APPENDIX E -
PRELIMINARY DRAINAGE LETTER

JENSEN DESIGN & SURVEY, INC.
Delivering excellence through experience

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Local 805 654-6977
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www.jdscivil.com

DEV3.5824
August 2, 2018

City of Camarillo
601 Carmen Dr.
Camarillo, CA 93010

Subject: Preliminary Drainage Letter for Camino Ruiz Apartments, Parcel Map No. LD 178A

LD 178A is a proposed rental apartment complex, known as Camino Ruiz Apartments, to be located at the intersection of Camino Ruiz and Verdugo Way in the City of Camarillo. The site is approximately 13.9 acres and this project will consist of the demolition of two of the existing buildings and some site improvements. Grading for several new building pads for the new apartment buildings and paved parking lot will be required.

The proposed project site is not within a FEMA Floodplain boundary as shown on the latest adopted FIRM Panel 06111C0931f from FEMA (included) and is designated as "areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood".

Existing Condition

This project is a redevelopment of an existing property with an approximated impervious area of 95%, mostly due to the existing buildings and parking lot. The existing drainage conditions are comprised of three sub-areas (see attached Hydrology Exhibit).

Area A, the easterly portion of the parcel, drains towards the road that leads to Verdugo Way. Area B, the northerly portion of the parcel, drains westerly towards the intersection of Verdugo Way and Camino Ruiz. Area C, the westerly portion of the parcel, drains easterly towards Camino Ruiz. The existing peak runoff for the 50-year storm event is approximately 60.1 cfs as shown in the calculations for the entire site with the entire flow, eventually draining via a 24" RCP and into the existing 48" RCP on Verdugo Way.

Proposed Condition

The project proposes a total impervious area of approximately 86%, a reduction in impervious area from the existing conditions of 9%. The reduction in impervious area will be achieved by the implementation of additional landscaped areas and proposed biofilters.

Since there is no increase in impervious area and the proposed impervious area has actually reduced, detention requirements should not be required.

The project has been designed to connect into two existing drain facilities on Verdugo Way. Drainage Area B and C will connect into an existing 24” RCP at the intersection of Camino Ruiz and Verdugo Way which then tie into the existing 48” RCP. Drainage Area A will connect into an existing 24” RCP on Verdugo Way which then ties into the existing 48” RCP. The 48” RCP conveys flow and eventually drains onto the Conejo Creek.

Due to the reduction in impervious area, the existing flows resulting from the 50-year storm event will be reduced. The proposed developed runoff for a 50-year storm event will result in a much lower time of concentration. Existing drainage connection points will be maintained and no additional connections to existing storm drain facilities are proposed. With the slight reduction in flows to the existing 48” RCP drain line, it should function as originally designed without need of modification.

Stormwater Treatment

The 2011 Ventura County Technical Guidance Manual for Stormwater Quality Control Measures (TGM) was used to determine BMP suitability and sizing. Stormwater runoff will be mitigated to meet the current MS-4 Permit requirements using a combination of INF-7 Bioinfiltration, and a CDS unit.

The INF-7 Bioinfiltration will treat the Storm Quality Design Volume (SQDV), in accordance with the TGM when project site soils are soil type 4. Infiltration feasibility was determined based on the Ventura County Soil Type description (see attached soil type exhibit and description from the TGM). Additional testing will be done prior to final design of LD 178A to conclude infiltration rates.

Feel free to contact me at 805-633-2227 if you have any questions.

Sincerely,
Jensen Design & Survey, Inc.

Kathleen Knight, P.E.
Senior Civil Engineer

Enc: Site Map
Existing and Proposed Hydrology Exhibits
Stormwater Quality Calculations
Soil Type Exhibit
FIRM Panel

Site Map

CAMINO RUIZ APARTMENTS

1 inch = 300 feet

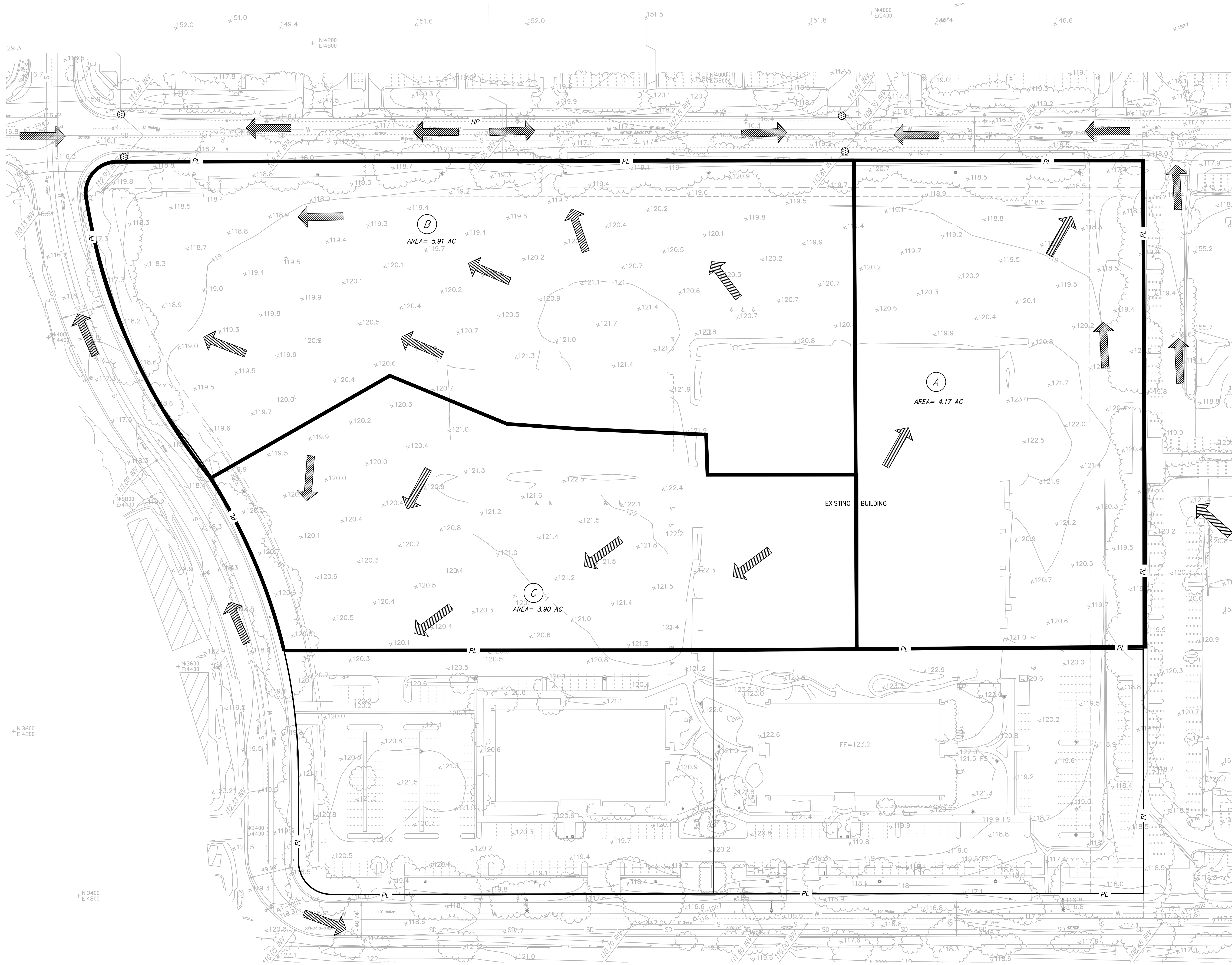
Path: J:\DEV35824_Data\GIS\2018-08-02.mxd

Parcel boundaries on this exhibit are a graphical representation only. They should not be used in place of record boundary information and/or field survey data and do not accurately define property boundaries.

JENSEN DESIGN & SURVEY, INC.

SITE MAP

Existing and Proposed Hydrology Exhibits
And Calculations



LEGEND:

- DRAINAGE BOUNDARY
- RUNOFF FLOW DIRECTION
- EXISTING CATCH BASIN
- (A) DRAINAGE SUB-AREA

EXISTING HYDROLOGY

RAINFALL ZONE K
SOIL NUMBER 4
TC 5 MIN (ASSUMED)

