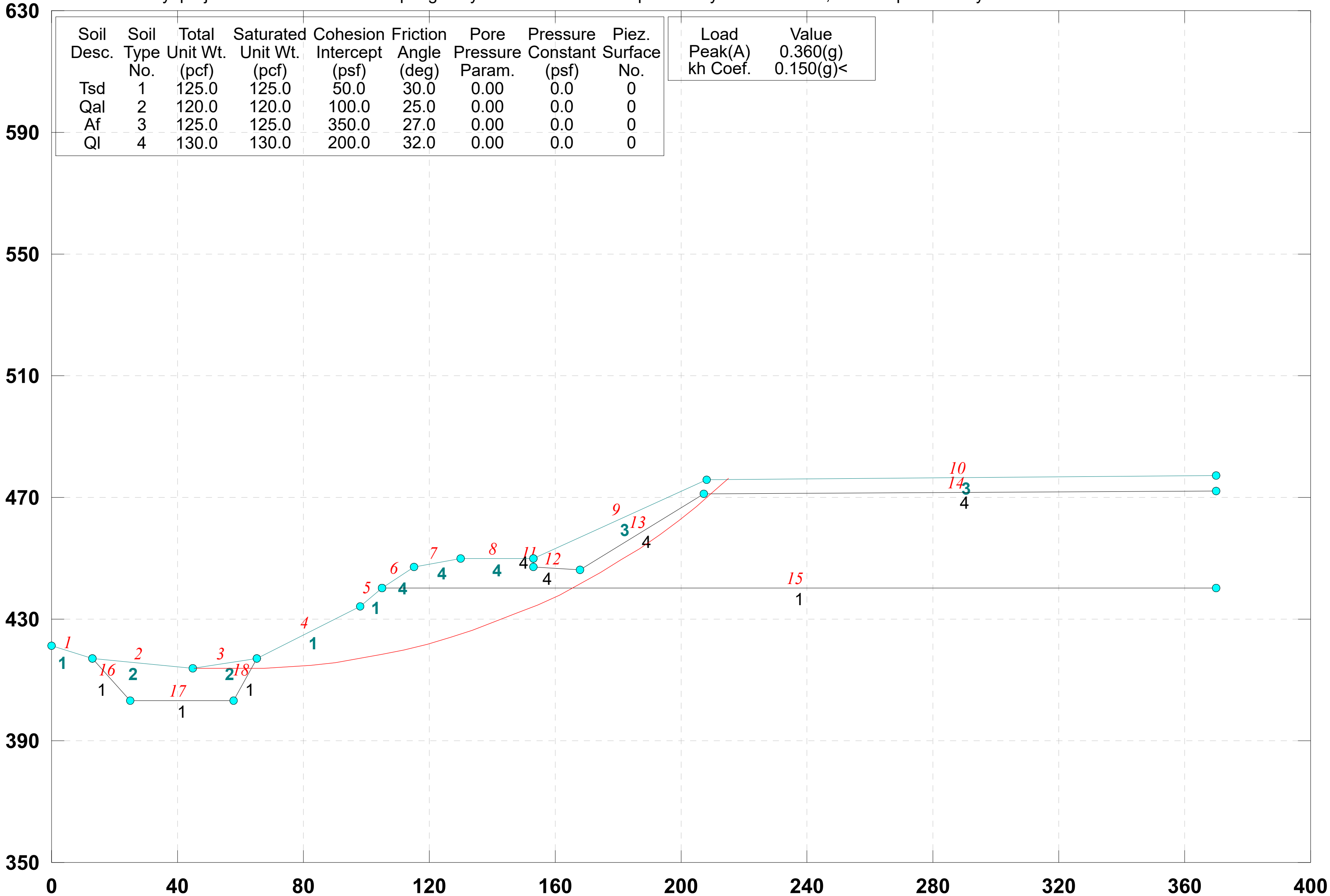
Pw	u	Fd	Fr	**FS**
3.20	199.56	208.19	335.09	**1.61**

Special Cases:

Saturated Sand: FS = (Ww/Ws)(tan(phi')/tan(a))
FS = 0.384666
Moist Clay FS = (c/Ws*z)(1/(cos^2(a)*tan(a))
FS = 0.96066

1304-04 -Otay Canyon Ranch- Section I-I'Fill over Cut over Natural,Pseudostatic

y:\project files\1304-04 colrich spring canyon ranch\1304-04 slope stability\i-1 surface #1, seismic.plt Run By: AGS 5/26/2017 03:55PM



GSTABL7 v.2 FSmin=1.276

Factor Of Safety Is Calculated By The Modified Bishop Method

APPENDIX E

INFILTRATION FEASIBILITY STUDY

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
485 Corporate Drive, Suite B
Escondido, CA 92029
Telephone: (619) 867-0487

ColRich
444 West Beech Street, Suite 300
San Diego, California 92101

May 26, 2017
P/W 1304-04
Report No. 1304-04-B-4

Attention: **Mr. Jason Shepard**

Subject: **Preliminary Infiltration Feasibility Study for Otay Canyon Ranch, Lumina Project, Otay Mesa Area, City of San Diego, California**

References: Attached

In accordance with your request, Advanced Geotechnical Solutions, Inc. (AGS) has prepared this Preliminary Infiltration Feasibility Study for Otay Canyon Ranch Project, Otay Mesa Area, City of San Diego, California. This report is intended to meet the preliminary infiltration testing requirements of the City of San Diego and provide an evaluation of the feasibility for storm water infiltration in accordance with the current Storm Water Standards – BMP Design Manual. A discussion of our field testing and findings are presented below. Worksheet Form C.4-1 and associated supporting worksheets and data are presented in Appendix 1.

Based on our review of the existing site conditions and proposed development, results of site specific subsurface exploration and infiltration testing, and our associated analyses it is our opinion that infiltration is feasible in portions of the site and not feasible in other portions of the site. Specifically, the northerly proposed basin should be designed for no infiltration and the southerly proposed basin can be designed for partial infiltration. In addition, use of smaller Low Impact Development (LID) infiltration devices or bioinfiltration type BMPs in interior portions of the site may be feasible provided adequate subsurface exploration and testing is performed at the proposed locations prior to approval or implementation.

1.0 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The irregular shaped site is comprised of 12 contiguous parcels located in the Otay Mesa area of San Diego, California. The overall site encompasses approximately 92 acres and is more specifically located westerly adjacent to Cactus Road and is bound to the north by Spring Canyon and an auto recycling facility, to the west by vacant land and a southwesterly-flowing drainage, and to the south a westerly flowing drainage and the future extension of Siempre Viva Road. In general, the site is relatively level to gently sloping except for two reentrant canyons on the northwest and southwest portions of the site. Elevations within the project limits range from elevation 404 msl (southwest corner) to 512 msl (northeast corner).

The southern portion of the site is currently occupied by an operational nursery which consists of an office building in the southeast corner; several barn, shed, and canopy type structures; and several growing areas. The remainder of the site is vacant land covered with a moderate growth of annual grasses and weeds with scattered trees adjacent to the canyons on the west and southern portions of the site. It appears that a portion of the site is currently being utilized for grazing.

At this time, AGS is unaware of specific septic system(s), water well(s) or utilities that may exist on the properties. However, it is likely that these improvements are onsite. If encountered, septic systems and water wells must be abandoned/mitigated in accordance with the specifications of the County of San Diego.

As depicted on the grading plan (Plates 1 through 3), the site will be graded into six (6) large sheet graded pads separated by interior roads. It is anticipated the pads will be developed to support multi-family and mixed-use residential structures. The overall project site is divided into two (2) drainage management areas (DMA), one for the northerly portion of the site and one for the southerly portion. A regional water quality basin is proposed for each DMA, one at the southeastern corner of the project and one in the northwestern portion.

2.0 SUBSURFACE EXPLORATION AND SITE GEOLOGY

As part of our infiltration feasibility study, seven (7) exploratory trenches were advanced with a rubber tire backhoe and logged at the site (PT-1 through PT-7). Prior to the infiltration study, several exploratory trenches were excavated, sampled, and logged as part of due diligence studies for individual parcels within the overall project site (AGS, 2013 & 2015). In addition, six separate limited geotechnical studies were performed by Geocon (Geocon, 2003 to 2005) for properties within the overall project site. In general, these studies consisted of limited mapping and the excavation, logging and sampling of a total of 21 backhoe test pits ranging from a few feet deep to a maximum depth of 16 feet.

The site is underlain to the depths explored by localized undocumented fill, alluvium, Lindavista Formation (terrace deposits) and San Diego Formation. Beneath the explored depths it is anticipated that Otay Formation unconformably underlies San Diego Formation. The approximate limits of these units are shown on the Plates 1 through 3.

2.1. Undocumented Artificial Fill (Map Symbol afu)

Undocumented artificial fill was encountered in the southern, western, and northern portions of the site. The more extensive undocumented fills appear to be related to previous canyon in-fills near the western and southern site boundaries. Some of the fill is also related to the backfill of former reservoir locations. The fill primarily consists of silty to clayey sands to sandy clay that are dry to moist, and very loose to moderately dense. Generally, colors vary from brown to reddish brown. The fill contains some gravel and cobbles, organic debris, trash and construction debris (e.g. concrete pieces). During the recent site subsurface investigation for this study the maximum depth of undocumented fill encountered was approximately nine (9) feet. Previously it was encountered to a depth of 13 feet. Based upon our observations isolated areas of undocumented fill could be as deep as 20 to 30 feet.

2.2. Topsoil (No Map Symbol)

A relatively thin veneer of topsoil blankets most of the upper mesa portion of the site. It typically consists of medium to dark brown sandy clay to clayey sand in a dry to slightly moist and loose condition. The topsoil commonly contains roots. During the recent site subsurface investigation the maximum depth of topsoil encountered ranged from 1 to 4 feet.

2.3. Alluvium (Map Symbol Qal)

Alluvial soils are present in the bottoms of the drainages onsite. The alluvium consists of brown, sandy to silty clay that is slightly moist to moist and loose. Occasional cobbles and small boulders were encountered. During previous subsurface investigations the depth of alluvium encountered ranged from 3 to 8 feet. Based upon our observations isolated areas of alluvium could be as deep as 12 to 15 feet.

2.4. Lindavista Formation (Map Symbol Ql)

Quaternary aged Lindavista Formation (Todd, 2004) caps most of the mesa portion of the site. This unit is commonly referred to as Terraced Deposits due to its depositional environment and has also been mapped as Very Old Alluvial Deposits (Tan and Kennedy, 2002) and Very Old Paralic Deposits (Kennedy and Tan, 2005). The Lindavista Formation generally ranges in color from brown to reddish brown to orange brown. As encountered during our recent explorations and previous subsurface investigations by Geocon, the Lindavista Formation varies from silty to sandy clay that is slightly moist to moist and firm to stiff to well graded sand with silt, gravel, and cobble that is slightly moist and moderately dense to dense.

2.5. San Diego Formation (Map Symbol Tsd)

It is anticipated that a majority of the site is underlain at depth by Pliocene aged San Diego Formation and is exposed beneath the Lindavista Formation in the lower portions of the onsite canyon walls. As encountered, the San Diego Formation generally consists of light gray to light olive brown silty fine-grained sandstone and clayey to sandy siltstone that is moderately hard to hard.

2.6. Otay Formation (Map Symbol To)

Although not encountered in our subsurface excavations, Oligocene aged Otay Formation unconformably underlies San Diego Formation and is exposed extensively in the project vicinity. The City of San Diego Seismic Safety Study (Grid Tile 3) identifies the lower portion of Spring Canyon on the north side of the project site as 'Slide-Prone Formations – Otay, Sweetwater, and others.'

3.0 TESTING METHODS AND PROCEDURES

To evaluate feasibility for infiltration of the proposed onsite water quality basins and to provide preliminary design infiltration rates, five (5) borehole percolation tests were performed in general conformance with Appendix D, Section D.3.3.2 of the current BMP Design Manual. One to two test borings were excavated in each basin location, with test locations chosen where the formational units were anticipated to be exposed nearer to the surface.

To provide representative continuous soil/geologic logs for the percolation test holes, the percolation test borings were continuously logged during excavation. Locations of the percolation test holes are shown on Plates 1 through 3, included herewith.

The percolation boreholes (P-1 through P-5) were excavated with a 6-inch diameter auger mounted to a CAT 420F rubber tire backhoe and extended to depths ranging from 36-inches to 72-inches below ground surface. Borings P-1 through P-3 extended through undocumented artificial fill to Lindavista Formation (terrace deposits) and boreholes P-4 and P-5 extended into artificial fill.

The resulting test holes were cleaned of loose debris then successively filled with several gallons of clean, potable water and allowed to pre-soak overnight. The following day the test holes were cleaned of sediment and the bottom was lined with approximately 2-inches of washed gravel prior to percolation testing. A series of falling head percolation tests were performed. The test holes were filled with clean, potable water to approximately 24 to 30 inches above infiltration surface and allowed to infiltrate. The water level was allowed to drop for a 30-minute period, the water level was then measured and the drop rate calculated in inches per hour. The test hole was then refilled with water as necessary and the test procedure was repeated over the course of 6 hours until a stabilized percolation rate was recorded. The stabilized percolation rate was then converted to an infiltration rate based on the "Porchet Method"

$$I_t = \frac{\Delta H \, \pi r^2 \, 60}{\Delta t(\pi r^2 + 2\pi r H_{avg})} = \frac{\Delta H \, 60 \, r}{\Delta t(r + 2H_{avg})}$$

Where:

I_t = tested infiltration rate, inches/hour
ΔH = change in head over the time interval, inches
Δt = time interval, minutes
$^*r$ = effective radius of test hole
H_{avg} = average head over the time interval, inches

utilizing the following equation:

Logs of the field testing and graphical representations of the test data presented as infiltration rate versus time interval are included in Appendix 2 as supporting documents for Worksheet C.4-1.

4.0 TEST RESULTS AND PRELIMINARY DESIGN VALUES

The results of our testing are summarized in Table 1 below.

TABLE 1 **SUMMARY OF INFILTRATION/PERCOLATION TEST RESULTS**					
Test Hole No.	Depth of Test Hole	Approximate Test Elevation	Geologic Unit	Description	Tested Infiltration Rate (inches/hour)
P-1	4’	485 msl	Ql	Cobbley Sand	0.73
P-2	5’	490 msl	Ql	Clayey Sand with Cobbles	0.77
P-3	6’	490 msl	Ql	Clayey Sand with Cobbles	0.40
P-4	4’	467 msl	afu	Clayey Sand with Cobbles	0.44
P-5	3’	467 msl	afu	Clay	0.17

In accordance with Appendix D, Section D.5. of the BMP Design Manual, a ‘Factor of Safety’ should be applied to the tested infiltration rates to determine the design infiltration rates. The factor of safety is determined by Worksheet D.5-1 and possesses a numerical value between 2 and 9. For the proposed project site, the factor of safety worksheet yielded a Combined Factor of Safety (S_{total}) of 4.5. However, for the purposes of feasibility screening, it is recommended that a Factor of Safety of 2.0 be utilized. Table 2 below summarizes the preliminary design infiltration rates for the subject test holes utilizing a factor of safety of 2.0.

TABLE 2 **SUMMARY OF PRELIMINARY DESIGN INFILTRATION RATES**			
Test Hole No.	Tested Infiltration Rate (in./hr.)	Factor of Safety	Preliminary Design Infiltration Rate (in./hr.)
P-1	0.73	2.0	**0.36**
P-2	0.77	2.0	**0.38**
P-3	0.40	2.0	**0.20**
P-4	0.44	2.0	**0.22**
P-5	0.17	2.0	**0.08**

5.0 DESIGN CONSIDERATIONS

5.1. Groundwater

No shallow groundwater was observed in the test borings nor in the test pits excavated onsite. Groundwater is anticipated to be on the order of 200 feet below ground surface and it is our opinion that the seasonal high groundwater elevation is greater than ten feet below the base of the proposed basin.

5.2. Geotechnical Hazards

5.2.1. Settlement and Volume Change

As currently proposed, the project will be sheet graded with cuts and fills generally on the order of 5 to 10 feet. Deeper fills up to 70 feet are proposed within onsite canyons and in areas of more extensive remedial grading where canyons and land depressions have been previously filled. The northerly proposed basin is partially situated over an area of deep fill. The anticipated fill depths beneath the westerly portion of the proposed basin are on the order 10 to 30 feet. Infiltration in deep fills is not recommended due to the increased potential for settlement. It may be possible to import or manufacture select permeable soils to be utilized beneath the basin as a ‘conduit’ to the native infiltration surface at depth; however, this option is highly cost prohibitive and not considered a reasonable mitigation.

Highly to critically expansive soils were encountered onsite during subsurface explorations by both Geocon and AGS, and are common within the project vicinity. Laboratory testing indicates the clay soils onsite typically have Expansion Indices (EI) greater than 90 (highly expansive) and locally greater than 130 (critically expansive). Expansive clays are capable of significant volume increases when exposed to water and can lead to heaving of overlying soils, structures, and other improvements. Infiltration BMPs should be avoided in areas where expansive soils will exist beneath or adjacent to the BMP. At a minimum, a 10-foot thick section of low expansive soils should overlay the underlying expansive soils in areas of proposed infiltration BMPs. Dependent upon the degree of expansion potential and the thickness of the expansive soil unit, the thickness of the low expansive soil cap may need to be increased to provide adequate confining pressure to mitigate the potential for heaving. Due to the broad distribution of expansive soils at the project site, it is recommended that the final locations of proposed infiltration BMPs be drilled and evaluated by the geotechnical consultant prior to approval or construction.

5.2.2. Slope Stability

Steep (>25 percent) natural slopes flank the north side of the site. After development, graded fill slopes and fill over natural slopes will be present in close proximity to the proposed northern basin. In addition the lower portion of the natural slope in the northerly portion of the site is identified as a ‘Slide-Prone Formation – Otay, Sweetwater, and others’ in the City of San Diego Seismic Safety Study. Infiltrating into more permeable fill over less permeable formational materials acts to concentrate subsurface water along that fill-bedrock contact rather than infiltrating vertically. Where slopes are subjacent to basins, there is a risk for infiltration of storm water to result in daylight seepage on slope faces and destabilization of slopes. If infiltration is permitted, there is a potential for water seepage and slope failure. For the proposed development, infiltration type BMPs should be set back from the top of slope a minimum distance of 1.5H, where H is the total slope height. If storm water BMPs cannot be located outside the recommended set back due to civil design constraints, the BMPs should be fully lined.

5.3. Soil and Groundwater Contamination

The project site has been the subject of several environmental assessments since 2004 and was enrolled in the San Diego County Department of Environmental Health Voluntary Action Program in 2014. In 2015 SCS Engineers prepared a Phase II Soil Sampling report that identified the presence of organochlorine pesticide (OCP) impacted soils as well as other soil contaminants of concern and general non-hazardous refuse. In 2017, C Young Associates prepared a Soil Management Plan (SMP) that addresses the removal and onsite placement (burial) of OCP impacted soils. The plan for the re-use of OCP impacted soils onsite includes their placement in ‘deep’ fill areas (greater than 10 feet below finish pad elevations). Specific areas identified in the SMP include the northwesterly portion of the site partially beneath the northerly proposed BMP basin and easterly adjacent to the basin. In consideration of the close proximity of the basin to contaminated soils, it is strongly recommended that active or passive infiltration in this basin not be allowed as it would likely contribute to the movement or dispersion of contaminants. If the proposed northerly BMP basin cannot be relocated due to civil design constraints, the BMP should be fully lined.

5.4. Pretreatment Prior to Infiltration

Details of the proposed BMP basins were not available for review at the time of this report; however it is anticipated that basins will have a filter course/choking layer above the infiltration surface.

5.5. Soil Characteristics and Anticipated Flow Paths

After the proposed grading is completed, the infiltration surfaces are anticipated be in compacted fill overlying Lindavista Formation. As encountered, the Lindavista Formation can generally be described as varying from silty to sandy clay, in a slightly moist to moist, and firm to stiff condition to well graded sand with silt, gravel, and cobbles in a slightly moist and moderately dense to dense condition. Infiltration rates within the Lindavista Formation are low. It is anticipated that the majority of stormwater will hit this contact and develop strong lateral flow rather than infiltrating vertically. This is of particular concern for the northerly proposed basin in consideration of its proximity to an approximately 90-foot high, steep (>25 percent) descending slope.

5.6. Proximity to Water Supply Wells

No water supply wells are known to exist within 100 feet of the proposed basins.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our preliminary infiltration testing, the onsite soils possess infiltration rates ranging between 0.17 and 0.77 inches/hour with preliminary design infiltration rates ranging between 0.08 and 0.38, utilizing a factor of safety of 2. The infiltration rates for the project site are low and full infiltration at the project site is not feasible. The preliminary infiltration rates do indicate that partial infiltration is feasible. Based on our feasibility evaluation, use of infiltration type BMPs in the southerly portion of the site as currently proposed is feasible. In addition, use of localized LID or proprietary infiltration devices or small bioinfiltration BMPs, such as modular wetlands, within the interior portion of the site is also considered feasible for the proposed development. However, the hazards associated with infiltrating stormwater in the northerly basin as currently planned cannot be reasonably mitigated and should be avoided.

