

Requirement 1 – Site Design and Runoff Reduction:

Identify the strategies used to reduce runoff through site design. Strategies 1-5 required.

Describe or attach simple plan details for 1. – 5.

1. Limit disturbance of creeks and natural drainage features and setback development from these features. See attached Biological Mitigation Plan for setbacks to existing creeks.
2. Minimize compaction of highly permeable soils
No highly permeable soils exist on site. See attached web soil survey for soil type and attached infiltration testing.
3. Minimize clearing of native vegetation and grading, conserving natural areas and maximizing undisturbed areas, and developing along natural landforms.
It is intended that the project will follow conservation requirements of the Avila Ranch Specific Plan and Biological Mitigation Requirements. Grading will mimic natural landforms wherever practical and aim to balance earthwork operations.
4. Minimize impervious surfaces including roadways and parking lots
Alley areas are planned to be pervious pavers to minimize impervious surfaces. Also, development has been planned to be primarily high-density to cluster the development and maximize open space and park lands. See attached Zoning Plan.
5. Other (Optional): Identify strategy(s) and describe or show how it will be done in the project.
LIDs are proposed along the frontage of all residential development to emphasize source treatment control. See attached Landscape LID plan.
6. Do **one** of the following: ✓
 - Direct roof run off into cistern, rain barrel, or vegetated area
 - Direct driveway and/or parking area into vegetated area
 - Construct surfaces (bike lanes, walks, driveways, parking areas) with permeable surfaces

Attachments

3. Biological Mitigation Plan
4. Soil Survey
5. Infiltration Testing
6. Zoning and Project Statistics exhibit
7. Landscape LID plan

Requirement 2 – Water Quality Treatment:

(Reference Post Construction Stormwater Management Requirements for Development Projects in the Central Coast Region – Adopted July 12, 2013 California Regional Water Quality Control Board Central Coast Region – for details regarding requirements – Section B.3 and Section C. Alternative Compliance.)

Treatment

Location ✓ On Site Off Site - Alternative Compliance

Measure Used ✓ 1. Harvesting, infiltration, evapotranspiration
 2. Bio-filtration Treatment (*Document inability to use 1.*)
 3. Non-Retention Based Treatment (*Document inability to use 1. or 2.*)

Description of structural controls:

Biofiltration with some infiltration will provide the majority of water quality treatment but underdrains will be utilized to meet the required draw-down. Biofiltration will be provided along the frontage of all private parcels to emphasize source treatment control. Some roadway water quality treatment will also utilize neighborhood parks and Tank Farm Creek setbacks. Site soils are assumed to have relatively low infiltration capacity so underdrains will be provided to supplement the infiltration and allow for adequate draw-down of retained runoff. The emphasis on well-distributed, localized water quality treatment areas don't lend themselves to large enough storage for significant ponding that can provide complete localized infiltration. In those cases where it is not possible to create large above grade pond areas for stormwater infiltration, a retention-based system will be installed to provide treatment.

Alternative compliance measures:

n/a

Attachments

- 8. Typical biofiltration facility
- 9. Stormwater Treatment Area exhibit
- 10. Treatment and retention calculations

Certification

I John Rogers certify that the systems selected and sized, as demonstrated in the attached calculations, meet the Water Quality Treatment required for this project per the Post Construction Requirements adopted by the Central Coast Regional Water Quality Control Board. Where identified in the attached documentation, Water Quality Treatment will be met through alternative compliance.

Signature

Date

Requirement 3 – Runoff Retention:

(Reference Post Construction Stormwater Management Requirements for Development Projects in the Central Coast Region – Adopted July 12, 2013 California Regional Water Quality Control Board Central Coast Region – for details regarding requirements – Section B.4 and Section C. Alternative Compliance.)

- *If a revision to the site's Watershed Management Zone is being requested, attach Watershed Management Revision Request Form (Exhibit) and supporting documentation.*
- *Rainfall maps are available from the Regional Water Quality Control Board*

Site Assessment Measures Summary

- Attach documentation of the following information:
 - Site topography
 - Development envelope
 - Hydrologic features including natural areas, wetlands, watercourses, seeps, springs, and required setbacks
 - Vegetative cover including trees
 - Open space requirements
 - Location of groundwater wells used for drinking water
 - Depth to seasonal high groundwater
 - Soil types and hydrologic soil groups
 - Depth to impervious layer such as bedrock
 - Presence of unique geology (e.g. karst)
 - Geotechnical hazards
 - Existing structures, utilities, and drainage infrastructure including municipal storm drain system components
 - Existing easements and covenants
 - Documented soil or groundwater contamination
 - Source and estimated stormwater run-on from offsite, coming to project area
 - Drainage Management Areas (B.4.d.iii)
 - Drainage management strategies by Drainage Management Area
 - Runoff reduction measures and any structural control measures by Drainage Management Area (or full site as appropriate)
- Technical infeasibility limits on-site compliance
 - 10% of equivalent impervious surface area is dedicated to retention based stormwater control measures – No alternative compliance for retention
Runoff volume - compliance not achieved on-site: [Click here to enter text.](#)
 - Alternative compliance for retention proposed
Runoff volume – compliance not achieved onsite: [Click here to enter text.](#)
Runoff volume – alternative compliance used: [Click here to enter text.](#)

Analysis and Sizing

- Attach calculated Tributary Areas and Design Volumes per the Post Construction Stormwater Management Requirements – Attachment D
 - Adjustment made for redevelopment
 - Adjustment made for being in, and meeting requirements of, an Urban Sustainability Area

Control Mechanism

Site in Zone 1, 4, 7, and/or 10 and over groundwater basin

- 95th percentile event retained via infiltration
- Finding of technical infeasibility – Structural Stormwater Measure proposed

Site in Zone 2

- 95th percentile event retained via storage, harvesting, infiltration, and/or evapotranspiration
- Finding of technical infeasibility – Structural Stormwater Measure proposed

Site in Zone 5 and/or 8

- 85th percentile event retained via infiltration
- Finding of technical infeasibility – Structural Stormwater Measure proposed

Site in Zone 6 and/or 9

- 85th percentile event retained via storage, harvesting, infiltration, and/or evapotranspiration
- Finding of technical infeasibility – Structural Stormwater Measure proposed

Attachments

- 11. Constraints and Hazards Map
- 12. Landscape Plan
- See example treatment and retention calculations attached to Form 2

Post-Construction Owner Identification

At the time of completion of the construction work, and the shift to post-construction stormwater controls, the below listed owner is responsible for Operations and Maintenance of stormwater control measures: City of San Luis Obispo where within public right-of-way, public parks and open space. Home Owners Association (HOA) where within HOA maintained common lots/parks.

Certification

I John Rogers certify that the systems selected, sized, and designed as demonstrated in the attached calculations, meet the Runoff Retention Performance Requirement for this project per the Post Construction Requirements adopted by the Central Coast Regional Water Quality Control Board. Where identified in the attached documentation, Runoff Retention will be met through alternative compliance.

Signature

Date

Requirement 4 – Peak Management

(Reference Post Construction Stormwater Management Requirements for Development Projects in the Central Coast Region – Adopted July 12, 2013 California Regional Water Quality Control Board Central Coast Region – for details regarding requirements – Section B.5)

*Show any stormwater control measures used to meet the requirements of this section, **in the documentation and attachments required for Retention** (Form 3), including in all mapping and Operations and Maintenance materials.*

Note: The local Waterways Management Plan requires that the overall rate of runoff from a project does not significantly exceed pre-development conditions for the 2-year, 10-year, and 100-year return interval peak runoff events. See the drainage report for Avila Ranch Tentative Tract Map 3089. The 2 through 10-year post-development peak flows do not exceed pre-development rates. This is achieved primarily through a cooperative agreement with the Chevron Tank Farm restoration and development project upstream of the Avila Ranch development. The restoration and wetland creation will over-detain and offset all increases in runoff associated with the development of the Avila Ranch property.

Peak Management Compliance

- Post-development peak flows, discharged from the site, do not exceed pre-project peak flows for the 2 through 10 years storm events.
- Technical infeasibility limits on-site compliance
 - Alternative compliance for retention proposed
Runoff volume – compliance not achieved onsite: [Click here to enter text.](#)
Runoff volume – alternative compliance used: [Click here to enter text.](#)

Attachments

- See drainage report for Avila Ranch Tentative Tract Map 3089 provided with the Tract Map submittal.

Post-Construction Owner Identification

At the time of completion of the construction work, and the shift to post-construction stormwater controls, the below listed owner is responsible for Operations and Maintenance of the peak management control measures:

Chevron Environmental will maintain the detention basins upstream of Avila Ranch.

