

# **PRELIMINARY/FINAL DRAINAGE REPORT**

**For**

## **CORVALLIS PHASE I**

Prepared for:  
**City of Fountain**  
116 S. Main Street  
Fountain, CO 80817

On Behalf of:  
**HPHR Properties, LLC**  
555 Middle Creek Parkway, Suite 380  
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Prepared by:



# **Matrix**

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September 2021

Project No. 21.1105.002

**ENGINEER'S STATEMENT:**

This report and plan for the drainage design of Corvallis Phase I was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Fountain does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, error or omissions on my part in preparing this report.

**Signature:** \_\_\_\_\_

Jesse Sullivan  
Colorado Professional Engineer No. 55600

**Date :** \_\_\_\_\_

**DEVELOPER'S STATEMENT:**

HPHR Properties, LLC hereby certifies that the drainage facilities for Corvallis Phase I shall be constructed according to the design presented in this report. I understand that the City of Fountain does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Fountain pursuant to the City Code; and cannot, on behalf of HPHR Properties, LLC, guarantee that final drainage design review will absolve HPHR Properties, LLC and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

**Name of Developer:** HPHR Properties, LLC

**Authorized Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Printed Name:** Ed Houle

**Title:** Director of Land Acquisition and Development

Address: 14160 Gleneagle Drive  
Colorado Springs, CO 80921

**CITY OF FOUNTAIN STATEMENT:**

Filed in accordance with the Code of the City of Fountain, 2009, as amended.

\_\_\_\_\_  
For the City Engineer

\_\_\_\_\_  
Date

Conditions:



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## I. INTRODUCTION

### A. PURPOSE AND SCOPE OF STUDY

The purpose of this report is intended to fulfill the City of Fountain requirements for a Preliminary / Final Drainage Report (PDR/FDR), to be submitted with the Preliminary Plat for the proposed Corvallis project. This project will involve construction of roads, utilities and storm sewer infrastructure associated with single-family and multi-family residential, and commercial development. The purpose of this report is the identification of offsite and onsite drainage patterns and design of storm sewer infrastructure associated with the proposed development, analysis of impacts from upstream drainage, and impacts to downstream facilities. This report has been prepared based on the guidelines and criteria presented in the City of Colorado Springs Drainage Criteria Manual (DCM).



### B. GENERAL PROJECT DESCRIPTION

#### 1. Specific Site Location:

- a. General Location: Part of the Northeast  $\frac{1}{4}$  of Section 21, and the Northwest  $\frac{1}{4}$  and a Portion of the Southwest  $\frac{1}{4}$  of the Northeast  $\frac{1}{4}$  of Section 22, all in Township 15 South, Range 65 West of the 6<sup>th</sup> P.M. in the City of Fountain, County of El Paso, State of Colorado.

- b. Surrounding Streets: Fontaine Boulevard directly borders the parcel to the north, and a portion of the eastern boundary is bordered directly by Marksheffel Road. Powers Boulevard (State Highway 21) is located approximately ½ mile to the west.
- c. Drainageway: The proposed site lies entirely within the West Fork Jimmy Camp Creek Drainage Basin and is currently undeveloped land, mostly covered by natural vegetation. The Fountain Mutual Irrigation Company (FMIC) irrigation ditch also enters and exits the site multiple times.
- d. Surrounding Developments: The site is bound by vacant land and Cottonwood Grove Filing No. 1 to the north, the Peaceful Valley Estates development to the West, The Glen at Widefield Subdivisions to the south, and Lorson Ranch to the east.

Refer to Appendix D for the Vicinity Map.

## **2. Drainage Area:**

- a. Onsite:  
Corvallis Phase I is a 140-acre parcel located at the southwest intersection of Marksheffel Road and Fontaine Boulevard. The Corvallis ODP prepared by Matrix Design Group, Inc dated July 27, 2021 includes for Phase I: single-family and multi-family residential units, commercial development, and dedicated open space.
- b. Offsite:  
Offsite flows to this phase include runoff from Fontaine Boulevard which will receive treatment and detention within one of the several detention facilities included in this phase of the development. A small portion of the Cottonwood Grove Filing No. 1 development (OS-7) will be captured conveyed to the Marksheffel Road ditch via a proposed swale. Another offsite flow consideration is the FMIC irrigation ditch. These flows will be routed through the site via a proposed 60-inch storm pipe to enable the flows (approximately 60 cfs) to continue along the FMIC ditch on the east side of the development.

## **3. Drainageway:**

As previously mentioned, the site is in the West Fork Jimmy Camp Creek Drainage Basin and is currently undeveloped meadow. For this phase flows on the site will be split between two different basins within this drainage fee basin. Approximately 85 acres are in the MDDP's East Basin which drains to the southeast corner of the site and will continue along Marksheffel Road following historic paths. Another 93 acres of Corvallis is in the middle basin which drains to an existing area inlet at the end of Spring Glen Drive at the north side of Glen at Widefield Filing No. 9 in El Paso County and just south of Corvallis Phase I. Ultimately both flows will find their way via historic paths to the main channel of the West Fork Jimmy Camp Creek stream.

## **4. Utilities and Encumbrances**

- **Storm Sewer:**
  - Existing crossroad culverts at the future intersection of the proposed arterial road will have to be relocated and extended to account for the proposed road and improvements to Marksheffel Road.

