Summary of Proposed Mapping Revisions for the Todd Creek Bellevue-Wilfred Flood Control Channel

Prepared for: County of Sonoma

Date: March 19, 2025

Prepared by: Andrew Nisenberg, E.I.T. & Baron Creager, P.E., C.F.M.

Reviewed by: Chris Fritz, P.E., C.F.M.
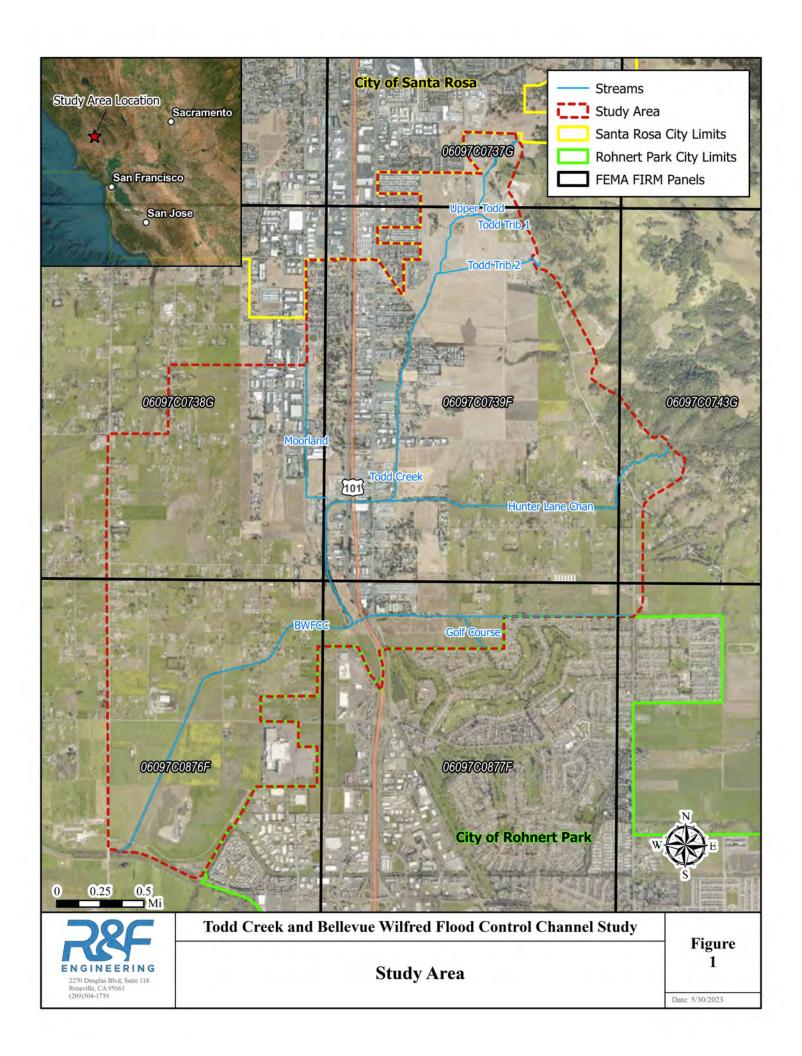
1. Introduction

The County of Sonoma (County) requested assistance with the remapping of FEMA flood zones for the area of the Todd Creek-Bellevue-Wilfred Flood Control Channel watershed. The remapping effort included developing a new hydrologic model[1], hydraulic model[2], and delineating new special flood hazard areas (SFHAs) to be submitted with the Letter of Mapping Revision (LOMR). The study area is located within the Todd Creek watershed between Stony Point Road to the west, South Santa Rosa to the north, Hinebaugh Creek to the south, and just beyond Snyder Lane and Petaluma Hill Road to the east. The study area is subject to flooding from Todd Creek and its various tributaries, Hunter Lane Channel, Moorland Flood Control Channel (MFCC), and the Bellevue-Wilfred Flood Control Channel (BWFCC). Figure 1 provides an overview of the study area.

The study area currently includes a mixture of AE Flood Zones and 500-year X Zones as mapped on FEMA Flood Insurance Rate Map (FIRM) Panels 06097C0738G, 06097C0739F, 06097C0876F, 06097C0877F, 06097C0737G, 06097C0743G, and 06097C0881E which are provided in Attachment A for reference.

The following Technical Memorandum (TM) describes the methods and results of the updated floodplain analysis and presents proposed revisions to the mapped FEMA flood zones within the identified study area.

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[1] R&F. Hydrologic Analysis for Todd Creek and Bellevue-Wilfred Flood Control Channel. June 2023.
[2] R&F. Todd Creek & Bellevue-Wilfred Flood Control Channel Study – Hydraulic Analysis Report. June 2023.

City of Santa Rosa

06097C0737G

Upper Todd
Todd Trib 1
Todd Trib 2

	Streams
	Study Area
	Santa Rosa City Limits
	Rohnert Park City Limits
	FEMA FIRM Panels

Study Area Location
Sacramento
San Francisco
San Jose

06097C0738G

Moorland

Todd Creek

101

Hunter Lane Chan

06097C0739F

06097C0743G

BWFCC

Golf Course

06097C0876F

06097C0877F

City of Rohnert Park

N
W E
S

0   0.25   0.5
Mi

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Todd Creek and Bellevue Wilfred Flood Control Channel Study

Study Area

Figure 1

Date: 5/30/2023

2. Hydraulic Model Setup

The HEC-RAS model used to determine the recommended floodplain revisions was newly developed using HEC-RAS version 6.3.1. The model utilized survey data from previous studies as well new survey data obtained in 2023. Detailed technical documentation for the hydraulic analysis is provided in Attachment B and describes the setup and technical details of the HEC-RAS model. All documentation and HEC-RAS model results from this study were reviewed by the County prior to submittal to FEMA.

3. Model Simulation Results

The HEC-RAS model was run for the 10-, 25-, 50-, 100- and 500-year flood scenarios. The floodplain results from 100- and 500-year scenarios are presented in Figures 2 and 3, respectively.

4. Evaluation of Floodplain Results

As shown in Figure 2, the 100-year floodplain results show mostly shallow (<1 ft) areas of flooding in various locations throughout the study area. For the proposed mapping revisions, the average depths of each of the individual ponded areas were calculated to determine the appropriate FEMA risk zone for mapping purposes.
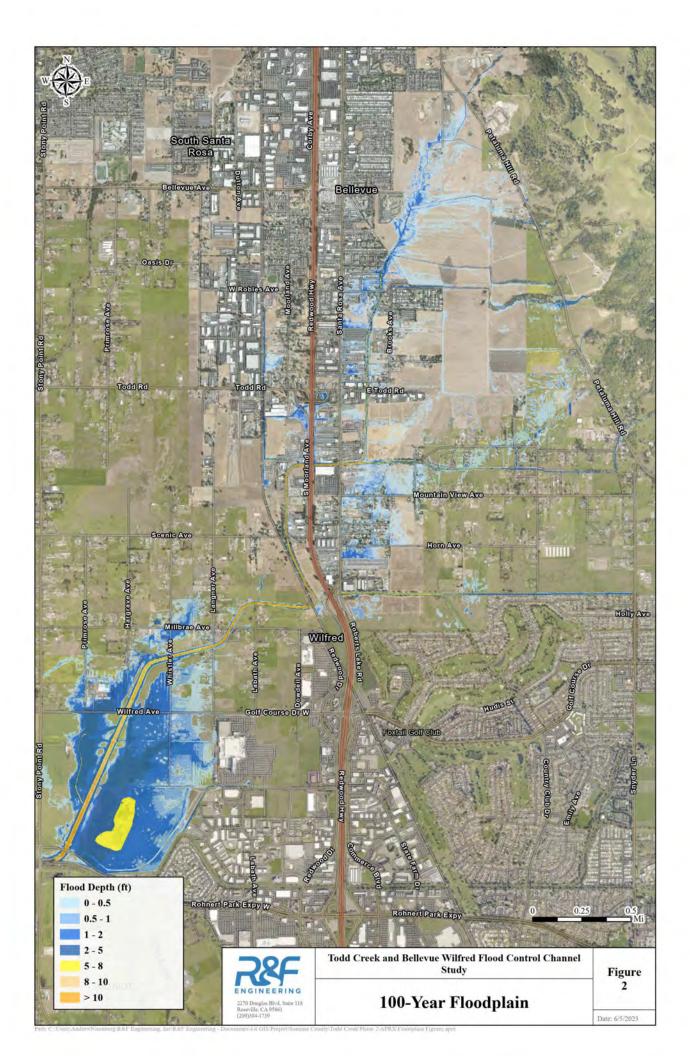
Consistent with FEMA guidance[3], two methods were considered to average the ponded areas: the cross-section method and the area method. The cross-section method calculates average depths along cross sections that are drawn perpendicular to streets. The area method calculates the average depths within a specified ponded area. The area method is preferrable for 1D/2D studies and was therefore the method chosen for this analysis.
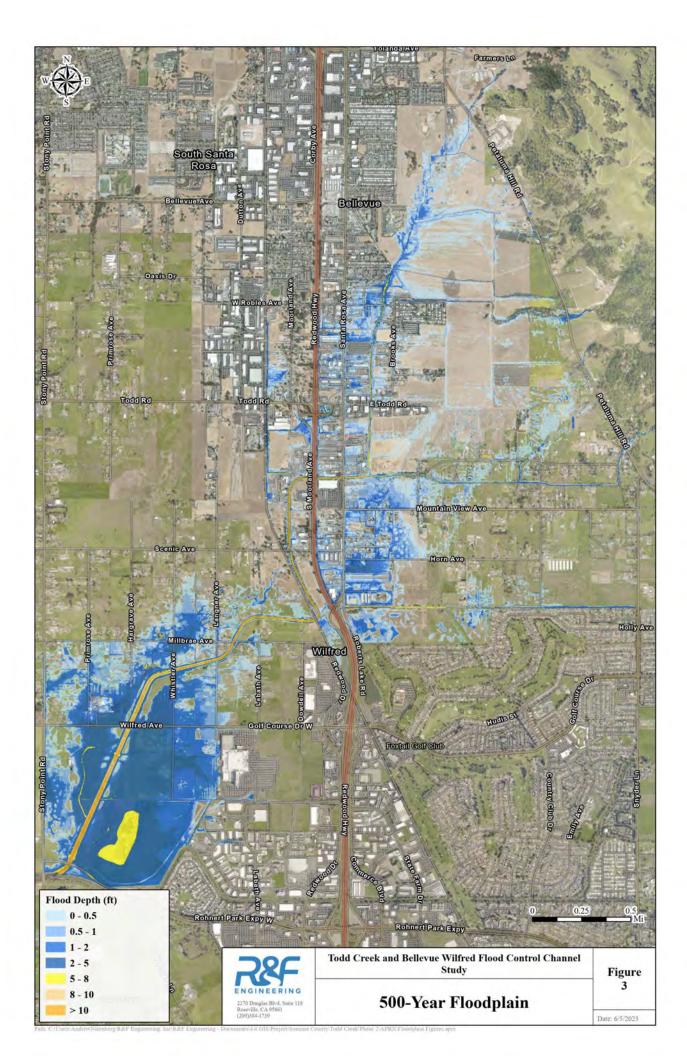
Figures 4 and 5 show the primary areas of ponding outlined with their respective average depths for the 100-year floodplain scenario. Average depths were calculated for wetted areas only (i.e., dry areas within the delineated pond outline did not get counted in the averaging).
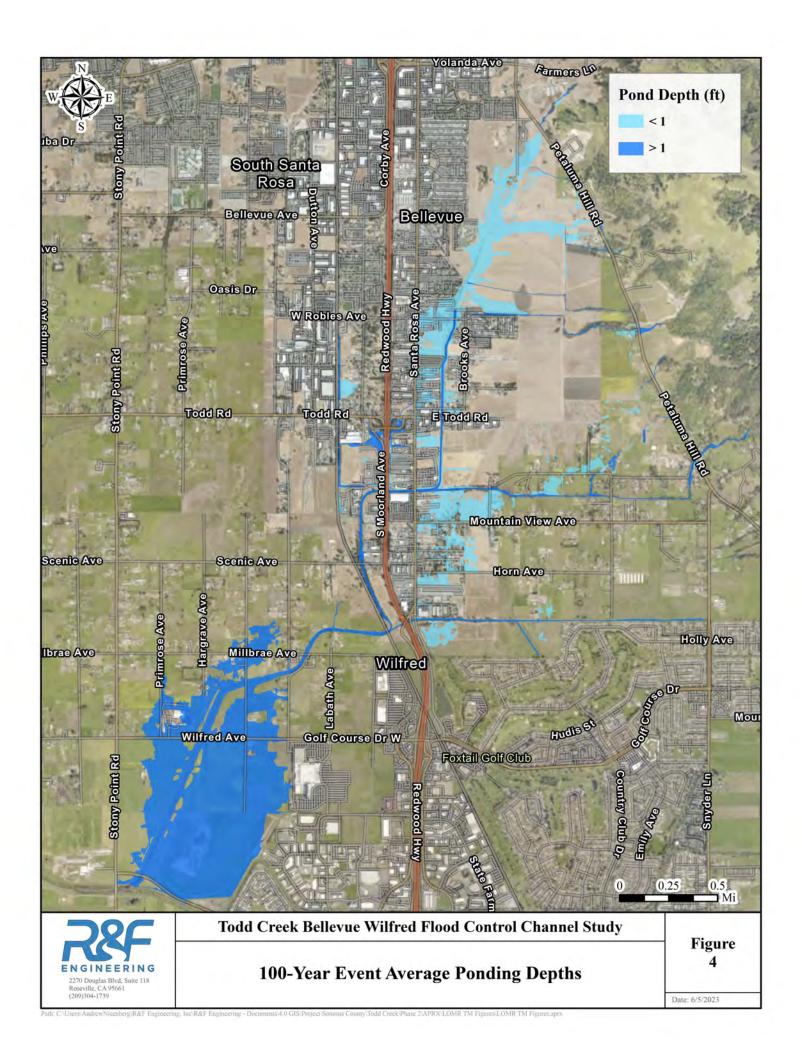
Per FEMA Guidance Document No. 84, "For NFIP mapping purposes, areas of shallow flooding with average depths of 1.0 foot or less are designated as Zone X." Of the 226 individual ponded areas analyzed for the 100-year event, only 71 (approx. 31%) ponded areas have an average depth of greater than one foot, including the areas between channel banks on the various streams analyzed as part of this study.
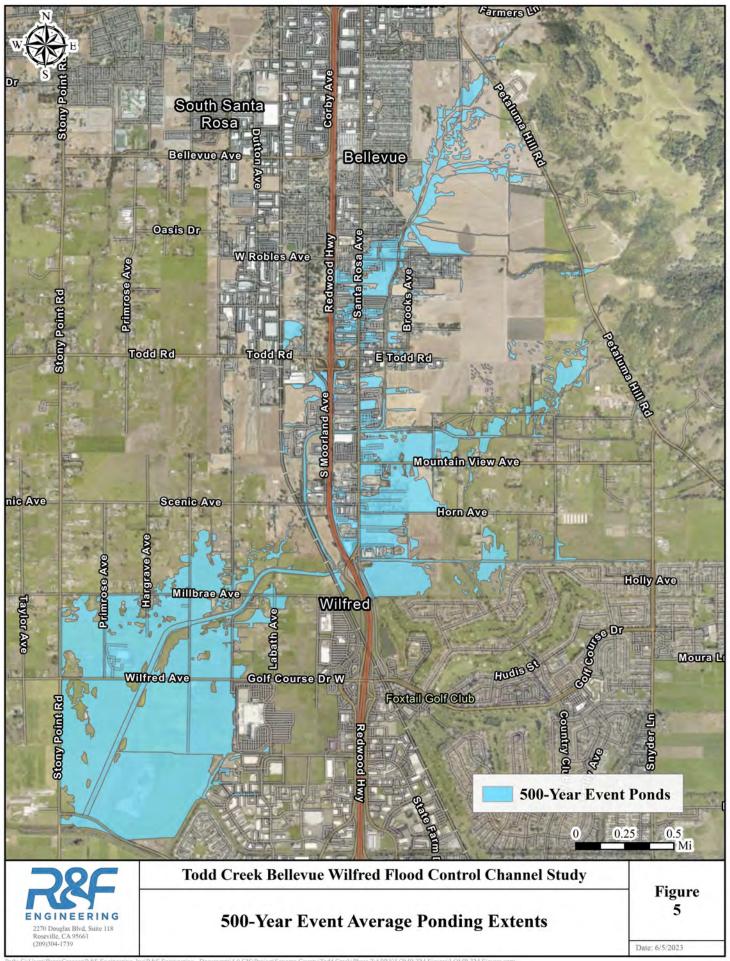
The areas of ponding were also delineated for the 500-year event. The proposed FIRM revisions include the ponded areas for the 100- and 500-year events, along with the proposed floodway extents (see more on this in Section 5).

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[3] FEMA. Guidance Document 84: *Guidance for Flood Risk Analysis and Mapping: Shallow Flooding Analysis and Mapping*. December 2020.

Flood Depth (ft)

	0 - 0.5
	0.5 - 1
	1 - 2
	2 - 5
	5 - 8
	8 - 10
	> 10

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Todd Creek and Bellevue Wilfred Flood Control Channel Study

100-Year Floodplain

Figure 2

Date: 6/5/2023

Flood Depth (ft)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 8
- 8 - 10
- > 10

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Todd Creek and Bellevue Wilfred Flood Control Channel Study

500-Year Floodplain

Figure 3

Date: 6/5/2023

Pond Depth (ft)

< 1
> 1

Todd Creek Bellevue Wilfred Flood Control Channel Study

100-Year Event Average Ponding Depths

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Roseville, CA 95661
(209)304-1739

Figure 4

Date: 6/5/2023

Path: C:\Users\AndrewNisenberg\R&F Engineering, Inc\R&F Engineering - Documents\4.0 GIS\Project\Sonoma County\Todd Creek\Phase 2\APRX\LOMR TM Figures\LOMR TM Figures.aprx

500-Year Event Ponds

0   0.25   0.5
Mi

Todd Creek Bellevue Wilfred Flood Control Channel Study

500-Year Event Average Ponding Extents

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Figure 5

Date: 6/5/2023

5. Floodway Analysis

Existing FEMA floodway designations are present along Todd Creek, Todd Creek Tributary 2, MFCC, and Hunter Lane Channel. However, portions of the existing floodway designations on MFCC, Hunter Lane Channel, Todd Creek Tributary 2, and Todd Creek were inconsistent with the model simulation results that were completed during this analysis. Therefore, all of the existing floodway regions were re-evaluated to confirm their extents.

Per FEMA Guidance Document No. 79 regarding floodway analysis in a 1D/2D hydraulic model, the existing floodway designations were reevaluated by first analyzing the depth times velocity (DxV) contours from the base flood event to establish equitable distribution of encroachment. However, given that the overland flow in the Todd Creek system is seen to generally overtop the banks of Todd Creek and dissipate out and away from the channel, the DxV values outside the channel were very low (see an example in Figure 6). Therefore, per FEMA guidance, an initial encroachment was set at the banks of the channels by modifying the model's lateral structures. Lateral structures along existing floodway designations were infinitely raised or set to a weir coefficient of zero (0) to effectively "turn off" the lateral structure and prevent flow from overtopping. The model was then run for the base flood (100-year) event and the surcharge within Todd Creek was analyzed to ensure there was no increase over one foot. For the reaches of Todd Creek Tributary 2 and MFCC, no surcharges were observed over one foot when the floodway was constrained to the channel banks. Therefore, the revised floodway extents for these reaches are proposed to be within the channel embankments.