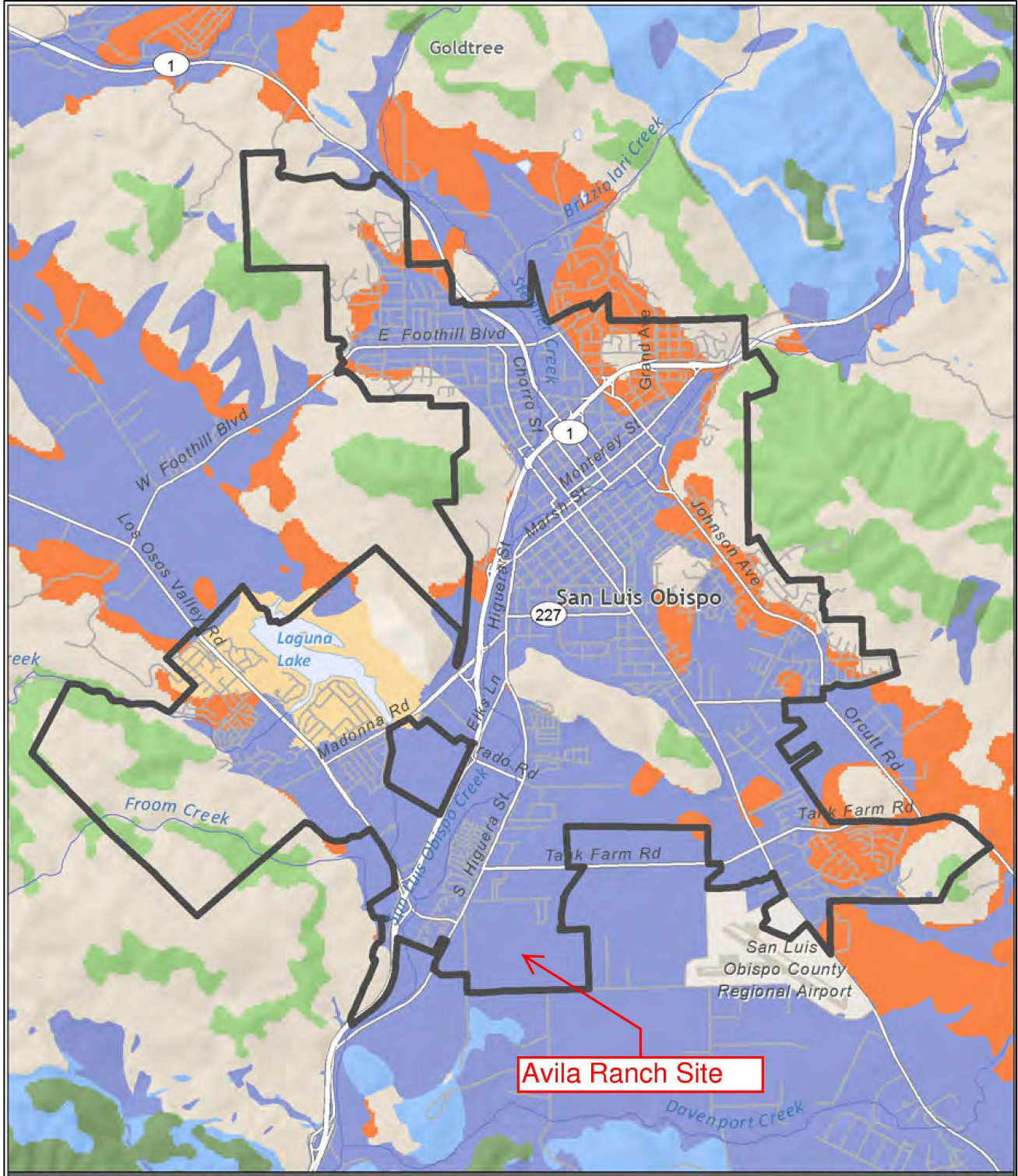
Certification

I John Rogers certify that the systems selected, sized, and designed as demonstrated in the attached calculations, meet the Peak Management requirements for this project per the Post Construction Requirements adopted by the Central Coast Regional Water Quality Control Board. Where identified in the attached documentation, Peak Management will be met through alternative compliance.

Signature

Date

Watershed Management Zones



CENTRAL COAST JOINT EFFORT

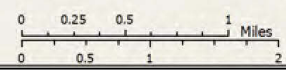
San Luis Obispo, California

Watershed management zones

- | | | |
|---|---|----|
| 1 | 5 | 9 |
| 2 | 6 | 10 |
| 3 | 7 | |
| 4 | 8 | |

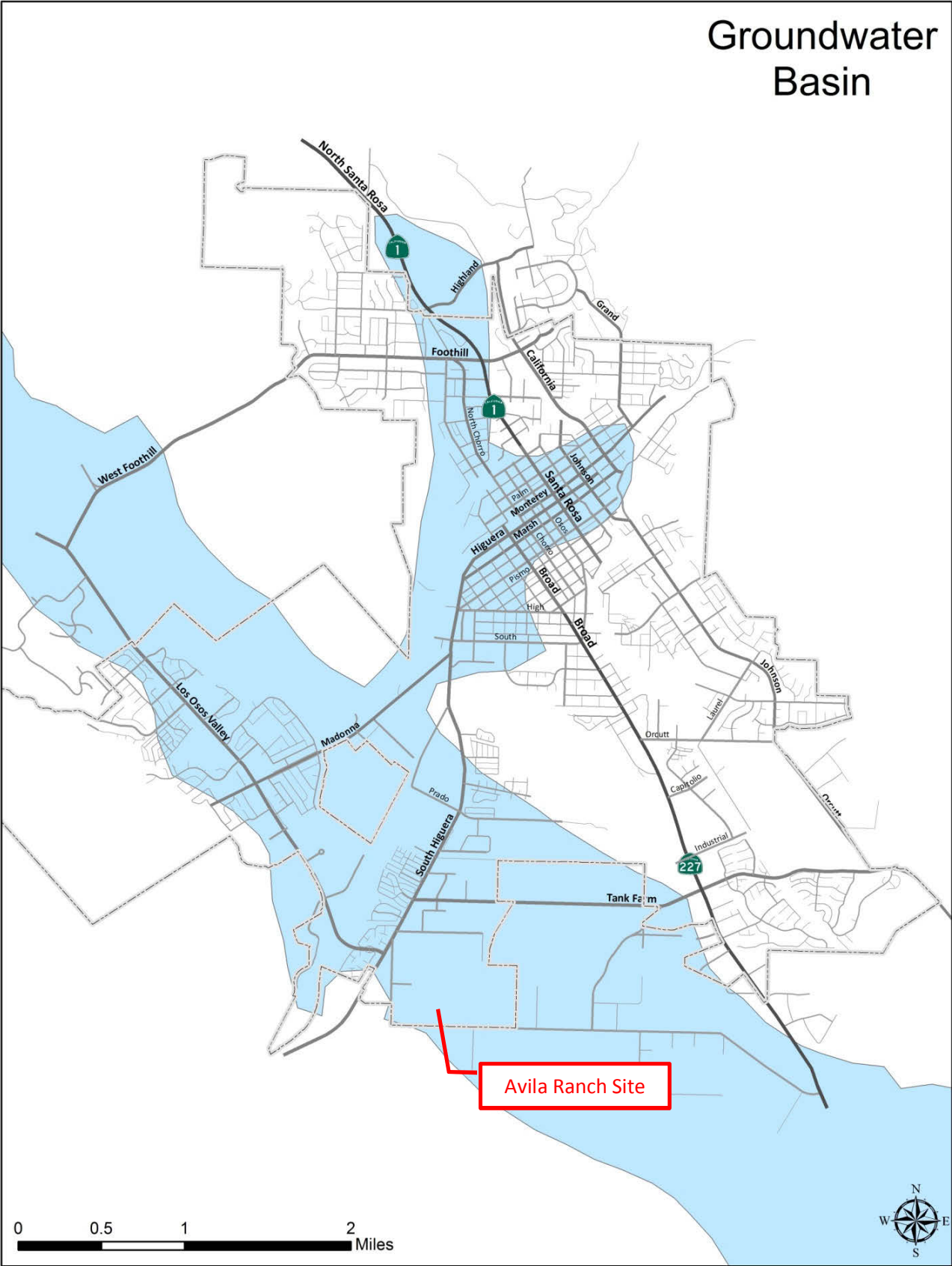
Urban area boundary

Data sources
 Watershed management zones: Stillwater Sciences, 2012
 Base data: ESRI 2010