- Existing storm at the tie-in to Glen Spring Drive in Glen at Widefield Filing No. 9 which will be connected to in the middle basin (on the west side of Corvallis Phase I).
- Existing FMIC Fontaine Boulevard crossroad pipe (56-inch x 38-inch CMP) northwest of Phase I and draining into the adjacent agricultural parcel. The receiving FMIC ditch on the east side of Corvallis Phase I terminates near Weeping Willow Drive at an existing 34" HDPE storm pipe.
- **Sanitary Sewer:** Existing 24-inch and 8-inch sanitary sewer mains lie within the intersection of Marksheffel Road and Lorson Boulevard near the site's southeast corner. The 8-inch will receive flow from this phase of the Corvallis Development. No encumbrance to the project is anticipated.
- **Gas:** There are currently two gas mains running along the west side of Corvallis Phase I. Currently, these are covered by a 30-foot blanket easement. A 110-foot easement will be provided as part of this development.
- There is also gas running along Marksheffel Road. No encumbrance is anticipated from this line.
- **Water:** The following existing water mains surround the site: a 16-inch water main in Marksheffel Road, a 24-inch water main in Spring Glen Drive, a 12-inch water stub at Dutch Loop, and an 8-inch water main at Fontaine Boulevard near Cottonwood Grove. A network of new 12-inch and 8-inch water mains will be constructed throughout the Corvallis site to provide looping and water services to the development.
- **Electric:** There is existing overhead electric power in Fontaine Boulevard along the north side of the property and along the site's western property line. Underground electric power is also located within the residential developments to the south and east of the site. Electric service will be provided to the Corvallis Development by extending underground electric throughout the subdivision for residential and commercial services. No encumbrance to the project is anticipated.
- **Communications:** Underground communication lines currently serve the residential neighborhoods adjacent to the project site which will be extended underground to serve Corvallis Development. No encumbrance to the project is anticipated.
- **Irrigation:** As mentioned in the storm sewer bullet point, there is an existing irrigation ditch which will be conveyed through the site by a proposed 60-inch pipe. It should be noted that there is very little elevation difference between the two FMIC culverts crossing Fontaine Boulevard and, therefore, the conveyance of this irrigation flows (Estimated to be 60 cfs by the FMIC) will be very flat. Entry and exit locations to and from the site will remain unchanged.

Written acceptance of planned modifications to FMIC ditch must be acquired from FMIC prior to beginning construction of these improvements. Pursuit of this acceptance is in progress. Documentation will be added to the report when it is available.

Once completed, the FMIC approved irrigation conveyances will be privately owned and maintained by the FMIC.

## 5. Streamside Zones:

This phase of the Corvallis development is not located on or perpendicularly adjacent to a streamside zone and, therefore, no stream improvements are required as part of this phase of development. Future phases may fall within that category.

### ***C. DATA SOURCES***

Topographical information for the site was found using a combination of ***United States Geological Survey*** (USGS) mapping, GIS LIDAR, as well as field surveying. The ***Web Soil Survey***, created by the ***Natural Resources Conservation Service***, was utilized to investigate the existing general soil types within the site.

### ***D. APPLICABLE CRITERIA AND STANDARDS***

As required by the City of Fountain, Colorado, this report has been prepared in accordance with the criteria set forth in the ***City of Colorado Springs Drainage Criteria Manual Volume 1*** (Drainage Criteria Manual), dated May 2014 and ***Volume 2 Stormwater Quality Policies, Procedures, and BMP's***, dated May 2014.

In addition to the City Criteria Manual, the ***Urban Storm Drainage Criteria Manuals, Volumes 1-3*** (UDFCD), published by the Urban Drainage and Flood Control District, latest update, have been used to supplement the Drainage Criteria Manual for water quality capture volume (WQCV).

### ***E. REFERENCED DRAINAGE REPORTS***

***West Fork Jimmy Camp Creek Drainage Basin Planning Study (WFJCC DBPS)***, by Kiowa Engineering Corp. October 2003.

***Master Drainage Development Plan (GAW-MDDP) The Glen at Widefield***, by Kiowa Engineering Corp. December 1999.

***Master Drainage Development Plan Amendment (MDDPA) The Glen at Widefield***, by Kiowa Engineering Corp. June 2007.

***Final Drainage Report (FDR F9) The Glen at Widefield Filing No. 9***, by Kiowa Engineering Corp. July 2018.

***Final Drainage Report (FDR F11) The Glen at Widefield Filing No. 11***, by Kiowa Engineering Corp. December 2019.

***Master Development Drainage Plan (MDDP) for Corvallis***, by Matrix Design Group. September 2021.

### ***F. LAND USES***

Presently, the site is unplatted and undeveloped land. Corvallis Phase I is a propose 140-acre development which will involve single and multi-family development, as well as commercial development. Development of utilities and internal roadways will also be included in this parcel.

### ***G. SOIL CONDITIONS***

The majority of the site is currently undeveloped and consists of natural vegetative land cover, as well as multiple natural creeks.

Soils can be classified in four different hydrologic groups, A, B, C, or D to help predict storm water runoff rates. Hydrologic group "A" is characterized by deep, well-drained coarse-grained

soils with a rapid infiltration rate when thoroughly wet and having a low runoff potential. Group “D” typically has a clay layer at or near to the surface, or a very shallow depth to impervious bedrock and has a very slow infiltration rate and a high runoff potential. See Soils Map; Appendix D. Table 1.1 on the following page indicates which soil types are present in the development area:

