

APPENDIX H
WATER STUDY

WATER STUDY

ROBLA ESTATES

City of Sacramento
February 10, 2021

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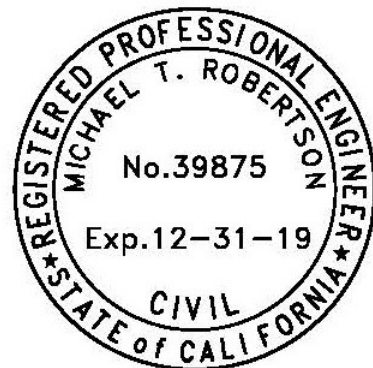


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I. Introduction

The purpose of this report is to analyze the proposed water distribution system capabilities and establish the available system demands to justify the proposed water distribution system pipe sizes for fire flow protection. The Robla Estates project area is located on the east side of Rio Linda Blvd. south of Robla Creek, and north of Claire Ave. and Marysville Blvd. within the city limits of Sacramento (See Figure Below).

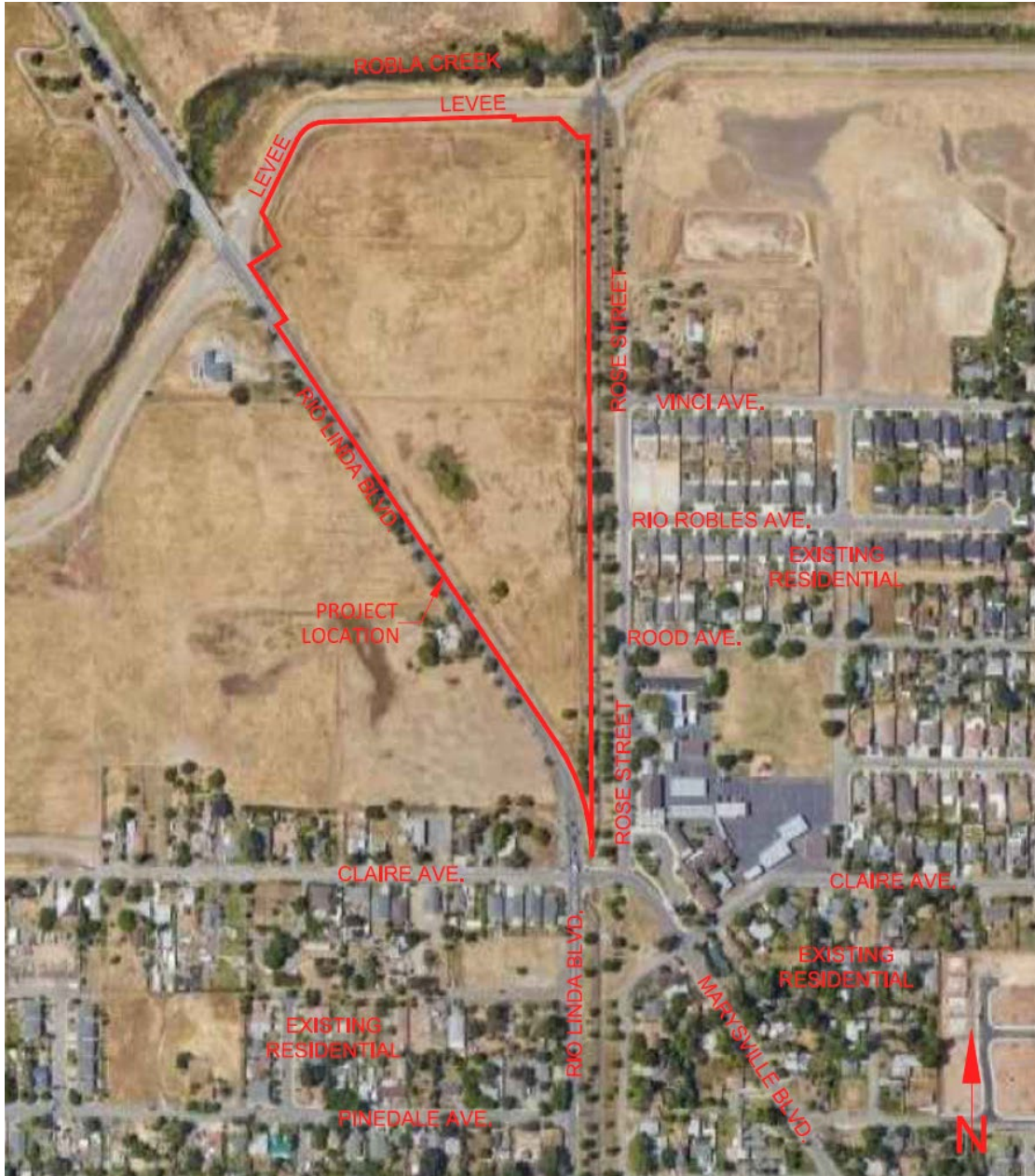


Figure 1 - Vicinity Map

This study is modeled using CivilCAD program software which uses Hazen-Williams formula to ensure that the proposed system meets the parameters set forth by the City of Sacramento County.

II. Background

A topographic survey was conducted and is based on NAVD 88 Datum with elevations of the project area range from 32 feet to 45 feet with an average elevation of 37 feet. The water system provided to the project is supplied and maintained by the City of Sacramento Department of Utilities.

III. Land Use and Demand Projections

The project area is zoned for agriculture, and is proposed as a residential subdivision. Surrounding areas are zoned for a combination of standard single family, Multi-family, and agricultural.

The proposed project will be a 178 lot (R-1A) single family subdivision with 178 water services. For a medium density residential development the average annual water demand is 0.39 AF/year/dwelling unit according to City of Sacramento SB 610/SB 221 Water Supply Assessment and Certification Form. The total demand for the 20.55 acre project would be 69.42 AF/year. There will also be a future apartment site to the south which will consist of a single water service which will service 47 apartment units. For a high density residential development the average annual water demand is 0.12 AF/year/dwelling unit according to City of Sacramento SB 610/SB 221 Water Supply Assessment and Certification Form. The future apartment site with a demand of 5.64 AF/year, or 3.20 gpm, will be analyzed as existing for this report at Node 1. See appendix G for City of Sacramento SB 610/SB 221 Water Supply Assessment and Certification Form. Through unit analysis the demand for the proposed subdivision is converted into design parameters shown in Table 1 below.

Demand	Whole Project (gal/day)	Per Lot (gal/day)	Per Lot (gpm)
Average Day	61,974	350	0.24
Maximum Day	123,948	700	0.48
Peak Hour	161,131	910	0.62

Table 1 - Project Demands

IV. Water System Definition and Level of Service

The water system provided to the project is supplied and maintained by the City of Sacramento. The existing water system consists of a 12” water main on the west side of Rio Linda Boulevard which dead ends at a fire hydrant to the south of the project, as well as an 8” water main within Rose Street to the east of the project. The proposed water system will connect at the existing fire hydrant to continue up Rio Linda Blvd. with a 12” water main. The proposed water main will serve the proposed project with 8” water lines which will loop the system by connecting in to the 8” water line within Rose Street.

The existing water system within Rio Linda Blvd is at an approximate elevation of 40 feet, and the water system within Rose Street is at an approximate elevation of 36 feet. With a design pressure of 32 psi as provided by the City of Sacramento, the hydraulic grade line of the system within Rio Linda Blvd is at an elevation of 113.6

feet, and the hydraulic grade line within Rose Street is 109.6 feet. The proposed water system was modeled using CivilCad analysis program, which uses Hazen-Williams formulas for water distribution systems and a coefficient value of 130. The system model was ran according to the City of Sacramento demands listed as follows: Fire flow demand of 1,500 gallons per minute (gpm) which exceeds the California Building Code (CBC) minimum flow of 1,000 gpm for a sprinklered building size up to 3,600 square feet (sf); a proposed residential max day demand of 0.48 gpm was used for each residence on the system, for a total system demand of 1590.64 gpm, including future demands. The 1,500 gpm was placed at the most remote hydrant (Node 9 at 35 ft. elevation), for a worst case scenario analysis. The fire flow plus max day demand is the worst case scenario for this project, so it is the only scenario that is modeled. If this model meets the max velocity of 10 fps and minimum pressure of 20 psi in the distribution mains, then the system will work for all other scenarios.

V. Hydraulic Model Results and Conclusions

Run Model A, Fire flow with Maximum Day Demand.

With the existing system capabilities of supplying the minimum required demands as set forth by the City of Sacramento, it is determined that the proposed system could supply approximately 1,500 gpm of fire flow at Node 9 with the Maximum Day residential demand for a 2 hour duration without falling below a minimum residual pressure of 20 psi, or above maximum velocity of 10 fps. The maximum allowable head loss per 1000 ft is 10 ft, which is met. Results for 1500gpm fire flow demand can be seen in Appendix A. A summary is listed in Table 2.

Min Pressure (psi)	Node with Min Pressure	Max Velocity (fps)	Pipe with Max Velocity	Max HL/1000 ft. (ft/kft)	Pipe with Max HL/1000 ft.
29.15	9	6.26	12	17.61	12

Table 2 – 1500gpm Fire Flow Demand Result Summary

Run Model B, Average Day Demand.

The Average Day residential demand results are shown in Appendix B. This model successfully runs without falling below a minimum residual pressure of 30 psi and minimum velocity of 0.1 fps, or above maximum velocity of 5 fps. A summary is listed in Table 3.

Min Pressure (psi)	Node with Min Pressure	Min Velocity (fps)	Pipe with Min Velocity	Max Velocity (fps)	Pipe with Max Velocity
32.63	7	0.19	5	3.90	6

Table 3 – Average Day Demand Result Summary

Run Model C, Maximum Day Demand.

The Maximum Day residential demand results are shown in Appendix C. This model successfully runs without falling below the minimum of 30 psi minimum residual pressure, and above a maximum velocity of 7 ft/s. A summary is listed in Table 4.

Max Velocity (fps)	Pipe with Max Velocity	Min Pressure (psi)	Pipe with Min Pressure
3.78	6	32.57	7

Table 4 – Maximum Day Demand Result Summary

Run Model D, Peak Hour Demand.

The Peak Hour Demand results are shown in Appendix D. This model successfully runs without falling below the minimum residual pressure of 30 psi. The model also successfully runs without rising above a maximum velocity of 7 ft/s. A summary is listed in Table 5.

Max Velocity (fps)	Pipe with Max Velocity	Min Pressure (psi)	Node with Min Pressure
3.71	6	32.53	7

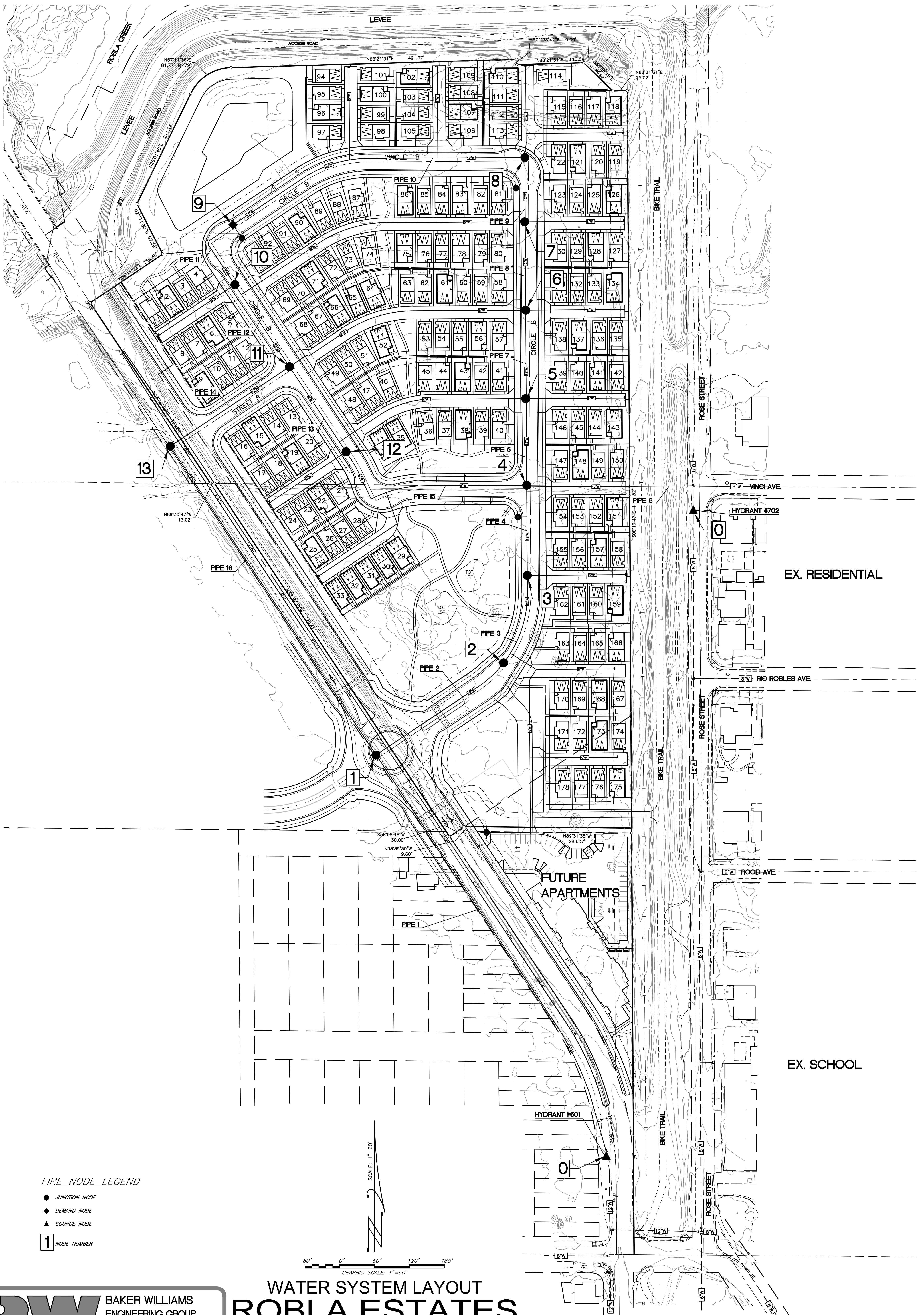
Table 5 – Peak Hour Demand Result Summary

VI. Findings

This model for the proposed water system extending into the project from Rio Linda Boulevard meets the Fire Flow demands and pressure requirements and the maximum pipe velocity. Therefore, the model is compliant to the City of Sacramento Standards.

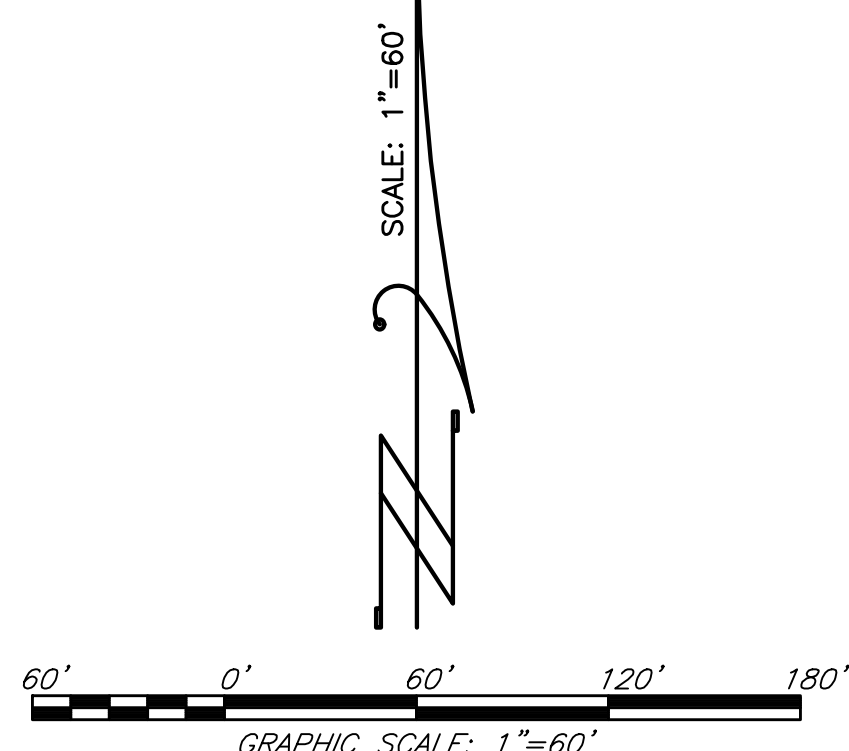
APPENDIX A

Water System Layout



FIRE NODE LEGEND

- JUNCTION NODE
- ◆ DEMAND NODE
- ▲ SOURCE NODE
- 1 NODE NUMBER



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WATER SYSTEM LAYOUT
ROBLA ESTATES

CITY OF SACRAMENTO,
 SACRAMENTO COUNTY, CALIFORNIA
 MARCH, 2021

JOB # 20-02-009

APPENDIX B

Average Residential Flow Model
for a demand of 0.24 gpm per lot

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March 12, 2021

Number of pipes: 16
 Number of junction nodes: 13

Flow unit of measure: GPM
 File name: 20009

Summary of Input Data

Pipe Data:

Pipe	Node #1	Node #2	Dia (in)	Length (ft)	H-W Coeff	Minor Fact	Pump Type	FGN Grade
1	0	1	12.0	794.0	130.0	0.0	-	113.60
2	1	2	12.0	272.0	130.0	0.0	-	-
3	2	3	12.0	160.0	130.0	0.0	-	-
4	3	4	12.0	155.0	130.0	0.0	-	-
5	4	5	12.0	149.0	130.0	0.0	-	-
6	0	4	12.0	328.0	130.0	0.0	-	109.60
7	5	6	12.0	152.0	130.0	0.0	-	-
8	6	7	12.0	152.0	130.0	0.0	-	-
9	7	8	12.0	111.0	130.0	0.0	-	-
10	8	9	12.0	533.0	130.0	0.0	-	-
11	9	10	12.0	139.0	130.0	0.0	-	-
12	10	11	12.0	170.0	130.0	0.0	-	-
13	11	12	8.0	176.0	130.0	0.0	-	-
14	11	13	12.0	246.0	130.0	0.0	-	-
15	12	4	8.0	364.0	130.0	0.0	-	-
16	13	1	12.0	638.0	130.0	0.0	-	-