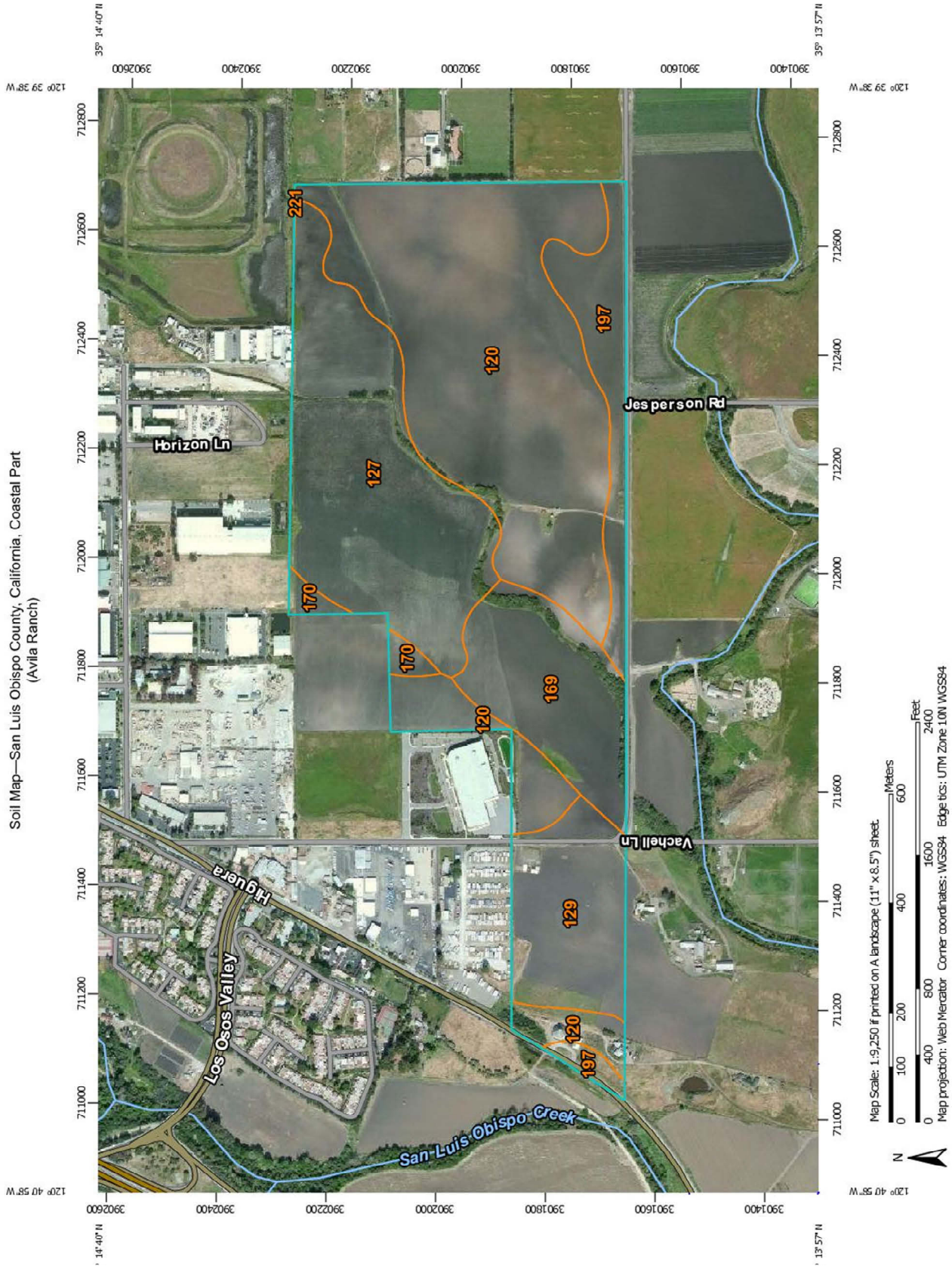


Stillwater Sciences
www.stillwatersci.com

Ground Water Basin



NRCS Soil Survey



Soil Map—San Luis Obispo County, California, Coastal Part (Avila Ranch)

Map Scale: 1:9,250 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

USDA
Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

NRCS Soil Survey

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

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

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot

- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: San Luis Obispo County, California, Coastal Part
 Survey Area Date: Version 6, Sep 26, 2014

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

Date(s) aerial images were photographed: May 8, 2010—May 21, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

San Luis Obispo County, California, Coastal Part (CA664)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
120	Concepcion loam, 2 to 5 percent slopes	76.7	44.2%
127	Cropley clay, 0 to 2 percent slopes	43.2	24.9%
129	Diablo clay, 5 to 9 percent slopes	17.9	10.3%
169	Marimel sandy clay loam, occasionally flooded	20.0	11.5%
170	Marimel silty clay loam, drained	2.3	1.3%
197	Salinas silty clay loam, 0 to 2 percent slopes	13.5	7.8%
221	Xererts-Xerolls-Urban land complex, 0 to 15 percent slopes	0.0	0.0%
Totals for Area of Interest		173.7	100.0%

Infiltration Testing

CONCLUSIONS

The infiltration test results indicate that infiltration rates of the surface materials can be categorized for hydrologic purposes utilizing the Hydrologic Soil Group (HSG) classification ranging from group B, C, and D (*Part 630, Hydrology, National Engineering Handbook, 2007*).

An inspection of Figure 3, Infiltration Test Results, shows that the soils on the north and west side of the creek tend to have better infiltration rates. Soils in localized areas adjacent to the creek tend to be very low permeable soils.