***Table 1.1 – NRCS Soil Survey for El Paso County***

<b><i>Soil ID</i></b>	<b><i>Soil</i></b>	<b><i>Hydrologic Classification</i></b>	<b><i>Permeability</i></b>	<b><i>Percent on Site</i></b>
30	Fort Collins Loam (0% - 3% slopes)	B	Moderately Rapid	8.2%
52	Manzanst Clay Loam (0% - 3% slopes)	C	Low Rapidity	3.7%
56	Nelson-Tassel Fine Sandy Loams (3% - 18% slopes)	B	Moderately Rapid	52.1%
59	Nunn Clay Loam (0% - 3% slopes)	C	Low Rapidity	10.1%
75	Razor-Midway Complex	D	Very Low Rapidity	0.6%
86	Stoneham Sandy Loam (3% - 8% slopes)	B	Moderately Rapid	25.3%

## ***H. GROUNDWATER***

According to the Geo-tech report for the site, groundwater levels vary. There is some seasonal and temporary raising of the water table along the FMIC and natural ditches. This fluctuation is likely due to irrigation water releases during the growing season; therefore, it is anticipated that the rerouting of the FMIC ditch via storm sewer will mitigate some of the water table fluctuations. Groundwater will be mitigated for in the construction plans as necessary. Borings in the Geotech report, dated March 15, 2021, indicates that the water table in this phase of the development, when extant, is 15 to 27 feet below existing grade.

## ***I. DRAINAGE DESIGN CRITERIA***

### **1. Design References**

As required by the City of Fountain, Colorado, this report has been prepared in accordance with the criteria set forth in the ***City of Colorado Springs Drainage Criteria Manual Volume 1*** (DCM), dated May 2014 and ***Volume 2 Stormwater Quality Policies, Procedures, and BMP's***, dated May 2014.

In addition to the City Criteria Manual, the ***Urban Storm Drainage Criteria Manuals, Volumes 1-3*** (UDFCD), published by the Urban Drainage and Flood Control District, latest update, have been used to supplement the Drainage Criteria Manual for water quality capture volume (WQCV).

### **2. Design Frequency**

The design frequency is based on criteria within the DCM. The 100-year storm event is used as the major storm for the project, and the 5-year storm event is the minor storm.

### 3. Design Discharge

#### i. Method of Hydrologic Analysis

##### a. Rational Method:

The hydrology for this project uses the Rational Method as recommended by the Drainage Criteria Manual for the minor and major storms for drainage basins less than 100-acres in size. The Rational Method uses the following equation:  $Q=C*i*A$

Where:

Q	=	Maximum runoff rate in cubic feet per second (cfs)
C	=	Runoff coefficient
i	=	Average rainfall intensity (inches per hour)
A	=	Area of drainage sub-basin (acres)

##### b. Runoff Coefficient

Rational Method coefficients from Table 6-6 of the DCM for developed land were utilized in the Rational Method calculations. See Appendix B for more information.

##### c. Time of Concentration

The time of concentration consists of the initial time of overland flow and the travel time in a channel to the inlet or point of interest. A minimum time of concentrations of 5 minutes is utilized for urban areas.

##### d. Rainfall Intensity

The hypothetical rainfall depths for the 1-hour storm duration were taken from Table 6-2 of the Colorado Springs Drainage Criteria Manual. Table 5.1, below, lists the rainfall depth for the Major and Minor 1-hour storm events.

**Table 5.1 – Project Area 1-Hour Rainfall Depth**

Storm Recurrence Interval	Rainfall Depth (inches)
5-year	1.50
100-year	2.52

The rainfall intensity equation for the Rational Method was taken from Drainage Criteria Manual Volume 1 Figure 6-5.

#### ii. StormCAD Analysis

##### a. Routing

Storm CAD was utilized to analyze the routing of runoff through the proposed storm sewer system. Catchments were either created in the model and calibrated to match the values calculated in the Rational Method spreadsheet or values from the Rational method spreadsheet were used to set flow values at design point locations within the StormCAD model of the storm sewer system.

**Table 9-4. STORMCAD Standard Method Coefficients**

Bend Loss		
Bend Angle	K Coefficient	
0°	0.05	
22.5°	0.10	
45°	0.40	
60°	0.64	
90°	1.32	
LATERAL LOSS		
One Lateral K Coefficient		
Bend Angle	Non-surcharged	Surcharged
45°	0.27	0.47
60°	0.52	0.90
90°	1.02	1.77
Two Laterals K Coefficient		
45°	0.96	
60°	1.16	
90°	1.52	