Junction Node Data:

Node #	Demand (GPM)	Elev (ft)	Connecting Pipes
1	3.19	35.00	1, 2, 16
2	3.86	33.00	2, 3
3	1.93	33.50	3, 4
4	1.93	34.00	4, 5, 6, 15
5	4.31	34.20	5, 7
6	4.58	35.00	7, 8
7	4.80	36.50	8, 9
8	6.96	36.00	9, 10

9	0.00	35.00	10,	11	
10	5.03	35.50	11,	12	
11	4.08	33.50	12,	13,	14
12	5.30	33.50	13,	15	
13	0.00	37.00	14,	16	

Simulation Results

Number of trials: 10
 Convergence : 0.0006

Pipe	Nodes (Q-->)	Dia (in)	Length (ft)	Flow (GPM)	Vel (fps)	Losses (ft) Head	Minor	Pump Head	Hd Loss /1000 ft
1	0	1	12.0	794.0	1093.81	2.38	0.00	-	2.99
2	1	2	12.0	272.0	676.04	0.33	0.00	-	1.23
3	2	3	12.0	160.0	672.18	0.19	0.00	-	1.22
4	3	4	12.0	155.0	670.25	0.19	0.00	-	1.21
5	5	4	12.0	149.0	236.03	0.03	0.00	-	0.17
6	4	0	12.0	328.0	1047.84	0.91	0.00	-	2.77
7	6	5	12.0	152.0	240.33	0.03	0.00	-	0.18
8	7	6	12.0	152.0	244.91	0.03	0.00	-	0.19
9	8	7	12.0	111.0	249.72	0.02	0.00	-	0.19
10	9	8	12.0	533.0	256.67	0.11	0.00	-	0.20
11	10	9	12.0	139.0	256.67	0.03	0.00	-	0.20
12	11	10	12.0	170.0	261.70	0.04	0.00	-	0.21
13	11	12	8.0	176.0	148.80	0.09	0.00	-	0.54
14	13	11	12.0	246.0	414.58	0.12	0.00	-	0.50
15	12	4	8.0	364.0	143.50	0.18	0.00	-	0.50
16	1	13	12.0	638.0	414.58	0.32	0.00	-	0.50

Summary of inflows (+) and outflows (-):

Pipe #	Flow (GPM)
1	1093.80+
6	1047.85-

Net system demand: 45.92 GPM

Maximum-Minimum Summary:

Pipe #	Vel (fps)	Pipe #	HL/1000 ft	Node #	Press (psi)
1	3.10	1	2.99	2	33.75
6	2.97	6	2.77	11	33.49
2	1.92	2	1.23	3	33.45
8	0.69	8	0.19	8	32.33
7	0.68	7	0.18	7	32.11
5	0.67	5	0.17	13	32.03

NOTE: 'HL/1000 ft' does NOT include Minor Losses; and Pipes with zero flow are not included under Minimum 'Vel (fps)'.

APPENDIX C

Max Day Demand with
Fire Flow Demand
@ Node 9

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March 12, 2021

Number of pipes: 16
Number of junction nodes: 13

Flow unit of measure: GPM
File name: 20009

Summary of Input Data

Pipe Data:

Pipe	Node #1	Node #2	Dia (in)	Length (ft)	H-W Coeff	Minor Fact	Pump Type	FGN Grade
1	0	1	12.0	794.0	130.0	0.0	-	113.60
2	1	2	12.0	272.0	130.0	0.0	-	-
3	2	3	12.0	160.0	130.0	0.0	-	-
4	3	4	12.0	155.0	130.0	0.0	-	-
5	4	5	12.0	149.0	130.0	0.0	-	-
6	0	4	12.0	328.0	130.0	0.0	-	109.60
7	5	6	12.0	152.0	130.0	0.0	-	-
8	6	7	12.0	152.0	130.0	0.0	-	-
9	7	8	12.0	111.0	130.0	0.0	-	-
10	8	9	12.0	533.0	130.0	0.0	-	-
11	9	10	12.0	139.0	130.0	0.0	-	-
12	10	11	12.0	170.0	130.0	0.0	-	-
13	11	12	8.0	176.0	130.0	0.0	-	-
14	11	13	12.0	246.0	130.0	0.0	-	-
15	12	4	8.0	364.0	130.0	0.0	-	-
16	13	1	12.0	638.0	130.0	0.0	-	-

Junction Node Data:

Node #	Demand (GPM)	Elev (ft)	Connecting Pipes
1	5.21	35.00	1, 2, 16
2	7.68	33.00	2, 3
3	3.86	33.50	3, 4
4	3.86	34.00	4, 5, 6, 15
5	8.62	34.20	5, 7
6	9.11	35.00	7, 8
7	9.61	36.50	8, 9
8	13.91	36.00	9, 10

9	1500.00	35.00	10,	11
10	10.10	35.50	11,	12
11	8.17	33.50	12,	13, 14
12	10.55	33.50	13,	15
13	0.00	37.00	14,	16

Simulation Results

Number of trials: 5

Convergence : 0.0002

```

=====
Pipe      Nodes  Dia  Length  Flow    Vel    Losses (ft)  Pump  Hd Loss
(Q--->)  (in)  (ft)  (GPM)   (fps)   Head  Minor  Head  /1000 ft
=====
  1     0    1  12.0   794.0  1336.39  3.79   3.44   0.00   -    4.34
  2     1    2  12.0   272.0   628.81  1.78   0.29   0.00   -    1.07
  3     2    3  12.0   160.0   621.14  1.76   0.17   0.00   -    1.05
  4     3    4  12.0   155.0   617.28  1.75   0.16   0.00   -    1.04
  5     4    5  12.0   149.0   655.08  1.86   0.17   0.00   -    1.16
  6     0    4  12.0   328.0   254.28  0.72   0.07   0.00   -    0.20
  7     5    6  12.0   152.0   646.46  1.83   0.17   0.00   -    1.13
  8     6    7  12.0   152.0   637.35  1.81   0.17   0.00   -    1.10
  9     7    8  12.0   111.0   627.75  1.78   0.12   0.00   -    1.07
 10    8    9  12.0   533.0   613.83  1.74   0.55   0.00   -    1.03
 11   10    9  12.0   139.0   886.17  2.51   0.28   0.00   -    2.03
 12   11   10  12.0   170.0   896.27  2.54   0.35   0.00   -    2.07
 13   12   11   8.0   176.0   202.06  1.29   0.17   0.00   -    0.95
 14   13   11  12.0   246.0   702.37  1.99   0.32   0.00   -    1.32
 15    4   12   8.0   364.0   212.61  1.36   0.38   0.00   -    1.04
 16    1   13  12.0   638.0   702.37  1.99   0.84   0.00   -    1.32
=====

```

Summary of inflows (+) and outflows (-):

```

=====
Pipe #      Flow (GPM)
=====
      1      1336.39+
      6      254.27+
=====

```

Net system demand: 1590.64 GPM

Maximum-Minimum Summary:

```

=====
Pipe #      Vel (fps)      Pipe #      HL/1000 ft      Node #      Press (psi)
=====
  1          3.79          1          4.34            2          33.31
 12          2.54          12         2.07            3          33.02
 11          2.51          11         2.03           12          32.78
-----
 15          1.36          10         1.03            8          31.59
 13          1.29          13         0.95            7          31.43
  6          0.72          6          0.20           13          31.34
=====

```

NOTE: 'HL/1000 ft' does NOT include Minor Losses; and Pipes with zero flow are not included under Minimum 'Vel (fps)'.

APPENDIX D

Peak Hour Residential Flow Model
for a demand of 0.62 gpm per lot

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March 12, 2021

Number of pipes: 16
 Number of junction nodes: 13

Flow unit of measure: GPM
 File name: 20009

Summary of Input Data

Pipe Data:

Pipe	Node #1	Node #2	Dia (in)	Length (ft)	H-W Coeff	Minor Fact	Pump Type	FGN Grade
1	0	1	12.0	794.0	130.0	0.0	-	113.60
2	1	2	12.0	272.0	130.0	0.0	-	-
3	2	3	12.0	160.0	130.0	0.0	-	-
4	3	4	12.0	155.0	130.0	0.0	-	-
5	4	5	12.0	149.0	130.0	0.0	-	-
6	0	4	12.0	328.0	130.0	0.0	-	109.60
7	5	6	12.0	152.0	130.0	0.0	-	-
8	6	7	12.0	152.0	130.0	0.0	-	-
9	7	8	12.0	111.0	130.0	0.0	-	-
10	8	9	12.0	533.0	130.0	0.0	-	-
11	9	10	12.0	139.0	130.0	0.0	-	-
12	10	11	12.0	170.0	130.0	0.0	-	-
13	11	12	8.0	176.0	130.0	0.0	-	-
14	11	13	12.0	246.0	130.0	0.0	-	-
15	12	4	8.0	364.0	130.0	0.0	-	-
16	13	1	12.0	638.0	130.0	0.0	-	-

Junction Node Data:

Node #	Demand (GPM)	Elev (ft)	Connecting Pipes
1	8.30	35.00	1, 2, 16
2	9.92	33.00	2, 3
3	4.98	33.50	3, 4
4	4.98	34.00	4, 5, 6, 15
5	11.18	34.20	5, 7
6	11.76	35.00	7, 8
7	12.39	36.50	8, 9
8	18.00	36.00	9, 10

9	0.00	35.00	10,	11
10	13.02	35.50	11,	12
11	10.55	33.50	12,	13, 14
12	13.65	33.50	13,	15
13	0.00	37.00	14,	16

Simulation Results

Number of trials: 10
 Convergence : 0.0005

```

=====
Pipe      Nodes  Dia   Length  Flow    Vel    Losses (ft)  Pump  Hd Loss
(Q--->)  (in)   (ft)  (GPM)   (fps)  Head  Minor  Head  /1000 ft
=====
  1      0     1   12.0   794.0  1114.02  3.16   2.46   0.00   -    3.10
  2      1     2   12.0   272.0   680.29  1.93   0.34   0.00   -    1.24
  3      2     3   12.0   160.0   670.37  1.90   0.19   0.00   -    1.21
  4      3     4   12.0   155.0   665.39  1.89   0.18   0.00   -    1.19
  5      5     4   12.0   149.0   200.29  0.57   0.02   0.00   -    0.13
  6      4     0   12.0   328.0   995.30  2.82   0.82   0.00   -    2.51
  7      6     5   12.0   152.0   211.47  0.60   0.02   0.00   -    0.14
  8      7     6   12.0   152.0   223.23  0.63   0.02   0.00   -    0.16
  9      8     7   12.0   111.0   235.62  0.67   0.02   0.00   -    0.17
 10     9     8   12.0   533.0   253.62  0.72   0.11   0.00   -    0.20
 11    10     9   12.0   139.0   253.62  0.72   0.03   0.00   -    0.20
 12    11    10   12.0   170.0   266.63  0.76   0.04   0.00   -    0.22
 13    11    12    8.0   176.0   148.24  0.95   0.09   0.00   -    0.53
 14    13    11   12.0   246.0   425.43  1.21   0.13   0.00   -    0.52
 15    12     4    8.0   364.0   134.60  0.86   0.16   0.00   -    0.45
 16     1    13   12.0   638.0   425.43  1.21   0.33   0.00   -    0.52
=====

```

Summary of inflows (+) and outflows (-):

```

=====
Pipe #      Flow (GPM)
=====
      1      1114.02+
      6      995.30-
=====

```

Net system demand: 118.68 GPM

Maximum-Minimum Summary:

```

=====
Pipe #      Vel (fps)      Pipe #      HL/1000 ft      Node #      Press (psi)
=====
  1          3.16          1          3.10           2          33.71
  6          2.82          6          2.51          11          33.44
  2          1.93          2          1.24           3          33.41
-----
  8          0.63          8          0.16           8          32.29
  7          0.60          7          0.14           7          32.06
  5          0.57          5          0.13          13          31.98
=====

```

NOTE: 'HL/1000 ft' does NOT include Minor Losses; and Pipes with zero flow are not included under Minimum 'Vel (fps)'.

APPENDIX E

City Water Supply Test for Project

CITY OF SACRAMENTO

WATER STUDY DESIGN MANUAL

This manual is intended to provide developers information needed to complete a water study for a new development project, including the form(s) necessary for a complete submittal.

January 2018

Every project, regardless of size, must fill out and submit the “SB 610/SB 221 Water Supply Assessment and Certification Form” (see Attachment 1). This form will confirm or deny the availability of water supply, per the latest Urban Water Management Plan, before the project can proceed.

Once water supply has been validated for the project, then a water study shall be completed for the project design. This study must be stamped by a licensed engineer and submitted to the Department of Utilities for review. The submittal shall include an electronic copy of every submittal, and if requested, electronic copies of the model/calculation tool.

The study must be based on a water system design that meets the City design standards for a public water system, including but not limited, to properly sizing pipe to meet both water quality and fire flow needs for the project, looping systems for redundancy and improved water supply, and hydrant placement as it relates to the surrounding area as well as the project.

Water studies shall follow the “Water Distribution System Criteria” (see Attachment 2) and incorporate the following information:

1) Study Purpose and Objectives

- a) Include description of the development including any proposed phasing of the improvements
 - i) Geographic location of the project and the surrounding area, including elevations
 - ii) Land use type of the project and the surrounding area (identify if different from the current General Plan)
 - iii) Number of services being proposed
 - iv) Existing water infrastructure as well as proposed new infrastructure, including pipe size, age, and material
 - v) Descriptions of any non-standard proposed designs and reasons for not meeting standards

2) Study Area

- a) Location Map
- b) Modeled Water Distribution Layout Map – Include pipe size, demand junctions (include elevations based on project area survey results), tie-in locations, and any necessary system modifications

3) Demands and Peaking Factors

- a) Land Use Designation (Units, Acres, and Demand Factor – include source)
- b) Flows to be assessed (concurrently)
 - i) Domestic
 - ii) Irrigation
 - iii) Hydrant Flow
 - iv) Fire Sprinkler Loads (*Fire sprinkler loads may be waived if authorization is provided by the current City of Sacramento Fire Marshall and the report includes details of the correspondence)
- c) Demand Factor (by Land Use Designation if more than one)
 - i) Average Day Demand (ADD)

- ii) Maximum Day Demand (MDD) - 2.0 x Average Day
 - iii) Peak Hour Demand (PHD) - 2.6 x Average Day
 - iv) Assumed System Losses
- 4) **Design Criteria**
- a) City of Sacramento Design Criteria – Include Source
 - i) Minimum velocity during Average Day Demand
 - ii) Minimum residual pressure during Peak Hour Demand
 - iii) Maximum velocity during Peak Hour Demand
 - iv) Minimum residual pressure during Maximum Day Demand plus fire flow
 - v) Maximum velocity during Maximum Day Demand plus fire flow
 - vi) Maximum headloss per 1,000-LF
 - vii) Minimum velocity during Average Day Demand
 - viii) Hazen Williams “C”
 - ix) Elevations at demand nodes (should reflect surveyed elevations for project)
 - b) Fire Flow Requirements – As Required by the Fire Department (shall be no less than 1,000-gpm with 20-psi residual)
 - i) Flow (gpm)
 - ii) Residual Pressure (psi)
 - iii) Duration (Hours)
- 5) **Hydraulic Analysis Summary**
- a) Model Description - Include software information (if applicable) and source of data
 - b) Existing Boundary Conditions, including results from field hydrant testing
 - c) Model Scenarios and Results
 - i) Include Minimum/Maximum Pressure and Maximum Velocity for Average Day Demand, Maximum Day Demand, Maximum Day Demand plus Fire Flow, and Peak Hour Demand for each scenario (include back-up by junction and pipe segment)
 - ii) Phased projects shall include intermediate and cumulative results
- 6) **Conclusions**

At the discretion of the City Engineer, additional information may be required for the water study. Each project is different and may require additional information dependent on the location, size of development and land use being proposed for the project.

Press to clear form

City of Sacramento
SB 610/SB 221 Water Supply Assessment and Certification Form

This form may be used to complete water supply assessments for projects located in an area covered by the City's most recent Urban Water Management Plan.

Note: Please do not use this form if the projected water demand for your project area was not included in the City's latest Urban Water Management Plan. To review the City's Urban Water Management Plan, please visit:
<http://www.cityofsacramento.org/Utilities/Resources/Reports>

Project:

Date:

Project Applicant (Name of Company):

Applicant Contact (Name of Individual):

Phone Number:

E-mail:

Address:

Project Applicant to fill in the following:

1. Does the project include:

Type of Development	Yes	No
A proposed residential development of 500 or more dwelling units		
A shopping Center employing more than 1,000 persons or having more than 500,000 square feet?		
A Commercial Office building employing more than 1,000 persons or having more than 250,000 square feet?		
A proposed hotel or motel, or both, having more than 500 rooms		
A proposed industrial, manufacturing, or processing plant or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area		
A mixed use project that includes one or more of the projects specified above		
A project that would demand an amount of water equivalent to, or greater than, the water required by a 500 dwelling unit project		

If the answer is no to all of the above, a water supply assessment is not required for the project.

2. Is the projected water demand for the project location included in the City's 2015 Urban Water Management Plan, adopted June 21, 2016?

Yes: _____

No: _____

If the answer is no, you cannot use this form. Please refer to the requirements of SB 610 for preparing a water supply assessment.