There were three areas where the one foot surcharge violation was observed when the floodway was limited to the channel banks: on Todd Creek near Delores Lane and near Miller Road, and on Hunter Lane Channel near Petaluma Hill Road. For these areas, the terrain was elevated from the channel banks (lateral structures) to a distance into the dryland area such that the maximum one-foot surcharge was not violated. The terrain modifications were also done such that any overland flow from upstream could not flank the terrain modification. Lastly, the lateral structures in these areas were also modified to capture the terrain modifications and allow flow to exit the channel and hit the encroachments. Figure 7 provides an example of the encroachment modeling on Todd Creek near Delores Lane. This was iterated in each of the three areas until there was less than one foot of surcharge due to the encroachments. Therefore, the revised floodway extents for these areas are proposed to be consistent with the limits of the encroachment regions.

Figure 8 presents the revised floodway extents for the Todd Creek system. As discussed, the revised floodway extents are proposed to be within the channel banks for MFCC, Todd Creek Tributary 2, and much of Todd Creek and Hunter Lane Channel. There are two (2) areas on Todd Creek and one (1) area on Hunter Lane Channel that require a floodway region beyond the channel banks to be below the one foot surcharge maximum. All revised floodway extents are consistent with FEMA guidance and the updated modeling for this study.

Figure 6. Inundation Areas (white) and DxV Contours (black lines, set to value of 1) show minor shallow flooding outside of channel banks with no DxV outside of channel banks between Delores Ln and Bucks Rd.
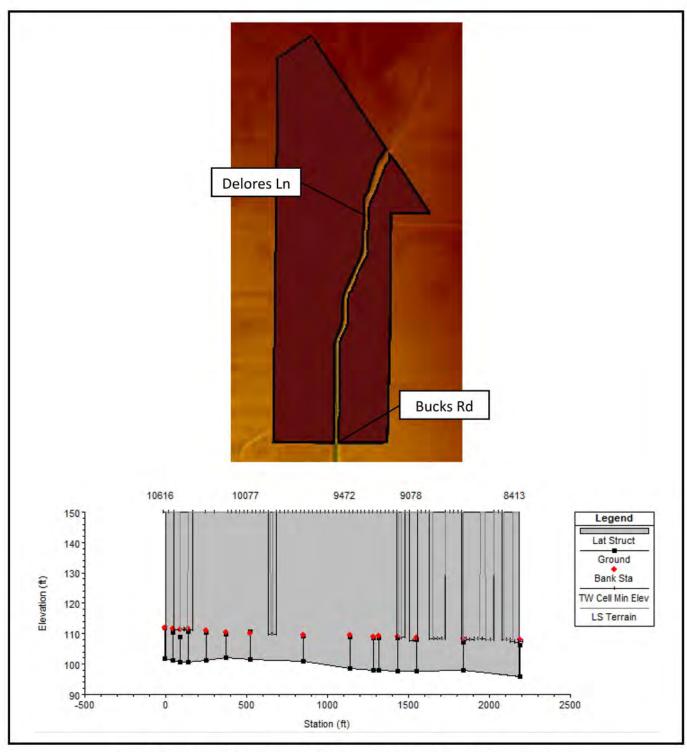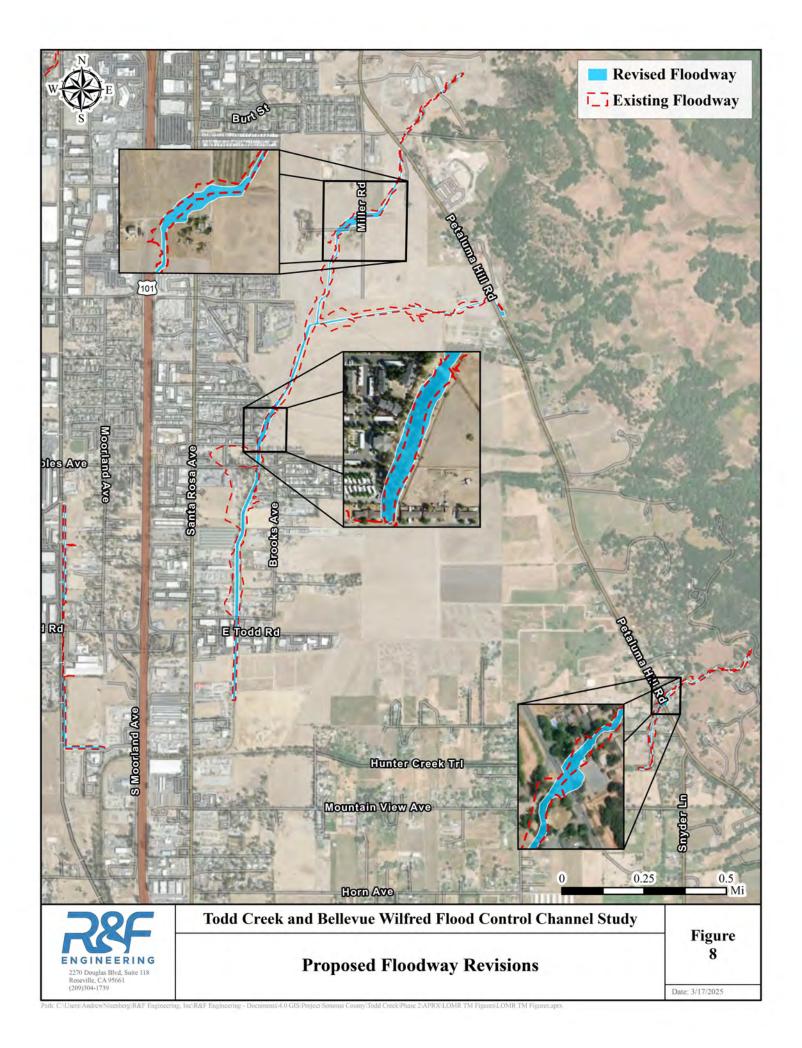
Figure 7. Terrain and Lateral Structure Modifications (raised to 150' EL) for Floodway Evaluation

Legend:
- Revised Floodway
- Existing Floodway

Map labels: Burt St, Miller Rd, Petaluma Hill Rd, Moorland Ave, Santa Rosa Ave, Brooks Ave, E Todd Rd, S Moorland Ave, Hunter Creek Trl, Mountain View Ave, Horn Ave, Snyder Ln, 101

Scale: 0 — 0.25 — 0.5 Mi

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Todd Creek and Bellevue Wilfred Flood Control Channel Study

Proposed Floodway Revisions

Figure 8

Date: 3/17/2025

6. Proposed FIRM Revisions

The proposed revisions to FEMA FIRM Panels 06097C0737G, 06097C0738G, 06097C0739F, 06097C0876F, 06097C0877F, 06097C0743G, and 06097C0881E are presented in Figures 9-14, based on the updated analyses conducted by R&F. The topographic work maps are presented in Attachment C per Section C of FEMA's Application/Certification Form 2 "Riverine Hydrology and Hydraulics Form".

As discussed previously, the updated 100-year floodplain modeling analysis shows mostly shallow (<1 ft) flooding that would warrant the designation of mostly Zone X throughout the study area. The refined 500-year flooding analysis was used to estimate the extents of the remaining recommended X Zones. Delineated areas from the 100-year floodplain with average depths greater than one foot were designated as Zone AE.

It is recommended that the existing floodways on Todd Creek, Todd Creek Tributary 2, MFCC, and Hunter Lane Channel be updated to reflect the modeling in this analysis. The revised floodway extents are primarily limited to within the channel banks on all streams except for two (2) small areas on Todd Creek and one (1) small area on Hunter Lane Channel.

As part of the comments received from FEMA and STARR II on July 31, 2024, several areas of the proposed SFHA mapping were revised based on the "AE_changes" shapefile which included specific locations and suggested delineation changes.

FLOOD HAZARD INFORMATION

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

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE)
Zone A, V, A99

With BFE or Depth Zone AE, AO, AH, VE, AR

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X

Future Conditions 1% Annual Chance Flood Hazard Zone X

OTHER AREAS OF FLOOD HAZARD

Area with Reduced Flood Risk due to Levee See Notes. Zone X

Area with Flood Risk due to Levee Zone D

OTHER AREAS

NO SCREEN   Areas of Minimal Flood Hazard Zone X

Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

Cross Sections with 1% Annual Chance Water Surface Elevation

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

OTHER FEATURES

Limit of Study

Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

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For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by National Agricultural Imagery Program. This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2016.

Proposed AE Zone
Proposed Regulatory Floodway
Proposed X Zone
Study Area

Proposed changes only shown within the study area limits.

SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

0   500   1,000   2,000 feet

0   125   250   500 meters

PANEL LOCATOR

0729	0733
0736	0737	0741
0738	0739	0743

SONOMA COUNTY

* PANEL NOT PRINTED

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 0737 OF 1150

COMMUNITY	NUMBER	PANEL	SUFFIX
SANTA ROSA, CITY OF	060381	0737	G
SONOMA COUNTY	060375	0737	G

National Flood Insurance Program

FEMA

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0737G

MAP REVISED
July 19, 2022

Map annotations:
Colgan Creek ZONE AE
PINEWOOD DR
ROSEWOOD DR
AX 141.2
COTTONWOOD DR
ZONE AE
0.2 PERCENT ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN STRUCTURE

122° 43' 07.5"
38° 26' 15"
6360000 FT
1920000 FT
1915000 FT
122° 41' 15"
38° 26' 15"
38° 24' 22.5"

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SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE)
Zone A, V, A99

With BFE or Depth Zone AE, AO, AH, VE, AR

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X

Future Conditions 1% Annual Chance Flood Hazard Zone X

OTHER AREAS OF FLOOD HAZARD

Area with Reduced Flood Risk due to Levee See Notes. Zone X

Area with Flood Risk due to Levee Zone D

OTHER AREAS

NO SCREEN   Area of Minimal Flood Hazard Zone X

Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

Cross Sections with 1% Annual Chance Water Surface Elevation

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

OTHER FEATURES

Limit of Study

Jurisdiction Boundary

NOTES TO USERS

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SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

0   500   1,000   2,000 feet

0   125   250   500 meters

PANEL LOCATOR

SONOMA COUNTY

0736   0737
0719   0738   0739
0857   0876   0877

* PANEL NOT PRINTED

Proposed AE Zone
Proposed Regulatory Floodway
Proposed X Zone
Study Area

Proposed changes only shown within the study area limits.
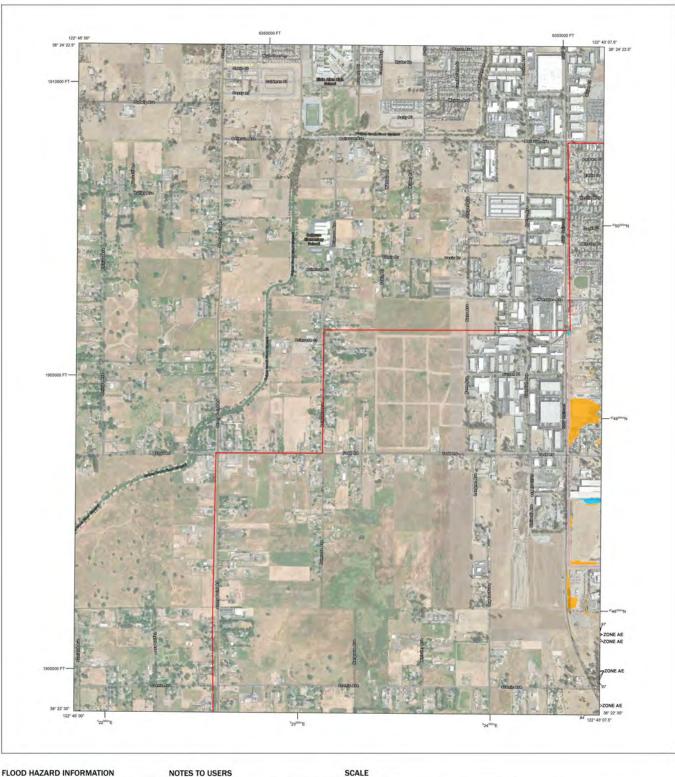
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 0738 of 1150

FEMA

National Flood Insurance Program

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
SANTA ROSA, CITY OF	060381	0738	G
SONOMA COUNTY	060375	0738	G

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0738G

MAP REVISED
July 19, 2022

ZONE AE
ZONE AE
ZONE AE
ZONE AE

FLOOD HAZARD INFORMATION

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

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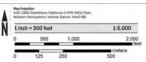
SPECIAL FLOOD HAZARD AREAS

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

OTHER AREAS OF FLOOD HAZARD

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

OTHER AREAS

- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES

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

- Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- Base Flood Elevation Line (BFE)

OTHER FEATURES

- Limit of Study
- Jurisdiction Boundary

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Legend

- Proposed AE Zone
- Proposed Regulatory Floodway
- Proposed X Zone
- Study Area

Proposed changes only shown within the study area limits.

SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88.

1 inch = 500 feet   1:6,000

0   500   1,000   2,000 feet

0   125   250   500 meters

PANEL LOCATOR

SONOMA COUNTY

0737	0741
0738	0739	0743
0876	0877
	0881

* PANEL NOT PRINTED

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 0739 OF 1150

Panel Contains:

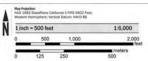| COMMUNITY	NUMBER	PANEL	SUFFIX
SANTA ROSA, CITY OF	060381	0739	F
SONOMA COUNTY	060375	0739	F

FEMA

National Flood Insurance Program

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0739F

MAP REVISED
July 19, 2022

FLOOD HAZARD INFORMATION

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

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SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE) *Zone A, V, A99*
With BFE or Depth *Zone AE, AO, AH, VE, AR*

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*

Future Conditions 1% Annual Chance Flood Hazard *Zone X*

OTHER AREAS OF FLOOD HAZARD

Area with Reduced Flood Risk due to Levee See Notes. *Zone X*

Area with Flood Risk due to Levee *Zone D*

OTHER AREAS

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Area of Undetermined Flood Hazard *Zone D*

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Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

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For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by National Agricultural Imagery Program. This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2016.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and FDTs may reflect stream channel distances that differ from what is shown on the map.

SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

| 0 | 500 | 1,000 | 2,000 |
feet

| 0 | 125 | 250 | 500 |
meters

PANEL LOCATOR

	0741	
SONOMA COUNTY		0745*
0739	0743	
0877	0882*	
	0881	

* PANEL NOT PRINTED

Proposed AE Zone
Proposed Regulatory Floodway
Proposed X Zone
Study Area

Proposed changes only shown within the study area limits.
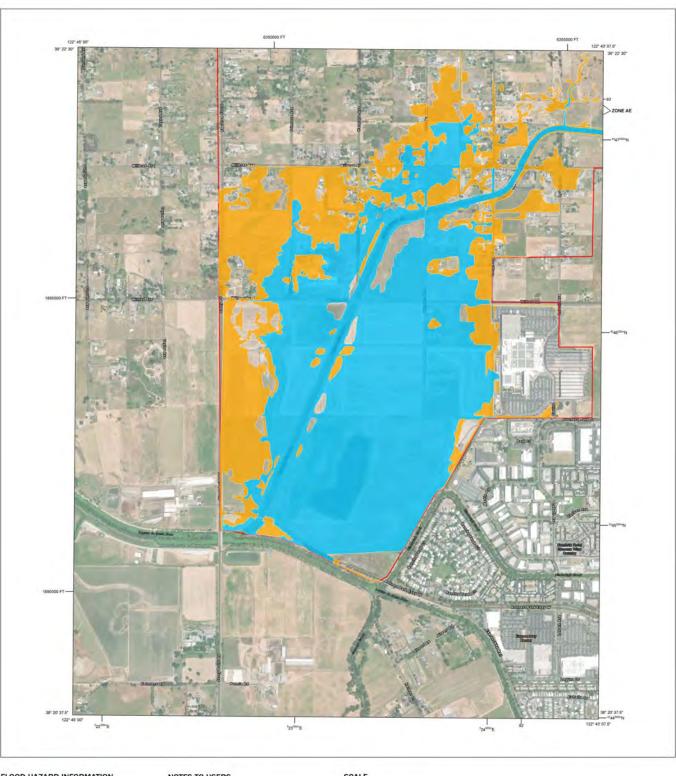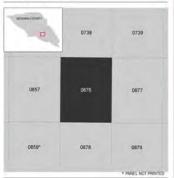
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL **0743** of **1150**

FEMA

National Flood Insurance Program

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
SONOMA COUNTY	060375	0743	G

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0743G

MAP REVISED
July 19, 2022

ZONE AE

FLOOD HAZARD INFORMATION

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

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE)
Zone A, V, A99

With BFE or Depth Zone AE, AO, AH, VE, AR

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X

Future Conditions 1% Annual Chance Flood Hazard Zone X

OTHER AREAS OF FLOOD HAZARD

Area with Reduced Flood Risk due to Levee See Notes. Zone X

Area with Flood Risk due to Levee Zone D

OTHER AREAS

NO SCREEN Areas of Minimal Flood Hazard Zone X

Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

Cross Sections with 1% Annual Chance Water Surface Elevation

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

OTHER FEATURES

Limit of Study

Jurisdiction Boundary

NOTES TO USERS

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To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by National Agricultural Imagery Program. This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2016.

Legend:
Proposed AE Zone
Proposed Regulatory Floodway
Proposed X Zone
Study Area

Proposed changes only shown within the study area limits.

SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

0   500   1,000   2,000 feet

0   125   250   500 meters

PANEL LOCATOR

SONOMA COUNTY

0738   0739
0857   0876   0877
0859*   0878   0879

* PANEL NOT PRINTED

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 0876 OF 1150

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
ROHNERT PARK, CITY OF	060380	0876	F
SONOMA COUNTY	060375	0876	F

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0876F

MAP REVISED
July 19, 2022

ZONE AE

ZONE AE

ZONE AO
(DEPTH 1)

ZONE AO
(DEPTH 1)

Rohnert Park

FLOOD HAZARD INFORMATION

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SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) *Zone A, V, A99*
		With BFE or Depth *Zone AE, AO, AH, VE, AR*
		Regulatory Floodway
		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
		Future Conditions 1% Annual Chance Flood Hazard *Zone X*
OTHER AREAS OF FLOOD HAZARD		Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
		Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN	Areas of Minimal Flood Hazard *Zone X*
		Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall

OTHER FEATURES

- ⓔ 18.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Ⓑ - - - Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

NOTES TO USERS

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SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

0   500   1,000   2,000 feet

0 125 250   500 meters

PANEL LOCATOR

SONOMA COUNTY

0739	0743
0876	0877	0881
0878	0879	0883

* PANEL NOT PRINTED

Proposed AE Zone
Proposed Regulatory Floodway
Proposed X Zone
☐ **Study Area**

Proposed changes only shown within the study area limits.