Dependent upon the final type, size, and location of proposed BMPs, additional investigation and testing may be warranted.

Advanced Geotechnical Solutions, Inc. appreciates the opportunity to provide you with geotechnical consulting services and professional opinions. If you have any questions, please contact the undersigned at (619) 867-0487.

Respectfully Submitted,
Advanced Geotechnical Solutions, Inc.

Prepared by:

SHANE P. SMITH
Staff Engineer

Reviewed by:

JOHN J. DONOVAN
RCE 65051, RGE 2790, Reg. Exp. 6-30-17

PAUL J. DERISI, Vice President
CEG 2536, Reg. Exp. 5-31-17

REGISTERED PROFESSIONAL ENGINEER JOHN J. DONOVAN GE 2790 GEOTECHNICAL STATE OF CALIFORNIA

PROFESSIONAL GEOLOGIST PAUL J. DERISI No. 2536 CERTIFIED ENGINEERING GEOLOGIST STATE OF CALIFORNIA

Distribution: (6) Addressee

Attachments: Appendix 1- References
Appendix 2- Storm Water Standards BMP Design Manual - Worksheet Form C-4.1, Support Documents and Field Data
Appendix 3- Subsurface Logs
Enclosure: Plates 1-3

APPENDIX 1

References

Advanced Geotechnical Solutions, Inc. (2013). "Geotechnical/Geologic Due Diligence Evaluation of Otay Canyon Ranch Project, Otay Mesa Area, City of San Diego, California," dated May 24, 2013, Report No. 1304-04-B-2.

---. (2015a). "Geotechnical/Geologic Due Diligence Evaluation of 'Jabir' Property, Otay Canyon Ranch, Cactus Road, Otay Mesa, City of San Diego, California," dated March 12, 2015, Report No. 1501-09-B-2.

---. (2015b). "Geotechnical/Geologic Due Diligence Evaluation of "Watson" Property, Otay Canyon Ranch, Cactus Road, Otay Mesa, City of San Diego, California," dated April 16, 2015, Report No. 1504-01-B-2.

Geocon, Inc. (2003a). "Preliminary Geotechnical Investigation, Centex South Otay – Kuta Property, San Diego, California," dated January 28, 2003.

---. (2003b). "Preliminary Geotechnical Investigation, Centex South Otay Mesa Property, San Diego, California," dated September 9, 2003

---. (2004). "Preliminary Geotechnical Investigation, Centex South Otay Mesa – Mascari Property, San Diego, California," dated January 28, 2004.

---. (2005a). "Soil and Geologic Reconnaissance, Blalock Property, San Diego, California," dated February 17, 2005.

---. (2005b). "Soil and Geologic Reconnaissance, Watson Property, San Diego, California," dated February 17, 2005.

---. (2005c). "Preliminary Geotechnical Investigation, Spring Canyon Ranch – Watson Parcel F, San Diego, California," dated August 29, 2005.

Kennedy, M.P. and Tan, S.S. (2008). *Geologic Map of the San Diego 30' x 60' Quadrangle, California*, California Geological Survey, Regional Geologic Map, Scale 1:100,000

Todd, V.R. (2004). *Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle*, USGS OFR 2004-1361.

APPENDIX 2

STORM WATER STANDARDS BMP DESIGN MANUAL – WORKSHEET FORM C-4.1

SUPPORT DOCUMENTS AND FIELD DATA

<table>
<tr><th colspan="2">Categorization of Infiltration Feasibility Condition</th><th colspan="2">Worksheet C.4-1</th></tr>
<tr><td colspan="4"><u>Part 1 - Full Infiltration Feasibility Screening Criteria</u>
Would infiltration of the full design volume be feasible from a physical perspective without any undesirable consequences that cannot be reasonably mitigated?</td></tr>
<tr><td>Criteria</td><td>Screening Question</td><td>Yes</td><td>No</td></tr>
<tr><td>1</td><td>Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.</td><td>☐</td><td>☒</td></tr>
<tr><td colspan="4">Provide basis:
Five (5) borehole percolation tests were performed. Three tests were performed in proximity to the proposed BMP basin located in the northerly portion of the site and two tests were performed in proximity to the proposed basin in the southerly portion of the site. Testing was performed in general conformance with Appendix D, Section D.3.3.2 of the 2016 BMP Design Manual. The stabilized percolation rates were then converted to infiltration rates based on the “Porchet Method”. Using a factor of safety of 2 for feasibility screening purposes, the infiltration rates in the northerly portion of the site ranged between 0.20 and 0.38 inches/hour, and between 0.08 and 0.22 in the southerly portion of the site, all of which are less than 0.5 inches/hour. A more detailed discussion of the testing and findings are presented the referenced Preliminary Infiltration Feasibility Study for Otay Canyon Ranch, Lumina Project, Otay Mesa Area, City of San Diego, California, Report No. 1304-04-B-4, dated May 26, 2017.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</td></tr>
<tr><td>2</td><td>Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.</td><td>☐</td><td>☒</td></tr>
<tr><td colspan="4">Provide basis:
Tested infiltration rates at the project site are less than 0.5 inches/hour. Infiltration at a rate greater than 0.5 inches/hour is not feasible for this project. As such, this screening question does not control the feasibility of infiltration at the project site and is not applicable.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</td></tr>
</table>

<table>
<tr><th colspan="4">Worksheet C.4-1 Page 2 of 4</th></tr>
<tr><td>Criteria</td><td>Screening Question</td><td>Yes</td><td>No</td></tr>
<tr><td>3</td><td>Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, storm water pollutants or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td>☐</td><td>☒</td></tr>
<tr><td colspan="4">Provide basis:
Tested infiltration rates at the project site are less than 0.5 inches/hour. Infiltration at a rate greater than 0.5 inches/hour is not feasible for this project. As such, this screening question does not control the feasibility of infiltration at the project site and is not applicable.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</td></tr>
<tr><td>4</td><td>Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td>☐</td><td>☒</td></tr>
<tr><td colspan="4">Provide basis:
The tested infiltration rates at the project site are less than 0.5 inches/hour. Infiltration at a rate greater than 0.5 inches/hour is not feasible for this project. As such, this screening question does not control the feasibility of infiltration at the project site. Per Section C.4.4 of the BMP Design Manual, final determination should be made by the project design engineer.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</td></tr>
<tr><td>Part 1 Result*</td><td colspan="2">If all answers to rows 1-4 are “Yes” a full infiltration design is potentially feasible. The feasibility screening category is Full Infiltration

If any answer from row 1-4 is “No”, infiltration may be possible to some extent but would not generally be feasible or desirable to achieve a “full infiltration” design. Proceed to Part 2</td><td></td></tr>
</table>

**To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by the City Engineer to substantiate findings*

<table>
<tr><th colspan="4">Worksheet C.4-1 Page 3 of 4</th></tr>
<tr><td colspan="4"><u>Part 2 – Partial Infiltration vs. No Infiltration Feasibility Screening Criteria</u>
Would infiltration of water in any appreciable amount be physically feasible without any negative consequences that cannot be reasonably mitigated?</td></tr>
<tr><td>Criteria</td><td>Screening Question</td><td>Yes</td><td>No</td></tr>
<tr><td>5</td><td>Do soil and geologic conditions allow for infiltration in any appreciable rate or volume? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.</td><td>☒</td><td>☐</td></tr>
<tr><td colspan="4">Provide basis:
As discussed in the referenced infiltration feasibility report and the response to Criteria 1, the infiltration rates in the northerly portion of the site ranged between 0.20 and 0.38 inches/hour, and between 0.08 and 0.22 in the southerly portion of the site when utilizing a Factor of Safety of 2. In accordance with the current interpretation of ‘appreciable rate or volume’, these rates are considered to be adequate to establish a ‘Partial Infiltration’ designation.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.</td></tr>
<tr><td>6</td><td>Can Infiltration in any appreciable quantity be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.</td><td>☒</td><td>☐</td></tr>
<tr><td colspan="4">Provide basis:
As discussed in the referenced Preliminary Infiltration Feasibility Study, partial infiltration in the proposed BMP basin in the southerly portion is feasible without increasing the risk of geotechnical hazards that cannot be mitigated to an acceptable level.

The proposed basin in the northerly portion of the site is currently planned across an area of deep fill, in close proximity to a steep descending slope, and in an area of highly to critically expansive soils. As such, there is a high likelihood that geotechnical issues related soil settlement, slope destabilization, and soil swelling/heave will occur. It is our opinion that these issues would have detrimental effects on future improvements and that they cannot be reasonably mitigated. It is recommended that the northerly basin as currently proposed be fully encapsulated with an impermeable liner.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.</td></tr>
</table>

<table>
<tr><th colspan="4">Worksheet C.4-1 Page 4 of 4</th></tr>
<tr><td>Criteria</td><td>Screening Question</td><td>Yes</td><td>No</td></tr>
<tr><td>7</td><td>Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, storm water pollutants or other factors)? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td>☒</td><td>☐</td></tr>
<tr><td colspan="4">Provide basis:
The project site has been the subject of several environmental assessments since 2004 and was enrolled in the San Diego County Department of Environmental Health (SDCDEH) Voluntary Action Program in 2014 (Case #DEH2014-LSAM-000254). In 2015 SCS Engineers prepared a Phase II Soil Sampling report that identified the presence of organochlorine pesticide (OCP) impacted soils as well as other soil contaminants of concern and general non-hazardous refuse. In 2017, C Young Associates prepared a Soil Management Plan (SMP) that addresses the removal and onsite placement (burial) of OCP impacted soils. The plan for the re-use of OCP impacted soils onsite includes their placement in ‘deep’ fill areas (greater than 10 feet below finish pad elevations). The SMP was approved by SDCDEH on May 23, 2017. Specific areas identified in the SMP include the northwesterly portion of the site partially beneath the northerly proposed BMP basin and easterly subjacent to the basin. In consideration of the close proximity of the basin to contaminated soils, it is strongly recommended that active or passive infiltration in this basin not be allowed as it would likely contribute to the movement or dispersion of contaminants. We recommend the basin be encapsulated with an impermeable liner as currently proposed. The southerly basin should not be impacted and partial infiltration is feasible.
Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.</td></tr>
<tr><td>8</td><td>Can infiltration be allowed without violating downstream water rights? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td>☒</td><td>☐</td></tr>
<tr><td colspan="4">Provide basis:
We do not anticipate that construction of the proposed BMP basins will violate downstream water rights. Per Section C.4.4 of the BMP Design Manual, final determination should be made by the project design engineer.
Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.</td></tr>
<tr><td>Part 2 Result*</td><td colspan="2">If all answers from row 5-8 are “Yes”, then partial infiltration design is potentially feasible. The feasibility screening category is Partial Infiltration.
If any answer from row 5-8 is “No”, then infiltration of any volume is considered to be infeasible within the drainage area. The feasibility screening category is No Infiltration.</td><td></td></tr>
</table>

**To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by the City Engineer to substantiate findings*

PERCOLATION TEST DATA SHEET

Project:	Otay Cyn. Ranch	Project No.:	1304-04	Date:	10/13/2016
Test Hole No.:	P-1	Tested By:	SS	Water Temp.:	68
Depth of Test Hole:	48	USCS:	SC	Air Temp.:	75

Test Hole Dimensions (Inches)

Length	48	Width	6	Diameter	6

Infiltration Test

Trial No.	Start Time (hr and min)	Stop Time (hr and min)	Time Interval (min.)	(Pieziometric Surface in inches) Start Depth	End Depth	Depth Change	Average Water Column	Perc Rate (in./hr.)	Infiltration Rate* (in./hr.)
1	9:43	10:14	31	26.34	33.03	6.69	29.69	12.95	0.623
2	10:15	10:47	32	25.94	32.63	6.69	29.29	12.54	0.611
3	10:46	11:34	48	24.76	34.21	9.45	29.49	11.81	0.572
4	11:35	12:07	32	23.58	33.03	9.45	28.31	17.72	0.892
5	12:10	12:40	30	21.22	32.64	11.42	26.93	22.84	1.205
6	12:42	13:16	34	22.80	33.04	10.24	27.92	18.07	0.921
7	13:18	13:49	31	25.16	32.64	7.48	28.90	14.48	0.714
8	13:51	14:25	34	25.16	32.64	7.48	28.90	13.20	0.651
9	14:26	14:56	30	25.16	32.64	7.48	28.90	14.96	0.738
10	14:57	15:27	30	25.16	32.64	7.48	28.90	14.96	0.738
11	15:28	15:58	30	25.16	32.64	7.48	28.90	14.96	0.738
12	15:59	16:29	30	25.16	32.64	7.48	28.90	14.96	0.738
13									
14									
15									

*Calculated via Porchet Method

PERCOLATION TEST DATA SHEET

Project: Otay Cyn. Ranch   Project No.: 1304-04   Date: 10/13/2016

Test Hole No.: P-2   Tested By: SS   Water Temp.: 68

Depth of Test Hole: 72   USCS: Air Temp.: 75

Test Hole Dimensions (Inches)

Length 72   Width 6   Diameter 6

Infiltration Test

Trial No.	Start Time (hr and min)	Stop Time (hr and min)	Time Interval (min.)	(Piezometric Surface in inches) Start Depth	End Depth	Depth Change	Average Water Column	Perc Rate (in./hr.)	Infiltration Rate* (in./hr.)
1	9:34	11:27	113	25.00	36.02	11.02	30.51	5.85	0.274
2	11:31	12:01	30	23.50	32.16	8.66	27.83	17.32	0.886
3	12:03	12:34	31	22.50	31.16	8.66	26.83	16.76	0.887
4	12:37	13:11	34	21.25	31.88	10.63	26.57	18.76	1.003
5	13:13	13:43	30	20.50	28.37	7.87	24.44	15.74	0.910
6	13:45	14:15	30	22.50	29.98	7.48	26.24	14.96	0.809
7	14:18	14:48	30	22.25	29.73	7.48	25.99	14.96	0.816
8	14:49	15:19	30	22.00	29.48	7.48	25.74	14.96	0.824
9	15:20	15:50	30	24.25	31.67	7.42	27.96	14.84	0.756
10	15:51	16:21	30	24.00	31.42	7.42	27.71	14.84	0.762
11	16:22	16:52	30	23.75	31.17	7.42	27.46	14.84	0.769
12	16:53	17:23	30	23.50	30.92	7.42	27.21	14.84	0.775
13									
14									
15									

*Calculated via Porchet Method

PERCOLATION TEST DATA SHEET

Project: Otay Cyn. Ranch | Project No.: 1304-04 | Date: 10/13/2016

Test Hole No.: P-3 | Tested By: SS | Water Temp.: 68

Depth of Test Hole: 72 | USCS: | Air Temp.: 75

Test Hole Dimensions (Inches)

Length 72 | Width 6 | Diameter 6

Infiltration Test

Trial No.	Start Time (hr and min)	Stop Time (hr and min)	Time Interval (min.)	Start Depth (Piezometric Surface in inches)	End Depth (Piezometric Surface in inches)	Depth Change (Piezometric Surface in inches)	Average Water Column	Perc Rate (in./hr.)	Infiltration Rate* (in./hr.)
1	9:27	10:02	35	28.50	33.62	5.12	31.06	8.78	0.404
2	10:03	10:34	31	28.00	32.33	4.33	30.17	8.38	0.397
3	10:35	11:24	49	27.63	32.35	4.72	29.99	5.78	0.275
4	11:25	11:56	31	27.25	31.58	4.33	29.42	8.38	0.407
5	11:58	12:29	31	27.25	31.57	4.32	29.41	8.36	0.406
6	12:33	13:08	35	27.13	31.98	4.85	29.56	8.31	0.402
7	13:10	13:40	30	27.22	31.52	4.30	29.37	8.60	0.418
8	13:41	14:12	31	27.18	31.33	4.15	29.26	8.03	0.392
9	14:13	14:43	30	27.23	31.38	4.15	29.31	8.30	0.404
10	14:44	15:14	30	27.32	31.47	4.15	29.40	8.30	0.403
11	15:15	15:45	30	27.41	31.56	4.15	29.49	8.30	0.402
12	15:46	16:16	30	27.15	31.30	4.15	29.23	8.30	0.405
13									
14									
15									

*Calculated via Porchet Method

PERCOLATION TEST DATA SHEET

Project: Otay Cyn. Ranch | Project No.: 1304-04 | Date: 10/13/2016

Test Hole No.: P-4 | Tested By: SS | Water Temp.: 68

Depth of Test Hole: 48 | USCS: | Air Temp.: 75

Test Hole Dimensions (Inches)

Length 48 | Width 6 | Diameter 6

Infiltration Test

Trial No.	Start Time	Stop Time	Time Interval	(Piezometric Surface in inches)			Average	Perc Rate	Infiltration Rate*
	(hr and min)	(hr and min)	(min.)	Start Depth	End Depth	Depth Change	Water Column	(in./hr.)	(in./hr.)
1	9:17	9:55	38	33.46	39.37	5.91	36.42	9.32	0.369
2	9:57	10:27	30	33.07	38.98	5.91	36.02	11.81	0.472
3	10:28	10:59	31	32.28	38.19	5.91	35.24	11.43	0.467
4	11:02	11:49	47	32.68	40.55	7.87	36.61	10.05	0.396
5	11:52	12:22	30	31.65	37.80	6.14	34.72	12.29	0.509
6	12:23	12:53	30	33.46	38.19	4.72	35.83	9.45	0.380
7	12:54	13:27	33	32.68	38.19	5.51	35.43	10.02	0.407
8	13:30	14:03	33	33.07	38.58	5.51	35.83	10.02	0.403
9	14:05	14:35	30	33.07	38.58	5.51	35.83	11.02	0.443
10	14:35	15:05	30	33.07	38.58	5.51	35.83	11.02	0.443
11	15:06	15:36	30	33.07	38.58	5.51	35.83	11.02	0.443
12	15:37	16:07	30	33.07	38.58	5.51	35.83	11.02	0.443
13									
14									
15									

*Calculated via Porchet Method

PERCOLATION TEST DATA SHEET

Project:	Otay Cyn. Ranch	Project No.:	1304-04	Date:	10/13/2016
Test Hole No.:	P-5	Tested By:	SS	Water Temp.:	68
Depth of Test Hole:	36	USCS:		Air Temp.:	75

Test Hole Dimensions (Inches)

Length	36	Width	6	Diameter	6

Infiltration Test

Trial No.	Start Time	Stop Time	Time Interval	(Pieziometric Surface in inches)			Average	Perc Rate	Infiltration Rate*
	(hr and min)	(hr and min)	(min.)	Start Depth	End Depth	Depth Change	Water Column	(in./hr.)	(in./hr.)
1	9:12	9:50	38	25.20	29.13	3.94	27.17	6.22	0.325
2	9:52	10:23	31	25.20	27.56	2.36	26.38	4.57	0.246
3	10:23	10:53	30	25.59	26.77	1.18	26.18	2.36	0.128
4	10:54	11:45	51	25.59	28.74	3.15	27.17	3.71	0.194
5	11:47	12:15	28	25.59	26.77	1.18	26.18	2.53	0.137
6	12:16	12:48	32	25.59	26.77	1.18	26.18	2.21	0.120
7	12:51	13:24	33	25.20	26.77	1.57	25.98	2.86	0.156
8	13:26	13:58	32	25.20	26.77	1.57	25.98	2.95	0.161
9	14:01	14:31	30	25.20	26.77	1.57	25.98	3.15	0.172
10	14:32	15:02	30	25.20	26.77	1.57	25.98	3.15	0.172
11	15:03	15:33	30	25.20	26.77	1.57	25.98	3.15	0.172
12	15:34	16:04	30	25.20	26.77	1.57	25.98	3.15	0.172
13									
14									
15									

*Calculated via Porchet Method

APPENDIX 3

BACKHOE TEST PITS (PT-1 THROUGH PT-7, AGS 2016)

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-1*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Saturation (percent)	Laboratory Testing: Others
				Artificial Fill, Undocumented:				
			SP	At 0-1.0 feet, Cobbley Sand with Silt, fine to coarse grained brown to gray brown, dry, losse to moderately dense				
			SC	At 1.0 feet, Clayey Sand with Cobble, fine to coarse grained, olive brown to dark brown with iron oxide, slightly moist, medium dense to dense; sub angular to sub rounded,				
				Lindavista Formation:				
5			SP	At 3.0 feet, Cobbley Sand with Silt Trace Clay, fine to coarse grained, olive brown to dark brown with iron oxied, slightly moist medium dense to dense; prodominately 6 inch minus with occassional plus 6-12 inch cobble At 6.0 feet, Gravely Sand with Cobble trace Clay, fine to coarse grianed, light orange brown to light brown, moist, dense				
10				At 12.0 feet, Gravely Clayey Sand with Cobble, fine to coarse grained, light orange brown to light brown, moist to wet, medium dense to dense				
15				Total Depth = 13.5 No Water Encountered No Caving				