3. Please fill in the project demands below:

Type of Development	Land Use Category	Demand Factor		Proposed Development			Current Zoning		
		Residential Water Use Factor, afy/dwelling unit	Non-Residential Water Use Factor, afy/employee	Number Dwelling Units	Number Employees	Total Demand	Number Dwelling Units	Number Employees	Total Demand
Residential - Low	Rural Residential (RR)								
	Suburban Neighborhood Low Density (SNLD)								
	Traditional Neighborhood Low Density (TLDR)								
Residential - Medium	Suburban Neighborhood Medium Density (SMDR)								
	Urban Neighborhood Low Density (ULDR)								
Residential - High	Suburban Neighborhood High Density (SHDR)								
	Traditional Neighborhood Medium Density (TMDR)								
	Urban Neighborhood Medium Density (UMDR)								
	Traditional Neighborhood High Density (THDR)								
Mixed Use	Employment Center Mid Rise (ECMR)								
	Suburban Center (SCnt)								
	Suburban Corridor (Scor)								
	Traditional Center (TCnt)								

Mixed Use - Higher Density	Urban Center High (UCntHigh)								
	Urban Center Low (UcntLow)								
	Urban Corridor High (UCorHigh)								
	Urban Corridor Low (UCorLow)								
Central Business District	Central Business District (CBD)								
	Urban Neighborhood High Density (UHDR)								
Commercial	Regional Commercial (RC)								
	Employment Center Low Rise (ECLR)								
Industrial	Industrial (IND)	NA							
Public	Public/Quasi-Public (PUB)								
Park	Parks and Recreation (PRK)								
Open Space	Open Space (OS)								
Other									
Other									
Other									
Total Demand (AFY)									

4. Required Elements of Water Supply Assessment (Water Code § 10910)

- A. Water supply entitlements, water rights or water service contracts (Water Code § 10910(d)):

The City's water supply entitlements, water rights and water service contract are identified and discussed in the Urban Water Management Plan, Chapters 3, 6 and 7.

All infrastructure necessary to deliver a water supply to the project is in place, excepting any distribution facilities required to be constructed and financed by the project applicant: Yes: _____ No: _____

- B. Identification of other sources of water supply if no water has been received under City's existing entitlements, water rights or water service contracts (Water Code § 10910(e)):

Not applicable.

- C. Information and analysis pertaining to groundwater supply (Water Code § 10910(f)):

Addressed by Urban Water Management Plan, Chapters 3, 6 and 7.

Verification of Water Supply
(for residential development of more than 500 dwelling units)

Based on the City's most recent Urban Water Management Plan, are there sufficient water supplies for the project during normal, single dry and multiple dry years over a 20 year period?

Yes: _____

No: _____

By: _____

Title: _____

Date: _____

This box to be filled in by the City

Distribution:

Applicant

Development Services Department (Org: 4913) – Assigned Planner: _____

Utilities Department (Org: 3334) - Development Review (Tony Bertrand)

Utilities Department (Org: 3332) - Capital Improvements (Brett Ewart)

City of Sacramento
Water Distribution System Criteria

Summary of Recommended Potable Water System Performance and Operational Criteria

Component	Criteria		Comments	
Fire Flow Requirements (flow [gpm] @ duration [hours])				
Single Family Residential	1,500 gpm @ 2 hrs		Existing Development will be evaluated on a case-by-case basis because of the historical varying standard	
Multi Family Residential	2,500 gpm @ 2 hrs			
Commercial	3,500 gpm @ 4 hrs (w/ approved automatic sprinkler system)			
Industrial	4,500 gpm @ 4 hrs (w/ approved automatic sprinkler system)			
Institutional	4,500 gpm @ 4 hrs (w/ approved automatic sprinkler system)			
Water Transmission Line Sizing				
Diameter	>= 18-inches		Locate new transmission pipelines within designated utility corridors wherever possible.	
<i>Average Day Demand Condition</i>				
Minimum Pressure [psi]	30 psi		Criteria based on requirements for new development, existing transmission mains will be evaluated on case-by-case basis. Evaluation will include age, material type, velocity, head loss, and pressure.	
Maximum Pressure [psi]	80 psi			
Maximum Head loss [ft/kft]	3 ft/kft			
Maximum Velocity [ft/sec]	3 ft/sec			
Minimum Velocity [ft/sec]	0.10 ft/sec			
<i>Maximum Day Demand Condition</i>				
Maximum Pressure [psi]	30 psi			
Maximum Head loss [ft/kft]	3 ft/kft			
Maximum Velocity [ft/sec]	5 ft/sec			
<i>Peak Hour Demand Condition</i>				
Minimum Pressure [psi]	30 psi		For consistency in hydraulic modeling.	
Maximum Head loss [ft/kft]	3 ft/kft			
Maximum Velocity [ft/sec]	5 ft/sec			
Hazen Williams "C" Factor	130			
Pipeline Material	CCP (Concrete Cylinder Pipe), Ductile Iron, or Welded Steel			
Water Distribution Line Sizing				
Diameter	< 18-inches		Must verify pipeline size with maximum day plus fire flow analysis. Locate new distribution pipelines within designated utility corridors wherever possible	
<i>Average Day Demand Condition</i>				
Minimum Pressure [psi]	30 psi		Criteria based on requirements for new development, existing distribution mains will be evaluated on case-by-case basis. Evaluation will include age, material type, velocity, head loss, and pressure.	
Maximum Pressure [psi]	80 psi			
Maximum Head loss [ft/kft]	7 ft/kft			
Maximum Velocity [ft/sec]	5 ft/sec			
Minimum Velocity [ft/sec]	0.10 ft/sec			
<i>Maximum Day with Fire Flow Demand Condition</i>				
Minimum Pressure [psi] (at fire node)	20 psi			
Maximum Head loss [ft/kft]	10 ft/kft			
Maximum Velocity [ft/sec]	10 ft/sec			
<i>Peak Hour Demand Condition</i>				
Minimum Pressure [psi]	30 psi		6-inch may apply where minimum velocities aren't met	
Maximum Head loss [ft/kft]	7 ft/kft			
Maximum Velocity [ft/sec]	7 ft/sec			
<i>Minimum Pipeline Diameter</i>				
General	8-inches		4-inch may apply where minimum velocities aren't met and the dead end is no longer than 250-feet. 6-inch dead end runs shall be no longer than 500-feet.	
Industrial	12-inches			
Distribution to cul-de-sac / dead-end street	6-inches		For consistency in hydraulic modeling.	
Distribution to fire hydrants	8-inches			
Hazen Williams "C" Factor	130		Install PRV if service pressure is greater than 80 psi.	
Pipeline Material	Ductile Iron or C900 PVC			
Maximum Water Service Pressure [psi]	80 psi		<p>(a) Use factor includes 10% for unaccounted-for water. Public and Park uses show small increases in residential dwelling units because the spatial analysis captures small residential areas adjacent to these land uses. Average of residential category used to estimate this small residential use. Significant irrigation requirements for parks are assumed to be provided from wells not connected to the potable water system. Other use factors, such as residential categories, include neighborhood park water use, incorporate park irrigation use in the non-residential category.</p> <p>(b) Use factor includes 10% for unaccounted for water. Residential Low, Medium and High have small non-residential water use sample size. Therefore, Mixed Use Non-Residential used for Residential Low and Medium. Mixed Use - Higher Density used for Residential High.</p>	
Gross Unit Water Use Factors for Retail Distribution System	Composite Residential Use Factor ^(a) [afy/dwelling unit]	Composite Non-Residential Water Use Factor ^(b) [afy/employee]		
Residential Low	0.61	0.09		
Residential Medium	0.39	0.09		
Residential High	0.12	0.04		
Mixed Use	0.19	0.09		
Mixed Use (Higher Density)	0.15	0.04		
Central Business Density	0.15	0.02		
Commercial/Office	0.15	0.09		
Industrial	--	0.14		
Public	0.37	0.17		
Park	0.37	0.17		
Gross Unit Water Use Factors for Study Areas				
	Gross Water Use Factor [afa/acre]		Use factor includes 10% for unaccounted-for water and 15% to account for rights-of-way and streets (net water use x 1.1/1.5 = gross water use).	
Residential Low	3.6			
Residential Medium	3.8			
Mixed Use	2.0			
Commercial/Office	1.5			
Industrial	0.9			
Park	3.0			

APPENDIX F

City Water Study Design Manual

WATER SUPPLY TEST - DEPARTMENT OF UTILITIES

City of Sacramento Community Development Dept. 300 Richards Blvd., 3rd Floor Sacramento, CA 95811	WORK ORDER #: 521195	WST NUMBER: 2008065
	ANALYSIS FEE: \$392.00	DATE PAID: 5.15.20
	FIELD TEST FEE: \$902.00	DATE PAID: 5.15.20
	HYDRAULIC BOUNDARY CONDITION	DATE PAID:
CONTACT: Mike Robertson	FEE: \$481.00; optional see item (3) below.	TEST NUMBER: 1 of 1
COMPANY: Baker Williams	PHONE NUMBER: 916.331.4336 ext 111	EMAIL: miker@bwengineers.com
ADDRESS: 6020 Rutland Drive sui carmichael ca 95608	ADDRESS OF TEST: 5330 Rio Linda Blvd	
	ASSESSOR'S PARCEL NUMBER: 226-0062-004,008,009,011, 226-0102-001	

The undersigned agrees to the following items and conditions:

- (1) *The street address and/or parcel number shown above is correct*
- (2) *Water supply data is developed from several sources of information which may include water supply test data, computer models, and pressure recording stations. The water supply data given is to be used for design purposes.*
- (3) *Based on hydrant locations, test results may not provide accurate flow information at the point of connection, for a fee the City can provide the hydraulic analysis necessary to transfer the results to a single point of connection.*
- (4) *Although the water supply data reported herein is believed to be accurate, the City makes no warranty, guaranty, certification or other representation of any kind that such data is accurate or correct, or that the pressures and/or flow rates reported herein can or will be maintained. The undersigned agrees that the City, its officers and employees shall not be liable for any damages of any kind resulting from the use of or reliance upon the water supply data reported herein by the undersigned or by any third party.*
- (5) *When more than one water supply test has been performed, the decision is left to the Fire Plan Checker as to which water supply test is to be used.*
- (6) *If the undersigned desires to witness the water supply test performed by the City, please check the box below:*
 I want to witness this water supply test, which will be scheduled at the convenience of the Department of Utilities.
- (7) *If the undersigned elects to hire a licensed engineer, at the undersigned's sole expense, to witness and certify the water supply test performed by the City, please check the box below:*
 At my expense, I will arrange for a licensed engineer to witness and certify this water supply test, which will be scheduled at the convenience of the Department of Utilities.

PRINT NAME: Mike Robertson	SIGNATURE: signed Hc
DATE: 5.14.20	

DATE OF TEST: 7/29/2020	TIME OF TEST: 6:30 AM
WTR. MAIN SIZE: 12"	TEST CONDUCTED BY: Sal Miano

	Hydrant Number	Map Page	Static Pres. (PSI)	Residual Pres. (PSI)	Pitot Pres. (PSI)	Outlet Dia. (Inches)	Coefficient		Calc. Flow @ Pres. (GPM)	Flow @ 20 PSI (G.P.M.)
							C ₁	C ₂		
Residual	902	N18	41	30						
Flowed	603	N18			17	4.5	0.90	0.83	1860	1950
Flowed	702	M19			7	4.5	0.90	0.83	1194	1251
Flowed										
Flowed										

* THE WATER SUPPLY TEST DATA IS NOT TO BE USED FOR THE DESIGN OF DOMESTIC WATER SYSTEMS.
 * (STATIC PRES. - RESIDUAL PRES.) / (STATIC PRES. - 20 PSI) MUST NOT BE LESS THAN 25%. THEREFORE, THESE RESULTS ARE ONLY VALID FOR RESIDUAL PRESSURES LESS THAN 36 PSI

WATER SUPPLY DATA SUMMARY

	Design (1)
Static Pressure	32 PSI
Residual Pressure	21 PSI
Total Flow @ Residual	3100 G.P.M.
Total Flow @ 20 PSI	3200 G.P.M.

(1) The Design Water Supply Data reflects fluctuations and future demands on the water distribution system. It is to be used for design purposes.

APPENDIX I
PRELIMINARY BASIN SIZING MEMORANDUM

TECHNICAL MEMORANDUM

DATE: March 31, 2022

Project No.: 937-60-20-01
SENT VIA: EMAIL

TO: Michael Robertson, Baker-Williams Engineering Group

FROM: Michele Miller, PE, RCE #88437

REVIEWED BY: Mark Kubik, PE, RCE #50963

SUBJECT: Robla Estates Preliminary Basin Sizing



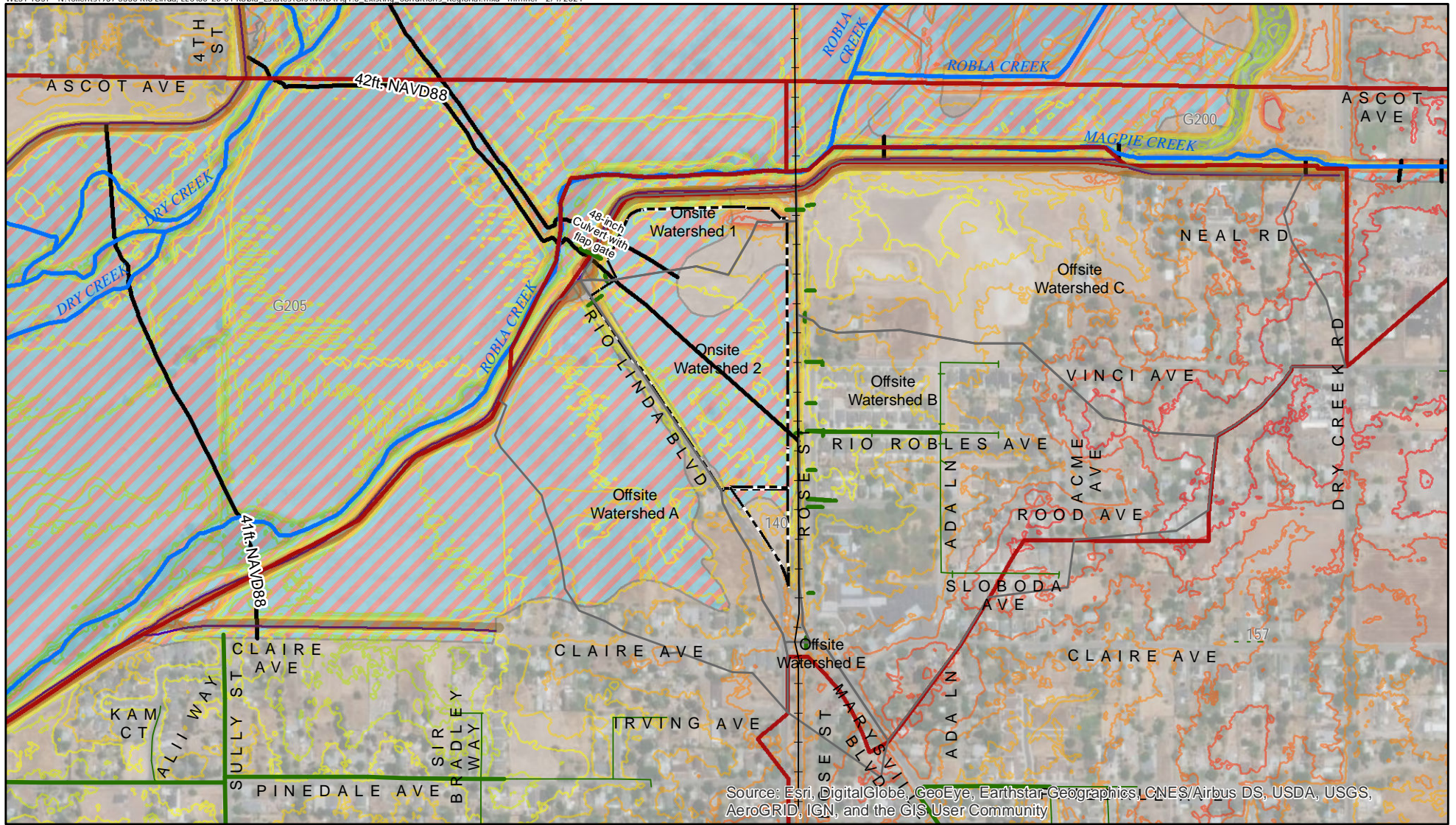
West Yost has conducted a preliminary study to size the proposed detention basin and pump station at Robla Estates which are intended to provide flood control and stormwater quality treatment for the 177-unit development. This draft Technical Memorandum (TM) summarizes the hydrologic and hydraulic (H&H) model creation, study assumptions, and preliminary sizing of the proposed detention basin, and the associated pump station. The sections of this TM include:

- Background Information
- Site Visit
- Hydrologic and Hydraulic Model Creation
- Study Assumptions
- Existing Watershed Characteristics
- Proposed Watershed Characteristics
- Preliminary Basin and Pump Station Sizing Process
- Detention Basin Sizing
- Flood Control Benefit
- Draft Conditions of Approval
- Low Impact Development and Water Quality
- Hydromodification and Outlet Configuration
- Preliminary Pipe Sizing

BACKGROUND INFORMATION

A residential development project is proposed at 5330 and 5240 Rio Linda Boulevard in the City of Sacramento (City). The project is located east of Rio Linda Boulevard, west of the Bike Trail, and south of Robla Creek as shown on Figure 1. A federally certified levee separates Robla Estate from Robla Creek. Robla Estates is within an existing Federal Emergency Management Agency (FEMA) floodplain at the

site. Currently, several offsite watersheds flow into the Robla Estate site and are drained to Robla Creek via an existing 48-inch culvert.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

- | | | | |
|------------------------------------|----|-----------------------------|----------------------------|
| Ground Elevation ft. NAVD88 | 38 | — Bike Trail | — Existing Storm Pipe |
| 26 | 40 | — Federal Levee | --- Robla Estates Boundary |
| 28 | 42 | — FEMA Base Flood Elevation | □ Existing Watershed |
| 30 | 44 | ▨ FEMA Flood Zone A | |
| 32 | 46 | ▨ FEMA Flood Zone AE | |
| 34 | 48 | ▭ City Drainage Basins | |
| 36 | 50 | — Creeks | |

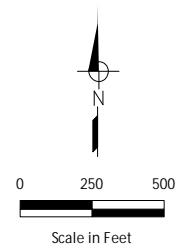


Figure 1
Regional Site Map
Stormwater Drainage

Robla Estates
 5330 Rio Linda, LLC

SITE VISIT

A site visit was conducted on October 29, 2020 to document the culvert locations and existing offsite and onsite flow patterns. Flap gates were noted on all eastern pipe connections to Robla Estates. The flap gate on the northern pipe outfall is currently missing and will be replaced by the City. The following flow paths and infrastructure were observed on the site and listed by watershed:

- Offsite Watershed A drains northeast to a 30-inch reinforced concrete pipe (RCP) culvert where it enters the Robla Estates site and is discharged through a 48-inch RCP culvert under the levee to Robla Creek.
- Offsite Watershed B drains to the west through the City storm drain system and is discharged to the East Channel. The East Channel is relatively flat, with a slight slope north to a 48-inch RCP culvert where flow enters the Robla Estates Site. The 48-inch RCP culvert flows to the Northern Channel for discharge to Robla Creek through a 48-inch RCP culvert with flap gate. Flow can also exit the East Channel through a 36-inch RCP culvert with flap gate west of Rio Robles Avenue, which discharges to Onsite Watershed 2.
- Offsite Watershed C drains to the northwest and enters the Robla Estates site by a 48-inch RCP culvert under the Bike Trail.
- Offsite Watershed D was delineated west of Offsite Watershed A, but was found not to contribute to flows at Robla Estate. Offsite Watershed D is omitted from discussion and figures.
- Offsite Watershed E drains north to a 12-inch RCP culvert then flows north in the East Channel.
- Onsite Watershed 1 flows northwest to the Northern Channel where it is discharged through a 48-inch RCP culvert through the levee to Robla Creek.
- Onsite Watershed 2 flows northwest through a series of shallow depressions to a 48-inch RCP culvert through the levee and discharges to Robla Creek. This is the same 48-inch culvert as mentioned in Watershed 1

HYDROLOGIC AND HYDRAULIC MODEL CREATION

A local hydrologic and hydraulic model was created encompassing offsite and onsite watersheds that flow to the 48-inch culvert discharging to Robla Creek. The Horton infiltration and SWMM routing parameters were input to match the City of Sacramento Section 11 Stormwater Collection System Standards (Section 11). Impervious percentages and watershed widths reflect the guidance of the Section 11 standards. The XPSWMM software was used to simulate runoff, calculate water surface elevations, and size the proposed detention basin. Robla Estates was modeled for existing and proposed conditions to illustrate the increase in runoff associated with development. Offsite sheds were assumed to remain consistent in land use, with no additional development or increase in runoff.