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 0877 OF 1150

FEMA

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
ROHNERT PARK, CITY OF	060380	0877	F
SONOMA COUNTY	060375	0877	F

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0877F

MAP REVISED
July 19, 2022

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0 North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was California State Plane II (FIPSZONE 402). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information on this FIRM was derived from multiple sources. Data was provided in digital format by the County of Sonoma Information Systems Department, derived from 1:1,200, 1:2,400, and 1:4,800 scale digital orthophotos, dated April-May 2000. Information was provided by the City of Healdsburg Department of Public Works, derived from 1:600 scale digital orthophotos, dated March 3, 2007. Additional information was derived from 1:12,000 scale U.S. Geological Survey Digital Orthophoto Quadrangles, dated 2002.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov.

Proposed AE Zone
Proposed Regulatory Floodway
Proposed X Zone
Study Area

Proposed changes only shown within the study area limits.

City of
Rohnert Park
060380

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A — No Base Flood Elevations determined.

ZONE AE — Base Flood Elevations determined.

ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~~ 513 ~~~ Base Flood Elevation line and value; elevation in feet*

(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

Cross section line

Transect line

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere

1000-meter Universal Transverse Mercator grid values, zone 10

5000-foot ticks: California State Plane coordinate system, zone II (FIPSZONE 0402), Lambert Conformal Conic projection

Bench mark (see explanation in Notes to Users section of this FIRM panel)

River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
December 2, 2008

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250   0   500   1000   FEET
150   0   150   300   METERS

R&F
ENGINEERING

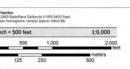ATTACHMENT A
Current FEMA FIRM Panels
06097C0737G
06097C0738G
06097C0739F
06097C0876F
06097C0877F
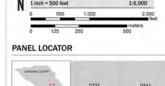06097C0743G
06097C0881E

FLOOD HAZARD INFORMATION

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SPECIAL FLOOD HAZARD AREAS

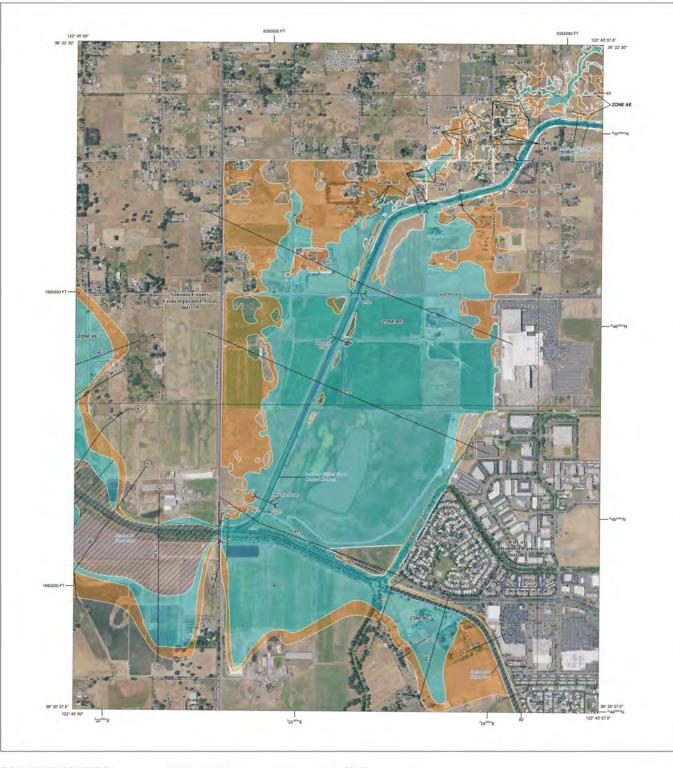Without Base Flood Elevation (BFE)
Zone A, V, A99

With BFE or Depth *Zone AE, AO, AH, VE, AR*

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*

OTHER AREAS OF FLOOD HAZARD

Future Conditions 1% Annual Chance Flood Hazard *Zone X*

Area with Reduced Flood Risk due to Levee See Notes. *Zone X*

Area with Flood Risk due to Levee *Zone D*

OTHER AREAS

NO SCREEN Areas of Minimal Flood Hazard *Zone X*

Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

OTHER FEATURES

Cross Sections with 1% Annual Chance Water Surface Elevation

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

Limit of Study

Jurisdiction Boundary

NOTES TO USERS

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SCALE

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1 inch = 500 feet   1:6,000

0   500   1,000   2,000 feet

0 125 250   500 meters

PANEL LOCATOR

SONOMA COUNTY

0729	0733
0736	0737	0741
0738	0739	0743

* PANEL NOT PRINTED

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 0737 OF 1150

National Flood Insurance Program

FEMA

Panel Contains:

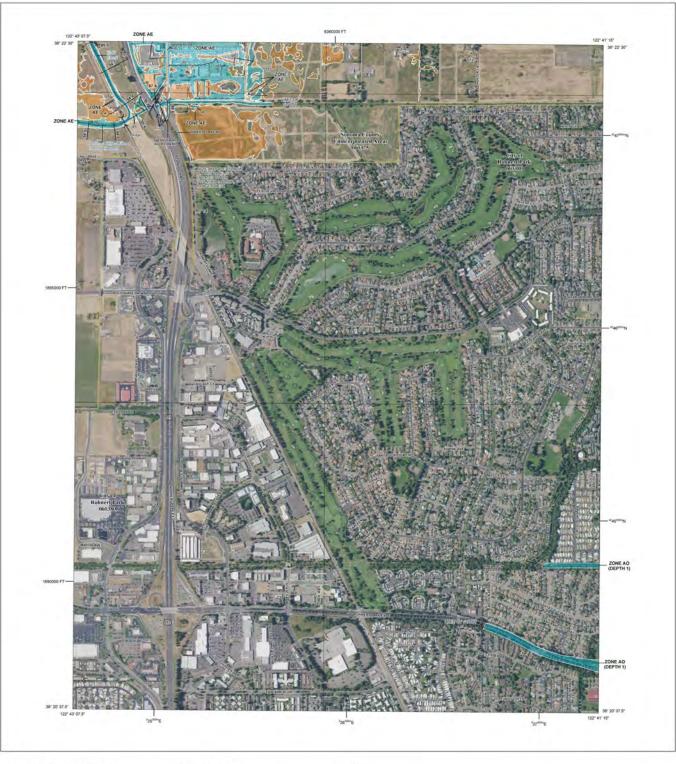| COMMUNITY	NUMBER	PANEL	SUFFIX
SANTA ROSA, CITY OF	060381	0737	G
SONOMA COUNTY	060375	0737	G

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0737G

MAP REVISED
July 19, 2022

FLOOD HAZARD INFORMATION

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SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE)
Zone A, V, A99
With BFE or Depth Zone AE, AO, AH, VE, AR

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X

Future Conditions 1% Annual Chance Flood Hazard Zone X

OTHER AREAS OF FLOOD HAZARD

Area with Reduced Flood Risk due to Levee See Notes. Zone X

Area with Flood Risk due to Levee Zone D

OTHER AREAS

NO SCREEN   Area of Minimal Flood Hazard Zone X

Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

Cross Sections with 1% Annual Chance Water Surface Elevation

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

OTHER FEATURES

Limit of Study

Jurisdiction Boundary

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SCALE

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Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

0   500   1,000   2,000 feet

0 125 250   500 meters

PANEL LOCATOR

	0736	0737
0719	**0738**	0739
0857	0876	0877

* PANEL NOT PRINTED

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 0738 of 1150

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
SANTA ROSA, CITY OF	060381	0738	G
SONOMA COUNTY	060375	0738	G

FEMA

National Flood Insurance Program

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0738G

MAP REVISED
July 19, 2022

FLOOD HAZARD INFORMATION

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SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE)
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Regulatory Floodway

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Future Conditions 1% Annual Chance Flood Hazard Zone X

OTHER AREAS OF FLOOD HAZARD

Area with Reduced Flood Risk due to Levee See Notes. Zone X

Area with Flood Risk due to Levee Zone D

OTHER AREAS

NO SCREEN — Areas of Minimal Flood Hazard Zone X

Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

Cross Sections with 1% Annual Chance Water Surface Elevation

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

OTHER FEATURES

Limit of Study

Jurisdiction Boundary

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SCALE

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0   125   250   500 meters

PANEL LOCATOR

SONOMA COUNTY

0737	0741
0738	0739	0743
0876	0877
	0881

* PANEL NOT PRINTED

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
And Incorporated Areas

PANEL 0739 of 1150

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
SANTA ROSA, CITY OF	060381	0739	F
SONOMA COUNTY	060375	0739	F

FEMA

National Flood Insurance Program

VERSION NUMBER
2.5.3.6

MAP NUMBER
06097C0739F

MAP REVISED
July 19, 2022

City Of Santa Rosa 060381

Sonoma County Unincorporated Areas 060375

ZONE AE

Miller Rd

128.8 Culvert 127.5

130

PANEL 0739

38° 24' 22.5"
122° 43' 07.5"

38° 24' 22.5"
122° 41' 15"

38° 22' 30"
122° 43' 07.5"

38° 22' 30"
122° 41' 15"

FLOOD HAZARD INFORMATION

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

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SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE)
Zone A, V, A99

With BFE or Depth Zone AE, AO, AH, VE, AR

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X

Future Conditions 1% Annual Chance Flood Hazard Zone X

OTHER AREAS OF FLOOD HAZARD

Area with Reduced Flood Risk due to Levee See Notes. Zone X

Area with Flood Risk due to Levee Zone D

OTHER AREAS

NO SCREEN — Areas of Minimal Flood Hazard Zone X

Area of Undetermined Flood Hazard Zone D

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Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

Cross Sections with 1% Annual Chance Water Surface Elevation

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

OTHER FEATURES

Limit of Study

Jurisdiction Boundary

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For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by National Agricultural Imagery Program. This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2016.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and FDTs may reflect stream channel distances that differ from what is shown on the map.

SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

| 0 | 500 | 1,000 | 2,000 |
feet

| 0 | 125 | 250 | 500 |
meters

PANEL LOCATOR

	0741	
SONOMA COUNTY		0745*
0739	0743	
0877	0881	0882*

* PANEL NOT PRINTED

FLOOD HAZARD INFORMATION

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

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE)
Zone A, V, A99

With BFE or Depth Zone AE, AO, AH, VE, AR

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X

OTHER AREAS OF FLOOD HAZARD

Future Conditions 1% Annual Chance Flood Hazard Zone X

Area with Reduced Flood Risk due to Levee See Notes. Zone X

Area with Flood Risk due to Levee Zone D

OTHER AREAS

NO SCREEN Area of Minimal Flood Hazard Zone X

Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

Cross Sections with 1% Annual Chance Water Surface Elevation

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Base Flood Elevation Line (BFE)

OTHER FEATURES

Limit of Study

Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by National Agricultural Imagery Program. This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2016.

SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

0   500   1,000   2,000 feet

0   125   250   500 meters

PANEL LOCATOR

	0738	0739
0857	0876	0877
0859*	0878	0879

SONOMA COUNTY

* PANEL NOT PRINTED

Flood Insurance Rate Map — Sonoma County, California, Panel 0877 of 1150

Map labels (on map):
- ZONE AE
- ZONE AE
- ZONE AE
- ZONE AE
- ZONE AE
- ZONE AE
- ZONE AO (DEPTH 1)
- ZONE AO (DEPTH 1)
- Sonoma County Unincorporated Areas 060375
- City of Rohnert Park 060380
- City of Rohnert Park 060380

Coordinates:
- 122° 43' 07.5" 38° 22' 30"
- 122° 41' 15" 38° 22' 30"
- 6360000 FT
- 1895000 FT
- 1890000 FT
- 38° 20' 37.5" 122° 43' 07.5"
- 38° 20' 37.5" 122° 41' 15"
- 42°47000mN
- 42°46000mN
- 42°45000mN

FLOOD HAZARD INFORMATION

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

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS

Without Base Flood Elevation (BFE) *Zone A,V, A99*

With BFE or Depth *Zone AE, AO, AH, VE, AR*

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*

Future Conditions 1% Annual Chance Flood Hazard *Zone X*

OTHER AREAS OF FLOOD HAZARD

Area with Reduced Flood Risk due to Levee See Notes. *Zone X*

Area with Flood Risk due to Levee *Zone D*

OTHER AREAS

NO SCREEN Area of Minimal Flood Hazard *Zone X*

Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

OTHER FEATURES

(E) 18.2 Cross Sections with 1% Annual Chance
17.5 Water Surface Elevation

(B) Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

513 Base Flood Elevation Line (BFE)

Limit of Study

Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

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For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by National Agricultural Imagery Program. This information was derived from digital orthophotography at a 1-meter resolution from photography dated 2016.

SCALE

Map Projection:
NAD 1983 StatePlane California II FIPS 0402 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet   1:6,000

0 500 1,000 2,000 feet

0 125 250 500 meters

PANEL LOCATOR

SONOMA COUNTY

0739	0743
0876	0877	0881
0878	0879	0883

* PANEL NOT PRINTED

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was California State Plane Zone II (FIPSZONE 402). The horizontal datum was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for bench marks shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at http://www.ngs.noaa.gov.

Base map information on this FIRM was derived from multiple sources. Data was provided in digital format by the County of Sonoma Information Systems Department, derived from 1:1,200, 1:2,400, and 1:4,800 scale digital orthophotos, dated April-May 2000. Information was provided by the City of Healdsburg Department of Public Works, derived from 1:600 scale digital orthophotos, dated March 3, 2007. Additional information was derived from 1:12,000 scale U.S. Geological Survey Digital Orthophoto Quadrangles, dated 2002.

This map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed Map Index for an overview map showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the FEMA Map Service Center at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have questions about this map or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at http://www.fema.gov.

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A   No Base Flood Elevations determined.

ZONE AE   Base Flood Elevations determined.

ZONE AH   Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO   Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR   Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99   Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V   Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE   Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increase in flood heights.

OTHER FLOOD AREAS

ZONE X   Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X   Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D   Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

—————————— 1% annual chance floodplain boundary
—————————— 0.2% annual chance floodplain boundary
—————————— Floodway boundary
— — — — — Zone D boundary
·············· CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~~ 513 ~~~   Base Flood Elevation line and value; elevation in feet*

(EL 987)   Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

—●—●—   Cross section line

—●———●—   Transect line

87°07'45", 32°22'30"   Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere

~76'~~N   1000-meter Universal Transverse Mercator grid values, zone 10

600000 FT   5000-foot grid ticks; California State Plane coordinate system, zone II (FIPSZONE 0402), Lambert Conformal Conic projection

DX5510 ×   Bench mark (see explanation in Notes to Users section of this FIRM panel)

●M1.5   River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index.

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
December 2, 2008

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

Title Block

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0881E

FIRM
FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 881 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ROHNERT PARK, CITY OF	060380	0881	E
SONOMA COUNTY	060375	0881	E

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
06097C0881E

EFFECTIVE DATE
DECEMBER 2, 2008

Federal Emergency Management Agency

ATTACHMENT B
Topographic Work Maps

Proposed Revised Special Flood Hazard Zones

- Floodway
- X Zone
- AE Zone

Current Effective Special Flood Hazard Zones

- AE Zone
- Regulatory Floodway
- X Zone
- Model Centerlines
- 5' Contours
- 20' Contours

0   1,000   2,000
Feet   1 inch = 500 feet   1:6,000

Vertical Datum: NAVD88-ft

Todd Creek and Bellevue Wilfred Flood Control Channel Study

R&F ENGINEERING
2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Topographic Work Map Overview
Panel Number 06097C0737G

REGISTERED PROFESSIONAL ENGINEER
Baron Creager
No. C 93454
Exp. 06/30/26
STATE OF CALIFORNIA

Date: 2/14/2025

N
W E
S

Proposed Revised Special Flood Hazard Zones

Floodway	X Zone	AE Zone

Current Effective Special Flood Hazard Zones

AE Zone	Regulatory Floodway	X Zone

Model Centerlines — 5' Contours — 20' Contours

0   1,000   2,000
Feet   1 inch = 500 feet   1:6,000

Vertical Datum: NAVD88-ft

Todd Creek and Bellevue Wilfred Flood Control Channel Study

R&F ENGINEERING
2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Topographic Work Map Overview
Panel Number 06097C0738G

REGISTERED PROFESSIONAL ENGINEER
Baron Creager
No. C 93454
Exp. 06/30/26
STATE OF CALIFORNIA

Date: 2/14/2025

Proposed Revised Special Flood Hazard Zones

Floodway   X Zone   AE Zone

Current Effective Special Flood Hazard Zones

AE Zone   Regulatory Floodway   X Zone

Model Centerlines   5' Contours   20' Contours

0   1,000   2,000   Feet   1 inch = 500 feet   1:6,000

Vertical Datum: NAVD88-ft

Todd Creek and Bellevue Wilfred Flood Control Channel Study

R&F ENGINEERING

2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Topographic Work Map Overview
Panel Number 06097C0739F

REGISTERED PROFESSIONAL ENGINEER
Baron Creager
No. C 93454
Exp. 06/30/26
STATE OF CALIFORNIA

Date: 2/14/2025

Proposed Revised Special Flood Hazard Zones

Floodway	X Zone	AE Zone

Current Effective Special Flood Hazard Zones

AE Zone	Regulatory Floodway	X Zone

Model Centerlines — 5' Contours — 20' Contours

0   1,000   2,000   Feet   1 inch = 500 feet   1:6,000

Vertical Datum: NAVD88-ft

Todd Creek and Bellevue Wilfred Flood Control Channel Study

R&F ENGINEERING
2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Topographic Work Map Overview
Panel Number 06097C0743G

REGISTERED PROFESSIONAL ENGINEER
Baron Creager
No. C 93454
Exp. 06/30/26
STATE OF CALIFORNIA

Date: 2/14/2025

Proposed Revised Special Flood Hazard Zones

Floodway X Zone AE Zone

Current Effective Special Flood Hazard Zones

AE Zone Regulatory Floodway X Zone

Model Centerlines 5' Contours 20' Contours

0 1,000 2,000
Feet 1 inch = 500 feet 1:6,000

Vertical Datum: NAVD88-ft

Todd Creek and Bellevue Wilfred Flood Control Channel Study

R&F ENGINEERING

2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Topographic Work Map Overview
Panel Number 06097C0876F

REGISTERED PROFESSIONAL ENGINEER
Baron Creager
No. C 93454
Exp. 06/30/26
STATE OF CALIFORNIA

Date: 2/14/2025

Todd Creek and Bellevue Wilfred Flood Control Channel Study

R&F ENGINEERING

2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Topographic Work Map Overview
Panel Number 06097C0877F

Date: 2/14/2025

Proposed Revised Special Flood Hazard Zones

Floodway X Zone AE Zone

Current Effective Special Flood Hazard Zones

AE Zone Regulatory Floodway X Zone

Model Centerlines 5' Contours 20' Contours

0 1,000 2,000 Feet 1 inch = 500 feet 1:6,000

Vertical Datum: NAVD88-ft

Todd Creek and Bellevue Wilfred Flood Control Channel Study

R&F ENGINEERING
2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Topographic Work Map Overview
Panel Number 06097C0881E

REGISTERED PROFESSIONAL ENGINEER
Baron Creager
No. C 93454
Exp. 06/30/26
STATE OF CALIFORNIA

Date: 2/14/2025

**ATTACHMENT C
Todd Creek & Bellevue-Wilfred Flood
Control Channel Study Hydrology &
Hydraulic Analysis Reports**

R&F ENGINEERING

Hydrologic Analysis for Todd Creek and Bellevue-Wilfred Flood Control Channel

Prepared for:	Sonoma County
Date:	November 28, 2023
Prepared by:	Michael Pantell, P.E.
Reviewed by:	Chris Fritz, P.E. & Baron Creager, P.E.

