# APPENDIX E – STORMWATER MANAGEMENT

# PRELIMINARY

# HYDROLOGY AND HYDRAULIC ANALYSIS

For:

## SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
## LIVERMORE, CALIFORNIA 94550

Project Name: Chick - fil - A Restaurant # 3805

Prepared for:

**Chick-fil-A, Inc.**
15635 Alton Parkway, Suite 350
Irvine, CA 92618

Prepared by


**Joseph C. Truxaw & Associates, Inc.**
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CRAIG S. DI BIAS
No. 75205
CIVIL
STATE OF CALIFORNIA

Prepared on: September 8, 2017

# Table of Contents

# 1.0 DISCUSSION

## 1.1 PURPOSE

This drainage study provides an analysis of the existing and proposed hydrology characteristics for the improvements of Chick-fil-A, Restaurant # 3805. The project site is located at southwest corner of N. Livermore Avenue and Freeway I-580 in the City of Livermore, County of Alameda, California and is at latitude and longitude of 37.6992° N and -121.7741° W, respectively. The project site is 1.62 acres within tributary drainage boundary . The subject site is bounded on the north and west by Arroyo Las Positas Creek, to the east by N. Livermore Avenue, and to the south by the existing Hawthorn Suites (by Wyndham Livermore). For Vicinity and location map see this report.

## 1.2 EXISTING SITE CONDITION

According to City of Livermore Zoning map the project site is in open space area and within the city's urban growth boundary line. (see zoning map in this report). The subject site is currently an irregular shaped vacant lot. According to the Geotechnical Engineering Report that was prepared by GILES Engineering Associates, Inc.(Geotechnical Engineering firm) the southern portion of the subject property was occupied by a residential property from at least 1949 through 2001, when the structures were demolished. Based on the ALTA Survey, prepared by Joseph C. Truxaw & Associates, dated April 8, 2016, elevations within the site ranges from approximately 455.0 feet along the westerly end of the property to 460.0 feet near the northeast corner of the site and near the top of the descending slope. The elevation of the toe of the descending slope is about 440.0 The adjacent northerly descending slope is covered by moderate vegetation that includes shrubs and occasional trees.

In the existing condition the drainage area has been divided into three subareas. The 0.51 acres of the site (subarea "A-1") sheet flows toward the northerly property line and gets intercepted by Arroyo Las Posias Creek. The runoff from the middle portion of the property, approximately the 0.88 acres (Subarea "A-2") sheet flows along the length of the project east to west and combines with runoff from subarea "A-1" in the creek bed of the Arroyo Las Positas. The runoff in subarea "A-3", the 0.24 acres sheet flows toward southwesterly of the project site and gets intercepted by an existing storm drain grated inlet, located in neighboring property. (See existing hydrology map in this report and page 4 for site images).

The discharge flow path from this site is into Arroyo Las Positas Creek, Arroyo Mocha, Arroyo De La Laguna, Alameda Creek, Old Alameda Creek and finally into Lower San Francisco Bay.

According to Livermore NRCS Soil Groups (Figure 3-4), the subject site is in the soil group type "C" (See soil map in this report) and is located in Arroyo Las Positas Watershed (see Figure 3-1 Livermore Creek Network exhibit map in this report).

**EXISTING SITE, LOOKING WEST**

**DESCENDING SLOPE ALONG ARROYO LAS POSITAS CREEK AND NORTHERLY PROPERTY LINE**

**NORTHWESTERLY OF THE PROJECT SITE AT THE EXISTING 48" RCP OUTLET TO ARROYO LAS POSITAS CREEK**

## 1.3 PROPOSED SITE IMPROVEMENTS

The proposed Chick-fil-A restaurant # 3805 building will be constructed in the northeasterly portion of the site and will be a single-story wood-frame structure with no basement or underground levels and will have a floor area of approximately 4634 square feet and finish floor elevation of 461.00. Entrance to the site will be from Livermore Avenue and is at southeasterly of the property. Other planned improvements include a paved drive thru parking lot, menu board signs, a trash enclosure, a patio, concrete walkways and planter areas. Parking lot improvement, within the subject property, will include sidewalks, curb and gutters, and underground utilities.

Three bioretention basins will be constructed along the northerly, westerly, and easterly property lines and will be sized according to Alameda County stormwater technical guidance dated May 2nd 2016.

The total site runoff will sheet flow to onsite curb and gutters and conveyed to the proposed bioretention basins. Storm water will then be collected by the proposed onsite storm drain system and conveyed to the existing 48-inch RCP. (See proposed hydrology map in this report). The overall site discharge from this site will be the same as existing condition into Arroyo Las Positas Creek.

## 1.4 METHODOLOGY

For the purpose of this study, all drainage runoffs have been calculated based on a, 10 year and 100 year storm event in accordance with the latest adopted Alameda County Zone 7 Standards. Storm drainage facilities are designed in conformance with the following standards:

- *The 10 year hydraulic grade-line of all closed conduit storm drainage systems shall be a minimum of 1.25 feet below top of curb elevation at any manhole or inlet.*
- *The 10 year water surface shall be kept below the top of bank of all drainage swales and V-ditches.*
- *The 100 –year water surface shall be 1 foot below new pad elevations of the tract.*
- *The design engineer shall map the street and overland flow routes within the subdivision for the 100- year storm.*
- *The map shall identify 100-year water surface elevations within the subdivision.*
- *The 100 –year water surface in the swales shall be 1 foot below the pad elevations.*
- *Upstream hydraulic grades shall be no higher than the top of curb elevation at any manhole or inlet.*

### 1.4a RAINFALL

From Attachment-6 (Alameda County Flood Control and Water Conservation District), The Mean Annual Precipitation for this project site is 14.8 inches. (See exhibit map in this report) The rainfall intensities are calculated using MAP in the equation shown in the Rational Method calculations.

### 1.4b PEAK RUNOFF –RATIONAL METHOD

The total runoff from the site will be computed using the information given by the Alameda County Hydrology and Hydraulics Manual for Zone 7. The design storm for this facility is 10-year and 100-year recurrence interval and shall be calculated using the Modified Rational Formula which is:

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area(Table 3-1).
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

The rain fall intensity is calculated using the following equation from chapter 3 of the Alameda County Hydrology and Hydraulic Manual (June 2003):
$i = (0.33 + 0.091144 * MAP) \times (0.249 + 0.1006 * Ki) * Tc^{-0.56253}$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches)
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)
Tc = Time of concentration: The time of concentration is the time required for the runoff from the most remote region of the watershed to reach the point of concentration at which the flow is to be calculated. The following equation is used to calculate the time of concentration.

$$Tc = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}} \quad \text{and} \quad S = \left(\frac{1000}{CN}\right) - 10$$

Where :

Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".
(See attachment in this report)

## 1.5 SUMMARY AND CONCLUSION

## 1.5 SUMMARY

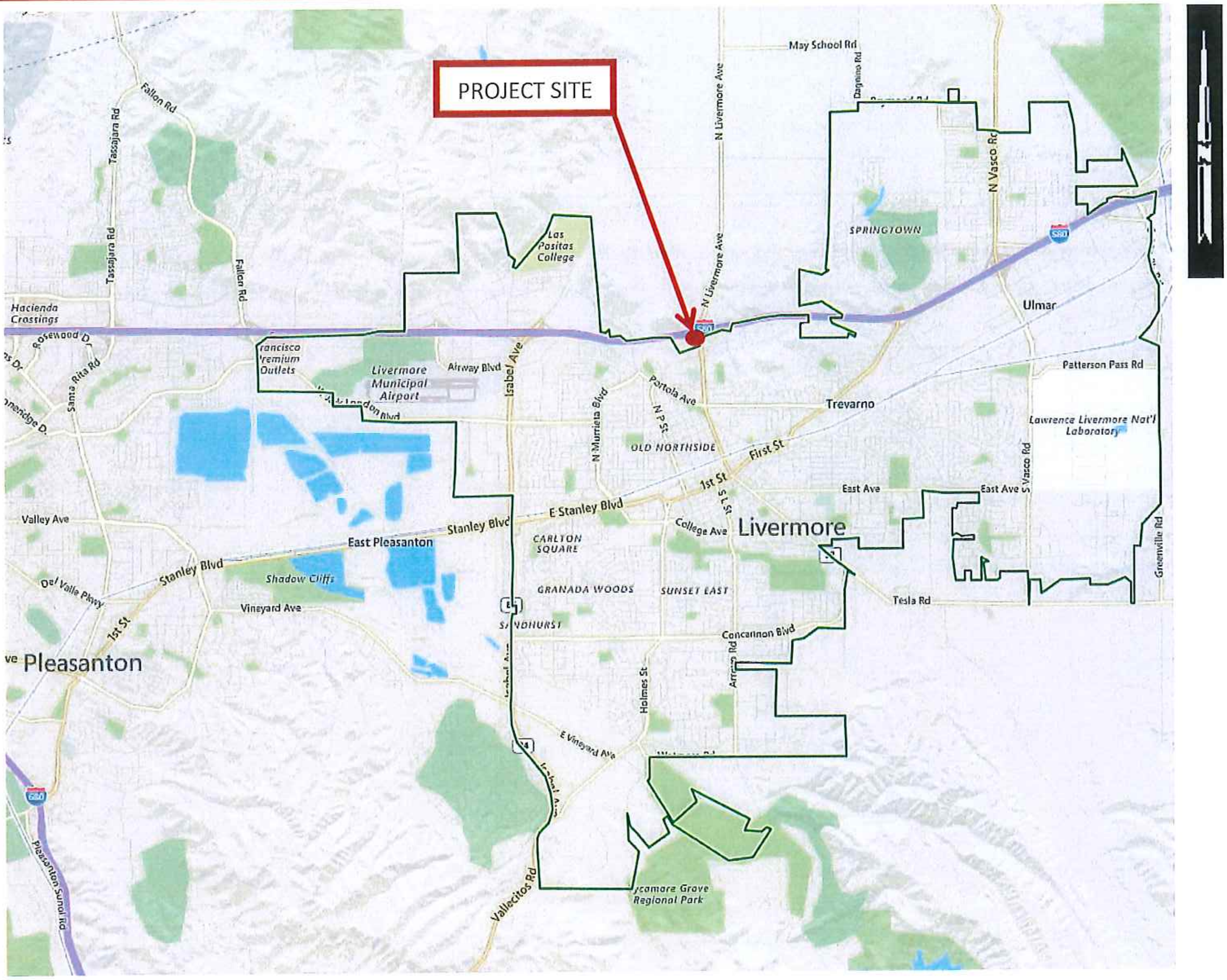
Below is the summary discharge data table from this site both in the existing and proposed condition.

| TOTAL SITE DISCHARGE | | |
|---|---|---|
| STORM EVENT (YEAR) | EXISTING CONDITION (cfs) | PROPOSED CONDITON (cfs) |
| 10 | 0.66 | 4.10 |
| 100 | 1.60 | 9.84 |

Below is the summary of basin volume data table for DMA areas.

| TOTAL BASIN VOLUME | | |
|---|---|---|
| DMA | VOLUME REQUIRED (CU-FT) | VOLUME PROVIDED (CU-FT) |
| 1 | 2,679 | 3,036 |
| 2 | 167 | 401 |

## 1.6 VICINITY MAP




| | |
|---|---|
| *DATE* | 02-13-17 |
| DRAWN BY | TONY E |
| JOB NO. | CFA16005 |
| SHEET NO. | 1 OF 1 SHEET |

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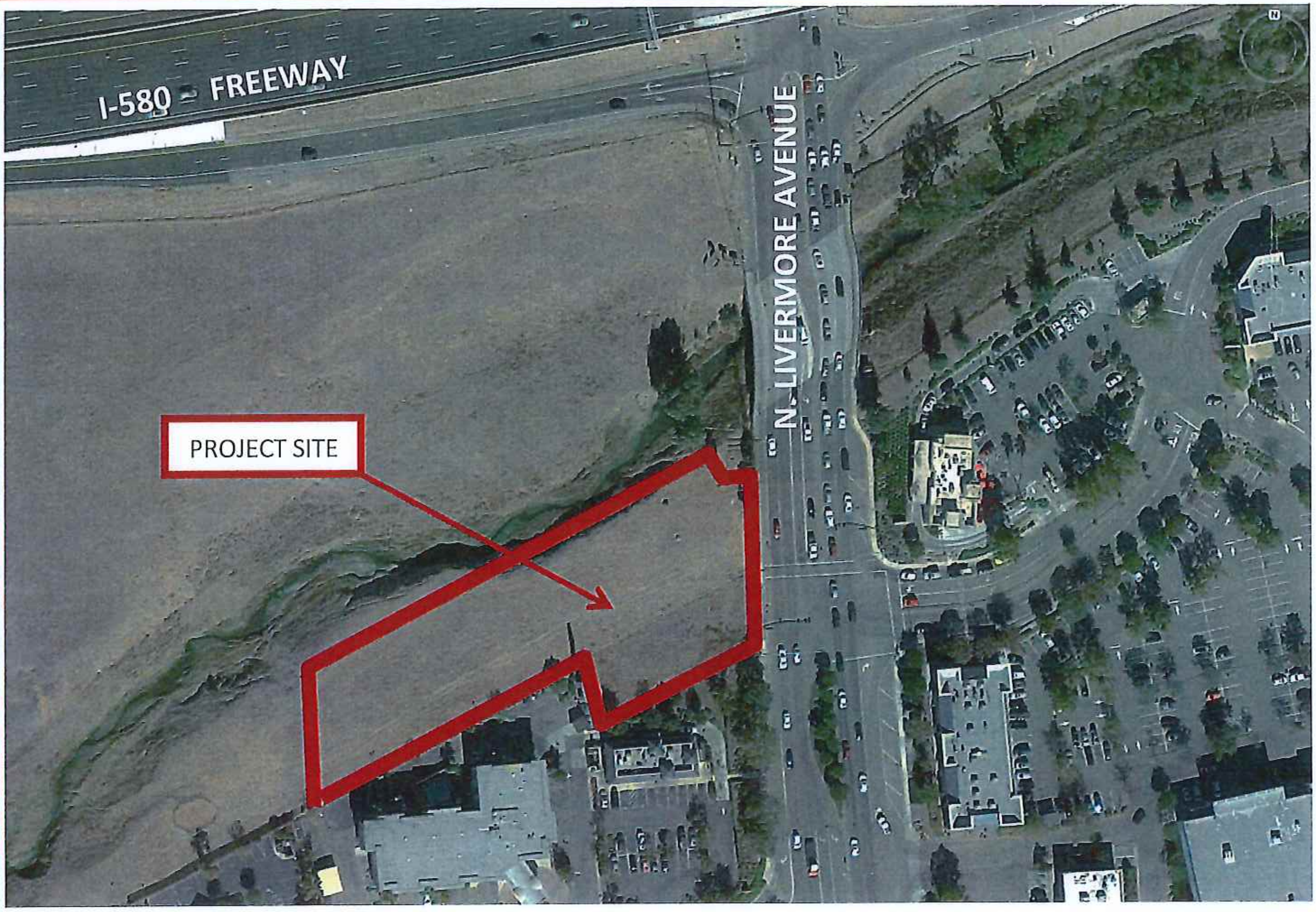
VICINITY MAP

SWC OF N. LIVERMORE AVE. & I-580 FREEWAY

LIVERMORE, CA

## 1.7 LOCATION MAP

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| *DATE* 02-13-17 |
| DRAWN BY TONY E |
| JOB NO. CFA16005 |
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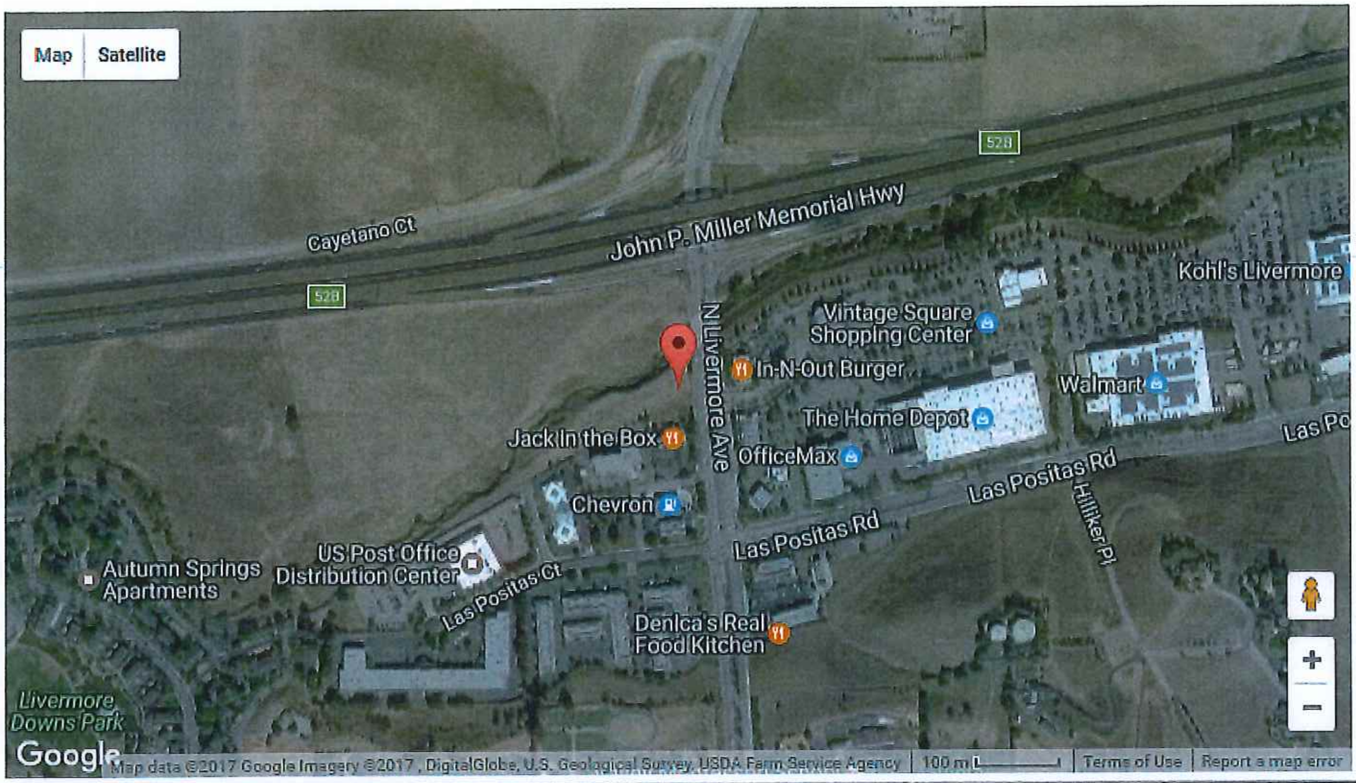
LOCATION MAP
SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
LIVERMORE, CA

## 1.8 LATITUDE AND LONGITUDE OF THE SITE

# Latitude and Longitude of a Point




Clear / Reset | Remove Last Blue Marker | Center Red Marker

## Get the Latitude and Longitude of a Point

When you click on the map, move the marker or enter an address the latitude and longitude coordinates of the point are inserted in the boxes below.

Latitude: 37.699178

Longitude: -121.774064

| | Degrees | Minutes | Seconds |
|---|---|---|---|
| Latitude: | 37 | 41 | 57.0408 |
| Longitude: | -121 | 46 | 26.6298 |

## Show Point from Latitude and Longitude

Use this if you know the latitude and longitude coordinates of a point and want to see where on the map the point is.

**Use:** **+** for *N* Lat or *E* Long **-** for *S* Lat or *W* Long.

**Example:** +40.689060 -74.044636

**Note:** Your entry should not have any embedded spaces.

Decimal Deg. Latitude:

Decimal Deg. Longitude:

Show Point

Example: **+34 40 50.12** for *34N 40' 50.12"*

| | Degrees | Minutes | Seconds |
|---|---|---|---|
| Latitude: | | | |
| Longitude: | | | |

Show Point

| |
|---|
| *DATE* 02-13-17 |
| DRAWN BY TONY E |
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Latitude and Longitude of the project site
SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
LIVERMORE, CA

## 1.9 SOIL MAP (Figure 3-4)

## 1.10 CREEK NETWORK MAP (Figure 3-1)

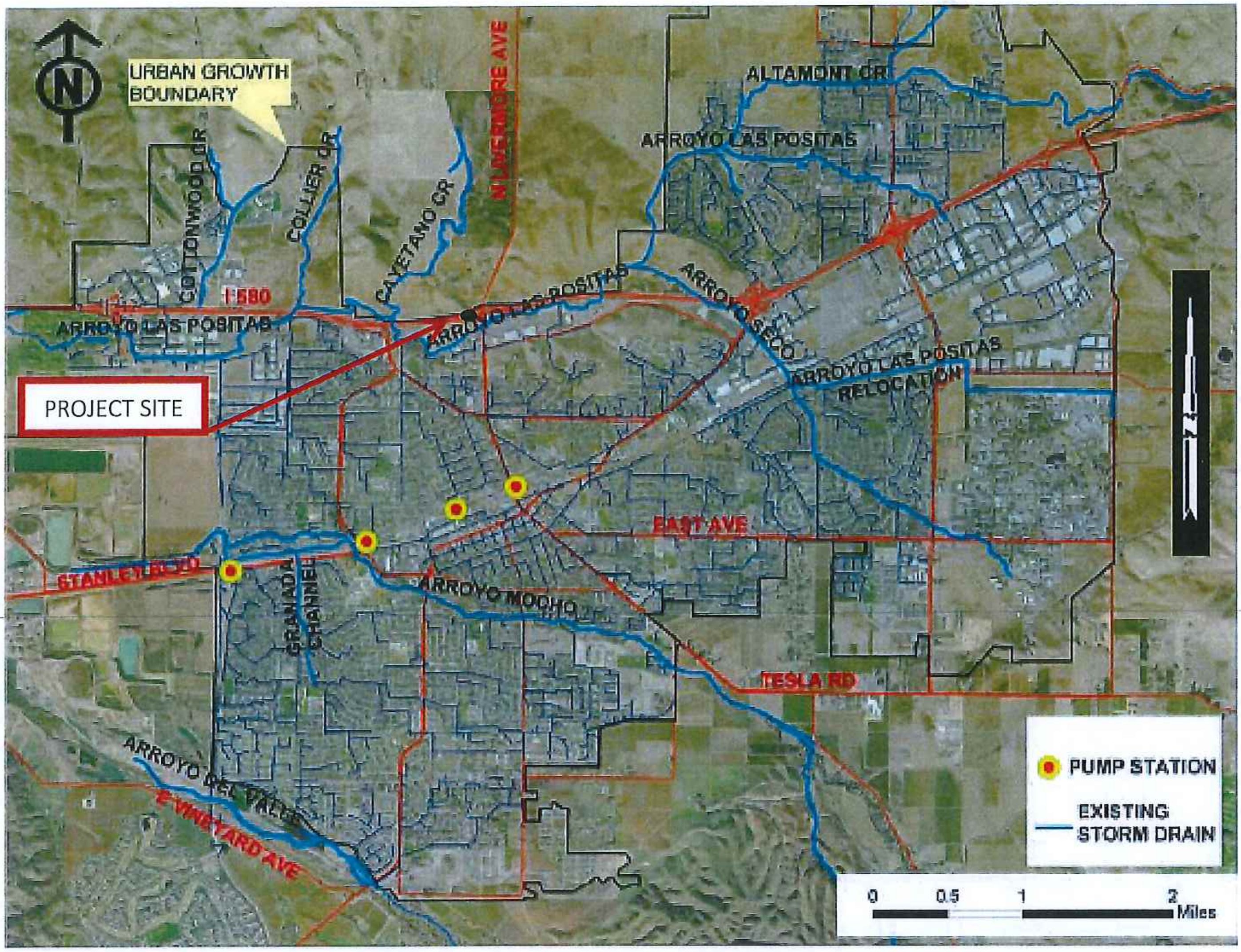


**Figure 3-1. Livermore Creek Network**

| | |
|---|---|
| *DATE* | 02-13-17 |
| DRAWN BY | TONY E |
| JOB NO. | CFA16005 |
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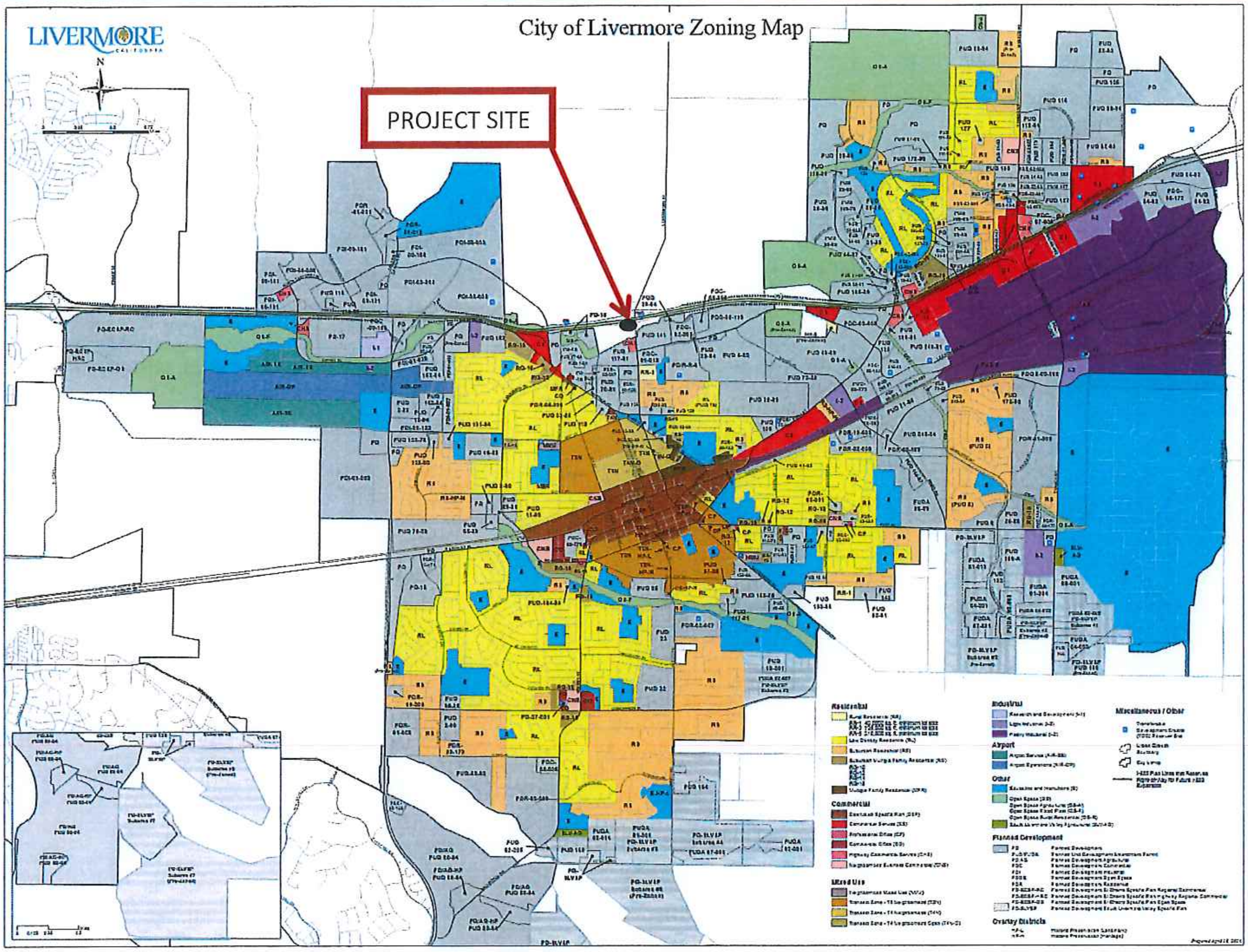
LIVERMORE CREEK NETWORK MAP
SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
LIVERMORE, CA

# 1.11 ZONING MAP

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|---|---|
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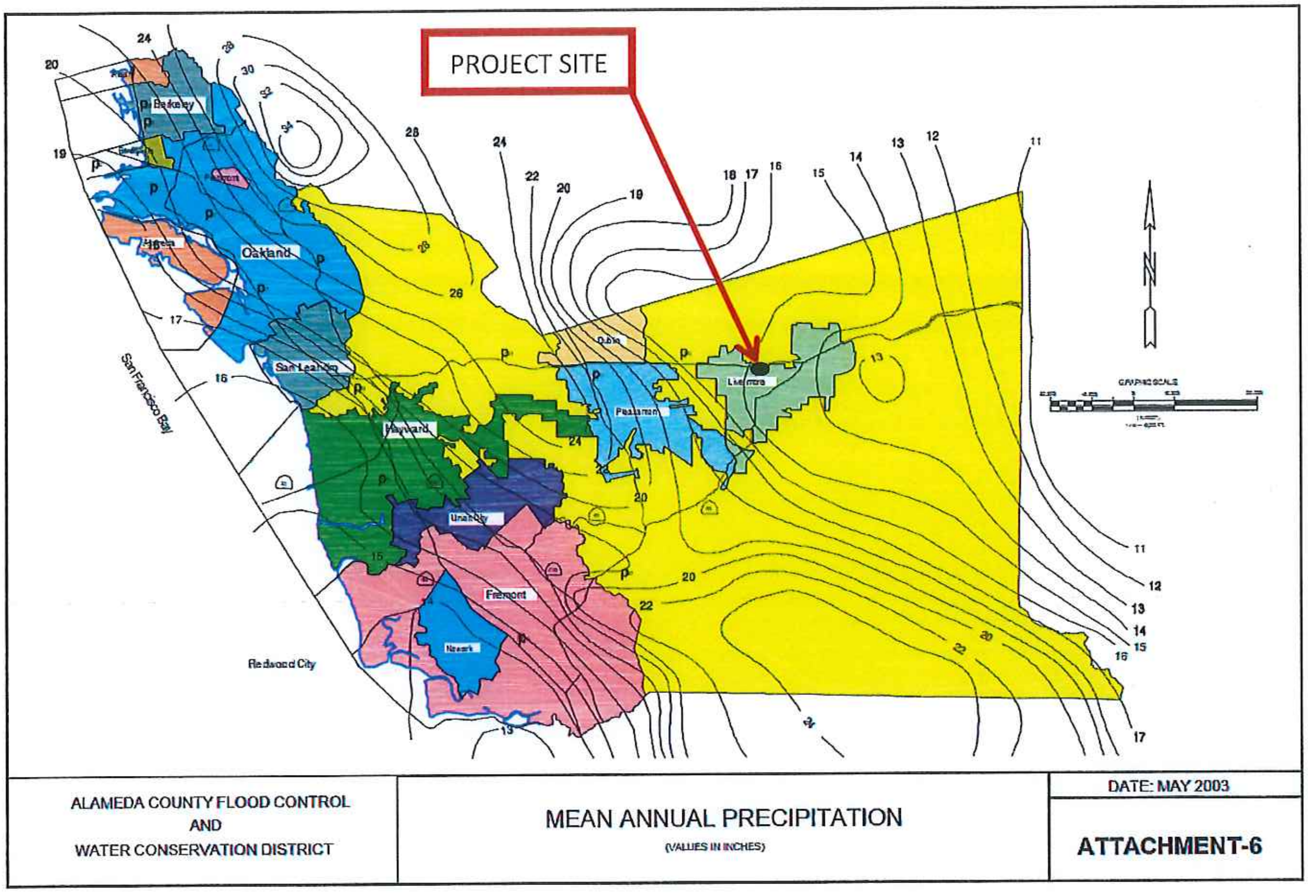
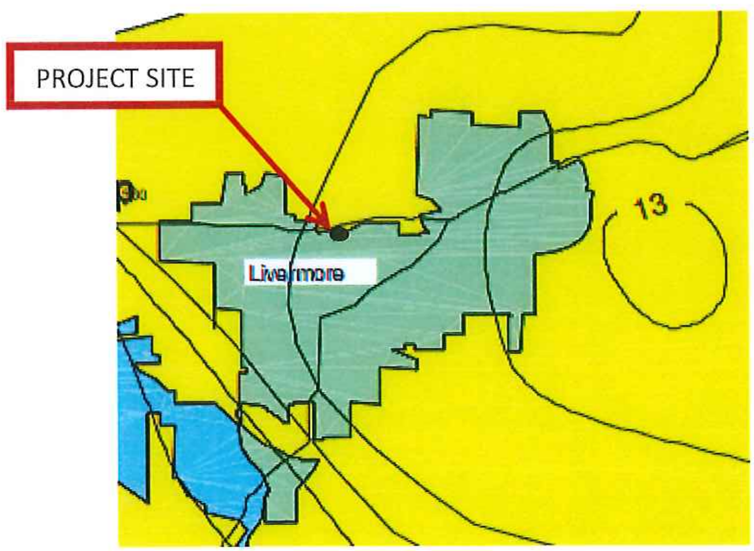
ZONING MAP
SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
LIVERMORE, CA

# 1.12 MEAN ANNUAL PRECIPITATION MAP (ATTACHMENT-6)




Mean Annual Precipitation = 14.8 inch




| DATE 02-13-17 |
|---|
| DRAWN BY TONY E |
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MEAN ANNUAL PRECIPITATION MAP
SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
LIVERMORE, CA