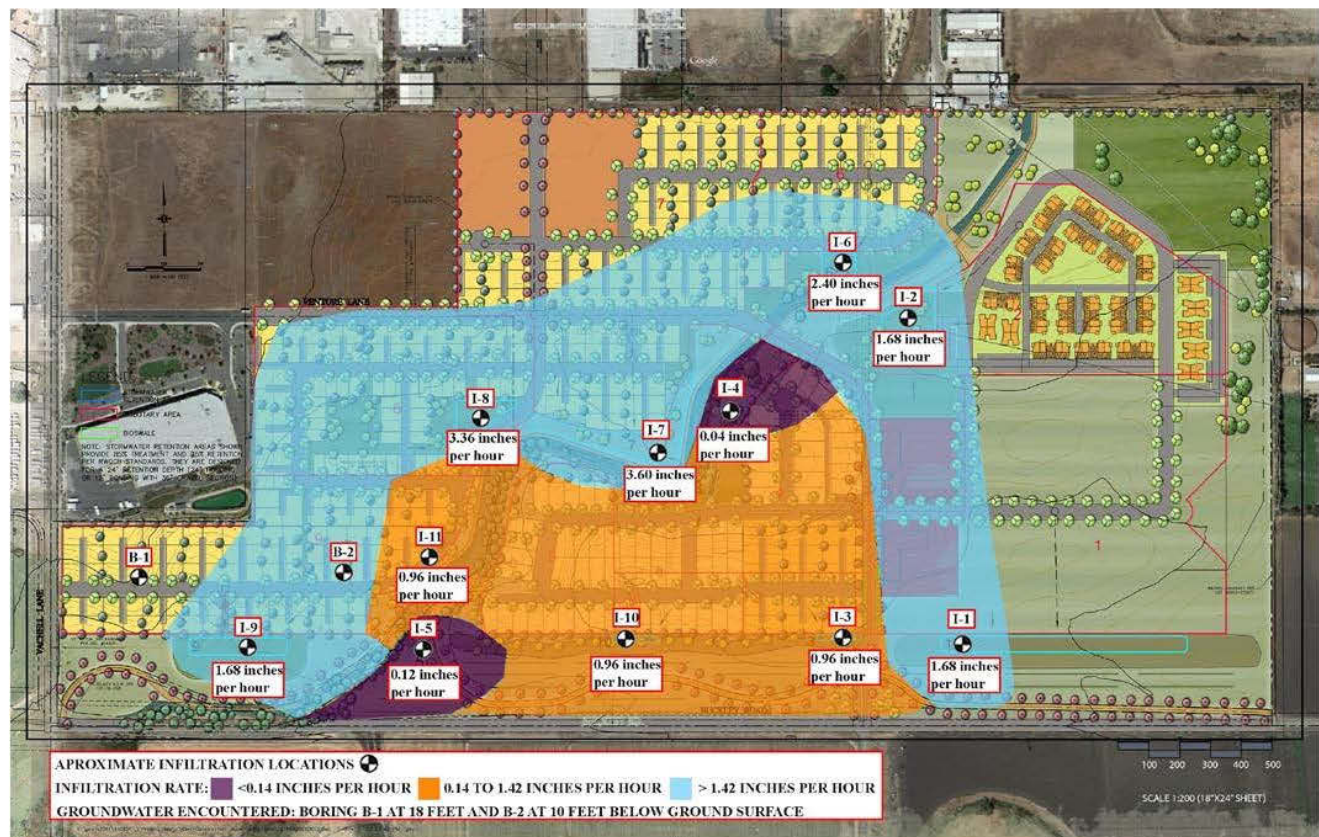


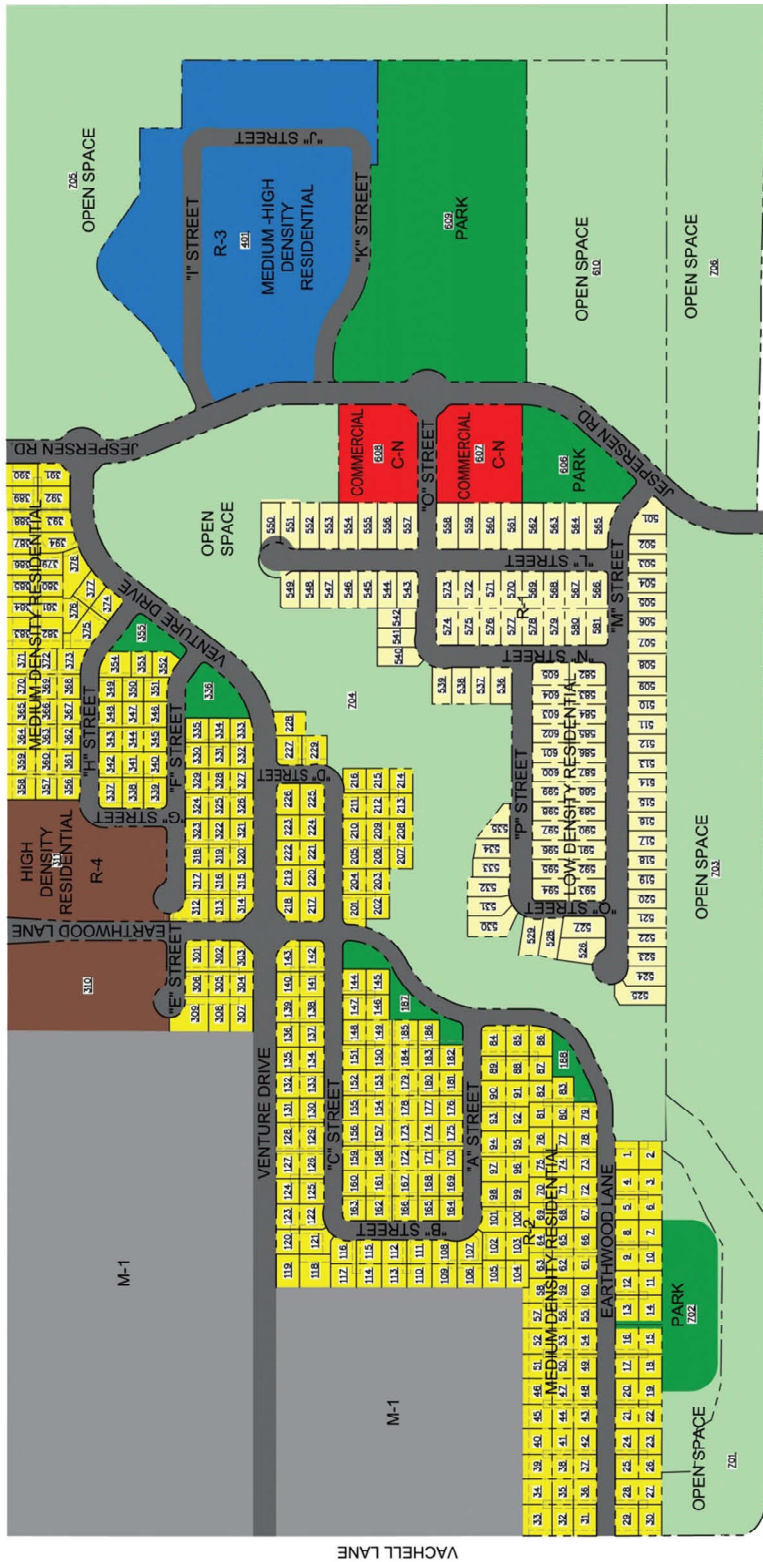
Figure 3: Infiltration Test Results

Although the recent drought condition has lowered the water table since the 2001 borings (ES 2001) groundwater is still present at relatively shallow depths on the southwest section of the property. In addition, soils are generally wet at depth throughout the site. Project designers should consider the groundwater elevation reported above from the 2001 event in design.

Group B-Soils in Group B have a moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 and 20 percent clay and 50 to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

The limits on the diagnostic physical characteristics of Group B are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 20 inches ranges from 1.42 to 5.67 inches per hour.

Zoning and Project Statistics



LEGEND

- OPEN SPACE (6 LOTS)
- PARK (8 LOTS)
- R-1 ZONE (105 LOTS)
- R-2 ZONE (905 LOTS)
- R-3 ZONE (3 LOTS W/ 185 TOWNHOMES)
- R-4 ZONE (2 LOTS W/125 UNITS)
- C-N ZONE (2 LOTS)

STATISTICS

LOT TYPE	TOTAL AREA (ACRE)
OPEN SPACE	58.2
PARK	11.9
R-1 ZONE	12.7
R-2 ZONE	28.9
R-3 ZONE	4.7
C-N	2.4

PUBLIC DEDICATION

RIGHT-OF-WAY	PARKS
EARTHWOOD LANE	LOT 187
VENTURE DRIVE	LOT 188
JASPERSEN ROAD	LOT 336
B STREET	LOT 605
C STREET	LOT 609
D STREET	LOT 610
E STREET	LOT 701
F STREET	LOT 702
G STREET	LOT 704
H STREET	LOT 705
I STREET	LOT 706
J STREET	LOT 707
K STREET	LOT 708
L STREET	LOT 709
M STREET	LOT 710
N STREET	LOT 711
O STREET	LOT 712
P STREET	LOT 713
Q STREET	LOT 714



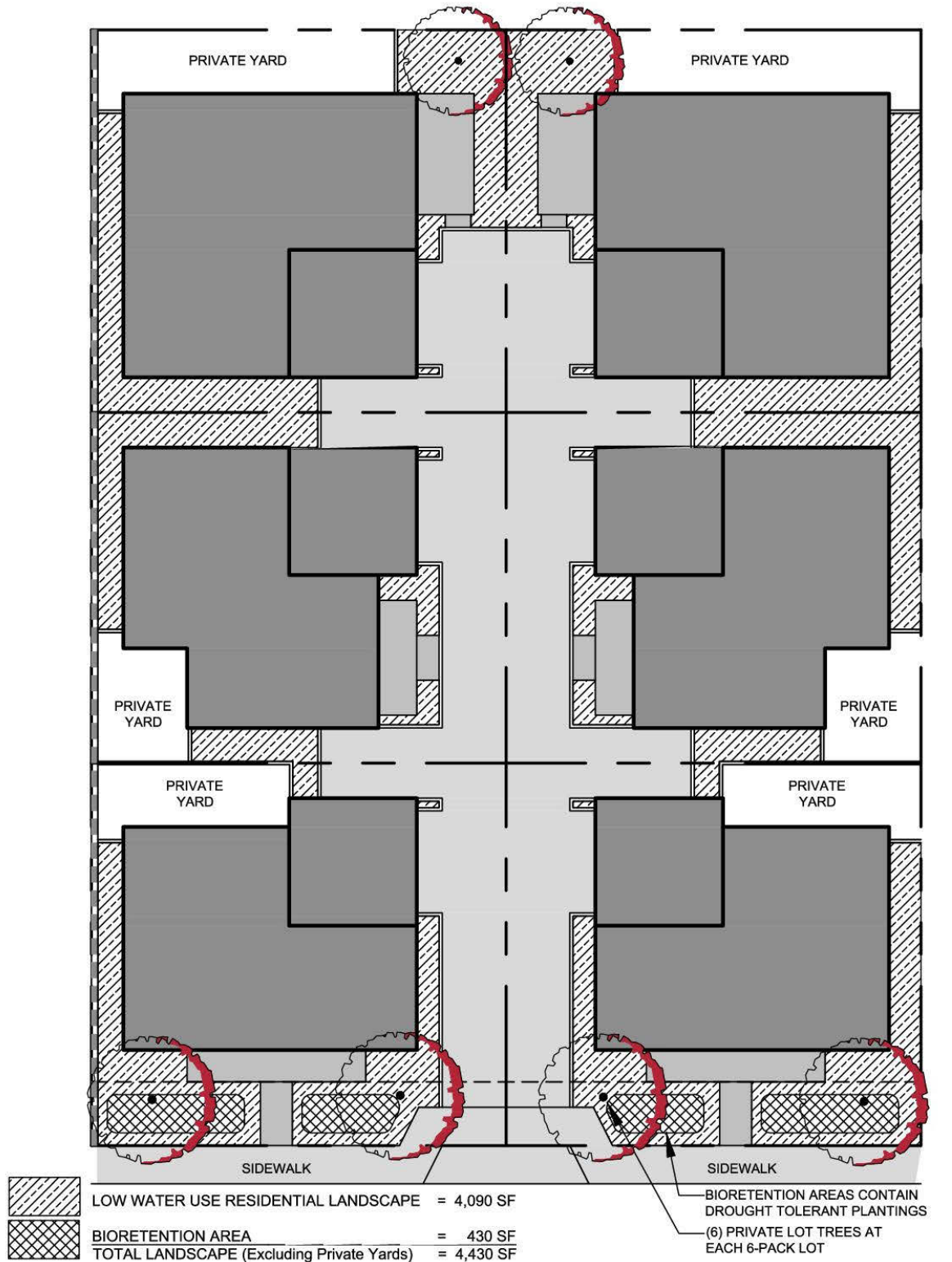
Canon
1000 Southward Drive
San Luis Obispo, CA 93408