LEGEND

Sample Type:	R --- Drive Sample		B --- Bulk Sample	--Water Table
Laboratory Testing:	AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
	SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-2*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SP	**Artificial Fill, Undocumented:** 0-2.0 feet, Gravely Clayey Sand with Cobbles, fine to coarse grained, brown to dark brown, slightly moist, dense				
			SP	**Lindavista Formation:** At 2.0 feet, Gravely Clayey Sand to Silty Sand with Cobbles, fine to coarse grained, orange brown to light brown, moist, moderately dense				
5								
				At 7.0 feet, Gravely Sand with Cobbles trace Clay, fine to coarse grained, orange brown to light brown, moist, moderately dense				
10								
				At 11.0 feet, Cemented Gravely Sand with Cobbles trace clay, fine to coarse grained, orange brown to light brown, moist, medium dense				
				At 13.0 feet, Clayey Sand with Cobbles, fine to coarse grained orange brown to light brown, moist to wet, moderately dense				
				Total Depth = 14.0 feet No Water Encountered No Caving				
15								

LEGEND

Sample Type:	R --- Drive Sample	B --- Bulk Sample	--Water Table	
Laboratory Testing:	AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
	SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Test Pit *PT-3*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SC	**Artificial Fill, Undocumented:** 0-2.0 feet, Clayey Sand with Cobbles, fine to coarse grained brown to dark brown, slightly moist, dense				
			SC	**Lindavista Formation:** At 2.0 feet, Clayey Sand to Silty Sand with Cobbles, fine to coarse grained, orange brown to light brown, slightly moist to moist, dense; cemented sand				
5			SP	At 5.5 feet, Gravely Sand with Cobbles, fine to coarse grained, light brown, slightly moist to moist, dense to very dense; calcium carbonate on fracture surfaces				
				Refusal at 6.5 feet No Water Encountered No Caving				
10								
15								

LEGEND

Sample Type: R --- Drive Sample; B --- Bulk Sample; --Water Table

Laboratory Testing:
AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis
SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.: 1304-04
PROJECT NAME: Otay Canyon Ranch
CLIENT: Colrich
LOCATION: Chula Vista

LOGGED BY: S.S.
EQUIPMENT: CAT 420F
DATE: 10/11/2016

Test Pit *PT-4*

Depth (ft)	Sample Type*	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SC	**Artificial Fill, Undocumented:** At 0-0.5 feet, Clayey Sand with Cobbles, fine to coarse grained brown to dark brown, slightly moist, dense				
			CL	At 0.5-4.0 feet, Clay, fine grained, brown to dark brown, moist, stiff				
5			CL	At 4.0 feet, Sandy Clay with Cobbles, fine to coarse grianed brown, moist, stiff; calcium carbonate on fracture surfaces				
			SC	**Lindavista Formation:** At 5.5 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, moist, medium dense to dense; calcium carbonate on fracture surfaces At 8.0 feet, Clayey Sand with Cobbles, fine to coarse grianed, orange brown to brown, moist, dense to very dense				
10								
				Refusal at 11.5 feet No Water Encountered No Caving				
15								

LEGEND

Sample Type: R --- Drive Sample; B --- Bulk Sample; --Water Table

Laboratory Testing:
AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis
SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/11/2016
LOCATION:	Chula Vista		

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	Test Pit *PT-5* — MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			SC	**Artificial Fill, Undocumented:** At 0-1.0 feet, Clayey Sand with Cobbles, fine to coarse grained brown, dry to slightly moist, medium dense				
			SC	**Lindavista Formation:** At 1.0 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, slightly moist, medium dense At 3.0 feet, Clayey Sand with Cobbles, fine to coarse grained, orange brown to brown, slightly moist, dense				
5								
			CL	At 6.0 feet, Clay with Cobbles, fine grained, light brown to gray brown, moist, very stiff				
				Refusal at 9.5 feet No Water Encountered No Caving				
10								
15								

LEGEND

Sample Type:	R --- Drive Sample	B --- Bulk Sample	--Water Table	
Laboratory Testing:	AL = Atterberg Limits	EI = Expansion Index	MD = Maximum Density	SA = Sieve Analysis
	SR = Sulfate/Resistivity Test	DS = Shear Testing	RV = R-Value Test	CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/12/2016
LOCATION:	Chula Vista		

Test Pit *PT-6*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
				<u>Artificial Fill, Undocumented:</u>				
			CL	At 0-2.5 feet, Sandy Clay with Gravel, fine to coarse grained, gray brown to dark brown, moist, firm; 5-10% 1 inch gravel				
			SC	At 2.5 feet, Clayey Sand with Cobbles, fine to coarse grained, brown to red brown, moist, medium dense				
				At 4.-0 feet Construction Debris, concrete, asphalt, metal stapping, trash				
5								
10				Refusal at 9.5 feet No Water Encountered No Caving				
15								

LEGEND

<u>Sample Type:</u> R --- Drive Sample B --- Bulk Sample --Water Table

<u>Laboratory Testing:</u> AL = Atterberg Limits EI = Expansion Index MD = Maximum Density SA = Sieve Analysis
SR = Sulfate/Resistivity Test DS = Shear Testing RV = R-Value Test CO = Consolidation

ADVANCED GEOTECHNICAL SOLUTIONS, INC.
LOG OF EXPLORATORY TEST PIT

P/W NO.:	1304-04	**LOGGED BY:**	S.S.
PROJECT NAME:	Otay Canyon Ranch	**EQUIPMENT:**	CAT 420F
CLIENT:	Colrich	**DATE:**	10/12/2016
LOCATION:	Chula Vista		

Test Pit *PT-7*

Depth (ft)	SAMPLES: Sample Type*	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Saturation (percent)	Others
			CL	**Artificial Fill, Undocumented:** At 0-3.0 feet, Sandy Clay, fine to coarse grained, gray brown to reddish brown, moist, firm				
5			CL	At 3.0 feet, Clay, fine grained, light green to gray, moist to wet, firm				
10								
			SC	**Lindavista Formation:** At 12.0 feet, Clayey Sand with Cobbles, fine to coarse grained gray to light gray with orange brown, moist to wet, moderately dense; sub-rounded				
15				Refusal at 13.0 feet No Water Encountered No Caving				

LEGEND

Sample Type: R --- Drive Sample; B --- Bulk Sample; --Water Table

Laboratory Testing: AL = Atterberg Limits; EI = Expansion Index; MD = Maximum Density; SA = Sieve Analysis; SR = Sulfate/Resistivity Test; DS = Shear Testing; RV = R-Value Test; CO = Consolidation

APPENDIX F

EARTHWORK SPECIFICATIONS

AND

GRADING DETAILS

GENERAL EARTHWORK SPECIFICATIONS

I. General

A. General procedures and requirements for earthwork and grading are presented herein. The earthwork and grading recommendations provided in the geotechnical report are considered part of these specifications, and where the general specifications provided herein conflict with those provided in the geotechnical report, the recommendations in the geotechnical report shall govern. Recommendations provided herein and in the geotechnical report may need to be modified depending on the conditions encountered during grading.

B. The contractor is responsible for the satisfactory completion of all earthwork in accordance with the project plans, specifications, applicable building codes, and local governing agency requirements. Where these requirements conflict, the stricter requirements shall govern.

C. It is the contractor's responsibility to read and understand the guidelines presented herein and in the geotechnical report as well as the project plans and specifications. Information presented in the geotechnical report is subject to verification during grading. The information presented on the exploration logs depicts conditions at the particular time of excavation and at the location of the excavation. Subsurface conditions present at other locations may differ, and the passage of time may result in different subsurface conditions being encountered at the locations of the exploratory excavations. The contractor shall perform an independent investigation and evaluate the nature of the surface and subsurface conditions to be encountered and the procedures and equipment to be used in performing his work.

D. The contractor shall have the responsibility to provide adequate equipment and procedures to accomplish the earthwork in accordance with applicable requirements. When the quality of work is less than that required, the Geotechnical Consultant may reject the work and may recommend that the operations be suspended until the conditions are corrected.

E. Prior to the start of grading, a qualified Geotechnical Consultant should be employed to observe grading procedures and provide testing of the fills for conformance with the project specifications, approved grading plan, and guidelines presented herein. All remedial removals, clean-outs, removal bottoms, keyways, and subdrain installations should be observed and documented by the Geotechnical Consultant prior to placing fill. It is the contractor's responsibility to apprise the Geotechnical Consultant of their schedules and notify the Geotechnical Consultant when those areas are ready for observation.

F. The contractor is responsible for providing a safe environment for the Geotechnical Consultant to observe grading and conduct tests.

II. Site Preparation

A. Clearing and Grubbing: Excessive vegetation and other deleterious material shall be sufficiently removed as required by the Geotechnical Consultant, and such materials shall be properly disposed of offsite in a method acceptable to the owner and governing agencies. Where applicable, the contractor may obtain permission from the Geotechnical Consultant, owner, and governing agencies to dispose of vegetation and other deleterious materials in designated areas onsite.

B. Unsuitable Soils Removals: Earth materials that are deemed unsuitable for the support of fill shall be removed as necessary to the satisfaction of the Geotechnical Consultant.

C. Any underground structures such as cesspools, cisterns, mining shafts, tunnels, septic tanks, wells, pipelines, other utilities, or other structures located within the limits of grading shall be removed and/or abandoned in accordance with the requirements of the governing agency and to the satisfaction of the Geotechnical Consultant.

D. Preparation of Areas to Receive Fill: After removals are completed, the exposed surfaces shall be scarified to a depth of approximately 8 inches, watered or dried, as needed, to achieve a generally uniform moisture content that is at or near optimum moisture content. The scarified materials shall then be compacted to the project requirements and tested as specified.

E. All areas receiving fill shall be observed and approved by the Geotechnical Consultant prior to the placement of fill. A licensed surveyor shall provide survey control for determining elevations of processed areas and keyways.

III. Placement of Fill

A. Suitability of fill materials: Any materials, derived onsite or imported, may be utilized as fill provided that the materials have been determined to be suitable by the Geotechnical Consultant. Such materials shall be essentially free of organic matter and other deleterious materials, and be of a gradation, expansion potential, and/or strength that is acceptable to the Geotechnical Consultant. Fill materials shall be tested in a laboratory approved by the Geotechnical Consultant, and import materials shall be tested and approved prior to being imported.

B. Generally, different fill materials shall be thoroughly mixed to provide a relatively uniform blend of materials and prevent abrupt changes in material type. Fill materials derived from benching should be dispersed throughout the fill area instead of placing the materials within only an equipment-width from the cut/fill contact.

C. Oversize Materials: Rocks greater than 8 inches in largest dimension shall be disposed of offsite or be placed in accordance with the recommendations by the Geotechnical Consultant in the areas that are designated as suitable for oversize rock placement. Rocks that are smaller than 8 inches in largest dimension may be utilized in the fill provided that they are not nested and are their quantity and distribution are acceptable to the Geotechnical Consultant.

D. The fill materials shall be placed in thin, horizontal layers such that, when compacted, shall not exceed 6 inches. Each layer shall be spread evenly and shall be thoroughly mixed to obtain near uniform moisture content and uniform blend of materials.

E. Moisture Content: Fill materials shall be placed at or above the optimum moisture content or as recommended by the geotechnical report. Where the moisture content of the engineered fill is less than recommended, water shall be added, and the fill materials shall be blended so that near uniform moisture content is achieved. If the moisture content is above the limits specified by the Geotechnical Consultant, the fill materials shall be aerated by discing, blading, or other methods until the moisture content is acceptable.

F. Each layer of fill shall be compacted to the project standards in accordance to the project specifications and recommendations of the Geotechnical Consultant. Unless otherwise specified by the Geotechnical Consultant, the fill shall be compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM Test Method: D1557-09.

G. Benching: Where placing fill on a slope exceeding a ratio of 5 to 1 (horizontal to vertical), the ground should be keyed or benched. The keyways and benches shall extend through all unsuitable materials into suitable materials such as firm materials or sound bedrock or as recommended by the Geotechnical Consultant. The minimum keyway width shall be 15 feet and extend into suitable materials, or as recommended by the geotechnical report and approved by the Geotechnical Consultant. The minimum keyway width for fill over cut slopes is also 15 feet, or as recommended by the geotechnical report and approved by the Geotechnical Consultant. As a general rule, unless otherwise recommended by the Geotechnical Consultant, the minimum width of the keyway shall be equal to 1/2 the height of the fill slope.

H. Slope Face: The specified minimum relative compaction shall be maintained out to the finish face of fill and stabilization fill slopes. Generally, this may be achieved by overbuilding the slope and cutting back to the compacted core. The actual amount of overbuilding may vary as field conditions dictate. Alternately, this may be achieved by back rolling the slope face with suitable equipment or other methods that produce the designated result. Loose soil should not be allowed to build up on the slope face. If present, loose soils shall be trimmed to expose the compacted slope face.

I. Slope Ratio: Unless otherwise approved by the Geotechnical Consultant and governing agencies, permanent fill slopes shall be designed and constructed no steeper than 2 to 1 (horizontal to vertical).

J. Natural Ground and Cut Areas: Design grades that are in natural ground or in cuts should be evaluated by the Geotechnical Consultant to determine whether scarification and processing of the ground and/or overexcavation is needed.

K. Fill materials shall not be placed, spread, or compacted during unfavorable weather conditions. When grading is interrupted by rain, filing operations shall not resume until the Geotechnical Consultant approves the moisture and density of the previously placed compacted fill.

IV. Cut Slopes

A. The Geotechnical Consultant shall inspect all cut slopes, including fill over cut slopes, and shall be notified by the contractor when cut slopes are started.

B. If adverse or potentially adverse conditions are encountered during grading; the Geotechnical Consultant shall investigate, evaluate, and make recommendations to mitigate the adverse conditions.

C. Unless otherwise stated in the geotechnical report, cut slopes shall not be excavated higher or steeper than the requirements of the local governing agencies. Short-term stability of the cut slopes and other excavations is the contractor's responsibility.

V. Drainage

A. Back drains and Subdrains: Back drains and subdrains shall be provided in fill as recommended by the Geotechnical Consultant and shall be constructed in accordance with the governing agency and/or recommendations of the Geotechnical Consultant. The location of subdrains, especially outlets, shall be surveyed and recorded by the Civil Engineer.

B. Top-of-slope Drainage: Positive drainage shall be established away from the top of slope. Site drainage shall not be permitted to flow over the tops of slopes.

C. Drainage terraces shall be constructed in compliance with the governing agency requirements and/or in accordance with the recommendations of the Geotechnical Consultant.

D. Non-erodible interceptor swales shall be placed at the top of cut slopes that face the same direction as the prevailing drainage.

VI. Erosion Control

A. All finish cut and fill slopes shall be protected from erosion and/or planted in accordance with the project specifications and/or landscape architect's recommendations. Such measures to protect the slope face shall be undertaken as soon as practical after completion of grading.

B. During construction, the contractor shall maintain proper drainage and prevent the ponding of water. The contractor shall take remedial measures to prevent the erosion of graded areas until permanent drainage and erosion control measures have been installed.

VII. Trench Excavation and Backfill

A. Safety: The contractor shall follow all OSHA requirements for safety of trench excavations. Knowing and following these requirements is the contractor's responsibility. All trench excavations or open cuts in excess of 5 feet in depth shall be shored or laid back. Trench excavations and open cuts exposing adverse geologic conditions may require further evaluation by the Geotechnical Consultant. If a contractor fails to provide safe access for compaction testing, backfill not tested due to safety concerns may be subject to removal.

B. Bedding: Bedding materials shall be non-expansive and have a Sand Equivalent greater than 30. Where permitted by the Geotechnical Consultant, the bedding materials can be densified by jetting.

C. Backfill: Jetting of backfill materials is generally not acceptable. Where permitted by the Geotechnical Consultant, the bedding materials can be densified by jetting provided the backfill materials are granular, free-draining and have a Sand Equivalent greater than 30.

VIII. Geotechnical Observation and Testing During Grading

A. Compaction Testing: Fill shall be tested by the Geotechnical Consultant for evaluation of general compliance with the recommended compaction and moisture conditions. The tests shall be taken in the compacted soils beneath the surface if the surficial materials are disturbed. The contractor shall assist the Geotechnical Consultant by excavating suitable test pits for testing of compacted fill.

B. Where tests indicate that the density of a layer of fill is less than required, or the moisture content not within specifications, the Geotechnical Consultant shall notify the contractor of the unsatisfactory conditions of the fill. The portions of the fill that are not within specifications shall be reworked until the required density and/or moisture content has been attained. No additional fill shall be placed until the last lift of fill is tested and found to meet the project specifications and approved by the Geotechnical Consultant.

C. If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as adverse weather, excessive rock or deleterious materials being placed in the fill, insufficient equipment, excessive rate of fill placement, results in a quality of work that is unacceptable, the consultant shall notify the contractor, and the contractor shall rectify the conditions, and if necessary, stop work until conditions are satisfactory.

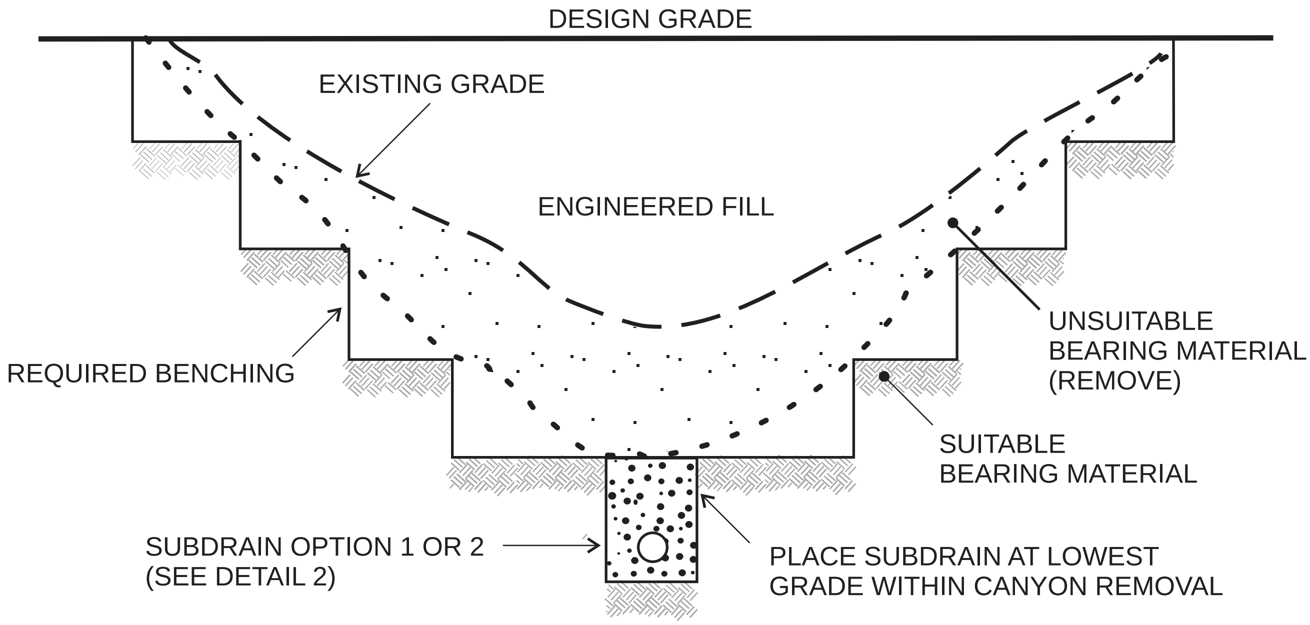
D. Frequency of Compaction Testing: The location and frequency of tests shall be at the Geotechnical Consultant's discretion. Generally, compaction tests shall be taken at intervals not exceeding two feet in fill height and 1,000 cubic yards of fill materials placed.

E. Compaction Test Locations: The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of the compaction test locations. The contractor shall coordinate with the surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations. Alternately, the test locations can be surveyed and the results provided to the Geotechnical Consultant.

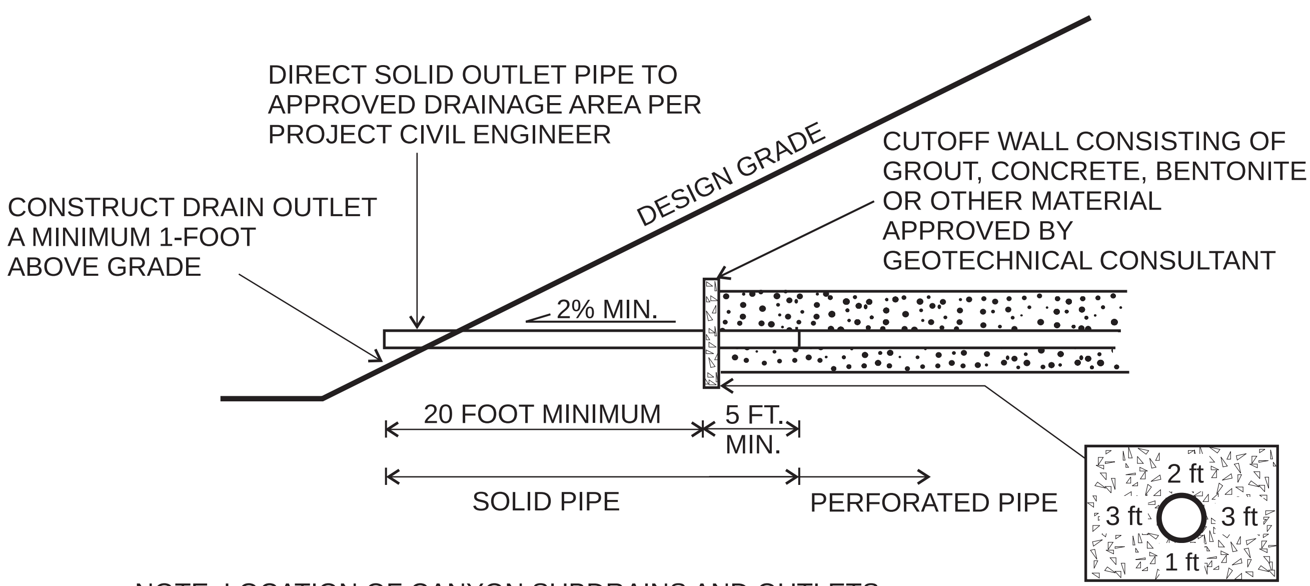
F. Areas of fill that have not been observed or tested by the Geotechnical Consultant may have to be removed and recompacted at the contractor's expense. The depth and extent of removals will be determined by the Geotechnical Consultant.