## 1.13 LAND USE, SOIL CURVE NUMBER (CN), PERCENT IMPERVIOUSNESS AND RUNOFF COEFFICIENTS (Table 3-1)

# Table 3-1. Land Use, Soil Curve Number (CN), Percent Imperviousness, and Runoff Coefficients

| Land Use Symbol | Land Use Description | CN for Soil with Hydrologic Group B | CN for Soil with Hydrologic Group C | CN for Soil with Hydrologic Group D | Percent Impervious | Runoff Coefficient, C (Soil Type B) | Runoff Coefficient, C (All Other Soils) |
|---|---|---|---|---|---|---|---|
| **RESIDENTIAL** | | | | | | | |
| RR | Rural Residential | 68 | 79 | 84 | 10 | 0.35 | 0.40 |
| UL | Urban Low Residential | 70 | 80 | 85 | 30 | 0.40 | 0.50 |
| UL-1 | Urban Low Residential, 1.5 d.u./ac. | 70 | 80 | 85 | 80 | 0.40 | 0.50 |
| UL-2 | Urban Low Residential, 2 d.u./ac. | 70 | 80 | 85 | 80 | 0.40 | 0.50 |
| ULM | Urban Low Medium Residential, 3.0 d.u./ac. | 72 | 81 | 86 | 45 | 0.40 | 0.50 |
| UM | Urban Medium Residential, 4.5 d.u./ac. | 75 | 83 | 87 | 60 | 0.50 | 0.60 |
| UMH | Urban Medium High Residential, 6.0 d.u./ac. | 80 | 87 | 90 | 70 | 0.50 | 0.60 |
| UH | Urban High Residential | 85 | 90 | 92 | 80 | 0.60 | 0.70 |
| UH-1 | Urban High Residential, 6-8 d.u./ac. | 85 | 90 | 92 | 80 | 0.60 | 0.70 |
| UH-2 | Urban High Residential, 8-14 d.u./ac. | 85 | 90 | 92 | 80 | 0.60 | 0.70 |
| UH-3 | Urban High Residential, 14-18 d.u./ac. | 88 | 91 | 93 | 80 | 0.60 | 0.70 |
| UH-4 | Urban High Residential, 18-22 d.u./ac. | 88 | 91 | 93 | 80 | 0.60 | 0.70 |
| VDSF | Very Low Density Single Family, 4 d.u./ac. | 75 | 83 | 87 | 20 | 0.50 | 0.60 |
| LDSF | Low Density Single Family, 6. d.u./ac. | 80 | 87 | 90 | 45 | 0.50 | 0.60 |
| HDV | High Density Village, 18 d.u./ac. | 92 | 94 | 95 | 80 | 0.70 | 0.75 |
| **COMMERCIAL** | | | | | | | |
| CORC | Core Commercial | 92 | 94 | 95 | 90 | 0.85 | 0.95 |
| CSGC | Community Serving General Commercial | 92 | 94 | 95 | 65 | 0.60 | 0.70 |
| DC | Dense Commercial | 92 | 94 | 95 | 90 | 0.85 | 0.95 |
| HC | Highway Commercial | 92 | 94 | 95 | 90 | 0.85 | 0.95 |
| NC | Neighborhood Commercial | 92 | 94 | 95 | 85 | 0.60 | 0.70 |
| OC | Office Commercial | 92 | 94 | 95 | 90 | 0.85 | 0.95 |
| SC | Service Commercial | 92 | 94 | 95 | 85 | 0.85 | 0.95 |
| SUPC | Support Commercial | 92 | 94 | 95 | 85 | 0.65 | 0.95 |
| UDP-# | See Downtown Urban Design Plan | 88 | 91 | 93 | 85 | 0.60 | 0.70 |
| **OPEN SPACE** | | | | | | | |
| AGVT | Agriculture / Viticulture, 1-5 d.u./100 ac. | 69 | 79 | 84 | 5 | 0.20 | 0.30 |
| GNAG | General Agriculture, 100 ac. Min. Site | 77 | 85 | 89 | 5 | 0.20 | 0.30 |
| HLCN | Hillside Conservation | 69 | 79 | 84 | 20 | 0.20 | 0.30 |
| LDAG | Limited Agriculture | 77 | 85 | 89 | 5 | 0.20 | 0.30 |
| LPA | Large Parcel Agriculture | 77 | 85 | 89 | 5 | 0.20 | 0.30 |
| OSP | Parks, Trail Ways, Rec. Corridors, and Protected Areas | 69 | 79 | 84 | 20 | 0.20 | 0.25 |
| R&G | Range and Grassland, 100 ac. Min. Site | 69 | 79 | 84 | 30 | 0.20 | 0.30 |
| RMG | Resource Management | 69 | 79 | 84 | 30 | 0.20 | 0.30 |
| S&G | Sand and Gravel Resources | 82 | 87 | 89 | 20 | 0.20 | 0.30 |
| VIT | Viticulture, 100 ac. Min. Site | 69 | 79 | 84 | 10 | 0.20 | 0.30 |
| WML | Water Management Lands | 75 | 75 | 75 | 10 | 0.20 | 0.30 |

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SOIL CURVE NUBER (CN) TABLE
SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
LIVERMORE, CA

*DATE* 02-13-17

DRAWN BY TONY E

JOB NO. CFA16005

SHEET NO. 1

OF 1 SHEET

# 2.0 HYDROLOGY ANALYSIS

# 2.1 10 YEAR HYDROLOGY ANALYSIS (EXISTING CONDITION)

# Pre-Development Condition

**Sub-area Node 100 to Node 103**
**(Subarea A-1)**

Since the northerly subarea sheet flows over the descending slope the upstream and downstream projection of the two remote points at the flow line of the creek was used to calculate the "Y" (ft/ft).

A = 0.50 acres, L = 622 ft. (flow line of Creek) $Y = \frac{439.8-436.3}{622} = 0.0056$ (ft/ft)
C = 0.25 (Per table 3-1)

$Tc = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".

$$S = \left(\frac{1000}{79}\right) - 10 = 2.6582$$

$$T_c = 622^{0.8} \frac{(2.6582+1)^{0.7}}{1900\sqrt{0.0056}} = 2.9956\ hr$$ ←

$i = (0.33 + 0.091144 * MAP) \times (0.249 + 0.1006 * Ki) * Tc^{-0.56253}$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10} = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * 1.339) * (2.9956)^{-0.56253}$

$I_{10} = 1.5740$ in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{10}$ = 0.25 x 1.5740 x 0.50 = 0.20 cfs.** ←

**Sub-area Node 101 to Node 102**
**(Subarea A-2)**

A = 0.88 acres L = 593 ft. Open Space $Y = \frac{460.4-455.2}{593} = 0.0088$ (ft/ft)
C = 0.25 (Per table 3-1)

$Tc = L^{0.8}\,\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".

$$S = \left(\frac{1000}{79}\right) - 10 = 2.658$$
$$T_c = 593^{0.8}\,\frac{(2.658+1)^{0.7}}{1900\sqrt{0.0088}} = 2.300\ hr \leftarrow$$

i = (0.33 + 0.091144 )* (MAP) * (0.249 + 0.1006) * (Ki) * $(Tc)^{-0.56253}$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10}$ = (0.33 + 0.091144) * (14.8) * (0.249 + 0.1006) * (1.339) * $(2.300)^{-0.56253}$

$I_{10}$ = 1.8262 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area(Table 3-1),
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{10}$ = 0.25 x 1.8262 x 0.88 = 0.40 cfs.** ←

**Sub-area Node 100 to Node 103**
**(Subarea A-1 & Subarea A-2)**

A = 1.38 acres L = 756 ft. Open Space $Y = \frac{439.8-436.3}{756} = 0.0046$ (ft/ft)
C = 0.25 (Per table 3-1)

$Tc = L^{0.8}\,\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".

$$S = \left(\frac{1000}{79}\right) - 10 = 2.658$$
$$T_c = 756^{0.8}\,\frac{(2.658+1)^{0.7}}{1900\sqrt{0.0046}} = 3.86\,hr$$ ←

i = (0.33 + 0.091144) * (MAP) * (0.249 + 0.1006) * (Ki) * $(Tc)^{-0.56253}$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10}$ = (0.33 + 0.091144) x* (14.8) x (0.249 + 0.1006) * (1.339) * $(3.86)^{-0.56253}$

$I_{10}$ = 1.3648 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area(Table 3-1),
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{10}$ = 0.25 x 1.3648 x 1.38 = 0.47cfs.** ←

**Sub-area Node 200 to Node 201**
**(Subarea A-3)**

A = 0.24 acres  L = 191 ft.  Open Space $Y = \frac{460.0-457.9}{191} = 0.0110$ (ft/ft)
C = 0.25 (Per table 3-1)

$Tc = L^{0.8}\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".

$$S = \left(\frac{1000}{79}\right) - 10 = 2.658$$
$$T_c = 191^{0.8}\frac{(2.658+1)^{0.7}}{1900\sqrt{0.0110}} = 0.8313\ hr$$ ←

$$i = (0.33 + 0.091144) * (MAP) * (0.249 + 0.1006) * (Ki) * (Tc)^{-0.56253}$$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10} = (0.33 + 0.091144) * (14.8) * (0.249 + 0.1006) * (1.339) * (0.8313)^{-0.56253}$
$I_{10} = 3.2372$ in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area(Table 3-1),
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{10}$ = 0.25 x 3.2372 x 0.24 = 0.19 cfs.** ←

$$\sum(SUBAREA\ \text{"A-1"} + SUBAREA\ \text{"A-2"} + SUBARE\ \text{"A-3"}) = 0.47 + 0.19 = 0.66$$

**Total $Q_{10}$ for project site = 0.66 cfs.** ←

# 2.2 100 YEAR HYDROLOGY ANALYSIS

# (EXISTING CONDITION)

# Pre-development Condition

**Sub-area Node 100 to Node 103**
**(Subarea A-1)**

Since the northerly subarea sheet flows over the descending slope the upstream and downstream projection of the two remote points at the flow line of the creek was used to calculate the "Y" (ft/ft).

A = 0.50 acres, L = 622 ft. (flow line of Creek) $Y = \frac{439.8-436.3}{622} = 0.0056$ (ft/ft)
C = 0.25 (Per table 3-1)

$Tc = L^{0.8}\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".

$$S = \left(\frac{1000}{79}\right) - 10 = 2.6582$$

$$T_c = 622^{0.8}\frac{(2.6582+1)^{0.7}}{1900\sqrt{0.0056}} = 2.9956\ hr$$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * 3.211) * (2.9956) $^{-0.56253}$

$I_{100}$ = 3.7749 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{100}$ = 0.25 x 3.7749 x 0.50 = 0.47 cfs.** ←

**Sub-area Node 101 to Node 102**

A = 0.88 acres L = 593 ft. Open Space $Y = \frac{460.4-455.2}{593} = 0.0088$ (ft/ft)
C = 0.25 (Per table 3-1)

$Tc = L^{0.8}\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".

$$S = \left(\frac{1000}{79}\right) - 10 = 2.658$$
$$T_c = 593^{0.8}\frac{(2.658+1)^{0.7}}{1900\sqrt{0.0088}} = 2.300\ hr \leftarrow$$

$i = (0.33 + 0.091144) * (MAP) * (0.249 + 0.1006) * (Ki) * (Tc)^{-0.56253}$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100} = (0.33 + 0.091144) * (14.8) * (0.249 + 0.1006) * (3.211) * (2.300)^{-0.56253}$

$I_{100}$ = 4.4564 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area(Table 3-1),
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{100}$ = 0.25 x 4.4564 x 0.88 = 0.98 cfs.** ←

**Sub-area Node 100 to Node 103**
**(Subarea A-1 & Subarea A-2)**

A = 1.38 acres L = 756 ft. Open Space $Y = \frac{439.8-436.3}{756} = 0.0046$ (ft/ft)
C = 0.25 (Per table 3-1)

$Tc = \mathbf{L}^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $\mathbf{S} = \left(\frac{1000}{CN}\right) - \mathbf{10}$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".

$$S = \left(\frac{1000}{79}\right) - 10 = 2.658$$
$$T_c = 756^{0.8} \frac{(2.658+1)^{0.7}}{1900\sqrt{0.0046}} = 3.86\ hr$$ ←

$i = (0.33 + 0.091144) * (MAP) * (0.249 + 0.1006) * (Ki) * (Tc)^{-0.56253}$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100} = (0.33 + 0.091144)\ x^* (14.8) \times (0.249 + 0.1006) * (3.211) * (3.86)^{-0.56253}$

$I_{100} = 3.2732$ in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area(Table 3-1),
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{100}$ = 0.25 x 3.2732x 1.38 = 1.13 cfs.** ←

**Sub-area Node 200 to Node 201**
**(Subarea A-3)**

A = 0.24 acres L = 191 ft. Open Space $Y = \frac{460.0-457.9}{191} = 0.0110$ (ft/ft)
C = 0.25 (Per table 3-1)

$Tc = L^{0.8}\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , OSP (Open Space-Parks, Trail Ways, etc.). CN = 79, and Service Commercial(SC), CN = 94 for Soil Type "C".

$$S = \left(\frac{1000}{79}\right) - 10 = 2.658$$
$$T_c = 191^{0.8}\frac{(2.658+1)^{0.7}}{1900\sqrt{0.0110}} = 0.8313\ hr$$ ←

i = (0.33 + 0.091144) * (MAP) * (0.249 + 0.1006) * (Ki) * $(Tc)^{-0.56253}$

i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100}$ = (0.33 + 0.091144) * (14.8) * (0.249 + 0.1006) * (3.211) * $(0.8313)^{-0.56253}$
$I_{100}$ = 7.7634 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area(Table 3-1),
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{100}$ = 0.25 x 7.7634 x 0.24 = 0.47 cfs.** ←

$$\sum(SUBAREA\ \text{"A-1"} + SUBAREA\ \text{"A-2"} + SUBARE\ \text{"A-3"}) = 1.14 + 0.47 = 1.67$$

**Total $Q_{100}$ for project site = 1.61 cfs.** ←

## 2.3 10 YEAR HYDROLOGY ANALYSIS

## (PROPOSED CONDITION)

# Post-development Condition

### Sub-area Node 100 to Node 101
### (Subarea A-1) – curb opening to easterly basin

A = 0.51 acres, L = 400 ft. $Y = \frac{460.4 - 456.9}{400} = 0.0088$ (ft/ft)

$Tc = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 400^{0.8} \frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0088}} = 0.9566\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (1.339) * $(0.9566)^{-0.56253}$
$I_{10}$ = 2.9914 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.0104 Ac) + (0.95) (0.4996 Ac) / 0.51 Ac = 0.94
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{10}$ = 0.94x 2.9914 x 0.51 = 1.43cfs.** ←

**Sub-area Node 102 to Node 103**
**(Subarea A-3) – southerly curb opening to westerly basin.**

A = 0.12 acres, L = 127 ft. $Y = \frac{457.6-456.6}{127} = 0.0079$ (ft/ft)

$Tc = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 127^{0.8} \frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0079}} = 0.4032\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (1.339) * $(0.4032)^{-0.56253}$
$I_{10}$ = 4.8633 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.0204Ac) + (0.95) (0.0996 Ac) / 0.12 Ac = 0.83
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{10}$ = 0.83 x 4.8633 x 0.12 = 0.48 cfs.** ←

**Sub-area Node 104 to Node 105**
**(Subarea A-4) - southerly curb opening to westerly basin.**

A = 0.55 acres, L = 483 ft. $Y = \frac{460.4-456.6}{483} = 0.0079$ (ft/ft)

$Tc = L^{0.8}\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 483^{0.8}\frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0079}} = 1.1740\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (1.339) * (1.1740) $^{-0.56253}$
$I_{10}$ = 2.6659 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.0434Ac) + (0.95) (0.5066 Ac) / 0.55 Ac = 0.89
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{10}$ = 0.89 x 2.6659 x 0.55 = 1.30 cfs.** ←

**Sub-area Node 104 to Node 106**
**(Subarea A-1 thru A-5) Total tributary area to Basin # 1 (DMA-1).**

A = 1.49 acres, L = 483 ft. $Y = \frac{460.4-455.0}{535} = 0.0101$ (ft/ft)

$Tc = L^{0.8}\,\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 535^{0.8}\,\frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0101}} = 1.1268\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (1.339) * (1.1268) $^{-0.56253}$
$I_{10}$ = 2.7281 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.2469Ac) + (0.95) (1.2431 Ac) / 1.49 Ac = 0.83
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{10}$ = 0.83 x 2.7281 x 1.49 = 3.37cfs.** ←

**Sub-area Node 107 to Node 108**
**(Subarea A-6) – Driveway entrance**

A = 0.022 acres, L = 37 ft. $Y = \frac{460.4-459.8}{37} = 0.0162$ (ft/ft)

$Tc = L^{0.8}\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where:
Tc = Lag time (hrs.).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft. /ft.).
CN = SCS curve number for the watershed (From Table 3-1, Service Commercial (SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 37^{0.8}\frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0162}} = 0.1050\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = the rainfall intensity (in/hr.).
MAP = Mean Annual Precipitation (Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (1.339) * (0.1050) $^{-0.56253}$
$I_{10}$ = 10.3667 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
i = The rainfall intensity (in/hr.).
A = Drainage area in acres.

**$Q_{10}$ = 0.95 x 10.3667 x 0.022 = 0.22 cfs.** ←

**Sub-area Node 109 to Node 110**
**(Subarea A-7)**

A = 0.104 acres, L = 79 ft. $Y = \frac{460.2-456.3}{79} = 0.0494$ (ft/ft)

$Tc = L^{0.8}\,\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs.).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft.).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 79^{0.8}\,\frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0494}} = 0.1103\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr.).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{10}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (1.339) * $(0.1103)^{-0.56253}$
$I_{10}$ = 10.0834 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs.).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.0698Ac) + (0.95) (0.0354 Ac) / 0.104 Ac = 0.49
i = The rainfall intensity (in/hr.).
A = Drainage area in acres.

**$Q_{10}$ = 0.49 x 10.0834x 0.104 = 0.51 cfs.** ←

$\sum (SUBAREAS$ "A -1" $through$ "A – 7"$)$

**<u>Total $Q_{10}$ for project site = 4.1 cfs.</u>** ←

## 2.4 100 YEAR HYDROLOGY ANALYSIS

## (PROPOSED CONDITION)

**Sub-area Node 100 to Node 101**
**(Subarea A-1) – curb opening to easterly basin**

A = 0.51 acres, L = 400 ft. $Y = \frac{460.4-456.9}{400} = 0.0088$ (ft/ft)

$Tc = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 400^{0.8} \frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0088}} = 0.9566\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (3.211) * (0.9566) $^{-0.56253}$
$I_{100}$ = 7.1739 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.0104 Ac) + (0.95) (0.4996 Ac) / 0.51 Ac = 0.94
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{100}$ = 0.94x 7.1739 x 0.51 = 3.44 cfs.** ←

**Sub-area Node 102 to Node 103**
**(Subarea A-3) – southerly curb opening to westerly basin.**

A = 0.12 acres, L = 127 ft. $Y = \frac{457.6-456.6}{127} = 0.0079$ (ft/ft)

$Tc = L^{0.8}\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 127^{0.8}\frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0079}} = 0.4032\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (3.211) * (0.4032) $^{-0.56253}$
$I_{100}$ = 11.6633 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.0204Ac) + (0.95) (0.0996 Ac) / 0.12 Ac = 0.83
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{100}$ = 0.83 x 11.6633 x 0.12 = 1.16 cfs.** ←

**Sub-area Node 104 to Node 105**
**(Subarea A-4) - southerly curb opening to westerly basin.**

A = 0.55 acres, L = 483 ft. $Y = \frac{460.4-456.6}{483} = 0.0079$ (ft/ft)

$Tc = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 483^{0.8} \frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0079}} = 1.1740\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (3.211) * $(1.1740)^{-0.56253}$
$I_{100}$ = 6.3933 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.0434Ac) + (0.95) (0.5066 Ac) / 0.55 Ac = 0.89
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{100}$ = 0.89 x 6.3933 x 0.55 = 3.13 cfs.** ←

**Sub-area Node 104 to Node 106**
**(Subarea A-1 thru A-5) Total tributary area to Basin # 1 (DMA-1).**

A = 1.49 acres, L = 483 ft. $Y = \frac{460.4-455.0}{535} = 0.0101$ (ft/ft)

$Tc = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 535^{0.8} \frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0101}} = 1.1268\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (3.211) * $(1.1268)^{-0.56253}$
$I_{100}$ = 6.5426 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.2469Ac) + (0.95) (1.2431 Ac) / 1.49 Ac = 0.83
i = The rainfall intensity (in/hr).
A = Drainage area in acres.

**$Q_{100}$ = 0.83 x 6.5426 x 1.49 = 8.09 cfs.** ←

**Sub-area Node 107 to Node 108**
**(Subarea A-6) – Driveway entrance**

A = 0.022 acres, L = 37 ft. $Y = \frac{460.4-459.8}{37} = 0.0162$ (ft/ft)

$Tc = L^{0.8}\,\frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where:
Tc = Lag time (hrs.).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft. /ft.).
CN = SCS curve number for the watershed (From Table 3-1, Service Commercial (SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 37^{0.8}\,\frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0162}} = 0.1050\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = the rainfall intensity (in/hr.).
MAP = Mean Annual Precipitation (Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (3.211) * (0.1050) $^{-0.56253}$
$I_{100}$ = 24.8614in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
i = The rainfall intensity (in/hr.).
A = Drainage area in acres.

**$Q_{100}$ = 0.95 x 24.8614 x 0.022 = 0.52 cfs.** ←

**Sub-area Node 109 to Node 110**
**(Subarea A-7)**

A = 0.104 acres, L = 79 ft. $Y = \frac{460.2-456.3}{79} = 0.0494$ (ft/ft)

$Tc = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$ and $S = \left(\frac{1000}{CN}\right) - 10$

Where :
Tc = Lag time (hrs.).
L = Hydraulic length of the watershed (feet).
S = Maximum retention in the watershed (inch).
Y = Watershed Slope in (ft./ft.).
CN = SCS curve number for the watershed (From Table 3-1 , Service Commercial(SC), CN = 94 for Soil Type "C".

$S = \left(\frac{1000}{94}\right) - 10 = 0.6383$

$T_c = 79^{0.8} \frac{(0.6383+1)^{0.7}}{1900\sqrt{0.0494}} = 0.1103\ hr$ ←

i = (0.33 + 0.091144 * MAP) x (0.249 + 0.1006 *Ki) * $Tc^{-0.56253}$
i = The rainfall intensity (in/hr.).
MAP = Mean Annual Precipitation ( Figure 3-2, inches) = 14.8
Tc = Storm duration (hours)
Ki = Frequency factor (1.339 for 10-year, 3.211 for 100 –year)

$I_{100}$ = (0.33 + 0.091144) * 14.8) * (0.249 + 0.1006) * (3.211) * $(0.1103)^{-0.56253}$
$I_{100}$ = 24.1822 in/hr. ←

Q=CiA
Where:
Q = design peak flow-rate (cfs.).
C = Runoff coefficient for the drainage area (Table 3-1),
C= 0.95 (for SC) , 0.25 (for OSP) soil type "C"
Weighted C = (0.25) (0.0698Ac) + (0.95) (0.0354 Ac) / 0.104 Ac = 0.49
i = The rainfall intensity (in/hr.).
A = Drainage area in acres.

**$Q_{100}$ = 0.49 x 24.1822 x 0.104 = 1.23 cfs.** ←

$\sum (SUBAREAS$ "A -1" $through$ "A − 7"

**Total $Q_{100}$ for project site = 9.84 cfs.** ←

# 3.0 HYDRAULIC ANALYSIS

## 3.1 STREET DEPTH OF FLOW CALCULATION FOR SIZING THE CURB OPENONG AT NODE 101

```
****************************************************************************
              HYDRAULIC ELEMENTS - I  PROGRAM PACKAGE
       (C) Copyright 1982-2012 Advanced Engineering Software (aes)
           Ver. 19.0  Release Date: 06/01/2012  License ID 1537

                      Analysis prepared by:

                   Joseph C. Truxaw & Associates
                     265 S. Anita Dr., Ste. 111
                         Orange, CA  92868


----------------------------------------------------------------------------
 TIME/DATE OF STUDY: 09:50 04/05/2017
============================================================================
 Problem Descriptions:
 STREET DEPTH CALCCULATION FOR SIZING CURB OPENING
 SWC OF LIVERMORE AVE. AND I-580, LIVERMORE, CA
 PROPOSED Q100 STORM EVENT
****************************************************************************
>>>>STREETFLOW MODEL INPUT INFORMATION<<<<
----------------------------------------------------------------------------
    CONSTANT STREET GRADE(FEET/FEET) = 0.004000
    CONSTANT STREET FLOW(CFS) =     3.44
    AVERAGE STREETFLOW FRICTION FACTOR(MANNING) = 0.018000
    CONSTANT SYMMETRICAL STREET HALF-WIDTH(FEET) =   45.00
    DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   43.00
    INTERIOR STREET CROSSFALL(DECIMAL) = 0.017000
    OUTSIDE  STREET CROSSFALL(DECIMAL) = 0.017000
    CONSTANT SYMMETRICAL CURB HEIGHT(FEET) =   0.50
    CONSTANT SYMMETRICAL GUTTER-WIDTH(FEET) =   2.00
    CONSTANT SYMMETRICAL GUTTER-LIP(FEET) =  0.03125
    CONSTANT SYMMETRICAL GUTTER-HIKE(FEET) =  0.16700
    FLOW ASSUMED TO FILL STREET ON ONE SIDE, AND THEN SPLITS
============================================================================
    STREET FLOW MODEL RESULTS:
----------------------------------------------------------------------------
    STREET FLOW DEPTH(FEET) =   0.43 ←
    HALFSTREET FLOOD WIDTH(FEET) =    15.77
    AVERAGE FLOW VELOCITY(FEET/SEC.) =     1.49
    PRODUCT OF DEPTH&VELOCITY =     0.64
============================================================================
```

## 3.2 CURB OPENING SIZE CALCULATION AT NODE 101

```
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                          Analysis prepared by:

                        Joseph C. Truxaw & Associates
                          265 S. Anita Dr., Ste. 111
                              Orange, CA  92868

----------------------------------------------------------------------------
  TIME/DATE OF STUDY: 09:59 04/05/2017
============================================================================
 Problem Descriptions:

 STREET DEPTH CALCCULATION FOR SIZING CURB OPENING
 SWC OF LIVERMORE AVE. AND I-580, LIVERMORE, CA
 PROPOSED Q100 STORM EVENT

****************************************************************************
>>>>FLOWBY CATCH BASIN INLET CAPACITY INPUT INFORMATION<<<<
----------------------------------------------------------------------------


    Curb Inlet Capacities are approximated based on the Bureau of
    Public Roads nomograph plots for flowby basins and sump basins.


    STREETFLOW(CFS) =     3.44
    GUTTER FLOWDEPTH(FEET) =  0.43
    BASIN LOCAL DEPRESSION(FEET) =  0.10

----------------------------------------------------------------------------
         FLOWBY BASIN ANALYSIS RESULTS:

       BASIN WIDTH      FLOW INTERCEPTION
            1.25            0.68
            1.50            0.80
            2.00            1.04
            2.50            1.27
            3.00            1.49
            3.50            1.68
            4.00            1.87
            4.50            2.05
            5.00            2.22
            5.50            2.38
            6.00            2.53
            6.50            2.67
            7.00            2.79
            7.50            2.89
            8.00            2.99
            8.50            3.07
            9.00            3.14
```

| | |
|---|---|
| 9.50 | 3.21 |
| 10.00 | 3.26 |
| 10.50 | 3.31 |
| 11.00 | 3.35 |
| 11.50 | 3.39 |
| 12.00 | 3.42 |
| 12.47 | 3.44 ← |

12.47 TOTAL LENGTH OF CURB OPENING
MIN. 9 - 18" OPENINGS AT 78" CENTER TO CENTER OF THE OPENING
TOTAL LENGTH OF OPENINGS = 13.5'

## 3.3 CURB OPENING SIZE CALCULATION AT NODE 103

```
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                        Analysis prepared by:

                     Joseph C. Truxaw & Associates
                       265 S. Anita Dr., Ste. 111
                           Orange, CA  92868

----------------------------------------------------------------------------
  TIME/DATE OF STUDY: 11:56 04/05/2017
============================================================================
 Problem Descriptions:
  CURB OPENING SIZE CALCULATION AT NODE 103
  SOUTHWEST OF I-580 FREEWAY AND LIVERMORE AVE.
  Q100 STORM EVENT
****************************************************************************
>>>>SUMP TYPE BASIN INPUT INFORMATION<<<<
----------------------------------------------------------------------------

    Curb Inlet Capacities are approximated based on the Bureau of
    Public Roads nomograph plots for flowby basins and sump basins.

    BASIN INFLOW(CFS) =     1.16
    BASIN OPENING(FEET) =  0.60
    DEPTH OF WATER(FEET) =  0.50

    >>>>CALCULATED ESTIMATED SUMP BASIN WIDTH(FEET) =       1.06 ←

============================================================================
```

**USE 2.0' CURB OPENING AT NODE 103**

## 3.4 CURB OPENING SIZE CALCULATION AT NOD 105

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

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                         265 S. Anita Dr., Ste. 111
                             Orange, CA  92868

 ----------------------------------------------------------------------------
   TIME/DATE OF STUDY: 11:58 04/05/2017
 ============================================================================
Problem Descriptions:
   CURB OPENING SIZE CALCULATION AT NODE 105
   SOUTHWEST OF I-580 FREEWAY AND LIVERMORE AVE.
   Q100 STORM EVENT

 ****************************************************************************
 >>>>SUMP TYPE BASIN INPUT INFORMATION<<<<
 ----------------------------------------------------------------------------


     Curb Inlet Capacities are approximated based on the Bureau of
     Public Roads nomograph plots for flowby basins and sump basins.