STUDY ASSUMPTIONS

Through this effort, both the 100-year, 24-hour and the 100-year, 10-day design storms were simulated in accordance with the City standards for volume sizing of a detention basin. Using a long duration storm is particularly important, as there are no overland releases for Robla Estates. The 10-year, 24-hour storm was also simulated to show the detention basin functionality in a smaller storm and to demonstrate the

pipe system hydraulic grade line meets City criteria. The downstream boundary condition of 42-feet (ft) North American Vertical Datum 88 (NAVD88) is from the 100-year static tailwater from the SAFCA Robla Creek HEC-RAS model. The 10-year tailwater water surface elevation (WSEL) was determined from the Robla Creek FEMA Flood Profile to be elevation 38-ft NAVD88. Currently, the City and County have no available data sources to define a dynamic tailwater stagegraph. Because of this, the detention basin and pump station sizes in this study are considered conservatively large. It is possible that size these facilities could be reduced if a dynamic tailwater was used in the analysis.

The following roughness and depressions storages have been used throughout the existing and proposed conditions model:

- Impervious Area Depression Storage: 0.1-inch
- Impervious Area Manning's "n": 0.02
- Pervious Area Depression Storage: 0.35-inch
- Pervious Area Manning's "n": 0.25

EXISTING WATERSHED CHARACTERISTICS

City Basin #140 was delineated into five watersheds to account for flow patterns within Robla Estates. Flows from the five watersheds travel north, through the Robla Estates site to be discharged to Robla Creek. The existing land use is primarily low density residential and open space. A composite infiltration rate was created to reflect the blend of land uses, which correspond to City zoning data. Refer to Figure 2 and Table 1 for existing watershed land use and hydrologic characteristics.

Existing surface storage was added to the hydraulic model to account for stormwater that can pond up within a watershed without resulting overland spills. The existing storage areas follow contour lines below elevation 38 which corresponds to the elevation of Rio Linda Boulevard and the bike path. Figure 2 shows the delineation of the existing storage areas

Watershed widths were estimated by using the Equation 11-3 from the Section 11:

$$\text{Equation 11-3} \quad W = A/L$$

Where:

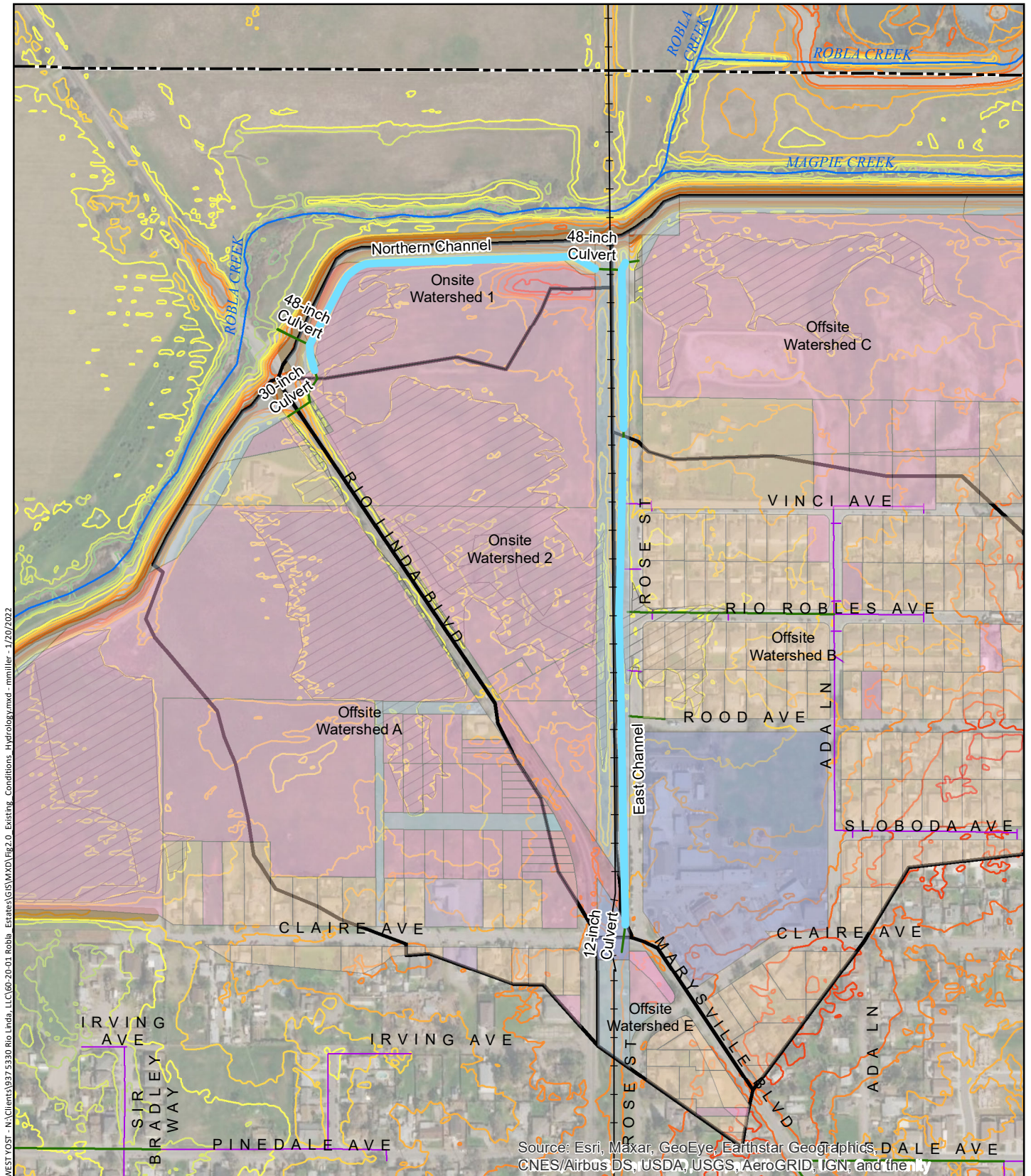
W = Shed Width (theoretical dimension)

L = Shed Length (feet) = overland (sheet) flow length = 150-feet for Residential,
200-feet for commercial

A = Shed Area (SF)

Table 1. Existing Watershed Characteristics

Subcatchment ID	Area, ac	Basin Length, ft	Basin Width, ft	Basin Slope, ft/ft	Composite Watershed Impervious Percent	NRCS Soil Type	10-Year, 24-Hour Peak Flow Rate, cfs	10-Year, 24-Hour Volume, ac-ft	100-Year, 24-Hour Peak Flow Rate, cfs	100-Year, 24-Hour Volume, ac-ft	100-Year, 10-Day Peak Flow Rate, cfs	100-Year, 10-Day Volume, ac-ft
<i>Offsite Watersheds</i>												
Offsite Watershed A	29.6	588.8	2,189.7	0.004	14.0	Type D	8.36	2.11	16.54	4.65	8.90	6.76
Offsite Watershed B	50.8	1,066.4	2,075.1	0.006	46.3	Type D	30.71	6.99	58.99	11.97	26.31	23.90
Offsite Watershed C	54.5	869.7	2,729.9	0.005	22.1	Type D	18.85	4.70	35.76	9.50	18.50	15.52
Offsite Watershed E	3.6	241.2	650.2	0.006	35.1	Type D	3.13	0.45	6.29	0.80	2.08	1.51
Subtotal	138.5	-	-	-	29.6	-	-	-	-	-	-	-
<i>Onsite Watersheds</i>												
Onsite Watershed 1	6.5	243.2	983.5	0.006	2.6	Type D	0.96	0.41	2.67	0.98	2.46	1.19
Onsite Watershed 2	21.7	289.3	2,091.2	0.004	11.1	Type D	5.46	1.43	11.06	3.28	6.25	4.53
Subtotal	28.3	-	-	-	57.1	-	-	-	-	-	-	-



WEST YOST - N:\Clients\937 5330 Rio Linda, LLC\60-20-01 Robla Estates\GIS\MXD\Fig2_0_Existing_Conditions_Hydrology.mxd - mmiller - 1/20/2022

Source: Esri, Maxar, GeoEye, Earthstar Geographics, DALE AVE CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the

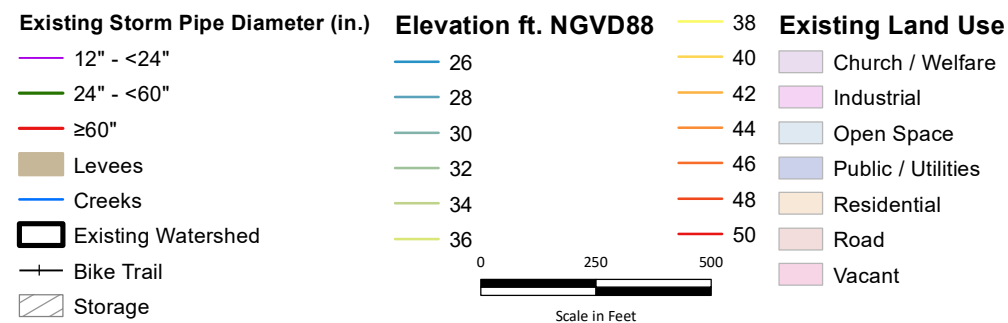


Figure 2
Existing Conditions Hydrology

Robla Estates
5330 Rio Linda, LLC

PROPOSED WATERSHED CHARACTERISTICS

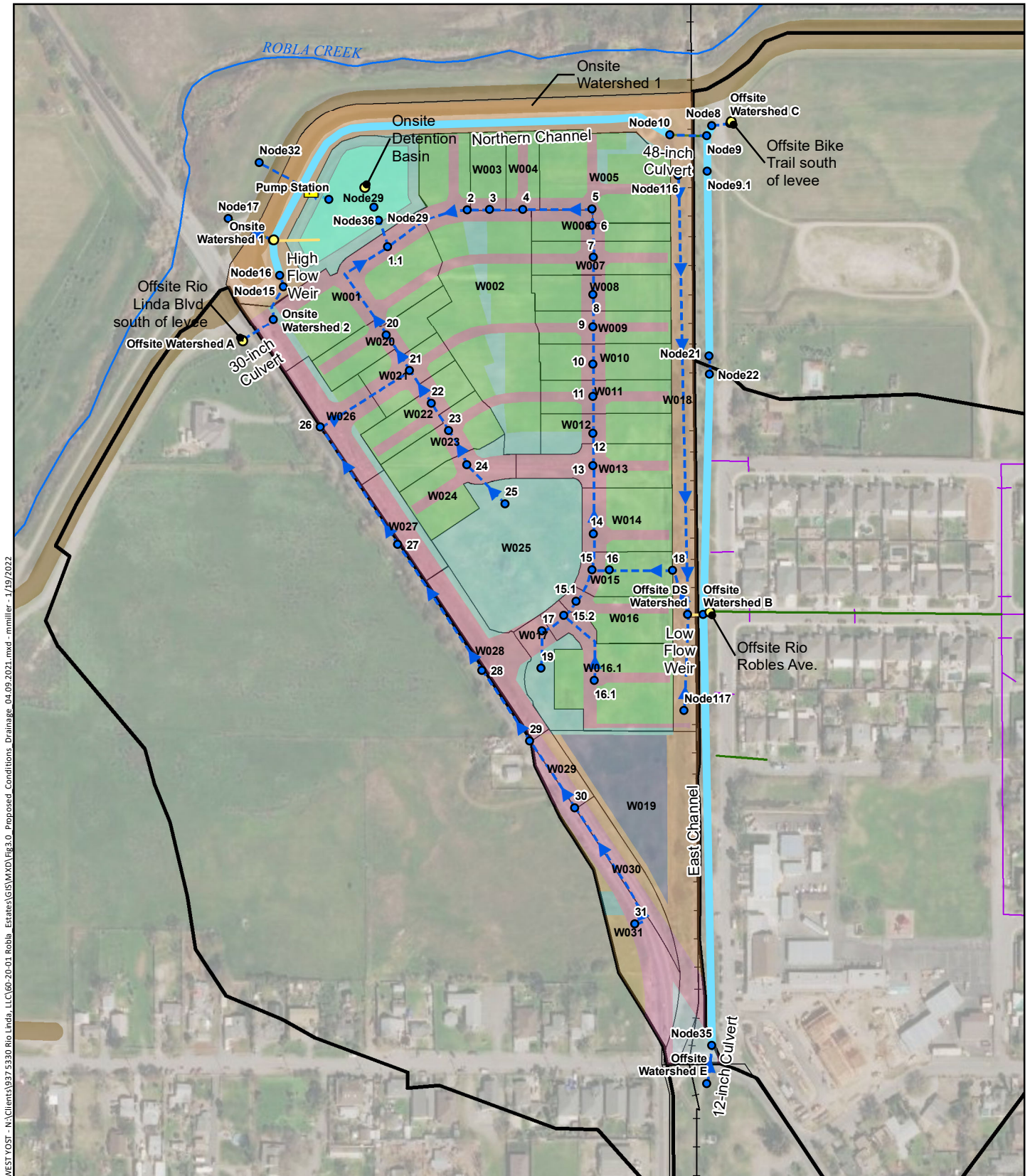
Onsite Watershed 1 was modified to reflect the site improvements proposed with the Robla Estates Development. Onsite Watershed 2 was replaced with Watersheds W001 through W031 for more precise delineation and routing to the proposed storm system. The proposed land use is primarily residential, with some commercial and open spaces. A composite infiltration rate was created to reflect the blend of proposed land uses, comprised of Medium Density Residential (70% impervious), Open Space (2% impervious), Recreation (5% impervious), Roads (95% impervious), and Commercial (95% impervious). Refer to Figure 3 and Table 2 for proposed watershed land use and hydrologic characteristics. No changes are proposed to any offsite watersheds. The following changes to flow path and infrastructure are listed by onsite watershed:

- Onsite Watershed 1 flows northwest to the Northern Channel, which conveys runoff to a 48-inch culvert that conveys runoff under the levee to Robla Creek.
- Watersheds W001 through W031 flow northwest through the proposed on-site pipe system to discharge to the proposed Detention Basin, which is also a discrete watershed. A watershed length of 150-feet was used for the proposed development watersheds.

In the model for proposed conditions, the existing storage surface storage volume remains on all offsite parcels and is removed on the Robla Estates site. All future upstream projects will be required to fully mitigate impacts of increased imperviousness.