G. Observation and testing by the Geotechnical Consultant shall be conducted during grading in order for the Geotechnical Consultant to state that, in his opinion, grading has been completed in accordance with the approved geotechnical report and project specifications.

H. Reporting of Test Results: After completion of grading operations, the Geotechnical Consultant shall submit reports documenting their observations during construction and test results. These reports may be subject to review by the local governing agencies.



CANYON SUBDRAIN PROFILE



NOTE: LOCATION OF CANYON SUBDRAINS AND OUTLETS SHOULD BE DOCUMENTED BY PROJECT CIVIL ENGINEER. OUTLETS MUST BE KEPT UNOBSTRUCTED AT ALL TIMES.

CUTOFF WALL DIMENSIONS

CANYON SUBDRAIN TERMINUS

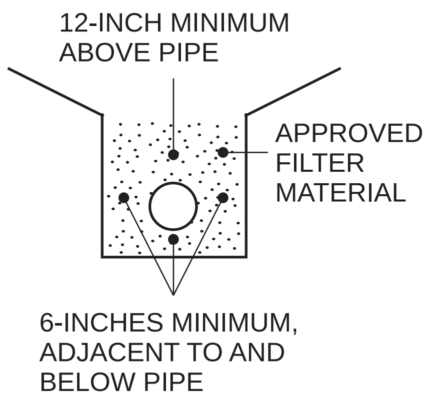
VER 1.0

NTS

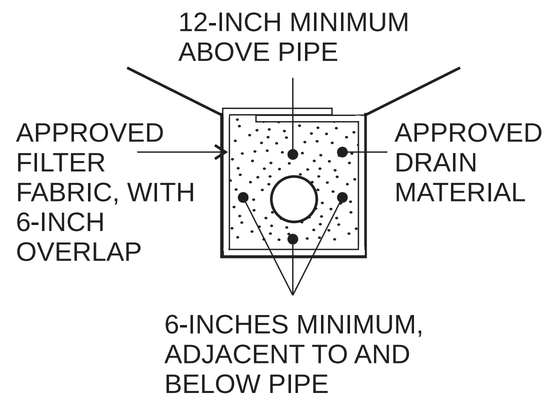
ADVANCED GEOTECHNICAL SOLUTIONS

CANYON SUBDRAIN

DETAIL 1



OPTION 1



OPTION 2

FILTER MATERIAL: MINIMUM VOLUME OF 9 CUBIC FEET PER LINEAL FOOT OF CALTRANS CLASS 2 PERMEABLE MATERIAL

DRAIN MATERIAL: MINIMUM VOLUME OF 9 CUBIC FEET PER LINEAL FOOT OF 3/4-INCH MAX ROCK OR APPROVED EQUIVALENT SUBSTITUTE

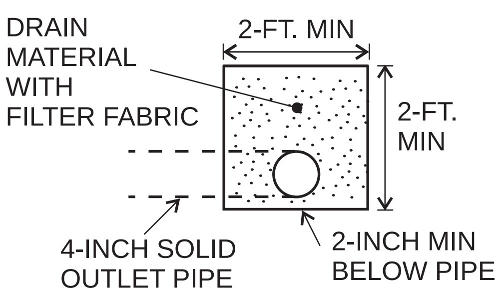
FILTER FABRIC: MIRAFI 140 FILTER FABRIC OR APPROVED EQUIVALENT SUBSTITUTE

PIPE: 6 OR 8-INCH ABS OR PVC PIPE OR APPROVED SUBSTITUTE WITH A MINIMUM OF 8 PERFORATIONS (1/4-INCH DIAMETER) PER LINEAL FOOT IN BOTTOM HALF OF PIPE

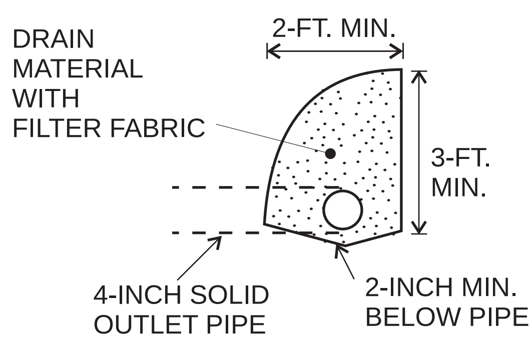
(ASTM D2751, SDR-35 OR ASTM D3034, SDR-35
ASTM D1527, SCHD. 40 OR ASTM D1785, SCHD. 40)

NOTE: CONTINUOUS RUN IN EXCESS OF 5OO FEET REQUIRES 8-INCH DIAMETER PIPE (ASTM D3034, SDR-35, OR ASTM D1785, SCHD. 40)

CANYON SUBDRAIN



OPTION 1



OPTION 2

DRAIN MATERIAL: GRAVEL TRENCH TO BE FILLED WITH 3/4-INCH MAX ROCK OR APPROVED EQUIVALENT SUBSTITUTE

FILTER FABRIC: MIRAFI 140 FILTER FABRIC OR EQUIVALENT SUBSTITUTE WITH A MINIMUM 6-INCH OVERLAP

PIPE: 4-INCH ABS OR PVC PIPE OR APPROVED EQUIVALENT SUBSTITUTE WITH A MINIMUM OF 8 PERFORATIONS (1/4-INCH DIAMETER) PER LINEAL FOOT IN BOTTOM HALF OF PIPE

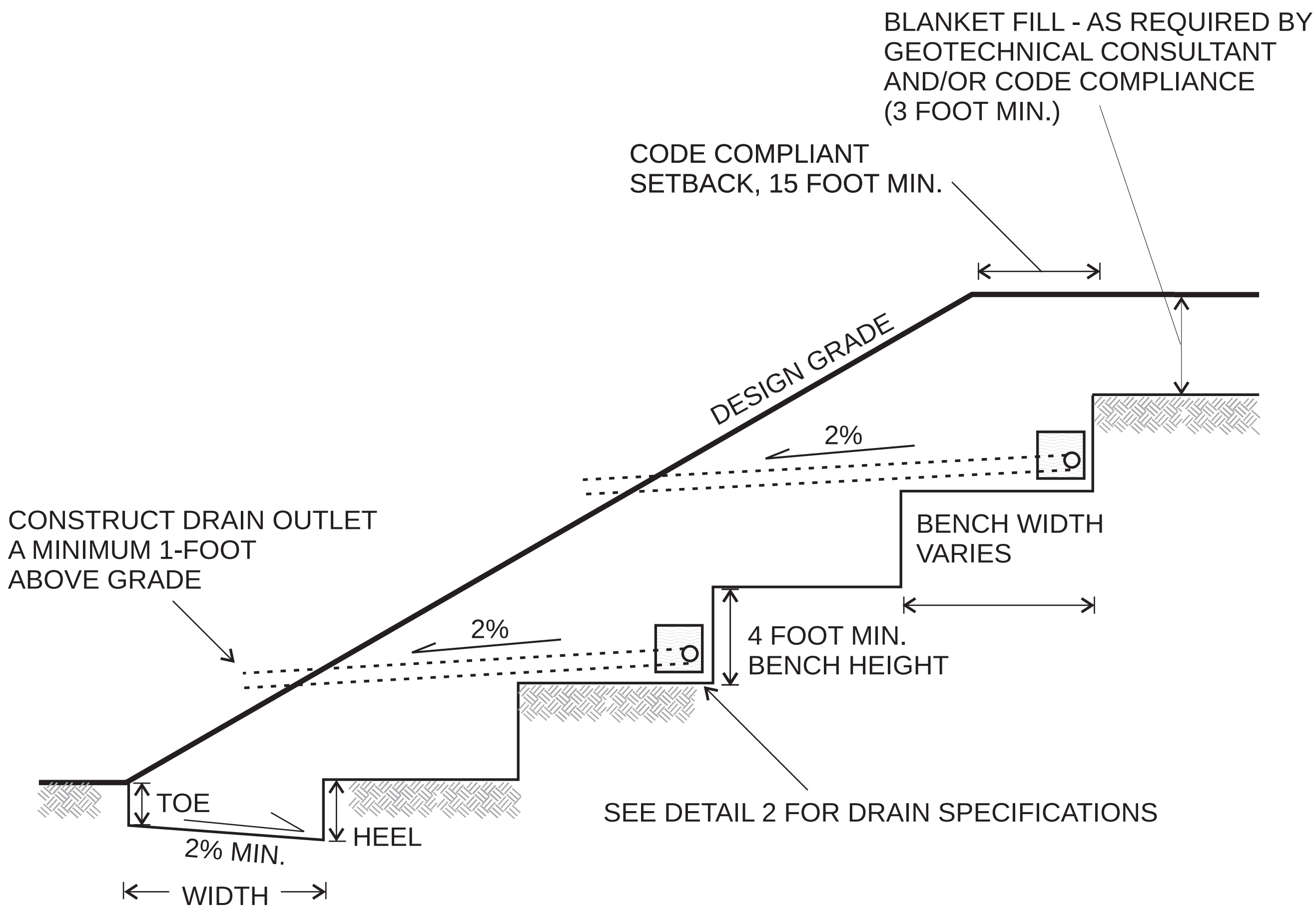
(ASTM D2751, SDR-35 OR ASTM D3034, SDR-35
ASTM D1527, SCHD. 40 OR ASTM D1785, SCHD. 40)

BUTTRESS/STABILIZATION DRAIN

VER 1.0

NTS

AGS ADVANCED GEOTECHNICAL SOLUTIONS	DRAIN SPECIFICATIONS	DETAIL 2



CODE COMPLIANT KEYWAY
WITH MINIMUM DIMENSIONS:

TOE 2 FOOT MIN.
HEEL 3 FOOT MIN.
WIDTH 15 FOOT MIN.

NOTES:

1. DRAIN OUTLETS TO BE PROVIDED EVERY 100 FEET CONNECT TO PERFORATED DRAIN PIPE BY “L” OR “T” AT A MINIMUM 2% GRADIENT.

2. THE NECESSITY AND LOCATION OF ADDITIONAL DRAINS SHALL BE DETERMINED IN THE FIELD BY THE GEOTECHNICAL CONSULTANT. UPPER STAGE OUTLETS SHOULD BE EMPTIED ONTO CONCRETE TERRACE DRAINS.

3. DRAIN PIPE TO EXTEND FULL LENGTH OF STABILIZATION/BUTTRESS WITH A MINIMUM GRADIENT OF 2% TO SOLID OUTLET PIPES.

4. LOCATION OF DRAINS AND OUTLETS SHOULD BE DOCUMENTED BY PROJECT CIVIL ENGINEER. OUTLETS MUST BE KEPT UNOBSTRUCTED AT ALL TIMES.

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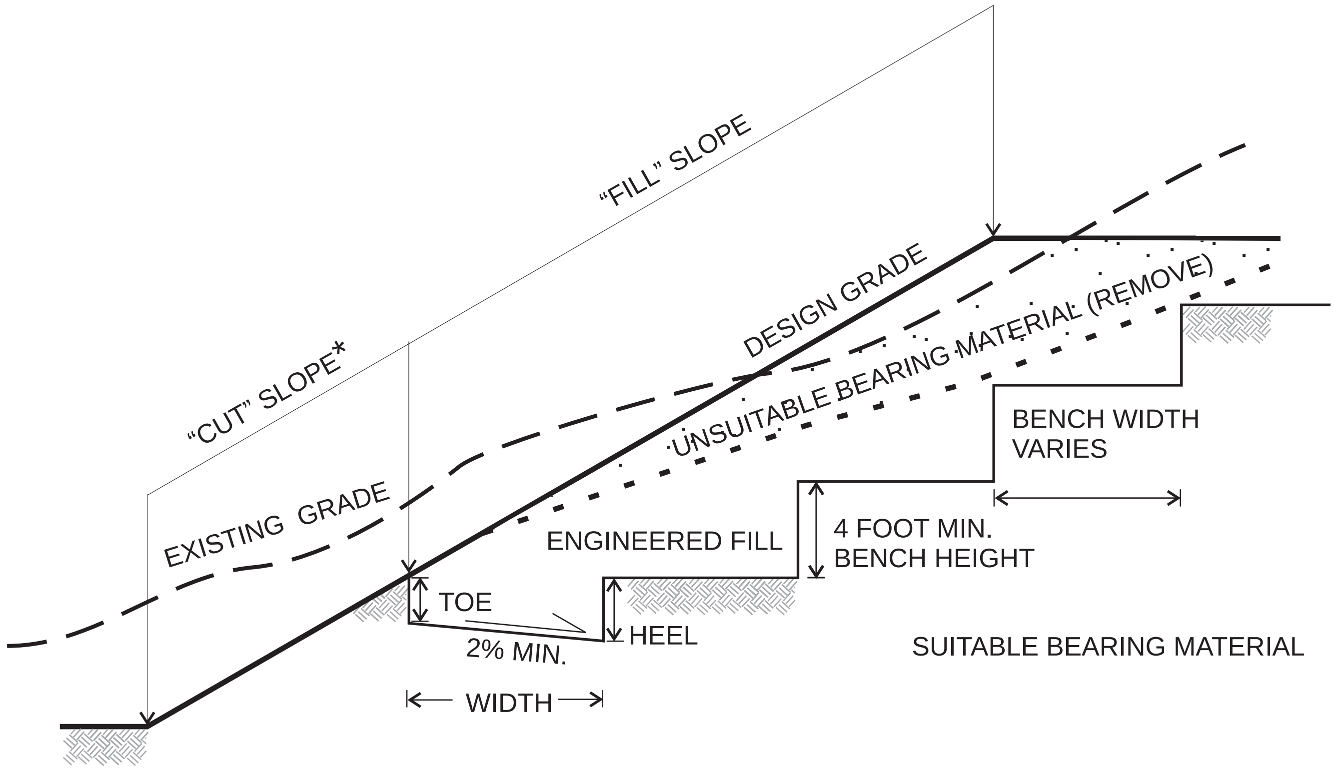
NTS

AGS ADVANCED GEOTECHNICAL SOLUTIONS	STABILIZATION/BUTTRESS FILL	DETAIL 3

* THE “CUT” PORTION OF THE SLOPE SHALL BE EXCAVATED AND EVALUATED BY THE GEOTECHNICAL CONSULTANT PRIOR TO CONSTRUCTING THE “FILL” PORTION



SUITABLE BEARING MATERIAL

CODE COMPLIANT KEYWAY WITH MINIMUM DIMENSIONS:

TOE: 2 FOOT MIN.
HEEL: 3 FOOT MIN.
WIDTH: 15 FOOT MIN.

NOTES:

1. THE NECESSITY AND LOCATION OF DRAINS SHALL BE DETERMINED IN THE FIELD BY THE GEOTECHNICAL CONSULTANT

2. SEE DETAIL 2 FOR DRAIN SPECIFICATIONS

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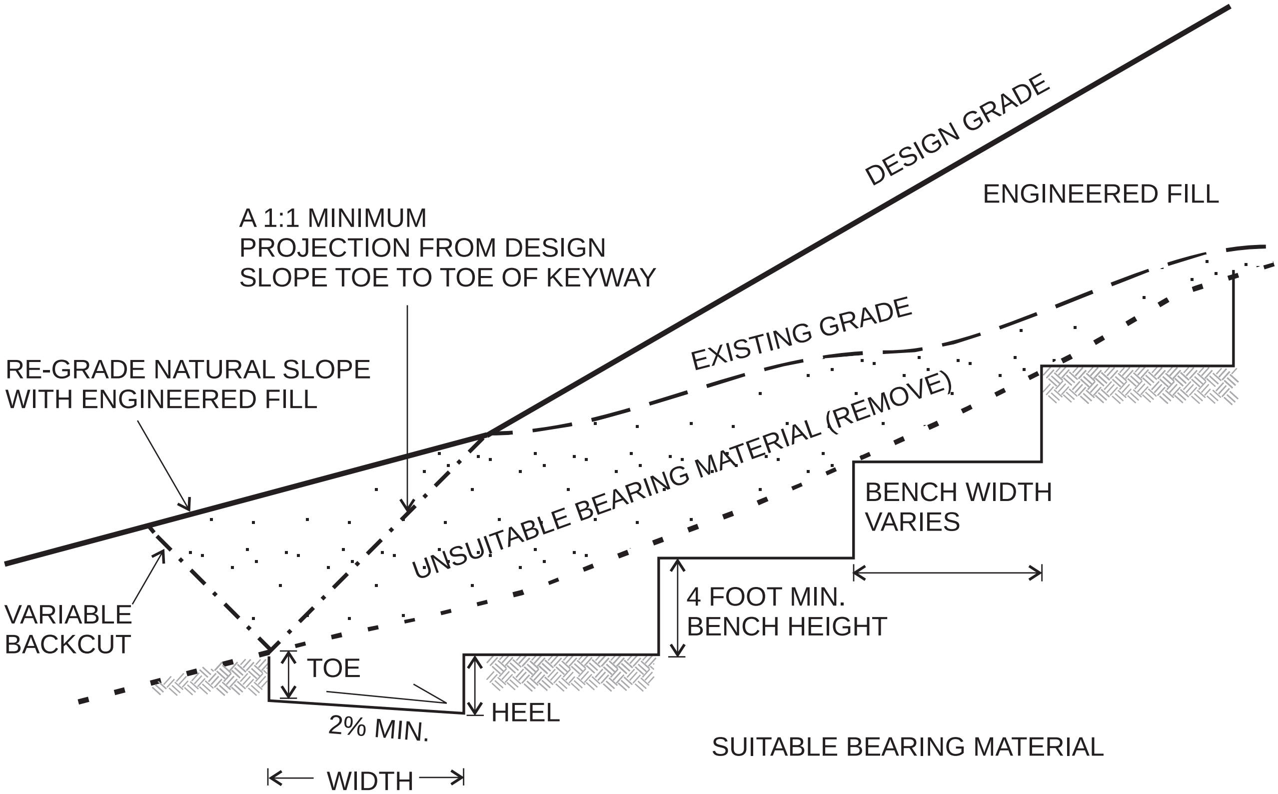
NTS

AGS
ADVANCED GEOTECHNICAL SOLUTIONS

FILL OVER CUT SLOPE

DETAIL 4



CODE COMPLIANT KEYWAY
WITH MINIMUM DIMENSIONS:

TOE: 2 FOOT MIN.
HEEL: 3 FOOT MIN.
WIDTH: 15 FOOT MIN.