     BASIN INFLOW(CFS) =     3.13
     BASIN OPENING(FEET) =  0.60
     DEPTH OF WATER(FEET) =  0.50

     >>>>CALCULATED ESTIMATED SUMP BASIN WIDTH(FEET) =       2.87

 ============================================================================
```

**USE 3.0' CURB OPENING AT NODE 105**

## 3.5
## DEPTH OF PONDING OVER PROPOSED GRATED INLETS # 1 AND # 2 IN BASIN 1

Q100 = C A $\sqrt{2Gh}$

A = Area of 36" by 36" opening → 50% opening = 9 /2 = 4.5 sq-ft.

Assumed 50% clogging factor → 4.5 / 2 = 2.25 sf.
A = 2.25 sf
G = 32.2
C = 0.67
h = depth of water over the grated inlet

Total $Q_{100}$ = 8.09 cfs 8.09 / 2 = 4.05 cfs per each grated inlet 1 and 2.

4.05 = 0.67 X 2.25 $\sqrt{2X\ 32.2\ X\ h}$

h = 0.11 ft. ← Depth of ponding over the each grated inlet .

## 3.6
## DEPTH OF PONDING OVER PROPOSED GRATED INLET # 3 AT NODE 108

Q100 = C A $\sqrt{2Gh}$

A = Area of existing 24" by 24" opening → 50% opening = 4 /2 = 2 sq-ft.

Assumed 50% clogging factor → 2 / 2 = 1.0 sf.
A = 1.0 sf
G = 32.2
C = 0.67
h = depth of water over the grated inlet

$Q_{100}$ = 0.52 cfs

0.52 = 0.67 X 1.0 $\sqrt{2X\ 32.2\ X\ h}$

h = 0.00094 ft. ← Depth of ponding over the grated inlet .

## 3.7 DEPTH OF PONDING OVER PROPOSED GRATED INLET # 4 AT NODE 110

$Q100 = C\ A\sqrt{2Gh}$

A = Area of existing 24" by 24" opening → 50% opening = 4 /2 = 2 sq-ft.

Assumed 50% clogging factor → 2 / 2 = 1.0 sf.
A = 1.0 sf
G = 32.2
C = 0.67
h = depth of water over the grated inlet

$Q_{100}$ = 1.23 cfs

$1.23 = 0.67\ X\ 1.0\sqrt{2X\ 32.2\ X\ h}$

h = 0.052 ft. ← Depth of ponding over the grated inlet .

## 3.8 BIOFILTRATION WITH UNDERDRAIN PIPE SIZE CALCULATION

### REQUIRED STORAGE VOLUME

Required Storage Volumes were calculated using the Alameda County Clean Water Program C3 Sizing Calculator for Volume and Flow Based. See attached worksheets for calculations.

**DMA-1**
Line 3-3, Required Capture Volume = 2,679 cu.ft.
Line 8-1, Final Surface Area of Treatment = 1,577 s.f.

**DMA-2**
Line 3-3, Required Capture Volume = 167 cu.ft.
Line 8-1, Final Surface Area of Treatment = 98 s.f.

### PROVIDED STORAGE VOLUME

*VOLUME CALCULATIONS*

Ponding Volume above Basin
Volume = Surface Area x Ponding Depth
Volume in Engineered Soil
Volume = Surface Area x Soil Depth x Void Area
Volume in Gravel
Volume = Surface Area x Gravel Depth x Void Area
Total Volume = Ponding Volume + Engineered Soil Volume + Gravel Volume

**DMA-1**
***Northerly Basin***

| | AREA (s.f.) | DEPTH (ft.) | VOID (%) | VOLUME (cu.ft.) |
|---|---|---|---|---|
| PONDING | 647 | 0.5 | - | **324** |
| ENGR. SOIL | 647 | 1.5 | 0.15 | **146** |
| GRAVEL | 647 | 1.17 | 0.35 | **265** |

Total Northerly Basin Volume Provided = 324 + 146 + 265 = 735 cu.ft.

***Westerly Basin***

| | AREA (s.f.) | DEPTH (ft.) | VOID (%) | VOLUME (cu.ft.) |
|---|---|---|---|---|
| PONDING | 2,033 | 0.5 | - | **1,017** |
| ENGR. SOIL | 2,033 | 1.5 | 0.15 | **451** |
| GRAVEL | 2,033 | 1.17 | 0.35 | **833** |

Total Westerly Basin Volume Provided = 1,017 + 451 + 833 = 2,301 cu.ft.

**Total Volume Provided for DMA-1 = 735 + 2,301 = 3,036 cu.ft.**

**Total Surface Area Provided for DMA-1= 647 + 2,033 = 2,680 s.f.**

**DMA-2**

| | AREA (s.f.) | DEPTH (ft.) | VOID (%) | VOLUME (cu.ft.) |
|---|---|---|---|---|
| PONDING | 401 | 0.5 | - | **201** |
| ENGR. SOIL | 401 | 1.5 | 0.15 | **90** |
| GRAVEL | 401 | 1.17 | 0.35 | **164** |

Total Basin Volume Provided = 201 + 90 + 164 = 455 cu.ft.

**Total Volume Provided for DMA-2 = 455 cu.ft.**

**Total Area Provided for DMA-2 = 401 s.f.**

**REQUIRED vs. PROVIDED**

**DMA-1**
Volume: 3,036 cu.ft. (provided) > 2,679 cu.ft. (required) **OK**
Area: 2,680 s.f. (provided) > 1,577 s.f. (required) **OK**

**DMA-2**
Volume: 455 cu.ft. (provided) > 167 cu.ft. (required) **OK**
Area: 401 s.f. (provided) > 98 s.f. (required) **OK**

# Worksheet for Calculating the Combination Flow and Volume Method

*Instructions: After completing Section 1, make a copy of this Excel file for each Drainage Management Area within the project. Enter information specific to the project and DMA in the cells shaded in yellow. Cells shaded in light blue contain formulas and values that will be automatically calculated.*

## 1.0 Project Information

The calculations presented here are based on the combination flow and volume hydraulic sizing method provided in the Clean Water Program Alameda County C.3 Technical Guidance, Version 4.0. The steps presented below are explained in Chapter 5, Section 5.1 of the guidance manual, applicable portions of which are included in this file, in the tab called "Guidance from Chapter 5".

| | | | |
|---|---|---|---|
| 1-1 | Project Name: | Chick-Fil-A No. 3805 | |
| 1-2 | City application ID: | | |
| 1-3 | Site Address or APN: | 04, 099-0100-051-01 & Portion of 099-100-003-05 | |
| 1-4 | Tract or Parcel Map No: | 6462 | |
| 1-5 | Site Mean Annual Precip. (MAP)[1] | 14.8 | Inches |

*Refer to the Mean Annual Precipitation Map in Appendix D of the C.3 Technical Guidance to determine the MAP, in inches, for the site.* Click here for map

1-6 Applicable Rain Gauge[2] San Jose

*Enter "Oakland Airport" if the site MAP is 16.4 inches or greater. Enter "San Jose" if the site MAP is less than 16.4 inches.*

*MAP adjustment factor is automatically calculated as:* 1.03

*(The "Site Mean Annual Precipitation (MAP)" is divided by the MAP for the applicable rain gauge, showin in Table 5.2, below.)*

## 2.0 Calculate Percentage of Impervious Surface for Drainage Management Area (DMA)

2-1 Name of DMA: DMA-1

For items 2-2 and 2-3, enter the areas in square feet for each type of surface within the DMA.

| | Type of Surface | Area of surface type within DMA (Sq. Ft) | Adjust Pervious Surface | Effective Impervious Area |
|---|---|---|---|---|
| 2-2 | Impervious surface | 54,842 | 1.0 | 54,842 |
| 2-3 | Pervious service | 10,062 | 0.1 | 1,006 |
| | *Total DMA Area (square feet) =* | 64,904 | | |

2-4 *Total Effective Impervious Area (EIA)* 55,848 Square feet

## 3.0 Calculate Unit Basin Storage Volume in Inches

| Table 5-2: Unit Basin Storage Volumes (in inches) for 80 Percent Capture Using 48-Hour Drawdowns | | |
|---|---|---|
| | | Unit Basin Storage Volume (in) for Applicable Runoff Coefficients |
| Applicable Rain Gauge | Mean Annual Precipitation (in) | Coefficient of 1.00 |
| Oakland Airport | 18.35 | 0.67 |
| San Jose | 14.4 | 0.56 |

3-1 *Unit basin storage volume from Table 5.2:* 0.56 Inches

*(The coefficient for this method is 1.00, due to the conversion of any landscaping to effective impervious area)*

3-2 *Adjusted unit basin storage volume:* 0.58 Inches

*(The unit basin storage volume is adjusted by applying the MAP adjustment factor.)*

3-3 *Required Capture Volume (in cubic feet):* 2,679 Cubic feet

*(The adjusted unit basin sizing volume [inches] is multiplied by the size of the DMA and converted to feet)*

## 4.0 Calculate the Duration of the Rain Event

| | | | |
|---|---|---|---|
| 4-1 | Rainfall intensity | 0.2 | Inches per hour |
| 4-2 | Divide Item 3-2 by Item 4-1 | 2.88 | Hours of Rain Event Duration |

## 5.0 Preliminary Estimate of Surface Area of Treatment Measure

| | | | |
|---|---|---|---|
| 5-1 | 4% of DMA impervious surface | 2,234 | Square feet |
| 5-2 | Area 25% smaller than item 5-1 | 1,675 | Square feet |
| 5-3 | Volume of treated runoff for area in Item 5-2 | 2,009 | Cubic feet (Item 5-2 * 5 inches per hour * 1/12 * Item 4-2) |

## 6.0 Initial Adjustment of Depth of Surface Ponding Area

| | | | |
|---|---|---|---|
| 6-1 | Subtract Item 5-3 from Item 3-3 | 670 | Cubic feet (Amount of runoff to be stored in ponding area) |
| 6-2 | Divide Item 6-1 by Item 5-2 | 0.4 | Feet (Depth of stored runoff in surface ponding area) |
| 6-3 | Convert Item 6-2 from ft to inches | 4.8 | Inches (Depth of stored runoff in surface ponding area) |

6-4 If ponding depth in Item 6-3 meets your target depth, skip to Item 8-1. If not, continue to Step 7-1.

## 7.0 Optimize Size of Treatment Measure

| | | | |
|---|---|---|---|
| 7-1 | Enter an area larger or smaller than Item 5-2 | 1577 | Sq.ft. (enter larger area if you need less ponding depth; smaller for more depth.) |
| 7-2 | Volume of treated runoff for area in Item 7-1 | 1,891 | Cubic feet (Item 7-1 * 5 inches per hour * 1/12 * Item 4-2) |
| 7-3 | Subtract Item 7-2 from Item 3-3 | 788 | Cubic feet (Amount of runoff to be stored in ponding area) |
| 7-4 | Divide Item 7-3 by Item 7-1 | 0.50 | Feet (Depth of stored runoff in surface ponding area) |
| 7-5 | Convert Item 7-4 from feet to inches | 5.99 | Inches (Depth of stored runoff in surface ponding area) |

7-6 If the ponding depth in Item 7-5 meets target, stop here. If not, repeat Steps 7-1 through 7-5 until you obtain target depth.

## 8.0 Surface Area of Treatment Measure for DMA

8-1 Final surface area of treatment* 1,577 Square feet (Either Item 5-2 or final amount in Item 7-1)

**Note: Check with the local jurisdiction as to its policy regarding the minimum biotreatment surface area allowed.*

# Worksheet for Calculating the Combination Flow and Volume Method

*Instructions: After completing Section 1, make a copy of this Excel file for each Drainage Management Area within the project. Enter information specific to the project and DMA in the cells shaded in yellow. Cells shaded in light blue contain formulas and values that will be automatically calculated.*

## 1.0 Project Information

The calculations presented here are based on the combination flow and volume hydraulic sizing method provided in the Clean Water Program Alameda County C.3 Technical Guidance, Version 4.0. The steps presented below are explained in Chapter 5, Section 5.1 of the guidance manual, applicable portions of which are included in this file, in the tab called "Guidance from Chapter 5".

1-1 Project Name: Chick-Fil-A No. 3805

1-2 City application ID:

1-3 Site Address or APN: 04, 099-0100-051-01 & Portion of 099-100-003-05

1-4 Tract or Parcel Map No: 6462

1-5 Site Mean Annual Precip. (MAP)[1] 14.8 Inches

*Refer to the Mean Annual Precipitation Map in Appendix D of the C.3 Technical Guidance to determine the MAP, in inches, for the site.* Click here for map

1-6 Applicable Rain Gauge[2] San Jose

*Enter "Oakland Airport" if the site MAP is 16.4 inches or greater. Enter "San Jose" if the site MAP is less than 16.4 inches.*

***MAP adjustment factor is automatically calculated as:*** 1.03

*(The "Site Mean Annual Precipitation (MAP)" is divided by the MAP for the applicable rain gauge, shown in Table 5.2, below.)*

## 2.0 Calculate Percentage of Impervious Surface for Drainage Management Area (DMA)

2-1 Name of DMA: DMA-2

For items 2-2 and 2-3, enter the areas in square feet for each type of surface within the DMA.

| | Type of Surface | Area of surface type within DMA (Sq. Ft) | Adjust Pervious Surface | Effective Impervious Area |
|---|---|---|---|---|
| 2-2 | Impervious surface | 3,354 | 1.0 | 3,354 |
| 2-3 | Pervious service | 1,176 | 0.1 | 118 |
| | *Total DMA Area (square feet) =* | 4,530 | | |

2-4 ***Total Effective Impervious Area (EIA)*** 3,472 Square feet

## 3.0 Calculate Unit Basin Storage Volume in Inches

| Table 5-2: Unit Basin Storage Volumes (in inches) for 80 Percent Capture Using 48-Hour Drawdowns | | |
|---|---|---|
| | | Unit Basin Storage Volume (in) for Applicable Runoff Coefficients |
| Applicable Rain Gauge | Mean Annual Precipitation (in) | Coefficient of 1.00 |
| Oakland Airport | 18.35 | 0.67 |
| San Jose | 14.4 | 0.56 |

3-1 ***Unit basin storage volume from Table 5.2:*** 0.56 Inches

*(The coefficient for this method is 1.00, due to the conversion of any landscaping to effective impervious area)*

3-2 ***Adjusted unit basin storage volume:*** 0.58 Inches

*(The unit basin storage volume is adjusted by applying the MAP adjustment factor.)*

3-3 ***Required Capture Volume (in cubic feet):*** 167 Cubic feet

*(The adjusted unit basin sizing volume [inches] is multiplied by the size of the DMA and converted to feet)*

## 4.0 Calculate the Duration of the Rain Event

| | | | |
|---|---|---|---|
| 4-1 | Rainfall intensity | 0.2 | Inches per hour |
| 4-2 | Divide Item 3-2 by Item 4-1 | 2.88 | Hours of Rain Event Duration |

## 5.0 Preliminary Estimate of Surface Area of Treatment Measure

| | | | |
|---|---|---|---|
| 5-1 | 4% of DMA impervious surface | 139 | Square feet |
| 5-2 | Area 25% smaller than item 5-1 | 104 | Square feet |
| 5-3 | Volume of treated runoff for area in Item 5-2 | 125 | Cubic feet (Item 5-2 * 5 inches per hour * 1/12 * Item 4-2) |

## 6.0 Initial Adjustment of Depth of Surface Ponding Area

| | | | |
|---|---|---|---|
| 6-1 | Subtract Item 5-3 from Item 3-3 | 42 | Cubic feet (Amount of runoff to be stored in ponding area) |
| 6-2 | Divide Item 6-1 by Item 5-2 | 0.4 | Feet (Depth of stored runoff in surface ponding area) |
| 6-3 | Convert Item 6-2 from ft to inches | 4.8 | Inches (Depth of stored runoff in surface ponding area) |

6-4 If ponding depth in Item 6-3 meets your target depth, skip to Item 8-1. If not, continue to Step 7-1.

## 7.0 Optimize Size of Treatment Measure

| | | | |
|---|---|---|---|
| 7-1 | Enter an area larger or smaller than Item 5-2 | 98 | Sq.ft. (enter larger area if you need less ponding depth; smaller for more depth.) |
| 7-2 | Volume of treated runoff for area in Item 7-1 | 118 | Cubic feet (Item 7-1 * 5 inches per hour * 1/12 * Item 4-2) |
| 7-3 | Subtract Item 7-2 from Item 3-3 | 49 | Cubic feet (Amount of runoff to be stored in ponding area) |
| 7-4 | Divide Item 7-3 by Item 7-1 | 0.50 | Feet (Depth of stored runoff in surface ponding area) |
| 7-5 | Convert Item 7-4 from feet to inches | 6.00 | Inches (Depth of stored runoff in surface ponding area) |

7-6 If the ponding depth in Item 7-5 meets target, stop here. If not, repeat Steps 7-1 through 7-5 until you obtain target depth.

## 8.0 Surface Area of Treatment Measure for DMA

8-1 Final surface area of treatment* 98 Square feet (Either Item 5-2 or final amount in Item 7-1)

**Note: Check with the local jurisdiction as to its policy regarding the minimum biotreatment surface area allowed.*

## 3.9 BAHM 2013 SITE ANALYSIS

# BAHM2013

# PROJECT REPORT

# General Model Information

| | |
|---|---|
| Project Name: | TEST |
| Site Name: | CFA16005 |
| Site Address: | LIVERMORE AVE. |
| City: | LIVERMORE |
| Report Date: | 7/31/2017 |
| Gage: | LIVERMORE |
| Data Start: | 1959/10/01 |
| Data End: | 2004/09/30 |
| Timestep: | Hourly |
| Precip Scale: | 0.000 (adjusted) |
| Version Date: | 2016/11/23 |

## *POC Thresholds*

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

*Landuse Basin Data*
*Predeveloped Land Use*

Basin 1

| | |
|---|---|
| Bypass: | No |
| GroundWater: | No |
| Pervious Land Use | acre |
| C D,Grass,Flat(0-5%) | 1.69 |
| Pervious Total | 1.69 |
| Impervious Land Use | acre |
| Impervious Total | 0 |
| Basin Total | 1.69 |

Element Flows To:

| Surface | Interflow | Groundwater |
|---|---|---|

## *Mitigated Land Use*

### Basin 1

| | |
|---|---|
| Bypass: | No |
| GroundWater: | No |
| Pervious Land Use | acre |
| C D,Grass,Flat(0-5%) | 0.2867 |
| Pervious Total | 0.2867 |
| Impervious Land Use | acre |
| Roof Area | 0.1064 |
| Driveways,Flat(0-5%) | 1.0051 |
| Sidewalks,Flat(0-5%) | 0.0918 |
| Impervious Total | 1.2033 |
| Basin Total | 1.49 |

Element Flows To:

| Surface | Interflow | Groundwater |
|---|---|---|
| Surface retention 1 | Surface retention 1 | |

## Basin 3

| | |
|---|---|
| Bypass: | No |
| GroundWater: | No |
| Pervious Land Use | acre |
| C D,Grass,Flat(0-5%) | 0.0686 |
| Pervious Total | 0.0686 |
| Impervious Land Use | acre |
| Driveways,Flat(0-5%) | 0.022 |
| Sidewalks,Flat(0-5%) | 0.0354 |
| Impervious Total | 0.0574 |
| Basin Total | 0.126 |

Element Flows To:

| Surface | Interflow | Groundwater |
|---|---|---|
| Surface retention 3 | Surface retention 3 | |

# *Routing Elements*
## *Predeveloped Routing*

## *Mitigated Routing*

### Bioretention 1

| | | |
|---|---|---|
| Bottom Length: | | 134.11 ft. |
| Bottom Width: | | 20.00 ft. |
| Material thickness of first layer: | | 1.5 |
| Material type for first layer: | | BAHM 5 |
| Material thickness of second layer: | | 1.17 |
| Material type for second layer: | | GRAVEL |
| Material thickness of third layer: | | 0 |
| Material type for third layer: | | GRAVEL |
| Underdrain used | | |
| Underdrain Diameter (feet): | | 0.5 |
| Orifice Diameter (in.): | | 6 |
| Offset (in.): | | 6 |
| Flow Through Underdrain (ac-ft.): | | 52.178 |
| Total Outflow (ac-ft.): | | 52.402 |
| Percent Through Underdrain: | | 99.57 |
| Discharge Structure | | |
| Riser Height: | 1 ft. | |
| Riser Diameter: | 40.62 in. | |
| Element Flows To: | | |
| Outlet 1 | Outlet 2 | |



Bioretention Hydraulic Table

| Stage(feet) | Area(ac.) | Volume(ac-ft.) | Discharge(cfs) | Infilt(cfs) |
|---|---|---|---|---|
| 452.33 | 0.0616 | 0.0000 | 0.0000 | 0.0000 |
| 452.38 | 0.0616 | 0.0011 | 0.0000 | 0.0000 |
| 452.43 | 0.0616 | 0.0022 | 0.0000 | 0.0000 |
| 452.47 | 0.0616 | 0.0033 | 0.0000 | 0.0000 |
| 452.52 | 0.0616 | 0.0045 | 0.0000 | 0.0000 |
| 452.57 | 0.0616 | 0.0056 | 0.0000 | 0.0000 |
| 452.62 | 0.0616 | 0.0067 | 0.0000 | 0.0000 |
| 452.66 | 0.0616 | 0.0078 | 0.0000 | 0.0000 |
| 452.71 | 0.0616 | 0.0089 | 0.0000 | 0.0000 |
| 452.76 | 0.0616 | 0.0100 | 0.0000 | 0.0000 |
| 452.81 | 0.0616 | 0.0112 | 0.0000 | 0.0000 |
| 452.85 | 0.0616 | 0.0123 | 0.0000 | 0.0000 |
| 452.90 | 0.0616 | 0.0134 | 0.0000 | 0.0000 |
| 452.95 | 0.0616 | 0.0145 | 0.0000 | 0.0000 |
| 453.00 | 0.0616 | 0.0156 | 0.0000 | 0.0000 |
| 453.05 | 0.0616 | 0.0167 | 0.0000 | 0.0000 |
| 453.09 | 0.0616 | 0.0179 | 0.0000 | 0.0000 |
| 453.14 | 0.0616 | 0.0190 | 0.0000 | 0.0000 |
| 453.19 | 0.0616 | 0.0201 | 0.0000 | 0.0000 |
| 453.24 | 0.0616 | 0.0212 | 0.0000 | 0.0000 |
| 453.28 | 0.0616 | 0.0223 | 0.0000 | 0.0000 |
| 453.33 | 0.0616 | 0.0234 | 0.0000 | 0.0000 |
| 453.38 | 0.0616 | 0.0246 | 0.0000 | 0.0000 |
| 453.43 | 0.0616 | 0.0257 | 0.0000 | 0.0000 |
| 453.47 | 0.0616 | 0.0268 | 0.0000 | 0.0000 |
| 453.52 | 0.0616 | 0.0279 | 0.0000 | 0.0000 |
| 453.57 | 0.0616 | 0.0290 | 0.0000 | 0.0000 |
| 453.62 | 0.0616 | 0.0301 | 0.0000 | 0.0000 |
| 453.67 | 0.0616 | 0.0312 | 0.0000 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| 453.71 | 0.0616 | 0.0324 | 0.0000 | 0.0000 |
| 453.76 | 0.0616 | 0.0335 | 0.0000 | 0.0000 |
| 453.81 | 0.0616 | 0.0346 | 0.0000 | 0.0000 |
| 453.86 | 0.0616 | 0.0358 | 0.0000 | 0.0000 |
| 453.90 | 0.0616 | 0.0370 | 0.0000 | 0.0000 |
| 453.95 | 0.0616 | 0.0382 | 0.0000 | 0.0000 |
| 454.00 | 0.0616 | 0.0395 | 0.0000 | 0.0000 |
| 454.05 | 0.0616 | 0.0407 | 0.0000 | 0.0000 |
| 454.09 | 0.0616 | 0.0419 | 0.0000 | 0.0000 |
| 454.14 | 0.0616 | 0.0431 | 0.0000 | 0.0000 |
| 454.19 | 0.0616 | 0.0443 | 0.0000 | 0.0000 |
| 454.24 | 0.0616 | 0.0456 | 0.0000 | 0.0000 |
| 454.29 | 0.0616 | 0.0468 | 0.0000 | 0.0000 |
| 454.33 | 0.0616 | 0.0480 | 0.0000 | 0.0000 |
| 454.38 | 0.0616 | 0.0492 | 0.0000 | 0.0000 |
| 454.43 | 0.0616 | 0.0504 | 0.0000 | 0.0000 |
| 454.48 | 0.0616 | 0.0517 | 0.0000 | 0.0000 |
| 454.52 | 0.0616 | 0.0529 | 0.0000 | 0.0000 |
| 454.57 | 0.0616 | 0.0541 | 0.0000 | 0.0000 |
| 454.62 | 0.0616 | 0.0553 | 0.0000 | 0.0000 |
| 454.67 | 0.0616 | 0.0565 | 0.0000 | 0.0000 |
| 454.71 | 0.0616 | 0.0577 | 0.0000 | 0.0000 |
| 454.76 | 0.0616 | 0.0590 | 0.0000 | 0.0000 |
| 454.81 | 0.0616 | 0.0602 | 0.0000 | 0.0000 |
| 454.86 | 0.0616 | 0.0614 | 0.0000 | 0.0000 |
| 454.91 | 0.0616 | 0.0626 | 0.0000 | 0.0000 |
| 454.95 | 0.0616 | 0.0638 | 0.0000 | 0.0000 |
| 455.00 | 0.0616 | 0.0650 | 0.0000 | 0.0000 |

Bioretention Hydraulic Table

| Stage(feet) | Area(ac.) | Volume(ac-ft.) | Discharge(cfs) | To Amended(cfs) | Infilt(cfs) |
|---|---|---|---|---|---|
| 2.6700 | 0.0616 | 0.0650 | 0.0000 | 0.3104 | 0.0000 |
| 2.7177 | 0.0625 | 0.0680 | 0.0000 | 0.3104 | 0.0000 |
| 2.7654 | 0.0633 | 0.0710 | 0.0000 | 0.3104 | 0.0000 |
| 2.8131 | 0.0642 | 0.0740 | 0.0000 | 0.3104 | 0.0000 |
| 2.8608 | 0.0651 | 0.0771 | 0.0000 | 0.3104 | 0.0000 |
| 2.9085 | 0.0660 | 0.0803 | 0.0000 | 0.3104 | 0.0000 |
| 2.9562 | 0.0669 | 0.0834 | 0.0000 | 0.3104 | 0.0000 |
| 3.0038 | 0.0677 | 0.0866 | 0.0000 | 0.3104 | 0.0000 |
| 3.0515 | 0.0686 | 0.0899 | 0.0000 | 0.3104 | 0.0000 |
| 3.0992 | 0.0695 | 0.0932 | 0.0000 | 0.3104 | 0.0000 |
| 3.1469 | 0.0704 | 0.0965 | 0.0000 | 0.3104 | 0.0000 |
| 3.1946 | 0.0713 | 0.0999 | 0.0000 | 0.3104 | 0.0000 |
| 3.2423 | 0.0721 | 0.1033 | 0.0000 | 0.3104 | 0.0000 |
| 3.2900 | 0.0730 | 0.1068 | 0.0000 | 0.3104 | 0.0000 |
| 3.3377 | 0.0739 | 0.1103 | 0.0000 | 0.3104 | 0.0000 |
| 3.3854 | 0.0748 | 0.1138 | 0.0000 | 0.3104 | 0.0000 |
| 3.4331 | 0.0757 | 0.1174 | 0.0000 | 0.3104 | 0.0000 |
| 3.4808 | 0.0766 | 0.1210 | 0.0000 | 0.3104 | 0.0000 |
| 3.5285 | 0.0774 | 0.1247 | 0.0000 | 0.3104 | 0.0000 |
| 3.5762 | 0.0783 | 0.1284 | 0.0000 | 0.3104 | 0.0000 |
| 3.6238 | 0.0792 | 0.1322 | 0.0000 | 0.3104 | 0.0000 |
| 3.6715 | 0.0801 | 0.1360 | 0.0000 | 0.3104 | 0.0000 |
| 3.7192 | 0.0810 | 0.1398 | 0.0000 | 0.3104 | 0.0000 |
| 3.7669 | 0.0818 | 0.1437 | 0.0000 | 0.3104 | 0.0000 |
| 3.8146 | 0.0827 | 0.1476 | 0.0350 | 0.3104 | 0.0000 |
| 3.8623 | 0.0836 | 0.1516 | 0.0383 | 0.3104 | 0.0000 |
| 3.9100 | 0.0845 | 0.1556 | 0.0456 | 0.3104 | 0.0000 |

| | | | | | |
|---|---|---|---|---|---|
| 3.9577 | 0.0854 | 0.1596 | 0.0538 | 0.3104 | 0.0000 |
| 4.0054 | 0.0862 | 0.1637 | 0.0627 | 0.3104 | 0.0000 |
| 4.0531 | 0.0871 | 0.1679 | 0.0725 | 0.3104 | 0.0000 |
| 4.1008 | 0.0880 | 0.1720 | 0.0775 | 0.3104 | 0.0000 |
| 4.1485 | 0.0889 | 0.1763 | 0.0947 | 0.3104 | 0.0000 |
| 4.1962 | 0.0898 | 0.1805 | 0.1009 | 0.3104 | 0.0000 |
| 4.2438 | 0.0906 | 0.1848 | 0.1138 | 0.3104 | 0.0000 |
| 4.2915 | 0.0915 | 0.1892 | 0.1277 | 0.3104 | 0.0000 |
| 4.3392 | 0.0924 | 0.1936 | 0.1426 | 0.3104 | 0.0000 |
| 4.3400 | 0.0924 | 0.1936 | 0.1585 | 0.3104 | 0.0000 |

## Surface retention 1

Element Flows To:

| | |
|---|---|
| Outlet 1 | Outlet 2 |
| Tank 1 | Bioretention 1 |

## Bioretention 3

| | |
|---|---|
| Bottom Length: | 20.00 ft. |
| Bottom Width: | 20.04 ft. |
| Material thickness of first layer: | 1.5 |
| Material type for first layer: | BAHM 5 |
| Material thickness of second layer: | 1.17 |
| Material type for second layer: | GRAVEL |
| Material thickness of third layer: | 0 |
| Material type for third layer: | GRAVEL |
| Underdrain used | |
| Underdrain Diameter (feet): | 0.5 |
| Orifice Diameter (in.): | 6 |
| Offset (in.): | 6 |
| Flow Through Underdrain (ac-ft.): | 2.835 |
| Total Outflow (ac-ft.): | 2.835 |
| Percent Through Underdrain: | 99.99 |

Discharge Structure
Riser Height: 1 ft.
Riser Diameter: 27.08 in.
Element Flows To:
Outlet 1 Outlet 2



Bioretention Hydraulic Table

| Stage(feet) | Area(ac.) | Volume(ac-ft.) | Discharge(cfs) | Infilt(cfs) |
|---|---|---|---|---|
| 456.04 | 0.0092 | 0.0000 | 0.0000 | 0.0000 |
| 456.09 | 0.0092 | 0.0002 | 0.0000 | 0.0000 |
| 456.13 | 0.0092 | 0.0003 | 0.0000 | 0.0000 |
| 456.18 | 0.0092 | 0.0005 | 0.0000 | 0.0000 |
| 456.22 | 0.0092 | 0.0006 | 0.0000 | 0.0000 |
| 456.27 | 0.0092 | 0.0008 | 0.0000 | 0.0000 |
| 456.31 | 0.0092 | 0.0010 | 0.0000 | 0.0000 |
| 456.36 | 0.0092 | 0.0011 | 0.0000 | 0.0000 |
| 456.41 | 0.0092 | 0.0013 | 0.0000 | 0.0000 |
| 456.45 | 0.0092 | 0.0014 | 0.0000 | 0.0000 |
| 456.50 | 0.0092 | 0.0016 | 0.0000 | 0.0000 |
| 456.54 | 0.0092 | 0.0018 | 0.0000 | 0.0000 |