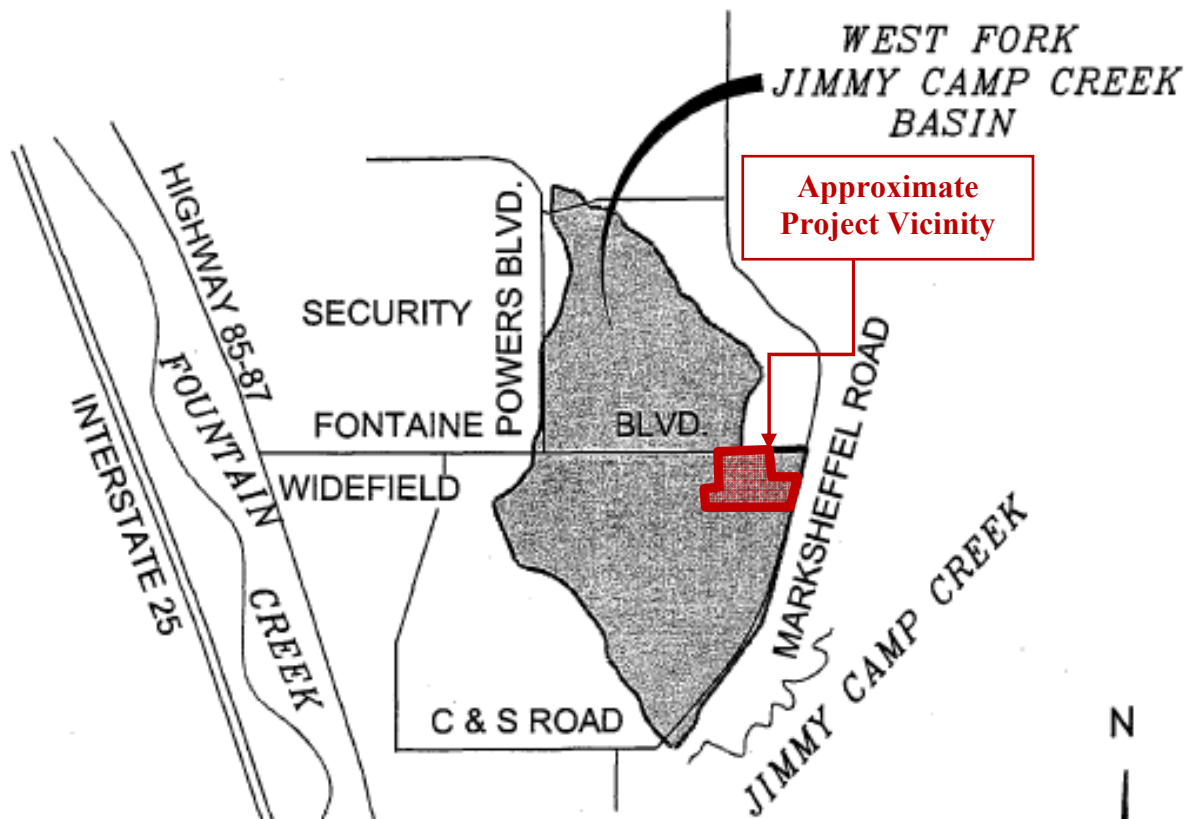
b. **HGL Profiles**

StormCAD was also used to determine the Hydraulic Grade Profiles for the major and minor storms. The standard method was used to calculate head loss in the system with K coefficients taken from Table 9-4 of the DCM (shown above).

## II. PROJECT CHARACTERISTICS

### A. MAJOR BASIN

Corvallis lies entirely within the West Fork Jimmy Camp Creek (WFJCC) Drainage Basin. The project includes offsite and onsite drainage area with the major confluence of offsite drainage happening at an existing bridge crossing that conveys the WFJCC flows southerly across Fontaine Boulevard. These flows continue south through the Corvallis site until they enter the Glen at Widefield Subdivision Filing No. 9. Two more broad natural swales run through the site, draining north to south, and join with the WFJCC after leaving the Corvallis parcel. The West Fork of Jimmy Camp Creek covers a total of 4 square miles. The developed area for Phase I (140-acres) is approximately 5.5% of the total drainage area within the WFJCC.



### B. COMPLIANCE WITH DBPS

This study complies with the latest DBPS study (*WFJCC DBPS*) of the West Fork Jimmy Camp Creek basin dated October 2003. All developed runoff from the site will be detained and released at pre-development peak rates, and the water quality volume will be treated. Both as determined by the UDFCD detention spreadsheet UD-Detention. This phase of the development will not



directly discharge to the channel, nor will it develop any perpendicularly adjacent parcels to WFJCC, and, thus, per the approved MDDP, it will not trigger stream improvements.

### III. HYDROLOGY AND HYDRAULICS

The general concept for management of storm water for the proposed Corvallis development will be to provide clear conveyance through the property to the multiple onsite detention facilities to mitigate developed runoff flows from the site. Development of the site will require over-lot grading, roadway paving, residential and commercial construction which will increase the imperviousness of the property from existing conditions.

The general drainage patterns will consist of positive drainage away from building sites, across lawns, parking lots, or open space, to curb and gutter within the internal roadways. Storm water within the roadways will be directed to inlet collection points, where it will be captured and conveyed through a storm sewer system to a full spectrum detention pond. For this phase the offsite flows from Fontaine Boulevard and Cottonwood Grove Filing No. 1 will be detained and treated within one of the propose full spectrum detention facilities.

#### A. EXISTING DRAINAGE CONDITIONS

Under the existing conditions, the site flows in a general north to south pattern until reaching one of three low points. As such, the site was divided by the MDDP into three major basin delineations (west (future phase), central, east) which collect flow to these discharge points, in conformance with the **WFJCC DBPS, MDDP**, and **FDRs** for the area. Corvallis Phase I will covers much of the center or middle basin and all of the east basin. The west basin will be part of a future phase of the Corvallis development.

Existing conditions for the central and east basins are described below:

##### **Central Basin**

Sub-basin EX-4 is an onsite, undeveloped portion of land that drains from the northeast to the southwest until reaching Design Point E6, the final discharge point of the Central Basin.

This discharge point is centrally located on the southern border of the Corvallis development. An existing area inlet and corresponding 48-inch RCP collects the flows ( $Q_5 = 7.2$  cfs and  $Q_{100} = 48.1$  cfs) and conveys them directly to the WFJCC. Per the approved FDR for the Glen at Widefield Filing No. 9, this point collects 44.8 cfs in the 5-year storm and 163 cfs in the 100-year storm. As with Design Point E8, the allowable release of flows for this point are set by the approved **WFJCC DPBS** and **MDDP**.

A summary of the existing basins and design points contributing to the Central Basin are shown below. Calculations can be found in Appendix A. Please refer to Appendix D for the Existing Conditions Map.