NOTES:

1. WHEN THE NATURAL SLOPE APPROACHES OR EXCEEDS THE DESIGN GRADE SLOPE RATIO, SPECIAL RECOMMENDATIONS ARE NECESSARY BY THE GEOTECHNICAL CONSULTANT

2. THE GEOTECHNICAL CONSULTANT WILL DETERMINE THE REQUIREMENT FOR AND LOCATION OF SUBSURFACE DRAINAGE SYSTEMS.

3. MAINTAIN MINIMUM 15 FOOT HORIZONTAL WIDTH FROM FACE OF SLOPE TO BENCH/BACKCUT

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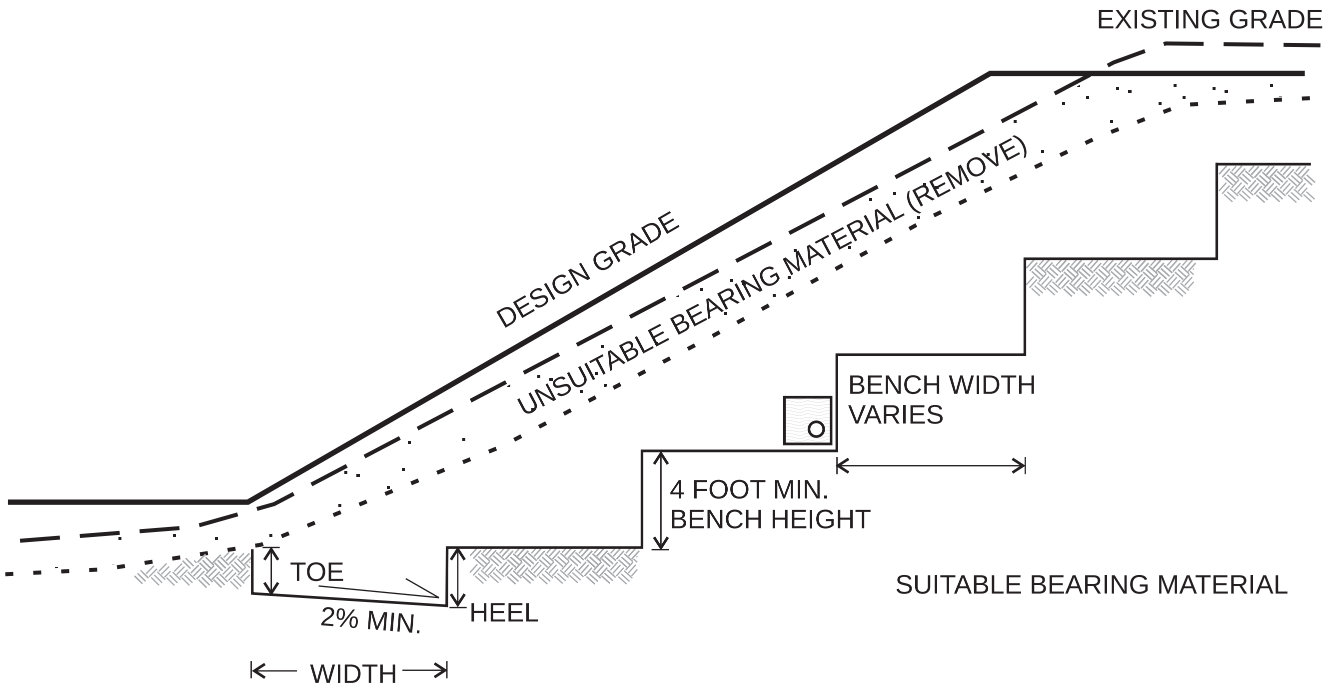
NTS

AGS ADVANCED GEOTECHNICAL SOLUTIONS	FILL OVER NATURAL SLOPE	DETAIL 5



CODE COMPLIANT KEYWAY
WITH MINIMUM DIMENSIONS:

TOE: 2 FOOT MIN.
HEEL: 3 FOOT MIN.
WIDTH: 15 FOOT MIN.

NOTES:

1. MAINTAIN MINIMUM 15 FOOT HORIZONTAL WIDTH FROM FACE OF SLOPE TO BENCH/BACKCUT
2. SEE DETAIL 2 FOR DRAIN SPECIFICATIONS

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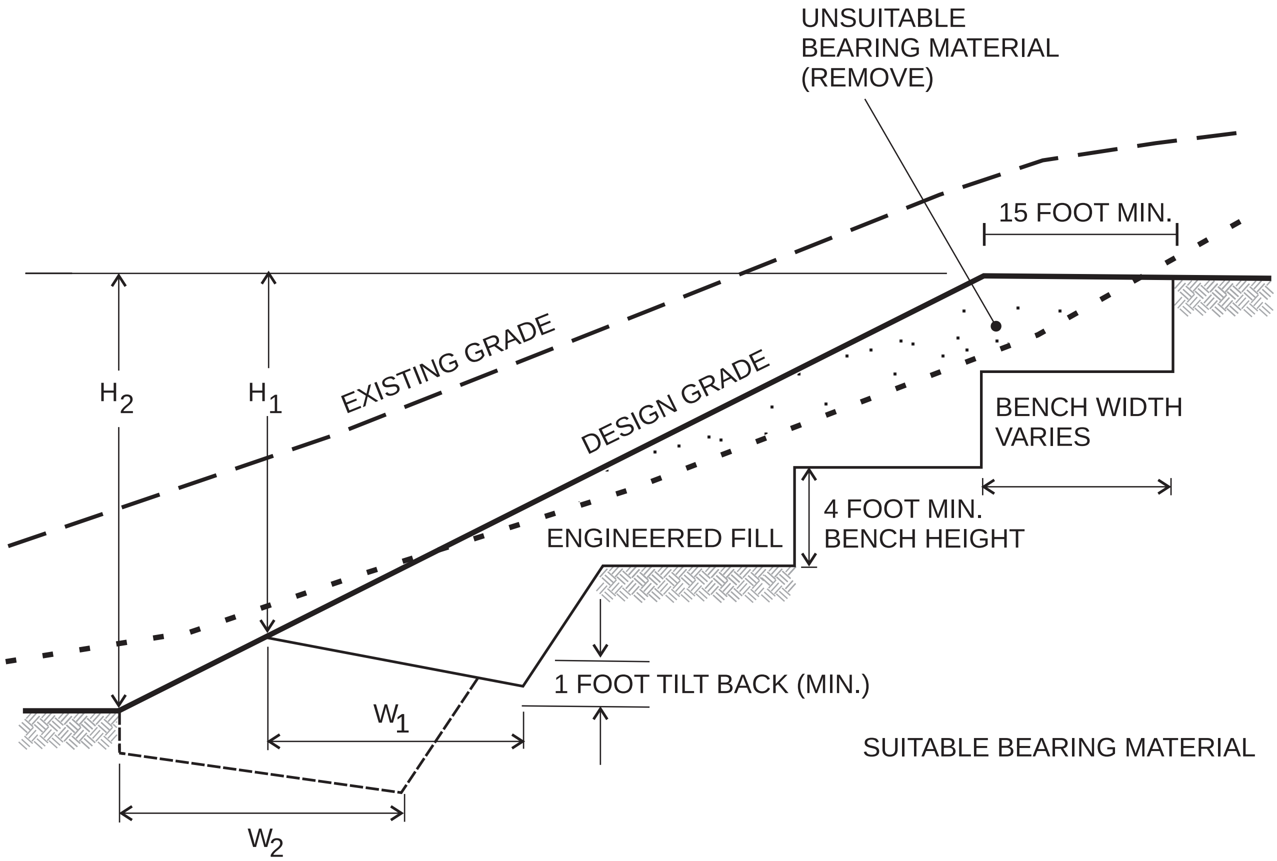
NTS

AGS ADVANCED GEOTECHNICAL SOLUTIONS	SKIN FILL CONDITION	DETAIL 6



NOTES:

1. IF RECOMMENDED BY THE GEOTECHNICAL CONSULTANT, THE REMAINING CUT PORTION OF THE SLOPE MAY REQUIRE REMOVAL AND REPLACEMENT WITH AN ENGINEERED FILL

2. “W” SHALL BE EQUIPMENT WIDTH (15 FEET) FOR SLOPE HEIGHT LESS THAN 25 FEET. FOR SLOPES GREATER THAN 25 FEET, “W” SHALL BE DETERMINED BY THE GEOTECHNICAL CONSULTANT. AT NO TIME SHALL “W” BE LESS THAN H/2

3. DRAINS WILL BE REQUIRED (SEE DETAIL 2)

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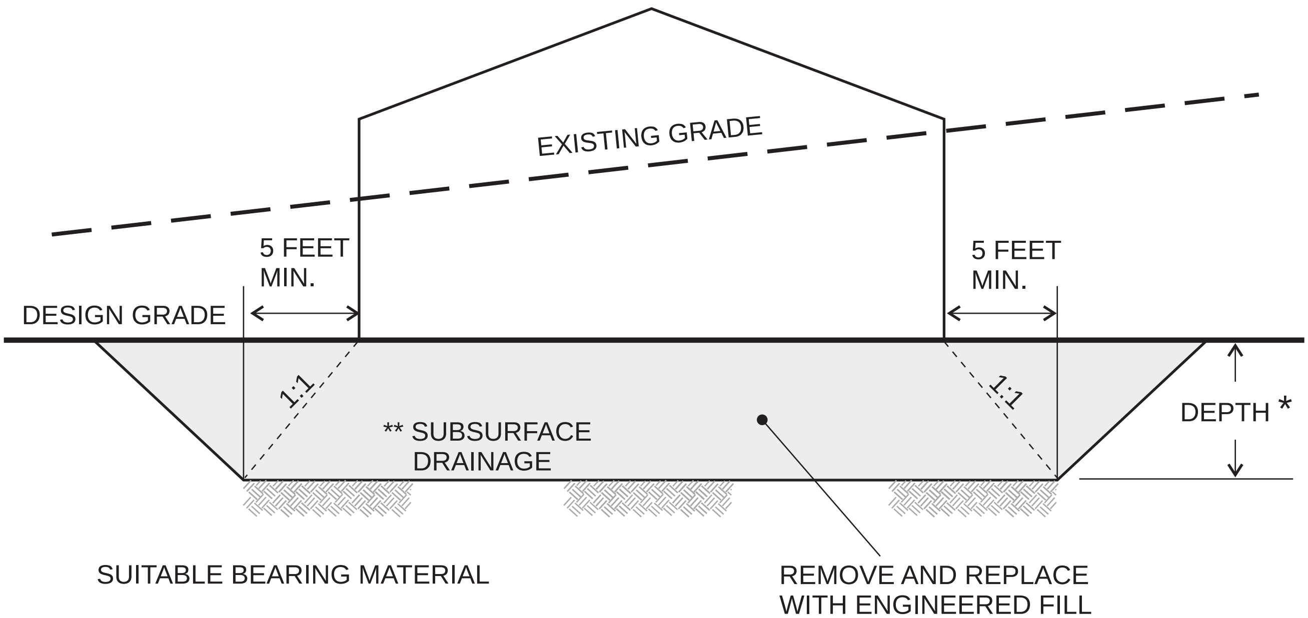
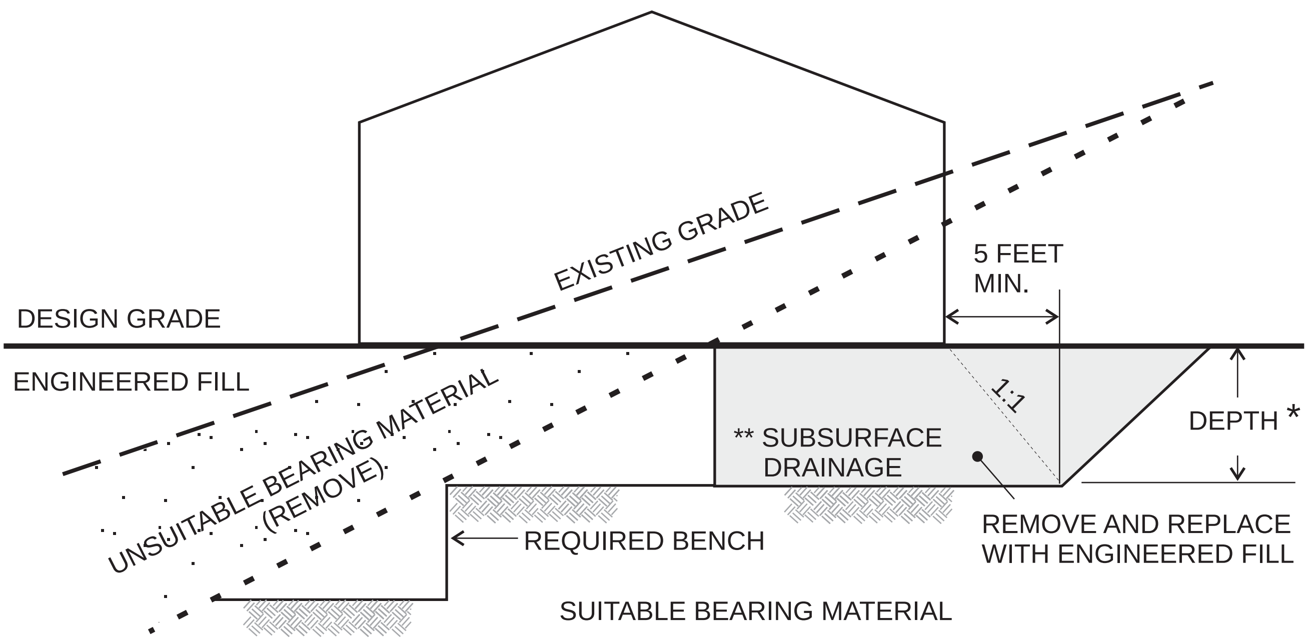
ADVANCED GEOTECHNICAL SOLUTIONS

PARTIAL CUT SLOPE STABILIZATION

DETAIL 7



CUT LOT OVEREXCAVATION



CUT-FILL LOT OVEREXCAVATION

NOTES:

* SEE REPORT FOR RECOMMENDED DEPTHS, DEEPER OVEREXCAVATION MAY BE REQUIRED BY THE GEOTECHNICAL CONSULTANT BASED ON EXPOSED FIELD CONDITIONS

** CONSTRUCT EXCAVATION TO PROVIDE FOR POSITIVE DRAINAGE TOWARDS STREETS, DEEPER FILL AREAS OR APPROVED DRAINAGE DEVICES BASED ON FIELD CONDITIONS

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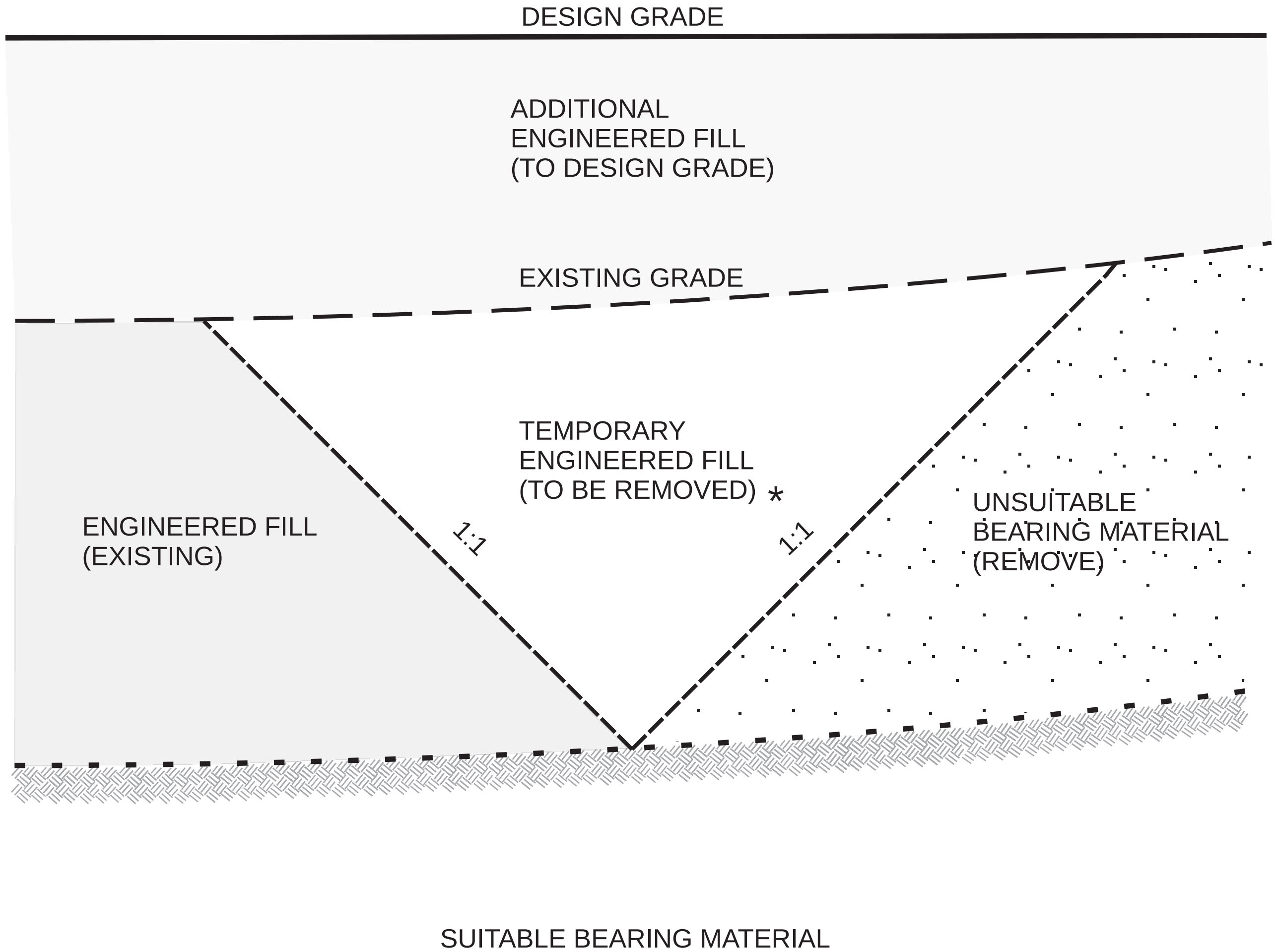
AGS ADVANCED GEOTECHNICAL SOLUTIONS	CUT & CUT-FILL LOT OVEREXCAVATION	DETAIL 8



* REMOVE BEFORE PLACING ADDITIONAL ENGINEERED FILL

TYPICAL UP-CANYON PROFILE

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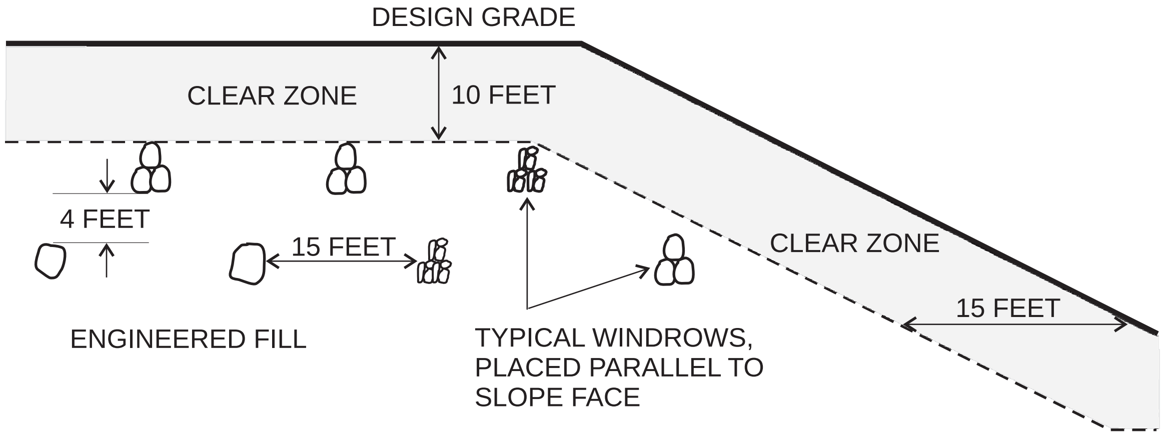
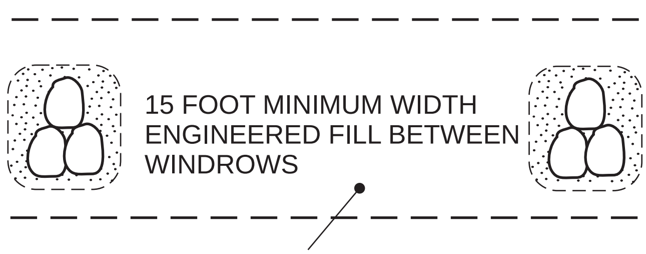
AGS ADVANCED GEOTECHNICAL SOLUTIONS	REMOVAL ADJACENT TO EXISTING FILL	DETAIL 9



CLEAR ZONE DIMENSIONS FOR REFERENCE ONLY, ACTUAL DEPTH, WIDTH, WINDROW LENGTH, ETC. TO BE BASED ON ELEVATIONS OF FOUNDATIONS, UTILITIES OR OTHER STRUCTURES PER THE GEOTECHNICAL CONSULTANT OR GOVERNING AGENCY APPROVAL