| 456.59 | 0.0092 | 0.0019 | 0.0000 | 0.0000 |
| 456.64 | 0.0092 | 0.0021 | 0.0000 | 0.0000 |
| 456.68 | 0.0092 | 0.0022 | 0.0000 | 0.0000 |
| 456.73 | 0.0092 | 0.0024 | 0.0000 | 0.0000 |
| 456.77 | 0.0092 | 0.0026 | 0.0000 | 0.0000 |
| 456.82 | 0.0092 | 0.0027 | 0.0000 | 0.0000 |
| 456.86 | 0.0092 | 0.0029 | 0.0000 | 0.0000 |
| 456.91 | 0.0092 | 0.0030 | 0.0000 | 0.0000 |
| 456.96 | 0.0092 | 0.0032 | 0.0000 | 0.0000 |
| 457.00 | 0.0092 | 0.0034 | 0.0000 | 0.0000 |
| 457.05 | 0.0092 | 0.0035 | 0.0000 | 0.0000 |
| 457.09 | 0.0092 | 0.0037 | 0.0000 | 0.0000 |
| 457.14 | 0.0092 | 0.0038 | 0.0000 | 0.0000 |
| 457.19 | 0.0092 | 0.0040 | 0.0000 | 0.0000 |
| 457.23 | 0.0092 | 0.0042 | 0.0000 | 0.0000 |
| 457.28 | 0.0092 | 0.0043 | 0.0000 | 0.0000 |
| 457.32 | 0.0092 | 0.0045 | 0.0000 | 0.0000 |
| 457.37 | 0.0092 | 0.0046 | 0.0000 | 0.0000 |
| 457.41 | 0.0092 | 0.0048 | 0.0000 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| 457.46 | 0.0092 | 0.0050 | 0.0000 | 0.0000 |
| 457.51 | 0.0092 | 0.0051 | 0.0000 | 0.0000 |
| 457.55 | 0.0092 | 0.0053 | 0.0000 | 0.0000 |
| 457.60 | 0.0092 | 0.0055 | 0.0000 | 0.0000 |
| 457.64 | 0.0092 | 0.0057 | 0.0000 | 0.0000 |
| 457.69 | 0.0092 | 0.0058 | 0.0000 | 0.0000 |
| 457.74 | 0.0092 | 0.0060 | 0.0000 | 0.0000 |
| 457.78 | 0.0092 | 0.0062 | 0.0000 | 0.0000 |
| 457.83 | 0.0092 | 0.0064 | 0.0000 | 0.0000 |
| 457.87 | 0.0092 | 0.0065 | 0.0000 | 0.0000 |
| 457.92 | 0.0092 | 0.0067 | 0.0000 | 0.0000 |
| 457.96 | 0.0092 | 0.0069 | 0.0000 | 0.0000 |
| 458.01 | 0.0092 | 0.0071 | 0.0000 | 0.0000 |
| 458.06 | 0.0092 | 0.0072 | 0.0000 | 0.0000 |
| 458.10 | 0.0092 | 0.0074 | 0.0000 | 0.0000 |
| 458.15 | 0.0092 | 0.0076 | 0.0000 | 0.0000 |
| 458.19 | 0.0092 | 0.0078 | 0.0000 | 0.0000 |
| 458.24 | 0.0092 | 0.0079 | 0.0000 | 0.0000 |
| 458.29 | 0.0092 | 0.0081 | 0.0000 | 0.0000 |
| 458.33 | 0.0092 | 0.0083 | 0.0000 | 0.0000 |
| 458.38 | 0.0092 | 0.0085 | 0.0000 | 0.0000 |
| 458.42 | 0.0092 | 0.0086 | 0.0000 | 0.0000 |
| 458.47 | 0.0092 | 0.0088 | 0.0000 | 0.0000 |
| 458.51 | 0.0092 | 0.0090 | 0.0000 | 0.0000 |
| 458.56 | 0.0092 | 0.0092 | 0.0000 | 0.0000 |
| 458.61 | 0.0092 | 0.0093 | 0.0000 | 0.0000 |
| 458.65 | 0.0092 | 0.0095 | 0.0000 | 0.0000 |
| 458.70 | 0.0092 | 0.0097 | 0.0000 | 0.0000 |
| 458.71 | 0.0092 | 0.0097 | 0.0000 | 0.0000 |



Bioretention Hydraulic Table

| Stage(feet) | Area(ac.) | Volume(ac-ft.) | Discharge(cfs) | To Amended(cfs) | Infilt(cfs) |
|---|---|---|---|---|---|
| 2.6700 | 0.0092 | 0.0097 | 0.0000 | 0.0464 | 0.0000 |
| 2.7158 | 0.0093 | 0.0101 | 0.0000 | 0.0464 | 0.0000 |
| 2.7616 | 0.0095 | 0.0106 | 0.0000 | 0.0464 | 0.0000 |
| 2.8075 | 0.0096 | 0.0110 | 0.0000 | 0.0464 | 0.0000 |
| 2.8533 | 0.0097 | 0.0115 | 0.0000 | 0.0464 | 0.0000 |
| 2.8991 | 0.0098 | 0.0119 | 0.0000 | 0.0464 | 0.0000 |
| 2.9449 | 0.0100 | 0.0124 | 0.0000 | 0.0464 | 0.0000 |
| 2.9908 | 0.0101 | 0.0128 | 0.0000 | 0.0464 | 0.0000 |
| 3.0366 | 0.0102 | 0.0133 | 0.0000 | 0.0464 | 0.0000 |
| 3.0824 | 0.0103 | 0.0138 | 0.0000 | 0.0464 | 0.0000 |
| 3.1282 | 0.0105 | 0.0142 | 0.0000 | 0.0464 | 0.0000 |
| 3.1741 | 0.0106 | 0.0147 | 0.0000 | 0.0464 | 0.0000 |
| 3.2199 | 0.0107 | 0.0152 | 0.0000 | 0.0464 | 0.0000 |
| 3.2657 | 0.0108 | 0.0157 | 0.0000 | 0.0464 | 0.0000 |
| 3.3115 | 0.0110 | 0.0162 | 0.0000 | 0.0464 | 0.0000 |
| 3.3574 | 0.0111 | 0.0167 | 0.0000 | 0.0464 | 0.0000 |
| 3.4032 | 0.0112 | 0.0172 | 0.0000 | 0.0464 | 0.0000 |
| 3.4490 | 0.0113 | 0.0177 | 0.0000 | 0.0464 | 0.0000 |
| 3.4948 | 0.0115 | 0.0182 | 0.0000 | 0.0464 | 0.0000 |
| 3.5407 | 0.0116 | 0.0188 | 0.0000 | 0.0464 | 0.0000 |
| 3.5865 | 0.0117 | 0.0193 | 0.0000 | 0.0464 | 0.0000 |
| 3.6323 | 0.0119 | 0.0199 | 0.0000 | 0.0464 | 0.0000 |
| 3.6781 | 0.0120 | 0.0204 | 0.0000 | 0.0464 | 0.0000 |
| 3.7240 | 0.0121 | 0.0210 | 0.0000 | 0.0464 | 0.0000 |
| 3.7698 | 0.0122 | 0.0215 | 0.0000 | 0.0464 | 0.0000 |
| 3.8156 | 0.0124 | 0.0221 | 0.0000 | 0.0464 | 0.0000 |

| | | | | | |
|---|---|---|---|---|---|
| 3.8614 | 0.0125 | 0.0226 | 0.0062 | 0.0464 | 0.0000 |
| 3.9073 | 0.0126 | 0.0232 | 0.0067 | 0.0464 | 0.0000 |
| 3.9531 | 0.0127 | 0.0238 | 0.0079 | 0.0464 | 0.0000 |
| 3.9989 | 0.0129 | 0.0244 | 0.0091 | 0.0464 | 0.0000 |
| 4.0447 | 0.0130 | 0.0250 | 0.0105 | 0.0464 | 0.0000 |
| 4.0905 | 0.0131 | 0.0256 | 0.0120 | 0.0464 | 0.0000 |
| 4.1364 | 0.0132 | 0.0262 | 0.0137 | 0.0464 | 0.0000 |
| 4.1700 | 0.0133 | 0.0266 | 0.0154 | 0.0464 | 0.0000 |

## Surface retention 3

Element Flows To:

| Outlet 1 | Outlet 2 |
|---|---|
| | Bioretention 3 |

## Tank 1

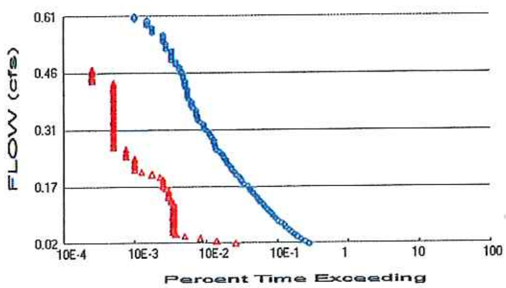
Dimensions
Depth: 1.5 ft.
Tank Type: Circular
Diameter: 1.5 ft.
Length: 369 ft.
Discharge Structure
Riser Height: 0.01 ft.
Riser Diameter: 18 in.
Element Flows To:
Outlet 1 Outlet 2

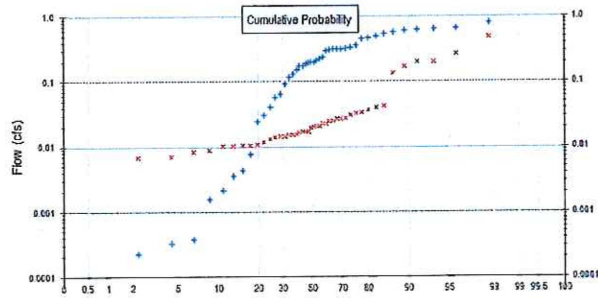
Tank Hydraulic Table

| Stage(feet) | Area(ac.) | Volume(ac-ft.) | Discharge(cfs) | Infilt(cfs) |
|---|---|---|---|---|
| 452.50 | 0.000 | 0.000 | 0.000 | 0.000 |
| 452.52 | 0.002 | 0.000 | 0.008 | 0.000 |
| 452.53 | 0.003 | 0.000 | 0.056 | 0.000 |
| 452.55 | 0.004 | 0.000 | 0.127 | 0.000 |
| 452.57 | 0.005 | 0.000 | 0.214 | 0.000 |
| 452.58 | 0.005 | 0.000 | 0.315 | 0.000 |
| 452.60 | 0.006 | 0.000 | 0.429 | 0.000 |
| 452.62 | 0.006 | 0.000 | 0.553 | 0.000 |
| 452.63 | 0.007 | 0.000 | 0.686 | 0.000 |
| 452.65 | 0.007 | 0.000 | 0.829 | 0.000 |
| 452.67 | 0.008 | 0.000 | 0.980 | 0.000 |
| 452.68 | 0.008 | 0.001 | 1.138 | 0.000 |
| 452.70 | 0.008 | 0.001 | 1.302 | 0.000 |
| 452.72 | 0.008 | 0.001 | 1.473 | 0.000 |
| 452.73 | 0.009 | 0.001 | 1.648 | 0.000 |
| 452.75 | 0.009 | 0.001 | 1.828 | 0.000 |
| 452.77 | 0.009 | 0.001 | 2.012 | 0.000 |
| 452.78 | 0.009 | 0.002 | 2.198 | 0.000 |
| 452.80 | 0.010 | 0.002 | 2.387 | 0.000 |
| 452.82 | 0.010 | 0.002 | 2.577 | 0.000 |
| 452.83 | 0.010 | 0.002 | 2.768 | 0.000 |
| 452.85 | 0.010 | 0.002 | 2.958 | 0.000 |
| 452.87 | 0.010 | 0.002 | 3.148 | 0.000 |
| 452.88 | 0.011 | 0.003 | 3.336 | 0.000 |
| 452.90 | 0.011 | 0.003 | 3.522 | 0.000 |
| 452.92 | 0.011 | 0.003 | 3.704 | 0.000 |
| 452.93 | 0.011 | 0.003 | 3.883 | 0.000 |
| 452.95 | 0.011 | 0.003 | 4.058 | 0.000 |
| 452.97 | 0.011 | 0.004 | 4.227 | 0.000 |
| 452.98 | 0.011 | 0.004 | 4.390 | 0.000 |
| 453.00 | 0.012 | 0.004 | 4.548 | 0.000 |
| 453.02 | 0.012 | 0.004 | 4.698 | 0.000 |
| 453.03 | 0.012 | 0.004 | 4.841 | 0.000 |
| 453.05 | 0.012 | 0.005 | 4.977 | 0.000 |
| 453.07 | 0.012 | 0.005 | 5.105 | 0.000 |
| 453.08 | 0.012 | 0.005 | 5.225 | 0.000 |
| 453.10 | 0.012 | 0.005 | 5.337 | 0.000 |
| 453.12 | 0.012 | 0.005 | 5.441 | 0.000 |
| 453.13 | 0.012 | 0.006 | 5.538 | 0.000 |
| 453.15 | 0.012 | 0.006 | 5.627 | 0.000 |
| 453.17 | 0.012 | 0.006 | 5.708 | 0.000 |

| | | | | |
|---|---|---|---|---|
| 453.18 | 0.012 | 0.006 | 5.783 | 0.000 |
| 453.20 | 0.012 | 0.006 | 5.853 | 0.000 |
| 453.22 | 0.012 | 0.007 | 5.917 | 0.000 |
| 453.23 | 0.012 | 0.007 | 5.978 | 0.000 |
| 453.25 | 0.012 | 0.007 | 6.037 | 0.000 |
| 453.27 | 0.012 | 0.007 | 6.164 | 0.000 |
| 453.28 | 0.012 | 0.007 | 6.232 | 0.000 |
| 453.30 | 0.012 | 0.008 | 6.298 | 0.000 |
| 453.32 | 0.012 | 0.008 | 6.364 | 0.000 |
| 453.33 | 0.012 | 0.008 | 6.430 | 0.000 |
| 453.35 | 0.012 | 0.008 | 6.495 | 0.000 |
| 453.37 | 0.012 | 0.009 | 6.559 | 0.000 |
| 453.38 | 0.012 | 0.009 | 6.622 | 0.000 |
| 453.40 | 0.012 | 0.009 | 6.685 | 0.000 |
| 453.42 | 0.012 | 0.009 | 6.747 | 0.000 |
| 453.43 | 0.012 | 0.009 | 6.809 | 0.000 |
| 453.45 | 0.012 | 0.010 | 6.870 | 0.000 |
| 453.47 | 0.012 | 0.010 | 6.931 | 0.000 |
| 453.48 | 0.012 | 0.010 | 6.991 | 0.000 |
| 453.50 | 0.012 | 0.010 | 7.051 | 0.000 |
| 453.52 | 0.011 | 0.010 | 7.110 | 0.000 |
| 453.53 | 0.011 | 0.011 | 7.168 | 0.000 |
| 453.55 | 0.011 | 0.011 | 7.227 | 0.000 |
| 453.57 | 0.011 | 0.011 | 7.284 | 0.000 |
| 453.58 | 0.011 | 0.011 | 7.341 | 0.000 |
| 453.60 | 0.011 | 0.011 | 7.398 | 0.000 |
| 453.62 | 0.011 | 0.012 | 7.455 | 0.000 |
| 453.63 | 0.010 | 0.012 | 7.511 | 0.000 |
| 453.65 | 0.010 | 0.012 | 7.566 | 0.000 |
| 453.67 | 0.010 | 0.012 | 7.621 | 0.000 |
| 453.68 | 0.010 | 0.012 | 7.676 | 0.000 |
| 453.70 | 0.010 | 0.012 | 7.730 | 0.000 |
| 453.72 | 0.009 | 0.013 | 7.784 | 0.000 |
| 453.73 | 0.009 | 0.013 | 7.838 | 0.000 |
| 453.75 | 0.009 | 0.013 | 7.891 | 0.000 |
| 453.77 | 0.009 | 0.013 | 7.944 | 0.000 |
| 453.78 | 0.008 | 0.013 | 7.996 | 0.000 |
| 453.80 | 0.008 | 0.013 | 8.048 | 0.000 |
| 453.82 | 0.008 | 0.013 | 8.100 | 0.000 |
| 453.83 | 0.008 | 0.014 | 8.152 | 0.000 |
| 453.85 | 0.007 | 0.014 | 8.203 | 0.000 |
| 453.87 | 0.007 | 0.014 | 8.254 | 0.000 |
| 453.88 | 0.006 | 0.014 | 8.304 | 0.000 |
| 453.90 | 0.006 | 0.014 | 8.355 | 0.000 |
| 453.92 | 0.005 | 0.014 | 8.405 | 0.000 |
| 453.93 | 0.005 | 0.014 | 8.454 | 0.000 |
| 453.95 | 0.004 | 0.014 | 8.504 | 0.000 |
| 453.97 | 0.003 | 0.014 | 8.553 | 0.000 |
| 453.98 | 0.002 | 0.014 | 8.601 | 0.000 |
| 454.00 | 0.000 | 0.015 | 8.650 | 0.000 |
| 454.02 | 0.000 | 0.000 | 8.698 | 0.000 |

# *Analysis Results*
## *POC 1*




+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.69
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.3553
Total Impervious Area: 1.2607

Flow Frequency Method: Weibull



Flow Frequency Return Periods for Predeveloped. POC #1

| Return Period | Flow(cfs) |
|---|---|
| 2 year | 0.199791 |
| 5 year | 0.467949 |
| 10 year | 0.609946 |
| 25 year | 0.67358 |

Flow Frequency Return Periods for Mitigated. POC #1

| Return Period | Flow(cfs) |
|---|---|
| 2 year | 0.019666 |
| 5 year | 0.035497 |
| 10 year | 0.17755 |
| 25 year | 0.286344 |

## Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

| Year | Predeveloped | Mitigated |
|---|---|---|
| 1960 | 0.189 | 0.017 |
| 1961 | 0.025 | 0.011 |
| 1962 | 0.200 | 0.014 |
| 1963 | 0.305 | 0.027 |
| 1964 | 0.004 | 0.201 |
| 1965 | 0.149 | 0.013 |
| 1966 | 0.093 | 0.012 |
| 1967 | 0.798 | 0.476 |
| 1968 | 0.130 | 0.027 |
| 1969 | 0.457 | 0.036 |
| 1970 | 0.324 | 0.025 |
| 1971 | 0.224 | 0.021 |
| 1972 | 0.000 | 0.010 |
| 1973 | 0.494 | 0.268 |

| | | |
|---|---|---|
| 1974 | 0.235 | 0.023 |
| 1975 | 0.118 | 0.017 |
| 1976 | 0.000 | 0.007 |
| 1977 | 0.000 | 0.007 |
| 1978 | 0.330 | 0.022 |
| 1979 | 0.317 | 0.020 |
| 1980 | 0.299 | 0.021 |
| 1981 | 0.004 | 0.010 |
| 1982 | 0.628 | 0.042 |
| 1983 | 0.471 | 0.031 |
| 1984 | 0.176 | 0.014 |
| 1985 | 0.041 | 0.010 |
| 1986 | 0.662 | 0.135 |
| 1987 | 0.031 | 0.014 |
| 1988 | 0.000 | 0.007 |
| 1989 | 0.002 | 0.008 |
| 1990 | 0.008 | 0.015 |
| 1991 | 0.193 | 0.017 |
| 1992 | 0.171 | 0.017 |
| 1993 | 0.310 | 0.025 |
| 1994 | 0.058 | 0.010 |
| 1995 | 0.566 | 0.167 |
| 1996 | 0.646 | 0.198 |
| 1997 | 0.367 | 0.027 |
| 1998 | 0.541 | 0.033 |
| 1999 | 0.214 | 0.015 |
| 2000 | 0.200 | 0.020 |
| 2001 | 0.002 | 0.015 |
| 2002 | 0.064 | 0.009 |
| 2003 | 0.311 | 0.032 |
| 2004 | 0.600 | 0.040 |



## Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

| Rank | Predeveloped | Mitigated |
|---|---|---|
| 1 | 0.7977 | 0.4757 |
| 2 | 0.6618 | 0.2683 |
| 3 | 0.6456 | 0.2011 |
| 4 | 0.6283 | 0.1980 |
| 5 | 0.6002 | 0.1666 |
| 6 | 0.5663 | 0.1350 |
| 7 | 0.5411 | 0.0424 |
| 8 | 0.4937 | 0.0400 |
| 9 | 0.4710 | 0.0362 |
| 10 | 0.4570 | 0.0330 |
| 11 | 0.3673 | 0.0323 |
| 12 | 0.3300 | 0.0307 |
| 13 | 0.3238 | 0.0275 |
| 14 | 0.3165 | 0.0268 |
| 15 | 0.3110 | 0.0266 |
| 16 | 0.3104 | 0.0250 |
| 17 | 0.3045 | 0.0245 |
| 18 | 0.2994 | 0.0227 |
| 19 | 0.2353 | 0.0223 |
| 20 | 0.2242 | 0.0209 |
| 21 | 0.2137 | 0.0207 |
| 22 | 0.2001 | 0.0200 |
| 23 | 0.1998 | 0.0197 |

| | | |
|---|---|---|
| 24 | 0.1934 | 0.0170 |
| 25 | 0.1890 | 0.0168 |
| 26 | 0.1757 | 0.0168 |
| 27 | 0.1710 | 0.0166 |
| 28 | 0.1492 | 0.0153 |
| 29 | 0.1298 | 0.0153 |
| 30 | 0.1176 | 0.0152 |
| 31 | 0.0935 | 0.0142 |
| 32 | 0.0637 | 0.0142 |
| 33 | 0.0578 | 0.0139 |
| 34 | 0.0406 | 0.0131 |
| 35 | 0.0311 | 0.0118 |
| 36 | 0.0246 | 0.0106 |
| 37 | 0.0077 | 0.0103 |
| 38 | 0.0043 | 0.0103 |
| 39 | 0.0035 | 0.0103 |
| 40 | 0.0021 | 0.0101 |
| 41 | 0.0016 | 0.0088 |
| 42 | 0.0004 | 0.0082 |
| 43 | 0.0003 | 0.0071 |
| 44 | 0.0002 | 0.0069 |
| 45 | 0.0001 | 0.0067 |

Duration Flows
The Facility PASSED

| Flow(cfs) | Predev | Mit | Percentage | Pass/Fail |
|---|---|---|---|---|
| 0.0200 | 1131 | 104 | 9 | Pass |
| 0.0259 | 994 | 56 | 5 | Pass |
| 0.0319 | 865 | 33 | 3 | Pass |
| 0.0379 | 758 | 20 | 2 | Pass |
| 0.0438 | 694 | 15 | 2 | Pass |
| 0.0498 | 633 | 14 | 2 | Pass |
| 0.0557 | 581 | 14 | 2 | Pass |
| 0.0617 | 541 | 14 | 2 | Pass |
| 0.0677 | 500 | 14 | 2 | Pass |
| 0.0736 | 457 | 14 | 3 | Pass |
| 0.0796 | 406 | 14 | 3 | Pass |
| 0.0855 | 381 | 14 | 3 | Pass |
| 0.0915 | 356 | 14 | 3 | Pass |
| 0.0974 | 328 | 14 | 4 | Pass |
| 0.1034 | 305 | 14 | 4 | Pass |
| 0.1094 | 286 | 14 | 4 | Pass |
| 0.1153 | 267 | 14 | 5 | Pass |
| 0.1213 | 249 | 14 | 5 | Pass |
| 0.1272 | 230 | 13 | 5 | Pass |
| 0.1332 | 219 | 13 | 5 | Pass |
| 0.1392 | 206 | 12 | 5 | Pass |
| 0.1451 | 195 | 12 | 6 | Pass |
| 0.1511 | 181 | 12 | 6 | Pass |
| 0.1570 | 169 | 12 | 7 | Pass |
| 0.1630 | 162 | 11 | 6 | Pass |
| 0.1690 | 151 | 10 | 6 | Pass |
| 0.1749 | 135 | 10 | 7 | Pass |
| 0.1809 | 126 | 10 | 7 | Pass |
| 0.1868 | 122 | 10 | 8 | Pass |
| 0.1928 | 116 | 9 | 7 | Pass |
| 0.1988 | 104 | 7 | 6 | Pass |
| 0.2047 | 98 | 5 | 5 | Pass |
| 0.2107 | 93 | 4 | 4 | Pass |
| 0.2166 | 90 | 4 | 4 | Pass |
| 0.2226 | 84 | 4 | 4 | Pass |
| 0.2286 | 79 | 4 | 5 | Pass |
| 0.2345 | 76 | 4 | 5 | Pass |
| 0.2405 | 73 | 4 | 5 | Pass |
| 0.2464 | 69 | 3 | 4 | Pass |
| 0.2524 | 67 | 3 | 4 | Pass |
| 0.2583 | 62 | 3 | 4 | Pass |
| 0.2643 | 55 | 3 | 5 | Pass |
| 0.2703 | 54 | 2 | 3 | Pass |
| 0.2762 | 52 | 2 | 3 | Pass |
| 0.2822 | 51 | 2 | 3 | Pass |
| 0.2881 | 51 | 2 | 3 | Pass |
| 0.2941 | 48 | 2 | 4 | Pass |
| 0.3001 | 46 | 2 | 4 | Pass |
| 0.3060 | 44 | 2 | 4 | Pass |
| 0.3120 | 42 | 2 | 4 | Pass |
| 0.3179 | 37 | 2 | 5 | Pass |
| 0.3239 | 37 | 2 | 5 | Pass |
| 0.3299 | 36 | 2 | 5 | Pass |

| | | | | |
|---|---|---|---|---|
| 0.3358 | 33 | 2 | 6 | Pass |
| 0.3418 | 30 | 2 | 6 | Pass |
| 0.3477 | 30 | 2 | 6 | Pass |
| 0.3537 | 29 | 2 | 6 | Pass |
| 0.3597 | 29 | 2 | 6 | Pass |
| 0.3656 | 29 | 2 | 6 | Pass |
| 0.3716 | 26 | 2 | 7 | Pass |
| 0.3775 | 25 | 2 | 8 | Pass |
| 0.3835 | 25 | 2 | 8 | Pass |
| 0.3895 | 25 | 2 | 8 | Pass |
| 0.3954 | 23 | 2 | 8 | Pass |
| 0.4014 | 22 | 2 | 9 | Pass |
| 0.4073 | 22 | 2 | 9 | Pass |
| 0.4133 | 22 | 2 | 9 | Pass |
| 0.4192 | 22 | 2 | 9 | Pass |
| 0.4252 | 21 | 2 | 9 | Pass |
| 0.4312 | 20 | 2 | 10 | Pass |
| 0.4371 | 20 | 2 | 10 | Pass |
| 0.4431 | 20 | 1 | 5 | Pass |
| 0.4490 | 19 | 1 | 5 | Pass |
| 0.4550 | 19 | 1 | 5 | Pass |
| 0.4610 | 18 | 1 | 5 | Pass |
| 0.4669 | 18 | 1 | 5 | Pass |
| 0.4729 | 17 | 1 | 5 | Pass |
| 0.4788 | 17 | 0 | 0 | Pass |
| 0.4848 | 15 | 0 | 0 | Pass |
| 0.4908 | 15 | 0 | 0 | Pass |
| 0.4967 | 13 | 0 | 0 | Pass |
| 0.5027 | 13 | 0 | 0 | Pass |
| 0.5086 | 13 | 0 | 0 | Pass |
| 0.5146 | 13 | 0 | 0 | Pass |
| 0.5206 | 13 | 0 | 0 | Pass |
| 0.5265 | 11 | 0 | 0 | Pass |
| 0.5325 | 11 | 0 | 0 | Pass |
| 0.5384 | 11 | 0 | 0 | Pass |
| 0.5444 | 10 | 0 | 0 | Pass |
| 0.5504 | 10 | 0 | 0 | Pass |
| 0.5563 | 10 | 0 | 0 | Pass |
| 0.5623 | 10 | 0 | 0 | Pass |
| 0.5682 | 7 | 0 | 0 | Pass |
| 0.5742 | 7 | 0 | 0 | Pass |
| 0.5801 | 7 | 0 | 0 | Pass |
| 0.5861 | 6 | 0 | 0 | Pass |
| 0.5921 | 6 | 0 | 0 | Pass |
| 0.5980 | 6 | 0 | 0 | Pass |
| 0.6040 | 4 | 0 | 0 | Pass |
| 0.6099 | 4 | 0 | 0 | Pass |

# Water Quality

*POC 2*

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

## *Model Default Modifications*

Total of 0 changes have been made.

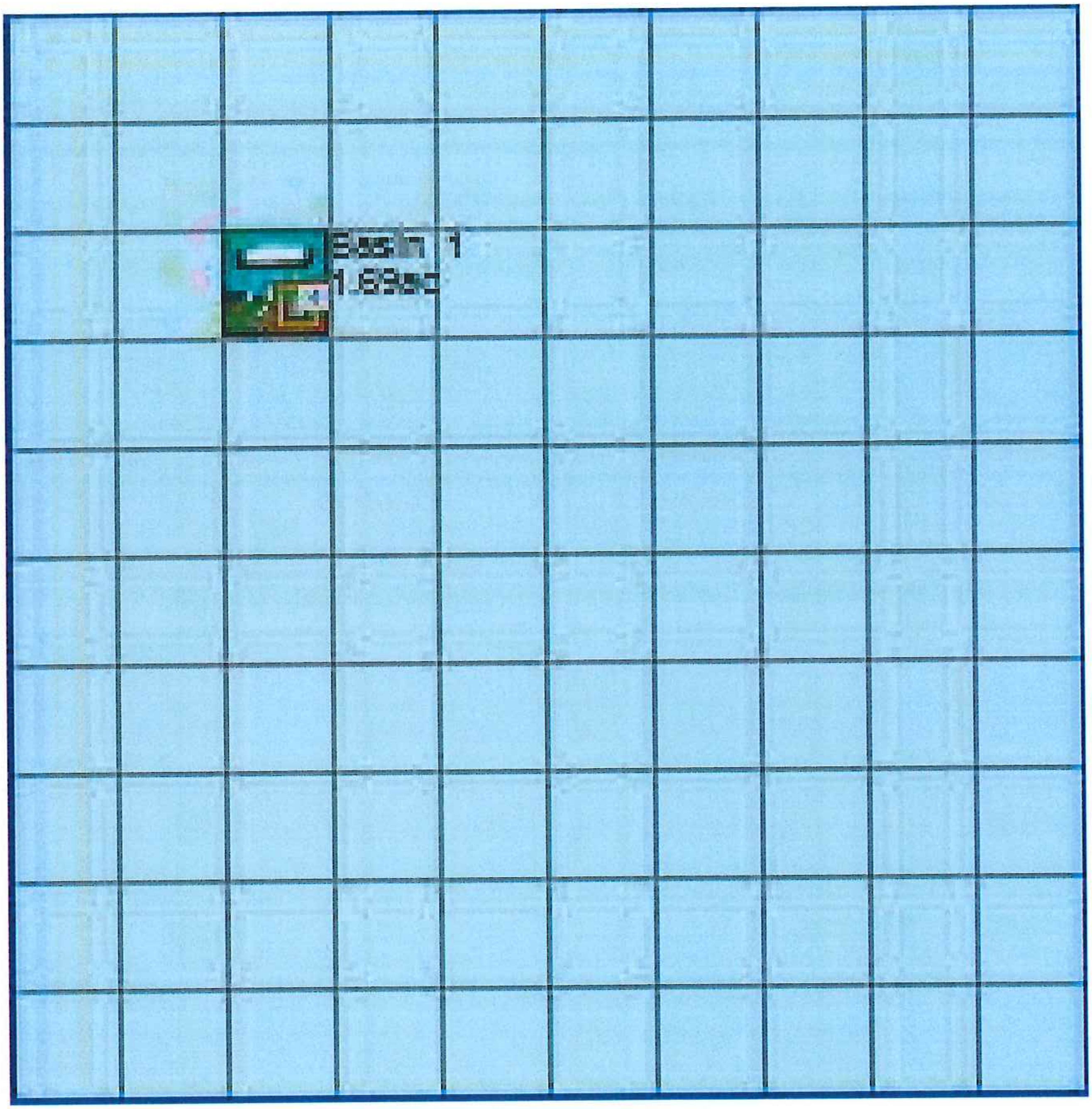
### *PERLND Changes*

No PERLND changes have been made.

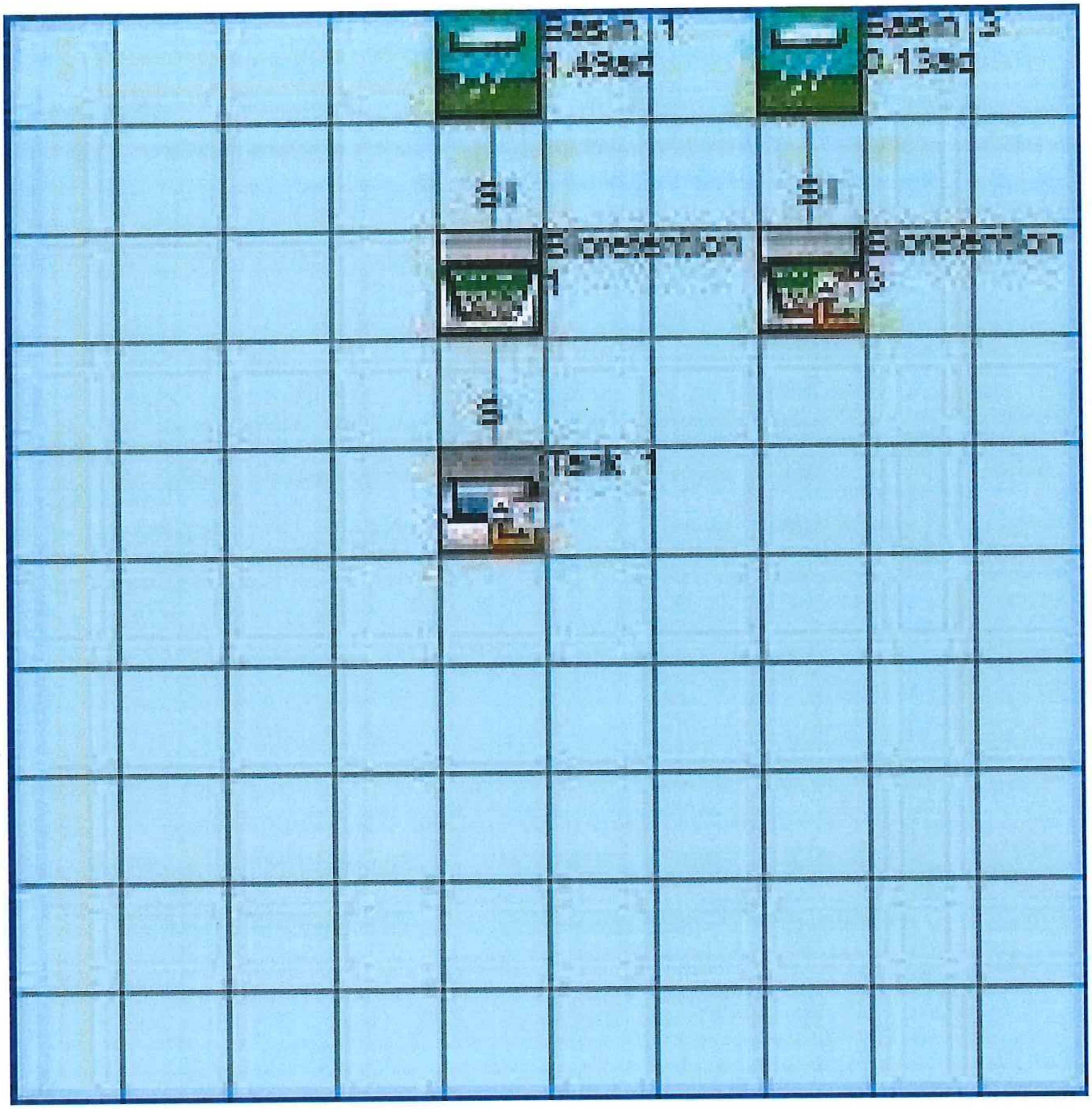
### *IMPLND Changes*

No IMPLND changes have been made.

# Appendix
## Predeveloped Schematic



## *Mitigated Schematic*



*Predeveloped UCI File*

*Mitigated UCI File*

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1959 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME      0 RUN      1                  UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   TEST.wdm
MESSU      25   MitTEST.MES
           27   MitTEST.L61
           28   MitTEST.L62
           30   POCTEST1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      41
      IMPLND       5
      IMPLND       6
      IMPLND      10
      RCHRES       1
      RCHRES       2
      RCHRES       3
      RCHRES       4
      RCHRES       5
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1   PYR DIG2 FIL2 YRND
    1        Surface retention  3       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
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   41      C/D,Grass,Flat(0-5%)    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 ***
```

```
  41          0     0     1     0     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  *********
  41          0     0     4     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 ***
  41          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
  41              0         4      0.04       400      0.05         2      0.95
 END PWAT-PARM2

 PWAT-PARM3
   <PLS >       PWATER input info: Part 3          ***
   # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  41             40        35         3         2      0.15      0.15         0
 END PWAT-PARM3
 PWAT-PARM4
   <PLS >     PWATER input info: Part 4                                    ***
   # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  41              0       0.3      0.25       0.7       0.5         0
 END PWAT-PARM4
 MON-LZETPARM
   <PLS >       PWATER input info: Part 3          ***
   # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
  41       0.4  0.4  0.4 0.45  0.5 0.55 0.55 0.55 0.55 0.55 0.45  0.4
 END MON-LZETPARM
 MON-INTERCEP
   <PLS >       PWATER input info: Part 3          ***
   # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
  41      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11    0
 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
  41              0         0      0.01         0       0.5       0.3      0.01
 END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------> Unit-systems   Printer ***
    # -  #                    User  t-series Engl Metr ***
                                      in  out          ***
    5      Roof Area             1     1    1   27    0
    6      Driveways,Flat(0-5%)  1     1    1   27    0
   10      Sidewalks,Flat(0-5%)  1     1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    ***
    5         0    0    1    0    0    0
    6         0    0    1    0    0    0
   10         0    0    1    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # - # ATMP SNOW IWAT  SLD  IWG IQAL   *********
    5         0    0    4    0    0    0    1    9
    6         0    0    4    0    0    0    1    9
   10         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       ***
    5         0    0    0    0    0
    6         0    0    0    0    0
   10         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >       IWATER input info: Part 2          ***
    # - # ***   LSUR      SLSUR       NSUR       RETSC
    5            100       0.05        0.1         0.1
    6            100       0.05        0.1         0.1
   10            100       0.05        0.1         0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >       IWATER input info: Part 3          ***
    # - # ***PETMAX    PETMIN
    5              0         0
    6              0         0
   10              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # - # ***  RETS       SURS
    5             0          0
    6             0          0
   10             0          0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                         <--Area-->     <-Target->    MBLK   ***
<Name>    #                        <-factor->     <Name>   #    Tbl#   ***
Basin  1***
PERLND  41                            0.2867      RCHRES   1       2
PERLND  41                            0.2867      RCHRES   1       3
IMPLND   5                            0.1064      RCHRES   1       5
IMPLND   6                            1.0051      RCHRES   1       5
IMPLND  10                            0.0918      RCHRES   1       5
Basin  3***
PERLND  41                            0.0686      RCHRES   3       2
PERLND  41                            0.0686      RCHRES   3       3
IMPLND   6                             0.022      RCHRES   3       5
IMPLND  10                            0.0354      RCHRES   3       5

******Routing******
RCHRES   1                                 1      RCHRES   5       7
RCHRES   1                                        COPY     1      17
RCHRES   1                                 1      RCHRES   2       8
PERLND  41                            0.0686      COPY     1      12
IMPLND   6                             0.022      COPY     1      15
IMPLND  10                            0.0354      COPY     1      15
PERLND  41                            0.0686      COPY     1      13
RCHRES   3                                 1      RCHRES   4       8
RCHRES   4                                 1      COPY   501      16
RCHRES   3                                 1      COPY   501      17
RCHRES   5                                 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        DISPLY   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     Surface retentio-015    3    1    1    1    28    0    1
    2     Bioretention  1         1    1    1    1    28    0    1
    3     Surface retentio-028    3    1    1    1    28    0    1
    4     Bioretention  3         1    1    1    1    28    0    1
    5     Tank  1                 1    1    1    1    28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1        1    0    0    0    0    0    0    0    0    0
    2        1    0    0    0    0    0    0    0    0    0
    3        1    0    0    0    0    0    0    0    0    0
    4        1    0    0    0    0    0    0    0    0    0
    5        1    0    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
    2        4    0    0    0    0    0    0    0    0    0    1    9
    3        4    0    0    0    0    0    0    0    0    0    1    9
    4        4    0    0    0    0    0    0    0    0    0    1    9
    5        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  5  6  0  0       0  0  0  0  0        2  2  2  2  2
    2        0  1  0  0    4  0  0  0  0       0  0  0  0  0        2  2  2  2  2
    3        0  1  0  0    4  5  6  0  0       0  0  0  0  0        2  2  2  2  2
    4        0  1  0  0    4  0  0  0  0       0  0  0  0  0        2  2  2  2  2
    5        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     452.33       0.5       0.0
    2             2      0.03       0.0     452.33       0.5       0.0
    3             3      0.01       0.0     456.04       0.5       0.0
    4             4      0.01       0.0     456.04       0.5       0.0
    5             5      0.07       0.0      452.5       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  5.0  6.0  0.0  0.0        0.0  0.0  0.0  0.0  0.0
    2           0          4.0  0.0  0.0  0.0  0.0        0.0  0.0  0.0  0.0  0.0
    3           0          4.0  5.0  6.0  0.0  0.0        0.0  0.0  0.0  0.0  0.0
    4           0          4.0  0.0  0.0  0.0  0.0        0.0  0.0  0.0  0.0  0.0
    5           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      2
   57    4
```