AVILA RANCH DEVELOPMENT
TRACT 3089 - VESTING TENTATIVE MAP
ZONING AND PROJECT STATISTICS

CITY OF SAN LUIS OBISPO, CA

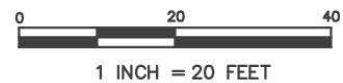
DATE: 2015-09-08
DRAWN BY: JN
CHECKED BY: JPS
SCALE: AS SHOWN
SHEET: 03 OF 41

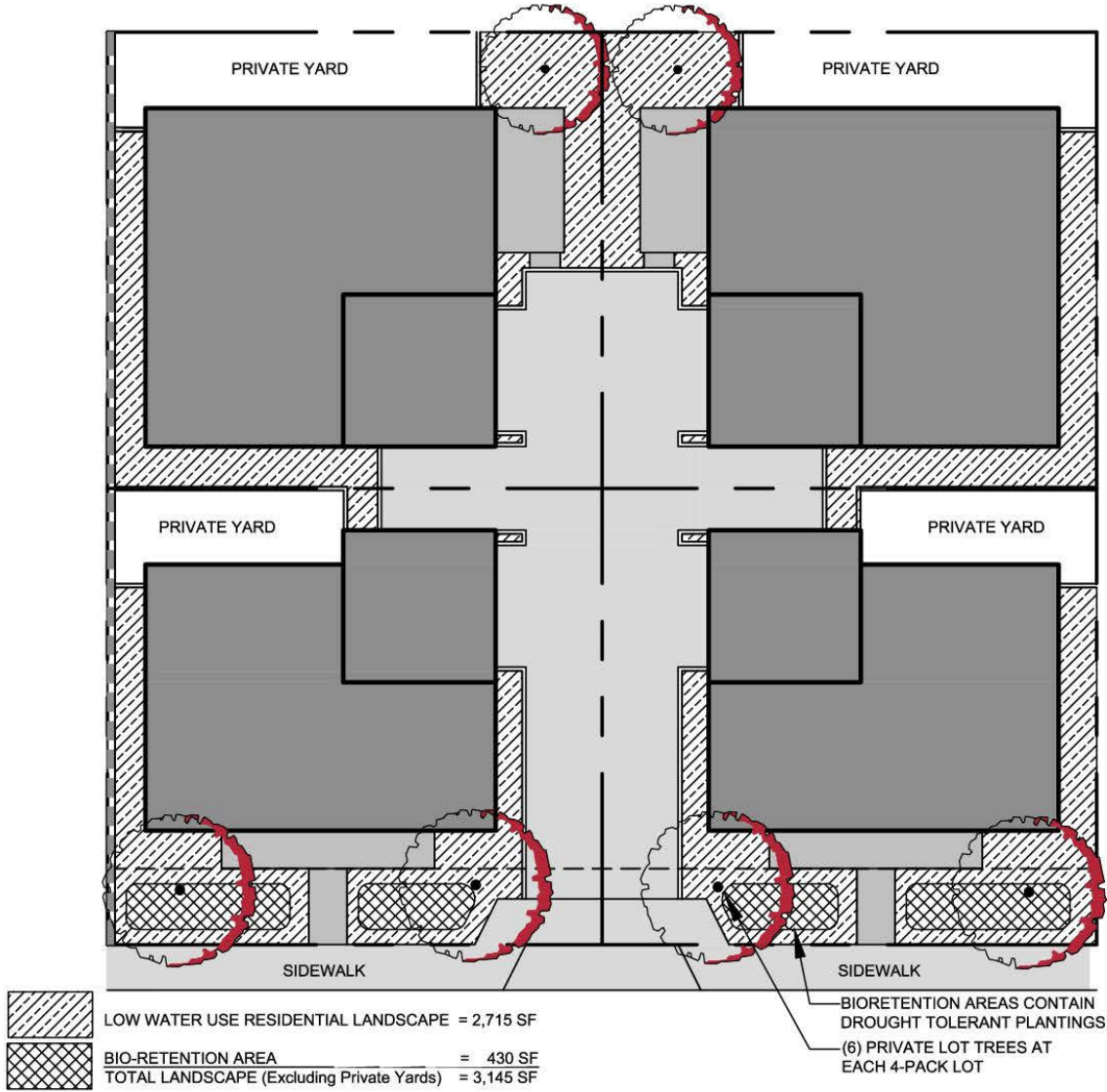
Landscape LID Plan



**AVILA RANCH
TYPICAL 6-PACK LOT LANDSCAPING**

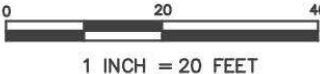
See Residential Plant Palette for plant species

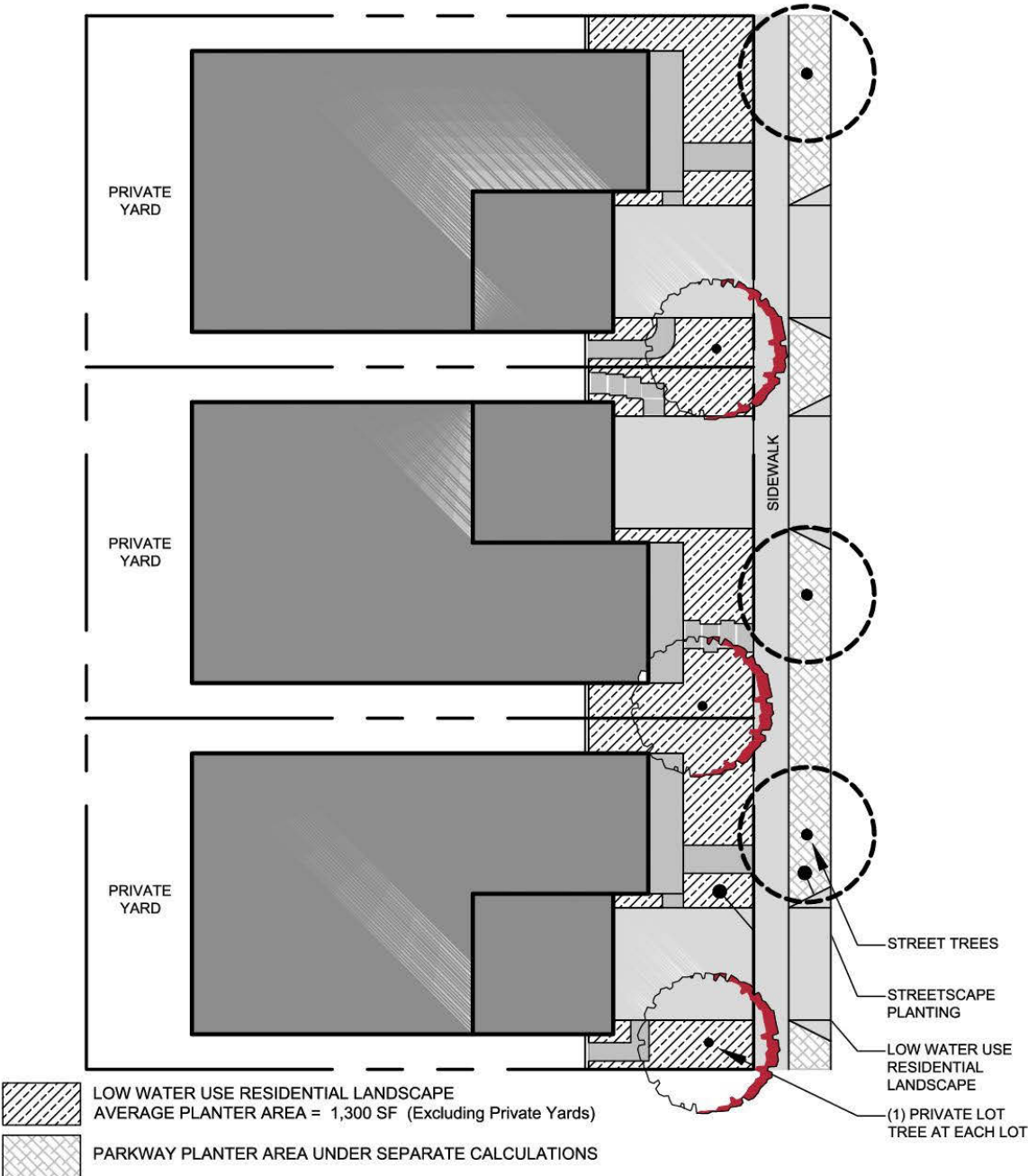




AVILA RANCH
TYPICAL 4-PACK LOT LANDSCAPING

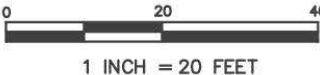
See Residential Plant Palette for plant species





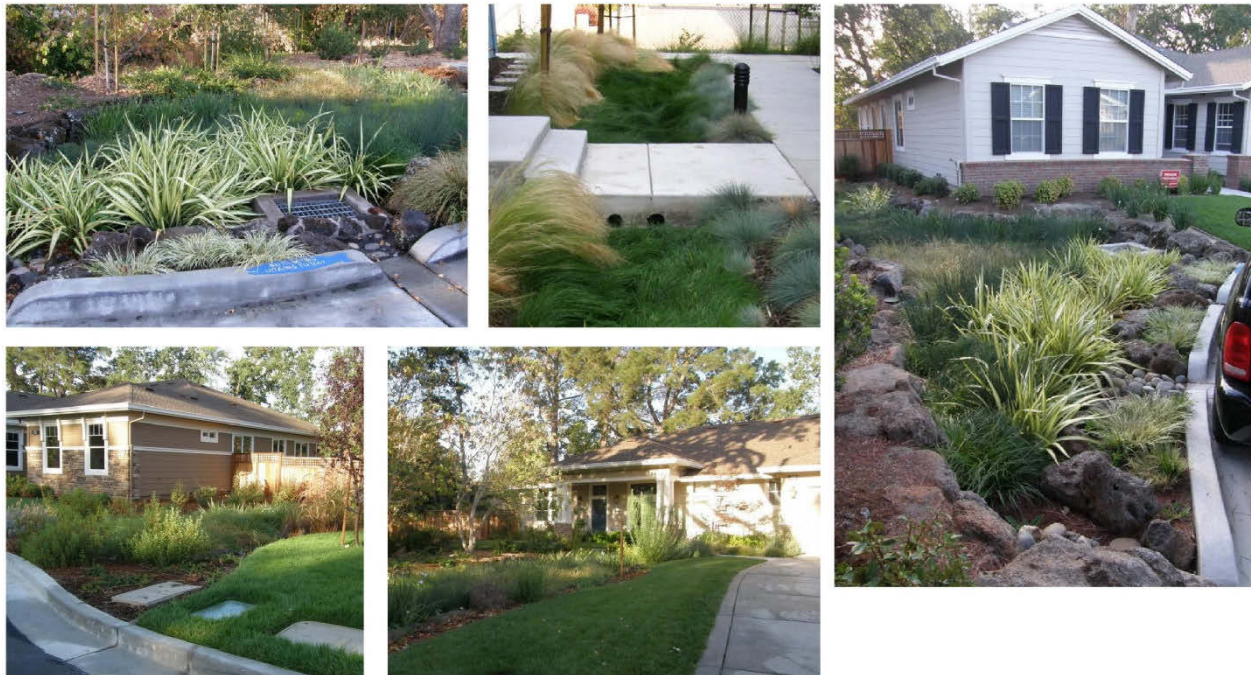
AVILA RANCH
TYPICAL SINGLE FAMILY LOT LANDSCAPING