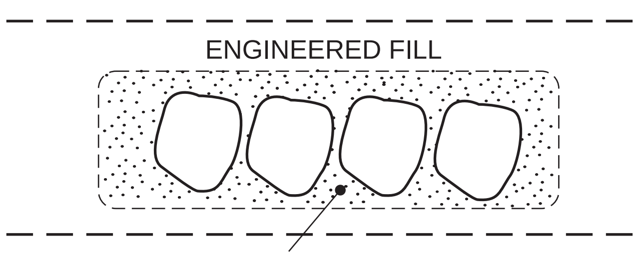
OVERSIZED MATERIAL DISPOSAL PROFILE



HORIZONTALLY PLACED ENGINEERED FILL, FREE OF OVERSIZED MATERIALS AND COMPACTED TO MINIMUM PROJECT STANDARDS

COMPACT ENGINEERED FILL ABOVE OVERSIZED MATERIALS TO FACILITATE "TRENCH" CONDITION PRIOR TO FLOODING GRANULAR MATERIALS

WINDROW CROSS-SECTION



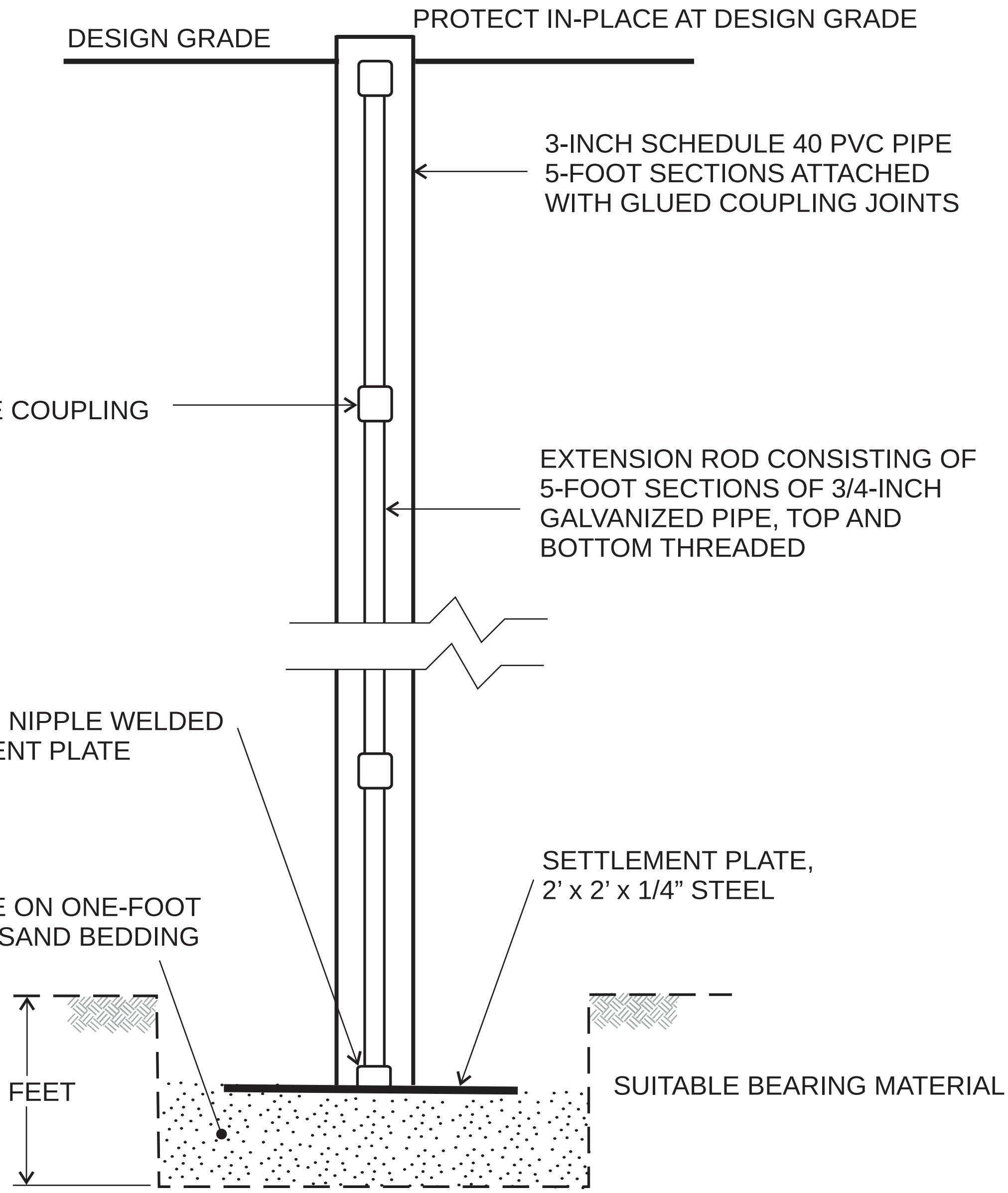
GRANULAR MATERIAL APPROVED BY THE GEOTECHNICAL CONSULTANT AND CONSOLIDATED IN-PLACE BY FLOODING

WINDROW PROFILE

VER 1.0

NTS

AGS ADVANCED GEOTECHNICAL SOLUTIONS	OVERSIZED MATERIAL DISPOSAL CRITERIA	DETAIL 10



NOTES:

1. SETTLEMENT PLATE LOCATIONS SHALL BE SUFFICIENTLY IDENTIFIED BY THE CONTRACTOR AND BE READILY VISIBLE TO EQUIPMENT OPERATORS.

2. CONTRACTOR SHALL MAINTAIN ADEQUATE HORIZONTAL CLEARANCE FOR EQUIPMENT OPERATION AND SHALL BE RESPONSIBLE FOR REPAIRING ANY DAMAGE TO SETTLEMENT PLATE DURING SITE CONSTRUCTION.

3. A MINIMUM 5-FOOT ZONE ADJACENT TO SETTLEMENT PLATE/EXTENSION RODS SHALL BE ESTABLISHED FOR HAND-HELD MECHANICAL COMPACTION OF ENGINEERED FILL. ENGINEERED FILL SHALL BE COMPACTED TO MINIMUM PROJECT STANDARD.

4. ELEVATIONS OF SETTLEMENT PLATE AND ALL EXTENSION ROD PLACEMENT SHALL BE DOCUMENTED BY PROJECT CIVIL ENGINEER OR SURVEYOR.

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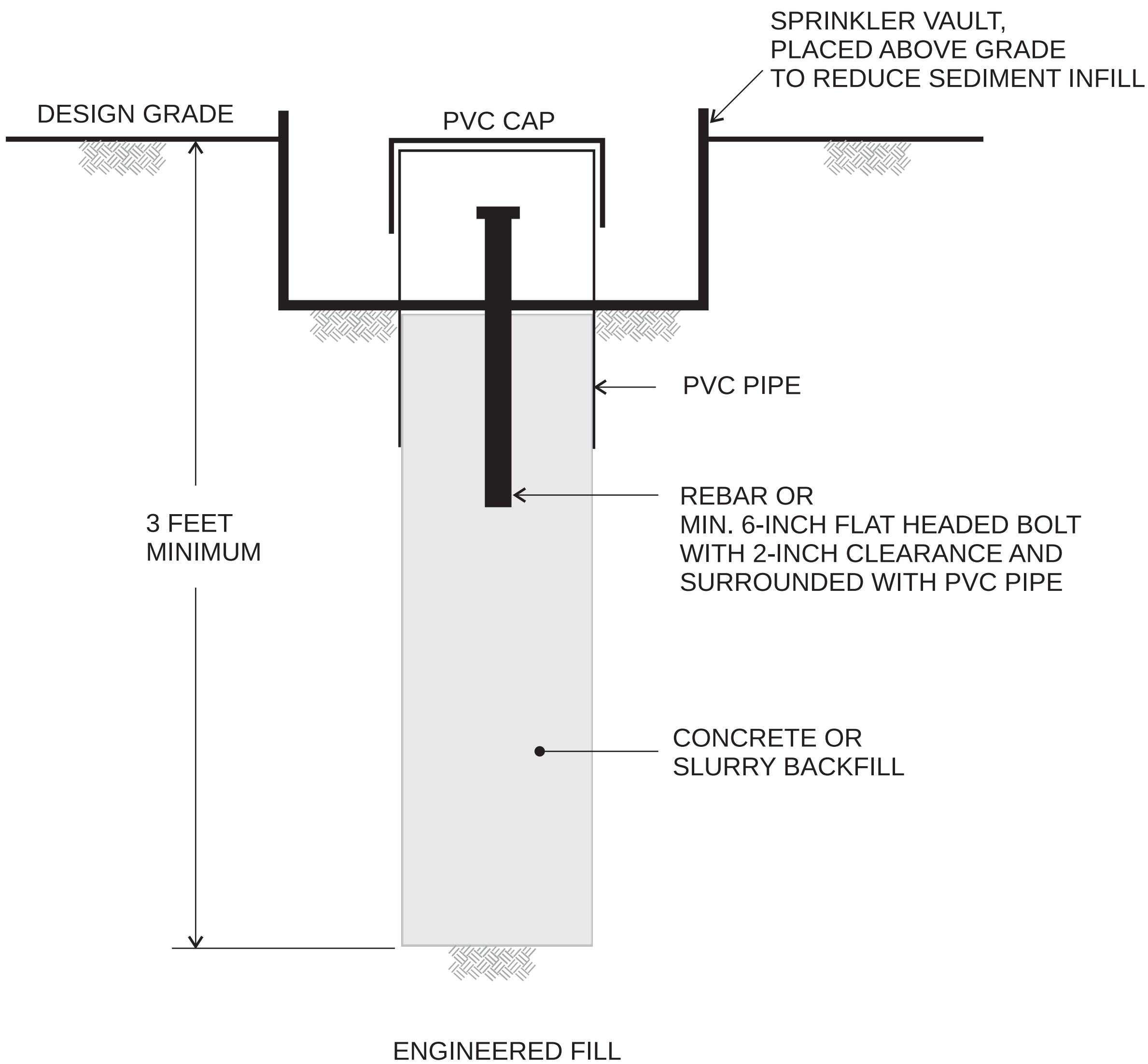
AGS
ADVANCED GEOTECHNICAL SOLUTIONS

SETTLEMENT PLATE

DETAIL 11



NOTES:

1. SETTLEMENT MONUMENT LOCATIONS SHALL BE SUFFICIENTLY IDENTIFIED AND BE READILY VISIBLE TO EQUIPMENT OPERATORS.

2. ELEVATIONS OF SURFACE MONUMENTS SHALL BE DOCUMENTED BY PROJECT CIVIL ENGINEER OR SURVEYOR.

VER 1.0

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AGS ADVANCED GEOTECHNICAL SOLUTIONS	SETTLEMENT MONUMENT	DETAIL 12

OTAY CANYON RANCH
TENTATIVE MAP NO.
LEGEND
afu ARTIFICIAL FILL-UNDOCUMENTED
Qal ALLUVIUM
Ql LINDA VISTA FORMATION
Tsd SAN DIEGO FORMATION
BRACKETED WHERE BURIED
GEOLOGIC CONTACT (DOTTED WHERE BURIED, QUERIED WHERE UNKNOWN)
TEST PIT (AGS, 2015)
TEST PIT (AGS, 2013)
TEST PIT (GEOCON, 2003-2005)
APPROXIMATE LOCATION OF INFILTRATION TEST (THIS REPORT)
APPROXIMATE LOCATION OF EXPLORATORY TEST PIT (THIS REPORT)
PROPOSED SUBDRAIN WITH DIAMETER
TRACE OF CROSS SECTION
N.A.P NOT A PART
TP-2 0-2.0' Topsoil 2.0-11.0' Ql T.D. 11.0' No Water No Caving
TP-8 0-2.0' Topsoil 2.0-10.5' Ql T.D. 10.5' No Water No Caving
TP-1 0-3.0' Topsoil 3.0-12.0' Ql T.D. 12.0' No Water No Caving
PT-3 0-2.0' afu 2.0-6.5' Ql T.D. 6.5' No Water No Caving
PT-5 0-1.0' afu 1.0-9.5' Ql T.D. 9.5' No Water No Caving
PT-4 0-5.5' afu 5.5-11.5' Ql T.D. 11.5' No Water No Caving
TP-7 0-6.0' Topsoil 6.0-10.0' Ql T.D. 10.0' No Water No Caving
TP-3 0-4.0' Topsoil 4.0-10.0' Ql T.D. 10.0' No Water No Caving
TP-6 0-5.0' Topsoil 5.0-11.5' Ql T.D. 11.5' No Water No Caving
TP-9 0-1.0' Topsoil 1.0-9.0' Ql T.D. 9.0' No Water No Caving
TP-10 0-2.5' Topsoil 2.5-10.0' Ql T.D. 10.0' No Water No Caving
T6-B 0-8.0' Ql T.D. 8.0' No Water No Caving
TP-4 0-2.0' Topsoil 2.0-10.0' afu T.D. 10.0' No Water No Caving
TP-1 0-7.5' afu 7.5-11.5' Tsd T.D. 11.5' No Water No Caving
TP-5 0-5.0' Topsoil 5.0-13.0' Ql T.D. 13.0' No Water No Caving
PT-1 0-3.0' afu 3.0-13.5' Ql T.D. 13.5' No Water No Caving
T7-B 0-11.5' Ql T.D. 11.5' No Water No Caving
T4-F 0-14.0' Ql T.D. 14.0' No Water No Caving
TP-9 0-12.0' Ql T.D. 12.0' No Water No Caving
T5-F 0-15.0' Ql T.D. 15.0' No Water No Caving
T3-F 0-15.0' Ql T.D. 15.0' No Water No Caving
T6-F 0-13.5' Ql T.D. 13.5' No Water No Caving
T1-E 0-16.0' Ql T.D. 16.0' No Water No Caving
T1-F 0-13.5' Ql T.D. 13.5' No Water No Caving
TP-2 0-8.0' Ql/Tsd T.D. 8.0' No Water No Caving
T2-F 0-16.0' Ql T.D. 16.0' No Water No Caving
T5-D 0-15.0' Ql T.D. 15.0' No Water No Caving
HOA LOT 23
HOA LOT 24 O.S. 0.89 AC
HOA LOT 23 1.89 AC
S.P.P.A. 13 MEDIUM HIGH MIXED USE
LOT 1 6.03 AC
LOT 2 4.26 AC
1.91 AC BOTTOM BASIN 488.4 HOA LOT 22
AIRWAY ROAD
S.P.P.A. 5 MEDIUM HIGH MIXED USE
S.P.P.A. 6 MEDIUM HIGH MIXED USE
LOT 8 1.90 AC
LOT 3 4.17 AC
LOT 4 3.93 AC
LOT 5 2.98 AC
LOT 9 2.04 AC
VILLAGE WAY
PRIVATE DRIVE
PROJECT BOUNDARY
SEE SHEET 4
SEE SHEET 6
PLATE 1 OF 4
Geology Plan
AGS ADVANCED GEOTECHNICAL SOLUTIONS, INC.
Project: P/W 1304-04
Report: 1304-04
Date: May 2017
GRAPHICAL SCALE SCALE: 1" = 60'
PREPARED BY:
NAME: PROJECT DESIGN CONSULTANTS
ADDRESS: 701 'B' STREET, SUITE 800 SAN DIEGO, CALIFORNIA 92101
PHONE #: (619) 235-6471
PROJECT ADDRESS: SAN DIEGO, CALIFORNIA
PROJECT NAME: OTAY CANYON RANCH
SHEET TITLE: GRADING AND STORM DRAIN PLANS
ORIGINAL DATE: 07/12/2016
SHEET 3 OF 29
PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey

OTAY CANYON RANCH

TENTATIVE MAP NO. ___________

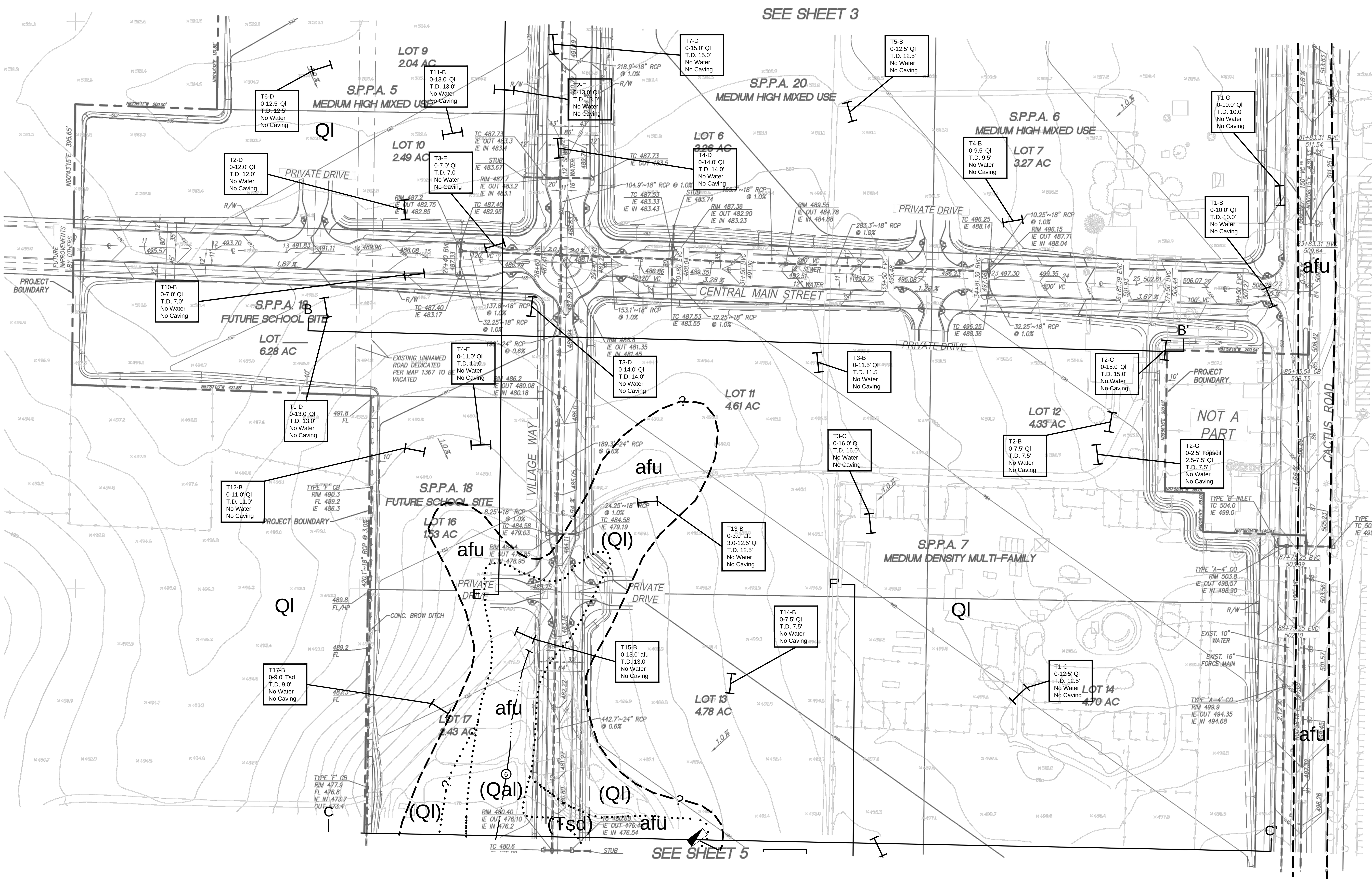


PLATE 2 OF 4

SEE PLATE 1 FOR LEGEND

Geology Plan

AGS ADVANCED GEOTECHNICAL SOLUTIONS, INC.

Project:	Report:	Date:
P/W 1304-04	1304-04	May 2017

PREPARED BY:
NAME: PROJECT DESIGN CONSULTANTS
ADDRESS: 701 'B' STREET, SUITE 800
SAN DIEGO, CALIFORNIA 92101
PHONE #: (619) 235-6471

PROJECT ADDRESS:
SAN DIEGO, CALIFORNIA

PROJECT NAME:
OTAY CANYON RANCH

SHEET TITLE:
GRADING AND STORM DRAIN PLANS

REVISION 14:
REVISION 13:
REVISION 12:
REVISION 11:
REVISION 10:
REVISION 09:
REVISION 08:
REVISION 07:
REVISION 06:
REVISION 05:
REVISION 04:
REVISION 03:
REVISION 02:
REVISION 01:
ORIGINAL DATE: 07/12/2016
SHEET 4 OF 29
DEP #

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey
701 B Street, Suite 800 San Diego, CA 92101 619.235.6471 Tel 619.234.0349 Fax

P:\2357.35\ENGR\DWG_PLANS\TM_PREPLAT\2357.35_TM04.DWG 5/25/2017 2:08 PM

OTAY CANYON RANCH

TENTATIVE MAP NO. ____________

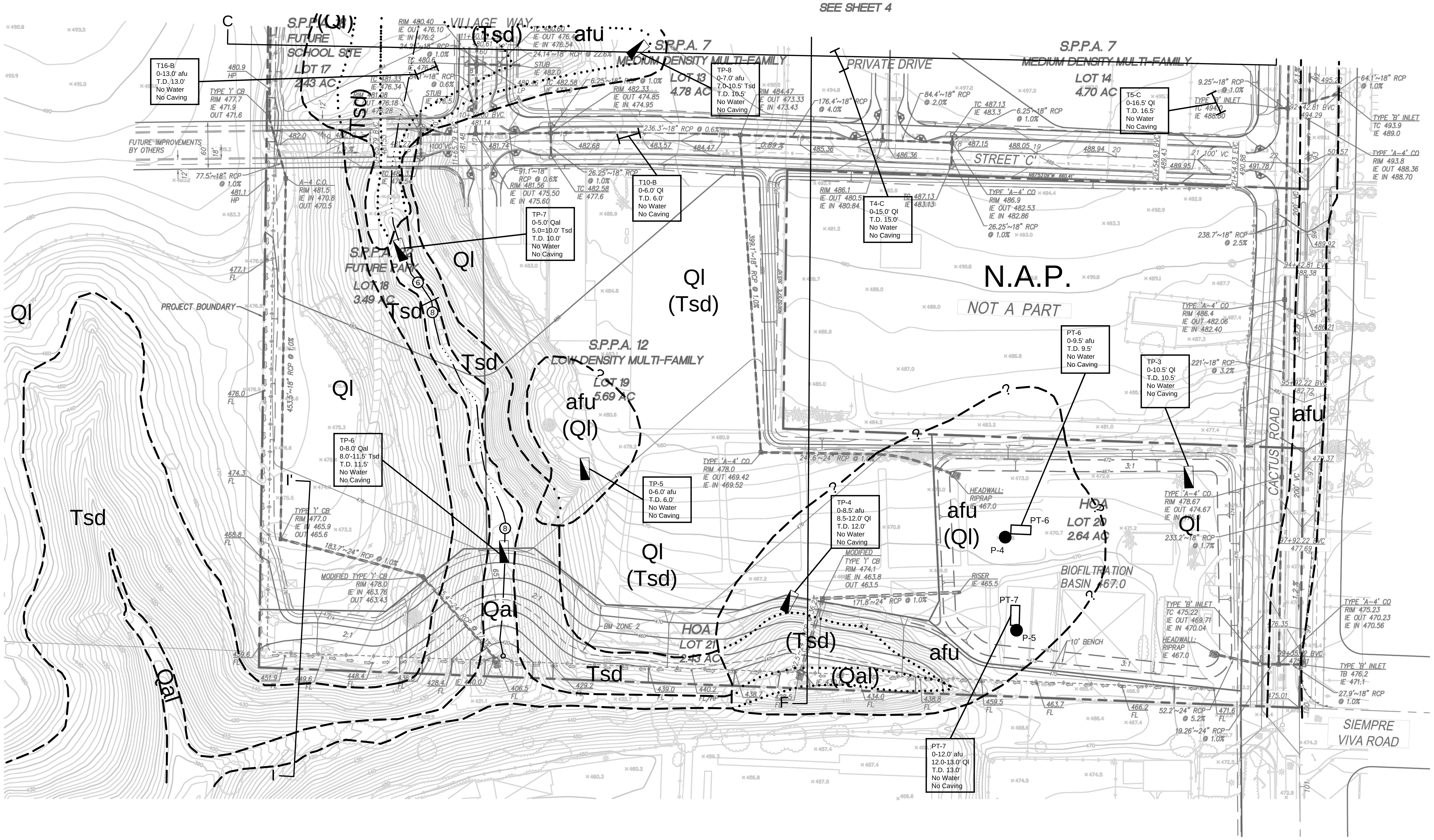


PLATE 3 OF 4

SEE PLATE 1 FOR LEGEND

Geology Plan

ADVANCED GEOTECHNICAL SOLUTIONS, INC.