| Depth (ft) | Area (acres) | Volume (acre-ft) | Outflow1 (cfs) | Velocity (ft/sec) | Travel Time*** (Minutes)*** |
|---|---|---|---|---|---|
| 0.000000 | 0.061575 | 0.000000 | 0.000000 | | |
| 0.047692 | 0.061575 | 0.001116 | 0.000000 | | |
| 0.095385 | 0.061575 | 0.002232 | 0.000000 | | |
| 0.143077 | 0.061575 | 0.003348 | 0.000000 | | |
| 0.190769 | 0.061575 | 0.004464 | 0.000000 | | |
| 0.238462 | 0.061575 | 0.005580 | 0.000000 | | |
| 0.286154 | 0.061575 | 0.006696 | 0.000000 | | |
| 0.333846 | 0.061575 | 0.007811 | 0.000000 | | |
| 0.381538 | 0.061575 | 0.008927 | 0.000000 | | |
| 0.429231 | 0.061575 | 0.010043 | 0.000000 | | |
| 0.476923 | 0.061575 | 0.011159 | 0.000000 | | |
| 0.524615 | 0.061575 | 0.012275 | 0.000000 | | |
| 0.572308 | 0.061575 | 0.013391 | 0.000000 | | |
| 0.620000 | 0.061575 | 0.014507 | 0.000000 | | |
| 0.667692 | 0.061575 | 0.015623 | 0.000000 | | |
| 0.715385 | 0.061575 | 0.016739 | 0.000000 | | |
| 0.763077 | 0.061575 | 0.017855 | 0.000000 | | |
| 0.810769 | 0.061575 | 0.018971 | 0.000000 | | |
| 0.858462 | 0.061575 | 0.020087 | 0.000000 | | |
| 0.906154 | 0.061575 | 0.021203 | 0.000000 | | |
| 0.953846 | 0.061575 | 0.022319 | 0.000000 | | |
| 1.001538 | 0.061575 | 0.023434 | 0.000000 | | |
| 1.049231 | 0.061575 | 0.024550 | 0.000000 | | |
| 1.096923 | 0.061575 | 0.025666 | 0.000000 | | |
| 1.144615 | 0.061575 | 0.026782 | 0.034957 | | |
| 1.192308 | 0.061575 | 0.027898 | 0.038326 | | |
| 1.240000 | 0.061575 | 0.029014 | 0.045646 | | |
| 1.287692 | 0.061575 | 0.030130 | 0.053763 | | |
| 1.335385 | 0.061575 | 0.031246 | 0.062703 | | |
| 1.383077 | 0.061575 | 0.032362 | 0.072494 | | |
| 1.430769 | 0.061575 | 0.033478 | 0.077508 | | |
| 1.478462 | 0.061575 | 0.034594 | 0.094725 | | |
| 1.526154 | 0.061575 | 0.035812 | 0.100853 | | |
| 1.573846 | 0.061575 | 0.037031 | 0.113814 | | |
| 1.621538 | 0.061575 | 0.038250 | 0.127732 | | |
| 1.669231 | 0.061575 | 0.039469 | 0.142632 | | |
| 1.716923 | 0.061575 | 0.040687 | 0.158534 | | |
| 1.764615 | 0.061575 | 0.041906 | 0.170602 | | |
| 1.812308 | 0.061575 | 0.043125 | 0.193428 | | |
| 1.860000 | 0.061575 | 0.044343 | 0.202810 | | |
| 1.907692 | 0.061575 | 0.045562 | 0.222382 | | |
| 1.955385 | 0.061575 | 0.046781 | 0.228470 | | |
| 2.003077 | 0.061575 | 0.047999 | 0.264813 | | |
| 2.050769 | 0.061575 | 0.049218 | 0.274389 | | |
| 2.098462 | 0.061575 | 0.050437 | 0.299551 | | |
| 2.146154 | 0.061575 | 0.051656 | 0.310440 | | |
| 2.193846 | 0.061575 | 0.052874 | 0.310440 | | |
| 2.241538 | 0.061575 | 0.054093 | 0.310440 | | |
| 2.289231 | 0.061575 | 0.055312 | 0.310440 | | |
| 2.336923 | 0.061575 | 0.056530 | 0.310440 | | |
| 2.384615 | 0.061575 | 0.057749 | 0.310440 | | |
| 2.432308 | 0.061575 | 0.058968 | 0.310440 | | |
| 2.480000 | 0.061575 | 0.060187 | 0.310440 | | |
| 2.527692 | 0.061575 | 0.061405 | 0.310440 | | |

| | | | |
|---|---|---|---|
| 2.575385 | 0.061575 | 0.062624 | 0.310440 |
| 2.623077 | 0.061575 | 0.063843 | 0.310440 |
| 2.670000 | 0.061575 | 0.136588 | 0.310440 |

END FTABLE 2
FTABLE 1
37 6

| Depth (ft) | Area (acres) | Volume (acre-ft) | Outflow1 (cfs) | Outflow2 (cfs) | outflow 3 (cfs) | Velocity (ft/sec) | Travel Time*** (Minutes)*** |
|---|---|---|---|---|---|---|---|
| 0.000000 | 0.061575 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | | |
| 0.047692 | 0.062456 | 0.002958 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.095385 | 0.063337 | 0.005957 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.143077 | 0.064218 | 0.008999 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.190769 | 0.065099 | 0.012083 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.238462 | 0.065980 | 0.015208 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.286154 | 0.066861 | 0.018376 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.333846 | 0.067742 | 0.021586 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.381538 | 0.068623 | 0.024838 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.429231 | 0.069504 | 0.028131 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.476923 | 0.070385 | 0.031467 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.524615 | 0.071266 | 0.034845 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.572308 | 0.072147 | 0.038265 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.620000 | 0.073028 | 0.041727 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.667692 | 0.073909 | 0.045231 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.715385 | 0.074790 | 0.048777 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.763077 | 0.075671 | 0.052364 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.810769 | 0.076552 | 0.055994 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.858462 | 0.077433 | 0.059666 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.906154 | 0.078314 | 0.063380 | 0.000000 | 0.310440 | 0.000000 | | |
| 0.953846 | 0.079195 | 0.067136 | 0.000000 | 0.310440 | 0.000000 | | |
| 1.001538 | 0.080076 | 0.070934 | 0.002170 | 0.310440 | 0.000000 | | |
| 1.049231 | 0.080957 | 0.074774 | 0.392430 | 0.310440 | 0.000000 | | |
| 1.096923 | 0.081838 | 0.078656 | 1.083402 | 0.310440 | 0.000000 | | |
| 1.144615 | 0.082719 | 0.082580 | 1.973449 | 0.310440 | 0.000000 | | |
| 1.192308 | 0.083600 | 0.086546 | 3.024116 | 0.310440 | 0.000000 | | |
| 1.240000 | 0.084481 | 0.090554 | 4.212104 | 0.310440 | 0.000000 | | |
| 1.287692 | 0.085362 | 0.094605 | 5.520437 | 0.310440 | 0.000000 | | |
| 1.335385 | 0.086243 | 0.098697 | 6.935214 | 0.310440 | 0.000000 | | |
| 1.383077 | 0.087124 | 0.102831 | 8.444097 | 0.310440 | 0.000000 | | |
| 1.430769 | 0.088005 | 0.107007 | 10.03550 | 0.310440 | 0.000000 | | |
| 1.478462 | 0.088886 | 0.111225 | 11.69815 | 0.310440 | 0.000000 | | |
| 1.526154 | 0.089767 | 0.115485 | 13.42080 | 0.310440 | 0.000000 | | |
| 1.573846 | 0.090648 | 0.119787 | 15.19212 | 0.310440 | 0.000000 | | |
| 1.621538 | 0.091529 | 0.124132 | 17.00060 | 0.310440 | 0.000000 | | |
| 1.669231 | 0.092410 | 0.128518 | 18.83459 | 0.310440 | 0.000000 | | |
| 1.670000 | 0.092424 | 0.128589 | 20.68227 | 0.310440 | 0.000000 | | |

END FTABLE 1
FTABLE 4
60 4

| Depth (ft) | Area (acres) | Volume (acre-ft) | Outflow1 (cfs) | Velocity (ft/sec) | Travel Time*** (Minutes)*** |
|---|---|---|---|---|---|
| 0.000000 | 0.009201 | 0.000000 | 0.000000 | | |
| 0.045824 | 0.009201 | 0.000160 | 0.000000 | | |
| 0.091648 | 0.009201 | 0.000320 | 0.000000 | | |
| 0.137473 | 0.009201 | 0.000481 | 0.000000 | | |
| 0.183297 | 0.009201 | 0.000641 | 0.000000 | | |
| 0.229121 | 0.009201 | 0.000801 | 0.000000 | | |
| 0.274945 | 0.009201 | 0.000961 | 0.000000 | | |
| 0.320769 | 0.009201 | 0.001122 | 0.000000 | | |
| 0.366593 | 0.009201 | 0.001282 | 0.000000 | | |
| 0.412418 | 0.009201 | 0.001442 | 0.000000 | | |
| 0.458242 | 0.009201 | 0.001602 | 0.000000 | | |
| 0.504066 | 0.009201 | 0.001762 | 0.000000 | | |
| 0.549890 | 0.009201 | 0.001923 | 0.000000 | | |
| 0.595714 | 0.009201 | 0.002083 | 0.000000 | | |
| 0.641538 | 0.009201 | 0.002243 | 0.000000 | | |
| 0.687363 | 0.009201 | 0.002403 | 0.000000 | | |
| 0.733187 | 0.009201 | 0.002564 | 0.000000 | | |
| 0.779011 | 0.009201 | 0.002724 | 0.000000 | | |

| | | | |
|---|---|---|---|
| 0.824835 | 0.009201 | 0.002884 | 0.000000 |
| 0.870659 | 0.009201 | 0.003044 | 0.000000 |
| 0.916484 | 0.009201 | 0.003204 | 0.000000 |
| 0.962308 | 0.009201 | 0.003365 | 0.000000 |
| 1.008132 | 0.009201 | 0.003525 | 0.000000 |
| 1.053956 | 0.009201 | 0.003685 | 0.000000 |
| 1.099780 | 0.009201 | 0.003845 | 0.000000 |
| 1.145604 | 0.009201 | 0.004006 | 0.000000 |
| 1.191429 | 0.009201 | 0.004166 | 0.006185 |
| 1.237253 | 0.009201 | 0.004326 | 0.006720 |
| 1.283077 | 0.009201 | 0.004486 | 0.007873 |
| 1.328901 | 0.009201 | 0.004646 | 0.009139 |
| 1.374725 | 0.009201 | 0.004807 | 0.010522 |
| 1.420549 | 0.009201 | 0.004967 | 0.012025 |
| 1.466374 | 0.009201 | 0.005127 | 0.013651 |
| 1.512198 | 0.009201 | 0.005302 | 0.015404 |
| 1.558022 | 0.009201 | 0.005477 | 0.017286 |
| 1.603846 | 0.009201 | 0.005652 | 0.019301 |
| 1.649670 | 0.009201 | 0.005827 | 0.021452 |
| 1.695495 | 0.009201 | 0.006002 | 0.023741 |
| 1.741319 | 0.009201 | 0.006177 | 0.026171 |
| 1.787143 | 0.009201 | 0.006352 | 0.028745 |
| 1.832967 | 0.009201 | 0.006527 | 0.031466 |
| 1.878791 | 0.009201 | 0.006702 | 0.034335 |
| 1.924615 | 0.009201 | 0.006877 | 0.037357 |
| 1.970440 | 0.009201 | 0.007052 | 0.040531 |
| 2.016264 | 0.009201 | 0.007227 | 0.043859 |
| 2.062088 | 0.009201 | 0.007402 | 0.046389 |
| 2.107912 | 0.009201 | 0.007577 | 0.046389 |
| 2.153736 | 0.009201 | 0.007752 | 0.046389 |
| 2.199560 | 0.009201 | 0.007927 | 0.046389 |
| 2.245385 | 0.009201 | 0.008102 | 0.046389 |
| 2.291209 | 0.009201 | 0.008277 | 0.046389 |
| 2.337033 | 0.009201 | 0.008452 | 0.046389 |
| 2.382857 | 0.009201 | 0.008627 | 0.046389 |
| 2.428681 | 0.009201 | 0.008802 | 0.046389 |
| 2.474505 | 0.009201 | 0.008977 | 0.046389 |
| 2.520330 | 0.009201 | 0.009152 | 0.046389 |
| 2.566154 | 0.009201 | 0.009327 | 0.046389 |
| 2.611978 | 0.009201 | 0.009501 | 0.046389 |
| 2.657802 | 0.009201 | 0.009676 | 0.046389 |
| 2.670000 | 0.009201 | 0.020418 | 0.046389 |

END FTABLE 4
FTABLE 3
34 6

| Depth (ft) | Area (acres) | Volume (acre-ft) | Outflow1 (cfs) | Outflow2 (cfs) | outflow 3 (cfs) | Velocity (ft/sec) | Travel Time*** (Minutes)*** |
|---|---|---|---|---|---|---|---|
| 0.000000 | 0.009201 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | | |
| 0.045824 | 0.009327 | 0.000425 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.091648 | 0.009454 | 0.000855 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.137473 | 0.009580 | 0.001291 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.183297 | 0.009706 | 0.001733 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.229121 | 0.009832 | 0.002180 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.274945 | 0.009959 | 0.002634 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.320769 | 0.010085 | 0.003093 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.366593 | 0.010211 | 0.003558 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.412418 | 0.010337 | 0.004029 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.458242 | 0.010463 | 0.004506 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.504066 | 0.010590 | 0.004988 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.549890 | 0.010716 | 0.005476 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.595714 | 0.010842 | 0.005970 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.641538 | 0.010968 | 0.006470 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.687363 | 0.011095 | 0.006975 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.733187 | 0.011221 | 0.007487 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.779011 | 0.011347 | 0.008004 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.824835 | 0.011473 | 0.008527 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.870659 | 0.011600 | 0.009055 | 0.000000 | 0.046389 | 0.000000 | | |
| 0.916484 | 0.011726 | 0.009590 | 0.000000 | 0.046389 | 0.000000 | | |

| | | | | | |
|---|---|---|---|---|---|
| 0.962308 | 0.011852 | 0.010130 | 0.000000 | 0.046389 | 0.000000 |
| 1.008132 | 0.011978 | 0.010676 | 0.017573 | 0.046389 | 0.000000 |
| 1.053956 | 0.012105 | 0.011228 | 0.300054 | 0.046389 | 0.000000 |
| 1.099780 | 0.012231 | 0.011785 | 0.753966 | 0.046389 | 0.000000 |
| 1.145604 | 0.012357 | 0.012349 | 1.327585 | 0.046389 | 0.000000 |
| 1.191429 | 0.012483 | 0.012918 | 1.997598 | 0.046389 | 0.000000 |
| 1.237253 | 0.012610 | 0.013493 | 2.748064 | 0.046389 | 0.000000 |
| 1.283077 | 0.012736 | 0.014073 | 3.565702 | 0.046389 | 0.000000 |
| 1.328901 | 0.012862 | 0.014660 | 4.438137 | 0.046389 | 0.000000 |
| 1.374725 | 0.012988 | 0.015252 | 5.353136 | 0.046389 | 0.000000 |
| 1.420549 | 0.013114 | 0.015850 | 6.298291 | 0.046389 | 0.000000 |
| 1.466374 | 0.013241 | 0.016454 | 7.260932 | 0.046389 | 0.000000 |
| 1.500000 | 0.013333 | 0.016901 | 8.228193 | 0.046389 | 0.000000 |

END FTABLE 3
FTABLE 5
91 4

| Depth (ft) | Area (acres) | Volume (acre-ft) | Outflow1 (cfs) | Velocity (ft/sec) | Travel Time*** (Minutes)*** |
|---|---|---|---|---|---|
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | | |
| 0.016667 | 0.002664 | 0.000030 | 0.008670 | | |
| 0.033333 | 0.003746 | 0.000084 | 0.056739 | | |
| 0.050000 | 0.004562 | 0.000153 | 0.127293 | | |
| 0.066667 | 0.005237 | 0.000235 | 0.214544 | | |
| 0.083333 | 0.005821 | 0.000327 | 0.315695 | | |
| 0.100000 | 0.006339 | 0.000429 | 0.428960 | | |
| 0.116667 | 0.006806 | 0.000538 | 0.553032 | | |
| 0.133333 | 0.007232 | 0.000655 | 0.686862 | | |
| 0.150000 | 0.007624 | 0.000779 | 0.829550 | | |
| 0.166667 | 0.007987 | 0.000909 | 0.980284 | | |
| 0.183333 | 0.008324 | 0.001045 | 1.138305 | | |
| 0.200000 | 0.008639 | 0.001187 | 1.302877 | | |
| 0.216667 | 0.008934 | 0.001333 | 1.473278 | | |
| 0.233333 | 0.009211 | 0.001484 | 1.648790 | | |
| 0.250000 | 0.009471 | 0.001640 | 1.828689 | | |
| 0.266667 | 0.009716 | 0.001800 | 2.012243 | | |
| 0.283333 | 0.009947 | 0.001964 | 2.198714 | | |
| 0.300000 | 0.010165 | 0.002131 | 2.387352 | | |
| 0.316667 | 0.010371 | 0.002303 | 2.577402 | | |
| 0.333333 | 0.010565 | 0.002477 | 2.768104 | | |
| 0.350000 | 0.010749 | 0.002655 | 2.958693 | | |
| 0.366667 | 0.010922 | 0.002835 | 3.148409 | | |
| 0.383333 | 0.011085 | 0.003019 | 3.336497 | | |
| 0.400000 | 0.011238 | 0.003205 | 3.522213 | | |
| 0.416667 | 0.011383 | 0.003393 | 3.704831 | | |
| 0.433333 | 0.011518 | 0.003584 | 3.883645 | | |
| 0.450000 | 0.011646 | 0.003777 | 4.057982 | | |
| 0.466667 | 0.011765 | 0.003972 | 4.227201 | | |
| 0.483333 | 0.011876 | 0.004169 | 4.390707 | | |
| 0.500000 | 0.011980 | 0.004368 | 4.547954 | | |
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| 0.533333 | 0.012165 | 0.004771 | 4.841786 | | |
| 0.550000 | 0.012246 | 0.004974 | 4.977603 | | |
| 0.566667 | 0.012321 | 0.005179 | 5.105644 | | |
| 0.583333 | 0.012389 | 0.005385 | 5.225736 | | |
| 0.600000 | 0.012450 | 0.005592 | 5.337811 | | |
| 0.616667 | 0.012504 | 0.005800 | 5.441911 | | |
| 0.633333 | 0.012552 | 0.006008 | 5.538198 | | |
| 0.650000 | 0.012593 | 0.006218 | 5.626966 | | |
| 0.666667 | 0.012628 | 0.006428 | 5.708649 | | |
| 0.683333 | 0.012656 | 0.006639 | 5.783832 | | |
| 0.700000 | 0.012678 | 0.006850 | 5.853262 | | |
| 0.716667 | 0.012694 | 0.007061 | 5.917859 | | |
| 0.733333 | 0.012703 | 0.007273 | 5.978727 | | |
| 0.750000 | 0.012707 | 0.007485 | 6.037164 | | |
| 0.766667 | 0.012703 | 0.007697 | 6.164450 | | |
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| 0.833333 | 0.012628 | 0.008542 | 6.430280 | | |
| 0.850000 | 0.012593 | 0.008752 | 6.495038 | | |

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WDM      2 PREC     ENGL      1            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL      1            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL      1            IMPLND   1 999 EXTNL  PETINP
WDM      2 PREC     ENGL      1            RCHRES   1     EXTNL  PREC
WDM      2 PREC     ENGL      1            RCHRES   3     EXTNL  PREC
WDM      1 EVAP     ENGL      0.5          RCHRES   1     EXTNL  POTEV
WDM      1 EVAP     ENGL      0.7          RCHRES   2     EXTNL  POTEV
WDM      1 EVAP     ENGL      0.5          RCHRES   3     EXTNL  POTEV
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END EXT SOURCES