See Residential Plant Palette for plant species



Typical Bioretention Facility

LID stormwater strategies front yard bioretention



Avila Ranch
Low Impact Development Strategies

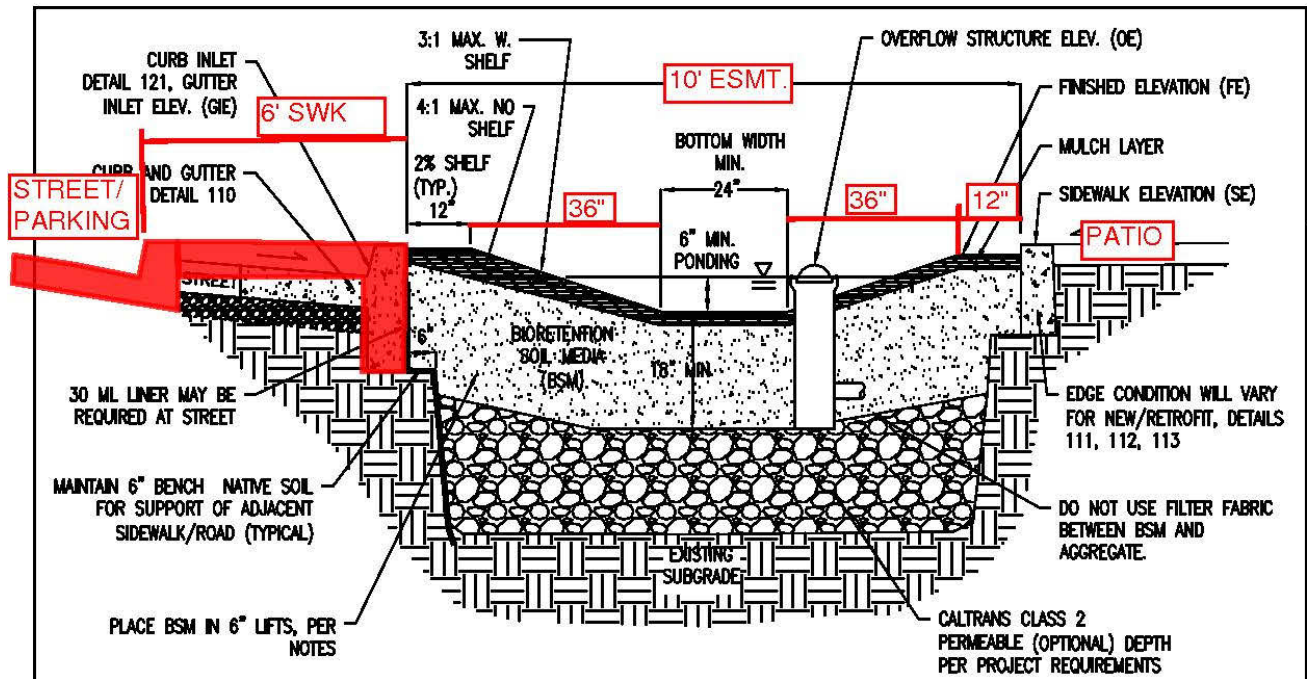


LID stormwater strategies residential applications



Avila Ranch
Low Impact Development Strategies





DESIGN NOTES

1. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT.
2. OVERFLOW STRUCTURE REQUIRED FOR IN-LINE SYSTEMS WITHOUT OVERFLOW BYPASS, DETAIL 140.
3. PROVIDE SPOT ELEVATIONS AT INLETS ON CIVL PLANS (FE, OE, GIE, SE). SEE DETAIL 121.
4. MAX. LONGITUDINAL SLOPE 6% WITH CHECK DAMS. SEE DETAILS 130, 131.
5. EDGE CONDITION WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB AND SIDEWALK DETAILS MAY BE MODIFIED FOR PROJECT BY CIVL AND GEOTECHNICAL ENGINEERS.
6. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
7. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP LAYER OF 3/4" (NO. 4) OPEN-GRADED AGGREGATE.
8. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
8. PLANTING DESIGN AND IRRIGATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
8. MULCH (OPTIONAL) PER BIORETENTION TECHNICAL SPECIFICATIONS.
9. LOCATE ENERGY DISSIPATION COBBLE ONLY AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.

CONSTRUCTION NOTES

1. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
2. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED SOIL AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVL PLANS.
3. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, ALLOW TO DRY OVERNIGHT BEFORE PLANTING.
4. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
5. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT TYPICAL DETAILS VERSION: 3/6/2013

Detail Number

SAN LUIS OBISPO COUNTY

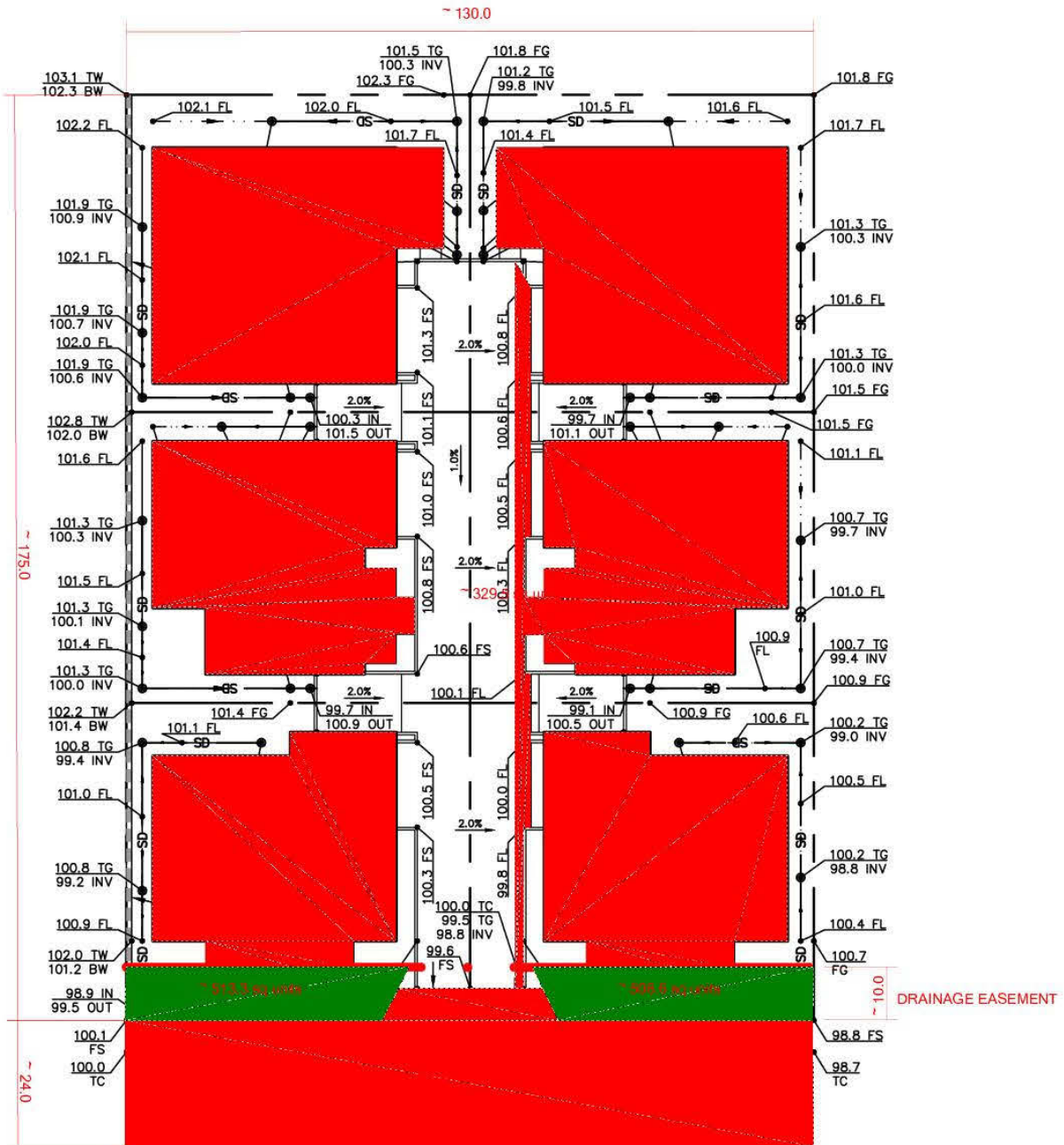


Street Bioretention Facility

(sloped sided, w. on-street parking, sidewalk, without underdrain)