Central Basin			
Basin Name	Acreage	Peak Flows	
		5-Year	100-Year
EX-4	58.6	7.2	48.1

Central Basin		
Design Point	Peak Flows	
	5-Year	100-Year
E6: EX-4	7.2	48.1

### ***East Basin***

Sub-basin OS-6 contains the southern portion of Fontaine Boulevard, to the crown of the roadway, that borders the site to the northeast. These flows are collected in a roadside swale and discharge onsite.

Sub-basin OS-7 consists of a single-family residential development located on the east side of the site. The back half of the existing residential lots drain to the south and west until discharging onto the Corvallis site.

Sub-basin EX-5 is the easternmost onsite basin. Currently undeveloped, this basin collects the flows from Sub-basins OS-6 and OS-7 and slopes from the northwest to the southeast until reaching Design Point E7.

The final discharge point for the East Basin (Design Point E7,  $Q_5 = 16.5$  cfs and  $Q_{100} = 93.1$  cfs) is located at the southeast corner of the site. These flows will be conveyed to the south in the existing roadside swale that runs parallel to Marksheffel Road. Discharge at this design point was set in the ***WFJCC DBPS*** and ***MDDP*** as  $Q_5 = 38$  cfs and  $Q_{100} = 153$  cfs and will control the allowable discharge in developed conditions.

A summary of all existing basins and design points, offsite and onsite, as well as a summary of design points contributing to the East Basin are shown below. Calculations can be found in Appendix A. Please refer to Appendix D for the Existing Conditions drainage maps.

East Basin			
Basin Name	Acreage	Peak Flows	
		5-Year	100-Year
OS-6	0.8	3.2	5.8
OS-7	2.9	2.5	9.4
EX-5	86.5	12.8	86.3

East Basin		
Design Point	Peak Flows	
	5-Year	100-Year
E7: EX-5, OS-6, OS-7	16.5	93.1

As previously mentioned, the Fountain Mutual Irrigation Company (FMIC) ditch system enters and exits the site periodically. The ditch in this area is approximated to have flows of 60 cfs as it meanders through the Corvallis site. This report follows the guidelines previously set in the ***WFJCC DPBS*** that states, “Existing and proposed runoff was assumed to be passed over or under the ditch in the hydrologic modeling of the basin. There was no diversion of runoff by the ditch assumed in compilation of the hydrologic model for this basin.” As such, no additional drainage from the site is anticipated to be conveyed by the FMIC and all flows released into the ditch are assumed to remain within the canal. There is a remote possibility of a bypass pipeline being constructed that will convey flows from Big Johnson Reservoir to the east side of Marksheffel Road, near Jimmy Camp Creek, however this has not been considered for this report.

### ***B. DEVELOPED DRAINAGE CONDITIONS***

As explained in the existing conditions, the developed site drainage will also discharge at two site low points and has been broken down into two major drainage basins for clarity. These design

points have been specified in the **WFJCC DBPS** and subsequent reports as the discharge points from the Corvallis development. The two major basins were further broken down in the MDDP to numbered basins and are even further broken down by this PDR/FDR to analyze street flows and facilitate storm sewer design. The basin naming convention generally reuses the MDDP sub-basin numbering with added letters as the previous sub-basins are further broken down for detailed design. Runoff from the developed site will conform to the specified flows at the two major discharge points pertinent to this phase of development. Developed hydrology calculations for the basins and design points can be found in Appendix A.

### ***Central Basin:***

Sub-basin OS-5 shows the runoff from required improvements to Fontaine Boulevard, adjacent to the Corvallis development which will have the required improvements at the time of development. Runoff from the roadway crown to the south will be collected in the proposed curb and gutter and directed to required inlet at the road low point. From here, flows will be conveyed to the south by a temporary drainage swale to DP 9-8. Future development of the central basin will extend storm sewer to capture these flows.

Sub-basins 4 & 5 represent the school site which will be treated and detained in proposed detention facility DF-4/5. Runoff in these basins will sheet flow off future buildings and paved surfaces to curb and gutters which will direct the channelized flows into future storm sewer which will direct flows into a forebay in the proposed detention facility. Internal storm sewer design for the school site will be completed in the future.

Sub-basin 9a includes the north portion of Wallooskee Street and the north half of Wallacut Road. Flows in this basin will sheet flow towards the adjacent street where curb and gutter will convey the channelized flows onward towards DP 9-8 where they will be combined with flows from Sub-basin OS-5 and conveyed onwards via a proposed swale.

Sub-basin 9b includes flows from the northern portion of Lost River Road and the east half of Wallooskee Street between Wallacut Road and Eddy Drive. Flows in this basin will sheet flow towards the adjacent street where curb and gutter will convey the channelized flows onward towards DP 9-2 where all but 0.2 cfs of the Q100 event and the entirety of the Q5 event will be captured by two 15-foot, at-grade CDOT Type R curb inlets at DP 9-2. Flow bypass will continue downstream to DP 10-1. Captured flows will be conveyed via storm sewer to DP 9-3.

Sub-basin 9c includes flows from the front half lots and the west half of Wallooskee Street between Wallacut Road and Eddy Drive. Flows in this basin will sheet flow towards the adjacent street where curb and gutter will convey the channelized flows onward towards DP 9-1 where all flows will be captured by a single 15-foot CDOT Type R curb inlet at DP 9-1. Captured flows will be conveyed onwards via storm sewer to DP 9-3. From this point the combined flows will continue onward via storm sewer to DP 9-7 where they will be combined with flows from DP 9-6.