EXT TARGETS
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RCHRES   4 HYDR   STAGE  1 1         1     WDM   1001 STAG     ENGL      REPL
RCHRES   3 HYDR   STAGE  1 1         1     WDM   1002 STAG     ENGL      REPL
RCHRES   3 HYDR   O      1 1         1     WDM   1003 FLOW     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
RCHRES   5 HYDR   RO     1 1         1     WDM   1018 FLOW     ENGL      REPL
RCHRES   5 HYDR   STAGE  1 1         1     WDM   1019 STAG     ENGL      REPL
END EXT TARGETS
```

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  MASS-LINK        3
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  END MASS-LINK    3

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  END MASS-LINK    5

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RCHRES     OFLOW  OVOL   1                    RCHRES          INFLOW IVOL
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  END MASS-LINK    15

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  END MASS-LINK    16

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END MASS-LINK

END RUN
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*Predeveloped HSPF Message File*

ERROR/WARNING ID: 238 1

The continuity error reported below is greater than 1 part in 1000 and is therefore considered high.

Did you specify any "special actions"? If so, they could account for it.

Relevant data are:
DATE/TIME: 1986/11/30 24: 0

RCHRES : 3

| RELERR | STORS | STOR | MATIN | MATDIF |
|---|---|---|---|---|
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Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR is the storage of material in the processing unit (land-segment or reach/reservior) at the end of the present interval.
STORS is the storage of material in the pu at the start of the present printout reporting period.
MATIN is the total inflow of material to the pu during the present printout reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the present printout reporting period.

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### *Legal Notice*



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Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

# 4.0 APPENDIX "A"

# 4.1 REFERENCE PLANS

| STATION | 37+00 | 37+50 | 38+00 | 38+50 | 39+00 | 39+50 | 40+00 |
|---|---|---|---|---|---|---|---|
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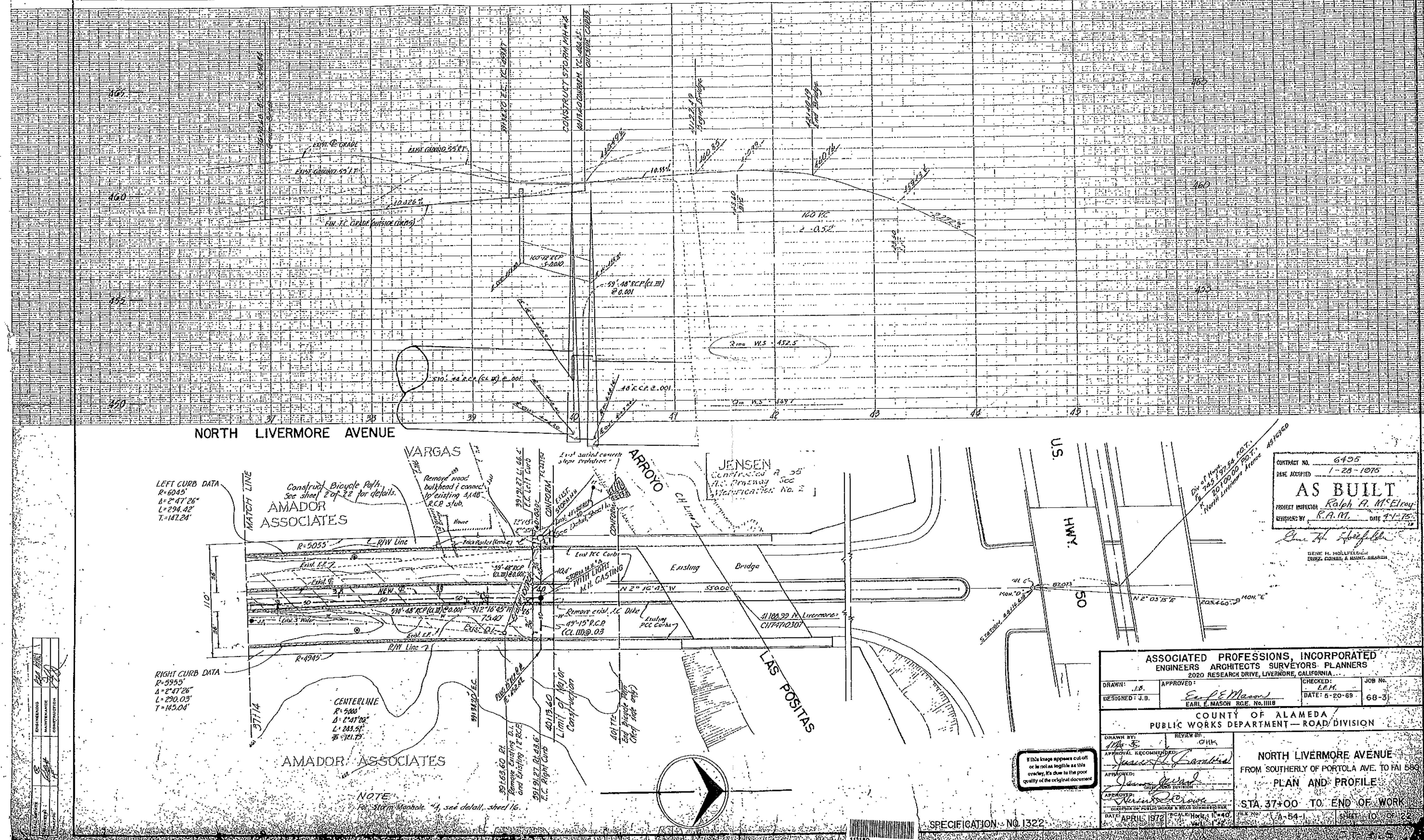
| TOP OF CURB GRADE - MEDIAN | 459.72 | 459.94 | 460.15 | 460.36 | 460.57 | 460.79 | 461.00 |




CONTRACT NO. 6495
DATE ACCEPTED 1-28-1975
**AS BUILT**
PROJECT INSPECTOR Ralph A. McElroy
REVISIONS BY R.A.M. DATE 4-1-75
GENE H. HOLLFELDER
CHIEF, CONST. & MAINT. BRANCH

**ASSOCIATED PROFESSIONS, INCORPORATED**
ENGINEERS ARCHITECTS SURVEYORS PLANNERS
2020 RESEARCH DRIVE, LIVERMORE, CALIFORNIA

DRAWN: J.B.
DESIGNED: J.B.
APPROVED: EARL E. MASON RCE. No. 11118
CHECKED: E.E.M.
DATE: 5-20-69
JOB No. 68-31

COUNTY OF ALAMEDA
PUBLIC WORKS DEPARTMENT — ROAD DIVISION

DRAWN BY:
REVIEW BY: GHK
APPROVAL RECOMMENDED:
APPROVED: CHIEF, ROAD DIVISION
APPROVED: DIRECTOR OF PUBLIC WORKS & ROAD COMMISSIONER

**NORTH LIVERMORE AVENUE**
FROM SOUTHERLY OF PORTOLA AVE. TO FAI 580
**PLAN AND PROFILE**
STA. 37+00 TO END OF WORK

DATE: APRIL 1972
SCALE: Horiz. 1" = 40' Vert. 1" = 2'
FILE No. A-54-1
SHEET 10 OF 22

SPECIFICATION NO. 1322

# 5.0 ATTACHMENTS

# 5.1 GUIDELINES

# SECTION 1

# INTRODUCTION

## 1.1 Background

Design guidelines presented within this document are based on the utility master plans recently completed for the City of Livermore (City). Separate reports were prepared for the City's sewer collection, storm drainage, water, and recycled water distribution systems. Each of the master plans established planning criteria for analyzing its system; identified capacity deficiencies in the existing system under existing and build-out conditions; recommended improvements to correct those deficiencies; and identified major extensions required to serve undeveloped areas.

The following reports should be consulted for detailed information on the City's utility master plans:

- City of Livermore 2004 Water Master Plan, July 2004
- City of Livermore 2004 Sewer Master Plan, July 2004
- City of Livermore Storm Drainage Master Plan, July 2004
- City of Livermore Recycled Water System Master Plan for Existing Service Area, July 2004

These reports contain maps showing existing and future major facilities and service areas. Electronic copies of the master plans and maps may be obtained from the City.

## 1.2 Guideline Purposes

These guidelines are intended for use by parties involved in the planning and design of water, recycled water, sewer, and storm drainage facilities to serve new development in the City. They cover criteria to be used to compute design flows and hydraulic capacities of facilities to serve new development. These guidelines should be used for design of on-site facilities not covered in the City's utility master plans, and for detailed design of master planned facilities as needed to supplement information in the master plans. Section 1.3 references other related guidelines and criteria for detailed design requirements for construction of facilities.

## 1.3 Related Guidelines and Standards

These guidelines make reference to other documents which may need to be consulted in certain cases. They include:

- The City of Livermore Development Plan Check Manual (latest edition) should be consulted for information on water, recycled water, sewer, and storm drainage requirements for development plans and capital improvement projects

- The latest adopted City of Livermore Standard Specifications and Details for water, recycled water, sanitary sewer, and storm drain projects should be consulted for detailed design requirements for construction.

- FEMA Flood Insurance Rate Maps for the City (latest edition) and for Alameda County Unincorporated Areas (latest edition) should be consulted as referenced in Section 3 of these guidelines.

- "Alameda County Hydrology and Hydraulics Manual" prepared by the Alameda County Flood Control District, June 2003, or latest edition, should be consulted as referenced in Section 3 of these guidelines.

- City of Livermore Guidelines For the Use of Recycled Water, May 2003, or latest edition, should be consulted for designing recycled water systems in the Zone 1 Recycled Water Service Area.

# SECTION 3

# STORM DRAINAGE SYSTEM CRITERIA

Storm drainage facilities shall conform to the City's latest adopted Storm Drainage Master Plan Development Plan Check Manual, City Standard Specifications and Details, and the Alameda Countywide NPDES Municipal Stormwater Permit. Key storm drainage facilities planning criteria are presented in this section. The design of storm drainage facilities is subject to evaluation using the City's storm drain model and these storm drainage facility guidelines subject to the approval of the City Engineer.

## 3.1 Major Creek Drainage

A network of small natural channels collect the storm water from the northern portion of the City. These channels include the Arroyo Seco, Arroyo Las Positas Relocation, Altamont Creek, Cayetano Creek, Collier Creek and Cottonwood Creek, all of which flow into the Arroyo Las Positas. The Arroyo Las Positas merges with the Arroyo Mocho to the west of Livermore, which eventually joins the Arroyo De La Laguna.

The Arroyo Mocho runs along the southern edge of the downtown portion of the City and conveys storm water from the downtown and southwest areas. It is a natural channel that has been excavated and improved in various reaches to provide enhanced flood flow conveyance. The Arroyo Del Valle runs along the southwestern edge of the City and picks up some storm water from the City. Both the Arroyo Mocho and the Arroyo Del Valle flow to the Arroyo De La Laguna to the west. The Arroyo De La Laguna drains to Alameda Creek, which reaches the San Francisco Bay approximately 4 miles downstream. This network of creeks along with the existing storm drain system is shown in Figure 3-1.

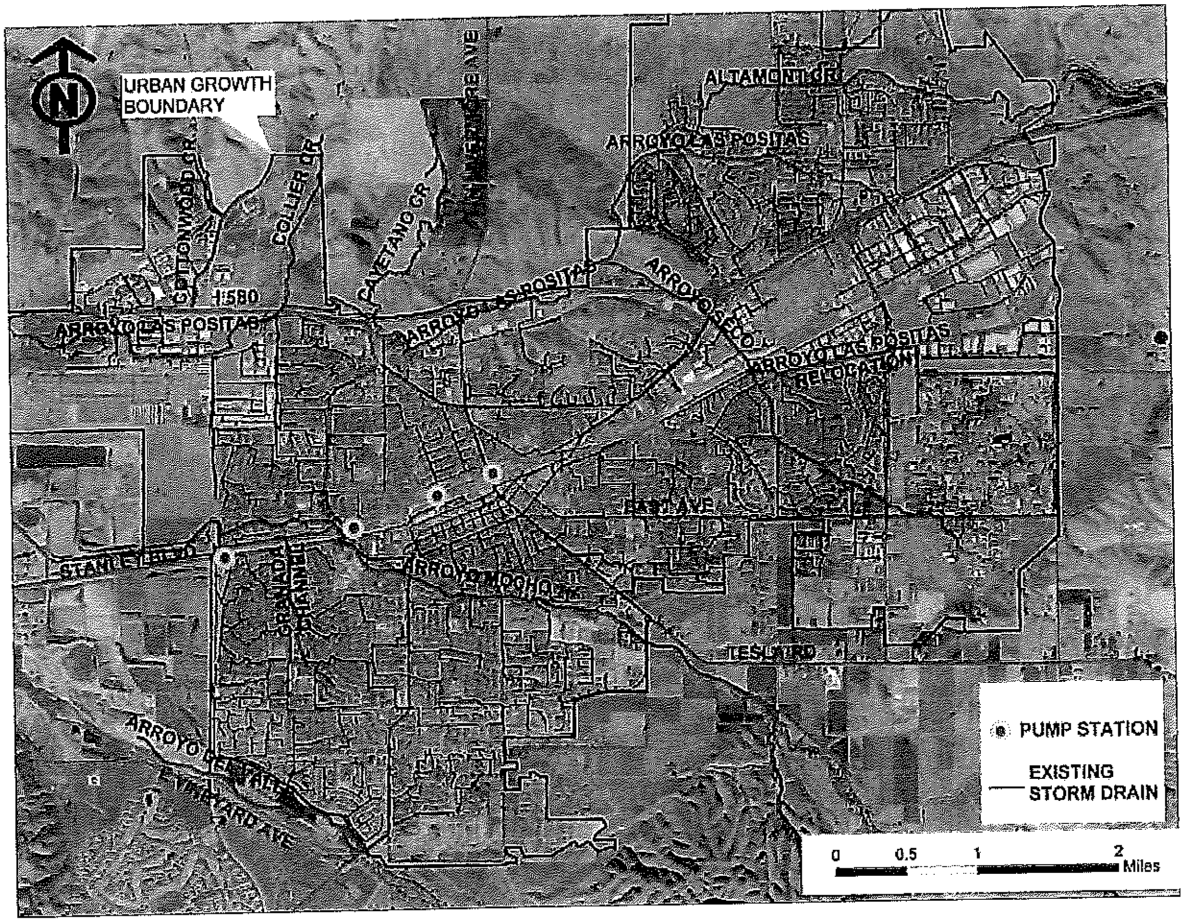



**Figure 3-1. Livermore Creek Network**

## 3.2 FEMA Studied Channels

FEMA prepared a Flood Insurance Study (FIS) for the City of Livermore in 1997, and for Alameda County in 2000. The FIS concentrated on 100-year flooding from Arroyo Del Valle, Collier Canyon Creek, Arroyo Seco, Altamont Creek, Arroyo Mocho and Arroyo Las Positas. Information on the 100-year and 500-year floodplain boundaries shall be obtained from the latest edition of the FIRM (Flood Insurance Rate Maps) prepared from the FEMA studies.

## 3.3 Drainage Concepts

The storm drainage system shall follow the natural drainage pattern as much as possible and shall take into account the constraints resulting from development. In general, open channels are preferable to an underground pipe system in suburban areas because of the strong environmental and aesthetic advantages that open stream corridors provide. However, for safety or convenience, it may be preferable to use an underground pipe system in certain developed areas. Stormwater detention or retention should be considered as an alternative or adjunct to pipe or channel improvements, especially where existing stream habitat or other sensitive environmental areas could be preserved by using a detention or retention system.

The following creeks shall remain as open channels: Arroyo Del Valle, Arroyo Mocho, Arroyo Las Positas, Arroyo Seco, Altamont Creek, Cayetano Creek, Collier Canyon Creek, and Cottonwood Creek. Generally, existing channels in North Livermore are to remain as open channels, unless otherwise approved. Storm drainage facilities within developments that are tributary to these open channels may be either open channels or pipes, subject to City approval.

Concrete-lined channels are not permitted in new development, and geometric earth-lined channels are generally not permitted. Channel design and friction factors must reflect requirements for revegetation within open channels. Concrete-lined interceptor v-ditches (typical 1-foot depth) may be used to control erosion, prevent off-site overland flow from entering lots, and prevent uncontrolled discharge of on-site flow from developed areas into neighboring properties.

At the discretion of the City Engineer, special drainage requirements may apply to any environmentally sensitive area within or adjacent to the City, especially the Springtown alkali sink wetlands, which is the site of known populations of a special status plant species (Bird's-Beak).

The 2003 Alameda Countywide NPDES municipal stormwater permit for the Alameda Countywide Clean Water Program (Order R2-2003-0021) requires that beginning February 2005 projects creating impervious area of one acre and greater need to provide permanent treatment for stormwater according to specific calculations. This means that the amount of water that must be treated before release to the stormdrain system is defined by specific hydraulic sizing design criteria. For specific calculations see the Numeric Sizing Criteria below. Projects smaller than one acre will still need to provide treatment to Maximum Extent Practicable. Beginning August 2006, projects creating 10,000 square feet or more of impervious area will need to provide permanent stormwater treatment according to the hydraulic sizing design criteria. Landscape measures that provide water quality treatment are the preferred option. Manufactured solutions are acceptable if it is shown that landscape measures are not feasible. The permit requires that the owner of every treatment facility enters into a maintenance agreement with the City to ensure that stormwater treatment devices are routinely maintained and function properly.

For resources and assistance to comply with the current and new NPDES requirements consult the following web sites: www.cabmphandbooks.com, www.scvurppp.org, www.cwp.org, www.basmaa.org.

## 3.4 Numeric Sizing Criteria for Pollutant Removal Treatment Systems

All Dischargers shall require that treatment BMPs be constructed for applicable projects, as defined in Section C.3.c. of the NPDES permit. These BMPs must incorporate, at a minimum, the following hydraulic sizing design criteria to treat stormwater runoff. As appropriate for each criterion, the Dischargers shall use or appropriately analyze local rainfall data to be used for that criterion.

A. Volume Hydraulic Design Basis: Treatment BMPs whose primary mode of action depends on volume capacity, such as detention/retention units or infiltration structures, shall be designed to treat stormwater runoff equal to:

   1. The maximized stormwater quality capture volume for the area, based on historical rainfall records, determined using the formula and volume capture coefficients set forth in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998(, pages 175-178 (e.g., approximately the 85th percentile 24-hour storm runoff event); or

   2. The volume of annual runoff required to achieve 80 percent or more capture, determined in accordance with the methodology set forth in Appendix D of the California Stormwater Best Management Practices Handbook, (1993), using local rainfall data.

B. Flow Hydraulic Design Basis: Treatment BMPs whose primary mode of action depends on flow capacity, such as swales, sand filters, or wetlands, shall be sized to treat:

   1. 10% of the 50-year peak flow rate; or

   2. The flow runoff produced by a rain event equal to at least two times the $85^{th}$ percentile hourly rainfall intensity for the applicable area, based on historical records of hourly rainfall depths; or

   3. The flow of runoff resulting from a rain event equal to at least 0.2 inches per hour intensity.

## 3.5 Design Storm and Calculation Submittal Requirements

City storm drain facilities shall be designed for the 10-yr design storm. Creeks that remain as open channels shall be designed for the 100-year design storm in accordance with the latest adopted Alameda County Zone 7 Standards. Any new storm drainage facilities should be designed in conformance with the following standards:

The 10 year hydraulic gradeline of all closed conduit storm drainage systems shall be a minimum of 1.25 feet below top of curb elevation at any manhole or inlet. The 10-year water surface shall be kept below the top of bank of all drainage swales and v-ditches.

The 100-year water surface shall be 1 foot below new pad elevations of the tract. The design engineer shall map the street and overland flow routes within the subdivision for the 100-year storm. The map shall identify the 100-year water surface elevations within the subdivision. Overland drainage easements and permanent drainage swales shall be provided between homes and through lots when the 100-year storm flow will not follow the streets through the subdivision. The 100-year water surface in the swales shall be 1 foot below the pad elevations. Mid-block low points that require overland flow easements through lots will not be allowed where an alternative design is possible and practical.

Parts of Livermore's existing collection system do not strictly meet these criteria; therefore, when new systems are tied into existing systems, it may not be possible to provide a design that meets the desired standard. The design and evaluation of new systems, particularly extensions of existing systems, must be done on a case-by-case basis. The following exceptions to the standard design criteria shall be considered in designing new collection systems that discharge to existing systems: when downstream surcharge effects are included, upstream hydraulic grades shall be no higher than the top of curb elevation at any manhole or inlet.

The design engineer shall submit the hydrologic calculations and hydraulic gradeline calculations. Profiles of each existing and proposed storm drain shall be submitted with the calculations. The profile shall show the following information: beginning water surface elevation and location for hydraulic calculations, storm drain invert and soffit, diameter, design flow, 10-year hydraulic gradeline, existing ground line, proposed ground line if applicable, and locations of street intersections and connections with other storm drains or channels. A plan view map shall also be provided for off-site profiles.

## 3.6 Rainfall

Figure 3-2 shows the Mean Annual Precipitation (MAP) in the Livermore area. The rainfall intensities are calculated using the MAP in the equation shown in the Rational Method section.

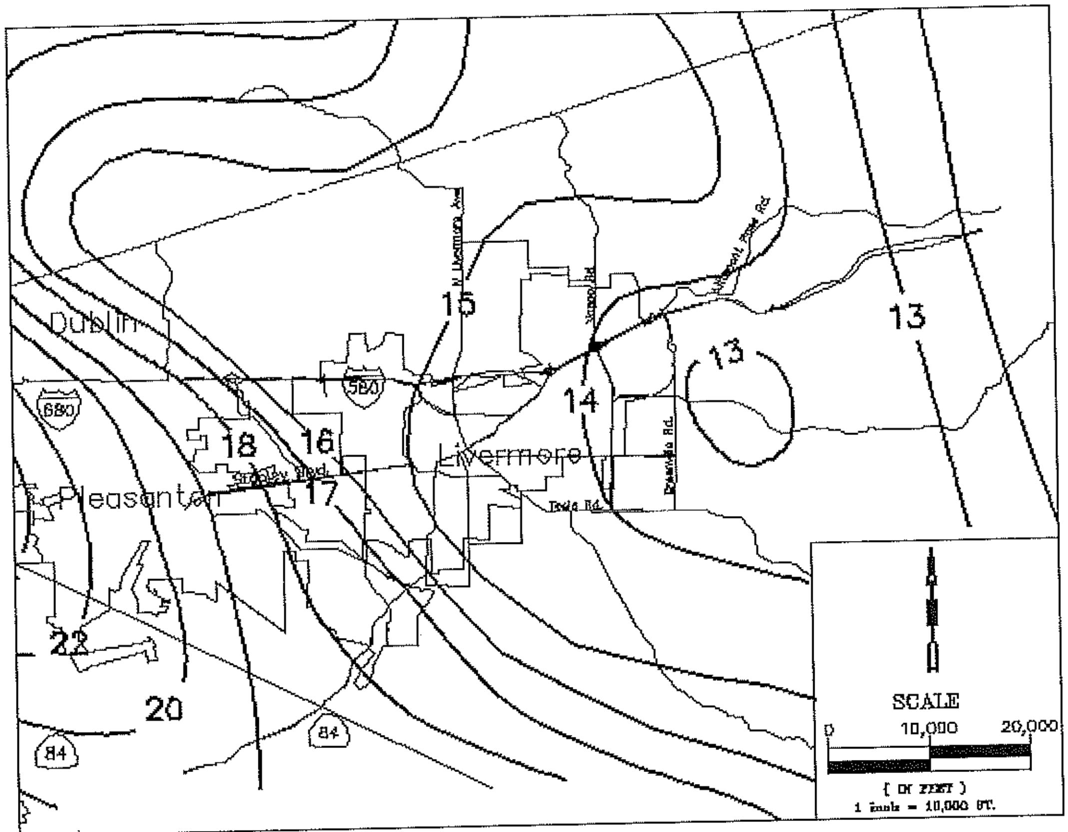



Figure 3-2. Livermore Mean Annual Precipitation in Inches (MAP)

## 3.7 Peak Runoff - Computerized Method

A computer simulation model can be used to estimate peak runoff. When using a computerized model, the SCS curve number method should be used so comparisons with the City's storm drain model can easily be performed. The City's Storm Drain Master Plan uses DHI's MOUSE model, which is available for use; however, a model license is required to access the modeling software. Ultimate buildout land use shall be assumed. Land use designations shall be obtained from the City's latest General Plan.

## 3.8 Peak Runoff - Rational Method

The Rational Method can be used to determine peak discharges for drainage areas up to 320 acres in size. At the option of the City Engineer, use of the Rational Method may be approved for larger drainage areas. Ultimate buildout land use shall be assumed. Land use designations shall be obtained from the City's latest General Plan.

The Rational Method Equation is:

**Q = CiA**

Where:
Q = design peak flow-rate (cfs)
C = runoff coefficient for the drainage area (Table 3-1)
i = rainfall intensity (inches/hr)
A = drainage area (acres)

The rainfall intensity shall be calculated using the following equation from Chapter 3 of the Alameda County Hydrology and Hydraulics Manual (June 2003):

$$\mathbf{i = (0.33 + 0.091144 * MAP) * (0.249 + 0.1006 * K_j) * T_c^{-0.56253}}$$

where:

i = Rainfall intensity (inches/hr)
MAP = Mean Annual Precipitation (Figure 3-2, inches)
$T_c$ = Storm duration (hours)
$K_j$ = Frequency factor (1.339 for 10-year, 3.211 for 100-year)

The following equation shall be used to calculate the time of concentration (Tc):

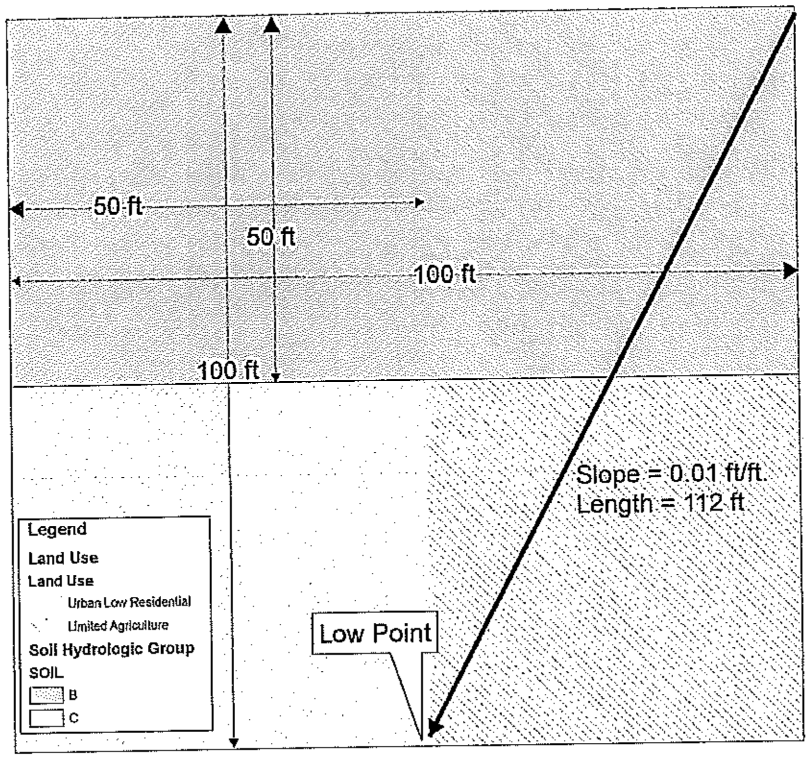
$$T_c = L^{0.8}\frac{(S+1)^{0.7}}{1900\sqrt{Y}} \quad \text{and,}$$

S = (1000/CN)-10

where:
$T_c$= Lag time (hrs)
L = Hydraulic length of watershed (ft)
S = Maximum retention in the watershed (in)
Y = Watershed slope (ft/ft)
CN = SCS curve number for the watershed (Table 3-1)

The *2003-2025 General Plan Land Use Map* (last revision 2/10/04) shows the general plan land use classifications throughout the City and is included as Figure 3-3. The City of Livermore Planning Department should be consulted to determine the most up to date land use designations in the drainage area. The soil curve numbers (CN), percent imperviousness, and the runoff coefficient (C) for each land use are listed in Table 3-1. The NRCS STATSGO soil groups for the City of Livermore are shown in Figure 3-4. A weighted soil curve number and runoff coefficient shall be calculated based on the percentage of the different land uses and soils in the drainage area. As shown in Table 3-1, Group B soils have higher infiltration rates and lower runoff coefficients than the other soil types in the study area. The SCS Soil Survey for Alameda Area, CA should be consulted for more detailed information on soils. An example peak runoff calculation for a drainage area with different land uses and soils is provided below.

Peak Runoff Example Calculation:




Q = CiA

Calculate average C value for the basin (values from Table 3-1):

C = 0.25(0.4)+.025(0.5)+0.25(0.2)+0.25(0.3) = 0.35

Calculate Tc:

$$T_c = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$$ and, S = (1000/CN)-10

where:

Y = 0.01 ft/ft (average basin slope calculated)

L = 112 ft (measured longest flow path to point of interest)

Average Cuver Number (CN) calculation (values from Table 3-1):

CN = 0.25(70)+0.25(80)+0.25(77)+0.25(85) = 78

S = (1000/78)-10 = 2.82

$$T_c = 112^{0.8} \frac{(2.82+1)^{0.7}}{1900\sqrt{0.01}} = \mathbf{0.59\ hrs}$$

Calculate the Rainfall Intensity:

$i = (0.33 + 0.091144 * MAP) * (0.249 + 0.1006 * K_j) * T_c^{-0.56253}$

MAP = 15 inches (find site location from Figure 3-2)

Kj = 1.339 (10-year flow frequency)

$= (0.33 + 0.091144*15)*(0.249+0.1006*1.339)*0.59^{-0.56253}$ = **0.88 in/hr**

Calculate Basin Area:

A = (100 ft X 100 ft)/43560 = **0.23 Acres**

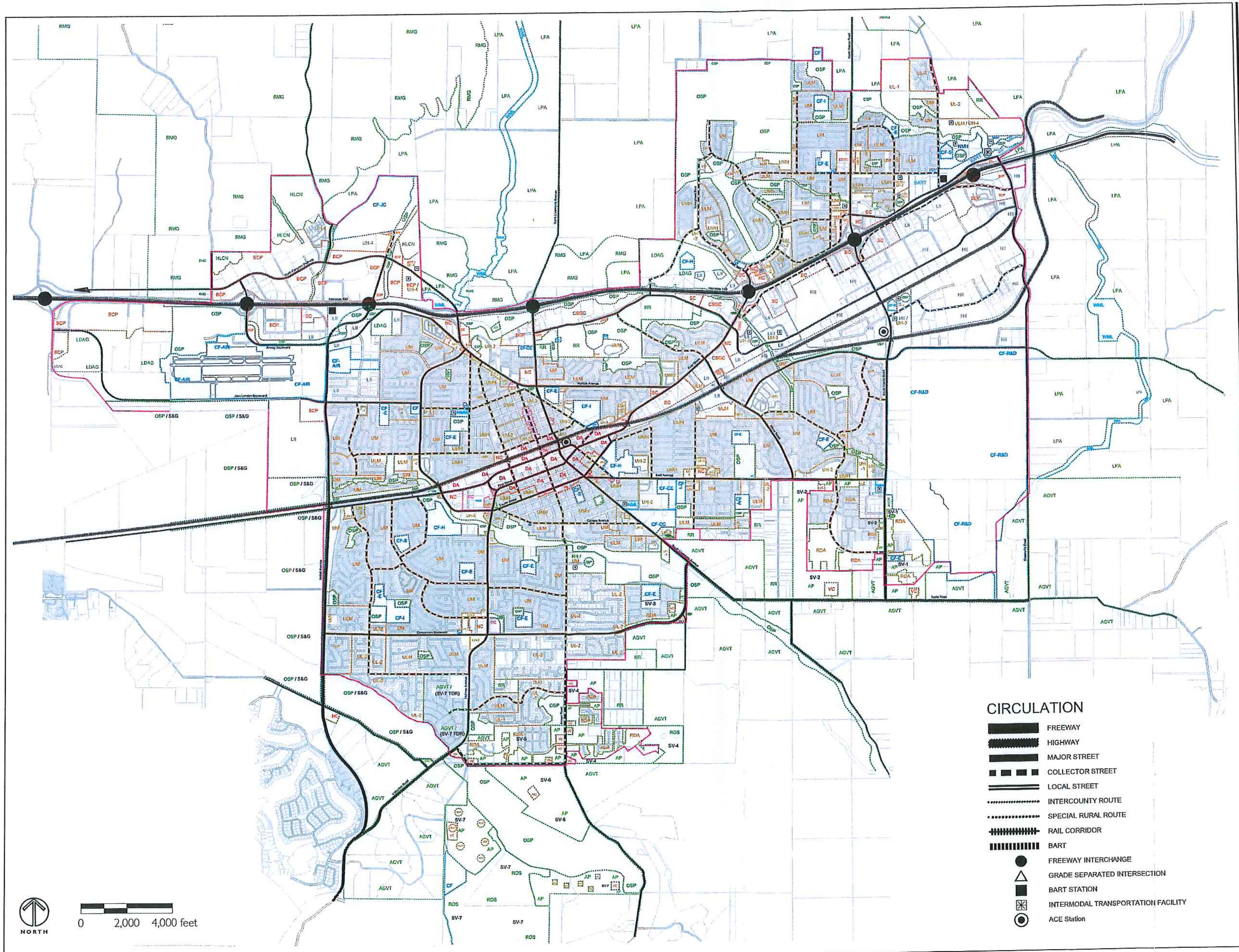
Q = CiA

= (0.35) * (0.88 in/hr) * (0.23 Acres) = **0.07 cfs**

**Insert Figure 3-3. General Plan Land Use Map**

FIGURE 3 - 3

# GENERAL PLAN LAND USE MAP




## RESIDENTIAL

| | | |
|---|---|---|
| RR | RURAL RESIDENTIAL | 1 to 5 Acre Site |
| UL-# | URBAN LOW RESIDENTIAL | #1 = 1.0 - 1.5 d.u./ac; #2 = 1.5 - 2.0 d.u./ac. |
| ULM | URBAN LOW MEDIUM RESIDENTIAL | 2.0 - 3.0 d.u./ ac. |
| UM | URBAN MEDIUM RESIDENTIAL | 3.0 - 4.5 d.u./ ac. |
| UMH | URBAN MEDIUM HIGH RESIDENTIAL | 4.5 - 6.0 d.u./ ac. |
| UH-# | URBAN HIGH RESIDENTIAL | 1 = 6 - 8 d.u./ ac.; 2 = 8 - 14 d.u./ ac.; 3 = 14 - 18 d.u./ ac.; 4 = 18 - 22 d.u./ ac.; 5 = 22 - 38 d.u./ ac; 6 = 38 - 55 d.u./ ac. |
| RDA | RESIDENTIAL DEVELOPMENT AREA (SLV) | |

## COMMERCIAL

| | | |
|---|---|---|
| NC | NEIGHBORHOOD COMMERCIAL | .3 FAR |
| SC | SERVICE COMMERCIAL | .3 FAR |
| HC | HIGHWAY COMMERCIAL | .3 FAR |
| OC | OFFICE COMMERCIAL | .3 FAR |
| CSGC | COMMUNITY SERVING GENERAL COMMERCIAL | .3 FAR |
| VC | VINEYARD COMMERCIAL (SLV) | |

## MIXED USE

| | | |
|---|---|---|
| NML | NEIGHBORHOOD MIXED LOW DENSITY | 12 -15 d.u./ ac. .3 Commercial FAR |
| NMM | NEIGHBORHOOD MIXED MEDIUM DENSITY | 15 - 24 d.u./ ac. .3 Commercial FAR |
| NMH | NEIGHBORHOOD MIXED HIGH DENSITY | 24 - 38 d.u./ ac. .3 Commercial FAR |
| DA | DOWNTOWN AREA (See DSP) | |

## OPEN SPACE

| | | |
|---|---|---|
| OSP | PARKS, TRAIL WAYS, RECREATION CORRIDORS, AND PROTECTED AREAS | |
| LDAG | LIMITED AGRICULTURE | 20 Acre Minimum Site |
| AGVT | AGRICULTURE / VITICULTURE | 1.0 - 5.0 d.u./ 100 ac. |
| HLCN | HILLSIDE CONSERVATION | 1.0 d.u./ ac - 1.0 d.u./ 100 ac. |
| S & G | SAND AND GRAVEL | |
| LPA | LARGE PARCEL AGRICULTURE | 100 Acre Minimum Site |
| RMG | RESOURCE MANAGEMENT | 100 Acre Minimum Site; 1 d.u./ parcel |
| WML | WATER MANAGEMENT LANDS | 100 Acre Minimum Site; 1 d.u./ parcel |
| AP | AGRICULTURE PRESERVE (SLV) | |
| ROS | REGIONAL OPEN SPACE (SLV) | |

## COMMUNITY FACILITIES

| | |
|---|---|
| CF-E | ELEMENTARY SCHOOL K-5 |
| CF-I | INTERMEDIATE SCHOOL 7 - 8 |
| CF-H | HIGH SCHOOL 9 - 12 |
| CF-JC | COMMUNITY COLLEGE |
| CF-S | SCHOOL - GENERAL |
| CF-R&D | RESEARCH & DEVELOPMENT |
| PO | POST OFFICE |
| FS | FIRE STATION |
| HOSP | HOSPITAL |
| CF-CC | CIVIC CENTER |
| CF-CE | CEMETERY |
| CF | GOVERMENT SERVICES |
| CF-AIR | AIRPORT |
| BART | BART STATION AND PARKING |

## INDUSTRIAL

| | | |
|---|---|---|
| BCP | BUSINESS AND COMMERCIAL PARK | .3 - .5 FAR |
| LII | LOW INTENSITY INDUSTRIAL | .45 FAR |
| HII | HIGH INTENSITY INDUSTRIAL | .6 FAR |

| | |
|---|---|
| R | TDC RECEIVER SITE |
| OSP | FLOATING POTENTIAL FUTURE PARK LOCATION |
| CF-I | FLOATING POTENTIAL FUTURE SCHOOL LOCATION |
| | Urban Growth Boundary |
| SV-# | SOUTH LIVERMORE VALLEY SPECIFIC PLAN (# = Subarea Number) |
| (SV-# TDR) | SLV Transferrable Development Rights (# = Subarea Number) |

## Table 3-1. Land Use, Soil Curve Number (CN), Percent Imperviousness, and Runoff Coefficients

| Land Use Symbol | Land Use Description | CN for Soil with Hydrologic Group B | CN for Soil with Hydrologic Group C | CN for Soil with Hydrologic Group D | Percent Impervious | Runoff Coefficient, C (Soil Type B) | Runoff Coefficient, C (All Other Soils) |
|---|---|---|---|---|---|---|---|
| RESIDENTIAL | | 68 | 79 | 84 | 10 | 0.35 | 0.40 |
| RR | Rural Residential | 70 | 80 | 85 | 30 | 0.40 | 0.50 |
| UL | Urban Low Residential | 70 | 80 | 85 | 80 | 0.40 | 0.50 |
| UL-1 | Urban Low Residential, 1.5 d.u./ac. | 70 | 80 | 85 | 80 | 0.40 | 0.50 |
| UL-2 | Urban Low Residential, 2 d.u./ac. | 72 | 81 | 86 | 45 | 0.40 | 0.50 |