i_{50} = 4.55 in/hr
c = .95
q_{50} = 4.32 cfs/acre

$Q_{50}A$ = 4.32 x 4.17
= 18.01 cfs

$Q_{50}B$ = 4.32 x 5.91
= 25.53 cfs

$Q_{50}C$ = 4.32 X 3.90
= 16.85 cfs

EXISTING CONDITION

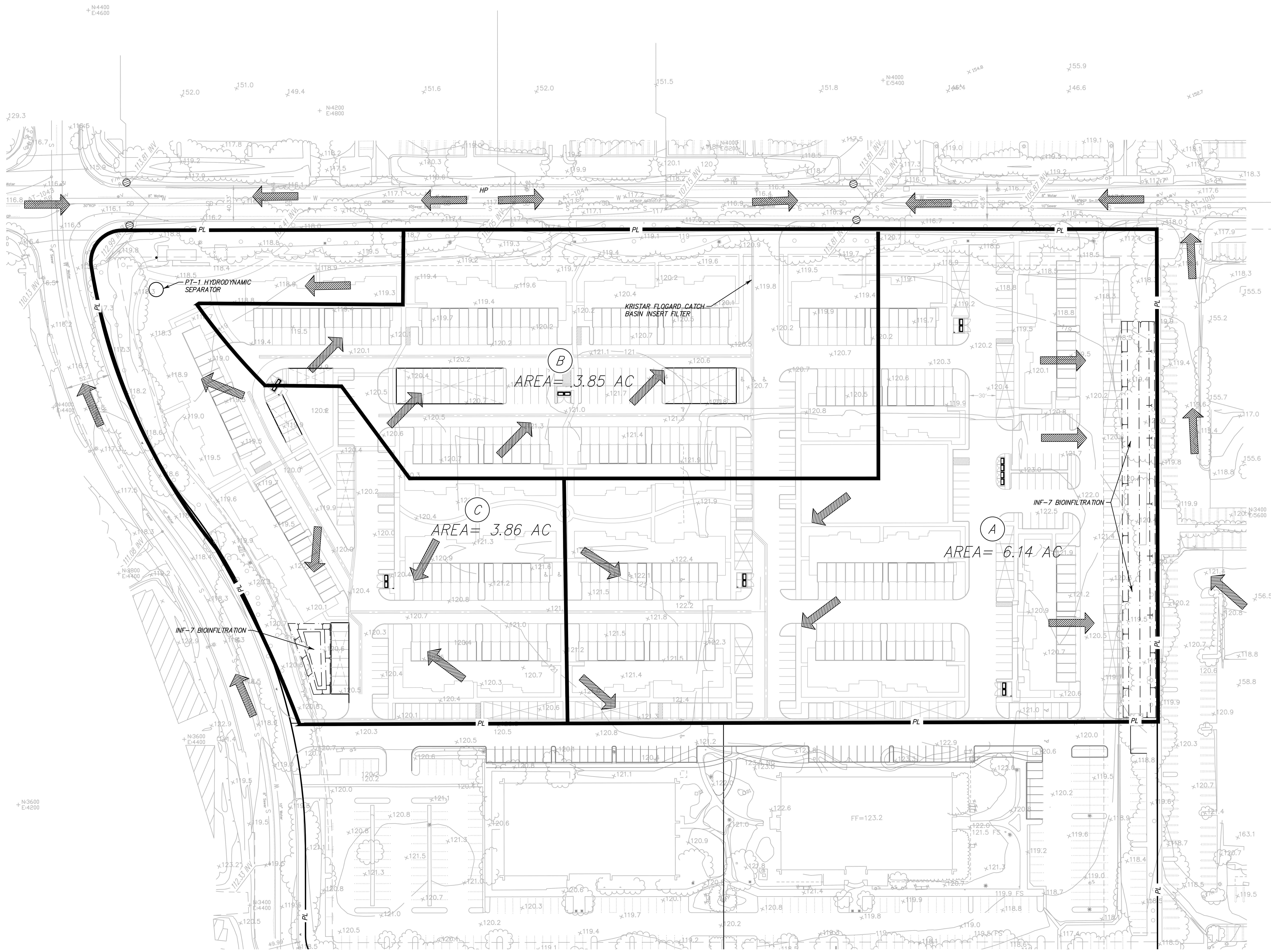
JENSEN DESIGN & SURVEY, INC
www.jdscivil.com
1672 DONLON STREET
VENTURA, CALIF. 93003
PHONE 805/654-6977
FAX 805/654-6979

SCALE: 1"=50'
J.N.: DEV35824
DATE: Aug 01, 2018
DWG. NAME:

DRAINAGE EXHIBIT
FOR
CAMINO RUIZ

Camino Ruiz & Verdugo Way
City of Camarillo
COUNTY OF VENTURA STATE OF CALIFORNIA

SHEET 1 OF 1



LEGEND:

- DRAINAGE BOUNDARY
- RUNOFF FLOW DIRECTION
- EXISTING CATCH BASIN
- DRAINAGE SUB-AREA

PROPOSED HYDROLOGY

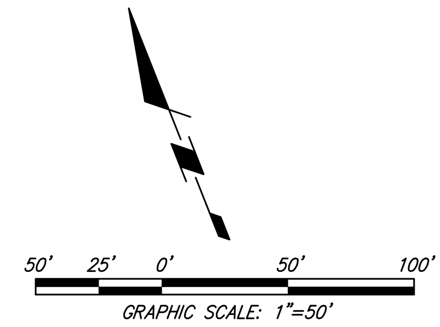
RAINFALL ZONE K
SOIL NUMBER 4
TC 5 MIN (ASSUMED)

i_{50} = 4.55 in/hr
c = .95
q_{50} = 4.28 cfs/acre

$Q_{50}A$ = 4.28 x 6.14
= 26.27 cfs

$Q_{50}B$ = 4.28 x 3.85
= 16.48 cfs

$Q_{50}C$ = 4.28 X 3.86
= 16.50 cfs



DEVELOPED CONDITIONS DRAINAGE EXHIBIT

SCALE: 1"=50'	J.N.: DEV35824	LD 178A FOR CAMINO RUIZ Camino Ruiz & Verdugo Way City of Camarillo	SHEET 1 OF 1
DATE: Aug 02, 2018	DWG. NAME:	COUNTY OF VENTURA STATE OF CALIFORNIA	

Stormwater Quality Calculations

CLIENT
PROJECT CAMINO RUIZ APT.
PREPARED BY
CHECKED BY
DATE 8/1/18
DATE

Q_{50} CALCULATIONS (EXISTING)

Q = CiA

C_{dev} = .95 i = 4.55 IN/HR A = 13.9 Ac
↳ APP. A

= (.95)(4.55)(13.9) = 60.1 CFS

Q PER ACRE

$\frac{60.1 \text{ CFS}}{13.9 \text{ Ac}}$ = 4.32 $\frac{\text{CFS}}{\text{ACRE}}$

SUBAREA A, B, C

Q_{50}A = 4.32 $\frac{\text{CFS}}{\text{Ac}}$ x 4.17 Ac = 18.01 CFS

Q_{50}B = 4.32 $\frac{\text{CFS}}{\text{Ac}}$ x 5.91 Ac = 25.53 CFS

Q_{50}C = 4.32 $\frac{\text{CFS}}{\text{Ac}}$ x 3.9 Ac = 16.85 CFS

C_{dev} = .95 x Imp + (1 - Imp) C
= .95 x .95 + (1 - .95) .91
= .95

FROM P A-18. EXHIBIT D
VCWPD HYDROLOGY MANL - 2017

CLIENT ______
PROJECT CAMINO RUIZ APT. | PREPARED BY ______ | DATE ______
CHECKED BY ______ | DATE ______

Q_{50} CALCULATIONS (PROPOSED)

Q = CiA

C_{dev} = .95 x Imp + (1 - Imp) C
= .95 x .86 + (1 - .86)(.91) = .94

i = 4.55 IN/HR
↳ App. A

A = 13.9 AC

Q = CiA =
= (.94)(4.55)(13.9) = 59.5 CFS

Q PER ACRE — $\frac{59.5\ CFS}{13.9\ AC}$ = 4.28 $\frac{CFS}{ACR}$

SUBAREA A, B, C

Q_{50} A = 4.28 x 6.26 = 26.8 CFS

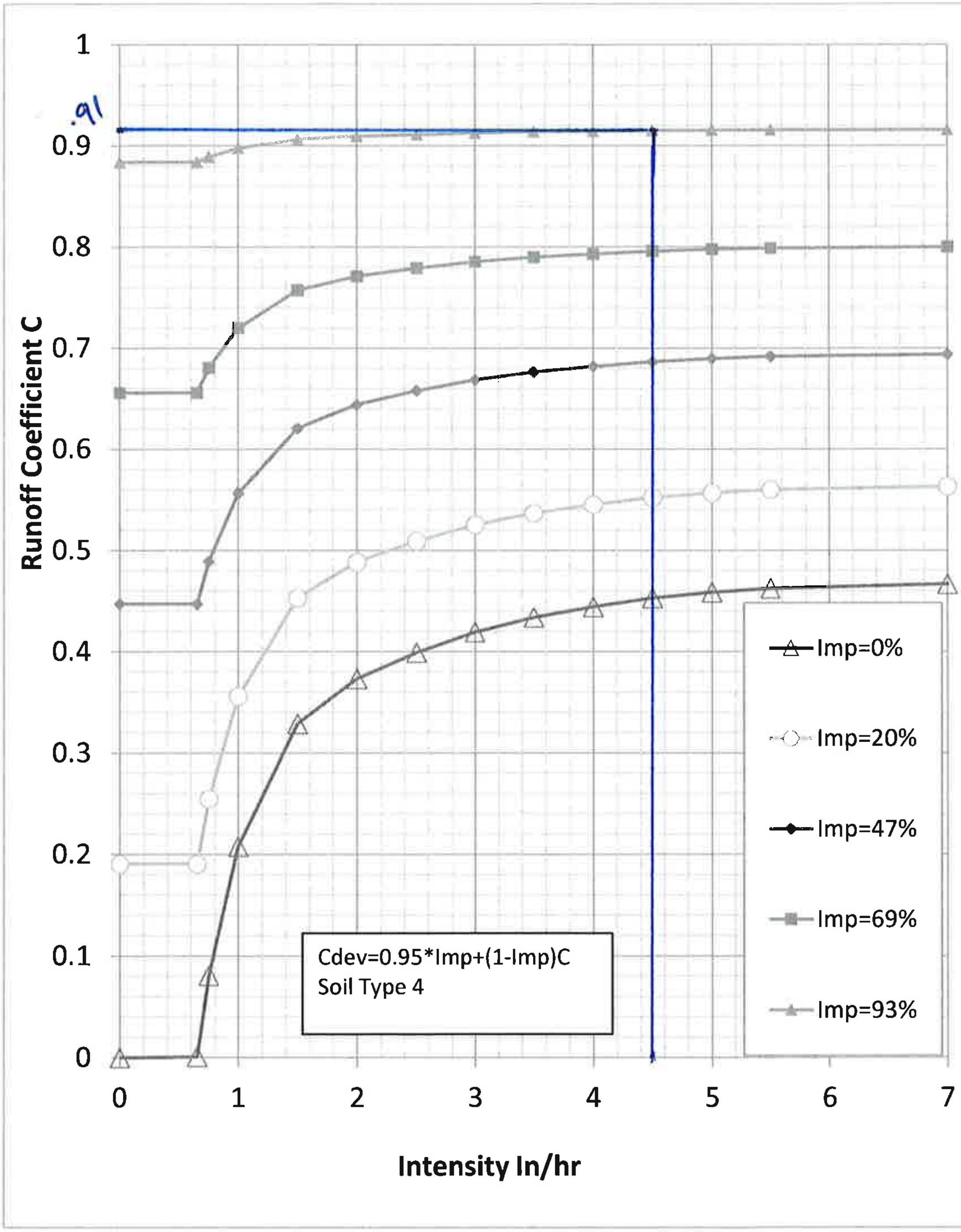
Q_{50} B = 4.28 $\frac{CFS}{AC}$ x 4.28 AC = 18.32 CFS