REGISTERED PROFESSIONAL ENGINEER

Baron Creager
No. C 93454
Exp. 06/30/24

STATE OF CALIFORNIA

Introduction

In July of 2022, Federal Emergency Management Agency (FEMA) updated the Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRM) for the Todd Creek and the Bellevue-Wilfred Flood Control Channel (BWFCC) in Sonoma County, CA. The update included new hydrology and hydraulics for the system with floodplains delineated as Special Flood Hazard Areas (SFHA). During FEMA's preparation of the hydrologic and hydraulic analyses, the County submitted several comments regarding the analysis and the resulting SFHAs. While some of the comments were addressed, many were left unresolved, and FEMA published final FIRMs which became effective July 19, 2022.

In response to these events, the County has contracted with R&F Engineering, Inc. (R&F) to perform a Letter of Mapping Revision (LOMR) of the area. This includes updating the hydrologic model, the hydraulic modeling, and delineating new SFHAs. This technical memorandum outlines the methods used to develop the hydrologic model for this LOMR and provides revised flows to be used in the hydraulic analyses and FIS.

Study Area

The study area consists of two major watersheds with several smaller tributaries flowing into them that combine and flow into the Laguna de Santa Rosa. The upper watershed is the Todd Creek watershed which flows parallel to Highway 101 from the City of Santa Rosa in the north and into the BWFCC. This watershed has several tributaries including two unnamed tributaries (Todd Creek Tributary 1 & 2), Todd Creek East Fork, Hunter Lane Channel, and the Moorland Flood Control Channel (MFCC).

The lower portion of the watershed is the BWFCC. The BWFCC originates in the Town of Rohnert Park and the area to the east then flows west under Highway 101 where it meets with Todd Creek. BWFCC then flows southwest and meets with the Laguna de Santa Rosa creek.

The study area consists of a mix of urban, rural grasslands, and rolling sparsely forested hills. On the east side of the study area lies a hill range that has a maximum elevation of approximately 1,400 ft-NAVD88. The terrain drops steeply down to Petaluma Hill Road which is at approximately 200 ft-NAVD88. From there the terrain becomes much flatter- dropping another 200 feet before reaching Laguna de Santa Rosa. To the west of Petaluma Hill Road lies several areas designated Wildlife Preserves. These areas have been graded to collect and preferentially flood to create habitat opportunities for wildlife.

The urban area runs along Highway 101 and in Rohnert Park. These areas have storm sewer systems that redirect and attenuate water. As-builts and storm sewer data was collected from the County, California Department of Transportation (CalTrans), Rohnert Park, and Santa Rosa to delineate the subbasins and help determine flow paths. Additionally, many of the areas carry water through open ditches and culverts.

The study streams for this project are shown in Figure 1.

Todd Creek Trib 1
Todd Creek Trib 2
Todd Creek East Fork
Hunter Lane Channel
Upper Todd Creek
Moorland FCC
Lower Todd Creek
BWFCC
BWFCC
Laguna de Santa Rosa

South Santa Rosa
Bellevue
Wilfred
Foxtail Golf Club

Hearn Ave
Bellevue Ave
Redwood Hwy
Santa Rosa Ave
Stony Point Rd
Wilfred Ave
Rohnert Park Expy
Paluma Hill Rd

Legend
— Streams
— 100' Contours
— 20' Contours

0   0.25   0.5
Mi

Todd Creek and Bellevue-Wilfred Flood Control Channel Study

Project Overview

Figure 1

Date: 6/14/2023

R&F ENGINEERING
2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Path: C:\Users\AndrewNisenberg\R&F Engineering, Inc\R&F Engineering - Documents\4.0 GIS\Project\Sonoma County\Todd Creek\Phase 2\APRX\Hydrology TM Figures\Hydrology TM Figures.aprx

Hydrologic Model Development

The hydrologic model for this study was developed using the Hydrologic Engineer Center Hydrologic Modeling System (HEC-HMS) version 4.10 developed by the United State Army Corps of Engineers (USACE). The following sections describe the hydrologic model inputs.

Subbasin Delineation

Subbasins were delineated for the study area using a 1-meter resolution digital elevation model (DEM) acquired from United States Geologic Survey (USGS)[1] and storm sewer as-builts and data obtained from Sonoma County[2] and the City of Rohnert Park[3]. Thirty two (32) subbasins were delineated with a total area of 7,825.4 acres and are shown with the storm drain lines and ditches in Figure 2.

Time of Concentration

The longest flow paths were used to compute the time of concentration and lag time for each subbasin per the Natural Resources Conservation Service (NRCS) TR-55 Manual[4]. The time of concentration for each subbasin was computed by dividing the longest flow path into overland flow, shallow concentrated flow, and channel or pipeline flow depending on longest flow path characteristics. The time of concentration was computed for each flow type separately then summed to determine the total time of concentration for each subbasin. The lag time for each subbasin was then computed using 0.6 the time of concentration per TR-55. The longest flow paths for each of the subbasins are shown in Figure 2. Table 1 provides the lag time and time of concentration for each subbasin. The full time of concentration calculations are provided in Appendix A.

---

[1] U.S. Geological Survey, 20200330, USGS one meter x52y425 CA Sonoma A4 2013: U.S. Geological Survey.
[2] Drainage Lines. https://gis-sonomacounty.hub.arcgis.com/datasets/sonomacounty::drainage-lines-1/about
[3] Rohnert Park GIS Viewer Hosted by City of Santa Rosa. https://maps.srcity.org/Html5Viewer/Index.html?viewer=rohnertpark
[4] NRCS, Urban Hydrology for Small Watersheds – Technical Release 55, June 1986

Todd Creek and Bellevue-Wilfred Flood Control Channel Study

Subbasins and Storm Drains

Figure 2

Date: 6/29/2023

R&F ENGINEERING
2270 Douglas Blvd, Suite 118
Roseville, CA 95661
(209)304-1739

Path: C:\Users\Andrew Nisenberg\R&F Engineering, Inc\R&F Engineering - Documents\4.0 GIS\Project\Sonoma County\Todd Creek\Phase 2\APRX\Hydrology TM Figures\Hydrology TM Figures.aprx

Table 1. Time of concentration and lag time.

Basin	Area (Acre)	Time of Concentration (Mins)	Lag Time (mins)
BWFCC-1	458.0	115.9	69.6
BWFCC-2	271.8	238.3	143.0
BWFCC-3	226.0	31.5	18.9
BWFCC-4	442.7	120.2	72.1
BWFCC-5	172.8	157.2	94.3
BWFCC-6	277.7	120.8	72.5
BWFCC-7	536.9	280.4	168.2
BWFCC-8	280.8	202.0	121.2
BWFCC-9	201.7	110.5	66.3
BWFCCT-1a	473.1	119.4	71.7
BWFCCT-1b	240.7	120.1	72.0
BWFCCT-2	348.3	61.2	36.7
BWFCCT-3	457.1	150.4	90.3
HLC-1	231.5	61.4	36.9
HLC-2a	152.0	43.7	26.2
HLC-2b	190.3	71.1	42.7
LTC-1	66.9	19.2	11.5
LTC-2	91.7	51.3	30.8
ML-1	276.1	86.4	51.9
ML-2	226.6	37.5	22.5
TCEF-1a	337.4	59.4	35.6
TCEF-1b	82.5	85.3	51.2
TCT1-1	93.4	38.0	22.8
TCT2-1	47.6	33.5	20.1
UTC-1	223.5	59.3	35.6
UTC-2	68.5	108.8	65.3
UTC-3	70.7	66.7	40.0
UTC-4a	124.1	69.5	41.7
UTC-4b	333.6	59.3	35.6
UTC-5a	205.9	49.3	29.6
UTC-5b	171.0	39.9	23.9
UTC-6	447.7	145.9	87.5

Curve Number and Land Use

The NRCS (formerly SCS) curve number method was used to determine the peak flow runoff for each of the subbasins. The NRCS method uses hydrologic soil group data from the NRCS soil survey and land use descriptions to assign a curve number to the subbasin. Higher curve numbers indicate more impervious area and result in higher runoff from the subbasin.

The hydrologic soil group data was collected from NRCS soil survey and is shown in Figure 3. Based on the soil survey data, the study area consists of a mixture of C and D soil groups. In much of the basin, the soil group was identified as C/D. This means that the soil will respond like a C soil during dry times but, once saturated, will respond like a D soil. For the most conservative results, a D soil was assigned to these areas for the purpose of this analysis.

The land use consists of a mix of urban, rural grasslands, and rolling sparsely forested hills. Zoning spatial data was collected from Sonoma County, Santa Rosa, and Rohnert Park and used as a baseline for the land use description. The land use data was then adjusted based on satellite imagery to best match the existing conditions. The land use was categorized as one of 11 land use types shown in Table 2. For this process it was assumed that all roads were paved roads. Figure 4 shows the land use for the study area.

Table 2. Curve number and % imperviousness by land use and hydrologic soil group.

Land Use Description	Curve Number by Hydrologic Soil Group			
	A	B	C	D
Open Space (Good Condition)	39.0	61.00	74.0	80.0
Paved Road	98.0	98.00	98.0	98.0
Residential, 1/8 acre	77.0	85.00	90.0	92.0
Residential, 1/4 acre	61.0	75.00	83.0	87.0
Residential, 1/3 acre	57.0	72.00	81.0	86.0
Residential, 1 acre	51.0	68.00	79.0	84.0
Residential, 2 acres	46.0	65.00	77.0	82.0
Woods-grass combination (Good)	32.0	58.00	72.0	79.0
Grassland (Good)	39.0	61.00	74.0	80.0
Industrial	81.0	88.00	91.0	93.0

The composite curve number was then calculated using a weighted area average method. The initial abstract value was then computed for each subbasin using the standard equation provided by NRCS based on the composite curve number. Table 3 shows the composite curve number value and initial abstraction for each subbasin. Appendix B provides the full curve number for each subbasin.

Table 3. Curve number and initial abstraction by subbasin.

Basin	Area (Acre)	Initial Abstraction (in)	Weighted CN
BWFCC-1	458.0	0.59	77.3
BWFCC-2	271.8	0.44	82.0
BWFCC-3	226.0	0.36	84.7
BWFCC-4	442.7	0.35	85.2
BWFCC-5	172.8	0.44	82.1
BWFCC-6	277.7	0.28	87.8
BWFCC-7	536.9	0.36	84.7
BWFCC-8	280.8	0.47	81.0
BWFCC-9	201.7	0.42	82.5
BWFCCT-1a	473.1	0.64	75.7
BWFCCT-1b	240.7	0.41	82.9
BWFCCT-2	348.3	0.54	78.7
BWFCCT-3	457.1	0.32	86.2
HLC-1	231.5	0.58	77.4
HLC-2a	152.0	0.48	80.5
HLC-2b	190.3	0.51	79.8
LTC-1	66.9	0.13	93.7
LTC-2	91.7	0.23	89.7
ML-1	276.1	0.16	92.8
ML-2	226.6	0.15	92.8
TCEF-1a	337.4	0.60	76.9
TCEF-1b	82.5	0.42	82.7
TCT1-1	93.4	0.71	73.8
TCT2-1	47.6	0.68	74.7
UTC-1	223.5	0.60	76.9
UTC-2	68.5	0.46	81.2
UTC-3	70.7	0.60	76.9
UTC-4a	124.1	0.47	81.1
UTC-4b	333.6	0.17	92.0
UTC-5a	205.9	0.61	76.6
UTC-5b	171.0	0.49	80.3
UTC-6	447.7	0.42	82.8

Figure 3 — Hydrologic Soil Groups

Legend

Subbasins

Hydrologic Soil Group
- C
- C/D
- D

Todd Creek and Bellevue-Wilfred Flood Control Channel Study

Hydrologic Soil Groups

Figure 3

Date: 4/12/2023

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Todd Creek and Bellevue-Wilfred Flood Control Channel Study

Land Use

Figure 4

Date: 4/12/2023

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Legend

Subbasins

Land Use

Commercial
Grassland (Good)
Industrial
Open Space (Good Condition)
Residential, 1 acre
Woods-grass combination (Good)

Residential, 1/4 acre
Residential, 1/8 acre
Residential, 2 acre
Road
Row Crops- Straight Row (Good)

Reach Routing

Nineteen (19) of the creeks, streams, and storm sewer systems in the project area were modeled as reaches to account for attenuation and travel time of the water. For the two (2) of the reaches that represent overland flow through another subbasin, a lag time method was chosen. The lag time for the channel was calculated using the lag time methods provided in the Time of Concentration section of this report (i.e., the lag time for the channel was based on the subbasin that the water was flowing through). For the other 17 of the reaches, the kinematic wave routing method was chosen within HMS for its applicability to higher slope channels per the HEC-HMS manual[5]. Each channel was broken into segments where an approximate bottom width, side slope, and channel slope were chosen based on the DEM data. Figure 5 shows the locations of each reach modeled.

Table 4 shows the parameters for the reaches that used lag time. Table 5 shows the parameters used for the reaches that used the kinematic wave method.

Table 4. Reach Parameters using Lag Time.

Reach	Lag Time (min)
UTC-5b_R-1	23.9
HLC-2b_R	42.7

---

[5] USACE, HEC-HMS User's Manual v4.10, July 2022

Table 5. Reach Parameters using Kinematic Wave.

Reach	Length (ft)	Slope (ft/ft)	Manning's n	Shape	Width (ft)	Side Slope (xH:1V)
BWFCCT_R-1a	2346.0	0.003	0.040	Trapezoid	5.0	2.0
BWFCCT_R-1b	6055.0	0.003	0.040	Trapezoid	5.0	2.0
BWFCC_R-1	5153.0	0.003	0.040	Trapezoid	10.0	2.0
BWFCC_R-2	2629.0	0.002	0.040	Trapezoid	15.0	2.0
BWFCC_R-4	4331.0	0.001	0.040	Trapezoid	25.0	2.5
BWFCC_R-5	3176.0	0.001	0.040	Trapezoid	65.0	2.5
BWFCC_R-6	3656.0	0.001	0.040	Trapezoid	75.0	2.5
Hunter Lane-1	4501.0	0.020	0.040	Trapezoid	5.0	2.0
Hunter Lane-2	3601.0	0.002	0.040	Trapezoid	6.0	2.5
LowerTodd-1	1909.0	0.001	0.040	Trapezoid	15.0	2.0
LowerTodd-2	3809.0	0.001	0.040	Trapezoid	15.0	2.0
TCEF_R-1	5472.0	0.030	0.040	Trapezoid	2.0	2.0
UpperTodd-1	2743.0	0.010	0.040	Trapezoid	2.0	2.0
UpperTodd-2	1525.0	0.005	0.040	Trapezoid	5.0	3.0
UpperTodd-3	952.0	0.003	0.040	Trapezoid	10.0	2.5
UpperTodd-4	4915.0	0.001	0.040	Trapezoid	10.0	2.5
BWFCCT_1a_R	4880.0	0.015	0.011	Circle	5.3	-

Todd Creek and Bellevue-Wilfred Flood Control Channel Study

Reaches

Figure 6

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Legend

Reaches

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Rainfall Data

The rainfall depth data was collected from NOAA Atlas 14 for the 10-, 25-, 50-, 100-, and 500-year events for the 24-hour duration. The data was computed for each subbasin, and an area-weighted average was calculated for each return period. An NRCS Type 1A hydrograph was used to develop the hydrograph. An area reduction factor was applied to the model using TP 40 and a storm area equal to the study area of 12.2 square miles. The rainfall data used for this analysis is provided in Table 6.

Table 6. NOAA Atlas 14 Rainfall Depths.

Duration	Rainfall Depth (in)				
	10-Year	25-Year	50-Year	100-Year	500-Year
24-Hour	5.3	6.1	6.8	7.4	8.9

The October 2021 rainfall event was also modeled in this study to validate the hydraulic model results. This rainfall data obtained from station STA in Santa Rosa from the California Data Exchange Center (CDEC). This data was input into the HEC-HMS model from October 23, 2021 at 11 AM to October 24, 2021 at 11 PM. This 36-hour storm dropped 7.43 inches of rain with a peak hourly intensity of 0.72 inches per hour. Figure 6 shows the hyetograph used for this storm event.

Figure 6. 2021 Storm Hyetograph Station: Santa Rosa (STA).

Results

Each return period rainfall event and the October 2021 rainfall event was simulated in the HEC-HMS model to determine peak runoff and timing for each subbasin. The peak flows for each scenario are provided in Attachment 3. The peak 100-year flow at key locations and the effective FEMA Peak 100-year flows are provided in Table 7.

Table 7. 100-Year Peak Flow Results.

River	Location	Peak 100-year Flow (cfs)	Effective FEMA Peak Flow (cfs)
Todd Creek	Downstream Trib 1	177	355
	Downstream Trib 2	277	684
	Downstream East Fork	1,532	1,339
	Downstream Hunter Lane	2,279	2,102
	Downstream Moorland	2,716	2,367
BWFCC	Downstream Golf Course	1,787	1,647
	Downstream Todd	4,476	3,468
	At Laguna de Santa Rosa	5,269	4,531

To verify the hydrologic results are within reason, these flows were compared to the USGS Regression equation at each location. The USGS regression equation is a statistical equation based on gage data for the region and produce an estimated mean peak flow based on the drainage area. Because it is a statistical equation, a standard deviation is also produced. Figure 7 shows the resulting 100-year flows from this analysis, the peak 100-year FEMA flow, and the USGS regression equation with plus and minus one standard deviation. The comparison shows that the peak flows for this analysis are within one standard deviation of the mean of the regression equation. Additionally, the peak flows are less than the effective FEMA for the smaller drainage areas. For locations further down in the drainage area the effective FEMA flows are less. This is due to timing of hydrographs from Todd Creek and BWFCC.

Table 8 provides the 100-year unit discharge for both this analysis and the effective FEMA analysis. The results show that this analysis produces much lower unit discharges for Todd Creek and similar unit discharge for BWFCC. This is due to updates in the delineation of subbasins and calculation of time of concentration.

Figure 7. 100-year Peak Flow Results Compared to FEMA and USGS Regression Equation.

Table 8. 100-Year Peak Flow per Area.

River	Location	Peak 100-year Unit Discharge (cfs/sq mi)	Effective FEMA Unit Discharge (cfs/sq mi)
Todd Creek	Downstream Trib 1	357.3	724.5
	Downstream Trib 2	352.4	670.6
	Downstream East Fork	445.1	637.6
	Downstream Hunter Lane	452.4	565.1
	Downstream Moorland	458.2	560.9
BWFCC	Downstream Golf Course	392.0	332.7
	Downstream Todd	421.1	372.1
	At Laguna de Santa Rosa	407.6	336.1

Table 9 provides the unit discharges for three nearby USGS gages. These gages produce unit discharges that are significantly lower than both this analysis and the effective FEMA analysis. This is likely a combination of a several factors:

1. NRCS Type 1A storms are theoretical storms that are much more intense than recorded rainfall events. For example, the 2021 event had a peak rainfall intensity of 0.72 in/hr while the Type 1A storm has a peak intensity of 1.14 in/hr. This will result in higher runoff for the same rainfall depth amount.
2. Hydrologic models may not accurately account for depression storage or attenuation from shallow flooding that would occur in open fields. While the curve number does account for some of this, flat areas with or other topographic features may have a larger impact than the curve number accounts for.
3. Storm sewer systems are not accounted for in the hydrologic model. In flat urban areas, the storm sewer will impact the peak flow and the hydrologic model does not account for this.