| ULM | Urban Low Medium Residential, 3.0 d.u./ac. | 75 | 83 | 87 | 60 | 0.50 | 0.60 |
| UM | Urban Medium Residential, 4.5 d.u./ac. | 80 | 87 | 90 | 70 | 0.50 | 0.60 |
| UMH | Urban Medium High Residential, 6.0 d.u./ac. | 85 | 90 | 92 | 80 | 0.60 | 0.70 |
| UH | Urban High Residential | 85 | 90 | 92 | 80 | 0.60 | 0.70 |
| UH-1 | Urban High Residential, 6-8 d.u./ac. | 85 | 90 | 92 | 80 | 0.60 | 0.70 |
| UH-2 | Urban High Residential, 8-14 d.u./ac. | 88 | 91 | 93 | 80 | 0.60 | 0.70 |
| UH-3 | Urban High Residential, 14-18 d.u./ac. | 88 | 91 | 93 | 80 | 0.60 | 0.70 |
| UH-4 | Urban High Residential, 18-22 d.u./ac. | 75 | 83 | 87 | 20 | 0.50 | 0.60 |
| VDSF | Very Low Density Single Family, 4 d.u./ac. | 80 | 87 | 90 | 45 | 0.50 | 0.60 |
| LDSF | Low Density Single Family, 6. d.u./ac. | 92 | 94 | 95 | 80 | 0.70 | 0.75 |
| HDV | High Density Village, 18 d.u./ac. | | | | | | |
| COMMERCIAL | | 92 | 94 | 95 | 90 | 0.85 | 0.95 |
| CORC | Core Commercial | 92 | 94 | 95 | 85 | 0.60 | 0.70 |
| CSGC | Community Serving General Commercial | 92 | 94 | 95 | 90 | 0.85 | 0.95 |
| DC | Dense Commercial | 92 | 94 | 95 | 90 | 0.85 | 0.95 |
| HC | Highway Commercial | 92 | 94 | 95 | 85 | 0.60 | 0.70 |
| NC | Neighborhood Commercial | 92 | 94 | 95 | 90 | 0.85 | 0.95 |
| OC | Office Commercial | 92 | 94 | 95 | 85 | 0.85 | 0.95 |
| SC | Service Commercial | 92 | 94 | 95 | 85 | 0.85 | 0.95 |
| SUPC | Support Commercial | 88 | 91 | 93 | 65 | 0.60 | 0.70 |
| UDP-# | See Downtown Urban Design Plan | | | | | | |
| OPEN SPACE | | 69 | 79 | 84 | 5 | 0.20 | 0.30 |
| AGVT | Agriculture / Viticulture, 1-5 d.u./100 ac. | 77 | 85 | 89 | 5 | 0.20 | 0.30 |
| GNAG | General Agriculture, 100 ac. Min. Site | 69 | 79 | 84 | 20 | 0.20 | 0.30 |
| HLCN | Hillside Conservation | 77 | 85 | 89 | 5 | 0.20 | 0.30 |
| LDAG | Limited Agriculture | 77 | 85 | 89 | 5 | 0.20 | 0.30 |
| LPA | Large Parcel Agriculture | 69 | 79 | 84 | 20 | 0.20 | 0.25 |
| OSP | Parks, Trail Ways, Rec. Corridors, and Protected Areas | 69 | 79 | 84 | 30 | 0.20 | 0.30 |
| R&G | Range and Grassland, 100 ac. Min. Site | 69 | 79 | 84 | 30 | 0.20 | 0.30 |
| RMG | Resource Management | 82 | 87 | 89 | 20 | 0.20 | 0.30 |
| S&G | Sand and Gravel Resources | 69 | 79 | 84 | 10 | 0.20 | 0.30 |
| VIT | Viticulture, 100 ac. Min. Site | 75 | 75 | 75 | 10 | 0.20 | 0.30 |
| WML | Water Management Lands | | | | | | |
| COMMUNITY FACILITIES | | 92 | 94 | 95 | 95 | 0.50 | 0.60 |
| BART | Bart Station | 92 | 94 | 95 | 85 | 0.50 | 0.60 |
| CF | Government Services | 79 | 85 | 89 | 90 | 0.70 | 0.95 |
| CF-AIR | Airport | 92 | 94 | 95 | 85 | 0.50 | 0.60 |
| CF-CC | Civic Center | 69 | 79 | 84 | 30 | 0.50 | 0.60 |
| CF-CE | Cemetery | 88 | 91 | 93 | 85 | 0.50 | 0.60 |
| CF-E, CF-H, CF-I | Schools | 92 | 94 | 95 | 85 | 0.50 | 0.60 |
| FS | Fire Station | 98 | 98 | 98 | 100 | 0.50 | 0.60 |
| ROAD | Road | | | | | | |
| INDUSTRIAL | | 88 | 91 | 93 | 90 | 0.65 | 0.80 |
| BCP | Business and Commercial Park | 88 | 91 | 93 | 95 | 0.75 | 0.90 |
| HII | High Intensity Industrial | 88 | 91 | 93 | 70 | 0.65 | 0.80 |
| LII | Light Intensity Industrial | | | | | | |
| MIXED USE | | 92 | 94 | 95 | 75 | 0.60 | 0.70 |
| DA | Mixed | 92 | 94 | 95 | 85 | 0.60 | 0.70 |
| DBG | Downtown Boulevard Gateway | 85 | 90 | 92 | 75 | 0.60 | 0.70 |
| DNN | Downtown Neighborhood North Side | 85 | 90 | 92 | 75 | 0.60 | 0.70 |
| DNS | Downtown Neighborhood South Side | 88 | 91 | 93 | 90 | 0.60 | 0.70 |
| DTG | Downtown Transit Gateway | 88 | 91 | 93 | 75 | 0.60 | 0.70 |
| NMH | Neighborhood Mixed High Density | 88 | 91 | 93 | 60 | 0.60 | 0.70 |
| NMM | Neighborhood Mixed Medium Density | 85 | 90 | 92 | 30 | 0.60 | 0.70 |
| NML | Neighborhood Mixed Low Density | | | | | | |
| SOUTH LIVERMORE VALLEY SPECIFIC PLAN | | 69 | 79 | 84 | 5 | 0.20 | 0.30 |
| SVA | Agriculture | 69 | 79 | 84 | 10 | 0.20 | 0.30 |
| SV-AP | | 92 | 94 | 95 | 90 | 0.60 | 0.70 |
| SVC | Wine Country Commercial | 69 | 79 | 84 | 20 | 0.20 | 0.30 |
| SVOS | Open Space | 69 | 79 | 84 | 20 | 0.20 | 0.25 |
| SVP | Park | 85 | 90 | 92 | 60 | 0.40 | 0.50 |
| SVR | Wine Country Residential | 88 | 91 | 93 | 85 | 0.50 | 0.60 |
| SVS | School | | | | | | |

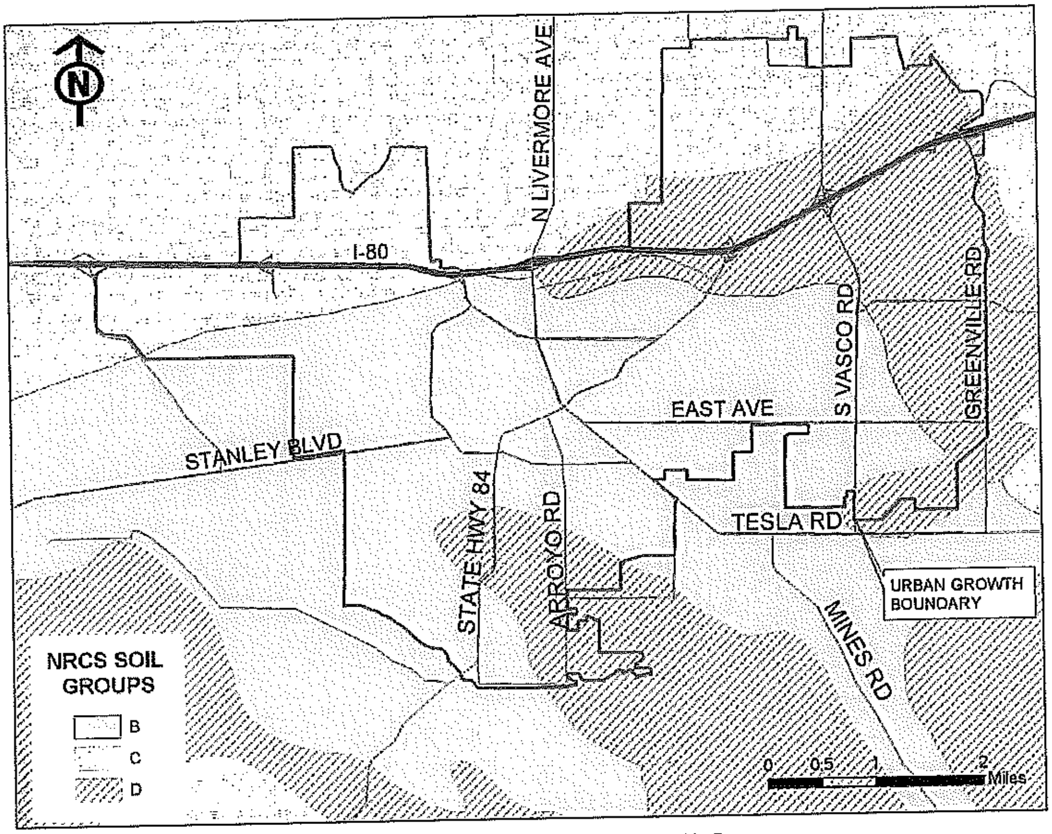



Figure 3-4. Livermore NRCS Soil Groups

## 3.9 Hydraulic Criteria

*Freeboard*

The 10-year design storm freeboard requirements for closed conduits and swales are shown in Table 3-2. Open channels shall be constructed as per Alameda County Zone 7 Standards. 100-year design storm requirements are discussed in Section 3.5.

**Table 3-2. 10-Year Design Storm Freeboard Requirements**

| Facility | Freeboard, ft | From Design HGL Up To: |
|---|---|---|
| Closed Conduit | 1.25 | Top of Curb |
| | 0.75 | Top of Inlet Grate |
| Swales | 0 | Top of Bank |

Calculations must be submitted to the city showing that the hydraulic grade line of the storm drainage facilities comply with the freeboard requirements. Example calculations for in-line friction and junction losses are given in the following section; other calculation methods need to be approved by City. A storm drain model developed for the existing system may also be used.

*Friction Losses*

Storm drain friction head losses shall be determined using Manning's equation (shown below) and the friction factors shown in Table 3-3:

Manning's equation for friction head loss:

$H_f = L*S_f$ and,

$$S_f = \left[\left(\frac{(Q/A)n}{K}\right)R^{1.5}\right]^2$$

Where:
$H_f$ = Friction head loss (ft)
L = Pipe length (ft)
$S_f$ = Friction slope (ft/ft)
Q = Flow rate (cfs)
A = Cross sectional area of the flow ($ft^2$)
n = Manning's roughness coefficient (Table 3-3)
K = 1.486
R = Hydraulic radius (ft)
R = flow area (SF)/wetted perimeter (ft)

**Table 3-3. Manning's n Roughness Coefficients**

| Type of Facility | Friction Factor |
|---|---|
| Reinforced Concrete Pipe ( and Cast-In-Place Pipe) | 0.013 |
| Concrete-Lined Interceptor V-Ditches | 0.017 |
| Reinforced Concrete Box | |
| Cast-in-Place | 0.015 |
| Pre-Cast | 0.014 |
| Natural Channels | |
| Straight bank | |
| - Some weeds and stones | 0.035 |
| - Very weedy reaches | 0.070 |
| Winding | |
| - Some weeds and stones | 0.045 |
| - Very weedy reaches | 0.125 |

*Manhole Minor Losses*

The head losses at structures should be calculated for inlets, manholes, wye branches, or bends in the design of full flow closed conduits. Minimum head loss used for calculations should be 0.10 feet at all structures, unless otherwise approved by the City Engineer. The following list of equations should be used for manhole, junction, and bend losses. Other equations must be approved by the City Engineer.

The energy loss for ***through manholes*** where there is no change in pipe sizes ($H_m$) is shown below.

$$H_m = 0.05 * \frac{V^2}{2g}$$

where:
$H_m$ = Through manhole minor head loss (ft)
V = Flow Velocity (ft/sec)
g = Acceleration due to gravity (32 $ft/sec^2$)

Losses in ***terminal manholes*** can be estimated with the following equation:

$$H_{tm} = \frac{V^2}{2g}$$

where:
$H_{tm}$ = Terminal manhole minor head loss (ft)
V = Flow Velocity (ft/sec)
g = Acceleration due to gravity (32 $ft/sec^2$)

*Bend Minor Losses*

***Bend losses*** can be estimated with the following equation:

$$H_b = K_b \frac{V^2}{2g} \quad \text{with, } K_b = \sqrt{\frac{\theta}{90}}$$

for curved lines with angles less than 40°, use Table 3-4 for bends greater than 40°

where:
$H_b$ = Minor bend head loss (ft)
$K_b$ = Bend loss coefficient
V = Flow velocity (ft/sec)
$\theta$ = central angle of bend (degrees)

**Table 3-4. Bend Loss Coefficients**

| Structure Description | Loss Coefficient, $k_b$ |
|---|---|
| Inlet or Manhole at Beginning of Line | 1.25 |
| 90° Bend with Radius = Pipe Diameter * | 0.50 |
| 90° Bend with Radius = 2 to 8 Pipe Diameters * | 0.40 |
| 90° Bend with Radius = 8 to 20 Pipe Diameters * | 0.25 |

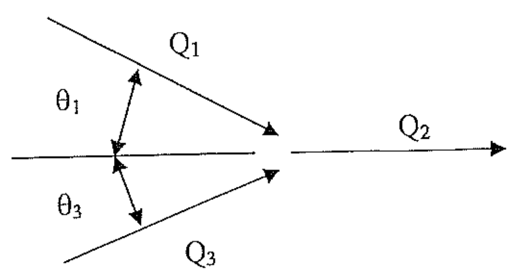
* These $K_b$ coefficients can be reduced by the following factors when bends other than 90° are used: 60° Bend-0.85; 45° Bend 0.70

*Junction Losses*

At points of change in the hydraulic parameters of flow rate or pipe diameter, the HGL and Energy Grade Line (EGL) shall be calculated. The Pressure-Momentum method should be used to calculate the change in water surface (HGL) at major junctions:

$$\Delta y = \frac{Q_2V_2 - Q_1V_1\cos(\theta_1) - Q_3V_3\cos(\theta_3)}{\frac{g(A_1 + A_2)}{2}}$$

where:




Δy = Change in hydraulic gradient (HGL) through the junction (ft).
Q = Flow in cubic feet per second (cfs).
V = Velocity (ft/s).
Q2 = Exit discharge (Q2 = Q1 + Q3)
Q1 = Inlet discharge
Q3 = Lateral discharge
θ3 = Angle of convergence between the center line of the exit discharge and the center line of the lateral discharge (degrees)
θ1 = Angle of the deflection between the inlet discharge and exit discharge center lines (degrees)
g = Acceleration due to gravity (32 ft/sec$^2$)
V1 = Velocity of Inflow (fps)
V2 = Velocity of Outflow (fps)

V3 = Velocity of Lateral (fps)
A1 = Area of Flow ($ft^2$) of Inlet
A2 = Area of flow ($ft^2$) of Outlet

*Hydraulic Jumps or Other Special Conditions*

If hydraulic jumps or other special conditions occur (such as wave action due to high velocity flows and/or effects of curvature or air entrainment due to high velocities > 14 fps), the design engineer shall submit a detailed analysis stating all assumptions.

## 3.10 Minimum Pipe Sizes

Storm drains shall be sized to handle peak flows from ultimate upstream development, but in any case, a minimum 12-inch diameter pipe shall be required for City storm drainage facilities. The City has information available on tributary areas, and on the trunk storm drainage system (pipes 24-inches in diameter and larger) as it existed when the Storm Drainage Master Plan was prepared. This information includes pipe sizes and ultimate design flows.

## 3.11 Allowable Slopes and Velocities

The system shall be designed to meet the velocity and slope criteria in Table 3-5.

**Table 3-5. Storm Drain Velocity and Slope Standards**

| Facility | Min. Velocity, ft/sec | Max. Velocity, ft/sec | Min. Slope, ft/ft |
|---|---|---|---|
| Earth Channels | 2.0 | 6.0 | 0.0007 |
| Closed Conduits (when flowing half full) | 2.5 | 14.0 | 0.0007 |

Where velocities exceed the above values, special design criteria must be established on a case-by-case basis to provide for scouring, maintenance, or uneven flow conditions. Concrete-lined channels shall not be used.

## 3.12 Beginning Water Surface Elevations (WSE)

For the 10-year hydraulic grade line, the beginning water surface elevations (WSE) shall be the 10-year water surface elevation for ultimate conditions. The starting point for the hydraulic gridline calculation shall be where the subdivision's storm drainage discharges to a FEMA studied creek or channel.

There are no ultimate condition studies provided by FEMA (FEMA shows only existing WSE). Unless a special study is performed to determine the ultimate 10-year WSE or information is available from the Alameda County Zone 7 creek flow models, the FEMA 100-yr WSE (which are based on existing conditions) shall be assumed to be representative of the ultimate 10-year or greater WSE and shall be used in the hydraulic analysis.

At the option of the City Engineer, the City may provide a starting WSE when tying into the existing storm drainage system; it will be based on the MOUSE hydraulic model.

The closest known downstream water surface elevation for the 10-year design storm for the ultimate conditions may also be used for the beginning water surface for the hydraulic grade line analysis.

## 3.13 Summary of Design Standards

Manholes should be no farther than 500 feet apart, and catch basins are to be spaced so that the maximum width of gutter flow does not exceed eight feet from the face of curb during a ten-year design storm. On street drainage shall not exceed the maximum gutter runs listed in Table 3-6. The maximum gutter run shall not exceed 1,500 feet, regardless of street slope.

**Table 3-6. Maximum Gutter Runs**

| Average Street Slope | Maximum Gutter Run |
|---|---|
| .005 | 500 feet |
| .006 | 550 feet |
| .007 | 600 feet |
| .008 | 650 feet |
| .009 | 700 feet |
| .010 | 750 feet |

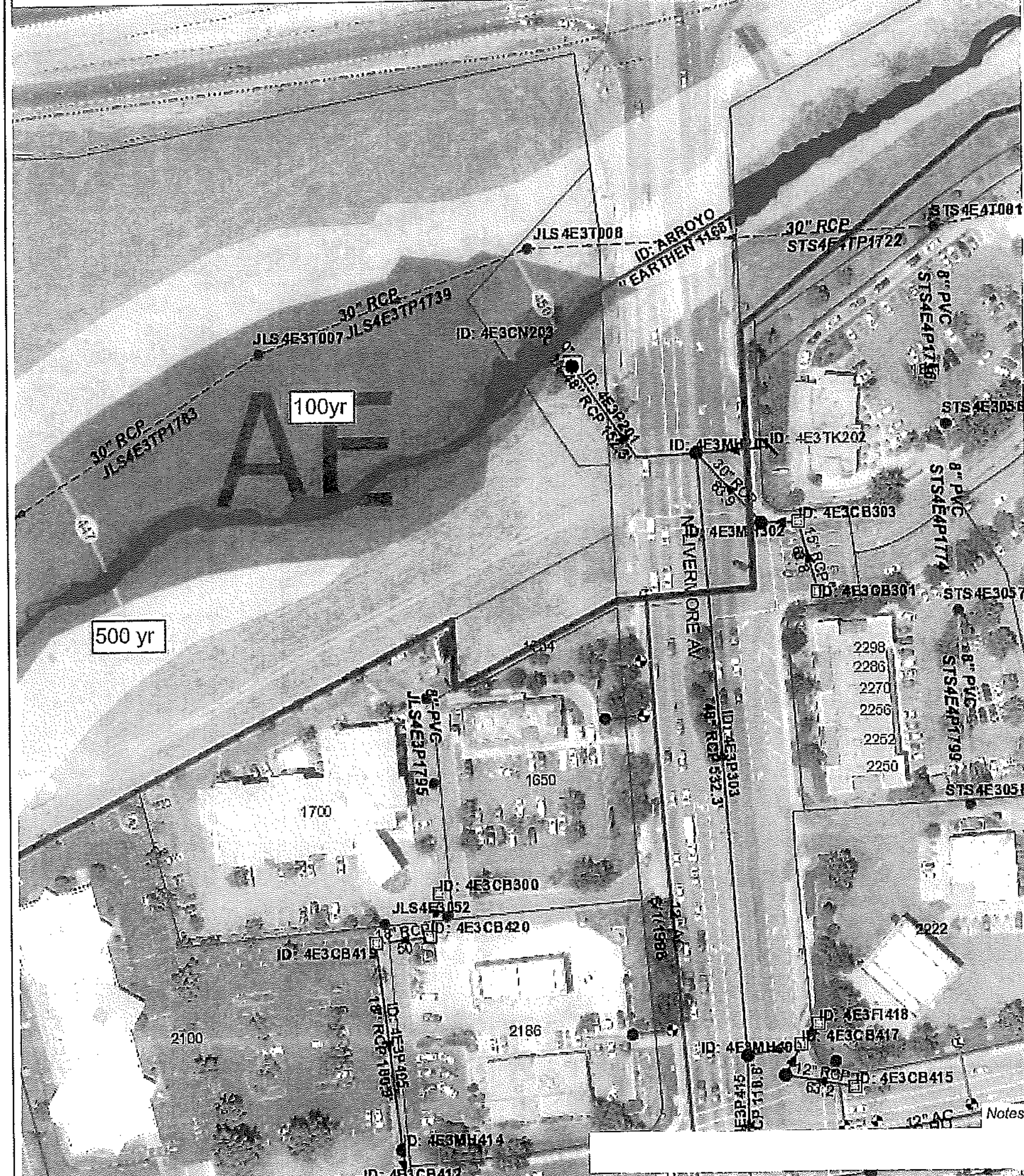
Table 3-7 summarizes the storm drain design standards. Refer to the latest adopted Storm Drain Master Plan for design criteria for storage facilities (retention and detention) and pumping facilities.

**Table 3-7. Summary of Design Standards**

| Condition | Design Criteria |
|---|---|
| New Systems | 10-year HGL 1.25' below curb |
| New Systems | 100-year HGL 1' below bldg pads |
| New Outfalls | Flap-Gated |
| Swales/V-ditches | 10-year HGL below top of bank |
| Open Channels | Per Zone 7 Standards |
| Closed Conduits | Max. Velocity < 14 ft/sec |
| Closed Conduits | Min. Velocity > 2.5 ft/sec |
| Closed Conduits | Min. Slope > 0.0007 |
| Earth Swales | Max. Velocity < 6 ft/sec |
| Earth Swales | Min. Velocity > 2 ft/sec |
| Earth Swales | Min. Slope > 0.0007 |
| Closed Conduit | Min. Pipe Size 12-inches |
| Improvements | Min. Pipe Size 12-inches |

LIVERMORE

# City of Livermore




229.2 0 114.58 229.2 Feet

NAD_1983_StatePlane_California_III_FIPS_0403_Feet
Livermore IT, GIS Services

Scale: 1: 1,375

This map is based on City of Livermore GIS information and reflects the most current information at the time of this printing. The map is intended for reference purposes only and the City and its staff is not responsible for errors.

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2/17/2016
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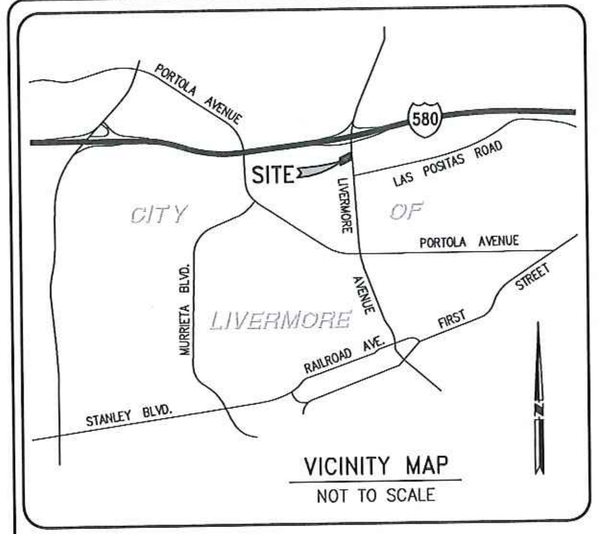
## 6.0 HYDROLOGY MAP

# 6.1 HYDROLOGY MAP (EXISTING CONDITION)



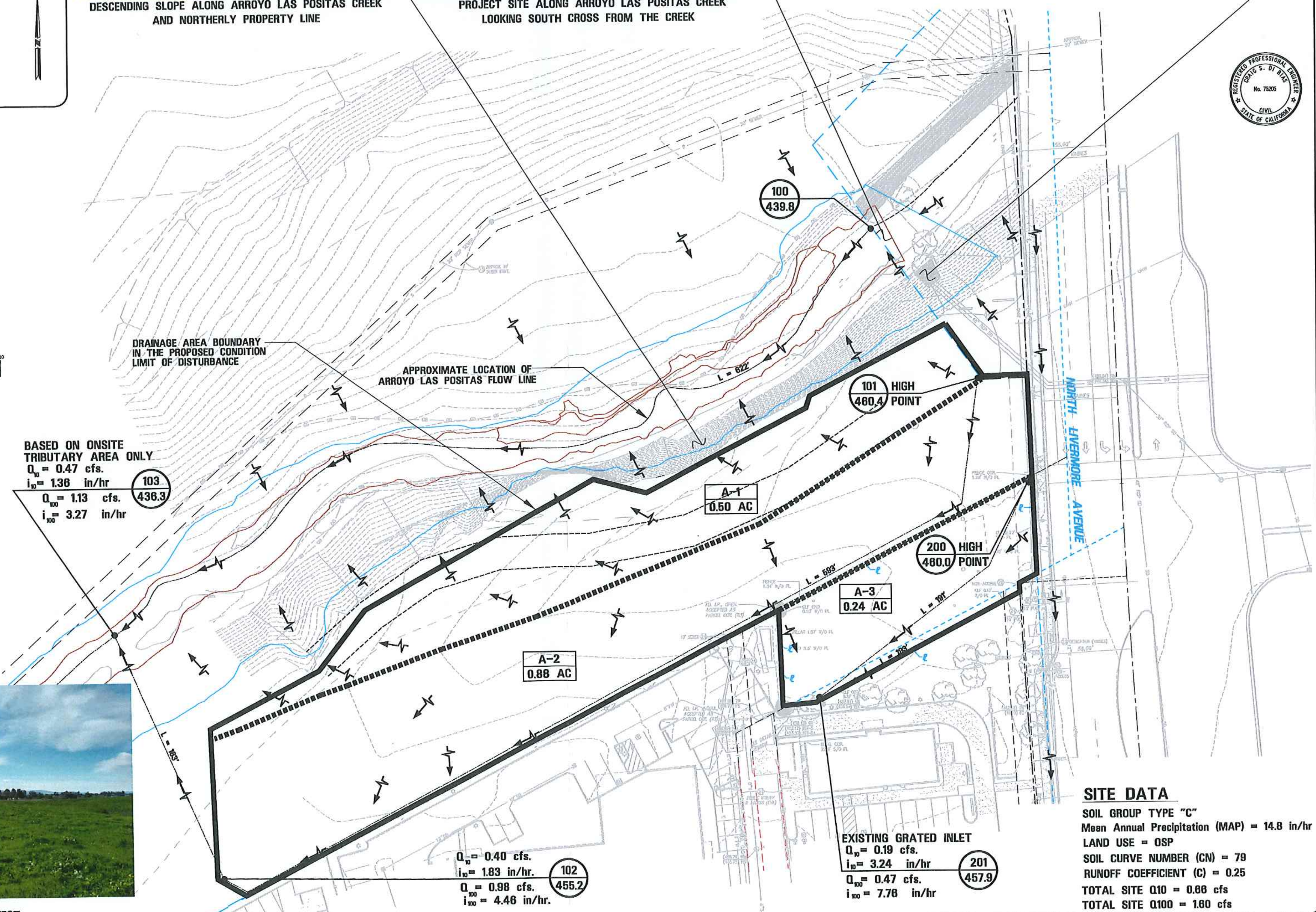

VICINITY MAP
NOT TO SCALE

DESCENDING SLOPE ALONG ARROYO LAS POSITAS CREEK AND NORTHERLY PROPERTY LINE


PROJECT SITE ALONG ARROYO LAS POSITAS CREEK LOOKING SOUTH CROSS FROM THE CREEK

NORTHEASTERLY CORNER OF THE PROJECT SITE ALONG ARROYO LAS POSITAS CREEK

NORTHEASTERLY CORNER OF THE PROJECT SITE AT THE EXISTING 48" RCP OUTLET




GRAPHIC SCALE
30 0 15 30 60 120
( IN FEET )
1 inch = 30 ft.

## LEGEND

- DRAINAGE BOUNDARY
- DRAINAGE SUB-AREA BOUNDARY
- 101 / 450: NODE, CONCENTRATION POINT, ELEVATION
- A-1 / 0.497: SUB-AREA, AREA IN ACRES
- $Q_{25}$ = 1.17 cfs — DESIGN FLOW
- $Q_2$ = 1.17 cfs — LOW FLOW
- PATH OF FLOW

PROJECT SITE LOOKING WEST

## SITE DATA

SOIL GROUP TYPE "C"
Mean Annual Precipitation (MAP) = 14.8 in/hr
LAND USE = OSP
SOIL CURVE NUMBER (CN) = 79
RUNOFF COEFFICIENT (C) = 0.25
TOTAL SITE Q10 = 0.66 cfs
TOTAL SITE Q100 = 1.60 cfs

REGISTERED PROFESSIONAL ENGINEER
CRAIG S. DI BIAS
No. 75205
CIVIL
STATE OF CALIFORNIA

| NO. | REVISIONS | DATE |
|---|---|---|
| | | |

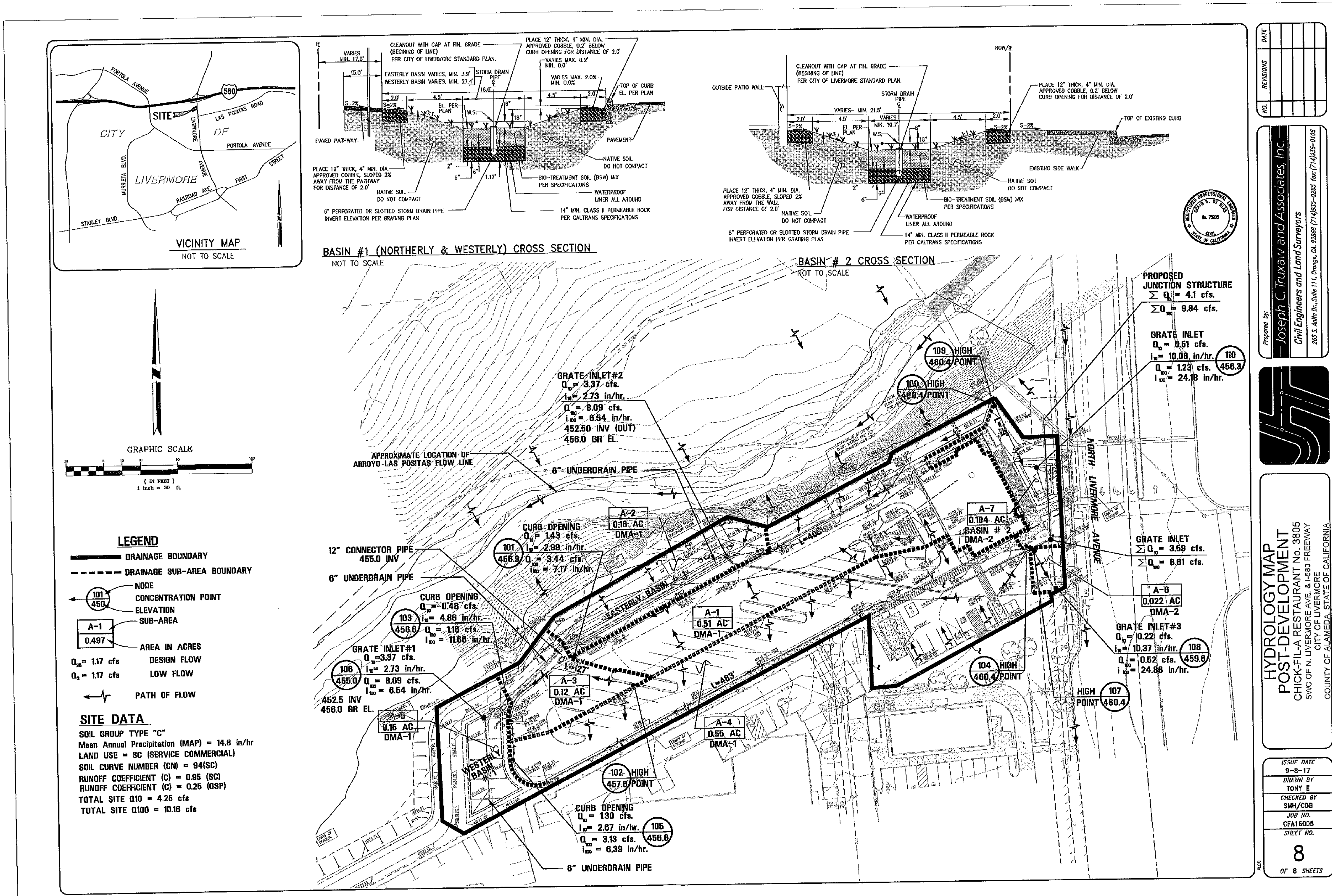
Prepared by:
Joseph C. Truxaw and Associates, Inc.
Civil Engineers and Land Surveyors
265 S. Anita Dr., Suite 111, Orange, CA. 92868 (714)935-0265 fax:(714)935-0106

# HYDROLOGY MAP
# PRE-DEVELOPMENT

CHICK-FIL-A RESTAURANT No. 3805
SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
CITY OF LIVERMORE
COUNTY OF ALAMEDA, STATE OF CALIFORNIA

ISSUE DATE
9-8-17
DRAWN BY
TONY E
CHECKED BY
SMH
JOB NO.
CFA16005
SHEET NO.
7
OF 8 SHEETS

## 6.2 HYDROLOGY MAP (PROPOSED CONDITION)


VICINITY MAP
NOT TO SCALE
PORTOLA AVENUE
580
SITE
LAS POSITAS ROAD
CITY OF LIVERMORE
PORTOLA AVENUE
MURRIETA BLVD.
LIVERMORE AVENUE
FIRST STREET
RAILROAD AVE.
STANLEY BLVD.
BASIN #1 (NORTHERLY & WESTERLY) CROSS SECTION
NOT TO SCALE
CLEANOUT WITH CAP AT FIN. GRADE (BEGINING OF LINE) PER CITY OF LIVERMORE STANDARD PLAN.
PLACE 12" THICK, 4" MIN. DIA. APPROVED COBBLE, 0.2' BELOW CURB OPENING FOR DISTANCE OF 2.0'
VARIES MIN. 17.0'
EASTERLY BASIN VARIES, MIN. 3.9'
WESTERLY BASIN VARIES, MIN. 27.4'
STORM DRAIN PIPE
VARIES MAX. 0.2' MIN. 0.0'
VARIES MAX. 2.0% MIN. 0.0%
TOP OF CURB EL. PER PLAN
PAVED PATHWAY
PAVEMENT
NATIVE SOIL DO NOT COMPACT
PLACE 12" THICK, 4" MIN. DIA. APPROVED COBBLE, SLOPED 2% AWAY FROM THE PATHWAY FOR DISTANCE OF 2.0'
BIO-TREATMENT SOIL (BSW) MIX PER SPECIFICATIONS
WATERPROOF LINER ALL AROUND
6" PERFORATED OR SLOTTED STORM DRAIN PIPE INVERT ELEVATION PER GRADING PLAN
14" MIN. CLASS II PERMEABLE ROCK PER CALTRANS SPECIFICATIONS
BASIN # 2 CROSS SECTION
NOT TO SCALE
OUTSIDE PATIO WALL
ROW/R.
TOP OF EXISTING CURB
EXISTING SIDE WALK
PLACE 12" THICK, 4" MIN. DIA. APPROVED COBBLE, 2% AWAY FROM THE WALL FOR DISTANCE OF 2.0'
GRAPHIC SCALE
( IN FEET )
1 inch = 30 ft.
LEGEND
DRAINAGE BOUNDARY
DRAINAGE SUB-AREA BOUNDARY
NODE
CONCENTRATION POINT
ELEVATION
101
450
SUB-AREA
A-1
0.497
AREA IN ACRES
Q25= 1.17 cfs DESIGN FLOW
Q2= 1.17 cfs LOW FLOW
PATH OF FLOW
SITE DATA
SOIL GROUP TYPE "C"
Mean Annual Precipitation (MAP) = 14.8 in/hr
LAND USE = SC (SERVICE COMMERCIAL)
SOIL CURVE NUMBER (CN) = 94(SC)
RUNOFF COEFFICIENT (C) = 0.95 (SC)
RUNOFF COEFFICIENT (C) = 0.25 (OSP)
TOTAL SITE Q10 = 4.25 cfs
TOTAL SITE Q100 = 10.16 cfs
GRATE INLET#2
Q10= 3.37 cfs.
i10= 2.73 in/hr.
Q100= 8.09 cfs.
i100= 6.54 in/hr.
452.50 INV (OUT)
456.0 GR EL.
APPROXIMATE LOCATION OF ARROYO LAS POSITAS FLOW LINE
6" UNDERDRAIN PIPE
CURB OPENING
Q10= 1.43 cfs.
i10= 2.99 in/hr.
Q100= 3.44 cfs.
i100= 7.17 in/hr.
101
456.9
A-2
0.16 AC
DMA-1
12" CONNECTOR PIPE
455.0 INV
6" UNDERDRAIN PIPE
CURB OPENING
Q10= 0.48 cfs.
i10= 4.86 in/hr.
Q100= 1.16 cfs.
i100= 11.66 in/hr.
103
456.6
GRATE INLET#1
Q10=3.37 cfs.
i10= 2.73 in/hr.
Q100= 8.09 cfs.
i100= 6.54 in/hr.
106
455.0
452.5 INV
456.0 GR EL.
A-5
0.15 AC
DMA-1
WESTERLY BASIN
EASTERLY BASIN #1
L=127'
L=483'
L=400'
A-3
0.12 AC
DMA-1
A-1
0.51 AC
DMA-1
A-4
0.55 AC
DMA-1
102 HIGH
457.6 POINT
CURB OPENING
Q10= 1.30 cfs.
i10= 2.87 in/hr.
Q100= 3.13 cfs.
i100= 6.39 in/hr.
105
456.6
6" UNDERDRAIN PIPE
109 HIGH
460.4 POINT
100 HIGH
460.4 POINT
A-7
0.104 AC
BASIN # 2
DMA-2
NORTH LIVERMORE AVENUE
104 HIGH
460.4 POINT
HIGH POINT
107
460.4
PROPOSED JUNCTION STRUCTURE
ΣQ10= 4.1 cfs.
ΣQ100= 9.84 cfs.
GRATE INLET
Q10= 0.51 cfs.
i10= 10.09 in/hr.
Q100= 1.23 cfs.
i100= 24.18 in/hr.
110
456.3
GRATE INLET
ΣQ10= 3.59 cfs.
ΣQ100= 8.61 cfs.
A-6
0.022 AC
DMA-2
GRATE INLET#3
Q10= 0.22 cfs.
i10= 10.37 in/hr.
Q100= 0.52 cfs.
i100= 24.88 in/hr.
108
459.6
NO. REVISIONS DATE
Prepared by:
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Civil Engineers and Land Surveyors
265 S. Anita Dr., Suite 111, Orange, CA. 92868 (714)935-0265 fax:(714)935-0106
HYDROLOGY MAP
POST-DEVELOPMENT
CHICK-FIL-A RESTAURANT No. 3805
SWC OF N. LIVERMORE AVE. & I-580 FREEWAY
CITY OF LIVERMORE
COUNTY OF ALAMEDA, STATE OF CALIFORNIA
ISSUE DATE
9-8-17
DRAWN BY
TONY E
CHECKED BY
SMH/CDB
JOB NO.
CFA16005
SHEET NO.
8
OF 8 SHEETS

# Stormwater Requirements Checklist

**Municipal Regional Stormwater Permit (MRP 2.0)**
**Stormwater Controls for Development Projects**

**CITY OF LIVERMORE**
**1052 South Livermore Avenue**
**Livermore, CA 94550**
**PHONE: 925-960-4500, FAX: 925-960-4505**
**WEB: http://www.cityoflivermore.net**

## I. Applicability of C.3 and C.6 Stormwater Requirements

**I.A. Enter Project Data** *(For "C.3 Regulated Projects," data will be reported in the municipality's stormwater Annual Report.)*

I.A.1 Project Name: CFA Livermore

I.A.2 Project Address (include cross street): 1650 N Livermore Ave

I.A.3 Project APN: ______ I.A.4 Project Watershed[1]: Arroyo Las Positas

I.A.5 Applicant Name: Kier & Wright Civil Engineers I.A.6 Date Submitted: 3/6/2020

I.A.7 Applicant Address: 2850 Collier Canyon Rd., Livermore, CA 94551

I.A.8 Applicant Phone: 925-245-8788 I.A.9 Applicant Email Address: *Ejohnson@kierwright.com*

I.A.10 Development type: (check all that apply)
☐ Residential ☒ Commercial ☐ Industrial ☐ Mixed-Use ☐ Streets, Roads, etc.
☐ 'Redevelopment' as defined by MRP: creating, adding and/or replacing exterior existing impervious surface on a site where past development has occurred[2]
☐ 'Special land use categories' as defined by MRP: (1) auto service facilities[3], (2) retail gasoline outlets, (3) restaurants[3], (4) uncovered parking area (stand-alone or part of a larger project)

I.A.11 Project Description[4]: (Also note any past or future phases of the project.) Construction of a new 4,752 sf building for Chick-Fil-A with associated landscape and parking.

I.A.12 Total Area of Site: 1.61 acres I.A.13 Slope on Site: 1%

I.A.14 Total Area of land disturbed during construction (include clearing, grading, excavating and stockpile area:_1.61 acres_.

**I.B. Is the project a "C.3 Regulated Project" per MRP Provision C.3.b?**

I.B.1. Enter the amount of impervious surface[4] created and/or replaced by the project (if the total amount is 5,000 sq.ft. or more):

***Table of Impervious and Pervious Surfaces***

| | a | b | C | d |
|---|---|---|---|---|
| **Type of Impervious Surface** | Pre-Project Impervious Surface (sq.ft.) | Existing Impervious Surface to be Replaced[7] (sq.ft.) | New Impervious Surface to be Created[7] (sq.ft.) | Post-project pervious surface (sq.ft.) |
| Roof area(s) – excluding any portion of the roof that is vegetated ("green roof") | 0 | 0 | 4,752 | 10,634 |
| Impervious[5] sidewalks, patios, paths, driveways | 0 | 0 | 34,413 | |
| Impervious[5] uncovered parking[6] | 0 | 0 | 39,165 | |
| Streets (public) | | 0 | 0 | |
| Streets (private) | | 0 | 0 | |
| Totals: | 0 | **0** | **59,627** | |
| Area of Existing Impervious Surface to remain in place | | N/A | | |
| Total New Impervious Surface *(sum of totals for columns b and c)*: | | **59,627** | | |

1 Watershed is defined by the maps from the Alameda County Flood Control District at http://acfloodcontrol.org/resources/explore-watersheds
2 Roadway projects that replace existing impervious surface are subject to C.3 requirements only if one or more lanes of travel are added.
3 Standard Industrial Classification (SIC) codes are in Section 2.3 of the C.3 Technical Guidance (download at www.cleanwaterprogram.org)
4 Project description examples: 5-story office building, industrial warehouse, residential with five 4-story buildings for 200 condominiums, etc.
5 Per the MRP, pavement that meets the following definition of pervious pavement is NOT an impervious surface. Pervious pavement is defined as pavement that stores and infiltrates rainfall at a rate equal to immediately surrounding unpaved, landscaped areas, or that stores and infiltrates the rainfall runoff volume described in Provision C.3.d.
6 Uncovered parking includes top level of a parking structure.
7 "Replace" means to install new impervious surface where existing impervious surface is removed. "Create" means to install new impervious surface where there is currently no impervious surface.

**I.B. Is the project a "C.3 Regulated Project" per MRP 2.0 Provision C.3.b? (continued)**

| | | Yes | No | NA |
|---|---|---|---|---|
| I.B.2 | In Item I.B.1, does the Total New Impervious Surface equal 10,000 sq.ft. or more? *If YES, skip to Item I.B.5 and check "Yes." If NO, continue to Item I.B.3.* | ☒ | ☐ | ☐ |
| I.B.3 | Does the Item I.B.1 Total New Impervious Surface equal 5,000 sq.ft. or more, but less than 10,000 sq.ft? *If YES, continue to Item I.B.4. If NO, skip to Item I.B.5 and check "No."* | ☐ | ☐ | ☒ |
| I.B.4 | Is the project a "Special Land Use Category" per Item I.A.10? For uncovered parking, check YES only if there is 5,000 sq.ft or more uncovered parking. *If NO, go to Item I.B.5 and check "No." If YES, go to Item I.B.5 and check "Yes."* | ☐ | ☐ | ☒ |
| I.B.5 | Is the project a C.3 Regulated Project? *If YES, go to Item I.B.6; if NO, continue to Item I.C.* | ☒ | ☐ | ☐ |
| I.B.6 | Does the total amount of Replaced impervious surface equal 50 percent or more of the Pre-Project Impervious Surface? *If YES, stormwater treatment requirements apply to the whole site; if NO, these requirements apply only to the impervious surface created and/or replaced.* | ☐ | ☐ | ☒ |
| I.B.7 | Is the project installing a total of 3,000 sq.ft. or more (excluding private-use patios in single family homes, townhomes, or condominiums) of new pervious pavement systems? (Pervious pavement systems include pervious concrete, pervious asphalt, pervious pavers and grid pavers etc. and are described in the C3 Technical Guidance at www.cleanwaterprogram.org) If YES, stormwater treatment system inspection requirements (C.3.h) apply; (Municipal staff – add this site to your list of sites needing a final inspection at the end of construction and on-going O&M inspections.) If NO, inspection requirements only apply if there are other treatment systems installed on the project. | ☐ | ☒ | ☐ |