Sub-basin 9d includes flows tributary to the south portion of Lost River Road and the north half of Eddy Drive. Flows in this basin will sheet flow towards the adjacent street where curb and gutter will convey the channelized flows onward towards DP 9-4 where all but 3 cfs will be captured by a single 15-foot CDOT Type R curb inlet at DP 9-4. Flow bypass will continue downstream to DP 10-1. Captured flows will be conveyed via storm sewer to DP 9-6 where they

will combine with the small flow captured at DP 9-5. From DP 9-6 flows will be conveyed to DP 9-7 to mix with flows from DP 9-3. The combined flows will be conveyed to the east across the gas easement to discharge to a proposed ditch at DP 9-9.

Sub-basin 14a includes flows tributary to the west half of Selway Street. Flows in this basin will sheet flow off the front of lots towards Selway Street where the channelized flows will be conveyed downstream via curb and gutter towards a 15-foot sump CDOT Type R curb inlet at DP 14-4 on Spring Basin Drive just west of its intersection with Naches Road. Captured flows will be directed to DP 14-6 via storm sewer flow.

Sub-basin 14b includes flows tributary to the west half of Naches Road. Flows in this basin will sheet flow off the front of lots towards Naches Road where the channelized flows will be conveyed downstream via curb and gutter towards a 10-foot CDOT Type R curb inlet at DP 14-1. Captured flows will be directed to DP 14-3 via storm sewer flow.

Sub-basin 14c includes flows tributary to the east half of Naches Road. Flows in this basin will sheet flow off the front of lots towards Naches Road where the channelized flows will be conveyed downstream via curb and gutter towards a 10-foot CDOT Type R curb inlet at DP 14-2. Captured flows will be directed to DP 14-3 via storm sewer flow.

Sub-basin 14d is the sub-basin on the west half of Lost River Road between the intersection of Naches Road and Lost River Road and Naches Road and Spring Basin Drive. Flows in this sub-basin will sheet flow off the lots towards Lost River Road where the curb and gutter will convey channelized flows downstream to the 15-foot sump CDOT Type R curb inlet at DP 14-4. Captured flows will be combined with flows from DP's 14-3 and 14-4 at DP 14-6.

Sub-basins 14e & 14f represents the south half of Spring Basin Drive and the east half of Lost River Road. Flows in these two sub-basins will sheet flow to the west and north to curb and gutter in the two streets. Once captured the now channelized flows will be conveyed downstream via curb and gutter to the 10-foot sump CDOT Type R curb inlet at DP 14-5. Captured flows in the inlet will combine with flows from DP's 14-4 and 14-3 in the manhole at DP 14-6. From here flows will be conveyed to the west towards DP 10-2 FUT.

Sub-basin 10a includes flows to tributary to the east half of Wallooskee Street between Eddy Drive and Spring Basin Drive. Flows in this basin will sheet flow towards the adjacent street where curb and gutter will convey the channelized flows onward towards the 10-foot at-grade CDOT Type R curb inlet at DP 10-1. Flows not captured by the inlet will continue via swale flow to DP 10-2. When the adjacent phase is developed these bypass flows will be conveyed to DP 10-2 FUT via curb and gutter.

Sub-basin 10b is opposite Sub-basin 10a across Wallooskee Street and includes flows from the front of lots and west half of Wallooskee Street between Eddy Drive and Spring Basin Drive. Flows in this basin will sheet flow towards the adjacent street where curb and gutter will convey the channelized flows onward towards DP 10-1. Once reaching DP 10-1 flows will be captured by an at-grade 10-foot CDOT Type R curb inlet. Any bypass flows will be conveyed downstream to DP 9-9 via a proposed drainage swale. Once the adjacent phase is developed these flows will continue along the Spring Basin Drive curb and gutter to sump CDOT Type R curb inlets at DP 10-2 FUT just east of the future intersection of Spring Basin Drive and Spring Glen Drive.

Sub-basin 10c includes undeveloped flows from the area just west of Corvallis Phase I. Flows in this basin will sheet flow towards the proposed swale running along what was previously the FMIC channel. This channel will be regraded under proposed conditions to convey flows from this sub-basin as well as flows from DP 9-8 eventually combining with other flows at DP 9-9.

Once development of the adjacent future phase, represented in the downstream sub-basins, takes place these flows will be captured and conveyed onwards via storm sewer.

Sub-basin 10d (Developed and/or Undeveloped) represents a basin between Sub-basin 10c and 9c which will remain mostly undeveloped for this phase of the project. Runoff within this basin will sheet flow downhill to the proposed drainage swale. Channelized flows within the swale will be combined with flows from DP 9-8 and 9-7 at DP 9-9. The swale from DP 9-9 down to DP 10-2 will be armored with Type M rip rap to provide stable conveyance in the interim between development phases.

Once developed by a future phase, flows will sheet flow off the front of lots towards curb and gutter which will convey the channelized flows to downstream at-grade inlets (to be designed in the future phase). Captured flows will be directed downstream in the future storm system to DP 10-3 FUT where they will combine with other developed flows.

Sub-basin 10e (Developed and/or Undeveloped) is the third and final future phase basin along the west side of Corvallis Phase I. This basin will be considered undeveloped for Phase I conditions but has been analyzed for anticipated future conditions to properly size the proposed storm sewer infrastructure. Flows in this basin will sheet flow to the south towards DP 10-2 where they will be captured by a proposed 48-inch flared end section after combining with flows from DP 10-1 and 9-9.

Once developed by a future phase, flows will sheet flow off of the front of lots towards curb and gutter which will convey the channelized flows to downstream sump inlets at DP 10-2 FUT. Captured flows will be directed downstream in the future storm system to DP 10-5 FUT where they will combine with other developed flows.