Project:	Report:	Date:
P/W 1304-04	1304-04	May 2017

GRAPHICAL SCALE
SCALE: 1" = 60'

PREPARED BY:
NAME: PROJECT DESIGN CONSULTANTS
ADDRESS: 701 'B' STREET, SUITE 800
SAN DIEGO, CALIFORNIA 92101
PHONE #: (619) 235-6471

PROJECT ADDRESS:
SAN DIEGO, CALIFORNIA

PROJECT NAME:
OTAY CANYON RANCH

SHEET TITLE:
GRADING AND STORM DRAIN PLANS

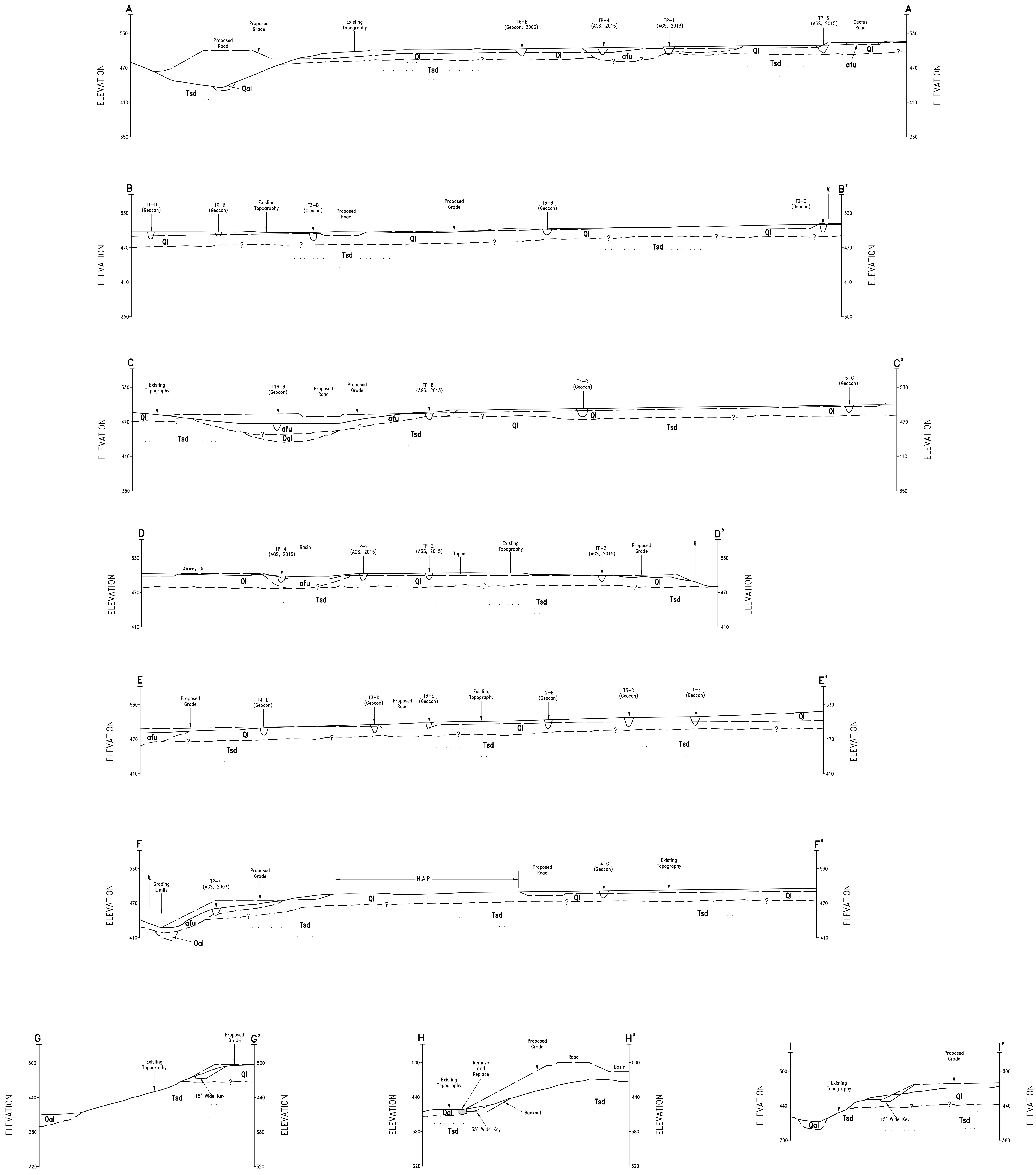
REVISION 14:
REVISION 13:
REVISION 12:
REVISION 11:
REVISION 10:
REVISION 09:
REVISION 08:
REVISION 07:
REVISION 06:
REVISION 05:
REVISION 04:
REVISION 03:
REVISION 02:
REVISION 01:

ORIGINAL DATE: 07/12/2016

SHEET 5 OF 29

DEP #

PROJECT DESIGN CONSULTANTS
Planning | Landscape Architecture | Engineering | Survey



LEGEND:

afu	Artificial Fill-Undocumented
Qal	Alluvium
Ql	Lindavista Formation
Tsd	San Diego Formation
T3-B	Geocon Testpit
TP-8	AGS Testpit, 2013
TP-2	AGS Testpit, 2015

SCALE: 1"=60' H&V

PLATE 4

AGS
ADVANCED GEOTECHNICAL SOLUTIONS, INC.

Project:	Report:	Date:
P/W 1304-04	1304-04	May 2017

Brian F. Smith and Associates, Inc.
Archaeology / Biology / History / Paleontology / Air Quality / Traffic / Acoustics

27 March 2018

Ms. Rita Mahoney
ColRich
444 West Beech Street, Suite 300
San Diego, California 92101

Ms. Jerrica Harding
T&B Planning, Inc.
17542 East 17th Street, Suite 100
Tustin, California 92780

Subject: Paleontological records search, Lumina Project, Otay Mesa, San Diego, San Diego County, California

Dear Ms. Mahoney and Ms. Harding:

We have completed paleontological literature and museum collections and records searches for the Lumina project site, located in the Otay Mesa neighborhood in the City of San Diego, San Diego County, California (Attachment 1). The project site is 93.43 acres and is south of State Highway Route 905, between the west side of Cactus Road and the east side of Pacific Gateway Park (Attachment 2). The southern property boundary is approximately 0.5 mile north of the U.S-Mexico international border. The project site includes Assessor's Parcel Numbers 646-10-017, -018, -020, -021, -038, -071, -076, and 646-09-307, -309, -310, -311, and -312. On the U. S. Geological Survey's 1:24,000-scale Otay Mesa, California topographic quadrangle map, the project site is located within the western half of Section 33, Township 18 South, Range 1 West, San Bernardino Base and Meridian (Attachment 2).

Geology

Geologically, most of the project site is mapped as underlain by sediments of the early to middle Pleistocene (0.5 to 1.5 million year old) Lindavista Formation ("Ql" on Attachment 3). Shown underlying the Lindavista Formation at the southern and northwestern portions of the project at canyon heads are the marine middle Pliocene (~ 1.5 to 4 million year old) San Diego Formation ("Tsdss") and the fluvial upper Oligocene (29 million year old) Otay Formation ("To") (Kennedy and Tan, 1977).

The Lindavista Formation has been assigned a "moderate paleontological sensitivity," whereas the San Diego and Otay Formations are assigned a "high paleontological resource sensitivity" by Deméré and Walsh (1993) and the City of San Diego (2002), indicative of the likelihood of potentially yielding significant nonrenewable paleontological resources (*i.e.*, fossils) during any trenching, excavation, and/or mass grading activities in the formational sediments. In the city of San Diego, ground-disturbing activities in formations assigned a "moderate" or "high paleontological resource sensitivity" require implementation of a mitigation, monitoring and reporting program (MMRP) to reduce the negative impact to a level below significance (City of San Diego, 2002).

Collections and Records Search

The paleontological collections and records search was based on the locality data files of the Department of Paleontology at the San Diego Natural History Museum (SDNHM), the Edwin C. Allison Center collections previously held in the Department of Geological Sciences at San Diego State University (SDSU), and the Invertebrate Paleontology Section of the Natural History Museum of Los Angeles County (LACMIP, which also contains the collections and records of the University of California at Los Angeles, the California Institute of Technology, and the University of Southern California).

The in-house records search did not reveal any previously recorded fossil localities from within the limits of the Lumina project site, nor within one mile of the project's limits. A records search by the Paleontology Department of the SDNHM was performed for the site (K. McComas, 2017, attached). The records search indicated that three fossil localities (San Diego Society of Natural History [SDSNH] locs. 6734, 6738, and 6739) lay to the northwest within one mile of the project. The fossils recovered were from the San Diego Formation and represent pholad clam borings in sediments (locs. 6734, 6738) and the fossil bones of the prehistoric horse *Equus* sp., the ribs of an extinct sea cow *Hydrodamalis cuestae*, and other unidentified mammal bones (loc. 6739) recovered during construction work performed for State Route 905 improvements. Fossil locality 6075, as reported in the attached SDNHM report, is an error and is located farther to the north across Otay Valley.

There are no recorded fossil localities nearby that represent the lower Pleistocene Lindavista Formation or the upper Oligocene Otay Formation.

Mitigation

The results of the university and museum collections and records search resulted in three megafossil localities being identified within a one-mile radius of the Lumina Project, indicative of the potential for fossil resources in the immediate vicinity of the project site. Well-preserved fossils are particularly significant in understanding the fossil record of the greater San Diego area. The City of San Diego (2002) has assigned both the Pliocene San Diego Formation and the Oligocene Otay Formation a "high paleontological resource sensitivity" rating, indicative of its concern for preserving these important nonrenewable resources under CEQA guidelines, whereas the Pleistocene Lindavista Formation has been assigned a "moderate paleontological resource sensitivity" rating. The City of San Diego requires a paleontological MMRP to be implemented as part of its permit process whenever significant paleontological resources are likely to be destroyed or otherwise adversely affected by construction-related activities. Based upon the environmental regulations for the project, it is necessary to reduce any direct effects (damage or destruction of potential nonrenewable paleontological resources, *i.e.*, fossils) to a level below significance. These are required to be placed on the grading plans for the construction project, and the City's Mitigation Monitoring Coordination (MMC) section of the Development Services Department oversees its implementation. Final signoff on any project by the City of San Diego MMC will not happen without final approval of the paleontological report and archival conservation of any recovered fossils into a museum or university paleontological collection. With the completion of the required MMRP, there are no further indirect or cumulative effects anticipated with paleontological mitigation. Mitigation and monitoring procedures are covered by the City of San Diego's (2002) "Paleontology Guidelines," *q.v.*

Summary

The presence of shallow-water marine invertebrates and mammalian vertebrates from the underlying Pliocene San Diego Formation support the need to conduct paleontological monitoring and mitigation of any excavation-related activities that might occur during the redevelopment of the Lumina Project. Both the San Diego and Otay Formations are assigned a "high paleontological resource sensitivity" by Deméré and Walsh (1993) and the City of San Diego (2002), indicative of the likelihood of yielding fossils during any grading and excavation activities in these formations. The Lindavista Formation, the uppermost geological unit underlying the site, is assigned a "moderate paleontological resource sensitivity" rating by Deméré and Walsh (1993) and City of San Diego (2002), indicating the formation's paleontological potential. The university and museum collections and records search revealed just three known fossil localities within a one-mile radius of the project site, a likely reflection of the area's undeveloped and little-explored history. However, the San Diego Formation is richly fossiliferous, which indicates the likelihood of recovering additional significant specimens of marine invertebrate and marine vertebrate fossils during paleontological monitoring of any construction-related activities. Although there are no recorded fossil localities from the Oligocene Otay Formation in the immediate vicinity of the Lumina project site, the formation can yield relatively abundant remains of terrestrial animals including reptiles, marsupials, rodents, and small artiodactyls during paleontological monitoring of construction activities, thus supporting the need to monitor exposures of the formation should grading activities reach depths where the formation is present. Likewise, although there are no fossil localities from the Pleistocene Lindavista Formation in the vicinity of the project, the potential exists for fossil remains of mollusks and other marine invertebrates to be present, according to the City of San Diego Paleontology Guidelines (2002). In summary, this records and literature search supports the need for the monitoring for paleontological resources (fossils) during any excavation, drilling, trenching, and mass grading activities at the Lumina Project.

If you have any questions concerning this assessment, please feel free to contact us at our Poway address. Thank you for the opportunity to provide continuing paleontological services on this project.

Sincerely,

Todd Wirths, M.S., P.G. 7588
Project Paleontologist, Prof. Calif. Geologist

George L. Kennedy, Ph.D.
Senior Paleontologist

Attachments: Location maps, records search report

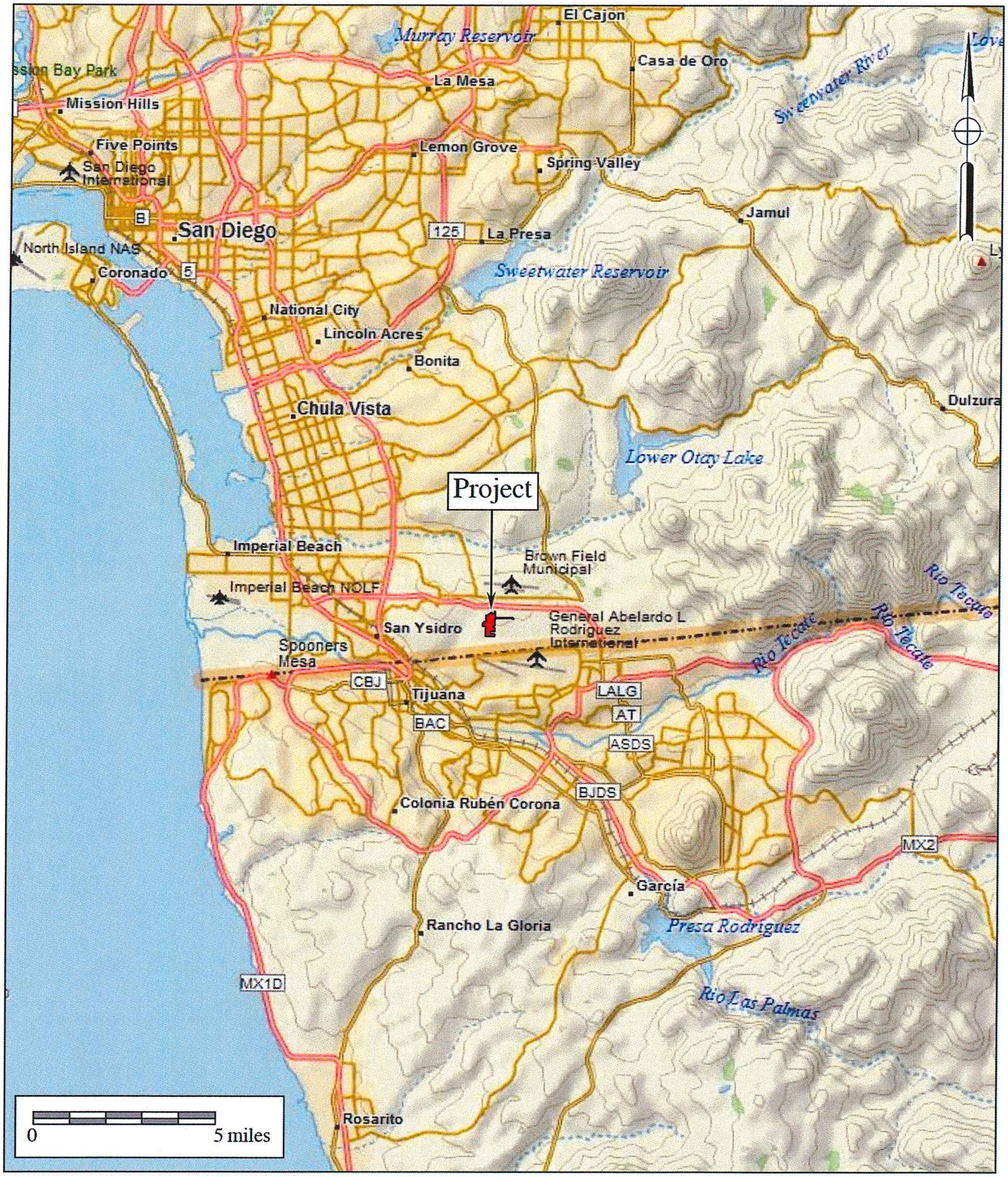
PROFESSIONAL GEOLOGIST
TODD A. WIRTHS
No. 7588
STATE OF CALIFORNIA

References

City of San Diego. 2002. City of San Diego paleontology guidelines [1996, revised July 2002]. Unpublished in-house report prepared and distributed by the City of San Diego, Development Services Department. Pp. [i] + 1-11.

Deméré, T. A., and Walsh, S. L. 1993. Paleontological resources – County of San Diego. Unpublished report prepared for the San Diego County Department of Public Works, San Diego, by the Department of Paleontology, San Diego Natural History Museum. Pp. i-iii + 1-68, figs. 1-3, 8 maps.

Kennedy, M. P., and Tan, S. S. 1977. Geology of National City, Imperial Beach, and Otay Mesa Quadrangles, southern San Diego Metropolitan area, California. California Division of Mines and Geology, Map Sheet 29.