Q_{50} C = 4.28 $\frac{CFS}{AC}$ x 3.42 A = 14.64 CFS

EXHIBIT 2. MAXIMUM RAINFALL INTENSITIES

Zone	J	Jp	K	L	J	Jp	K	L	J	Jp	K	L	J	Jp	K	L
Year	**10**	**10**	**10**	**10**	**25**	**25**	**25**	**25**	**50**	**50**	**50**	**50**	**100**	**100**	**100**	**100**
Cum. Rain (in.)	**3.17**	**4.38**	**5.53**	**7.21**	**3.91**	**5.28**	**6.41**	**8.81**	**5.0**	**6.0**	**8.0**	**11.0**	**7.0**	**6.66**	**10.6**	**15.0**
Tc (min)	**Maximum Rainfall Intensity (in/hr)**															
5	2.16	2.16	3.72	4.31	2.64	3.34	4.27	4.94	2.94	3.79	4.55	5.58	3.23	4.06	5.10	6.11
6	2.02	2.01	3.40	3.90	2.52	2.94	3.80	4.39	2.80	3.34	4.10	5.05	2.90	3.55	4.59	5.43
7	1.86	1.90	3.09	3.56	2.30	2.65	3.45	3.99	2.55	3.01	3.77	4.63	2.67	3.19	4.23	4.95
8	1.74	1.82	2.86	3.30	2.14	2.58	3.19	3.69	2.36	2.93	3.52	4.28	2.50	2.99	3.95	4.58
9	1.63	1.76	2.68	3.07	1.99	2.44	2.99	3.45	2.21	2.77	3.33	4.00	2.36	2.87	3.74	4.30
10	1.53	1.70	2.52	2.86	1.87	2.29	2.81	3.24	2.08	2.60	3.16	3.76	2.25	2.78	3.57	4.07
11	1.45	1.64	2.40	2.70	1.76	2.17	2.66	3.07	1.95	2.46	3.02	3.56	2.13	2.67	3.39	3.88
12	1.38	1.59	2.29	2.56	1.66	2.07	2.53	2.92	1.85	2.35	2.90	3.39	2.02	2.58	3.23	3.72
13	1.33	1.55	2.20	2.44	1.58	1.98	2.43	2.80	1.76	2.25	2.80	3.25	1.94	2.49	3.10	3.59
14	1.28	1.51	2.12	2.34	1.52	1.90	2.34	2.70	1.68	2.16	2.72	3.13	1.86	2.42	2.99	3.47
15	1.23	1.47	2.04	2.25	1.46	1.84	2.26	2.60	1.62	2.09	2.62	3.02	1.80	2.36	2.89	3.37
16	1.18	1.43	1.98	2.18	1.40	1.78	2.18	2.50	1.56	2.02	2.54	2.92	1.73	2.29	2.79	3.25
17	1.14	1.39	1.92	2.11	1.36	1.73	2.12	2.42	1.50	1.96	2.47	2.83	1.67	2.22	2.70	3.14
18	1.11	1.35	1.86	2.04	1.31	1.68	2.06	2.34	1.45	1.90	2.41	2.75	1.61	2.16	2.62	3.05
19	1.07	1.32	1.82	1.99	1.27	1.63	2.01	2.28	1.41	1.86	2.35	2.68	1.56	2.11	2.55	2.96
20	1.04	1.29	1.77	1.94	1.24	1.60	1.96	2.22	1.37	1.81	2.29	2.62	1.52	2.07	2.49	2.88
21	1.02	1.26	1.73	1.90	1.20	1.55	1.91	2.17	1.33	1.76	2.23	2.55	1.48	2.03	2.43	2.82
22	0.99	1.23	1.68	1.85	1.17	1.51	1.87	2.12	1.30	1.72	2.17	2.49	1.44	1.99	2.36	2.76
23	0.97	1.21	1.65	1.82	1.14	1.48	1.83	2.07	1.27	1.68	2.12	2.44	1.41	1.95	2.31	2.70
24	0.95	1.19	1.62	1.78	1.12	1.44	1.79	2.03	1.24	1.64	2.07	2.39	1.38	1.92	2.26	2.65
25	0.93	1.16	1.58	1.75	1.09	1.41	1.76	1.99	1.21	1.61	2.03	2.34	1.35	1.89	2.22	2.60
26	0.90	1.14	1.56	1.72	1.07	1.39	1.73	1.96	1.18	1.57	1.98	2.29	1.32	1.86	2.17	2.56
27	0.88	1.13	1.53	1.68	1.05	1.36	1.70	1.92	1.16	1.54	1.94	2.25	1.29	1.83	2.13	2.51
28	0.87	1.11	1.50	1.66	1.03	1.34	1.67	1.89	1.14	1.52	1.90	2.21	1.27	1.80	2.09	2.46
29	0.85	1.09	1.48	1.63	1.01	1.31	1.64	1.87	1.12	1.49	1.87	2.17	1.24	1.77	2.05	2.42
30	0.83	1.08	1.46	1.61	0.99	1.29	1.61	1.84	1.10	1.47	1.84	2.13	1.22	1.74	2.02	2.38

EXHIBIT 5D. UPDATED RUNOFF COEFFICIENT CURVE- SOIL 4 (NRCS TYPE B)



C=.91

Designer:	Jensen Design & Survey, Inc
Project Proponent:	
Date:	8/2/2018
Project:	Camino Ruiz Apartments
Location:	Camarillo, CA

Type of Vegetation: (Check type used or describe "Other"		
	________	Native Grass
	________	Irrigated Turf Grass
	X	Other

Step 1: Determine Water Quality Design Volume				
1-1	Enter Project Area	$A_{project}$=	13.9	ac
1-2	Enter the maximum allowable percent of the Project area that may be effective impervious area (%)(refer to permit), ranges from 5-30% allowable	$\%_{allowable}$=	5	%
1-3	Determine the maximum allowable effective impervious area (ac), $EIA_{allowable} = (A_{project})*(\%allowable)$	$EIA_{allowable}$=	0.70	ac
1-4	Enter Project Impervious fraction, IMP	IMP =	0.86	
1-5	Determine the Project Total Impervious Area (ac) $TIA = A_{project}*IMP$	TIA =	11.95	ac
1-6	Determine the total area from which runoff must be retained (ac), $A_{retain}=TIA-EIA_{allowable}$	A_{retain} =	11.26	ac
1-7	Determine pervious runoff coefficient using Table E-1, C_p	C_p =	0.050	
1-8	Calculate runoff coefficient $C=0.95*IMP + C_p(1-IMP)$	C =	0.8240	
1-9	Enter design rainfall depth of the storm (in), P_i (3/4" storm event)	P_i =	0.75	in
1-10	Calculate rainfall depth (ft), $P = P_i/12$	P =	0.0625	ft
1-11	Calculate Water Quality Design Volume (CF) $SQDV = 43560*C*P*A_{retain}$	SQDV =	25257.77	cf

Step 2: Determine the design percolation rate				
2-1	Enter measured soil percolation rate (in/hr)	$P_{measured}$=	0.5	in/hr
2-2	Determine percolation rate correction factor, S_A based on suitability assessment (see Section 6 INF-1, Table 6-2)	S_A =	2	
2-3	Determine percolation rate correction factor, S_B based on design (see Section 6 INF-1)	S_B =	3	
2-4	Calculate Combine safety factor, $S = S_A * S_B$	S =	6	
2-5	Calculate the design percolation rate (in/hr) $P_{design} = P_{measured}/S$	P_{design} =	0.083	in/hr
Step 3: Calculate Bioretention Infiltrating Surface Area				
3-1	Enter Water Quality Design Volume (cf), SQDV	SQDV =	25257.77	hr
3-2	Enter design percolation rate (in/hr), P_{design}	P_{design} =	0.083	in/hr
3-3	Enter the required drain time (48 hours), $t_{ponding}$	$t_{ponding}$ =	48	hrs
3-4	Calculate the maximum depth of surface ponding that	d_{max} =	0.333	ft
3-5	select surface ponding depth (ft), dp such that dp <= dmax	d_p =	0.300	ft
3-6	Select thickness of amended media (ft, 2 ft minimum, 3 ft preferred), l_{media}	l_{media} =	3	ft
3-7	Enter Porosity of amended media (roughly 25% or 0.25 ft/ft), n_{media}	n_{media} =	0.3	ft/ft

3-8	Select thickness of optional gravel layer (ft), l_{gravel}	l_{gravel} =	2.0	ft
3-9	Enter porosity of gravel (roughly 30% or 0.3 ft/ft), n_{gravel}	n_{gravel} =	0.3	ft/ft
3-10	Calculate the total effective storage depth of bioretention facility (ft):	$d_{effective}$ =	1.7	ft
3-11	Check that the entire effective depth infiltrates in the required drainage time, 96 hours: t_{total} =	t_{total} =	237.6	hrs
3-12	Calculate the required infiltrating surface area (sf)	A_{req} =	15307.736	sf
Step 4: Calculate bioretention Area Total Footprint				
4-1	Enter Water Quality Design Volume (cf), SQDV			

VENTURA COUNTY WATERSHED PROTECTION DISTRICT

TIME OF CONCENTRATION

TC Program Version: 2.64.0.30

Project:

Date: 12:00:00 AM

Engineer:

Consultant:

Watershed Name: Watershed

Sub-Area Name: SubArea

Tc: 4.244 Minutes

DATA FOR SUB AREA 1

SUB AREA TIME OF CONCENTRATION: 4.244 min. = 4 min.

SUB AREA INPUT DATA

Sub Area Name: SubArea

Total Area (ac): 1.64

Flood Zone: 3

Rainfall Zone: K

Storm Frequency (years): 50

Development Type: Industrial

Soil Type: 4.00

Percent Impervious: 100

SUB AREA OUTPUT

Intensity (in/hr): 5.160

C Total: 0.950

Sum Q Segments (cfs): 8.04

Q Total (cfs): 8.04

Sum Percent Area (%): 100.0

Sum of Flow Path Travel Times (sec): 254.64

Time of Concentration (min): 4.244

DATA FOR FLOW PATH 1

Flow Path Name: 2

FLOW PATH TRAVEL TIME (min): 3.3333

Flow Type: Overland

Length (ft): 200

Top Elevation (ft): 145.3

Bottom Elevation (ft): 143.5

Contributing Area (acres): 0.44

Percent of Sub-Area (%): 26.8

Overland Type: Valley

Development Type: Industrial

Map Slope: 0.0090

Effective Slope: 0.0090

Q for Flow Path (cfs): 2.16

Avg Velocity (ft/s): 1.00

Passed Scour Check: N/A

DATA FOR FLOW PATH 2

Flow Path Name: 1

FLOW PATH TRAVEL TIME (min): 0.9107

Flow Type: Channel

Length (ft): 200

Top Elevation (ft): 120.8

Bottom Elevation (ft): 117.4

Contributing Area (acres): 1.2

Percent of Sub-Area (%): 73.2

Bottom Width (ft): 0.5

Side Slope (H:V): 100

Manning's N: 0.015

Map Slope: 0.0170

Q for Flow Path (cfs): 5.88

Q Top (cfs): 2.16

Q Bottom (cfs): 8.04

Velocity Top (ft/s): 1.83

Velocity Bottom (ft/s): 2.58

Avg Velocity (ft/s): 2.20

Wave Velocity (ft/s): 3.66

Project:

Date: 12:00:00 AM

Engineer:

Consultant:

Sub-Area Name: SubArea

Tc: 0.000 Minutes

DATA FOR SUB AREA 2

SUB AREA TIME OF CONCENTRATION: 0.000 min. = 0 min.