Sub-basin 10f (Developed and/or Undeveloped) is the middle basin along the west side of Corvallis Phase I. This basin is considered undeveloped for the current design phase but has also been analyzed for anticipated developed conditions to properly size storm sewer infrastructure. Flows in this basin will sheet flow to the proposed swale which will convey channelized flows to DP 9-9. Flows reaching DP 9-9 will be conveyed to DP 10-2 via a Type M Rip Rap armored channel.

Once developed by a future phase, flows will sheet flow off the front of lots towards curb and gutter which will convey the channelized flows to downstream at-grade inlets (to be designed in the future phase). Captured flows will be directed downstream in the future storm system to DP 10-5 FUT where they will combine with other developed flows from DP 10-3 FUT and 10-2 FUT.

Sub-basin 10g represents the north half of Rivers Boulevard from the drainage dividing line between the east and central basins to the divide between the central and west basins. This basin

is considered as though future phases to the north of Rivers Boulevard are developed. Flows will sheet flow of the back of lots to the Rivers Boulevard curb and gutter which will convey the channelized flows to the sump inlet at DP 10-4 located just east of the intersection with Spring Glen Drive. Future phases will also install a sump inlet on the west side of the intersection as well. Downstream infrastructure has been designed to handle the whole of the sub-basin entering the system at either location.

Sub-basin 10h will be developed in a future phase. Capture of runoff from this basin will not happen during Corvallis Phase I but, after development of future phases, the basin will be captured in a pair of sump inlets at the west side of the basin. Runoff from the future developed basin will sheet flow off of lots towards adjacent curb and gutter. Once captured in the curb and gutter, channelized flows will be conveyed downstream to the future sump inlets at DP 10-4 FUT. Captured flows will combine with other developed flows at DP 10-5 FUT.

Sub-basin 11a is a multi-family parcel south of Rivers Boulevard and between the gas easement and Spring Glen Road. Storm sewer for the multi-family portion of this basin will be designed in the future. The sub-basin also contains a proposed detention facility DF-5 which will be located in the southwest corner of the basin.

Sub-basin 11b is the south half of Rivers Boulevard along the north boundary of Sub-basin 11a (multi-family). Flows in this sub-basin will sheet flow to the curb and gutter which will convey the channelized flows west to the sump inlet at DP 10-5. Captured flows will be conveyed downstream via storm sewer.

Sub-basin 11c is the south half of Rivers Boulevard along the north boundary of the school sub-basin (Sub-basins 4 & 5). Flows in this basin will sheet flow to the curb and gutter which will convey the channelized flows to a future sump inlet to be located just west of the Rivers Boulevard and Spring Glen Drive intersection. Downstream infrastructure is designed to handle conveyance of these flows.

Sub-basin 11d is the east half of Spring Glen Drive along the west boundary of the multi-family basin (11a). Flows in this basin will sheet flow to the curb and gutter which will convey the channelized flows south to two at-grade inlets located just north of the south boundary of Corvallis Phase I at DP 10-10. Captured flows will be conveyed to Pond DF-4/5 via storm sewer.

Sub-basin 11e is the west half of Spring Glen Drive along the east boundary of the school basin (5). Flows in this basin will sheet flow to the curb and gutter which will convey the channelized flows south to two at-grade inlets located just north of the south boundary of Corvallis Phase I at DP 10-11. Captured flows will be conveyed to Pond DF-4/5 via storm sewer.

**Design Point DP11** is the ultimate discharge point for the Central Basin. This design point is located at an existing area inlet which currently captures the tributary runoff from Corvallis. Development will include installing a solid lid on this structure and adjusting the manhole rim to match the paved surface.

The final proposed discharge for the proposed conditions includes the discharge from the full spectrum EDB DF-5 ( $Q_5 = 10.5$  cfs and  $Q_{100} = 79.6$  cfs). DP 11 is the proposed condition equivalent to Design Point E6 in the predevelopment conditions which indicates 44.8 cfs for the

minor storm and 163.0 cfs for the major event. The proposed discharge to this point is below the approved flows from the **WFJCC DBPS** and **GAW-MDDP**, as well as the anticipated flows per the Glen at Widefield Filing No. 9 FDR.

Summaries of the sub-basins and design points within the Central Basin are shown below:

<u>CORVALLIS PHASE I</u> Central Basin Proposed Conditions Sub-basin Summary			
Basin	Area	Q5	Q100
	acres	cfs	cfs
4.0	9.5	19.2	43.2
5.0	4.4	8.4	20.3
9a	4.4	8.3	18.3
9b	4.5	7.5	17.6
9c	1.2	2.3	5.1
9d	3.2	6.3	13.9
10a	1.9	4.0	8.8
10b	0.8	1.7	3.7
10c	3.7	2.5	10.5
10d (Undeveloped)	8.9	3.7	17.2
10e (Undeveloped)	7.1	3.8	17.2
10f (Undeveloped)	2.8	1.5	7.8
10d (Developed)	8.9	8.5	22.0
10e (Developed)	7.1	10.8	26.2
10f (Developed)	2.8	5.3	11.7
10g	3.6	7.1	15.6
10h	6.5	12.0	26.3
11a	11.9	18.8	49.8
11b	0.8	3.4	6.2
11c	0.6	2.2	4.0
11d	0.6	2.5	4.5
11e	0.6	2.4	4.5