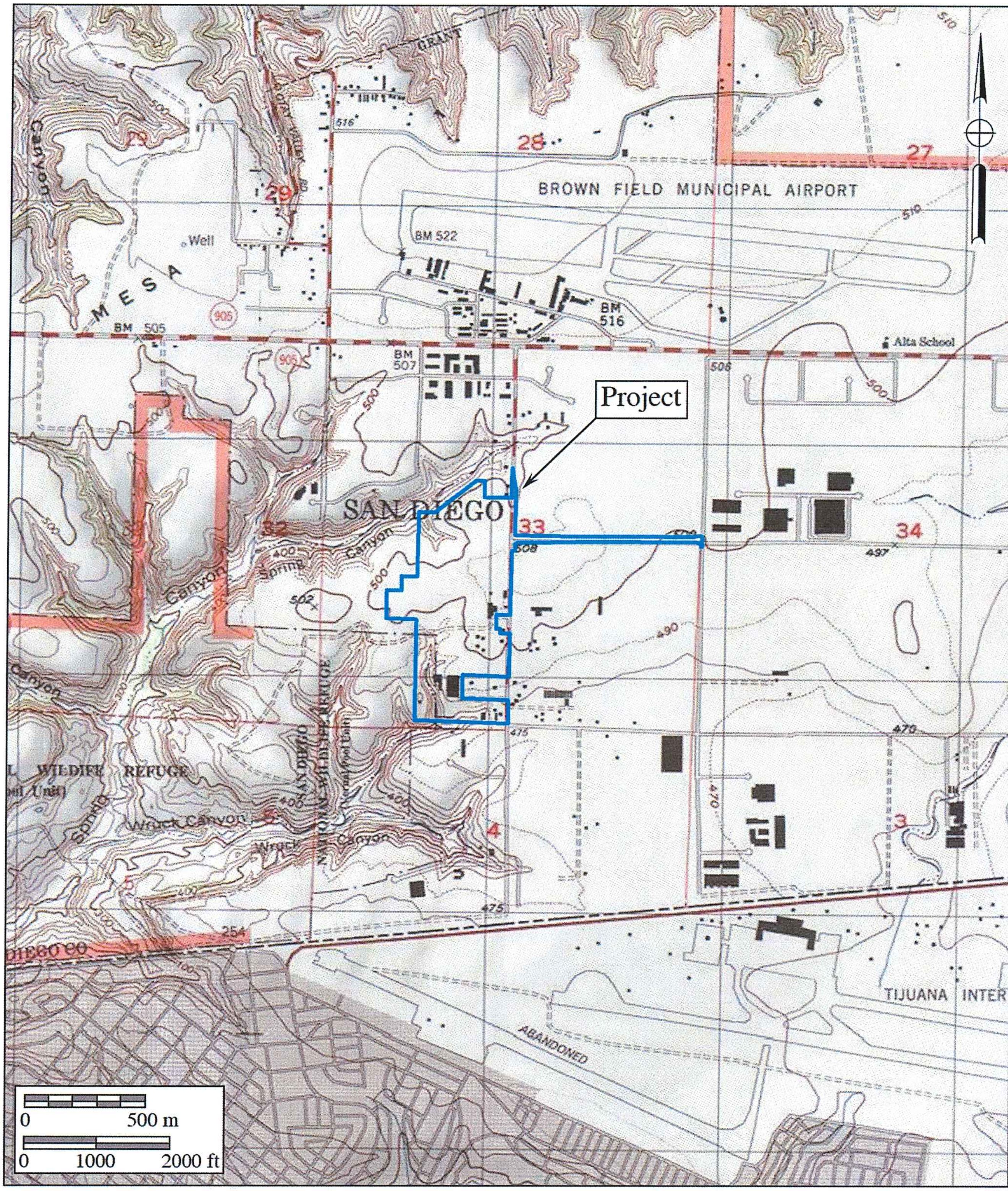


Attachment 1

General Location Map

The Lumina Project

DeLorme (1:250,000)

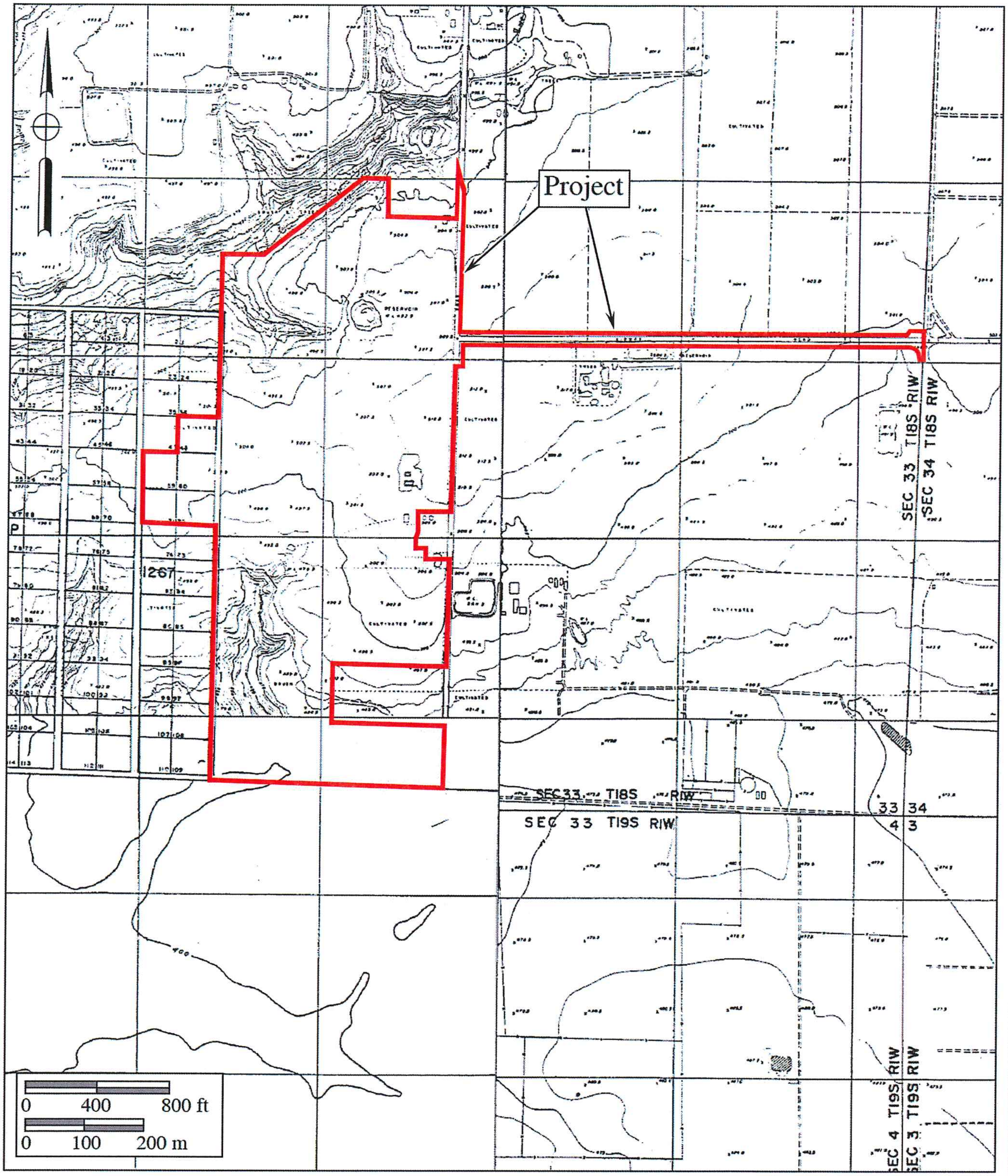


Attachment 2

Project Location Map

The Lumina Project

USGS *Imperial Beach* and *Otay Mesa* Quadrangles (7.5-minute series)

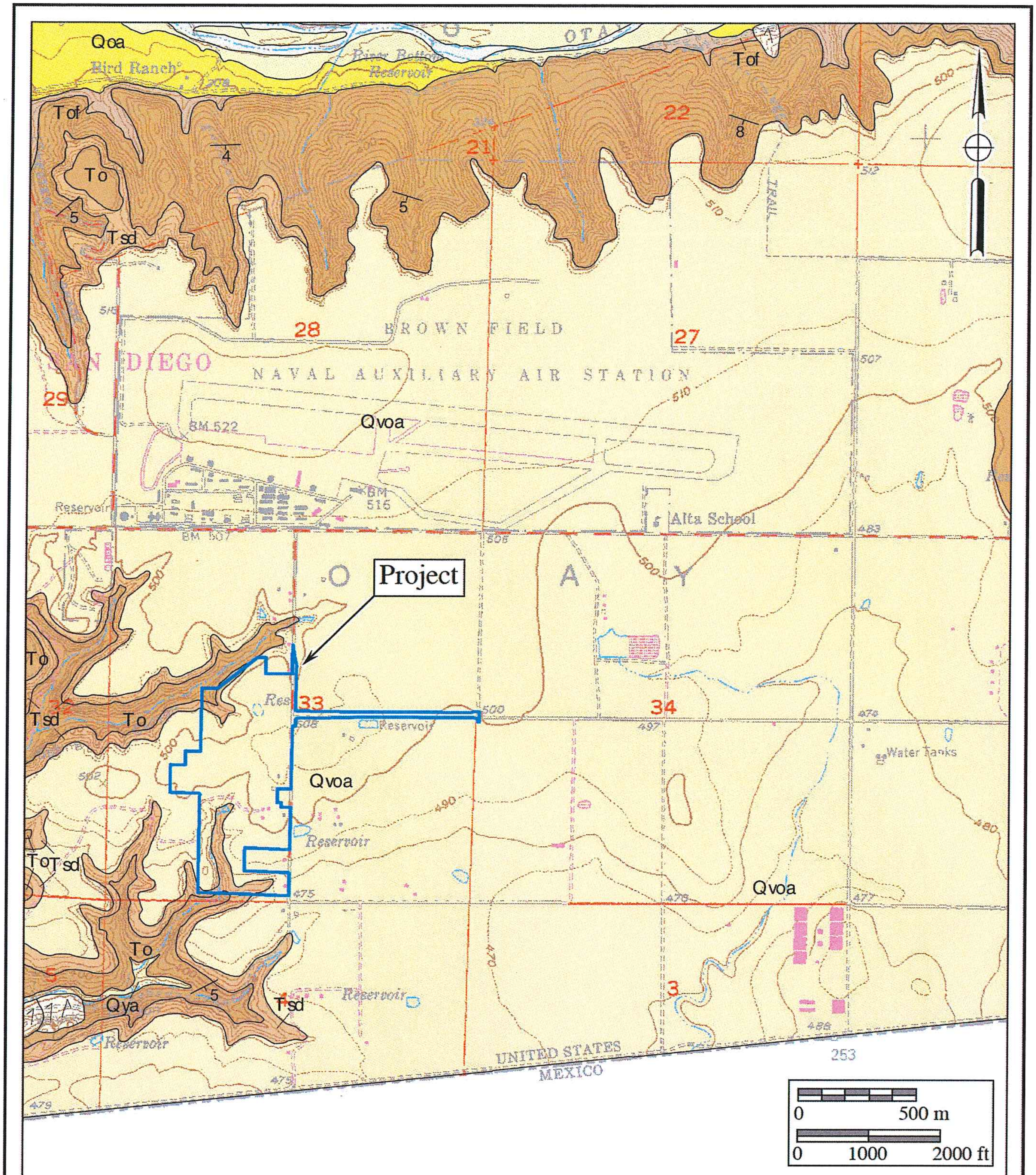


Attachment 3

Project Location Map

The Lumina Project

Shown on The City of San Diego 1" to 800' Scale Engineering Map



Attachment 4

Geologic Map

The Lumina Project

Geology after Kennedy and Tan (1977)

12 October 2017

Mr. Todd Wirths
Brian F. Smith & Associates, Inc.
14010 Poway Road
Poway, CA 92064

RE: Paleontological Records Search – Lumina Project

Dear Mr. Wirths:

This letter presents the results of a paleontological records search conducted for the Lumina project, located in the central portion of the Otay Mesa Neighborhood and Community Plan Area of the City of San Diego, San Diego County, CA. The project site lies just south of State Route 905, and is bounded to the east by Cactus Road, to the south by light industrial development, to the west by agricultural development, and to the north by undeveloped land and commercial development.

A review of published geological maps covering the project site and surrounding area was conducted to determine the specific geologic units underlying the project. Each geologic unit was subsequently assigned a paleontological resource sensitivity following City of San Diego and County of San Diego guidelines (City of San Diego, 2011; Deméré and Walsh, 1993; Stephenson et al., 2009). Published geological reports (e.g., Tan and Kennedy, 2002; Todd, 2004) covering the project area indicate that the proposed project has the potential to impact the early to middle Pleistocene-age Lindavista Formation, the late Pliocene to early Pleistocene-age San Diego Formation, and the late Oligocene-age Otay Formation. These geologic units and their paleontological sensitivity are summarized in detail in the following section.

In addition, a search of the paleontological collection records housed at the San Diego Natural History Museum (SDNHM) was conducted in order to determine if any documented fossil collection localities occur at the project site or within the immediate surrounding area (Figure 1). The SDNHM has four recorded fossil localities within one mile of the project site, all from the San Diego Formation. The content of these localities is described in greater detail below.

Geologic Rock Units Underlying the Project Area

Lindavista Formation – The majority of the project site is underlain by the marine and/or nonmarine terrace deposits of the early to middle Pleistocene-age (approximately 1.5 to 0.5 million years old) Lindavista Formation. The SDNHM does not have any fossil localities from the Lindavista Formation within a 1-mile radius of the project area. Elsewhere in San Diego County, these deposits have produced marine invertebrates (e.g., clams, scallops, snails, barnacles, and sand dollars) and sparse remains of the marine vertebrates (e.g., sharks and baleen whales). Fossils have primarily been recovered from localities in Tierrasanta and Mira Mesa where the Lindavista Formation is assigned a high paleontological sensitivity; elsewhere in San Diego County, including in the project area, the Lindavista Formation is assigned a moderate paleontological sensitivity.

San Diego Formation – Marine sedimentary deposits of the late Pliocene to early Pleistocene-age (approximately 3 to 1.5 million years old) San Diego Formation underlie the southern and northwestern portions of the project site, along the uppermost margins of Spring and Wruck canyons, and likely underlie the Lindavista Formation at unknown depths elsewhere within the project site. The SDNHM has four fossil collection localities from the San Diego Formation within a 1-mile radius of the project area. These localities produced trace fossils (e.g., sponge borings and pholad clam burrows) and fossilized impressions or remains of marine invertebrates (e.g., snails, oysters, and clams), marine vertebrates (e.g., sea cows), and terrestrial vertebrates (e.g., horses). Based on the important fossil remains of marine mammals, sea birds, and mollusks recovered from this unit in San Diego County, the San Diego Formation has been assigned a high paleontological sensitivity.

Otay Formation – The fluvial deposits of the late Oligocene-age (approximately 29 million years old) Otay Formation underlie the southern and northwestern margins of the project site, below outcrops of the San Diego Formation in Spring and Wruck canyons. The Otay Formation is divided into three members: a basal angular conglomerate unit, a middle gritstone unit, and an upper sandstone-mudstone unit (Walsh and Deméré, 1991). The SDNHM does not have any recorded fossil collection localities within a 1-mile radius of the project site, but there are three fossil collection localities from the Otay Formation just over 2 miles to the northwest of the project site, and an additional nine fossil collection localities just over 3 miles to the east of the project site. These localities produced fossilized impressions or remains of plants (e.g., freshwater green algae and vascular plants), nonmarine invertebrates (e.g., land or freshwater snails), and terrestrial vertebrates (e.g., lizards, snakes, marsupials, rodents, and artiodactyls, including *Sespia* spp. and *Hypertragulus* sp.). The upper sandstone-mudstone unit of the Otay Formation has produced important vertebrate fossil remains, and has been assigned a high paleontological sensitivity, while the lower fanglomerate and gritstone units have produced vertebrate fossils at only a few localities and have been assigned a moderate paleontological sensitivity.

Summary and Recommendations

The high paleontological sensitivity of the San Diego Formation, high to moderate paleontological sensitivity of the Otay Formation, and moderate paleontological sensitivity of the Lindavista Formation in San Diego County (Deméré and Walsh, 1993; Stephenson et al., 2009), as well as the presence of several SDNHM fossil collection localities near the project site, suggest the potential for construction of the proposed project to result in impacts to paleontological resources. Any proposed excavation activities that extend deep enough to encounter previously undisturbed deposits of these geologic units have the potential to impact the paleontological resources preserved therein. For these reasons, implementation of a complete paleontological resource mitigation program during ground-disturbing activities is recommended.

The fossil collection locality information contained within this paleontological records search should be considered private and is the sole property of the San Diego Natural History Museum. Any use or reprocessing of information contained within this document beyond the scope of the Lumina project is prohibited.

If you have any questions concerning these findings please feel free to contact me at 619-255-0321 or kmccomas@sdnhm.org.

Sincerely,

Katie McComas
Paleontology Collections Assistant
San Diego Natural History Museum

Enc: Figure 1: Project map
Appendix: List of SDNHM fossil localities in the vicinity of the project

Literature Cited

City of San Diego. 2011. California Environmental Quality Act, Significance Determination Thresholds. Development Services Department, 84 p.

Deméré, T.A., and Walsh, S.L. 1993. Paleontological Resources, County of San Diego. Prepared for the San Diego Planning Commission: 1–68.

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Tan, S.S., and Kennedy, M.P. 2002. Geologic map of the Otay Mesa 7.5-minute quadrangle, San Diego County, California: California Geological Survey and United States Geological Survey.

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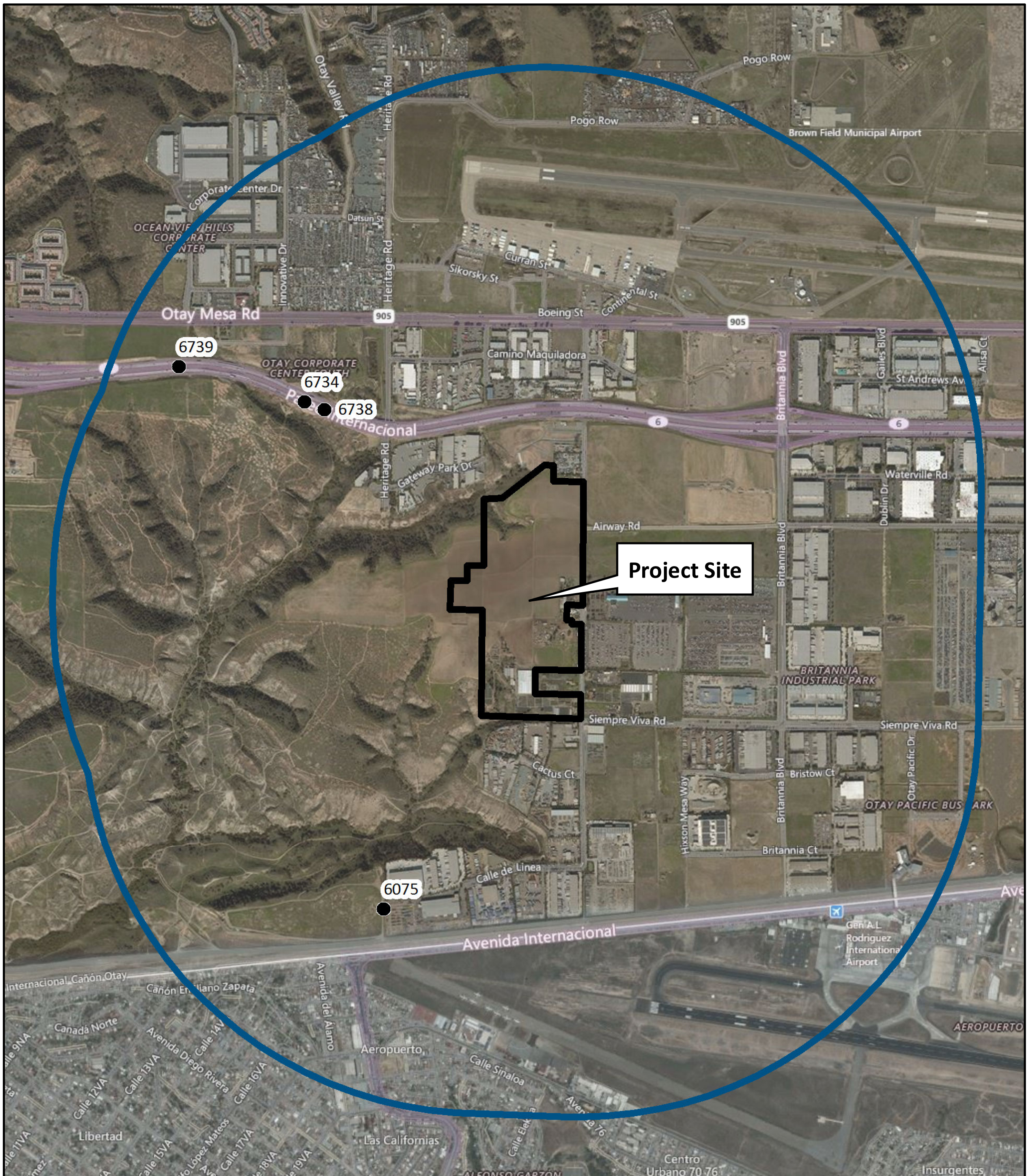
Walsh, S.L., and Deméré, T.A. 1991. Age and stratigraphy of the Sweetwater and Otay Formations, San Diego County, California. In, P.L. Abbott and J.A. May (eds.), Eocene Geologic History San Diego Region. Society of Economic Mineralogists and Paleontologists, Pacific Section 68: 131–148.

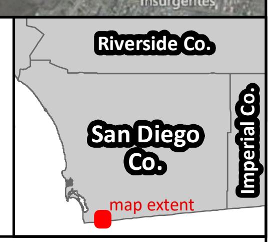


Sources: Bing Maps Hybrid Imagery, Microsoft et al., 2017

Project site

1 mile radius buffer

SDSNH localities



PALEOSERVICES

FIGURE 1

Project Map
Lumina Project
City of San Diego, San Diego County, California

0 0.4
scale in miles

Appendix: Locality List

San Diego Natural History Museum
Department of Paleontology

Locality Number	Locality Name	Location	Elevation (feet)	Geologic Unit	Era	Period	Epoch
6734	Caltrans SR-905, Phase 1B	City of San Diego, San Diego County, CA	447	San Diego Formation, member 1	Cenozoic	Neogene	late Pliocene
6075	Otay Ranch Village 2 North	City of Chula Vista, San Diego County, CA	467	San Diego Formation, member 2b	Cenozoic	Neogene	late Pliocene
6738	Caltrans SR-905, Phase 1B	City of San Diego, San Diego County, CA	469	San Diego Formation, member 5	Cenozoic	Neogene	late Pliocene
6739	Caltrans SR-905, Phase 1B	City of San Diego, San Diego County, CA	488	San Diego Formation, member 5	Cenozoic	Neogene	late Pliocene