SUB AREA INPUT DATA

Sub Area Name: SubArea

Total Area (ac): 2.66

Flood Zone: 3

Rainfall Zone: K

Storm Frequency (years): 50

Development Type: Industrial

Soil Type: 4.00

Percent Impervious: 100

SUB AREA OUTPUT

Intensity (in/hr): 0.000

C Total: 0.000

Sum Q Segments (cfs): 0.00

Q Total (cfs): 0.00

Sum Percent Area (%): 0.0

Sum of Flow Path Travel Times (sec): 0.00

Time of Concentration (min): 0.000

DATA FOR FLOW PATH 1

Flow Path Name: 3

FLOW PATH TRAVEL TIME (min): 0.0000

Flow Type: Overland

Length (ft): 200

Top Elevation (ft): 145.5

Bottom Elevation (ft): 143.5

Contributing Area (acres): 0.4

Percent of Sub-Area (%): 15.0

Overland Type: Valley

Development Type: Industrial

Map Slope: 0.0000

Effective Slope: 0.0000

Q for Flow Path (cfs): 0.00

Avg Velocity (ft/s): 0.00

Passed Scour Check: N/A

DATA FOR FLOW PATH 2

Flow Path Name: 4

FLOW PATH TRAVEL TIME (min): 0.0000

Flow Type: Channel

Length (ft): 510

Top Elevation (ft): 121.3

Bottom Elevation (ft): 118.4

Contributing Area (acres): 2.26

Percent of Sub-Area (%): 85.0

Bottom Width (ft): 0.5

Side Slope (H:V): 100

Manning's N: 0.015

Map Slope: 0.0000

Q for Flow Path (cfs): 0.00

Q Top (cfs): 0.00

Q Bottom (cfs): 0.00

Velocity Top (ft/s): 0.00

Velocity Bottom (ft/s): 0.00

Avg Velocity (ft/s): 0.00

Wave Velocity (ft/s): 0.00

INF-7: Bioinfiltration

Bioinfiltration facilities are designed for partial infiltration of runoff and partial biotreatment. These facilities are similar to bioretention devices with underdrains, but the underdrain is raised above the gravel sump to facilitate infiltration. These facilities can be used in areas where there are no hazards associated with infiltration, but infiltration of the full DCV may not be feasible due to low infiltration rates (Soil Type 3) or high depths of fill. These facilities may not result in retention of the DCV but they can be used to meet the MEP standards.

Bioretention in Parkway and parking lots

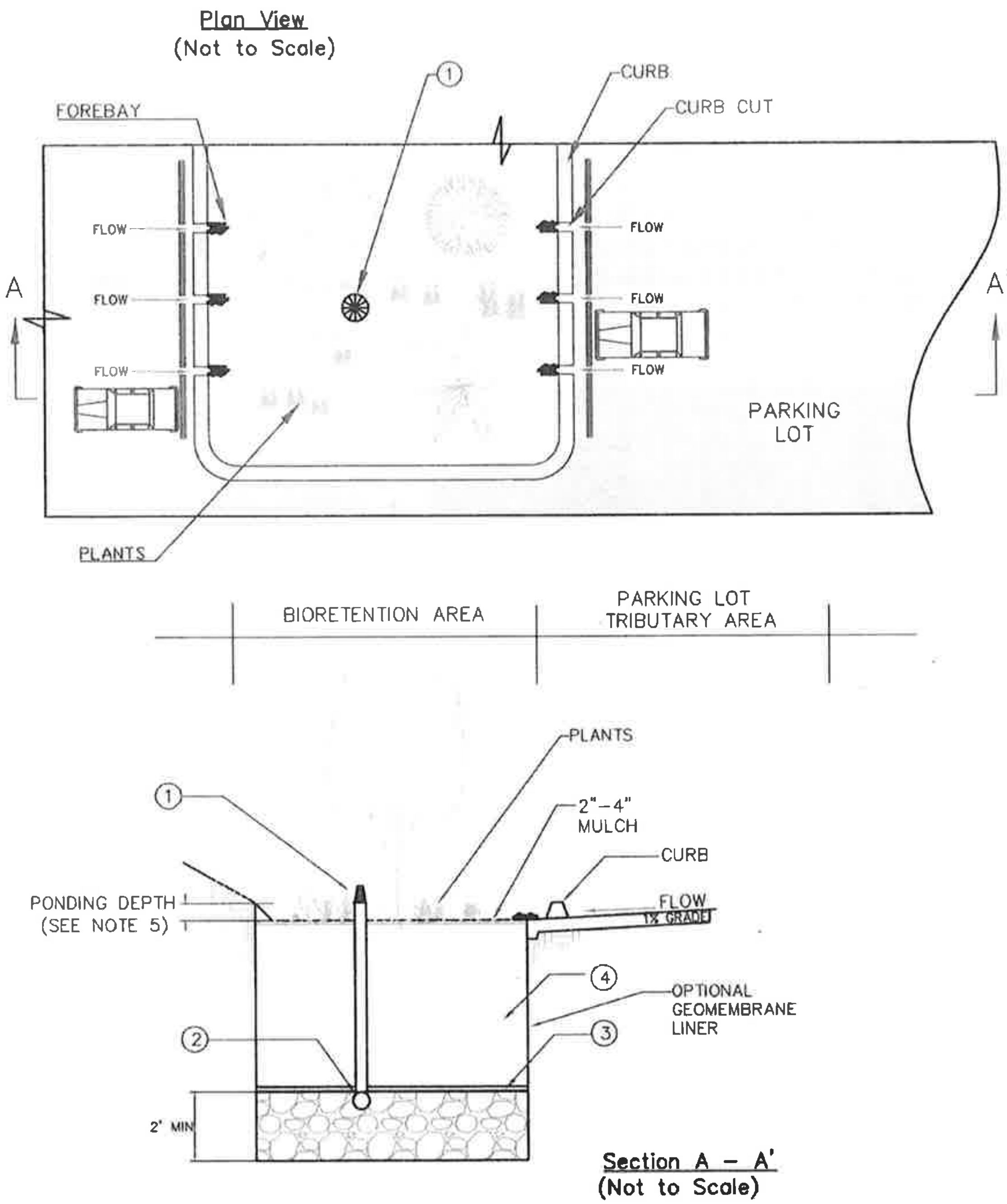
Photo Credits: Geosyntec Consultants

Application

- Commercial, residential, mixed use, institutional, and recreational uses
- Parking lot islands, traffic circles
- Road parkways & medians

Preventative Maintenance

- Repair small eroded areas
- Remove trash and debris and rake surface soils
- Remove accumulated fine sediments, dead leaves and trash
- Remove weeds and prune back excess plant growth
- Remove sediment and debris accumulation near inlet and outlet structures
- Periodically observe function under wet weather conditions



NOTES:

1. OVERFLOW DEVICE: VERTICAL RISER OR EQUIVALENT.
2. PERFORATED 6" MIN PVC PIPE UNDERDRAIN.
3. OPTIONAL CHOKING GRAVEL LAYER.
4. 2' MIN PLANTING MIX; 3' PREFERRED.
5. PONDING DEPTH 18" WITH FENCE; 6" WITHOUT FENCE.
6. 2' MIN GRAVEL LAYER DEPTH.

Geosyntec consultants

Figure 6-8: Bioinfiltration

Limitations

The following limitations should be considered before choosing to use bioinfiltration:

1) Native soil infiltration rate - soil permeability at the bioinfiltration location must be no less than 0.3 inches per hour.

2) Depth to groundwater, bedrock, or low permeability soil layer – 5 feet vertical separation is required between the bottom of the infiltration trench and the seasonal high groundwater level or mounded groundwater level, bedrock, or other barrier to infiltration to ensure that the facility will completely drain between storms and that infiltrating water will receive adequate treatment though the soils before it reaches the groundwater.

3) Slope stability - infiltration BMPs must be sited at least 50 feet away from slopes steeper than 15 percent or an alternative setback established by the geotechnical expert for the project.

4) Setbacks - a minimum setback (100 feet or more) must be provided between infiltration BMPs and potable wells, non-potable wells, drain fields, and springs. Infiltration BMPs must be setback from building foundations at least eight feet or have an alternative setback established by the geotechnical expert for the project.

5) Groundwater contamination - the application of infiltration BMPs should include significant pretreatment in an area identified as an unconfined aquifer to ensure groundwater is protected for pollutants of concern.

6) Contaminated soils or groundwater plumes - infiltration BMPs are not allowed at locations with contaminated soils or groundwater where the pollutants could be mobilized or exacerbated by infiltration, unless a site-specific analysis determines that infiltration would be beneficial.

7) High pollutant land uses - infiltration BMPs should not be placed in high-risk areas such as at or near service/gas stations, truck stops, and heavy industrial sites due to the groundwater contamination risk unless a site-specific evaluation demonstrates that sufficient pretreatment is provided to address pollutants of concern, high risks areas are isolated from stormwater runoff, or infiltration areas have little chance of spill migration.

8) High sediment loading rates – infiltration BMPs may clog quickly if sediment loads are high (e.g., unstabilized site) or if flows are not adequately pretreated.

9) Vertical relief and proximity to storm drain - site must have adequate relief between the land surface and storm drain to permit vertical percolation through the soil media and collection.

Design Criteria

Bioinfiltration should be designed according to the requirements listed in Table 6-16 and outlined in the section below.