103

Stormwater Treatment Area

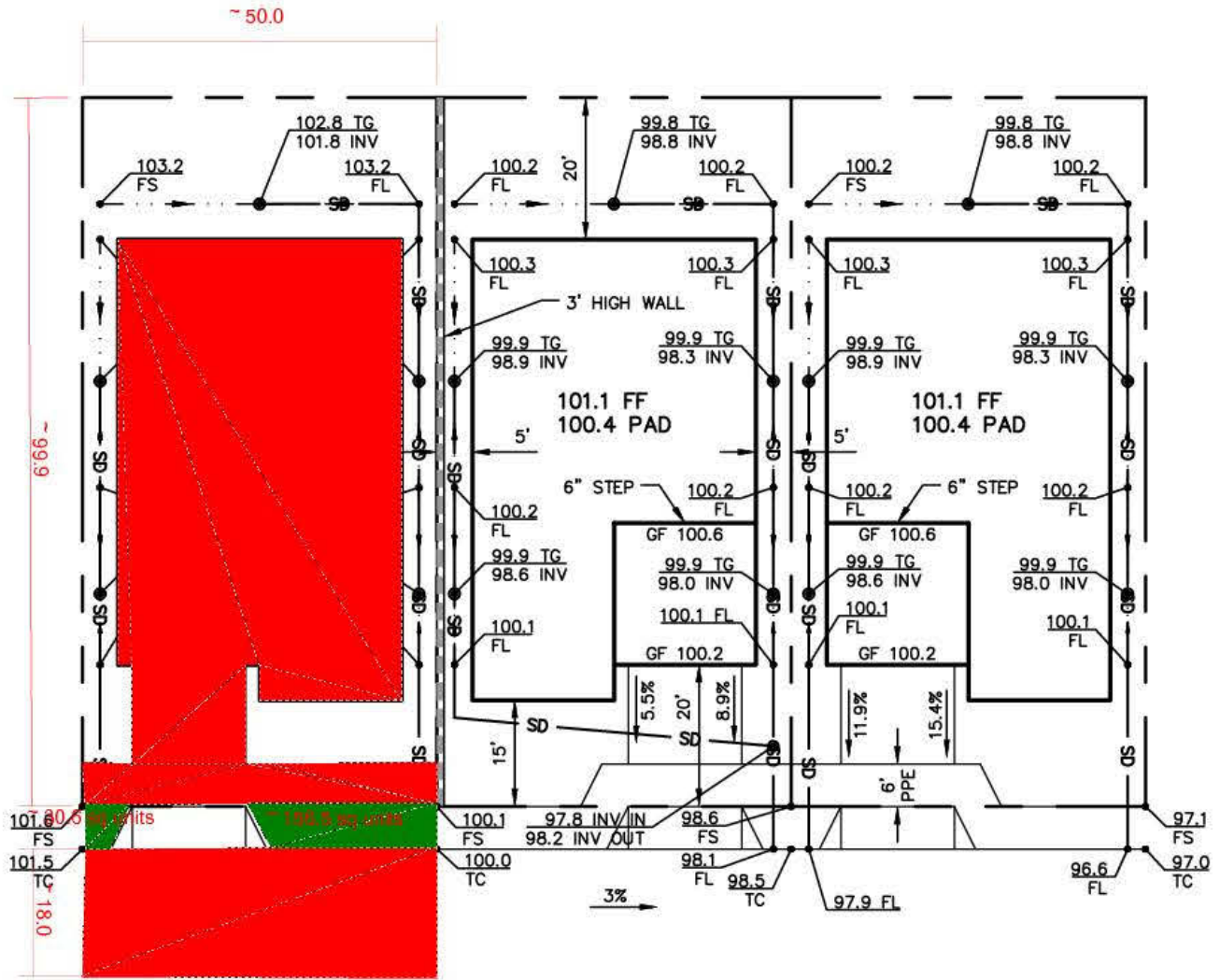


6-PACK AREA = 130' X 175' = 22,570 SF
 IMP. AREA = 12,300 SF
 REQ. TREATMENT AREA = 300 SF
 REQ. RETENTION = 820 SF

6-PACK ROW AREA = 3,300 SF
 IMP. AREA = 3,300 SF
 REQ. TREATMENT AREA = 120 SF
 REQ. RETENTION = 200 SF

TYPICAL 6-PACK LOTS

SCALE HORIZ 1"=20'



6-PACK AREA = 123' X 50' = 6,150 SF
 IMP. AREA = 3,900 SF
 REQ. TREATMENT AREA = 100 SF
 REQ. RETENTION = 180 SF

TYPICAL SINGLE-FAMILY LOTS

SCALE HORIZ 1"=20'

Treatment and Retention Calculations

6-PACK ONSITE

TOTAL AREA	22,570	SF
IMP AREA	12,300	SF
IMP %	50%	

6-pack			
85% Event	1.2	IN	
95% Event	1.9	IN	
Lots	22,570	SF	
R-O-W	-	SF	
Parks	-	SF	
% Impervious Lots	50		
% Impervious ROW	100		
% Impervious Parks	-		
Imp Surface	11,285	SF	
Trib Area	22,570	SF	
Impervious	0.50000		
C	0.33925		
85% Runoff	766	CF	
95% Runoff	1,212	CF	
Design Volumes:			
95% Area with 6" PONDING, 18" SOIL, 18" ROCK	820	SF	
Design Flows:			
85% treatment	300	SF	
85% treatment	0.04	CFS	

NOTE: 10' bio swale width volume assumes 6" ponding, 18" soil, 18" rock. This section could be reduced if infiltration is considered.

6-PACK ROADWAY

TOTAL AREA	3,300	SF
IMP AREA	3,300	SF
IMP %	100%	

6-pack		
85% Event	1.2	IN
95% Event	1.9	IN
Lots	-	SF
R-O-W	3,300	SF
Parks	-	SF
% Impervious Lots	50	
% Impervious ROW	100	
% Impervious Parks	-	
Imp Surface	3,300	SF
Trib Area	3,300	SF
Impervious	1.00000	
C	0.89200	
85% Runoff	294	CF
95% Runoff	466	CF
Design Volumes:		
95% Area with 1' PONDING, 24" SOIL, 24" ROCK	200	SF
Design Flows:		
85% treatment	120	SF
85% treatment	0.01	CFS

NOTE: Park area per 6-pack assumes volume associated with 1' ponding, 24" soil, 24" rock. This section could be reduced if infiltration is considered.

SINGLE FAMILY ONSITE & ROADWAY

TOTAL AREA	6,150	SF
IMP AREA	3,900	SF
IMP %	60%	

6-pack		
85% Event	1.2	IN
95% Event	1.9	IN
Lots	6,150	SF
R-O-W	-	SF
Parks	-	SF
% Impervious Lots	60	
% Impervious ROW	100	
% Impervious Parks	-	
Imp Surface	3,690	SF
Trib Area	6,150	SF
Impervious	0.60000	
C	0.40893	
85% Runoff	251	CF
95% Runoff	398	CF
Design Volumes:		
95% Area with 6" PONDING, 18" SOIL, 36" ROCK	180	SF
Design Flows:		
85% treatment	100	SF
85% treatment	0.01	CFS

NOTE: 5' bio swale width volume assumes 6" ponding, 24" soil, 36" rock. This section could be reduced if infiltration is considered.



Appendix E

Floodplain Analyses



September 14, 2015

Project No. 1428.001

Mr. John Rogers
Civil Senior Associate Engineer
CANNON
105 Southwood Drive
San Luis Obispo, CA 93401

Hydrology Study and Floodplain Analysis
Avila Ranch Development
San Luis Obispo, California

Dear Mr. Rogers:

This report documents the hydrologic and hydraulic analyses conducted to assess the extents of the 100-year floodplain and 100-year base flood elevations for existing conditions and proposed post-development conditions at the Avila Ranch property in San Luis Obispo, California (the site).

This evaluation was conducted in part to support efforts in developing a final grading plan and storm water infrastructure for the site. The analysis does not take into account actual pad elevations and in such assumes that flood waters are constrained to the grading extents provided by Cannon as of the writing of this report. This analysis shall be updated when final grading elevations and storm water infrastructure for the development project are finalized in support of a Conditional Letter of Map Revision (CLOMR) submittal.

INTRODUCTION AND BACKGROUND

The site is located in the City of San Luis Obispo, California and encompasses approximately 141 acres northeast of the intersection between Vachell Lane and Buckley Road (Figure 1). The site currently supports agricultural uses and is bisected by Tank Farm Creek which runs from the northeastern portion of the property to the southwestern corner. The site's post-development condition is planned for residential, open space, and public park development.

This report identifies the land use, drainage catchments, and hydraulic conditions of the site for both existing conditions as well as proposed post-development conditions to determine peak storm water flow rates through Tank Farm Creek for the 100-year storm event and to delineate the 100-year floodplain for each condition. For the purposes of this study, existing conditions at the site assumes that storm water management improvements proposed by Chevron on the property upstream of the site have been completed. Improvements proposed by Chevron include increasing storm water detention on their property and metering the peak flow rate from their property through Tank Farm Creek to approximately 90 cubic feet per second (cfs) for the 100-year storm. It is also assumed that as part of the project Tank Farm Creek will be rerouted to extend from the

Hydrology Study and Floodplain Analysis

southeastern portion of the Chevron property, through the Avila Ranch development, and reconnect with the existing Tank Farm Creek alignment (Figure 2).

The following sections describe the hydrologic and floodplain analyses performed for both the existing and proposed post-development conditions at the site.

HYDROLOGIC ANALYSIS

The hydrologic analysis takes on the approach provided in Volume III of the Waterway Management Plan (WMP) for the City and County of San Luis Obispo. The approach uses the Rational Method as described in the WMP for determining peak storm water runoff flow rates from the various catchments that makeup the subject watershed and using the peak flow rates in developing a model of the channel system.

Catchments tributary to Tank Farm Creek were delineated through examination of topographic and City storm water infrastructure mapping of the study area. The hydrology for each catchment was calculated on a macro scale and did not take into consideration local storm water management infrastructure such as privately owned detention basins, storm water detention vaults, and storm water conveyance infrastructure. Peak storm water runoff for each catchment was estimated using the Rational Method as outlined in Volume III of the Waterway Management Plan for the City and County of San Luis Obispo.

Existing Conditions Hydrology

Delineated catchments for existing conditions are shown in Figure 2. Runoff coefficients, time of concentration, and rainfall intensity were determined for each catchment using tables and equations published in Section H (Hydrology) of the San Luis Obispo County Department of Public Works and Transportation Standard Construction Drawings (SLO County DPW 2014). Where land use conditions were not uniform over the entire catchment an area weighted average runoff coefficient was calculated. A summary of area, average slope, time of concentration, rainfall intensity, runoff coefficient, and peak storm water runoff during the 100-year storm event for each catchment under the existing conditions is provided in Table 1. The peak flows for catchments and discharges from neighboring properties were then assigned as inflows into the HEC-RAS model, a table summarizing the inflows and cumulative peak flows at cross-sections along Tank Farm Creek is provided in Table 3.