Table 9. 100-Year Flow per Area at Local Gages.

Gage Location	Unit Discharge (cfs/sq mi)
Sonoma Creek @ Kenwood	198.3
Laguna De Santa Rosa @ Stony Point Rd	104.8
Copeland Creek @ Rohnert Park	160.3

Conclusion

The hydrologic analysis produced 100-year peak flows that were similar to or lower than the current effective FEMA flows except for locations downstream of the confluence of BWFCC and Todd Creek. Comparisons to the USGS regression equation show that the peak flows are within one standard deviation of the mean but remain on the higher end. Comparisons of unit discharges to gages in the region show that the analysis is still producing flows that are much higher than recorded gage data. This suggests that the hydrologic analysis is likely not accounting for attenuation in flow. This is likely due to overland and storm sewer flow attenuation not being accounted for and differences in the theoretical versus actual storm intensities.

Of these issues, the overland and storm sewer flow attenuation can be resolved in the hydraulic modeling process. Overland flow can be accounted for using HEC-RAS 2D which can model shallow overland flow. While future versions of HEC-RAS will have storm sewer modeling, currently this function is not available. Other hydraulic modeling software may be required to model the storm sewer system. It is recommended that, at a minimum, flows recorded in the FIS be taken from the hydraulic model to account for the overland flow attenuation.

ATTACHMENT 1
Time of Concentration Calculations

		Overland Flow						Shallow Concentrated Flow						Channel Flow							Pipe Flow						Results			
Subbasin	Longest Flow Path (ft) (1)	Length (ft) (2)	Land Use/ Surface Desciption (4)	n value	2-Year 24 hour Precip (in)	Slope (%) (5)	Tc Overland (min) (7)	Length 1 (ft) (8)	Slope 1 (%) (9)	Factor	V1 (ft/s) (10)	Ground Cover Type (11)	Tc Shallow Concentrated (min) (12)	Length 2 (ft) (13)	Slope 2 (%) (14)	Bankfull Area (ft²) (15)	Bankfull Wet Perimeter (ft) (16)	n-Value (17)	V2 (ft/s) (18)	Tc Channel (min) (19)	Pipe Diameter (in) (20)	Pipe Length (ft) (21)	Pipe Slope (%) (22)	n-Value (23)	V3 (ft/s) (24)	Tc Pipe (min) (25)	SubBasin	Total Tc (min) (26)	TLag (min) (27)	TLag (hr) (28)
BWFCC-1	9140	250	Light Underbrush	0.4	3.63	21%	16.45																				BWFCC-1	16.4		
								4791	19.4%	5.032	2.22	Woodland	36.04															36.0		
								4099	2.4%	6.962	1.08	Short-Grass Prairie	63.46															63.5		
																												115.9	69.6	1.2
BWFCC-2	8651	200	Short Prarie Grass	0.15	3.63	2%	16.02																				BWFCC-2	16.0		
								8451	1%	6.962	0.63	Short-Grass Prairie	222.29															222.3		
																												0.0		
																												238.3	143.0	2.4
BWFCC-3	6488	150	Short Prarie Grass	0.15	3.63	2%	12.72																				BWFCC-3	12.7		
																					24	4546	0.110%	0.015	5.23	14.49		14.5		
														1160	0.86%	100	21	0.065	6.04	3.20								3.2		
																					45	632	0.949%	0.015	10.08	1.05		1.0		
																												31.5	18.9	0.3
BWFCC-4	10355	200	Short Prarie Grass	0.15	3.63	5%	11.10																				BWFCC-4	11.1		
								7655	0.6%	16.135	1.26	Unpaved	100.91									7655						100.9		
																					45	2500	0.240%	0.015	5.07	8.22		8.2		
																												120.2	72.1	1.2
BWFCC-5	3855	250	Short Prarie Grass	0.15	3.63	1%	27.62																				BWFCC-5	27.6		
								3605	0.4%	6.962	0.46	Short-Grass Prairie	129.54															129.5		
																												0.0		
																												157.2	94.3	1.6
BWFCC-6	7670	150	Smooth Surface	0.011	3.63	1%	2.44																				BWFCC-6	2.4		
								3035	0.10%	20.238	0.64	Paved	79.50															79.5		
														4485	0.07%	12.5	5.6	0.035	1.92	38.86								38.9		
																												120.8	72.5	1.2
BWFCC-7	11057	300	Smooth Surface	0.011	3.63	0%	5.61																				BWFCC-7	5.6		
																					42	1879	0.373%	0.015	6.61	4.74		4.7		
								10715	0.2%	16.135	0.66	Unpaved	270.04															270.0		
																												280.4	168.2	2.8
BWFCC-8	4141	200	Smooth Surface	0.011	3.63	0%	4.55																				BWFCC-8	4.6		
								3941	0.2%	6.962	0.33	Short-Grass Prairie	197.43															197.4		
																												202.0	121.2	2.0
BWFCC-9	3620	100	Short Prarie Grass	0.15	3.63	1%	16.02																				BWFCC-9	16.0		
								3520	0.8%	6.962	0.62	Short-Grass Prairie	94.48															94.5		
																												110.5	66.3	1.1
BWFCCT-1a	11614	300	Short Prarie Grass	0.15	3.63	22%	8.54																				BWFCCT-1a	8.5		
								7967	12%	5.032	1.76	Woodland	75.43															75.4		
								3347	5%	6.962	1.57	Short-Grass Prairie	35.45															35.4		
																												0.0		
																												119.4	71.7	1.2

ID	Area	Len	Surface	n	P2	Slope	Tt	Flow	Slope	V	Tt	Cover	Tc	ChA1	ChA2	ChA3	ChA4	ChA5	ChA6	ChA7	ChB1	ChB2	ChB3	ChB4	ChB5	ChB6	Result
BWFCCT-1b	7209	250	Short Prarie Grass	0.15	3.63	3%	16.74																				16.7
								5581	2%	6.962	0.93	Short-Grass Prairie	99.81														99.8
																					42	1378	0.363%	0.015	6.53	3.52	3.5
																											120.1	72.0	1.2
BWFCCT-2	8047	250	Short Prarie Grass	0.15	3.63	22%	7.39																				7.4
								3897	19%	5.032	2.18	Woodland	29.84														29.8
								1800	4%	6.962	1.39	Short-Grass Prairie	21.55														21.5
																					42	2100	1.762%	0.015	14.38	2.43	2.4
																											61.2	36.7	0.6
BWFCCT-3	13836	185	Smooth Surface	0.011	3.63	4%	1.44																				1.4
								6076	2%	6.962	0.86	Short-Grass Prairie	117.57														117.6
																					42	5075	0.138%	0.015	4.02	21.02	21.0
														2500	0.20%	192	25	0.065	4.01	10.40							10.4
																											150.4	90.3	1.5
ML-1	11464	250	Smooth Surface	0.011	3.63	0%	4.51																				4.5
								4753	0.6%	16.135	1.26	Unpaved	62.85														62.9
																					66	2000	0.400%	0.015	5.06	6.59	6.6
														4461	0.20%	132	24	0.035	5.95	12.50							12.5
																											86.4	51.9	0.9
ML-2	9382	300	Smooth Surface	0.011	3.63	0%	5.61																				5.6
																					40	4882	0.164%	0.015	4.53	17.96	18.0
														4200	0.14%	132	24	0.035	5.03	13.92							13.9
																											37.5	22.5	0.4
LTC-1	2891	150	Smooth Surface	0.011	3.63	1%	2.08																				2.1
																											0.0
														2741	0.18%	8	4.5	0.035	2.67	17.13							17.1
																											19.2	11.5	0.2
LTC-2	2373	100	Smooth Surface	0.011	3.63	2%	1.28																				1.3
								2273	0.2%	16.135	0.76	Unpaved	50.06														50.1
																											0.0
																											51.3	30.8	0.5
HLC-1	7663	220	Short Prarie Grass	0.15	3.63	5%	11.98																				12.0
								5953	18%	5.032	2.11	Woodland	46.95														46.9
														1490	8.12%	85	18	0.12	9.98	2.49							2.5
																											61.4	36.9	0.6
HLC-2a	4186	250	Light Underbrush	0.4	3.63	32%	13.84																				13.8
								3936	19.1%	5.032	2.20	Woodland	29.86														29.9
																											0.0
																											43.7	26.2	0.4
HLC-2b	3935	200	Short Prarie Grass	0.15	3.63	10%	8.41																				8.4
								3735	2%	6.962	0.99	Short-Grass Prairie	62.68														62.7
																											0.0
																											71.1	42.7	0.7
TCT1-1	6979	250	Short Prarie Grass	0.15	3.63	32%	6.32																				6.3
								5148	17.8%	6.962	2.94	Short-Grass Prairie	29.18														29.2
														1581	2.72%	24.5	8	0.05	10.37	2.54							2.5
																											38.0	22.8	0.4
TCT2-1	5468	130	Short Prarie Grass	0.15	3.63	9%	6.27																				6.3
								2439	17%	6.962	2.88	Short-Grass Prairie	14.14														14.1
														2899	0.50%	4.5	3.3	0.035	3.70	13.07							13.1
																											33.5	20.1	0.3

ID	Area		Cover									Type									ID	Result
TCEF-1a	6598	250	Short Prarie Grass	0.15	3.63	9%	10.59														TCEF-1a	10.6
								6348	18.5%	5.032	2.17	Woodland	48.83									48.8
																						0.0
																						59.4 / **35.6** / **0.6**
TCEF-1b	4974	250	Short Prarie Grass	0.15	3.63	5%	13.49														TCEF-1b	13.5
								3973	2%	6.962	1.03	Short-Grass Prairie	64.27									64.3
								751	1%	20.238	1.65	Paved	7.58									7.6
																						85.3 / **51.2** / **0.9**
UTC-1	7490	275	Short Prarie Grass	0.15	3.63	17%	8.76														UTC-1	8.8
								6469	10.3%	6.962	2.23	Short-Grass Prairie	48.34									48.3
														746	0.80%	8	4.5	0.035	5.58	2.23		2.2
																						59.3 / **35.6** / **0.6**
UTC-2	2774	250	Short Prarie Grass	0.15	3.63	1%	27.62														UTC-2	27.6
								2524	1%	6.962	0.52	Short-Grass Prairie	81.13									81.1
																						0.0
																						108.8 / **65.3** / **1.1**
UTC-3	4004	200	Light Underbrush	0.4	3.63	15%	15.68														UTC-3	15.7
								1169	18.2%	6.962	2.97	Short-Grass Prairie	6.56									6.6
								2635	2.0%	6.962	0.99	Short-Grass Prairie	44.48									44.5
																						66.7 / **40.0** / **0.7**
UTC-4	15407	230	Short Prarie Grass	0.15	3.63	13%	8.58														UTC-4	8.6
								3576	11%	5.032	1.70	Woodland	35.11									35.1
								5063	1%	20.238	1.97	Paved	42.82									42.8
																72	6538	0.444%	0.015	5.03	21.67	21.7
																						108.2 / **64.9** / **1.1**
UTC-5a	5301	200	Light Underbrush	0.4	3.63	27%	12.49														UTC-5a	12.5
								5101	21.1%	5.032	2.31	Woodland	36.79									36.8
																						0.0
																						49.3 / **29.6** / **0.5**
UTC-5b	5048	200	Short Prarie Grass	0.15	3.63	6%	10.69														UTC-5b	10.7
								1399	3%	6.962	1.23	Short-Grass Prairie	18.88									18.9
														3449	0.80%	8	4.5	0.035	5.58	10.30		10.3
																						39.9 / **23.9** / **0.4**
UTC-6	6923	260	Short Prarie Grass	0.15	3.63	9%	10.90														UTC-6	10.9
								6663	1%	6.962	0.82	Short-Grass Prairie	135.01									135.0
																						0.0
																						145.9 / **87.5** / **1.5**

ATTACHMENT 2
Curve Number Calculations

				Subbasin Curve Number BWFCC-1				
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	16.8	4%	0%	98	0.0	98.0
Road	C	11.7			70%	98	68.3	
Road	D	5.1			30%	98	29.7	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	50.5	11%	0%	65	0.0	77.3
Residential, 2 acre	C	47.4			94%	77	72.2	
Residential, 2 acre	D	3.1			6%	82	5.1	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	285.9	62%	0%	58.0	0.0	77.1
Woods-grass combination (Good)	C	77.8			27%	72.0	19.6	
Woods-grass combination (Good)	D	208.2			73%	79.0	57.5	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	104.8	23%	0%	61	0.0	74.5
Grassland (Good)	C	96.2			92%	74	67.9	
Grassland (Good)	D	8.7			8%	80	6.6	
	Total	458.0	458.0				Weighted Total	77.3

Subbasin Curve Number BWFCC-2								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	8.9	3%	0%	61	0.0	80.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	8.9			100%	80	80.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	15.3	6%	0%	98	0.0	98.0
Road	C	2.0			13%	98	12.7	
Road	D	13.3			87%	98	85.3	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	92.9	34%	0%	65	0.0	80.9
Residential, 2 acre	C	19.6			21%	77	16.3	
Residential, 2 acre	D	73.3			79%	82	64.7	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	27.1	10%	0%	75	0.0	87.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	27.1			100%	87	87.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	127.6	47%	0%	61	0.0	79.9
Grassland (Good)	C	2.0			2%	74	1.2	
Grassland (Good)	D	125.6			98%	80	78.7	
	Total	271.8	271.8				Weighted Total	82.0

Subbasin Curve Number BWFCC-3								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	71.8	32%	0%	61	0.0	80.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	71.8			100%	80	80.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	27.9	12%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	27.9			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	41.6	18%	0%	75	0.0	87.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	41.6			100%	87	87.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	66.8	30%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	66.8			100%	80	80.0	
	Total	226.0	226.0				Weighted Total	84.7

Subbasin Curve Number BWFCC-4								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	29.0	7%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	29.0			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	71.9	16%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	71.9			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	273.1	62%	0%	65	0.0	82.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	273.1			100%	82	82.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	1.0	0%	0%	68.0	0.0	84.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	1.0			100%	84.0	84.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	49.2	11%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	49.2			100%	80	80.0	
	Total	442.7	442.7				Weighted Total	85.2

Subbasin Curve Number BWFCC-5								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	6.1	4%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	6.1			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	2.8	2%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	2.8			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	109.1	63%	0%	65	0.0	82.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	109.1			100%	82	82.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	54.8	32%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	54.8			100%	80	80.0	
	Total	172.8	172.8				Weighted Total	82.1

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	39.7	14%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	39.7			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	26.4	9%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	26.4			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	114.6	41%	0%	65	0.0	82.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	114.6			100%	82	82.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	38.8	14%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	38.8			100%	80	80.0	
	Total	277.7	277.7				Weighted Total	87.8

Subbasin Curve Number BWFCC-6

			Subbasin Curve Number BWFCC-7					
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	21.7	4%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	21.7			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	119.8	22%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	119.8			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	293.7	55%	0%	65	0.0	82.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	293.7			100%	82	82.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	1.6	0%	0%	75	0.0	87.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	1.6			100%	87	87.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	100.0	19%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	100.0			100%	80	80.0	
	Total	536.9	536.9				Weighted Total	84.7

Subbasin Curve Number BWFCC-8								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	7.9	3%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	7.9			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	10.4	4%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	10.4			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	262.5	93%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	262.5			100%	80	80.0	
	Total	280.8	280.8				Weighted Total	81.0

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
		Subbasin Curve Number BWFCC-9						
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	10.4	5%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	10.4			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	16.5	8%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	16.5			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	55.2	27%	0%	65	0.0	82.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	55.2			100%	82	82.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	119.6	59%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	119.6			100%	80	80.0	
	Total	**201.7**	**201.7**				**Weighted Total**	**82.5**

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
			Subbasin Curve Number BWFCCT-1a					
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	2.7	1%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.5	
Road	D	2.7			100%	98	97.5	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	378.9	80%	0%	58.0	0.0	75.1
Woods-grass combination (Good)	C	212.4			56%	72.0	40.4	
Woods-grass combination (Good)	D	166.5			44%	79.0	34.7	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	91.5	19%	0%	61	0.0	77.7
Grassland (Good)	C	34.5			38%	74	27.9	
Grassland (Good)	D	57.0			62%	80	49.8	
	Total	473.1	473.1			Weighted Total		75.7

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Subbasin Curve Number BWFCCT-1b								
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0			0%	61	0.0	
Open Space (Good Condition)	C	0.0	6.2	3%	0%	74	0.0	80.0
Open Space (Good Condition)	D	6.2			100%	80	80.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0			0%	98	0.0	
Road	C	0.0	20.7	9%	0%	98	0.0	98.0
Road	D	20.7			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0			0%	88	0.0	
Industrial	C	0.0	0.0	0%	0%	91	0.0	0.0
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0			0%	92	0.0	
Commerical	C	0.0	0.0	0%	0%	94	0.0	0.0
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0			0%	65	0.0	
Residential, 2 acre	C	0.0	0.0	0%	0%	77	0.0	0.0
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0			0%	68.0	0.0	
Residential, 1 acre	C	0.0	0.0	0%	0%	79.0	0.0	0.0
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0			0%	72	0.0	
Residential, 1/3 acre	C	0.0	0.0	0%	0%	81	0.0	0.0
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0			0%	75	0.0	
Residential, 1/4 acre	C	0.0	45.5	19%	0%	83	0.0	87.0
Residential, 1/4 acre	D	45.5			100%	87	87.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0			0%	85.0	0.0	
Residential, 1/8 acre	C	0.0	0.0	0%	0%	90.0	0.0	92.0
Residential, 1/8 acre	D	0.0			100%	92.0	92.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0			0%	58.0	0.0	
Woods-grass combination (Good)	C	0.0	0.0	0%	0%	72.0	0.0	0.0
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0			0%	61	0.0	
Grassland (Good)	C	15.6	162.3	67%	10%	74	7.1	79.4
Grassland (Good)	D	146.6			90%	80	72.3	
	Total	240.7	240.7			Weighted Total		82.9

				Subbasin Curve Number BWFCCT-2				
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0			0%	61	0.0	
Open Space (Good Condition)	C	0.0	2.9	1%	0%	74	0.0	80.0
Open Space (Good Condition)	D	2.9			100%	80	80.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0			0%	98	0.0	
Road	C	7.7	12.8	4%	60%	98	59.0	98.0
Road	D	5.1			40%	98	39.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0			0%	88	0.0	
Industrial	C	0.0	0.0	0%	0%	91	0.0	0.0
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0			0%	92	0.0	
Commerical	C	0.0	0.0	0%	0%	94	0.0	0.0
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0			0%	65	0.0	
Residential, 2 acre	C	0.0	0.0	0%	0%	77	0.0	0.0
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0			0%	68.0	0.0	
Residential, 1 acre	C	0.0	0.0	0%	0%	79.0	0.0	0.0
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0			0%	72	0.0	
Residential, 1/3 acre	C	0.0	0.0	0%	0%	81	0.0	0.0
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0			0%	75	0.0	
Residential, 1/4 acre	C	6.4	16.1	5%	40%	83	33.3	85.4
Residential, 1/4 acre	D	9.6			60%	87	52.1	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0			0%	85.0	0.0	
Residential, 1/8 acre	C	0.0	0.0	0%	0%	90.0	0.0	0.0
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0			0%	58.0	0.0	
Woods-grass combination (Good)	C	65.0	222.4	64%	29%	72.0	21.0	77.0
Woods-grass combination (Good)	D	157.4			71%	79.0	55.9	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0			0%	61	0.0	
Grassland (Good)	C	17.5	94.2	27%	19%	74	13.7	78.9
Grassland (Good)	D	76.7			81%	80	65.2	
	Total	348.3	348.3				Weighted Total	78.7