**I.C. Projects that are NOT C.3 Regulated Projects**

If you answered NO to Item I.B.5, or the project creates/replaces less than 5,000 sq. ft. of impervious surface, then the project is NOT a C.3 Regulated Project, and stormwater treatment is not required, BUT the municipality may determine that source controls and site design measures are required. Skip to Section II.

**I.D. Projects that ARE C.3 Regulated Projects**

If you answered YES to Item I.B.5, then the project is a C.3 Regulated Project. The project must include appropriate site design measures and source controls AND hydraulically-sized stormwater treatment measures. Hydromodification management may also be required; refer to Section II to make this determination. If final discretionary approval was granted on or after **DECEMBER 1, 2011**, Low Impact Development (LID) requirements apply, except for "Special Projects." See Section II.

**I.E. Identify C.6 Construction-Phase Stormwater Requirements**

| | | Yes | No |
|---|---|---|---|
| I.E.1 | Does the project disturb 1.0 acre (43,560 sq.ft.) or more of land? (See Item I.A.14). *If Yes, obtain coverage under the state's Construction General Permit at https://smarts.waterboards.ca.gov/smarts/faces/SwSmartsLogin.jsp. Submit to the municipality a copy of your Notice of Intent and Storm Water Pollution Prevention Plan (SWPPP) before a grading or building permit is issued.* | ☒ | ☐ |
| I.E.2 | Is the site a "High Priority Site" that disturbs less than 1.0 acre (43,560 sq.ft.) of land? (Municipal staff will make the final determination.)<br>"High Priority Sites" are sites having any of the following criteria:<br>▪ that require a grading permit,<br>▪ are adjacent to a creek,<br>▪ or are otherwise high priority for stormwater protection during construction (see MRP 2.0 Provision C.6.e.ii.(2)(c)) | ☐ | ☒ |
| I.E.3 | Is the site a "Hillside Site" that disturbs 5,000 sq.ft. or more, but less than 1.0 acre (43,560 sq.ft.) of land? (Municipal staff will make the final determination.)<br>▪ "Hillside Sites" are located on hillsides, as indicated on a jurisdictional map of hillside development areas or as indicated by meeting jurisdictional hillside development criteria.<br>▪ If no map or criteria exist, then Hillside Sites are sites with a slope of 15% or more (see I.A.13 above and MRP 2.0 Provision C.6.e.ii.(2)(b)). | ☐ | ☒ |

- NOTE TO APPLICANT: All projects require appropriate stormwater best management practices (BMPs) during construction. Refer to the Section II to identify appropriate construction BMPs.

- NOTE TO MUNICIPAL STAFF: If the answer is "Yes" to I.E.1, I.E.2, OR I.E.3, refer this project to construction site inspection staff to be added to their list of projects that require stormwater inspections at least monthly during the wet season (October 1 through April 30) and other times of the year as appropriate.

# II. Implementation of Stormwater Requirements

**II.A.** Complete the appropriate sections for the project. For non-C.3 Regulated Projects, Sections II.B, II.C, and II.D apply. For C.3 Regulated Projects, all sections of Section II apply.

**II.B. Select Appropriate Site Design Measures**

- *Required for C.3 Regulated Projects.*
- *Starting December 1, 2012, projects that create and/or replace 2,500 - 10,000 sq.ft. of impervious surface, and stand-alone single family homes that create/replace 2,500 sq.ft. or more of impervious surface, must include one of Site Design Measures a through f.*[8]
- *All other projects are encouraged to implement site design measures, which may be required at municipality discretion.*
- *Consult with municipal staff about requirements for your project.*

II.B.1 Is the site design measure included in the project plans?

| Yes | No | Plan Sheet No. | |
|---|---|---|---|
| ☐ | ☒ | | a. Direct roof runoff into cisterns or rain barrels and use rainwater for irrigation or other non-potable use. |
| ☒ | ☐ | | b. Direct roof runoff onto vegetated areas. |
| ☒ | ☐ | | c. Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas. |
| ☒ | ☐ | | d. Direct runoff from driveways and/or uncovered parking lots onto vegetated areas. |
| ☐ | ☒ | | e. Construct sidewalks, walkways, and/or patios with pervious surfaces. Use the specifications in the C3 Technical Guidance (Version 4.1) or for small projects see the BASMAA Pervious Paving Factsheet. For these documents and others go to www.cleanwaterprogram.org and click on "Resources." |
| ☐ | ☒ | | f. Construct bike lanes, driveways, and/or uncovered parking lots with pervious surfaces. Use the specifications in the C3 Technical Guidance (Version 4.1) or for small projects see the BASMAA Pervious Paving Factsheet. For these documents and others go to the program website at: www.cleanwaterprogram.org and click on "Resources." |
| ☐ | ☒ | | g. Minimize land disturbance and impervious surface (especially parking lots). |
| ☒ | ☐ | | h. Maximize permeability by clustering development and preserving open space. |
| ☐ | ☒ | | i. Use micro-detention, including distributed landscape-based detention. |
| ☒ | ☐ | | j. Protect sensitive areas, including wetland and riparian areas, and minimize changes to the natural topography. |
| ☐ | ☒ | | k. Self-treating area (see Section 4.1 of the C.3 Technical Guidance) |
| ☐ | ☒ | | l. Self-retaining area (see Section 4.2 of the C.3 Technical Guidance) |
| ☐ | ☒ | | m. Plant or preserve interceptor trees (Section 4.5, C.3 Technical Guidance) |

[8] See MRP Provision C.3.a.i(6) for non-C.3 Regulated Projects, C.3.c.i(2)(a) for Regulated Projects, C.3.i for projects that create/replace 2,500 to 10,000 sq.ft. of impervious surface and stand-alone single family homes that create/replace 2,500 sq.ft. or more of impervious surface.

**II.C. Select appropriate source controls** *(Applies to C.3 Regulated Projects; encouraged for other projects. Consult municipal staff.[9])*

| Are these features in project? Yes | No | Features that require source control measures | Source control measures (Refer to Local Source Control List for detailed requirements) | Is source control measure included in project plans? Yes | No | Plan Sheet No. |
|---|---|---|---|---|---|---|
| ☒ | ☐ | Storm Drain | Mark on-site inlets with the words "No Dumping! Flows to Bay" or equivalent. | ☒ | ☐ | C3.0 |
| ☒ | ☐ | Floor Drains | Plumb interior floor drains to sanitary sewer[10] [or prohibit]. | ☐ | ☒ | |
| ☒ | ☐ | Parking garage | Plumb interior parking garage floor drains to sanitary sewer.[9] | ☒ | ☐ | C7.0 |
| ☒ | ☐ | Landscaping | ▪ Retain existing vegetation as practicable.<br>▪ Select diverse species appropriate to the site. Include plants that are pest- and/or disease-resistant, drought-tolerant, and/or attract beneficial insects.<br>▪ Minimize use of pesticides and quick-release fertilizers.<br>▪ Use efficient irrigation system; design to minimize runoff. | ☐ | ☒ | |
| ☐ | ☐ | Pool/Spa/Fountain | Provide connection to the sanitary sewer to facilitate draining.[9] | ☐ | ☐ | N/A |
| ☐ | ☐ | Food Service Equipment (non-residential) | Provide sink or other area for equipment cleaning, which is:<br>▪ Connected to a grease interceptor prior to sanitary sewer discharge. [9]<br>▪ Large enough for the largest mat or piece of equipment to be cleaned.<br>▪ Indoors or in an outdoor roofed area designed to prevent stormwater run-on and run-off, and signed to require equipment washing in this area. | ☐ | ☐ | N/A |
| ☐ | ☐ | Refuse Areas | ▪ Provide a roofed and enclosed area for dumpsters, recycling containers, etc., designed to prevent stormwater run-on and runoff.<br>▪ Connect any drains in or beneath dumpsters, compactors, and tallow bin areas serving food service facilities to the sanitary sewer.[9] | ☐ | ☐ | N/A |
| ☐ | ☐ | Outdoor Process Activities [11] | Perform process activities either indoors or in roofed outdoor area, designed to prevent stormwater run-on and runoff, and to drain to the sanitary sewer.[9] | ☐ | ☐ | N/A |
| ☐ | ☐ | Outdoor Equipment/ Materials Storage | ▪ Cover the area or design to avoid pollutant contact with stormwater runoff.<br>▪ Locate area only on paved and contained areas.<br>▪ Roof storage areas that will contain non-hazardous liquids, drain to sanitary sewer[9], and contain by berms or similar. | ☐ | ☐ | N/A |
| ☐ | ☐ | Vehicle/ Equipment Cleaning | ▪ Roofed, pave and berm wash area to prevent stormwater run-on and runoff, plumb to the sanitary sewer[9], and sign as a designated wash area.<br>▪ Commercial car wash facilities shall discharge to the sanitary sewer.[9] | ☐ | ☐ | N/A |
| ☐ | ☐ | Vehicle/ Equipment Repair and Maintenance | ▪ Designate repair/maintenance area indoors, or an outdoors area designed to prevent stormwater run-on and runoff and provide secondary containment. Do not install drains in the secondary containment areas.<br>▪ No floor drains unless pretreated prior to discharge to the sanitary sewer. [9]<br>▪ Connect containers or sinks used for parts cleaning to the sanitary sewer. [9] | ☐ | ☐ | N/A |
| ☐ | ☐ | Fuel Dispensing Areas | ▪ Fueling areas shall have impermeable surface that is a) minimally graded to prevent ponding and b) separated from the rest of the site by a grade break.<br>▪ Canopy shall extend at least 10 ft in each direction from each pump and drain away from fueling area. | ☐ | ☐ | N/A |
| ☐ | ☐ | Loading Docks | ▪ Cover and/or grade to minimize run-on to and runoff from the loading area.<br>▪ Position downspouts to direct stormwater away from the loading area.<br>▪ Drain water from loading dock areas to the sanitary sewer.[9]<br>▪ Install door skirts between the trailers and the building. | ☐ | ☐ | N/A |
| ☐ | ☐ | Fire Sprinklers | Design for discharge of fire sprinkler test water to landscape or sanitary sewer.[9] | ☐ | ☐ | N/A |
| ☐ | ☐ | Miscellaneous Drain or Wash Water | ▪ Drain condensate of air conditioning units to landscaping. Large air conditioning units may connect to the sanitary sewer.[9]<br>▪ Roof drains shall drain to unpaved area where practicable.<br>▪ Drain boiler drain lines, roof top equipment, all washwater to sanitary sewer [9]. | ☐ | ☐ | N/A |
| ☐ | ☐ | Architectural Copper | ▪ Discharge rinse water to sanitary sewer [9], or collect and dispose properly offsite. See flyer "Requirements for Architectural Copper." | ☐ | ☐ | N/A |

[9] See MRP Provision C.3.a.i(7) for non-C.3 Regulated Projects and Provision C.3.c.i(1) for C.3 Regulated Projects.
[10] Any connection to the sanitary sewer system is subject to sanitary district approval.
[11] Businesses that may have outdoor process activities/equipment include machine shops, auto repair, industries with pretreatment facilities.

**II.D. Implement Construction Best Management Practices (BMPs)** *(Applies to all projects – see Provision C.6 for more details.)*

| Yes | No | Best Management Practice (BMP) |
|---|---|---|
| ☒ | ☐ | Attach the municipality's construction BMP plan sheet to project plans and require contractor to implement the applicable BMPs on the plan sheet. |
| ☒ | ☐ | Temporary erosion controls to stabilize all denuded areas until permanent erosion controls are established. |
| ☒ | ☐ | Delineate with field markers clearing limits, easements, setbacks, sensitive or critical areas, buffer zones, trees, and drainage courses. |
| ☒ | ☐ | Provide notes, specifications, or attachments describing the following:<br>▪ Construction, operation and maintenance of erosion and sediment controls, include inspection frequency;<br>▪ Methods and schedule for grading, excavation, filling, clearing of vegetation, and storage and disposal of excavated or cleared material;<br>▪ Specifications for vegetative cover & mulch, include methods and schedules for planting and fertilization;<br>▪ Provisions for temporary and/or permanent irrigation. |
| ☒ | ☐ | Perform clearing and earth moving activities only during dry weather. |
| ☒ | ☐ | Use sediment controls or filtration to remove sediment when dewatering and obtain all necessary permits. |
| ☒ | ☐ | Protect all storm drain inlets in vicinity of site using sediment controls such as berms, fiber rolls, or filters. |
| ☒ | ☐ | Trap sediment on-site, using BMPs such as sediment basins or traps, earthen dikes or berms, silt fences, check dams, soil blankets or mats, covers for soil stock piles, etc. |
| ☐ | ☐ | Divert on-site runoff around exposed areas; divert off-site runoff around the site (e.g., swales and dikes). |
| ☒ | ☐ | Protect adjacent properties and undisturbed areas from construction impacts using vegetative buffer strips, sediment barriers or filters, dikes, mulching, or other measures as appropriate. |
| ☒ | ☐ | Limit construction access routes and stabilize designated access points. |
| ☒ | ☐ | No cleaning, fueling, or maintaining vehicles on-site, except in a designated area where washwater is contained and treated. |
| ☒ | ☐ | Store, handle, and dispose of construction materials/wastes properly to prevent contact with stormwater. |
| ☒ | ☐ | Contractor shall train and provide instruction to all employees/subcontractors re: construction BMPs. |
| ☒ | ☐ | Control and prevent the discharge of all potential pollutants, including pavement cutting wastes, paints, concrete, petroleum products, chemicals, washwater or sediments, rinse water from architectural copper, and non-stormwater discharges to storm drains and watercourses. |

**PROJECTS THAT ARE <u>NOT</u> C.3 REGULATED PROJECTS STOP HERE!**

### II.E. Biotreatment, Infiltration and Rain Water Harvesting and Use.

MRP 2.0 no longer requires that a feasibility analysis of infilration and rainwater harvesting be conducted. However, applicants using biotreatment are encouraged to maximize infiltration of stormwater if site conditions allow.

If feasible and desired, infiltration and rainwater harvesting may be cost effective solutions depending on the project.

### II.F. Stormwater Treatment Measures (Applies to C.3 Regulated Projects)

**II.F.1** Check the applicable box and indicate the treatment measures to be included in the project.

| Yes | No | |
|---|---|---|
| ☐ | ☒ | Is the project a Special Project? (See Appendix K of the C.3 Technical Guidance for criteria.)<br>If Yes, complete the Special Projects Worksheet (go to the program website at: www.cleanwaterprogram.org and click on "Resources") and consult with municipal staff about the need to prepare a discussion of the feasibility and infeasibility of 100% LID treatment. Indicate the type of non-LID treatment to be used, the hydraulic sizing method*, and percentage of the amount of runoff specified in Provision C.3.d that is treated:<br>Non-LID Treatment — Hydraulic sizing method* — % of C.3.d amount of runoff treated<br>☐ Media filter<br>☐ Tree well filter |
| ☒ | ☐ | Is the project using biotreatment to treat the C.3.d amount of runoff?<br>For more information on infiltration and rainwater harvesting and use of stormwater, refer to the C3 Technical Guidance downloadable at the program website: www.cleanwaterprogram.org<br>If Yes, indicate the biotreatment measures to be used, and the hydraulic sizing method:<br>Biotreatment Measures — Hydraulic sizing method*<br>☒ Bioretention area — 3. Combination hydraulic sizing approach<br>☐ Flow-through planter<br>☐ Other (specify): |
| ☐ | ☒ | Is the project using infiltration or rainwater harvesting/use?<br>For more information on infiltration and rainwater harvesting and use of stormwater, refer to the C3 Technical Guidance downloadable at the program website: www.cleanwaterprogram.org<br>If Yes, indicate the measures to be used, and hydraulic sizing method:<br>LID Treatment Measure (non-biotreatment) — Hydraulic sizing method*<br>☐ Rainwater harvesting and use<br>☐ Bioinfiltration[12]<br>☐ Infiltration trench<br>☐ Other (specify):____________________________ |

***Hydraulic Sizing Method:** Indicate which of the following Provision C.3.d.i hydraulic sizing methods were used:

1. Volume based approaches – Refer to Provision C.3.d.i.(1):
   1(a) Urban Runoff Quality Management approach, or
   1(b) 80% capture approach (recommended volume-based approach).
2. Flow-based approaches – Refer to Provision C.3.d.i.(2):
   2(a) 10% of 50-year peak flow approach,
   2(b) Percentile rainfall intensity approach, or
   2(c) 0.2-Inch-per-hour intensity approach (this is recommended flow-based approach AND the basis for the 4% rule of thumb described in Section 5.1 of the C.3 Technical Guidance).
3. Combination hydraulic sizing approach -- Refer to Provision C.3.d.i.(3):
   If a combination flow and volume design basis was used, indicate which flow-based and volume-based criteria were used.

[12] See Section 6.1 of the C.3 Technical Guidance for conditions in which bioretention areas provide bioinfiltration.

**II.G. Is the project a Hydromodification Management[13] (HM) Project?** (Complete this section for C.3 Regulated Projects)

II.G.1 Does the project create and/or replace 1 acre (43,560 sq. ft.) or more of impervious surface? (Refer to Item I.B.1.)

☒ Yes. *Continue to Item II.G.2.*

☐ No. *The project is NOT required to incorporate HM measures. Skip to Item II.G.6 and check "No."*

II.G.2 Is the total impervious area increased over the pre-project condition? (Refer to Item I.B.1.)

☒ Yes. *Continue to Item II.G.3.*

☐ No. *The project is NOT required to incorporate HM measures. Skip to Item II.G.6 and check "No."*

II.G.3 Is the site located in a tidally influenced/depositional area, or in the extreme eastern portion of the county that is not subject to HM requirements? *(See HMP Susceptibility Map in Appendix I of the C.3 Technical Guidance.)*

☐ Yes. *Project is exempt from HM requirements. Attach map indicating project location. Skip to II.G.6 and check "No".*

☒ No. *Continue to II.G.4.*

II.G.4 Is the site located in a high slope zone or special consideration watershed, as shown on the HMP Susceptibility Map?

☒ Yes. *Project is subject to HM requirements. Attach map indicating project location. Skip to II.G.6 and check "Yes."*

☐ No. *Continue to II.G.5.*

II.G.5 For sites located in a white area on the HMP Susceptibility Map, has an engineer or qualified environmental professional determined that runoff from the project flows only through a hardened channel or enclosed pipe along its entire length before emptying into a waterway in the exempt area?

☐ Yes. *Project is exempt from HM requirements. Attach signed statement by qualified professional. Go to II.G.6 and check "No."*

n/a ☐ No. *Project is subject to HM requirements. Attach map indicating project location. Go to Item G.6 and check "Yes."*

II.G.6 Is the project a Hydromodification Management Project?

☒ Yes. *The project is subject to HM requirements in Provision C.3.g of the Municipal Regional Stormwater Permit.*

☐ No. *The project is EXEMPT from HM requirements.*

☐ HM requirements are impracticable. *(Attach documentation needed to comply with the impracticability provision in MRP Attachment B.)*

- *If the project is subject to the HM requirements, incorporate in the project flow duration stormwater control measures designed such that post-project stormwater discharge rates and durations match pre-project discharge rates and durations. The Bay Area Hydrology Model (BAHM) has been developed to size flow duration controls. See [www.bayareahydrologymodel.org](www.bayareahydrologymodel.org). Guidance is provided in Chapter 7 of the C.3 Technical Guidance.*

**II.H Stormwater Treatment Measure and/HM Control Owner or Operator's Information:**

Name: TBD

Address:

Phone: Email:

*Applicant must call for inspection and receive inspection within 45 days of installation of treatment measures and/or hydromodification management controls.*

Name of applicant completing the form: Liz Johnson

Signature: [signature] Date: 3-6-2020

[13] Hydromodification is the modification of a stream's hydrograph, caused in general by increases in flows and durations that result when land is developed (made more impervious). The effects of hydromodification include, but are not limited to, increased bed and bank erosion, loss of habitat, increased sediment transport and deposition, and increased flooding. Hydromodification management control measures are designed to reduce these effects.

# III. For Completion By Municipal Staff

**III.1 Alternative Certification:** Was the treatment system sizing and design reviewed by a qualified third-party professional that is not a member of the project team or agency staff?

☐ Yes ☐ No Name of Reviewer________________________________________________

**III.2. Confirm Operations and Maintenance (O&M) Submittal:**

*The following questions apply to C.3 Regulated Projects and Hydromodification Management Projects.*

| | | Yes | No | N/A |
|---|---|---|---|---|
| III.2.a | Was maintenance plan submitted? | ☐ | ☐ | ☐ |
| III.2.b | Was maintenance plan approved? | ☐ | ☐ | ☐ |
| III.2.c | Was maintenance agreement submitted? (Date executed:____________) | ☐ | ☐ | ☐ |

- *Attach the executed maintenance agreement as an appendix to this checklist.*

**III.3 Incorporate HM Controls (if required)**

**Are the applicable items for HM compliance included in the plan submittal?**

| Yes | No | NA | Documentation for HM Compliance |
|---|---|---|---|
| ☐ | ☐ | ☐ | Site plans with pre- and post-project impervious surface areas, surface flow directions of entire site, locations of flow duration controls and site design measures per HM site design requirement |
| ☐ | ☐ | ☐ | Soils report or other site-specific document showing soil types at all parts of site |
| ☐ | ☐ | ☐ | If project uses the Bay Area Hydrology Model (BAHM), a list of model inputs. |
| ☐ | ☐ | ☐ | If project uses custom modeling, a summary of the modeling calculations with corresponding graph showing curve matching (existing, post-project, and post-project with HM controls curves), goodness of fit, and (allowable) low flow rate. |
| ☐ | ☐ | ☐ | If project uses the Impracticability Provision, a listing of all applicable costs and a brief description of the alternative HM project (name, location, date of start up, entity responsible for maintenance). |
| ☐ | ☐ | ☐ | If the project uses alternatives to the default BAHM approach or settings, a written description and rationale. |

- *Municipal staff: Refer to the "Flow Duration Control Review Worksheet for HM Submittals" to review the documentation submitted for HM compliance.*

**III.4 Annual Operations and Maintenance (O&M) Submittals:**

*For C.3 Regulated Projects and Hydromodification Management Projects, indicate the dates on which the Applicant submitted annual reports for project O&M:* ______________________________________________

______________________________________________

**III.5 Comments:**

______________________________________________

______________________________________________

______________________________________________

______________________________________________

**III.6 Notes:**

Section I Notes:______________________________________________

Section II Notes:______________________________________________

Section III Notes:______________________________________________

**III.7 Project Close-Out:**

III.7.a Were final Conditions of Approval met? ☐ ☐

| | | | | |
|---|---|---|---|---|
| III.7.b | Was initial inspection of the completed treatment/HM measure(s) conducted?<br>(Date of inspection:_______________) | ☐ | ☐ | ☐ |
| III.7.c | Was maintenance plan submitted?<br>(Date executed:_________________) | ☐ | ☐ | ☐ |
| III.7.d | Was project information provided to staff responsible for O&M verification inspections?<br>(Date provided to inspection staff:_____________________) | ☐ | ☐ | ☐ |

Name of staff confirming project is closed out:________________________________________________

Signature:________________________________ Date:________________

Name of O&M staff receiving information:________________________________________________

Signature:________________________________ Date:________________

**Appendices**

Appendix A: O&M Agreement
Appendix B: O&M Annual Report Form