Proposed Post-Development Conditions Hydrology

Post-development catchment delineations for the site incorporates proposed storm water management infrastructure (i.e. street drop inlets, storm drain piping, etc...) provided by Cannon for management of both onsite storm water runoff and offsite storm water runoff. Peak flow discharges at various locations along the creek for onsite storm water runoff were provided by Cannon and are summarized in Table 4. Delineated offsite catchments for the proposed post-development conditions are shown in Figure 4. Catchment areas, times of concentration, and runoff coefficients for the post-development conditions were calculated based on the reconfiguration of catchments as a result of proposed storm water management infrastructure

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improvements as well as the change in land use. A summary of peak storm water runoff for the 100-year storm event and the associated parameters used to calculate this peak using the Rational Method is provided in Table 2. The peak flows for the onsite catchments, offsite catchments, and discharges from neighboring properties were then assigned as inflows into the HEC-RAS model, a table summarizing the inflows and cumulative peak flows at cross-sections along Tank Farm Creek is provided in Table 4.

FLOODPLAIN ANALYSIS

The floodplain analysis was conducted by creating a model using the US Army Corp of Engineers Hydrologic Engineering Center River Analysis System (HEC-RAS) to determine water surface elevations within a creek and adjacent floodplain based on peak storm water runoff flow rates. A HEC-RAS model for the East Fork San Luis Obispo Creek, was provided by the City of San Luis Obispo and assumed a peak flow rate discharge from Tank Farm Creek at its confluence of 900 cfs.

As part of this study, a model for Tank Farm Creek was constructed that extends from the northern property boundary of the site to the confluence of Tank Farm Creek and the East Fork San Luis Obispo Creek. The newly constructed Tank Farm Creek model was then merged with the City provided East Fork San Luis Obispo Creek model and the associated assumed peak flow rate assigned in the City provided model was removed.

The following sections describe how the Tank Farm Creek model was created, what parameters were used and the results of the model run. An output of the model parameters and cross sections is included in Appendix A.

Model Geometry

The alignment of Tank Farm Creek and associated cross sections were generated in AutoCAD Civil 3D 2015. Elevations for each cross section were determined using existing and proposed maximum grading extents topography provided by Cannon. The alignment and cross sections for Tank Farm Creek were exported from AutoCAD and imported into the existing City provided HEC-RAS model for the East Fork San Luis Obispo Creek. Additional parameters such as left and right bank stations and elevations and obstructions were defined for each cross section within the model.

Levee definitions were used within the model for Tank Farm Creek where adjacent land elevations were below the left or right bank station elevations. Without defining the left or right bank elevation as a levee within the model the model engine will artificially extend water surface elevations to adjacent areas even though the water surface elevation calculated by the model does not exceed the channel bank elevations.

Manning's Roughness Coefficient

Manning's roughness coefficients ("n" values) were defined for the channel section and the overbank section of each cross-sections. Manning's "n" values were selected based on guidance from tables presented in USGS Guide for Selecting Manning's Roughness Coefficients for Natural

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Channels and Flood Plains WSP 2339 (Arcement, 1989). Using this methodology an initial Manning's "n" value is selected based on the soil conditions (firm soil for this site), this initial value is then increased based on adjustments for irregularity of the channel or floodplain, variation in channel cross-section, degree of obstruction, and degree of vegetation. Based on field observations, Tank Farm Creek in the study area is a highly vegetated channel with reeds, bushes, and trees growing within the channel banks. A Manning's "n" value of 0.071 was selected for this portion of the channel. The overbank areas are primarily occupied by cultivated fields, with minor irregularities and no major obstructions. A Manning's "n" value of .041 was selected for the overbank areas. In the northern portion of the project site a reduced Manning's "n" value of 0.35 was used for the realigned channel section of Tank Farm Creek as this will be an engineered channel, and the degree of obstruction and vegetation can be managed.

Hydraulic Structures

Several hydraulic structures were modeled along Tank Farm Creek within the study area. The first of these structures is a 48" diameter corrugated metal culvert at Station 29+00 of Tank Farm Creek in the HEC-RAS model. The next two structures are bridges over Tank Farm Creek at Buckley Road (Station 6+60) and Vachell Lane (Station 2+75). The geometry of the bridges were approximated within the model based on record drawings, aerial photography, survey data and measurements taken in the field.

RESULTS AND CONCLUSION

In the existing conditions, 100-year base flood elevations exceed the defined bank elevations of Tank Farm Creek in several locations along its length resulting in the 100-year floodplain extending into the adjacent agricultural fields. The extents of the 100-year floodplain and water surface elevations for existing conditions are shown in Figure 3.

Approximately 1,500 feet upstream of the confluence between Tank Farm Creek and the East Fork San Luis Obispo Creek 100-year base flood elevations exceed the defined banks of Tank Farm Creek. This appears to be the result of backwater conditions from peak flow through the East Fork San Luis Obispo Creek as the floodplain in this area matches the existing City HEC-RAS model results as shown in the City and County's Waterway Management Plan. The 100-year base flood elevation across Buckley Road bridge is modeled to be approximately 102.68 feet. The bridge deck is estimated to be at approximately 98.5 feet from existing topography. This translates to a submergence of approximately 4.2 feet in the existing conditions scenario during the 100-year storm event at the Buckley Road bridge.

In the post-development conditions it was assumed that development of the site would constrain flood elevations within the existing riparian corridor along Tank Farm Creek. In order to assess the maximum flood elevations expected, and to set development pad elevations, the post-development model utilizes obstructions defined along the Tank Farm Creek channel at the edge of the defined development grading. The resulting effect on base flood elevations along Tank Farm Creek calculated by the HEC-RAS model in comparison to existing base flood elevations was minimal (less than 2.5 inches).

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The post-development 100-year base flood elevation across Buckley Road bridge is modeled to be approximately 102.80 feet which results in a submergence of approximately 4.3 feet, an increase of less than 1.5 inches over existing conditions. The post-development 100-year floodplain delineation and water surface elevations for the post-development condition is shown in Figure 5.

If you have any questions regarding this report or require additional information, please do not hesitate to call the undersigned at (949) 296-0977 x108.

Respectfully submitted,

AVOCET ENVIRONMENTAL, INC.



Tim Hunt, P.E.
Project Manager

TH:gs

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REFERENCES

Arcement Jr., George , J., and Verne R. Schneider, 1989, "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains," United States Geological Survey Water Supply Paper 2339.

San Luis Obispo County Department of Public Works & Transportation, 2014, "2014 Standard Construction Drawings", pp. H-1-H-4.

Tables

Table 1
Existing Conditions Catchment and Discharge Information

Avila Ranch Development
 San Luis Obispo, CA

Catchment	Area acres	Longest Flow Path ft	Highest Elevation ft	Lowest Elevation ft	Tc Minutes	Rainfall Intensity in/hr	Runoff Coefficient	Peak 100-Year Flow cfs
A1	32.30	2082	125	113	20.4	3.70	0.75	90
A2	22.07	2132	130	115	19.3	3.90	0.62	54
A3	30.37	1950	128	115	18.4	3.98	0.66	80
A4	8.49	957	123	118	11.7	4.76	0.80	32
B	49.03	2344	135	111	17.9	4.03	0.37	73
B2	14.85	656	124	110	5.1	5.00	0.37	27
C	36.64	1410	124	102	10.3	4.96	0.37	67
D	36.40	1884	124	97	13.3	4.54	0.37	61
D2	59.80	3969	132	98	28.8	3.01	0.37	67
E	7.10	1014	127	92	5.9	5.00	0.37	13
Chevron								82
Lockheed								2

Note: Tc calculated based on formula provided in SLO County Department of Public Works and Transportation Standard Details 2014. Tc was taken to be a minimum value of 10 min. for the purposes of evaluating rainfall intensity using the tables provided in this standard.

Table 2
Post-Development Conditions Catchment and Discharge Information

Avila Ranch Development
 San Luis Obispo, CA

Catchment	Area acres	Longest Flow Path ft	Highest Elevation ft	Lowest Elevation ft	Tc Minutes	Rainfall Intensity in/hr	Runoff Coefficient	100-Year Peak Flow cfs
A1	32.30	2082	125	113	20.4	3.79	0.75	92
A2	22.07	2132	130	115	19.3	3.90	0.62	54
A3	30.37	1950	128	115	18.4	3.99	0.66	80
A4	17.69	1711	125	111	15.3	4.27	0.58	44
B offsite portion	18.56	1190	135	116.5	9.1	5.00	0.37	34
D2 offsite portion	15.40	1095	132	123.5	11.1	4.85	0.37	28
E	7.10	1014	127	92	5.9	5.00	0.37	13
Chevron								82
Lockheed								2

Note: Tc calculated based on formula provided in SLO County Department of Public Works and Transportation Standard Details 2014. Tc was taken to be a minimum value of 10 min. for the purposes of evaluating rainfall intensity using the tables provided in this standard.

Table 3
Existing Conditons Model Flows

Avila Ranch Development
San Luis Obispo, CA

Cross Section Station	Total Peak Inflow cfs	Cumulative Flow cfs
47+01	82	82
37+97	163	245
30+50	27	272
23+97	233	505
8+00	130	635
3+98	13	648

Table 4
Post-Development Conditions Model Flows

Avila Ranch Development
San Luis Obispo, CA

Cross Section Station	Peak Onsite Inflow cfs	Peak Offsite Inflow cfs	Total Peak Inflow cfs	Cumulative Flow cfs
47+01	17	116	133	133
39+99	51.6	0	52	185
36+98	13.4	146	159	344
33+99	32.2	0	32	376
32+00	47.9	0	48	424
23+97	40.1	123	164	587
20+97	16.6	0	17	604
18+00	16.7	0	17	621
8+00	130.1	43	173	793