Subbasin Curve Number BWFCCT-3								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	77.9	17%	0%	61	0.0	80.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	77.9			100%	80	80.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	63.8	14%	0%	98	0.0	98.0
Road	C	1.0			2%	98	1.6	
Road	D	62.8			98%	98	96.4	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	133.9	29%	0%	75	0.0	86.9
Residential, 1/4 acre	C	2.8			2%	83	1.8	
Residential, 1/4 acre	D	131.1			98%	87	85.2	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	38.4	8%	0%	85.0	0.0	92.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	38.4			100%	92.0	92.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	122.3	27%	0%	61	0.0	80.0
Grassland (Good)	C	0.3			0%	74	0.2	
Grassland (Good)	D	122.0			100%	80	79.8	
	Total	457.1	457.1				Weighted Total	86.2

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
		Subbasin Curve Number HLC-1						
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	1.8	1%	0%	98	0.0	98.0
Road	C	1.8			100%	98	98.0	
Road	D	0.0			0%	98	0.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	13.4	6%	0%	65	0.0	78.3
Residential, 2 acre	C	10.0			74%	77	57.2	
Residential, 2 acre	D	3.5			26%	82	21.1	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	216.3	93%	0%	58.0	0.0	77.2
Woods-grass combination (Good)	C	56.3			26%	72.0	18.7	
Woods-grass combination (Good)	D	160.0			74%	79.0	58.4	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	0.0	0%	0%	61	0.0	0.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	0.0			0%	80	0.0	
	Total	231.5	231.5			Weighted Total		77.4

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
			Subbasin Curve Number HLC-2a					
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	4.7	3%	0%	98	0.0	98.0
Road	C	4.7			100%	98	98.0	
Road	D	0.0			0%	98	0.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	82.3	54%	0%	65	0.0	80.8
Residential, 2 acre	C	20.4			25%	77	19.1	
Residential, 2 acre	D	61.9			75%	82	61.7	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	65.0	43%	0%	58.0	0.0	78.9
Woods-grass combination (Good)	C	0.9			1%	72.0	0.9	
Woods-grass combination (Good)	D	64.1			99%	79.0	78.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	0.0	0%	0%	61	0.0	0.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	0.0			0%	80	0.0	
	Total	152.0	152.0				Weighted Total	80.5

				Subbasin Curve Number HLC-2b				
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	4.8	3%	0%	98	0.0	98.0
Road	C	2.5			52%	98	51.4	
Road	D	2.3			48%	98	46.6	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	113.0	59%	0%	65	0.0	81.0
Residential, 2 acre	C	22.4			20%	77	15.2	
Residential, 2 acre	D	90.7			80%	82	65.8	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	72.5	38%	0%	61	0.0	76.7
Grassland (Good)	C	39.4			54%	74	40.2	
Grassland (Good)	D	33.2			46%	80	36.6	
	Total	190.3	190.3			Weighted Total		79.8

Type of Landuse	Subbasin Curve Number LTC-1							
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	9.7	15%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	9.7			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	50.1	75%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	50.1			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	1.1	2%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	1.1			100%	80	80.0	
	Total	66.9	66.9				Weighted Total	93.7

Subbasin Curve Number LTC-2								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	20.9	23%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	20.9			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	39.5	43%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	39.5			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	31.3	34%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	31.3			100%	80	80.0	
	Total	91.7	91.7				Weighted Total	89.7

Subbasin Curve Number ML-1								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0	0.0	0%	0%	39	0.0	0.0
Open Space (Good Condition)	B	0.0			0%	61	0.0	
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0	50.4	18%	0%	98	0.0	98.0
Road	B	0.0			0%	98	0.0	
Road	C	4.6			9%	98	9.0	
Road	D	45.7			91%	98	89.0	
Industrial	A	0.0	40.8	15%	0%	81	0.0	93.0
Industrial	B	0.0			0%	88	0.0	
Industrial	C	0.0			0%	91	0.0	
Industrial	D	40.8			100%	93	93.0	
Commerical	A	0.0	0.0	0%	0%	89	0.0	0.0
Commerical	B	0.0			0%	92	0.0	
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0	0.0	0%	0%	46	0.0	0.0
Residential, 2 acre	B	0.0			0%	65	0.0	
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0	0.0	0%	0%	51.0	0.0	0.0
Residential, 1 acre	B	0.0			0%	68.0	0.0	
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0	0.0	0%	0%	57	0.0	0.0
Residential, 1/3 acre	B	0.0			0%	72	0.0	
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0	63.8	23%	0%	61	0.0	87.0
Residential, 1/4 acre	B	0.0			0%	75	0.0	
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	63.8			100%	87	87.0	
Residential, 1/8 acre	A	0.0	58.2	21%	0%	77.0	0.0	92.0
Residential, 1/8 acre	B	0.0			0%	85.0	0.0	
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	58.2			100%	92.0	92.0	
Woods-grass combination (Good)	A	0.0	0.0	0%	0%	32.0	0.0	0.0
Woods-grass combination (Good)	B	0.0			0%	58.0	0.0	
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0	0.0	0%	0%	39	0.0	0.0
Grassland (Good)	B	0.0			0%	61	0.0	
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	0.0			0%	80	0.0	
	Total	276.1	276.1				Weighted Total	92.8

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Subbasin Curve Number ML-2								
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	46.6	21%	0%	98	0.0	98.0
Road	C	0.0			0%	98	0.0	
Road	D	46.6			100%	98	98.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	74.6	33%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	74.6			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	1.5	1%	0%	75	0.0	87.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	1.5			100%	87	87.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	61.1	27%	0%	85.0	0.0	92.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	61.1			100%	92.0	92.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	19.4	9%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	19.4			100%	80	80.0	
	Total	**226.6**	**226.6**				**Weighted Total**	**92.8**

			Subbasin Curve Number TCEF-1a					
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	0.8	0%	0%	98	0.0	98.0
Road	C	0.8			100%	98	98.0	
Road	D	0.0			0%	98	0.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	336.6	100%	0%	58.0	0.0	76.8
Woods-grass combination (Good)	C	104.8			31%	72.0	22.4	
Woods-grass combination (Good)	D	231.8			69%	79.0	54.4	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	0.0	0%	0%	61	0.0	0.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	0.0			0%	80	0.0	
	Total	337.4	337.4				Weighted Total	76.9

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	0.3	0%	0%	98	0.0	98.0
Road	C	0.1			51%	98	49.7	
Road	D	0.1			49%	98	48.3	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	18.6	22%	0%	85.0	0.0	92.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	18.6			100%	92.0	92.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	63.7	77%	0%	61	0.0	79.9
Grassland (Good)	C	1.0			2%	74	1.2	
Grassland (Good)	D	62.7			98%	80	78.8	
	Total	82.5	82.5			Weighted Total		82.7

Subbasin Curve Number TCEF-1b

Subbasin Curve Number TCT1-1								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	0.6	1%	0%	98	0.0	98.0
Road	C	0.6			100%	98	98.0	
Road	D	0.0			0%	98	0.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	83.7	90%	0%	58.0	0.0	73.5
Woods-grass combination (Good)	C	65.5			78%	72.0	56.4	
Woods-grass combination (Good)	D	18.1			22%	79.0	17.1	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	9.1	10%	0%	61	0.0	74.7
Grassland (Good)	C	8.0			88%	74	65.0	
Grassland (Good)	D	1.1			12%	80	9.7	
	Total	93.4	93.4				Weighted Total	73.8

Subbasin Curve Number TCT2-1								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0	0.0	0%	0%	39	0.0	0.0
Open Space (Good Condition)	B	0.0			0%	61	0.0	
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0	0.9	2%	0%	98	0.0	98.0
Road	B	0.0			0%	98	0.0	
Road	C	0.9			100%	98	98.0	
Road	D	0.0			0%	98	0.0	
Industrial	A	0.0	0.0	0%	0%	81	0.0	0.0
Industrial	B	0.0			0%	88	0.0	
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0	0.0	0%	0%	89	0.0	0.0
Commerical	B	0.0			0%	92	0.0	
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0	0.0	0%	0%	46	0.0	0.0
Residential, 2 acre	B	0.0			0%	65	0.0	
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0	0.0	0%	0%	51.0	0.0	0.0
Residential, 1 acre	B	0.0			0%	68.0	0.0	
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0	0.0	0%	0%	57	0.0	0.0
Residential, 1/3 acre	B	0.0			0%	72	0.0	
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0	0.0	0%	0%	61	0.0	0.0
Residential, 1/4 acre	B	0.0			0%	75	0.0	
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0	0.0	0%	0%	77.0	0.0	0.0
Residential, 1/8 acre	B	0.0			0%	85.0	0.0	
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0	27.6	58%	0%	32.0	0.0	72.0
Woods-grass combination (Good)	B	0.0			0%	58.0	0.0	
Woods-grass combination (Good)	C	27.6			100%	72.0	72.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0	19.1	40%	0%	39	0.0	77.6
Grassland (Good)	B	0.0			0%	61	0.0	
Grassland (Good)	C	7.6			40%	74	29.3	
Grassland (Good)	D	11.6			60%	80	48.3	
	Total	47.6	47.6				Weighted Total	74.7

Subbasin Curve Number UTC-1								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	4.6	2%	0%	98	0.0	98.0
Road	C	2.8			61%	98	59.5	
Road	D	1.8			39%	98	38.5	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	32.2	14%	0%	88	0.0	91.7
Industrial	C	20.2			63%	91	57.1	
Industrial	D	12.0			37%	93	34.6	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	2.0	1%	0%	85.0	0.0	90.4
Residential, 1/8 acre	C	1.6			80%	90.0	71.8	
Residential, 1/8 acre	D	0.4			20%	92.0	18.6	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	154.0	69%	0%	58.0	0.0	72.8
Woods-grass combination (Good)	C	136.2			88%	72.0	63.7	
Woods-grass combination (Good)	D	17.8			12%	79.0	9.1	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	30.7	14%	0%	61	0.0	77.5
Grassland (Good)	C	12.5			41%	74	30.2	
Grassland (Good)	D	18.1			59%	80	47.3	
	Total	223.5	223.5				Weighted Total	76.9

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
		Subbasin Curve Number UTC-2						
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	1.7	2%	0%	98	0.0	98.0
Road	C	0.0			1%	98	0.7	
Road	D	1.7			99%	98	97.3	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	14.7	21%	0%	65	0.0	82.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	14.7			100%	82	82.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	2.0	3%	0%	85.0	0.0	92.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.1	
Residential, 1/8 acre	D	2.0			100%	92.0	91.9	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	50.1	73%	0%	61	0.0	80.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	50.1			100%	80	80.0	
	Total	68.5	68.5			Weighted Total		81.2

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
			Subbasin Curve Number UTC-3					
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	1.5	2%	0%	98	0.0	98.0
Road	C	1.5			100%	98	98.0	
Road	D	0.0			0%	98	0.0	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	4.3	6%	0%	65	0.0	77.0
Residential, 2 acre	C	4.3			100%	77	77.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	64.9	92%	0%	61	0.0	76.4
Grassland (Good)	C	38.9			60%	74	44.3	
Grassland (Good)	D	26.0			40%	80	32.1	
	Total	70.7	70.7				Weighted Total	76.9

Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
			Subbasin Curve Number UTC-4					
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.6	0%	0%	61	0.0	80.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.6			100%	80	80.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	47.2	10%	0%	98	0.0	98.0
Road	C	1.6			3%	98	3.3	
Road	D	45.6			97%	98	94.7	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	38.1	8%	0%	88	0.0	92.7
Industrial	C	5.5			14%	91	13.1	
Industrial	D	32.7			86%	93	79.6	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	0.0	0%	0%	65	0.0	0.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	0.0			0%	82	0.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	190.2	42%	0%	85.0	0.0	92.0
Residential, 1/8 acre	C	3.5			2%	90.0	1.7	
Residential, 1/8 acre	D	186.7			98%	92.0	90.3	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	27.4	6%	0%	58.0	0.0	72.0
Woods-grass combination (Good)	C	27.3			100%	72.0	71.8	
Woods-grass combination (Good)	D	0.1			0%	79.0	0.3	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	88.7	20%	0%	61	0.0	77.8
Grassland (Good)	C	33.2			37%	74	27.7	
Grassland (Good)	D	55.5			63%	80	50.1	
	Total	454.5	454.5			Weighted Total		89.1

Subbasin Curve Number UTC-5a								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	3.5	2%	0%	98	0.0	98.0
Road	C	1.0			29%	98	28.2	
Road	D	2.5			71%	98	69.8	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	49.2	24%	0%	65	0.0	81.2
Residential, 2 acre	C	7.8			16%	77	12.2	
Residential, 2 acre	D	41.4			84%	82	69.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	153.3	74%	0%	58.0	0.0	74.6
Woods-grass combination (Good)	C	95.6			62%	72.0	44.9	
Woods-grass combination (Good)	D	57.6			38%	79.0	29.7	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	0.0	0%	0%	61	0.0	0.0
Grassland (Good)	C	0.0			0%	74	0.0	
Grassland (Good)	D	0.0			0%	80	0.0	
	Total	205.9	205.9				Weighted Total	76.6

Subbasin Curve Number UTC-5b								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	1.7	1%	0%	98	0.0	98.0
Road	C	0.4			25%	98	24.7	
Road	D	1.2			75%	98	73.3	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	0.0	0%	0%	88	0.0	0.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	0.0			0%	93	0.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	15.7	9%	0%	65	0.0	81.8
Residential, 2 acre	C	0.7			5%	77	3.5	
Residential, 2 acre	D	15.0			95%	82	78.3	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	0.0	0%	0%	85.0	0.0	0.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	0.0			0%	92.0	0.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	153.6	90%	0%	61	0.0	79.9
Grassland (Good)	C	2.4			2%	74	1.1	
Grassland (Good)	D	151.2			98%	80	78.8	
	Total	171.0	171.0				Weighted Total	80.3

Subbasin Curve Number UTC-6								
Type of Landuse	Soil Complex	Area of Soil Type Per Landuse (acres)	Area of Landuse (acres)	Percent Landuse of Total Area	Percent Soil Per Landuse	CN of each Hydrologic Soil Complex	Compted CN for Each Landuse	Weighted CN fo each Landuse
Open Space (Good Condition)	A	0.0			0%	39	0.0	
Open Space (Good Condition)	B	0.0	0.0	0%	0%	61	0.0	0.0
Open Space (Good Condition)	C	0.0			0%	74	0.0	
Open Space (Good Condition)	D	0.0			0%	80	0.0	
Road	A	0.0			0%	98	0.0	
Road	B	0.0	10.1	2%	0%	98	0.0	98.0
Road	C	0.7			6%	98	6.3	
Road	D	9.5			94%	98	91.7	
Industrial	A	0.0			0%	81	0.0	
Industrial	B	0.0	66.7	15%	0%	88	0.0	93.0
Industrial	C	0.0			0%	91	0.0	
Industrial	D	66.7			100%	93	93.0	
Commerical	A	0.0			0%	89	0.0	
Commerical	B	0.0	0.0	0%	0%	92	0.0	0.0
Commerical	C	0.0			0%	94	0.0	
Commerical	D	0.0			0%	95	0.0	
Residential, 2 acre	A	0.0			0%	46	0.0	
Residential, 2 acre	B	0.0	34.5	8%	0%	65	0.0	82.0
Residential, 2 acre	C	0.0			0%	77	0.0	
Residential, 2 acre	D	34.5			100%	82	82.0	
Residential, 1 acre	A	0.0			0%	51.0	0.0	
Residential, 1 acre	B	0.0	0.0	0%	0%	68.0	0.0	0.0
Residential, 1 acre	C	0.0			0%	79.0	0.0	
Residential, 1 acre	D	0.0			0%	84.0	0.0	
Residential, 1/3 acre	A	0.0			0%	57	0.0	
Residential, 1/3 acre	B	0.0	0.0	0%	0%	72	0.0	0.0
Residential, 1/3 acre	C	0.0			0%	81	0.0	
Residential, 1/3 acre	D	0.0			0%	86	0.0	
Residential, 1/4 acre	A	0.0			0%	61	0.0	
Residential, 1/4 acre	B	0.0	0.0	0%	0%	75	0.0	0.0
Residential, 1/4 acre	C	0.0			0%	83	0.0	
Residential, 1/4 acre	D	0.0			0%	87	0.0	
Residential, 1/8 acre	A	0.0			0%	77.0	0.0	
Residential, 1/8 acre	B	0.0	14.5	3%	0%	85.0	0.0	92.0
Residential, 1/8 acre	C	0.0			0%	90.0	0.0	
Residential, 1/8 acre	D	14.5			100%	92.0	92.0	
Woods-grass combination (Good)	A	0.0			0%	32.0	0.0	
Woods-grass combination (Good)	B	0.0	0.0	0%	0%	58.0	0.0	0.0
Woods-grass combination (Good)	C	0.0			0%	72.0	0.0	
Woods-grass combination (Good)	D	0.0			0%	79.0	0.0	
Grassland (Good)	A	0.0			0%	39	0.0	
Grassland (Good)	B	0.0	321.9	72%	0%	61	0.0	79.8
Grassland (Good)	C	9.4			3%	74	2.2	
Grassland (Good)	D	312.4			97%	80	77.7	
	Total	447.7	447.7			Weighted Total		82.8

ATTACHMENT 3
Peak Flow Results

Basin	Area (Acre)	10-Year Flow (cfs)	25-Year Flow (cfs)	50-Year Flow (cfs)	100-Year Flow (cfs)	500-Year Flow (cfs)	2021 Event Flow (cfs)
BWFCC-1	458.034	164.2	214.7	253	289.7	382.4	230.9
BWFCC-2	271.764	85.3	108.1	125.3	141.5	182.3	119.1
BWFCC-3	226.015	177.5	221	253.3	283.8	359.3	149.9
BWFCC-4	442.693	214.6	266.8	305.7	342.4	433.3	245.5
BWFCC-5	172.8	66.2	83.9	97.1	109.7	141.1	86.3
BWFCC-6	277.656	146.6	179.7	204.1	227.1	283.9	157.7
BWFCC-7	536.893	172.4	215.1	247.1	277.2	352.4	229.5
BWFCC-8	280.849	91.7	117	136	154.1	199.3	128.3
BWFCC-9	201.714	92	116.2	134.3	151.4	194.1	110.6
BWFCCT-1a	473.094	155.9	205.9	244.2	281	374.2	230.8
BWFCCT-1b	240.716	107.5	135.4	156.3	176.1	225.3	130.1
BWFCCT-2	348.294	173.8	225.1	263.9	300.9	393.8	202.5
BWFCCT-3	457.086	207.8	256.9	293.5	327.8	413	242.1
HLC-1	231.53	109	142.4	167.7	192	253.1	132
HLC-2a	151.951	92.5	118.3	137.7	156.1	202.1	94.1
HLC-2b	190.34	93.5	120.3	140.5	159.7	207.7	109.9
LTC-1	66.933	74.6	88.6	98.9	108.5	132.2	47.9
LTC-2	91.692	72.9	88.4	99.8	110.5	136.8	61.3
ML-1	276.082	193.9	231.5	259.2	285.1	348.8	174.6
ML-2	226.552	216.2	258	288.7	317.4	388	158.4
TCEF-1a	337.367	157.1	206.1	243.4	279	369	191.9
TCEF-1b	82.522	42.3	53.3	61.6	69.5	89	47.9
TCT1-1	93.377	43.6	58.6	70.1	81.2	109.5	52.9
TCT2-1	47.647	24.1	32.2	38.3	44.3	59.3	27.6
UTC-1	220.248	101.5	133.3	157.6	180.9	239.6	124.8
UTC-2	68.514	29.9	38	44.1	50	64.5	37.1
UTC-3	70.65	31.4	41.2	48.7	55.8	73.8	39.5
UTC-4a	124.091	65	82.9	96.3	109	140.8	73.2
UTC-4b	333.584	267.8	320.8	359.8	396.3	486.1	222.7
UTC-5a	205.947	101.3	133.1	157.4	180.6	239.3	119.2
UTC-5b	171.001	106.2	136	158.5	179.7	232.9	106.3
UTC-6	447.729	182.3	229.9	265.7	299.4	383.7	230

R&F ENGINEERING

Todd Creek & Bellevue-Wilfred Flood Control Channel Study Hydraulic Analysis Report

Prepared for: Sonoma County

Date: November 28, 2023

Prepared by: Baron Creager, PE & Andrew Nisenberg, EIT

Reviewed by: Chris Fritz, PE

Introduction

In July of 2022, the Federal Emergency Management Agency (FEMA) updated the Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRM) for the Todd Creek and the Bellevue-Wilfred Flood Control Channel (BWFCC) in Sonoma County, CA (County). The update included new hydrology and hydraulics with floodplains delineated as Special Flood Hazard Areas (SFHAs). During the preparation of the hydrologic and hydraulic models, the County made several comments regarding the analysis and the resulting SHFAs. While some of the comments were addressed, many were left unresolved.