Table 2. Proposed Watershed Characteristics

Subcatchment ID	Area, ac	Proposed Roadway Area, ac	Basin Length, ft	Basin Width, ft	Basin Slope, ft/ft	Composite Watershed Impervious Percent	NRCS Soil Type	10-Year, 24-Hour Peak Flow Rate, cfs	10-Year, 24-Hour Volume, ac-ft	100-Year, 24-Hour Peak Flow Rate, cfs	100-Year, 24-Hour Volume, ac-ft	100-Year, 10-Day Peak Flow Rate, cfs	100-Year, 10-Day Volume, ac-ft
<i>Offsite Watersheds</i>													
Offsite Watershed A	29.60	-	589	2,190	0.004	14.0	Type D	14.14	2.56	30.93	5.29	14.15	8.05
Offsite Watershed B	50.80	-	1,066	2,075	0.006	46.3	Type D	45.58	7.20	86.99	12.24	29.43	24.64
Offsite Watershed C	54.50	-	870	2,730	0.005	22.1	Type D	32.40	5.39	66.16	10.50	26.18	17.48
Offsite Watershed E	3.60	-	241	650	0.006	35.1	Type D	4.48	0.46	9.26	0.81	2.33	1.56
Subtotal	138.50	-	-	-	-	29.6	-	-	-	-	-	-	-
<i>Onsite Watersheds</i>													
Onsite Watershed 1	2.50	0.00	102	1,064	0.003	2.0	Type D	1.24	0.19	3.79	0.41	1.52	0.57
W-001	1.55	0.76	150	451	0.01	78.9	Type D	3.94	0.31	7.21	0.47	1.11	1.11
W-002	2.60	0.56	150	755	0.01	66.4	Type D	5.97	0.47	11.20	0.73	1.83	1.65
W-003	0.31	0.05	150	89	0.01	73.9	Type D	0.75	0.06	1.39	0.09	0.22	0.21
W-004	0.29	0.12	150	84	0.01	80.0	Type D	0.74	0.06	1.36	0.09	0.21	0.21
W-005	1.19	0.25	150	344	0.01	69.9	Type D	2.81	0.22	5.23	0.34	0.84	0.78
W-006	0.37	0.14	150	108	0.01	79.1	Type D	0.95	0.07	1.74	0.11	0.27	0.27
W-007	0.52	0.22	150	150	0.01	80.6	Type D	1.32	0.10	2.42	0.16	0.37	0.37
W-008	0.55	0.10	150	158	0.01	74.4	Type D	1.34	0.10	2.47	0.16	0.39	0.37
W-009	0.49	0.21	150	144	0.01	80.7	Type D	1.27	0.10	2.32	0.15	0.35	0.36
W-010	0.53	0.10	150	153	0.01	74.6	Type D	1.30	0.10	2.39	0.16	0.37	0.36
W-011	0.48	0.21	150	140	0.01	80.8	Type D	1.24	0.10	2.27	0.15	0.35	0.35
W-012	0.48	0.08	150	140	0.01	60.8	Type D	1.05	0.08	1.99	0.13	0.34	0.29
W-013	0.62	0.37	150	180	0.01	84.9	Type D	1.63	0.13	2.96	0.20	0.45	0.46
W-014	0.64	0.24	150	185	0.01	79.6	Type D	1.62	0.13	2.97	0.20	0.46	0.46
W-015	0.46	0.11	150	133	0.01	75.9	Type D	1.14	0.09	2.09	0.14	0.33	0.32
W-016	0.49	0.15	150	141	0.01	77.9	Type D	1.23	0.10	2.25	0.15	0.35	0.34
W-016.1	1.55	0.73	150	450	0.01	80.5	Type D	3.97	0.32	7.20	0.48	1.11	1.12
W-017	0.41	0.11	150	119	0.01	29.1	Type D	0.56	0.05	1.18	0.09	0.27	0.17
W-018	1.45	0.01	82	768	0.01	2.5	Type D	1.34	0.11	3.30	0.24	1.43	0.79
W-019	2.08	0.13	200	454	0.01	51.6	Type D	3.80	0.32	7.44	0.53	1.43	1.13
W-020	0.54	0.16	150	156	0.01	77.3	Type D	1.35	0.11	2.48	0.16	0.38	0.38
W-021	0.42	0.24	150	122	0.01	84.3	Type D	1.10	0.09	2.00	0.13	0.30	0.31
W-022	0.48	0.17	150	139	0.01	78.9	Type D	1.22	0.10	2.23	0.15	0.34	0.34
W-023	0.54	0.15	150	156	0.01	76.7	Type D	1.34	0.11	2.47	0.16	0.38	0.38
W-024	0.60	0.24	150	174	0.01	75.5	Type D	1.49	0.12	2.74	0.18	0.43	0.41
W-025	1.83	0.01	150	531	0.01	5.4	Type D	1.24	0.15	3.25	0.31	1.15	0.46
W-026	0.61	0.43	150	176	0.01	79.5	Type D	1.55	0.12	2.83	0.19	0.43	0.43
W-027	0.35	0.26	150	102	0.01	72.6	Type D	0.85	0.07	1.58	0.10	0.25	0.24
W-028	0.62	0.53	150	180	0.01	81.5	Type D	1.60	0.13	2.92	0.19	0.44	0.45
W-029	0.20	0.11	150	59	0.01	54.1	Type D	0.41	0.03	0.79	0.05	0.14	0.11
W-030	0.40	0.25	150	115	0.01	60.8	Type D	0.86	0.07	1.63	0.11	0.28	0.24
W-031	0.99	0.69	150	287	0.01	67.0	Type D	2.28	0.18	4.28	0.28	0.70	0.63
Detention Basin	1.36	0.00	110	538	0.01	5.5	Type D	1.14	0.11	2.84	0.23	0.87	0.35
Subtotal	28.3	7.88	-	-	-	57.1	-	-	-	-	-	-	-

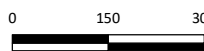


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- ➔ Modeled Link
- Modeled Node
- Existing Storm Pipe Diameter (in.)**
- 12" - <24"
- 24" - <60"
- ≥ 60"
- Basin Extents
- Levees
- Offsite Watersheds
- Onsite Subwatersheds
- Creeks
- |— Bike Trail
- Hydraulic Results Location

Proposed Land Use

- Commercial
- Medium Density Residential
- Open Space
- Recreation
- Road



Scale in Feet



Figure 3

Proposed Conditions Hydrology

Robla Estates
5330 Rio Linda, LLC

PRELIMINARY BASIN AND PUMP STATION SIZING PROCESS

To determine the required size and outlet configurations for the detention basin, the following steps were taken:

- Determined the total tributary area and impervious percentage to be served by the detention basin.
- Determined the stormwater quality treatment volume (SWQV) for the detention basin based on the amount of Low Impact Development (LID) achieved above the minimum requirements.
- Performed hydrologic modeling with the Sacramento Area Hydrology Model (SAHM) to determine the required volume and outlet configuration to provide hydromodification mitigation.
- Performed hydrologic and hydraulic modeling with XPSWMM to determine the required storage volumes and outlet configurations for flood control, addressing the following City requirements:
 - 0.5-foot of freeboard is required to the DI Grate in the 10-year, 24-hour storm.
 - The detention basin crest must be equal or higher to the 100-year, 24-hour storm. No freeboard is required.
 - 1.0-foot of freeboard is required to the finished floor of new structures for the 100-year, 24-hour storm.
 - There are no overland releases from the basin triggering the need for public safety hazard criteria for sizing the detention basin.
- Performed hydrologic and hydraulic modeling with XPSWMM to meet alternative City controlling Overland Release Path (ORP) criteria. See Draft Conditions of Approval for an additional discussion:
 - The justification for the variance is that ORP low elevation release path is 39.6-ft NAVD88 which exceeds the 200-yr, 24-hour HGL of 39.7-ft NAVD88 with complete pump station failure.
 - City suggested alternative ORP criterion 1 to set minimum finished floor to the 100-year, 24-hour HGL with complete pump station failure. This resulting water surface elevation for this scenario is 38.7 feet NAVD88.
 - City suggested alternative ORP criterion 2 to set minimum 10-year, 24-hour HGL with complete pump failure at or below the top of the DI grates and no more than 6 inches above the gutter flowline in low lying areas.

DETENTION BASIN SIZING

The 100-year, 24-hour design storm was used to analyze peak flow to determine required conveyance capacities. The detention basin was also simulated for the 100-year, 10-day design storm rainfall to consider volume, as there is no emergency overland flow path. The Table 3 illustrates the detention basin geometry. A 45 cubic feet per second (cfs) firm capacity pump station is required to mitigate the peak flows in the basin, maintaining freeboard requirements. If additional area can be added to the

detention basin extents, the pump capacity could be decreased. A geotechnical evaluation will need to be conducted to assess the soil stability for building the detention basin adjacent the levee. The levee owner and operator will need to be notified of the detention basin and pump station construction.

Table 3 shows the detention basin and the associated pump station location. Currently, offsite flows make their way to the Northern Channel before being discharged to Robla Creek. A high flow weir was added to the Northern Channel to continue to route minor storm flows directly to the existing 48-inch culvert through the levee. Only when the water level in Robla Creek rises and the 48-inch culvert's flap gate is closed will flows overtop the weir (crest elevation 34-ft NAVD88) and spill into the detention basin. Once in the detention basin, flows will need to be pumped out. This high flow weir will minimize pumping during minor storm events when the water levels in Robla Creek are relatively low.

In addition to the high flow weir at the detention basin, a second weir is proposed at the East Channel. This low flow weir reduces pumping at the detention basin by routing minor event flows to the Northern Channel for gravity discharge to Robla Creek. In larger events, the high flows will enter the detention basin. The East Channel bottom width will be expanded to 10-feet, with a 3-foot retaining wall running along the west side adjacent to the development. The east side of the East Channel will remain undisturbed. The Northern Channel and the Eastern Channel have a 1-foot freeboard in the 100-year storm.

Description	Elevation, ft, NAVD88	Depth	Area, sf	Area, ac	Volume, ac-ft
Bottom of Basin	26.0	0.0	11,485	0.26	0.00
	27.0	1.0	13,385	0.31	0.29
	28.0	2.0	15,414	0.35	0.62
WQV WSEL (29.1)	29.0	3.0	17,571	0.40	0.99
	30.0	4.0	19,856	0.46	1.42
	31.0	5.0	22,269	0.51	1.91
	32.0	6.0	24,810	0.57	2.45
	33.0	7.0	27,479	0.63	3.05
10-year, 24-hour WSEL (34.3)	34.0	8.0	30,276	0.69	3.71
100-year, 10-day WSEL (35.6)	35.0	9.0	33,201	0.76	4.44
100-year, 24-hour WSEL (36.2)	36.0	10.0	36,254	0.83	5.23
Top of Basin	36.5	10.5	37,828	0.87	5.66
ac-ft = acre-feet sf = square feet					

The following City detention basin design standards are met:

- Side slopes: 4H:1V
- Low flow channel slope at detention basin bottom: 1 percent
- Access road to bottom of pond

- Access road to the pump station

The pump station is sized for 45 cfs firm capacity and 60 cfs total capacity. The operation levels will meet the following design standards:

- Pump 1: Turns on at: Stormwater Quality WSEL (29.1-ft NAVD88)
- Pump 2: Turns on at: 1-foot Above Stormwater Quality WSEL (30.0-ft NAVD88)
- Pump 3: Turns on at: 2-feet Above Stormwater Quality WSEL (31.0-ft NAVD88)
- Pump 4: Redundant Pump

City flow meter installation standards will allow for the use of 90% of the pump curve flow rates; otherwise, the project is restricted to 75% of the pump curve flow rate. If utilizing a flow meter, further modeled pump operation (including on/off levels) will be added as an addendum.

FLOOD CONTROL BENEFIT

The Robla Estates detention basin and pump station will reduce the flood depth throughout the project site and in the offsite watersheds. Table 4 and Table 5 show the benefit of the detention basin and pump station at five locations (refer to Figure 1 for hydraulic results locations).

Scenario	Onsite upstream of 48-inch discharge culvert, ft NAVD88	Onsite Detention Basin, ft NAVD88	Offsite Rio Linda Blvd. south of levee, ft NAVD88	Offsite Bike Trail south of levee, ft NAVD88	Offsite Rio Robles Ave., ft NAVD88
Ground Surface	38.0	36.5	38.0	41.2	41.8
Existing Condition	38.2	-	38.2	38.2	38.2
Proposed Condition	36.2	36.2	36.3	37.7	37.5

Scenario	Onsite upstream of 48-inch discharge culvert, ft NAVD88	Onsite Detention Basin, ft NAVD88	Offsite Rio Linda Blvd. south of levee, ft NAVD88	Offsite Bike Trail south of levee, ft NAVD88	Offsite Rio Robles Ave., ft NAVD88
Ground Surface	38.0	36.5	38.0	41.2	41.8
Existing Condition	37.5	-	37.5	37.5	37.5
Proposed Condition	34.7	34.3	34.9	37.0	36.8

Consideration was given to ensuring that the pump station discharge rate have no significant impact to Robla Creek. FEMA freeboard requirements state that 3-ft of freeboard from 100-year water surface elevation to the levee crest is required. Currently there is 4-ft of freeboard in Robla Creek as indicated by the 100-year water surface elevation in the FEMA flood insurance study. The addition of 45 cfs to the 2,900 cfs contained in Robla Creek will not likely affect the water surface elevation or freeboard.

DRAFT CONDITIONS OF APPROVAL

A meeting was held with the City of Sacramento to discuss the Controlling Overland Release Path (ORP) criteria. Section 11 specifies the finished floor elevation of structures as 12-inches over the ORP, but adhering to this criteria would be infeasible at this site. The project site is the regional low point on the upstream side of the levee. The ORP of this site would be above Rio Linda Boulevard which is 39.9-ft NAVD88, higher than the 200-yr, 24-hour design storm HGL of 39.7-ft NAVD88 with complete pump station failure. The following ORP criteria has been established as a variance to Section 11 which will be incorporated into the Draft Conditions of Approval (COA):

- City suggested alternative ORP Criterion 1 to set minimum finished floor to the 100-year, 24-hour HGL with complete pump station failure 38.7 feet NAVD88. This criterion is similar to FEMA precedence.

- City suggested alternative ORP Criterion 2 to set minimum 10-year, 24-hour HGL with complete pump failure at or below the top of the DI grates and no more than 6 inches above the gutter flowline in low lying areas. At all locations the 10-year is below grade at manhole rim elevation with complete pump failure. At the lowest roadway rim elevation of 37.9-ft, the 10-year, 24-hour with complete pump failure, there is no water in the roadway (HGL is 37.8-ft NAVD88).

This additional modeling was considered when making the ORP variance:

- The FEMA/Community Rating System (CRS) finished floor requirements will be satisfied. Maximum 100-Year, 24-hour HGL of 36.2-ft NAVD88, below lowest pad of 38.7-ft NAVD88
- Dynamic analysis performed for more accurate decision-making tool:
 - 10-year, 24-hour HGL with complete station failure predicted at 37.8feet NAVD88
 - 100-year, 24-hour HGL with complete station failure predicted at 38.7 feet NAVD88
 - 200-year, 24-hour HGL with operational pump station predicted at 36.9 feet NAVD88
 - 200-year, 24-hour HGL with complete station failure predicted at 39.7 feet NAVD88

LOW IMPACT DEVELOPMENT AND WATER QUALITY

The implementation of the following low impact development (LID) features is required to manage onsite runoff and water quality. The following LID features together achieve above the 100-credit minimum, removing the need for additional water quality treatment measures.

- Natural Storage reservoirs and drainage corridors
- Buffer zones for natural water bodies
- Landscape area/park
- Flood Control/Drainage basin
- Infiltration Basin
- Disconnected Roof Drains
- Disconnected Pavement Worksheet

Attachment B details the calculations for the LID credits and refers to the SQDM to guide detailed design. Refer to Figure 4 for the potential spatial distribution of LID features that exceed the 100-credit minimum. Attachment A details the water quality volume of 1.01 acre-feet per the Stormwater Quality Design Manual (SQDM), that is planned for infiltration, as calculated by the Stormwater Quality Design Manual (SQDM). The City prefers infiltration basins over bio-retention basins, due to maintenance concerns. The detention basin's discharge structure has been designed to retain water for 48-hours.

In addition, the bottom of the detention pond (11,485 sq ft.) will be excavated and filled with a 2-foot-deep layer of gravel to promote infiltration. Using the SQDM recommendations for submerged gravel beds, an additional 0.15 acre-feet of storage will be added. The following design details from the SQDM will apply for the gravel:

- The gravel media will be 1" to 1-1/2" in size
- The bed depth is 2-feet
- The porosity of the gravel bed is 0.3

HYDROMODIFICATION AND OUTLET CONFIGURATION

Hydromodification control measures address changes to runoff characteristics from urbanization that result in the artificially altered rate of erosion or sedimentation within receiving waters. Based on the Hydromodification Mitigation Applicability Flow Chart provided in the 2018 Sacramento Region Stormwater Quality Design Manual (SQDM), the Study Area is not an exempt project and is therefore subject to hydromodification management requirements.

The detention basin was sized to provide hydromodification mitigation using the SAHM. The analysis was performed based on a pre-project and post-project evaluation of flow durations for flows ranging from 25 percent of the 2-year storm frequency to the 10-year storm frequency. Results of the hydromodification analyses are presented in Attachment A.