Table 6-16: Bioretention Design Criteria

Design Parameter	Unit	Design Criteria
Stormwater quality design volume (SQDV)	acre-feet	See Section 2 and Appendix E for calculating SQDV.
Forebay	-	Forebay should be provided for all tributary surfaces that contain landscaped areas. Forebays should be designed to prevent standing water during dry weather and should be planted with a plant palette that is tolerant of wet conditions.
Maximum drawdown time of water ponded on surface	hours	48
Maximum drawdown time of surface ponding plus subsurface pores	hours	96 (72 preferred)
Maximum ponding depth	inches	18
Minimum thickness of amended soil	feet	2 (3 preferred)
Minimum thickness of stabilized mulch	inches	2 to 4
Planting mix composition	-	60 to 80% fine sand, 20 to 40% compost
Underdrain sizing	-	Underdrain should be installed below the choking stone; 6 inch minimum diameter; 0.5% minimum slope; slotted, polyvinyl chloride (PVC) pipe (PVC SDR 35 or approved equivalent); spacing shall be determined to provide capacity for maximum rate filtered through amended media
Minimum thickness of gravel layer	feet	2
Overflow device	-	Required

Sizing Criteria

Bioinfiltration facilities can be sized using one of two methods: a simple sizing method or a routing modeling method. With either method the SQDV volume must be completely infiltrated within 96 hours (including subsurface pore space), and surface ponding must be infiltrated within 48 hours. The simple sizing procedure is provided below. For the routing modeling method, refer to TCM-4 Sand Filters.

Step 1: Calculate the Design Volume

Bioinfiltration facilities shall be sized to capture and partially infiltrate and partially biotreat the SQDV volume (see Section 2.3 and Appendix E).

Step 2: Determine the Design Percolation Rate

The percolation rate through the BMP and to the subsurface will decline between maintenance cycles as the surface becomes occluded and particulates accumulate in the infiltration layer. Monitoring of actual facility performance has shown that the full-scale infiltration rate is far lower than the rate measured by small-scale testing. It is important that adequate conservatism is incorporated in the selection of design percolation rates. For bioinfiltration facilities, the design percolation rate discussed here is the adjusted percolation rate of the underlying soils and not the percolation rate of the filter media bed. The measured short-term infiltration rate should be adjusted using a factor of safety of 2.0.

Step 3: Calculate the surface area

Determine the size of the required infiltrating surface by assuming the SQDV will fill the available ponding depth plus the void spaces in the media, based on the computed porosity of the filter media and optional aggregate layer.

1) Determine the maximum depth of surface ponding that can be infiltrated within the required surface drain time (48 hr), (d_{max}), as follows:

$$d_{max} = \frac{P_{design} \times t_{ponding}}{12 \frac{in}{ft}} \qquad \text{(Equation 6-14)}$$

Where:

$t_{ponding}$	=	required drain time of surface ponding (48 hrs)
P_{design}	=	design percolation rate of underlying soils (in/hr) (see Step 2, above)
d_{max}	=	the maximum depth of surface ponding water that can be infiltrated within the required drain time (ft), calculated using Equation 6-14

2) Choose surface ponding depth (d_p) such that:

$$d_p \le d_{max} \qquad \text{(Equation 6-15)}$$

Where:

d_p	=	selected surface ponding depth (ft)
d_{max}	=	the maximum depth of water that can be infiltrated within the required drain time (ft)

Choose thickness(es) of amended media and aggregate layer(s) and calculate total effective storage depth of the bioinfiltration area ($d_{effective}$), as follows:

$$d_{effective} \leq (d_p + n^{*}_{media} l_{media} + n_{gravel} l_{gravel}) \qquad \text{(Equation 6-16)}$$

Where:

$d_{effective}$	=	total equivalent depth of water stored in bioinfiltration area (ft), including surface ponding and volume available in pore spaces of media and gravel layers
d_p	=	surface ponding depth (ft), chosen using Equation 6=15
n^{*}_{media}	=	available porosity of amended soil media (ft/ft), approximately 0.25 ft/ft accounting for antecedent moisture conditions. This represents the volume of available pore space as a fraction of the total soil volume; sometimes has units of (ft^3/ft^3) or described as a percentage.
l_{media}	=	thickness of amended soil media layer (ft), minimum 2 ft
n_{gravel}	=	porosity of gravel layer (ft/ft), approximately 0.40 ft/ft
l_{gravel}	=	thickness of gravel layer (ft), minimum 2 ft

3) Check that entire effective depth (surface plus subsurface storage), $d_{effective}$, infiltrates in no greater than 96 hours as follows:

$$t_{total} = \frac{d_{effective}}{P_{design}} \times 12\frac{in}{ft} \leq 96\,hr \qquad \text{(Equation 6-17)}$$

Where:

$d_{effective}$	=	total equivalent depth of water stored in bioinfiltration area (ft), calculated using Equation 6-16

P_{design} = design percolation rate of underlying soils (in/hr) (see Step 2, above)

If $t_{total} > 96$ hrs, then reduce surface ponding depth and/or amended media thickness and/or gravel thickness and return to 1).

If $t_{total} \leq 96$ hrs, then proceed to 5).

4) Calculate required infiltrating surface area, (A_{req}):

$$A_{req} = \frac{SQDV}{d_{effective}}$$ (Equation 6-18)

Where:

A_{req} = required infiltrating area (ft²). Should be calculated at the contour corresponding to the mid ponding depth (i.e., $0.5 \times d_p$ from the bottom of the facility).

$SQDV$ = stormwater quality design volume (ft³)

$d_{effective}$ = total equivalent depth of water stored in bioinfiltration area (ft), calculated using Equation 6-16

5) Calculate total footprint required by including a buffer for side slopes and freeboard; A_{req} is calculated at the contour corresponding to the mid ponding depth (i.e., $0.5 \times d_p$ from the bottom of the facility).

Geometry

1) Minimum planting soil depth should be 2 feet, although 3 feet is preferred.

   The intention is that the minimum planting soil depth should provide a beneficial root zone for the chosen plant palette and adequate water storage for the stormwater quality design volume. A deeper soil depth will provide a smaller surface area footprint.

2) Minimum gravel layer depth is 2 feet.

   The intention is that the gravel sump provides partial retention of captured water.

3) Bioinfiltration should be designed to drain below the planting soil in less than 48 hours and completely drain from the gravel layer in 96 hours (both starting from the end of inflow).

   The intention is that soils must be allowed to dry out periodically in order to restore hydraulic capacity to receive flows from subsequent storms, maintain infiltration *rates, maintain adequate soil oxygen levels for healthy soil biota and vegetation, and to provide proper soil conditions for biodegradation and retention of pollutants.*

Flow Entrance and Energy Dissipation

The following types of flow entrance can be used for bioinfiltration cells:

1) Dispersed, low velocity flow across a landscape area. Dispersed flow may not be possible given space limitations or if the facility is controlling roadway or parking lot flows where curbs are mandatory.

2) Dispersed flow across pavement or gravel and past wheel stops for parking areas.

3) Curb cuts for roadside or parking lot areas: curb cuts should include rock or other erosion protection material in the channel entrance to dissipate energy. Flow entrance should drop 2 to 3 inches from curb line and it should provide a settling area and periodic sediment removal of coarse material before flow dissipates to the remainder of the cell.

4) Pipe flow entrance: Piped entrances, such as roof downspouts, should include rock, splash blocks, or other appropriate measures at the entrance to dissipate energy and disperse flows.

Woody plants (trees, shrubs, etc.) can restrict or concentrate flows and can be damaged by erosion around the root ball and should not be placed directly in the entrance flow path.

Underdrains

Underdrains should meet the following criteria:

1) 6-inch minimum diameter.

2) Underdrains should be made of slotted, polyvinyl chloride (PVC) pipe (PVC SDR 35 or approved equivalent). *The intention is that compared to round-hole perforated pipe, slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.*

3) Slotted pipe should have 2 to 4 rows of slots cut perpendicular to the axis of the pipe or at right angles to the pitch of corrugations. Slots should be 0.04 to 0.1 inches and should have a length of 1 to 1.25 inches. Slots should be longitudinally spaced such that the pipe has a minimum of one square inch of slot per lineal foot of pipe and should be placed with slots facing the bottom of the pipe.

4) Underdrains should be sloped at a minimum of 0.5%.

5) Rigid non-perforated observation pipes with a diameter equal to the underdrain diameter should be connected to the underdrain every 100 feet to provide a clean-out port as well as an observation well to monitor dewatering rates. The wells/cleanouts

should be connected to the perforated underdrain with the appropriate manufactured connections. The wells/cleanouts should extend 6 inches above the top elevation of the bioinfiltration facility mulch, and should be capped with a lockable screw cap. The ends of the underdrain pipes not terminating in an observation well/cleanout should also be capped.

Gravel Layer

1) The following aggregate should be used for the gravel layer below the underdrain pipe. Place the underdrain below the choking stone, within the top 6 inches of the gravel layer.

Sieve size	Percent Passing
¾ inch	100
¼ inch	30-60
US No. 8	20-50
US No. 50	3-12
US No. 200	0-1

2) At the option of the designer/geotechnical engineer, a geotextile fabric may be placed between the planting media and the gravel layer. If a geotextile fabric is used, it should meet a minimum permittivity rate of 75 gal/min/ft^2, should not impede the infiltration rate of the soil medium, and should meet the following minimum materials requirements.

Geotextile Property	Value	Test Method
Trapezoidal Tear (lbs)	40 (min)	ASTM D4533
Permeability (cm/sec)	0.2 (min)	ASTM D4491
AOS (sieve size)	#60 - #70 (min)	ASTM D4751
Ultraviolet resistance	70% or greater	ASTM D4355

Preferably, aggregate (choking stone) should be used in place of filter fabric to reduce the potential for clogging. This aggregate layer should consist of 2 to 4 inches of washed sand underlain with 2 inches of choking stone (Typically #8 or #89 washed).

3) Bioinfiltration facilities have the added benefit of enhanced nitrogen removal due to the elevated underdrain. This allows for a fluctuating anaerobic/aerobic zone below the drain pipe. *The intention is that denitrification within the anaerobic/anoxic zone is facilitated by microbes using forms of nitrogen (NO_2 and NO_3) instead of oxygen for respiration.*

4) The underdrain should drain freely to an acceptable discharge point. The underdrain can be connected to a downstream open conveyance (vegetated swale), to another bioinfiltration cell as part of a connected treatment system, to a storm drain, daylight

to a vegetated dispersion area using an effective flow dispersion device, or to a storage facility for harvesting.