In response to these events, the County contracted R&F Engineering, Inc. (R&F) to perform a Letter of Mapping Revision (LOMR) for the area. This includes updating the hydrologic model, the hydraulic model, and delineating new SFHAs to be submitted with the LOMR. This technical memorandum outlines the methods used to develop the hydraulic model for this LOMR.

Study Area

The study area consists of two major watersheds with several smaller tributaries flowing into them that combine and flow into the Laguna de Santa Rosa at the downstream end. The upper watershed is the Todd Creek watershed which flows parallel to Highway 101 from the City of Santa Rosa to the north into the BWFCC. This watershed has several tributaries including two unnamed tributaries (Todd Creek Tributary 1 & 2), Todd Creek East Fork, Hunter Lane Channel, and the Moorland Flood Control Channel (MFCC). The lower portion of the watershed is the BWFCC. The BWFCC originates in the City of Rohnert Park and the area to the east then flows west under Highway 101 where it meets with Todd Creek. BWFCC then flows southwest and meets with the Laguna de Santa Rosa. See Figure 1 for an overview of the study area.

Legend
- Streams
- Study Area
- Santa Rosa City Limits
- Rohnert Park City Limits

Study Area Location

Sacramento

San Francisco

San Jose

City of Santa Rosa

Upper Todd
Todd Trib 1
Todd Trib 2

Moorland

Todd Creek

101

Hunter Lane Chan

BWFCC

Golf Course

City of Rohnert Park

0   0.25   0.5
Mi

N W E S

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Todd Creek and Bellevue Wilfred Flood Control Channel Study

Study Area

Figure 1

Date: 5/30/2023

Hydraulic Model Development

Model Background

BakerAECOM completed a one-dimensional steady state hydraulic model[1] for the study area in 2013 using the Hydrologic Engineering Center River Analysis Software (HEC-RAS) Version 4.1. KSN provided an updated one-dimensional and two-dimensional (for select areas) model[2] in 2019 using HEC-RAS Version 5.0.6. KSN's model incorporated survey data and field measurements from 2018 on cross-sections and bridges. The BakerAECOM and KSN survey data and field measurements were utilized in this analysis.

For this analysis, a combined one-dimensional/two-dimensional (1D/2D) model was developed for the Todd Creek and BWFCC system using HEC-RAS Version 6.3.1. The NAVD 88 vertical datum and NAD 83 horizontal datum were used when developing the model.

The following sections describe the data and methods used to develop the HEC-RAS Model.

Terrain

The model utilized a 1-meter resolution digital elevation model (DEM) acquired from United States Geologic Survey (USGS)[3]. The NAD 83 California State Plane II projection was used. Minor terrain modifications were needed to correct LIDAR inconsistencies due to thick vegetation along Todd Creek Trib 3 and Todd Creek East Fork. The corrections were needed to allow HEC-RAS to interpolate a consistent invert elevation slope for a few select areas within the ditch. The two tributaries can be seen in Figure 2.

Channels

Table 1 lists the 1D streams modeled and their naming conventions. The model also includes three smaller channels that were modeled in 2D. Two of which are small tributaries to Todd Creek (Todd Creek Tributary 3 and Todd Creek East Fork), and one is a small drainage channel running under Highway 101 (Highway 101 Drainage). Figure 2 shows the location of 1D and 2D streams.

Table 1. 1D Streams Used in Model

Stream	Name in Model
Todd Creek Tributary 1	Todd Trib 1
Upper Todd Creek	Upper Todd
Todd Creek Tributary 2	Todd Trib 2
Todd Creek	Todd Creek
Hunter Lane Channel	Hunter Lane Chan
Moorland Flood Control Channel (MFCC)	Moorland
Golf Course Stream	Golf Course
Bellevue-Wilfred Flood Control Channel (BWFCC)	BWFCC

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[1] BakerAECOM, 2013, Todd, Moorland and Hunter Lane Creeks Flood Study
[2] Kjeldsen, Sinnock & Neudeck, Inc., 2019, Hydraulic Analyses Bellevue-Wilfred Flood Control Channel Watershed
[3] U.S. Geological Survey, 20200330, USGS one meter x52y425 CA Sonoma A4 2013: U.S. Geological Survey.

Todd Creek and Bellevue Wilfred Flood Control Channel Study

HEC-RAS 1D and 2D Streams

Figure 2

Date: 4/4/2023

Cross Sections

The hydraulic model used cross sections to create 1D reaches for BWFCC, Hunter Lane Channel, Todd Creek, Todd Creek Tributaries 1 & 2, and MFCC. Levee stations were added to the cross sections at the top of each of the banks to constrain modeled 1D flow to the channel until the banks are overtopped. As part of the 2019 analysis completed by KSN, a field survey was conducted on the BWFCC channel cross sections. This data was utilized for this analysis where applicable.

As part of this analysis, R&F identified questionable LiDAR data within critical reaches of Todd Creek and Hunter Lane Channel due to the presence of trees and heavy vegetation. With concerns of inaccurate LiDAR resulting in underestimates of conveyance capacities in the model, R&F contracted a survey team from KSN to conduct a field survey at additional cross sections along Todd Creek and Hunter Lane Channel. KSN obtained spot elevations along 14 cross sections at various points to capture the channel geometry and check the LiDAR elevations. R&F imported the spot elevations into HEC-RAS and developed cross sections based on the updated survey data.

The 23 channel cross sections surveyed in 2018 that are used in the model are summarized in Table 2, the 14 channel cross sections surveyed in 2023 are summarized in Table 3.

Table 2. Cross Sections Surveyed by KSN in 2018

Stream - Reach	Stream Station (ft)
BWFCC – Reach 2	691
	790
	3,320
	3,882
	3,898
	4,651
	4,718
	6,861
	8,771
BWFCC – Reach 1	11,099
	11,123
	11,184
	11,210
	11,347
	11,421
	11,575
	11,596
	11,616
	11,669
	11,699
	11,741
	11,812
	11,823

Table 3. Cross Sections Surveyed by KSN in 2023

Stream - Reach	Stream Station (ft)
Hunter Lane Chan - Main	297
	595
	885
	1,175
	1,461
Todd Creek – Mid Todd	4,833
	5,332
	5,685
Todd Creek – Up Todd Creek	7,112
	7,882
	10,236
	10,616
	11,026
	11,376

Interpolated cross-sections were added between surveyed and LIDAR-based cross-sections to improve the stability of the model. Table 4 lists the interpolated cross-sections added to the model.

Table 4. Interpolated Cross-Sections Used in Model

Stream - Reach	RS
Todd Creek – Up Todd Creek 2	11,517.3
	11,446.6
	11,259.3
	11,142.6
	10,898
	10,668.5
	10,570.5
	10,357
	7,506
	7,309
Todd Creek – Mid Todd Creek	5,020.5
	4,706.5
Hunter Lane Chan – Main	1,318
	1,030
	740
	446
	148

A representative example showing the differences in survey data for a cross-section in Todd creek just upstream of Delores Lane is shown in Figure 3. A representative example in Hunter Lane Channel just upstream of the confluence with Todd Creek is shown in Figure 4. As shown, the channel inverts were

lowered by several feet based on the new field survey data, increasing conveyance capacity for the streams within the HEC-RAS model. As shown, surveys completed for this study indicate the invert elevations are several feet lower than the LiDAR data previously suggested. Depending on downstream boundary conditions, the additional channel depth may result in increased conveyance capacity.

Figure 3. Representative Modified Cross-Section Example Showing Todd Creek – Up Todd Creek 2 RS: 11,026

Figure 4. Representative Modified Cross-Section Example Showing Hunter Lane Chan – Main RS: 1,461

The Manning's n roughness values were determined using field notes from the January 2023 site visit, aerial imagery, HEC-RAS guidance, and *Open-Channel Hydraulics* (Chow 1959). Table 5 summarizes the range of roughness values chosen for each 1D reach.

Table 5. n-Value Ranges Used in the Model

Stream - Reach	Manning's n Values
Upper Todd – Reach 2	0.035 – 0.04
Todd Trib 1 – Reach 1	0.045 – 0.06
Upper Todd – Reach 1	0.035
Todd Trib 2 – Reach 1	0.035 – 0.05
Todd Creek – Up Todd Creek 2	0.035 – 0.045
Moorland – Reach 1	0.02 – 0.04
Todd Creek – Mid Todd Creek	0.018 – 0.04
Golf Course – Reach 1	0.04
BWFCC – Reach 0	0.04
BWFCC – Reach 1	0.018 – 0.035
BWFCC – Reach 2	0.035 – 0.05

Ineffective flow areas were added to bounding cross sections at bridges as needed to represent blocked flow paths due to piers and abutments. Levee points were added to cross-sections to constrain the 1D flow inside of the channel until the water surface elevation in the channel rises above the top of bank elevations. Bank lines were added along the high ground adjacent to each 1D channel.

Bridges & Crossings

Bridges and crossings in the model were developed using a combination of KSN's 2018 and 2023 survey data, as-built drawings from CalTrans and Sonoma County, KSN's 2019 model, photographs and measurements from a January 2023 site visit, and aerial imagery. All as-built drawing elevation data provided in ft-NGVD29 was converted to ft-NAVD88. Table 6 provides a summary of each structure. A weir coefficient of 2.6 was used for each bridge. A representative bridge example is shown in Figure 5.

Table 6. Structures in the Model

Structure Name	Stream - Reach	RS	Data Source(s)
Rohnert Park Expressway	BWFCC – Reach 2	589	2018 KSN Survey & As-Built Drawings
Pedestrian Bridge	BWFCC – Reach 2	781.5	2018 KSN Survey
Pedestrian Bridge	BWFCC – Reach 2	3,815	2018 KSN Survey
Wilfred Avenue Bridge with Pedestrian Bridge	BWFCC – Reach 2	4,684.5	2018 KSN Survey & As-Built Drawings
Whistler Avenue Bridge	BWFCC – Reach 2	6,738	2018 KSN Survey & As-Built Drawings
Millbrae Avenue Bridge	BWFCC – Reach 2	8,632.5	2018 KSN Survey & As-Built Drawings
Sonoma-Marin Area Rail Transit Railroad Crossing	BWFCC – Reach 2	11,134.5	2018 KSN Survey & As-Built Drawings
Highway 101 Bridge	BWFCC – Reach 1	11,450	As-Built Drawings
Highway 101 Offramp	BWFCC – Reach 1	11,660	As-Built Drawings
Roberts Lake Road Bridge	BWFCC – Reach 1	11,800	2018 KSN Survey & As-Built Drawings
Scenic Avenue Bridge	Todd Creek – Mid Todd Creek	2,017	2023 KSN Survey
Highway 101 Todd Creek Overpass (Includes Moorland Avenue Crossing)	Todd Creek – Mid Todd Creek	4,461.5	2023 KSN Survey
Santa Rosa Avenue Overpass	Todd Creek – Mid Todd Creek	5,254	2023 KSN Survey
Todd Road Crossing	Moorland – Reach 1	2,851.5	Site Visit Photographs
Hunter Lane Extension Culvert	Hunter Lane Channel – Main	1,546.5	As-Built Drawings
Hunter Lane Culvert	Hunter Lane Channel – Main	4,866	As-Built Drawings
E Todd Road Crossing	Todd Creek – Upper Todd Creek 2	7,742.5	2023 KSN Survey
Bucks Road Crossing	Todd Creek – Upper Todd Creek 2	8,005	2023 KSN Survey
Pedestrian Bridge	Todd Creek – Upper Todd Creek 2	9,293	Site Visit Photographs
E Robles Ave Crossing	Todd Creek – Upper Todd Creek 2	10,501.5	2023 KSN Survey
Delores Lane Bridge	Todd Creek – Upper Todd Creek 2	10,745.5	2023 KSN Survey
W Miller Road Crossing	Upper Todd – Reach 1	1,647.5	Aerial Imagery
N Miller Road Crossing	Upper Todd – Reach 1	2,090	Aerial Imagery

Figure 5. Representative Bridge Example Showing the Highway 101 Bridge Developed from As-Built Drawings

2D Flow Areas

The hydraulic model contains the following eight 2D flow area perimeters:

- Perimeter 1 is between BWFCC Reach 0 and Golf Course Reach 1.
- Perimeter 2 encompasses the southernmost portion of the system between the left bank of the BWFCC and the left bank of Golf Course Reach 1.
- Perimeter 3 is enclosed by the left bank of the Hunter Lane Channel, left bank of Middle Todd Creek, and right bank of BWFCC Reaches 0 & 1.
- Perimeter 4 covers the largest area and is surrounded by the right bank of MFCC, right bank of Middle Todd Creek, and right bank of BWFCC Reach 2.
- Perimeter 7 is enclosed by Todd Creek Tributaries 1 & 2 and Upper Todd Creek Reach 1.
- Perimeter 8 is between Upper Todd Creek Reach 2 and Todd Creek Tributary 1.
- Perimeter 9 is between the left bank of MFCC and right bank of Upper Todd Creek.
- Perimeter 10 is bounded by the left bank of Todd Creek Tributary 2, left bank of Upper Todd Creek, and right bank of Hunter Lane Channel.

Breaklines were added for any flow-impeding terrain throughout the study area to improve the accuracy of the delineation of the floodplain. Breaklines were also added to model Todd Creek Tributary 3, Todd Creek East Fork, and to the drainage creek that flows into MFCC to improve model accuracy. Each 2D area mostly consists of a 100-foot by 100-foot hexagonal mesh. All breaklines are surrounded by a 50-foot by 50-foot hexagonal mesh and all 2D streams are surrounded by a 25-foot by 25-foot hexagonal mesh to increase the data resolution around important features. A representative example of the 2D flow areas is shown in Figure 6. See Figure 8 for an overview of all the 2D flow areas.

Figure 6. Representative 2D Flow Area Example Showing the Trib flows and ToddCreekTrib3 2D Streams

To accurately model the drainage creek and system of culverts through Highway 101 near the Todd Rd overpass, a refinement region was created and populated by 2D connections and culverts along breaklines based on Sonoma County storm system GIS data and field visit notes. There are five 2D connections: a pair of 4' x 4' box culverts underneath Todd Rd, a pair of 4' x 4' box culverts underneath the Todd Rd Overpass, a pair of 8' x 4' box culverts underneath Highway 101, a pair of 8' x 4' box culverts underneath S Moorland Ave, and a single 10' x 4' box culvert underneath a small private road to the west of S Moorland Ave. The drainage creek geometry is shown in Figure 7.

Figure 7. Drainage Creek Geometry

Land Cover

The land use consists of a mix of urban, rural grasslands, and rolling sparsely forested hills. Zoning spatial data was collected from Sonoma County, Santa Rosa, and Rohnert Park and used as a baseline for the land use description. The land use data was then adjusted based on satellite imagery and field visit data to best match the existing conditions. The land use was categorized as one of 11 land use types shown in Table 7. For this process it was assumed that all roads were paved roads. Figure 4 shows the land use for the study area.

Table 7. Manning's N Values for Each Land Use Classification

Land Use Classification	Manning's n Roughness Value
Commercial	0.16
Grassland	0.04
Industrial	0.16
Open Space	0.03
Residential 1 ac	0.08
Residential 0.25 ac	0.12
Residential 0.125 ac	0.14
Residential 2 ac	0.06
Road	0.02
Straight Row Crops	0.04
Woods-Grass Combo	0.1

Lateral Structures

Lateral structures were placed along the banks of the 1D reaches to connect the reaches to the adjacent 2D flow areas. The lateral structures in the model were generated from the LiDAR-based terrain data of the banks for each stream. Weir coefficients of 0.2 were used for each lateral structure. The overflow computation method for each lateral structure was chosen based on model stability. Where possible, the lateral structures were set to use the Normal 2D Equation instead of the Weir Equation. As model runs presented runtime errors and instabilities, lateral structures were incrementally set to use the Weir Equation until the model could successfully run with minimal error. Table 8 summarizes the lateral structures in the model. Figure 8 shows an overview of the model components.

Table 8. Lateral Structures in the Model.