The detention basin outlet was configured with a riser pipe with a round orifice at the bottom for low flows. During large storm events that exceed the design event (10-year), excess flow can spill over the top of the riser. The orifice diameter and elevation were set to release 75 percent of the water quality volume in a minimum of 24 hours and the total design volume over an additional 24 hours. The water quality volume was calculated as 1.01 acre-feet. A 5mm (or smaller) screen at the orifice outlet will be added to address the State Water Resources Control Board Trash Amendments. The outlet geometry is as follows:

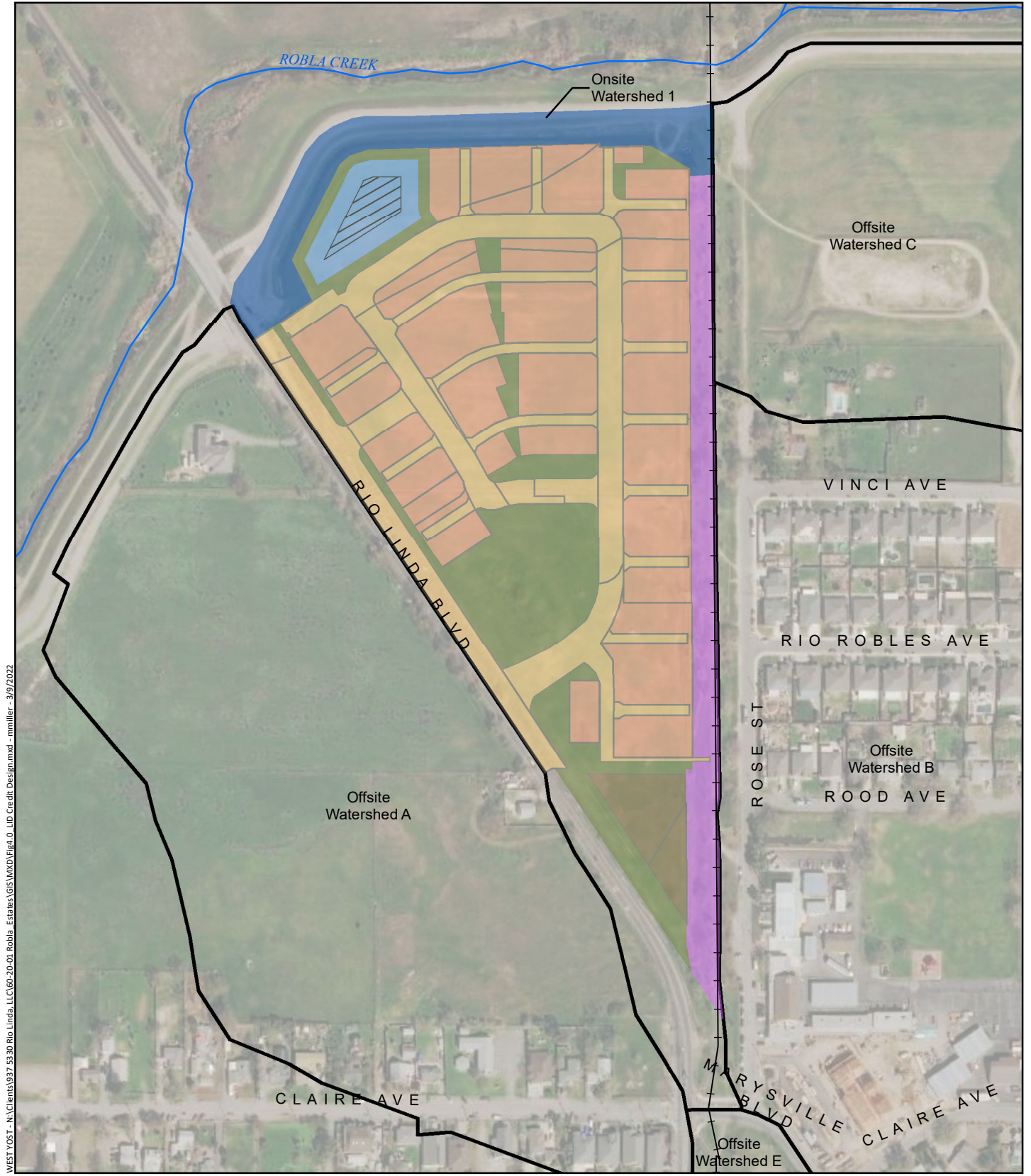
- Riser Diameter (in): 36
- Riser Height (ft): 6.5
- Orifice Diameter (in): 4.25
- Orifice Height (in): 0.15

PRELIMINARY PIPE SIZING

Onsite storm pipes for the Robla Estates site have been sized to meet the City standards. Pipes were sized using XPSWMM. In addition to those standards mentioned in the Preliminary Basin and Pump Sizing Process section, the following standards have been addressed:


- Manning's roughness of 0.015 for concrete pipe to account for friction and minor losses.
- The minimum design velocity shall be two feet-per-second and the maximum velocity shall be 10 feet-per-second utilizing the Manning equation:
 - Assuming the pipe is flowing freely at a depth of 0.8 times the inside diameter (80% full), and
 - During a 100-year event.

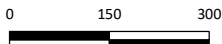
A list of pipe characteristics and hydraulic results are listed in Table 6.



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- Offsite Watersheds
- Bike Trail
- LID Features**
- Buildings/Parking
- WQ/Infiltration
- Natural Storage Reservoirs or Drainage Corridor
- Buffer Zones for Natural Water Bodies
- Flood Control/Drainage Basin
- Landscape Area/Park
- Streets and Driveways
- Buildings (Disconnected)





 Scale in Feet




Figure 4
Reommended LID Features

Robla Estates
 5330 Rio Linda, LLC
 January 2022

Table 6. Hydraulic Results

Table 6. Hydraulic Results																
Conduit Data									10-year, 24-hour Flows			100-year, 24-hour Flows				
Link Name	Upstream Node	Downstream Node	Upstream Rim Elevation	Downstream Rim Elevation	Upstream Invert	Downstream Invert	Diameter, ft	Roughness Manning's "n"	Upstream WSEL	Downstream WSEL	Maximum Flow, cfs	Upstream WSEL	Downstream WSEL	Maximum Flow, cfs	Maximum Velocity, ft/sec	Comment
253.1	1.1	Detention Basin	38.47	40.50	28.04	28.00	3.5	0.015	34.27	34.18	56.14	36.23	36.20	79.73	8.2	Proposed Pipe
299.1	2	1.1	38.87	38.47	28.17	28.04	3.5	0.015	34.45	34.31	38.19	36.31	36.23	48.73	5.0	Proposed Pipe
302.1	5	4	39.07	38.77	28.42	28.30	3.5	0.015	34.71	34.58	30.85	36.45	36.38	35.06	3.6	Proposed Pipe
305.1	14	13	39.37	39.07	29.28	29.10	3	0.015	35.88	35.59	25.62	37.16	36.95	25.82	3.6	Proposed Pipe
311.1	26	21	39.87	39.17	28.52	28.34	2.5	0.015	34.55	34.45	6.71	36.31	36.24	11.37	2.3	Proposed Pipe
313.1	27	26	39.67	39.87	28.90	28.52	2	0.015	34.83	34.55	5.23	36.92	36.31	8.62	2.7	Proposed Pipe
316.1	24	23	39.07	38.77	28.85	28.69	1.5	0.015	34.94	34.85	2.58	37.06	36.94	5.33	2.9	Proposed Pipe
322.1	25	24	37.00	39.07	29.13	28.85	1.5	0.015	34.96	34.94	1.17	37.07	37.06	3.85	2.1	Proposed Pipe
327.1	28	27	40.37	39.67	29.42	28.90	1.5	0.015	35.70	34.83	4.46	38.80	36.92	7.10	3.9	Proposed Pipe
330.1	29	28	41.07	40.37	29.71	29.42	1.5	0.015	35.94	35.70	2.98	39.19	38.80	4.82	2.6	Proposed Pipe
336.1	17	15.2	38.87	38.97	29.66	29.66	1.5	0.015	36.05	36.04	4.25	37.47	37.29	8.30	4.6	Proposed Pipe
341.1	23	22	38.77	38.97	28.69	28.58	1.5	0.015	34.85	34.71	3.84	36.94	36.67	6.67	3.7	Proposed Pipe
343.1	20	1.1	38.77	38.47	28.27	28.04	2.5	0.015	34.32	34.31	14.04	36.23	36.23	23.85	4.8	Proposed Pipe
345.1	21	20	39.17	38.77	28.34	28.27	2.5	0.015	34.45	34.32	12.74	36.24	36.23	21.45	4.3	Proposed Pipe
346.1	22	21	38.97	39.17	28.58	28.34	1.5	0.015	34.71	34.45	4.99	36.67	36.24	8.17	4.5	Proposed Pipe
349.1	3	2	38.57	38.87	28.24	28.17	3.5	0.015	34.52	34.45	32.25	36.35	36.31	37.60	3.9	Proposed Pipe
350.1	4	3	38.77	38.57	28.30	28.24	3.5	0.015	34.58	34.52	31.55	36.38	36.35	36.34	3.8	Proposed Pipe
352.1	6	5	38.67	39.07	28.47	28.42	3.5	0.015	34.74	34.71	28.09	36.47	36.45	30.57	3.2	Proposed Pipe
354.1	7	6	38.87	38.67	28.55	28.47	3.5	0.015	34.80	34.74	27.57	36.50	36.47	29.61	3.1	Proposed Pipe
356.1	8	7	38.72	38.87	28.65	28.55	3.5	0.015	34.86	34.80	27.29	36.53	36.50	28.84	3.0	Proposed Pipe
358.1	9	8	38.97	38.72	28.74	28.65	3	0.015	34.99	34.86	27.00	36.60	36.53	28.26	4.0	Proposed Pipe
360.1	10	9	39.27	38.97	28.83	28.74	3	0.015	35.15	34.99	26.74	36.68	36.60	27.80	3.9	Proposed Pipe
362.1	11	10	39.07	39.27	28.92	28.83	3	0.015	35.29	35.15	26.45	36.76	36.68	27.31	3.8	Proposed Pipe
364.1	12	11	38.67	39.07	29.02	28.92	3	0.015	35.45	35.29	26.20	36.86	36.76	26.87	3.8	Proposed Pipe
365.1	13	12	39.07	38.67	29.10	29.02	3	0.015	35.59	35.45	25.93	36.95	36.86	26.38	3.7	Proposed Pipe
368.1	15	14	38.87	39.37	29.38	29.28	3	0.015	36.03	35.88	25.30	37.29	37.16	25.30	3.5	Proposed Pipe
370.1	15.1	15	39.07	38.87	29.48	29.38	2	0.015	36.04	36.03	8.08	37.29	37.29	15.18	4.8	Proposed Pipe
394.1	15.2	15.1	38.97	39.07	29.66	29.48	2	0.015	36.04	36.04	8.13	37.29	37.29	15.29	4.8	Proposed Pipe
L18.1	Node116.1.1	16	38.35	38.74	29.57	29.43	3	0.015	36.28	36.09	23.40	37.48	37.33	21.66	3.0	Proposed Pipe
L19	19	17	38.00	38.87	30.15	29.66	1.5	0.015	36.06	36.05	3.74	37.97	37.47	7.27	4.0	Proposed Pipe
L30	30	29	41.20	41.07	30.00	29.71	1	0.015	37.40	35.94	2.70	41.23	39.19	4.30	5.2	Proposed Pipe
L31	31	30	43.50	41.20	30.75	30.00	1	0.015	38.64	37.40	2.03	43.54	41.23	2.95	3.5	Proposed Pipe
L32	16.1	15.2	38.00	38.97	30.20	29.66	2	0.015	36.04	36.04	3.93	37.30	37.29	7.15	2.2	Proposed Pipe
Link0	Offsite Watershed C	Node8	40.00	38.00	35.82	35.67	2	0.015	37.01	36.74	10.47	37.68	37.41	18.19	6.1	Proposed Pipe
Link1	Node9	Node10	41.80	39.28	35.65	35.28	4	0.015	36.73	36.19	9.87	37.41	36.88	22.65	4.4	Proposed Pipe
Link10	Node22	Offsite Watershed B	40.00	41.80	35.39	35.51	Channel	0.040	36.77	36.79	-6.12	37.46	37.51	-12.14	-0.7	Existing Channel
Link13	Onsite Watershed 2	Node15	39.00	38.00	33.24	33.12	3	0.015	34.75	34.73	5.94	36.28	36.27	11.64	2.5	Existing Culvert
Link14	Node8	Node9	38.00	41.80	35.67	35.65	Channel	0.040	36.74	36.73	10.48	37.41	37.41	18.10	0.9	Existing Channel
Link2	Offsite Watershed B	Offsite DS Watershed	41.80	38.18	36.00	35.68	2	0.015	36.79	36.46	28.64	37.51	37.53	50.06	8.7	Proposed Pipe
Link27	Offsite Watershed E	Node35	44.00	44.00	41.44	40.94	1	0.015	42.99	41.58	4.38	44.11	41.89	6.38	8.2	Existing Culvert
Link28	Node35	Offsite Watershed B	44.00	41.80	40.94	35.51	Channel	0.060	41.58	36.79	2.61	41.89	37.51	5.79	1.1	Existing Channel
Link3	Offsite Watershed A	Onsite Watershed 2	39.00	39.00	34.14	33.24	2.5	0.015	34.89	34.75	5.94	36.29	36.28	11.61	5.1	Existing Culvert
Link4	Node15	Node16	38.00	38.00	33.12	33.04	2.5	0.015	34.73	34.72	5.95	36.27	36.27	11.65	2.8	Existing Culvert
Link5	Onsite Watershed 1	Node17	39.28	46.00	32.84	31.23	4	0.015	34.72	38.00	0.00	36.27	42.00	0.00	0.0	No Discharge with flap gate
Link6	Node10	Onsite Watershed 1	39.28	39.28	35.28	32.84	Channel	0.035	36.19	34.72	9.66	36.88	36.27	22.26	1.6	Existing Channel
Link65	Node116	Offsite DS Watershed	38.68	38.18	35.68	34.40	Channel	0.035	36.38	36.37	-3.03	37.52	37.53	-14.44	-0.4	Existing Channel
Link66	Node117	Offsite DS Watershed	38.68	38.18	35.68	34.88	Channel	0.035	36.41	36.41	-1.23	37.53	37.53	-4.25	-0.3	Existing Channel
Link7	Node16	Onsite Watershed 1	38.00	39.28	33.04	32.84	Channel	0.035	34.72	34.72	6.02	36.27	36.27	12.43	-0.2	Existing Channel
Link8	Node9	Node9.1	41.80	37.64	35.65	35.64	Channel	0.040	36.73	36.73	-2.73	37.41	37.41	-9.73	-0.5	Existing Channel
Link8.1	Node9.1	Node21	37.64	40.00	35.64	35.58	Channel	0.040	36.73	36.76	-3.37	37.41	37.45	-10.33	-0.5	Existing Channel
Link9	Node21	Node22	40.00	40.00	35.58	35.39	4	0.015	36.76	36.77	-4.48	37.45	37.46	-10.75	-1.9	Existing Culvert



Attachment A

Hydromodification Analyses Results

Stormwater Quality Volume Calculation

Roblas Estates

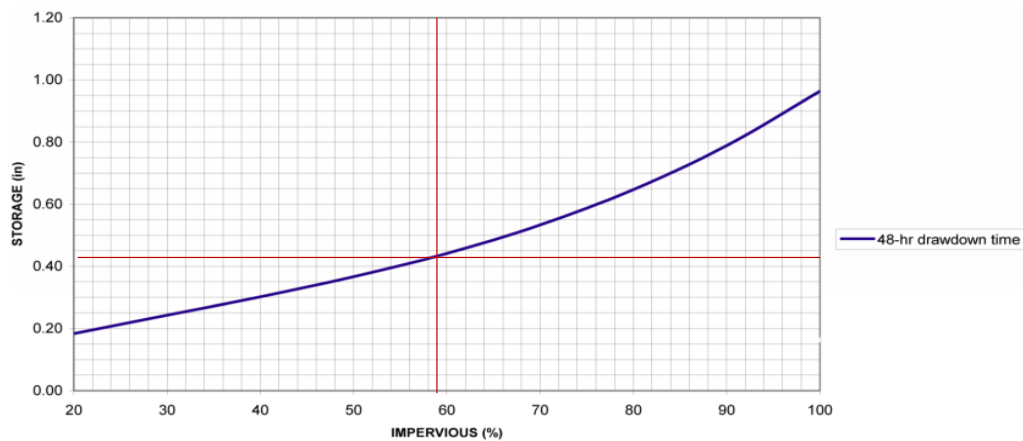
Water Quality Volume Calculation

Equation:

$$WQV(\text{ac-ft}) = P_0 * A/12$$

Variables:

54.6	%	Drainage shed impervious area
28.3	A	Drainage shed area in acres that drains to the proposed control measure
0.43	P_0	Maximized Detention Volume in watershed inches (From Graph)
1.01	WQV	Water Quality Volume in acre-feet



Source: URBAN RUNOFF QUALITY MANAGEMENT: WEF Manual of Practice No. 23 and Report on Engineering Practice No. 87.

**Curve for Maximized
Detention Volume P_0**

Date: August
2006

Figure: E-3

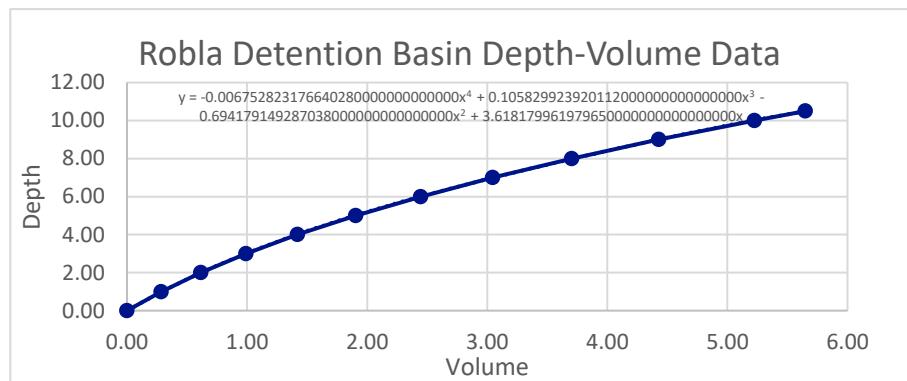
Orifice Design for Risers

Roblas Estates

Water Quality Volume Calculation

Key:	
WQCV	
Manually input	
Design Criteria	

Orifice Coeff	0.61
Orifice Elev.* (ft)	0.15
Orifice Dia (in)	4.25
Orifice Dia (ft)	0.35
Orifice Area (sf)	0.099



Time (hr)	Volume of water (ac-ft)	Water Elevation (ft)	Orifice Equ Flow (cfs)
0.00	1.01	3.06	0.82
1.00	0.95	1.02	0.45
2.00	0.91	0.92	0.42
3.00	0.87	0.88	0.41
4.00	0.84	0.85	0.40
5.00	0.81	0.82	0.39
6.00	0.77	0.79	0.38
7.00	0.74	0.75	0.37
8.00	0.71	0.72	0.37
9.00	0.68	0.69	0.36
10.00	0.65	0.66	0.35
11.00	0.62	0.64	0.34
12.00	0.59	0.61	0.33
13.00	0.57	0.58	0.32
14.00	0.54	0.56	0.31
15.00	0.52	0.53	0.30
16.00	0.49	0.51	0.29
17.00	0.47	0.48	0.28
18.00	0.44	0.46	0.27
19.00	0.42	0.44	0.26
20.00	0.40	0.41	0.25
21.00	0.38	0.39	0.24
22.00	0.36	0.37	0.23
23.00	0.34	0.35	0.22
24.00	0.32	0.34	0.21
25.00	0.31	0.32	0.20
26.00	0.29	0.30	0.19
27.00	0.27	0.29	0.18

- For single orifice outlet control or single row of orifices at the permanent pool elevation (WS Elevpp) (see Figure CWB-1), use the orifice equation based on the WQV (ft³) and depth of water above orifice centerline D (ft) to determine orifice area (ft²):
Orifice Equation

$$Q = C \times A \times (2gD)^{1/2}$$

Where:

Q = Flow rate, (cfs)

C = Orifice coefficient (use 0.61)

A = Area of orifice, (ft²)

g = Acceleration due to gravity (32.2 ft/sec²)

D = Depth of water above orifice centerline (D_{WQV})

28.00	0.26	0.27	0.17
29.00	0.25	0.26	0.16
30.00	0.23	0.24	0.15
31.00	0.22	0.23	0.14
32.00	0.21	0.22	0.13
33.00	0.20	0.21	0.12
34.00	0.19	0.20	0.11
35.00	0.18	0.19	0.10
36.00	0.17	0.18	0.08
37.00	0.17	0.17	0.07
38.00	0.16	0.17	0.06
39.00	0.15	0.16	0.05
40.00	0.15	0.16	0.04
41.00	0.15	0.15	0.03
42.00	0.14	0.15	0.02
43.00	0.14	0.15	#NUM!
44.00	#NUM!	#NUM!	#NUM!
45.00	#NUM!	#NUM!	#NUM!
46.00	#NUM!	#NUM!	#NUM!
47.00	#NUM!	#NUM!	#NUM!
48.00	#NUM!	#NUM!	#NUM!