Overflow

An overflow device is required at the 18-inch ponding depth. The following, or equivalent should be provided:

1) A vertical PVC pipe (SDR 35) to act as an overflow riser.

2) The overflow riser(s) should be 6 inches or greater in diameter, so it can be cleaned without damage to the pipe.

The inlet to the riser should be at the ponding depth (18 inches for fenced bioinfiltration areas and 6 inches for areas that are not fenced), and be capped with a spider cap to exclude floating mulch and debris. Spider caps should be screwed in or glued, i.e., not removable.

Hydraulic Restriction Layers

Infiltration pathways may need to be restricted due to the close proximity of roads, foundations, or other infrastructure. A geomembrane liner, or other equivalent water proofing, may be placed along the vertical walls to reduce lateral flows. This liner should have a minimum thickness of 30 mils.

Planting/Storage Media

1) The planting media placed in the cell should achieve a long-term, in-place infiltration rate of at least 1 inch per hour. Higher infiltration rates are permissible. If the design long-term, in-place infiltration rate of the soil exceeds 12 inches per hour, documentation should be provided to demonstrate that the media will adequately address pollutants of concern at a higher flowrate. Bioinfiltration soil shall also support vigorous plant growth.

2) Planting media should consist of 60 to 80% fine sand and 20 to 40% compost.

3) Sand should be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size should be non-plastic. Sand for bioinfiltration should be analyzed by an accredited lab using #200, #100, #40, #30, #16, #8, #4, and 3/8 sieves (ASTM D 422 or as approved by the local permitting authority) and meet the following gradation (Note: all sands complying with ASTM C33 for fine aggregate comply with the gradation requirements below):

Sieve Size (ASTM D422)	% Passing (by weight)	
	Minimum	Maximum
3/8 inch	100	100
#4	90	100
#8	70	100
#16	40	95
#30	15	70
#40	5	55
#100	0	15
#200	0	5

Note: the gradation of the sand component of the media is believed to be a major factor in the hydraulic conductivity of the media mix. If the desired hydraulic conductivity of the media cannot be achieved within the specified proportions of sand and compost (#2), then it may be necessary to utilize sand at the coarser end of the range specified in above ("minimum" column).

4) Compost should be a well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes, or other organic materials not including manure or biosolids meeting standards developed by the US Composting Council (USCC). The product shall be certified through the USCC Seal of Testing Assurance (STA) Program (a compost testing and information disclosure program). Compost quality should be verified via a lab analysis to be:

   - Feedstock materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
   - Organic matter: 35-75% dry weight basis.
   - Carbon and Nitrogen Ratio: 15:1 < C:N < 25:1
   - Maturity/Stability: shall have dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120 F) upon delivery or rewetting is not acceptable.
   - Toxicity: any one of the following measures is sufficient to indicate non-toxicity:
     - NH4:NH3 < 3
     - Ammonium < 500 ppm, dry weight basis
     - Seed Germination > 80% of control
     - Plant trials > 80% of control

- e. Solvita® > 5 index value
- Nutrient content:
  - Total Nitrogen content 0.9% or above preferred
  - Total Boron should be <80 ppm, soluble boron < 2.5 ppm
- Salinity: < 6.0 mmhos/cm
- pH between 6.5 and 8 (may vary with plant palette)

Compost for bioinfiltration should be analyzed by an accredited lab using #200, ¼ inch, ½ inch, and 1 inch sieves (ASTM D 422 or as approved by the local permitting authority) and meet the following gradation:

Sieve Size (ASTM D422)	% Passing (by weight)	
	Minimum	Maximum
1 inch	99	100
½ inch	90	100
¼ inch	40	90
#200	2	10

Tests should be sufficiently recent to represent the actual material that is anticipated to be delivered to the site. If processes or sources used by the supplier have changed significantly since the most recent testing, new tests should be requested.

Note: the gradation of compost used in bioinfiltration media is believed to play an important role in the saturated hydraulic conductivity of the media. To achieve a higher saturated hydraulic conductivity, it may be necessary to utilize compost at the coarser end of this range ("minimum" column). The percent passing the #200 sieve (fines) is believed to be the most important factor in hydraulic conductivity.

In addition, a coarser compost mix provides more heterogeneity of the bioinfiltration media, which is believed to be advantageous for more rapid development of soil structure needed to support health biological processes. This may be an advantage for plant establishment with lower nutrient and water input.

5) The bioinfiltration area should be covered with 2 to 4 inches (average 3 inches) of mulch at the start and an additional placement of 1 to 2 inches of mulch should be added annually. *The intention is that to help sustain the nutrient levels, suppress weeds, retain moisture, and maintain infiltration capacity.*

Planting/Storage Media Design for Nutrient Sensitive Receiving Waters

1) Where the BMP discharges to receiving waters with nutrient impairments or nutrient TMDLs, the planting media placed in the cell should be designed with the specific goal

of minimizing the potential for initial and long term leaching of nutrients from the media.

2) In general, the potential for leaching of nutrients can be minimized by:

   a. Utilizing stable, aged compost (as required of media mixes under all conditions).

   b. Utilizing other sources of organic matter, as appropriate, that are safe, non-toxic, and have lower potential for nutrient leaching than compost.

   c. Reducing the content of compost or other organic material in the media mix to the minimum amount necessary to support vigorous plant growth and healthy biological processes.

3) A landscape architect should be consulted to assist in the design of planting/storage media to balance the interests of plant establishment, water retention capacity (irrigation demand), and the potential for nutrient leaching. The following practices should be considered in developing the media mix design:

   a. The actual nutrient content and organic content of the selected compost source should be considered when specifying the proportions of compost and sand. The compost specification allows a range of organic content over approximately a factor of 2 and nutrient content may vary more widely. Therefore determining the actual organic content and nutrient content of the compost expected to be supplied is important in determining the proportion to be used for amendment.

   b. A commitment to periodic soil testing for nutrient content and a commitment to adaptive management of nutrient levels can help reduce the amount of organic amendment that must be provided initially. Generally, nutrients can be added planting areas through the addition of organic mulch, but cannot be removed.

   c. Plant palettes and the associated planting mix should be designed with native plants where possible. Native plants generally have a broader tolerance for nutrient content, and can be longer lived in leaner/lower nutrient soils. An additional benefit of lower nutrient levels is that native plants will generally have less competition from weeds.

   d. Nutrients are better retained in soils with higher cation exchange capacity (CEC). CEC can be increased through selection of organic material with naturally high CEC, such as peat, and/or selection of inorganic material with high CEC such as some sands or engineered minerals (e.g., low P-index sands, zeolites, rhyolites, etc.). Including higher CEC materials would tend to reduce the net leaching of nutrients.

e. Soil structure can be more important than nutrient content in plant survival and biologic health of the system. If a good soil structure can be created with very low amounts of compost, plants survivability should still be provided. Soil structure is loosely defined as the ability of the soil to conduct and store water and nutrients as well as the degree of aeration of the soil. While soil structure generally develops with time, planting/storage media can be designed to promote earlier development of soil structure. Soil structure is enhanced by the use of amendments with high hummus content (as found in well-aged organic material). In addition, soil structure can be enhanced through the use of compost/organic material with a distribution of particle sizes (i.e., a more heterogeneous mix). Finally, inorganic amendments such as polymer beads may be useful for promoting aeration and moisture retention associated with a good soil structure. An example of engineered soil to promote soil structure can be found here:

   http://www.hort.cornell.edu/uhi/outreach/pdfs/custructuralsoilwebpdf.pdf

f. Younger plants are generally more tolerant of lower nutrient levels and tend to help develop soil structure as they grow. Starting plants from smaller transplants can help reduce the need for organic amendments and improve soil structure. The project should be able to accept a plant mortality rate that is somewhat higher than starting from larger plants and providing high organic content.

g. With these considerations, it is anticipated that less than 10 percent compost amendment could be used, while still balancing plant survivability and water retention.

Plants

1) Plant materials should be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for 48 to 96 hours.

2) It is recommended that a minimum of three types of tree, shrubs, and/or herbaceous groundcover species be incorporated to protect against facility failure due to disease and insect infestations of a single species.

3) Native plant species and/or hardy cultivars that are not invasive and do not require chemical inputs should be used to the maximum extent practicable.

Operations and Maintenance

Bioinfiltration areas require annual plant, soil, and mulch layer maintenance to ensure optimum infiltration, storage, and pollutant removal capabilities. In general, bioinfiltration maintenance requirements are typical landscape care procedures and include:

1) Watering: Plants should be drought-tolerant. Watering may be required during prolonged dry periods after plants are established.

2) Erosion control: Inspect flow entrances, ponding area, and surface overflow areas periodically, and replace soil, plant material, and/or mulch layer in areas if erosion has occurred (see Appendix I for a bioinfiltration inspection and maintenance checklist). Properly designed facilities with appropriate flow velocities should not have erosion problems, except perhaps in extreme events. If erosion problems occur, the following should be reassessed: (1) flow velocities and gradients within the cell, and (2) flow dissipation and erosion protection strategies in the pretreatment area and flow entrance. If sediment is deposited in the bioinfiltration area, immediately determine the source within the contributing area, stabilize, and remove excess surface deposits.

3) Plant material: Depending on aesthetic requirements, occasional pruning and removing of dead plant material may be necessary. Replace all dead plants and if specific plants have a high mortality rate, assess the cause and, if necessary, replace with more appropriate species. Periodic weeding is necessary until plants are established. The weeding schedule should become less frequent if the appropriate plant species and planting density have been used and, as a result, undesirable plants excluded.

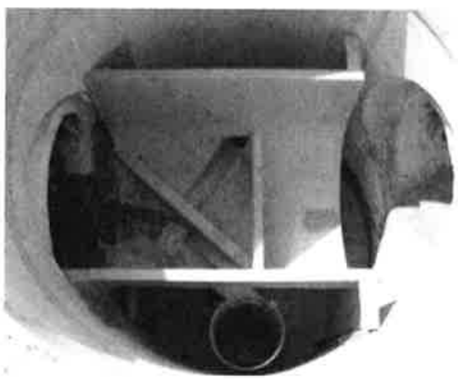
4) Nutrients and pesticides: The soil mix and plants should be selected for optimum fertility, plant establishment, and growth. Nutrient and pesticide inputs should not be required and may degrade the pollutant processing capability of the bioinfiltration area, as well as contribute pollutant loads to receiving waters. By design, bioinfiltration facilities are located in areas where phosphorous and nitrogen levels are often elevated and these should not be limiting nutrients. If in question, have soil analyzed for fertility.