Stream - Reach	Lateral Structure RS	Position	Overflow Computation Method
Upper Todd – Reach 2	5274	Left overbank	Weir Equation
	5273	Right overbank	Weir Equation
	3495	Left overbank	Weir Equation
	3488	Right overbank	Weir Equation
Todd Trib 1 – Reach 1	1661	Left overbank	Weir Equation
	1659	Right overbank	Weir Equation
	1382	Left overbank	Weir Equation
	1376	Right overbank	Weir Equation
Upper Todd – Reach 1	2330	Left overbank	Weir Equation
	2233	Right overbank	Weir Equation
	1110	Left overbank	Weir Equation
	1105	Right overbank	Weir Equation
Todd Trib 2 – Reach 1	3326	Left overbank	Weir Equation
	3327	Right overbank	Weir Equation
	2867.999	Left overbank	Weir Equation
	2867	Right overbank	Weir Equation
	1479.99	Left overbank	Weir Equation
	1479.98	Right overbank	Weir Equation
Todd Creek – Up Todd Creek 2	13041.99	Left overbank	Normal 2D Equation
	13040	Right overbank	Normal 2D Equation
	12073	Left overbank	Weir Equation
	12074	Right overbank	Weir Equation
	10700	Left overbank	Weir Equation
	10535.98	Left overbank	Weir Equation
	10599	Right overbank	Weir Equation
	8046.98	Left overbank	Normal 2D Equation
	8046.7	Right overbank	Weir Equation
Hunter Lane Chan – Main	10011	Left overbank	Normal 2D Equation
	10010	Right overbank	Normal 2D Equation
	8036	Left overbank	Normal 2D Equation
	8037.7	Right overbank	Normal 2D Equation
	6791.98	Left overbank	Normal 2D Equation

Stream - Reach	Lateral Structure RS	Position	Overflow Computation Method
	6791.99	Right overbank	Normal 2D Equation
	5191	Left overbank	Weir Equation
	5192	Right overbank	Weir Equation
	3514.999	Left overbank	Weir Equation
	3514.998	Right overbank	Weir Equation
	1895.999	Left overbank	Weir Equation
	1895.98	Right overbank	Weir Equation
Moorland – Reach 1	4965.5	Left overbank	Normal 2D Equation
	4965	Right overbank	Weir Equation
	2786.999	Left overbank	Normal 2D Equation
	2787.3	Right overbank	Weir Equation
Todd Creek – Mid Todd Creek	5684.98	Left overbank	Weir Equation
	5625.205	Right overbank	Weir Equation
	3875	Right overbank	Weir Equation
	3739	Left overbank	Weir Equation
	3739.99	Right overbank	Weir Equation
	2155	Left overbank	Weir Equation
	2156	Right overbank	Weir Equation
Golf Course – Reach 1	1104.999	Left overbank	Normal 2D Equation
	1101	Right overbank	Normal 2D Equation
BWFCC – Reach 0	19589.99	Left overbank	Normal 2D Equation
	19582	Right overbank	Normal 2D Equation
	15734	Left overbank	Weir Equation
	15731	Right overbank	Weir Equation
BWFCC – Reach 1	14457.98	Left overbank	Weir Equation
	14457.99	Right overbank	Weir Equation
	12810.98	Left overbank	Weir Equation
	12810.99	Right overbank	Weir Equation
BWFCC – Reach 2	11177.98	Left overbank	Normal 2D Equation
	11177.99	Right overbank	Normal 2D Equation
	9713.98	Left overbank	Normal 2D Equation
	9713.99	Right overbank	Normal 2D Equation
	8480.98	Left overbank	Normal 2D Equation
	8480.99	Right overbank	Normal 2D Equation
	6860.98	Left overbank	Normal 2D Equation
	6860.99	Right overbank	Normal 2D Equation
	4418.98	Left overbank	Normal 2D Equation
	4418.99	Right overbank	Normal 2D Equation
	2213.98	Left overbank	Normal 2D Equation
	2213.99	Right overbank	Normal 2D Equation

Legend
- Unmodified Cross Sections (RS)
- Modified Cross Sections (RS)
- Rivers
- Lateral Structures
- Breaklines
- 2D Flow Areas

Perimeter 8
Perimeter 7
Perimeter 9
Perimeter 10
Perimeter 4
Perimeter 3
Perimeter 1
Perimeter 2

South Santa Rosa
Bellevue
Wilfred

Todd Creek and Bellevue Wilfred Flood Control Channel Study	Figure 8
Hydraulic Model Overview	Date: 5/31/2023

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Hydrology

Hydrology data from the Hydrologic Engineer Center Hydrologic Modeling System (HEC-HMS) version 4.10 model developed for this study was coded into the HEC-RAS model. The accompanying hydrology report[4] details the hydrological model that was developed for this project.

The following storm scenarios were simulated in the model: 10-year, 25-year, 50-year, 100-year, 500-year, the recorded October 2021 storm event, and the recorded December 2022 - January 2023 storm event. The 2021 and 2023 storm events were used to calibrate and verify the model results which is discussed further below.

The downstream boundary condition was set to a constant stage for the duration of each simulation. The return interval storm stages for the downstream boundary conditions were taken from the current effective FEMA base flood elevation and Flood Insurance Study profiles. The 2021 and 2023 event stages were taken from observed data at the USGS gauge on Laguna De Santa Rosa just downstream of Stony Point Rd (USGS 11465680). Table 9 presents the downstream stage boundary conditions used in the BWFCC for each simulation scenario.

Table 9. Downstream Stage Boundary Condition in BWFCC for each Simulation Scenario

Simulation Scenario	Downstream Stage (ft)
2021 Event	85.35
2023 Event	85.22
10-Year	89.00
25-Year	90.40
50-Year	90.80
100-Year	91.00
500-Year	92.00

Table 10 below shows a comparison of the 2023 R&F 100-year flows and the FEMA effective model 100-year flows.

Table 10. Comparison of Updated 2023 R&F and FEMA Effective Model 100-Year Flows

River	Location	Flow (cfs)	
		Current Effective	R&F (Updated)
Todd Creek	Downstream Todd Trib 1	355	177
	Downstream Todd Trib 2	684	277
	Downstream Todd Trib 4	1,339	1,532
	Downstream Hunter Lane	2,102	2,279
	Downstream Moorland	2,367	2,716
BWFCC	Downstream Golf Course	1,647	1,787
	Downstream Todd Creek	3,468	4,476
	At Laguna De Santa Rosa	4,531	5,269

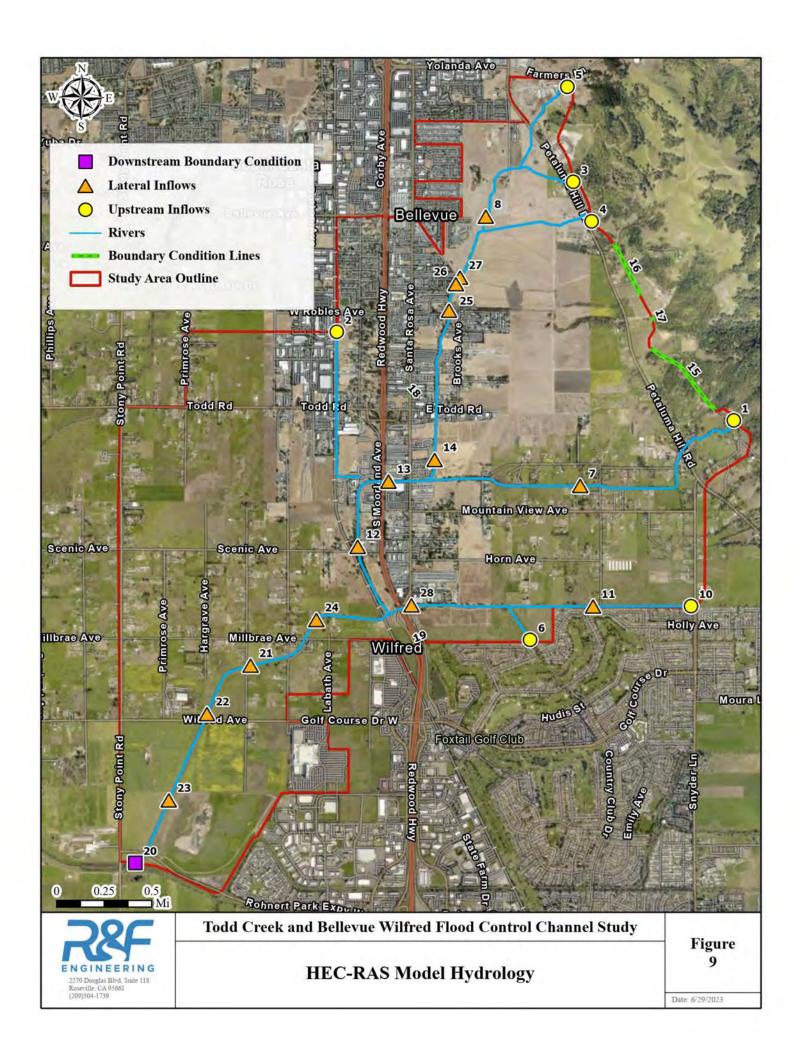[4] R&F Engineering, Inc., 2023, Hydrological Analysis for Todd Creek and Bellevue-Wilfred Flood Control Channel

Table 11 summarizes the flows that were coded into the HEC-RAS model. Figure 9 shows the location of each boundary condition and flow coded into the model.

Table 11. HEC-HMS Flows Used in the Model

Stream – Reach or 2D Area	RS or Perimeter	Boundary Condition	HEC-HMS Flow	#
Hunter Lane Chan – Main	10036	Flow Hydrograph	HLC-1	1
Moorland – Reach 1	4966	Flow Hydrograph	ML-1	2
Todd Trib 1 – Reach 1	1667	Flow Hydrograph	TCT1-1	3
Todd Trib 2 – Reach 1	3330	Flow Hydrograph	TCT2-1	4
Upper Todd – Reach 2	5287	Flow Hydrograph	UTC-1	5
Golf Course – Reach 1	1105	Flow Hydrograph	GOLF COURSE HW	6
Hunter Lane Chan – Main	4314 – 4233	Lateral Inflow Hydr.	HLC-2B	7
Upper Todd – Reach 1	296 – 413	Lateral Inflow Hydr.	UTC-2 & UTC-3	8
Todd Creek – Up Todd Creek 2	11469 – 11527	Lateral Inflow Hydr.	UTC-4	9
BWFCC – Reach 0	19590	Flow Hydrograph	BWFCC-1	10
	16416-16870	Lateral Inflow Hydr.	BWFCC-2	11
Todd Creek – Mid Todd Creek	2068 – 2157	Lateral Inflow Hydr.	LTC-2	12
	4580 – 4647	Lateral Inflow Hydr.	LTC-1	13
Todd Creek – Up Todd Creek 2	6094 – 6351	Lateral Inflow Hydr.	UTC-6	14
Perimeter_5_BC_Line	Perimeter 10	BC Line	HLC-2a	15
Perimeter_6_BC_Line	Perimeter 10	BC Line	UTC-5a	16
ToddCreekTrib3	Perimeter 10	BC Line	TCEF-1a	17
drainage creek	Perimeter 9	BC Line	ML-2	18
santa rosa culv	Perimeter 2	BC Line	BWFCC-3	19
BWFCC – Reach 2	211	Stage Hydrograph	-	*20*
	6761 – 6861	Lateral Inflow Hydr.	BWFCC-7	21
	4718 – 4884	Lateral Inflow Hydr.	BWFCC-6	22
	1492 – 2214	Lateral Inflow Hydr.	BWFCC-8 & BWFCC-9	23
	8771 – 9249	Lateral Inflow Hydr.	BWFCC-5	24
Todd Creek – Up Todd Creek 2	10536 – 10601	Lateral Inflow Hydr.	TCEF-1b	25
	11171 – 11372	Lateral Inflow Hydr.	UTC-4b	26
	11527 – 11588	Lateral Inflow Hydr.	UTC-5B	27
BWFCC – Reach 1	11812 – 11823	Lateral Inflow Hydr.	BWFCC-4	28

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HEC-RAS Model Hydrology

Figure 9

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Model Verification

The 2021 and 2023 storm events were simulated to verify the results of the hydraulic model. The hydrology for these events was generated from rainfall data obtained from station STA in Santa Rosa from the California Data Exchange Center (CDEC) (see Hydrology report for further discussion).

Observations during the 2021 storm event yielded highwater marks and observations for the Santa Rosa Ave bridge, the confluence of Todd Creek and Hunter Channel, and the Hunter Ln Exd bridge. It should be noted that the highwater mark photos used for the model verification were taken at approximate peak flow conditions, but it is not certain that they captured the true peak highwater marks. Figure 10 shows the highwater conditions in Todd Creek at the Santa Rosa Bridge on October 24, 2021.

During the 2021 storm, the water level at the Santa Rosa Ave bridge was found to be approximately 97.5'. In the model, the water level at the Santa Rosa Ave bridge was found to be 98.1', confirming the model accuracy at that location to within 0.6'. Figure 11 shows a comparison of the January 2021 site visit picture of the Santa Rosa Ave bridge water level and the water level in the model. Based on photos during the 2021 storm, between three to five feet of freeboard was observed at the confluence of Todd Creek and Hunter Channel. In the model, the water level at the confluence was found to be 96.8', which is 4.7' lower than the right channel bank and 4.4' lower than the left channel bank. Figure 12 shows the confluence under the 2021 storm conditions. The Hunter Ln Exd bridge was observed to have approximately 1 to 2 feet of freeboard underneath the soffit during the 2023 storm. The model results for the 2021 event show that the water level at the bridge was 113.7', which is 1 foot lower than the soffit at 114.7'. Figure 13 shows the observed water level at the Hunter Ln Exd bridge.

Figure 10. Highwater Conditions at the Santa Rosa Bridge during the 2021 Storm Event (Image: Oct 24, 2021, 8:41 AM)
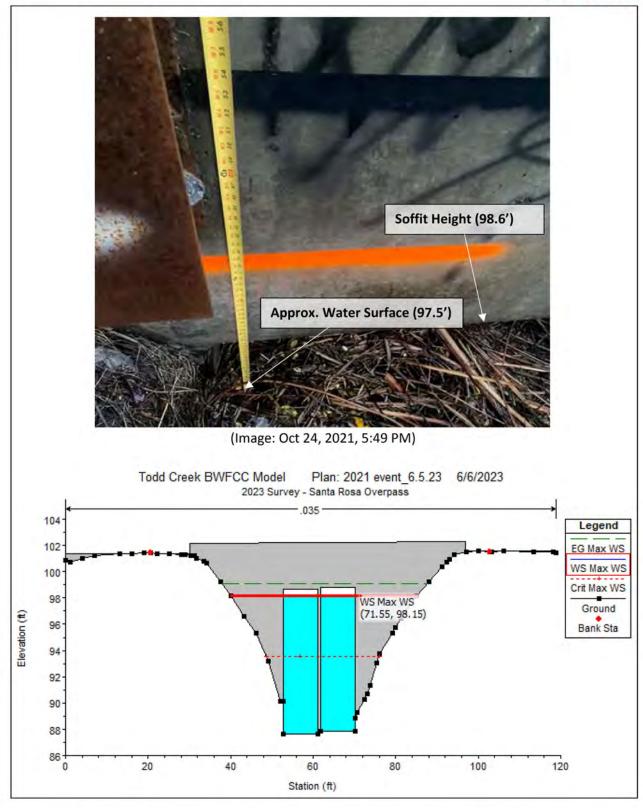
(Image: Oct 24, 2021, 5:49 PM)

Figure 11. Comparison of Observed Water Level to Model Results in the Santa Rosa Bridge during the 2021 Storm Event

Figure 12. 2021 Storm Conditions at the Todd Creek and Hunter Channel Confluence (Image: Oct 24, 2021, 1:23 PM)

Figure 13. Hunter Ln Exd Conditions during the 2021 Storm Event (Image: Oct 24, 2021, 3:08 PM)

Shallow ponding from overland flows was also observed during the 2021 storm event and used to further verify the model results. Just north of the corner of Brooks Ave and Ward Rd (south of Todd Creek East Fork), shallow flooding was observed along the road and throughout the nearby business and parking lots and was confirmed to have been caused by overland flows from the east during a discussion with the locals. The model results were consistent with this information, as shallow flooding (less than 6 inches deep) was found along Brooks Ave and around the business and parking lots due to overflows out of Todd Creek East Fork. Figure 14 shows a comparison of the ponding observed during the site visit and the ponding presented in the model results.

Figure 14. Comparison of Observed Flooding and Model Results. The Star Shows Where the Picture was Taken (looking east)
(Image taken on Oct 24, 2021, 3:41 PM)

During the 2023 event, the water level at the Santa Rosa Bridge was found to be approximately 8' below the top of wall. Using the surveyed top of wall elevation of 102.3', the observed water level was estimated to be 94.3'. The model calculated a max water surface of 95.6', which is approximately 1.3' greater than the observed water level. Figure 15 shows the highwater conditions in Todd Creek at the Santa Rosa Bridge on January 5, 2023. The water level at the E Todd Rd Bridge was measured to be approximately 5.5' below the bridge deck during the 2023 event, which is approximately 99.8' when using the surveyed bridge deck elevation of 105.27'. The water surface at the E Todd Rd Bridge in the model was 100.53', which is approximately 0.7' greater than the observed water level. Figure 16 shows the highwater conditions in Todd Creek at the E Todd Rd Bridge on January 5, 2023.
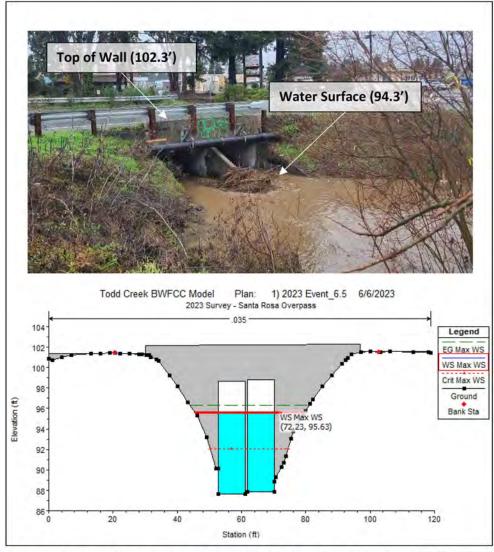

Figure 15. Comparison of Observed Water Level to Model Results in the Santa Rosa Bridge during the 2023 Storm Event (Photo: Jan 5, 2023, 10:11 AM)

Figure 16. Comparison of Observed Water Level to Model Results in the E Todd Rd Bridge during the 2023 Storm Event.
(Image: Jan 5, 2023, 10:36 AM)

Results

Floodplain maps for the 10-year, 25-year, 50-year, 100-year, and 500-year events are shown in Figures 17-21. Also included are the floodplain maps for the 2021 and 2023 events (Figures 22 and 23). The modeled inundation extents and depths are generally consistent with what was observed during these high flow events.

The inundation observed during all the events is primarily due to overland flows from the overtopping of channel banks along Todd Creek and the BWFCC, primarily located in open area farmland and within constructed wetlands. The overland flows result in shallow flooding, forming ponds up to 5 feet deep during the 100-year and 500-year events. The land adjacent to the downstream reaches of the BWFCC exhibits the greatest inundation at approximately 5 feet deep, primarily due to backwater effects from the Laguna de Santa Rosa. The confluence of Upper Todd Creek and its tributaries exhibits overland flows and shallow (0' - 1') ponding due to the flat topography. Both Hunter Lane Channel and the BWFCC show overtopping and ponding at their intersection with Highway 101.

Flood Depth (ft)
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 8
- 8 - 10
- > 10

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10-Year Floodplain

Figure 17

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Flood Depth (ft)
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 8
- 8 - 10
- > 10

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25-Year Floodplain

Figure 18

Date: 6/5/2023

Flood Depth (ft)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 8
- 8 - 10
- > 10

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50-Year Floodplain

Figure 19

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Flood Depth (ft)

	0 - 0.5
	0.5 - 1
	1 - 2
	2 - 5
	5 - 8
	8 - 10
	> 10

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100-Year Floodplain

Figure 20

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Flood Depth (ft)
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 8
- 8 - 10
- > 10

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500-Year Floodplain

Figure 21

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Date: 6/5/2023

Flood Depth (ft)
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 8
- 8 - 10
- > 10

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Todd Creek and Bellevue Wilfred Flood Control Channel Study

2021 Event Floodplain

Figure 22

Date: 6/5/2023

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Flood Depth (ft)
- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 8
- 8 - 10
- > 10

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Todd Creek and Bellevue Wilfred Flood Control Channel Study

2023 Event Floodplain

Figure 23

Date: 6/5/2023