SAHM

PROJECT REPORT

General Model Information

Project Name: SAHM_Robla Estates_Hydro
Site Name: Robla Estates
Site Address: Rio Linda Blvd.
City: Sacramento
Report Date: 1/21/2022
Gage: RANCHO C
Data Start: 1961/10/01
Data End: 2004/09/30
Timestep: Hourly
Precip Scale: 0.94
Version Date: 2016/03/29

POC Thresholds

Low Flow Threshold for POC1: 25 Percent of the 2 Year
High Flow Threshold for POC1: 10 Year

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Landuse Basin Data

Pre-Project Land Use

Onsite Watersheds

Bypass: No

GroundWater: No

Pervious Land Use acre
D,Grass,Flat(0-1%) 25.64

Pervious Total 25.64

Impervious Land Use acre
Imperv,Flat(0-1%) 2.58

Impervious Total 2.58

Basin Total 28.22

Element Flows To:
Surface Interflow Groundwater

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Mitigated Land Use

Proposed Watersheds

Bypass:	No
GroundWater:	No
Pervious Land Use D,Urban,Flat(0-1%)	acre 12.13
Pervious Total	12.13
Impervious Land Use Imperv,Flat(0-1%)	acre 16.15
Impervious Total	16.15
Basin Total	28.28

Element Flows To:
Surface Interflow Groundwater
SSD Table 1 SSD Table 1

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Routing Elements
Pre-Project Routing

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Mitigated Routing

SSD Table 1

Depth: 11 ft.
Element Flows To:
Outlet 1 Outlet 2

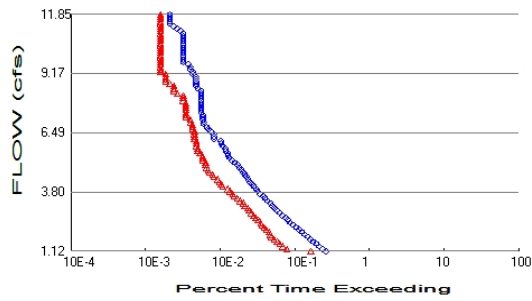
SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	0.260	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.310	0.290	0.452	0.000	0.000	0.000	0.000
2.000	0.350	0.620	0.667	0.000	0.000	0.000	0.000
3.000	0.400	0.990	0.827	0.000	0.000	0.000	0.000
4.000	0.460	1.420	0.962	0.000	0.000	0.000	0.000
5.000	0.510	1.910	1.079	0.000	0.000	0.000	0.000
6.000	0.570	2.450	1.186	0.000	0.000	0.000	0.000
7.000	0.630	3.050	5.247	0.000	0.000	0.000	0.000
8.000	0.690	3.710	32.75	0.000	0.000	0.000	0.000
9.000	0.760	4.430	43.98	0.000	0.000	0.000	0.000
10.000	0.830	5.230	52.64	0.000	0.000	0.000	0.000
11.00	0.870	5.650	60.05	0.000	0.000	0.000	0.000

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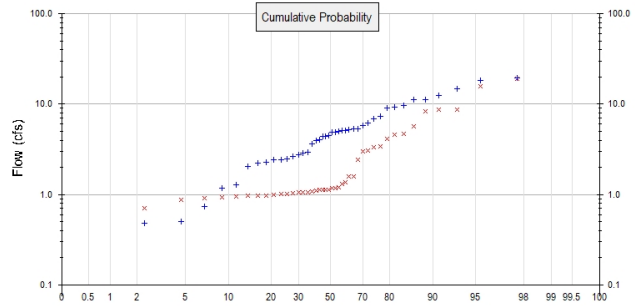
Analysis Results

POC 1



+ Pre-Project

x Mitigated



Pre-Project Landuse Totals for POC #1

Total Pervious Area: 25.64
Total Impervious Area: 2.58

Mitigated Landuse Totals for POC #1

Total Pervious Area: 12.13
Total Impervious Area: 16.15

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #1

Return Period	Flow(cfs)
2 year	4.46704
5 year	9.136381
10 year	11.8537
25 year	18.592377

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	1.1374
5 year	4.19996
10 year	8.497806
25 year	16.116023

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #1

Year	Pre-Project	Mitigated
1962	5.074	3.411
1963	2.638	1.125
1964	1.289	0.957
1965	4.885	1.582
1966	0.740	0.933
1967	5.007	4.588
1968	2.065	0.914
1969	4.467	1.179
1970	3.643	1.208
1971	5.367	4.114
1972	0.482	0.873
1973	11.196	1.183
1974	3.918	1.083
1975	5.231	1.047

1976	0.412	0.702
1977	0.505	0.566
1978	5.847	1.132
1979	2.224	1.001
1980	9.312	1.137
1981	1.185	1.062
1982	9.097	5.639
1983	11.242	8.779
1984	4.422	3.071
1985	2.771	1.306
1986	18.428	15.629
1987	2.426	1.005
1988	4.067	0.961
1989	6.174	1.124
1990	5.099	1.110
1991	4.380	1.582
1992	6.819	2.980
1993	4.915	1.375
1994	2.445	1.008
1995	19.631	19.201
1996	12.364	3.322
1997	14.857	8.309
1998	9.669	8.655
1999	2.949	1.042
2000	7.299	4.712
2001	2.470	0.977
2002	2.262	0.979
2003	2.852	1.060
2004	5.287	2.425

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #1

Rank	Pre-Project	Mitigated
1	19.6309	19.2005
2	18.4284	15.6290
3	14.8565	8.7791
4	12.3637	8.6550
5	11.2417	8.3092
6	11.1964	5.6388
7	9.6690	4.7118
8	9.3122	4.5881
9	9.0973	4.1137
10	7.2986	3.4113
11	6.8194	3.3219
12	6.1740	3.0712
13	5.8469	2.9804
14	5.3672	2.4249
15	5.2868	1.5823
16	5.2312	1.5822
17	5.0994	1.3750
18	5.0736	1.3059
19	5.0071	1.2079
20	4.9147	1.1830
21	4.8852	1.1787
22	4.4670	1.1374
23	4.4220	1.1325
24	4.3802	1.1252
25	4.0675	1.1240

26	3.9176	1.1096
27	3.6434	1.0829
28	2.9495	1.0615
29	2.8519	1.0598
30	2.7710	1.0469
31	2.6375	1.0421
32	2.4697	1.0076
33	2.4446	1.0045
34	2.4256	1.0007
35	2.2620	0.9788
36	2.2237	0.9768
37	2.0653	0.9613
38	1.2892	0.9572
39	1.1848	0.9326
40	0.7397	0.9145
41	0.5048	0.8728
42	0.4822	0.7023
43	0.4123	0.5664

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Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.1168	987	619	62	Pass
1.2252	885	297	33	Pass
1.3337	795	262	32	Pass
1.4421	732	237	32	Pass
1.5506	664	220	33	Pass
1.6590	610	200	32	Pass
1.7675	568	184	32	Pass
1.8759	516	177	34	Pass
1.9844	471	170	36	Pass
2.0928	434	158	36	Pass
2.2013	393	146	37	Pass
2.3098	356	137	38	Pass
2.4182	330	132	40	Pass
2.5267	308	122	39	Pass
2.6351	282	112	39	Pass
2.7436	254	105	41	Pass
2.8520	237	98	41	Pass
2.9605	215	93	43	Pass
3.0689	200	88	44	Pass
3.1774	189	80	42	Pass
3.2858	179	78	43	Pass
3.3943	163	69	42	Pass
3.5027	150	64	42	Pass
3.6112	142	58	40	Pass
3.7197	129	56	43	Pass
3.8281	121	51	42	Pass
3.9366	115	48	41	Pass
4.0450	106	41	38	Pass
4.1535	100	39	39	Pass
4.2619	94	37	39	Pass
4.3704	89	35	39	Pass
4.4788	85	31	36	Pass
4.5873	81	30	37	Pass
4.6957	76	27	35	Pass
4.8042	73	26	35	Pass
4.9126	68	25	36	Pass
5.0211	65	24	36	Pass
5.1296	59	24	40	Pass
5.2380	54	22	40	Pass
5.3465	50	22	44	Pass
5.4549	48	22	45	Pass
5.5634	47	20	42	Pass
5.6718	45	19	42	Pass
5.7803	44	19	43	Pass
5.8887	41	18	43	Pass
5.9972	39	18	46	Pass
6.1056	38	18	47	Pass
6.2141	31	17	54	Pass
6.3225	31	17	54	Pass
6.4310	31	17	54	Pass
6.5395	28	17	60	Pass
6.6479	26	16	61	Pass
6.7564	25	16	64	Pass

6.8648	23	16	69	Pass
6.9733	23	15	65	Pass
7.0817	22	15	68	Pass
7.1902	22	13	59	Pass
7.2986	22	13	59	Pass
7.4071	21	13	61	Pass
7.5155	21	13	61	Pass
7.6240	21	13	61	Pass
7.7325	21	13	61	Pass
7.8409	21	13	61	Pass
7.9494	21	12	57	Pass
8.0578	21	12	57	Pass
8.1663	21	12	57	Pass
8.2747	21	10	47	Pass
8.3832	21	9	42	Pass
8.4916	19	9	47	Pass
8.6001	18	9	50	Pass
8.7085	18	8	44	Pass
8.8170	18	7	38	Pass
8.9254	18	7	38	Pass
9.0339	18	7	38	Pass
9.1424	16	7	43	Pass
9.2508	16	6	37	Pass
9.3593	15	6	40	Pass
9.4677	15	6	40	Pass
9.5762	14	6	42	Pass
9.6846	12	6	50	Pass
9.7931	12	6	50	Pass
9.9015	12	6	50	Pass
10.0100	12	6	50	Pass
10.1184	12	6	50	Pass
10.2269	12	6	50	Pass
10.3353	12	6	50	Pass
10.4438	12	6	50	Pass
10.5523	12	6	50	Pass
10.6607	12	6	50	Pass
10.7692	12	6	50	Pass
10.8776	12	6	50	Pass
10.9861	12	6	50	Pass
11.0945	11	6	54	Pass
11.2030	10	6	60	Pass
11.3114	9	6	66	Pass
11.4199	8	6	75	Pass
11.5283	8	6	75	Pass
11.6368	8	6	75	Pass
11.7452	8	6	75	Pass
11.8537	8	6	75	Pass

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POC 2

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

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POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

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Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

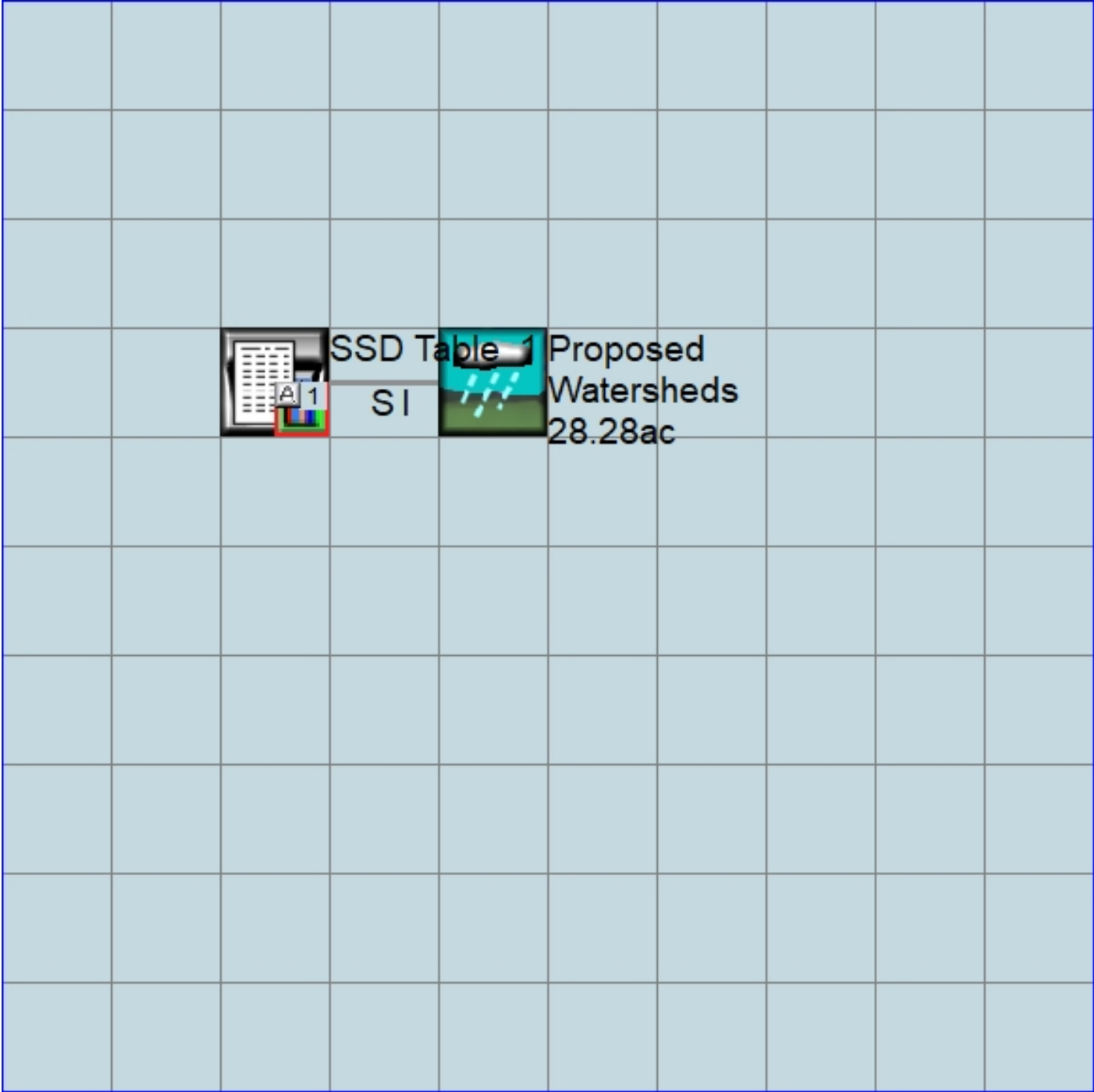
No IMPLND changes have been made.

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Appendix
Pre-Project Schematic



Mitigated Schematic



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Mitigated UCI File

RUN

GLOBAL

```
WVHM4 model simulation
START      1961 10 01      END      2004 09 30
RUN INTERP OUTPUT LEVEL   3      0
RESUME     0 RUN         1
UNIT SYSTEM 1
```

END GLOBAL

FILES

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<File> <Un#> <-----File Name----->***
<-ID->                                     ***
WDM      26      SAHM_Robla Estates_Hydro.wdm
MESSU    25      MitSAHM_Robla Estates_Hydro.MES
          27      MitSAHM_Robla Estates_Hydro.L61
          28      MitSAHM_Robla Estates_Hydro.L62
          30      POCSAHM_Robla Estates_Hydro1.dat
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END FILES

OPN SEQUENCE

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INGRP          INDELT 00:60
  PERLND        57
  IMPLND         1
  RCHRES         1
  COPY           1
  COPY          501
  DISPLY         1
```

END INGRP

END OPN SEQUENCE

DISPLY

DISPLY-INFO1

```
# - #<-----Title----->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
1      SSD Table 1      MAX          1      2      30      9
```

END DISPLY-INFO1

END DISPLY

COPY

TIMESERIES

```
# - # NPT NMN ***
1      1      1
501    1      1
```

END TIMESERIES

END COPY

GENER

OPCODE

```
#      # OPCODE ***
```

END OPCODE

PARAM

```
#      #          K ***
```

END PARAM

END GENER

PERLND

GEN-INFO

```
<PLS ><-----Name----->NBLKS  Unit-systems  Printer ***
# - #          User  t-series  Engl Metr ***
          in  out          ***
57      D,Urban,Flat(0-1%)  1      1      1      1      27      0
```

END GEN-INFO

*** Section PWATER***

ACTIVITY

```
<PLS > ***** Active Sections *****
# - # ATMP SNOW PWAT  SED  PST  PWG  PQAL MSTL  PEST  NITR  PHOS  TRAC ***
57      0      0      1      0      0      0      0      0      0      0      0
```

END ACTIVITY

PRINT-INFO