5) Mulch: Replace mulch annually in bioinfiltration facilities where heavy metal deposition is likely (e.g., contributing areas that include industrial and auto dealer/repair parking lots and roads). In residential lots or other areas where metal deposition is not a concern, replace or add mulch as needed to maintain a 2 to 3 inch depth at least once every two years.

6) Soil: Soil mixes for bioinfiltration facilities are designed to maintain long-term fertility and pollutant processing capability. Estimates from metal attenuation research suggest that metal accumulation should not present an environmental concern for at least 20 years in bioinfiltration systems. Replacing mulch in bioinfiltration facilities where heavy metal deposition is likely provides an additional level of protection for prolonged performance. If in question, have soil analyzed for fertility and pollutant levels.

PT-1: Hydrodynamic Separation Device

Hydrodynamic separation devices (alternatively, swirl concentrators) are devices that remove trash, debris, and coarse sediment from incoming flows using screening, gravity settling, and centrifugal forces generated by forcing the influent into a circular motion. By having the water move in a circular fashion, rather than a straight line, it is possible to obtain significant removal of suspended sediments and attached pollutants with less space as compared to wet vaults and other settling devices. Hydrodynamic devices were originally developed for combined sewer overflows (CSOs), where they were used primarily to remove coarse inorganic solids. Hydrodynamic separation has been adapted for stormwater treatment by several manufacturers and is currently used to remove trash, debris, and other coarse solids down to sand-sized particles. Several types of hydrodynamic separation devices are also designed to remove floating oils and grease using sorbent media.



Hydrodynamic Separation

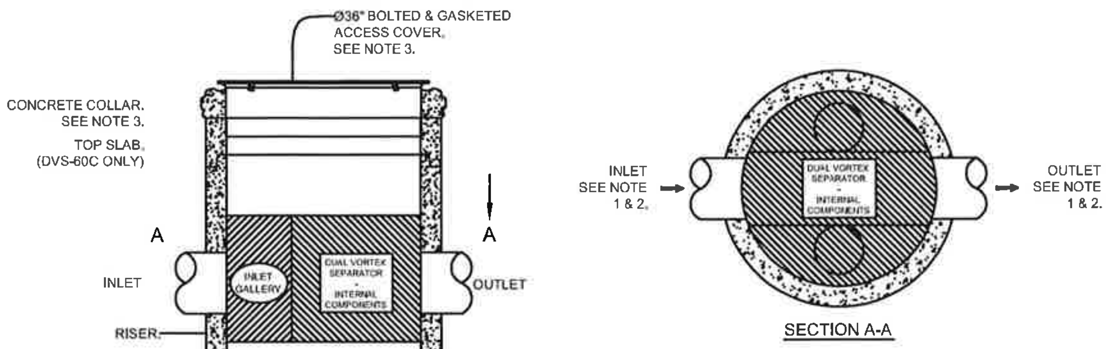
Photo Credits: 1. Contech Stormwater Solutions, Inc.; 2. Dave Weller, FedCo Construction

Application

- Parking lots
- Areas adjacent to parking lots
- Areas adjacent to buildings
- Road medians and shoulders

Preventative Maintenance

- Sediment, trash and debris removal
- Vector control

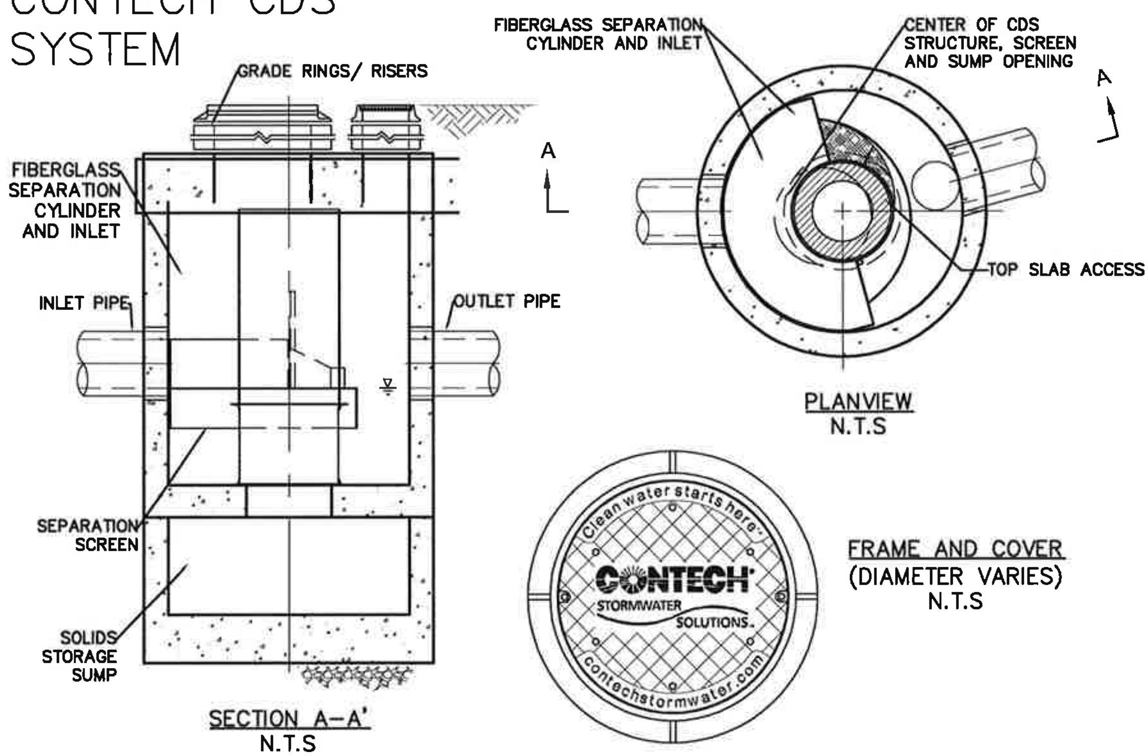


FloGard DUAL-VORTEX

KriStar Enterprises, Inc.

360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

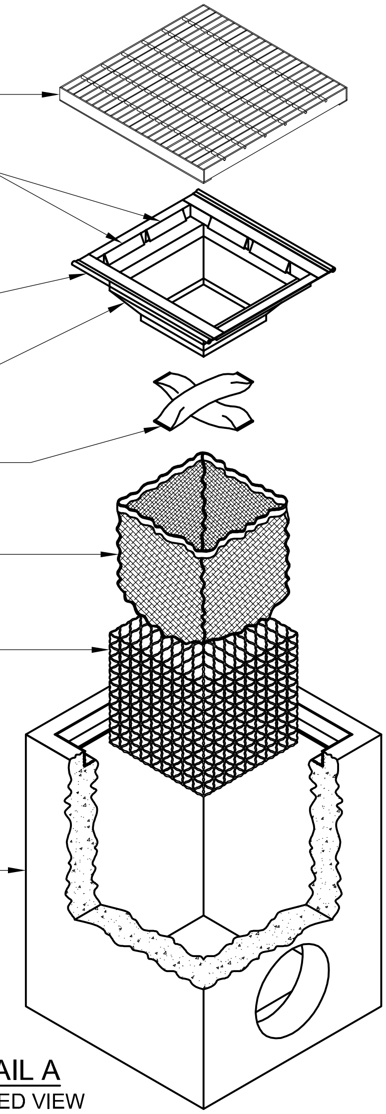
CONTECH CDS SYSTEM



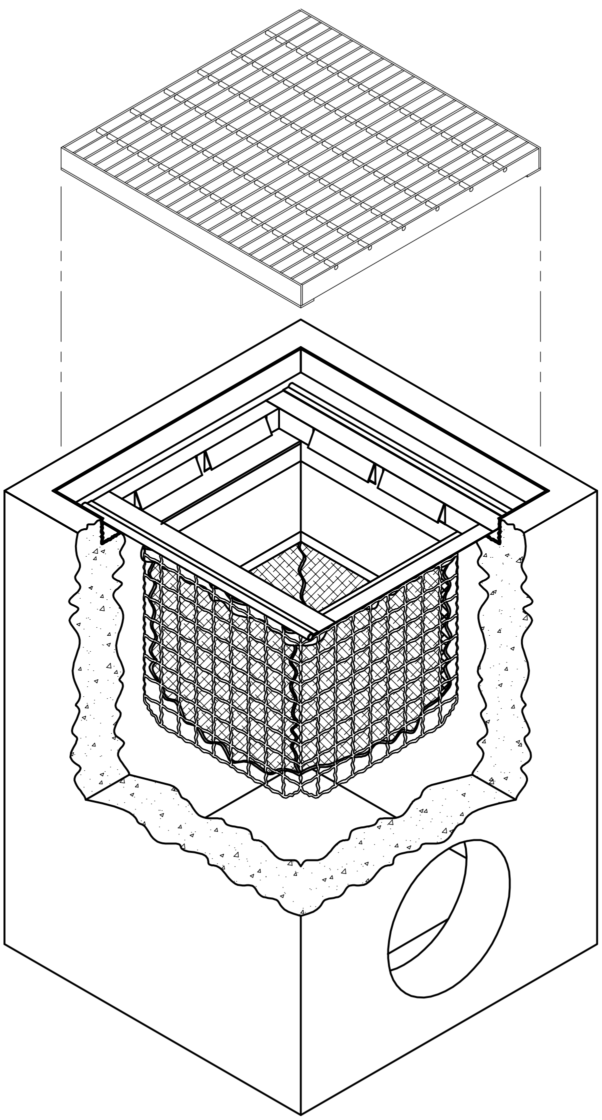
Geosyntec consultants

Figure 6-25: Hydrodynamic Separation

FGP-0001



DETAIL A
EXPLODED VIEW



FloGard® FILTER
-INSTALLED INTO CATCH BASIN-

NOTES:

1. Filter insert shall have a high flow bypass feature.

2. Filter support frame shall be constructed from stainless steel Type 304.

3. Filter medium shall be *Fossil Rock* ™, installed and maintained in accordance with manufacturer specifications.

4. Storage capacity reflects 80% of maximum solids collection prior to impeding filtering bypass.

U.S. PATENT # 6,00,023 & 6,877,029

Inlet Filtration

FloGard®

Catch Basin Insert Filter

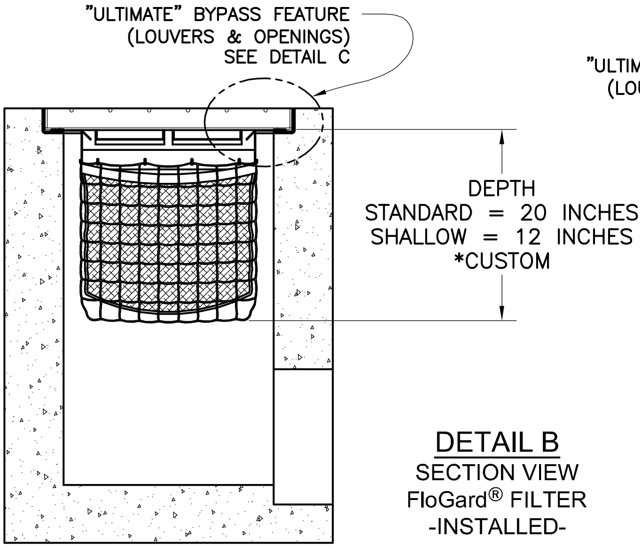
Grated Inlet Style

Oldcastle®
Stormwater Solutions

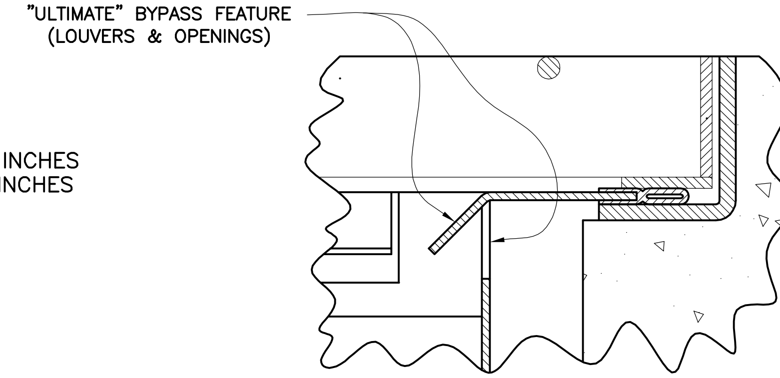
7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

DRAWING NO.	REV	ECO	DATE	
FGP-0001	G	ECO-0142 JPR 7/13/16	JPR 11/3/06	SHEET 1 OF 2

U.S. PATENT # 6,00,023 & 6,877,029



DETAIL B
SECTION VIEW
FloGard® FILTER
-INSTALLED-



DETAIL C
"ULTIMATE"
BYPASS FEATURES

* MANY OTHER STANDARD & CUSTOM SIZES & DEPTHS AVAILABLE UPON REQUEST.

SPECIFIER CHART

MODEL NO. STANDARD DEPTH	STANDARD & SHALLOW DEPTH (Data in these columes is the same for both STANDARD & SHALLOW versions)			STANDARD DEPTH -20 Inches-		MODEL NO. SHALLOW DEPTH	SHALLOW DEPTH -12 Inches-	
	INLET ID Inside Dimension (inch x inch)	GRATE OD Outside Dimension (inch x inch)	TOTAL BYPASS CAPACITY (cu. ft. / sec.)	SOLIDS STORAGE CAPACITY (cu. ft.)	FILTERED FLOW (cu. ft. / sec.)		SOLIDS STORAGE CAPACITY (cu. ft.)	FILTERED FLOW (cu. ft. / sec.)
FGP-12F	12 X 12	12 X 14	2.8	0.3	0.4	FGP-12F8	.15	.25
FGP-16F	16 X 16	16 X 19	4.7	0.8	0.7	FGP-16F8	.45	.4
FGP-18F	18 X 18	18 X 20	4.7	0.8	0.7	FGP-18F8	.45	.4
FGP-1824F	16 X 22	18 X 24	5.0	1.5	1.2	FGP-1824F8	.85	.7
FGP-1836F	18 X 36	18 X 40	6.9	2.3	1.6	FGP-1836F8	1.3	.9
FGP-2024F	18 X 22	20 X 24	5.9	1.2	1.0	FGP-2024F8	.7	.55
FGP-21F	22 X 22	22 X 24	6.1	2.2	1.5	FGP-21F8	1.25	.85
FGP-24F	24 X 24	24 X 27	6.1	2.2	1.5	FGP-24F8	1.25	.85
FGP-2430F	24 X 30	26 X 30	7.0	2.8	1.8	FGP-2430F8	1.6	1.05
FGP-2436F	24 X 36	24 X 40	8.0	3.4	2.0	FGP-2436F8	1.95	1.15
FGP-2448F	24 X 48	26 X 48	9.3	4.4	2.4	FGP-2448F8	2.5	1.35
FGP-28F	28 X 28	32 X 32	6.3	2.2	1.5	FGP-28F8	1.25	.85
FGP-30F	30 X 30	30 X 34	8.1	3.6	2.0	FGP-30F8	2.05	1.15
FGP-36F	36 X 36	36 X 40	9.1	4.6	2.4	FGP-36F8	2.65	1.35
FGP-3648F	36 X 48	40 X 48	11.5	6.8	3.2	FGP-3648F8	3.9	1.85
FGP-48F	48 X 48	48 X 54	13.2	9.5	3.9	FGP-48F8	5.45	2.25
FGP-SD24F	24 X 24	28 X 28	6.1	2.2	1.5	FGP-SD24F8	1.25	.85

Inlet
Filtration

FloGard®

Catch Basin Insert Filter

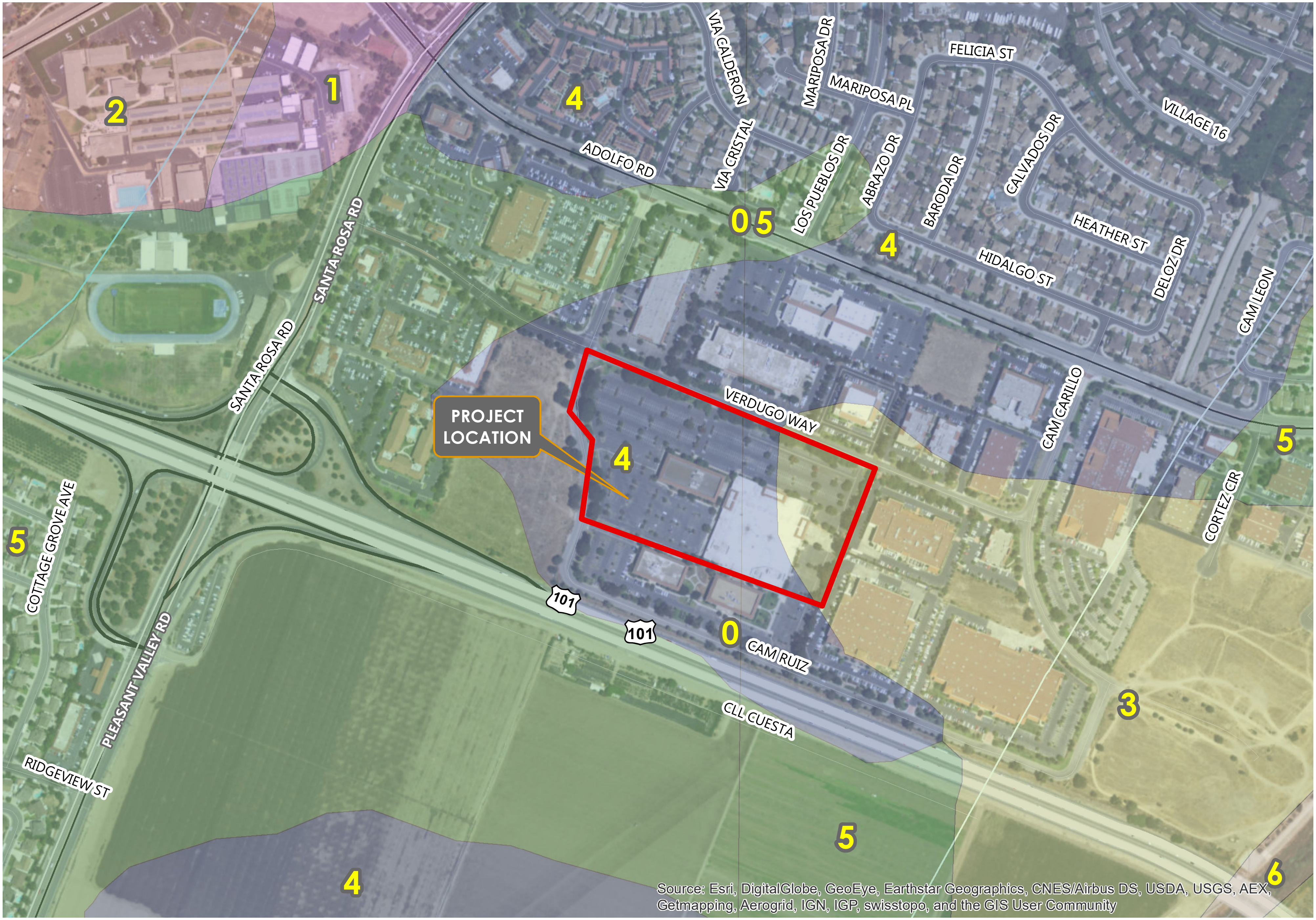
Grated Inlet Style

Oldcastle®
Stormwater Solutions

7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

DRAWING NO.	REV	ECO	DATE	
FGP-0001	G	ECO-0142 JPR 7/13/16	JPR 11/3/06	SHEET 2 OF 2

Soil Type Exhibit



1 INCH = 500 FEET

CAMINO RUIZ & VERDUGO WAY

VENTURA COUNTY SOIL TYPE EXHIBIT

FIRM Panel

National Flood Hazard Layer FIRMette

FEMA

34°13'1.52"N

119°0'21.43"W

118°59'43.97"W

34°12'31.77"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/3/2018 at 11:48:42 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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