```
<PLS > ***** Print-flags ***** PIVL  PYR
# - # ATMP SNOW PWAT  SED  PST  PWG  PQAL MSTL  PEST  NITR  PHOS  TRAC  *****
```

57 0 0 4 0 0 0 0 0 0 0 0 0 0 1 9
END PRINT-INFO

PWAT-PARM1
<PLS > PWATER variable monthly parameter value flags ***
- # CSNO RTOP UZFG VCS VUZ VNN VIFW VIRC VLE INFC HWT ***
57 0 0 0 1 0 0 0 0 1 0 0
END PWAT-PARM1

PWAT-PARM2
<PLS > PWATER input info: Part 2 ***
- # ***FOREST LZSN INFILT LSUR SLSUR KVARY AGWRC
57 0 4.45 0.02 400 0.01 3 0.92
END PWAT-PARM2

PWAT-PARM3
<PLS > PWATER input info: Part 3 ***
- # ***PETMAX PETMIN INFEXP INFILD DEEPFR BASETP AGWETP
57 40 35 2 2 0 0 0.05
END PWAT-PARM3

PWAT-PARM4
<PLS > PWATER input info: Part 4 ***
- # CEPSC UZSN NSUR INTFW IRC LZETP ***
57 0 0.3 0.25 0.5 0.4 0
END PWAT-PARM4

MON-LZETPARM
<PLS > PWATER input info: Part 3 ***
- # JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC ***
57 0.5 0.5 0.5 0.6 0.65 0.65 0.65 0.65 0.65 0.65 0.55 0.5
END MON-LZETPARM

MON-INTERCEP
<PLS > PWATER input info: Part 3 ***
- # JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC ***
57 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11
END MON-INTERCEP

PWAT-STATE1
<PLS > *** Initial conditions at start of simulation
ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
- # *** CEPS SURS UZS IFWS LZS AGWS GWVS
57 0 0 0.15 0 4 0.05 0
END PWAT-STATE1

END PERLND

IMPLND

GEN-INFO
<PLS ><-----Name-----> Unit-systems Printer ***
- # User t-series Engl Metr ***
in out ***
1 Imperv,Flat(0-1%) 1 1 1 27 0
END GEN-INFO
*** Section IWATER***

ACTIVITY
<PLS > ***** Active Sections *****
- # ATMP SNOW IWAT SLD IWG IQAL ***
1 0 0 1 0 0 0
END ACTIVITY

PRINT-INFO
<ILS > ***** Print-flags ***** PIVL PYR
- # ATMP SNOW IWAT SLD IWG IQAL *****
1 0 0 4 0 0 0 1 9
END PRINT-INFO

IWAT-PARM1
<PLS > IWATER variable monthly parameter value flags ***
- # CSNO RTOP VRS VNN RTLI ***
1 0 0 0 0 0

END IWAT-PARM1

IWAT-PARM2
<PLS > IWATER input info: Part 2 ***
- # *** LSUR SLSUR NSUR RETSC
1 100 0.01 0.05 0.1
END IWAT-PARM2

IWAT-PARM3
<PLS > IWATER input info: Part 3 ***
- # ***PETMAX PETMIN
1 0 0
END IWAT-PARM3

IWAT-STATE1
<PLS > *** Initial conditions at start of simulation
- # *** RETS SURS
1 0 0
END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source-> <--Area--> <-Target-> MBLK ***
<Name> # <-factor-> <Name> # Tbl# ***
Proposed Watersheds***
PERLND 57 12.13 RCHRES 1 2
PERLND 57 12.13 RCHRES 1 3
IMPLND 1 16.15 RCHRES 1 5
*****Routing*****
PERLND 57 12.13 COPY 1 12
IMPLND 1 16.15 COPY 1 15
PERLND 57 12.13 COPY 1 13
RCHRES 1 1 COPY 501 16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> # <Name> # #<-factor->strg <Name> # # <Name> # # ***
COPY 501 OUTPUT MEAN 1 1 12.1 DISPLAY 1 INPUT TIMSER 1

<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> # <Name> # #<-factor->strg <Name> # # <Name> # # ***
END NETWORK

RCHRES
GEN-INFO
RCHRES Name Nexits Unit Systems Printer ***
- #<-----><----> User T-series Engl Metr LKFG ***
in out ***
1 SSD Table 1 1 1 1 1 28 0 1
END GEN-INFO
*** Section RCHRES***

ACTIVITY
<PLS > ***** Active Sections *****
- # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFQ PKFG PHFG ***
1 1 0 0 0 0 0 0 0 0
END ACTIVITY

PRINT-INFO
<PLS > ***** Print-flags ***** PIVL PYR
- # HYDR ADCA CONS HEAT SED GQL OXRX NUTR PLNK PHCB PIVL PYR *****
1 4 0 0 0 0 0 0 0 0 0 1 9
END PRINT-INFO

HYDR-PARM1

```

RCHRES  Flags for each HYDR Section ***
# - # VC A1 A2 A3 ODFVFG for each *** ODGTFG for each FUNCT for each
      FG FG FG FG possible exit *** possible exit possible exit
      * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
1      0 1 0 0      4 0 0 0 0      0 0 0 0 0      2 2 2 2 2
END HYDR-PARM1

```

```

HYDR-PARM2
# - # FTABNO LEN DELTH STCOR KS DB50 ***
<-----><-----><-----><-----><-----><-----><-----> ***
1      1      0.01      0.0      0.0      0.5      0.0 ***
END HYDR-PARM2

```

```

HYDR-INIT
RCHRES  Initial conditions for each HYDR section ***
# - # *** VOL Initial value of COLIND Initial value of OUTDGT
      *** ac-ft for each possible exit for each possible exit
<-----><-----> <-----><-----><-----><-----> *** <-----><-----><-----><-----><----->
1      0      4.0 0.0 0.0 0.0 0.0      0.0 0.0 0.0 0.0 0.0
END HYDR-INIT
END RCHRES

```

```

SPEC-ACTIONS
END SPEC-ACTIONS

```

```

FTABLES
FTABLE 1
12 4
Depth Area Volume Outflowl Velocity Travel Time***
(ft) (acres) (acre-ft) (cfs) (ft/sec) (Minutes)***
0.000000 0.260000 0.000000 0.000000
1.000000 0.310000 0.290000 0.451904
2.000000 0.350000 0.620000 0.666688
3.000000 0.400000 0.990000 0.827483
4.000000 0.460000 1.420000 0.961761
5.000000 0.510000 1.910000 1.079462
6.000000 0.570000 2.450000 1.185535
7.000000 0.630000 3.050000 5.246885
8.000000 0.690000 3.710000 32.75419
9.000000 0.760000 4.430000 43.97818
10.00000 0.830000 5.230000 52.64104
11.00000 0.870000 5.650000 60.05271
END FTABLE 1
END FTABLES

```

```

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <Member-> ***
<Name> # <Name> # tem strg<-factor->strg <Name> # # <Name> # # ***
WDM 2 PREC ENGL 0.944 PERLND 1 999 EXTNL PREC
WDM 2 PREC ENGL 0.944 IMPLND 1 999 EXTNL PREC
WDM 1 EVAP ENGL 0.85 PERLND 1 999 EXTNL PETINP
WDM 1 EVAP ENGL 0.85 IMPLND 1 999 EXTNL PETINP
WDM 22 IRRG ENGL 0.7 SAME PERLND 57 EXTNL SURLI
END EXT SOURCES

```

```

EXT TARGETS
<-Volume-> <-Grp> <Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name> # <Name> # #<-factor->strg <Name> # <Name> tem strg strg***
RCHRES 1 HYDR RO 1 1 1 WDM 1000 FLOW ENGL REPL
RCHRES 1 HYDR STAGE 1 1 1 WDM 1001 STAG ENGL REPL
COPY 1 OUTPUT MEAN 1 1 12.1 WDM 701 FLOW ENGL REPL
COPY 501 OUTPUT MEAN 1 1 12.1 WDM 801 FLOW ENGL REPL
END EXT TARGETS

```

```

MASS-LINK
<Volume> <-Grp> <Member-><--Mult--> <Target> <-Grp> <Member->***
<Name> <Name> # #<-factor-> <Name> <Name> # #***
MASS-LINK 2
PERLND PWATER SURO 0.083333 RCHRES INFLOW IVOL
END MASS-LINK 2

```

MASS-LINK		3				
PERLND	PWATER	IFWO	0.083333	RCHRES	INFLOW	IVOL
END MASS-LINK		3				
MASS-LINK		5				
IMPLND	IWATER	SURO	0.083333	RCHRES	INFLOW	IVOL
END MASS-LINK		5				
MASS-LINK		12				
PERLND	PWATER	SURO	0.083333	COPY	INPUT	MEAN
END MASS-LINK		12				
MASS-LINK		13				
PERLND	PWATER	IFWO	0.083333	COPY	INPUT	MEAN
END MASS-LINK		13				
MASS-LINK		15				
IMPLND	IWATER	SURO	0.083333	COPY	INPUT	MEAN
END MASS-LINK		15				
MASS-LINK		16				
RCHRES	ROFLOW			COPY	INPUT	MEAN
END MASS-LINK		16				

END MASS-LINK

END RUN

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DRAFT

Attachment B

Low Impact Development Credits and Treatment BMP Sizing Calculations for Residential Sites

Appendix D-1: Residential Sites: Low Impact Development (LID) Credits and Treatment BMP Sizing Calculations

Name of Drainage Shed: **Robla Estates** Fill in Blue Highlighted boxes
 Location of project: **Sacramento**

Step 1 - Open Space and Pervious Area Credits

Is your project within the drainage area of a common drainage plan that includes open space? If not, skip to 1 b.

1 a. Common Drainage Plan Area acres A_{CDP}

Common Drainage Plan Open Space (Off-project) acres A_{OS} see area example below

a. Natural storage reservoirs and drainage corridors acres
 b. Buffer zones for natural water bodies acres
 c. Natural areas including existing trees, other vegetation, and soil acres
 d. Common landscape area/park acres
 e. Regional Flood Control/Drainage basins acres

1 b. Project Drainage Shed Area (Total) acres A

Project-Specific Open Space (In-project, communal)** acres A_{PSOS} see area example below

a. Natural storage reservoirs and drainage corridors acres
 b. Buffer zones for natural water bodies acres
 c. Natural areas including existing trees, other vegetation, and soil acres
 d. Landscape area/park acres
 e. Flood Control/Drainage basins acres

** Doesn't include impervious areas within individual lots and surrounding individual units. That is accounted for below using Form D-1a in Step 2.

Area with Runoff Reduction Potential $A - A_{PSOS} =$ acres A_T

Number of Units in A_T

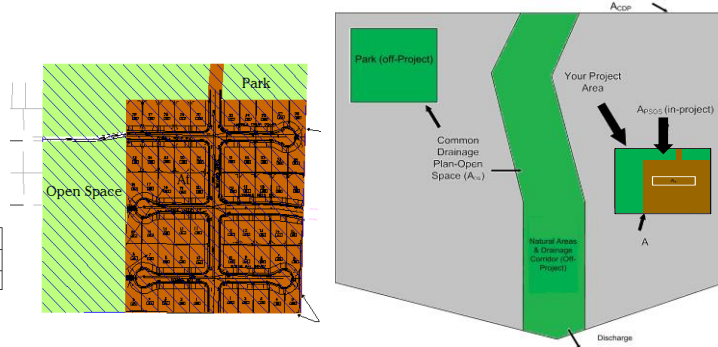
Number of units per acre in A_T $DU/A_T =$ DUA

Assumed Initial Impervious Fraction of A_T I
 (determined using Table D-1a)

Open Space & Pervious Area LID Credit (Step 1)
 $(A_{OS}/A_{CDP} + A_{PSOS}/A) \times 100 =$ pts

Dwelling units per acre	Imperviousness
1	0.17
2	0.25
3,4	0.35
5,6	0.40
7	0.50
8,9	0.55
10-14	0.60
15-20	0.70

A - Drainage Shed Area
 A_{PSOS} Parks and Open Space
 A_T - Area with Runoff Reduction Potential



Step 2 - Runoff Reduction Credits

Runoff Reduction Measures	Effective Area Managed (A_C)
Disconnected Roof Drains (see Fact Sheet) use Form D-1a for credits	<input type="text" value="1.04"/> acres
Disconnected Pavement (see Fact Sheet) use Form D-1b for credits	<input type="text" value="0.11"/> acres
Interceptor Trees (see Fact Sheet) use Form D-1c for credits	<input type="text" value="0.00"/> acres
Alternative Driveway Design (see Fact Sheet) use Form D-1d for credits	<input type="text" value="0.00"/> acres
Total Effective Area Managed (Credit Area)	A_C <input type="text" value="1.15"/> acres EAM
Runoff Reduction Credit (Step 2)	$(A_C / A_T) \times 100 =$ <input type="text" value="6"/> pts

Form D-1a: Disconnected Roof Drains Worksheet

See Fact Sheet for more information regarding Disconnected Roof Drain credit guidelines

Effective Area Managed (A_c)

1. Determine efficiency Multiplier

Runoff is directed to a dispersal trench or dry well (Type A and B soils only)	1.00
Runoff is directed across landscaping, determine setback	
25 ft +	Use multiplier of 1.00
≥ 20 and < 25 ft	Use multiplier of 0.90
≥ 15 and < 20 ft	Use multiplier of 0.70
≥ 10 and < 15 ft	Use multiplier of 0.45
≥ 5 and < 10 ft	Use multiplier of 0.25

Efficiency Multiplier → Box J1

2. Determine percentage of roof drains disconnected

→ Box J2

3. Select project density in dwelling units per acre:

1	Use reduction factor of	0.08
2	Use reduction factor of	0.13
3,4	Use reduction factor of	0.19
5,6	Use reduction factor of	0.23
7	Use reduction factor of	0.29
8,9	Use reduction factor of	0.33
10-14	Use reduction factor of	0.37
15-20	Use reduction factor of	0.44

Reduction Factor → Box J3

4. Determine Area Managed

Multiply Box J3 by A_T, and enter the result in Box J4 acres Box J4

5. Multiply Boxes J1, J2 and J4, and enter 60% of the Result in Box J

acres Box J

This is the amount of area credit to enter into the "Disconnected Roof Drains" Box of Form D-1

Form D-1b: Disconnected Pavement Worksheet

See Fact Sheet for more information regarding NDC Pavement credit guidelines

Effective Area Managed (A_c)

Divided Sidewalks

1. Determine percentage of units with divided Sidewalks

Box K1

Multiply Box K1, A_T, and 0.04 and enter 60% of the result in Box K

acres Box K

This is the amount of area credit to enter into the "Disconnected Pavement" Box of Form D-1

Form D-1c: Interceptor Tree Worksheet

See Fact Sheet for more information regarding Interceptor Tree credit guidelines

Effective Area Managed (A_c)

New Evergreen Trees

1. Enter number of new evergreen trees that qualify as Interceptor Trees in Box L1.

trees Box L1

2. Multiply Box L1 by 200 and enter result in Box L2

sq. ft. Box L2

New Deciduous Trees

3. Enter number of new deciduous trees that qualify as Interceptor Trees in Box L3.

trees Box L3

4. Multiply Box L3 by 100 and enter result in Box L4

sq. ft. Box L4

Existing Tree Canopy

5. Enter square footage of existing tree canopy that qualifies as Existing Tree canopy in Box L5.

sq. ft. Box L5

6. Multiply Box L5 by 0.5 and enter the result in Box L6

sq. ft. Box L6

Total Interceptor Tree Credits

Add Boxes L2, L4, and L6 and enter it into Box L7

sq. ft. Box L7

Divide Box L7 by 43,560 and multiply by 20% to get effective area managed and enter the result in Box L8

acres Box L8

This is the amount of area credit to enter into the "Interceptor Trees" Box of Form D-1

Form D-1d: Alternative Driveway Design

See Fact Sheet for more information regarding Alternative Driveway Design credit guidelines

1. Select type of driveway

Pervious Driveway:	Multiplier:
Cobblestone Block P	0.40
Pervious Concrete/A	0.60
Modular Block	
Porous Pavement	0.75
Porous Gravel	
Not Directly-connected	1.00

Box M1

2. Determine percentage of units with Alternative Driveways:

Box M2

4. Multiply Boxes M1, M2, A_T and 0.04, and enter the result in Box M

acres

This is the amount of area credit to enter into the "Alternative Driveway Design" Box of Form D-1

Step 3 - Runoff Management Credits

Capture and Use Credits

Impervious Area Managed by Rain barrels, Cisterns, and automatically-emptied systems

(see Fact Sheet) enter gallons, for simple rain barrels acres

Automated-Control Capture and Use System

(see Fact Sheet, then enter impervious area managed by the system) acres

Bioretention/Infiltration Credits

Impervious Area Managed by Bioretention BMPs

(see Fact Sheet) Bioretention Area sq ft (Private Maintenance)
 Subdrain Elevation inches
 Ponding Depth, inches inches acres

Impervious Area Managed by Infiltration BMPs

(see Fact Sheet) Drawdown Time, hrs drawdown_hrs_inf
 Soil Infiltration Rate, in/hr soil_inf_rate
 Sizing Option 1: Capture Volume, acre-ft capture_vol_inf acres
 Sizing Option 2: Infiltration BMP surface area, sq ft soil_surface_area acres
 Basin or trench? approximate BMP depth ft

Impervious Area Managed by Amended Soil or Mulch Beds

(see Fact Sheet) Mulched Infiltration Area, sq ft mulch_area acres

Total Effective Area Managed by Capture-and-Use/Bioretention/Infiltration BMPs A_{LIDC}

Runoff Management Credit (Step 3) $A_{LIDC}/A_T * 200 =$ pts

Total LID Credits (Step 1+2+3) LID compliant, check for treatment sizing in Step 4

Does project require hydromodification management? If yes, proceed to using SacHM.

Adjusted Area for Flow-Based, Non-LID Treatment $A_T - A_C - A_{LIDC} =$ A_{AT}

Adjusted Impervious Fraction of A for Volume-Based, Non-LID Treatment $(A_T * I_A - A_{LIDC}) / A =$ I_A

STOP: No additional treatment needed

Step 4a Treatment - Flow-Based (Rational Method)

Form D-1e

Calculate treatment flow (cfs): $Flow = Runoff\ Coefficient \times Rainfall\ Intensity \times Adjusted\ Treatment\ Area$

Determine C Factor using Table D-1b C
 Determine i using Table D-1c (Rainfall Intensity) i
 A_{AT} from Step 2 A_{AT}
 Flow = C * i * A_{AT} cfs

TABLE D-1b

Development Type	Runoff Coefficient (Rational), C
Single-family areas	0.50
Multi-units, detached	0.60
Apartment dwelling areas	0.70
Multi-units, attached	0.75
User Specified	0.00

Table D-1c

Rainfall Intensity	
Roseville	i = 0.20 in/hr
Sacramento	i = 0.18 in/hr
Folsom	i = 0.20 in/hr

Step 4b Treatment - Volume-Based (ASCE-WEF)

Calculate water quality volume (Acre-Feet): $WQV = Area \times Maximized\ Detention\ Volume\ (P_0)$

Obtain A from Step 1 A hrs Specified Draw Down time

Obtain P₀: Maximized Detention Volume from figures E-1 to 4 in Appendix E of this manual using I_A from Step 2. $E =$ P₀

Calculate treatment volume (acre-ft): **Treatment volume = A x (P₀ / 12)** Acre-Feet