Proposed Design Point Summary - Central Basin				
CORVALLIS PHASE I				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
9-1	9c	1.18	2.30	5.07
9-2	9b	4.46	7.52	17.56
9-3	9b, 9c	5.64	9.68	22.31
9-4	9d	3.17	6.29	13.86
9-5	n/a	0.12	0.49	0.90
9-6	9d	3.29	6.75	14.70
9-7	9b-9d	8.93	16.82	37.95
9-8	9a, 10c, OS-5	9.25	12.66	31.42
9-9	9a-9d, 10c, 10d, 10f, OS-5	29.82	30.33	87.72
10-1	10a, 10b	2.72	5.59	12.31
10-2	9a-9d, 10c-10e, OS-5	36.92	35.73	110.70
10-3a	10g	3.62	7.07	15.58
10-3b	9a-9d, 10a-10d, 10g, OS-5	43.26	44.79	130.57
14-1	14b	2.03	3.49	7.69
14-2	14c	0.93	1.86	4.11
14-3	14b, 14c	2.96	5.20	11.45
14-4	14d, 14a	7.03	9.16	23.29
14-5	14e, 14f	4.81	9.01	19.84
14-6	14a-14f	14.80	21.47	50.42
10-1 FUT	DP 14-6, 10a, 10b	17.52	23.02	53.50
10-2 FUT	DP 14-6, 10a, 10b, 10e	24.62	28.40	66.75
9-8 FUT	9a, 10c, OS-5	9.25	12.25	30.40
9-9 FUT	9-7, 9-8 FUT, 10d	27.04	29.35	71.19
10-3 FUT	9-9 FUT, 10f	29.82	30.24	72.63
10-4 FUT	10h	6.47	11.96	26.35



Proposed Design Point Summary - Central Basin				
CORVALLIS PHASE I				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
10-5 FUT	10-4 FUT,10-3 FUT, 10-2 FUT	60.92	61.37	144.65
10-3c	14a-14f, 9a-9d,10a-10d, 10g, OS-5	58.06	51.55	141.35
10-4	10g	3.62	7.07	15.58
10-5	11b	0.81	3.40	6.20
10-6	9a-9d,10a-10d, 10g, 11b, OS-5	58.87	51.97	141.01
10-7	10-4 FUT,10-3 FUT, 10-2 FUT	60.92	61.37	144.65
10-8	9a-9d,10a,10b, 10f, 10g, 11b, OS-5	65.81	74.92	174.35
10-9	11e	0.59	2.35	4.29
10-10	11d	0.58	2.46	4.49
10-11	9a-9d,10a-10f, 11b-11d, OS-5	66.99	79.74	184.20
DF-5 in	11a	11.91	18.78	49.81
DF-4 in	4, 5, DP 10-11	80.98	89.05	205.51
DF-4/5 in	DF-4 in & DF-5 in	92.88	100.70	236.44
DF-4/5 out / DP 11	DF-4 in & DF-5 in	92.88	10.50	79.60

DP11 Summary							
Approved DBPS/MDDP		Glen at Widefield FDR 9		MDDP (Ex. Cond.)		PDR (Pr. Cond.)	
5-Year	100-Year	5-Year	100-Year	5-Year	100-Year	5-Year	100-Year
48.0	163.0	44.8	163.0	7.2	48.1	10.5	79.6

***East Basin:***

Sub-basin OS-6 consists of the southern half of Fontaine Boulevard east of its intersection with Lorson Boulevard and along the north boundary of Corvallis Phase I. This basin includes the proposed improvements that will be required adjacent to Corvallis Phase I. Two at-grade 10-foot CDOT Type R curb inlets will be installed at the downstream end of the basin in order to capture

flows from this basin and direct them via a proposed swale into DF-7 where treatment and detention will be provided.

Sub-basin 8a is a proposed commercial development that will have its own onsite water quality and detention pond, DF-6. This basin also includes the west half of Eddy Drive. Detention and water quality treatment will be provided in DF-6 at the south end of this basin. Once treated, the historic release will be directed to the west in an 18-inch storm drain, combining with discharges from DF-7 at DP M2.

Sub-basin 8b is the east half of Lorson Boulevard which is adjacent to the commercial parcel in sub-basin 8a. Flows in this basin will sheet flow to the curb and gutter of Lorson Boulevard. Channelized flows will be conveyed downstream via curb and gutter to two 10-foot at-grade CDOT Type R curb inlets at DP 8-2a. Captured flows will be conveyed via storm sewer to DF-6 for treatment and detention.

Sub-basin 8c is the west half of Lorson Boulevard, roughly equivalent in length to Sub-basin 8b. Flows in this sub-basin will sheet flow to the curb and gutter which will convey the channelized flows down stream to two 10-foot at-grade CDOT Type R curb inlets. The captured flows will be conveyed downstream via storm sewer to DP 8-2b where they will combine with flows from DP 8-2a and continue onward to DF-6 for treatment and detention.

Sub-basin 12a is the sub-basin along the north half of Lorson Boulevard between its intersections with Eddy Drive and Padden Drive. Flows in this sub-basin will sheet flow to the curb and gutter which will convey the now channelized flows downstream to Padden Drive where they will continue on to the 15-foot sump CDOT Type R curb inlet at DP 12-4. Captured flows will be conveyed onward via storm sewer to DP 12-6.

Sub-basin 12b is bounded by Lummi Road on the north, Omak Road on the east, Eddy Drive on the west, and Tipsoo Road on the south. Flows in this sub-basin will sheet flow towards the adjacent road where they will be conveyed via curb and gutter to two 10-foot at-grade CDOT Type R curb inlets at DP 12-1. Captured flows will be conveyed onwards via storm sewer to DP 12-3. Flows not captured in the inlet will continue via curb and gutter to the 15-foot sump inlet at DP 12-4.

Sub-basin 12c is the south half of Tipsoo Street and adjacent development. Flows in this sub-basin will sheet flow north to Tipsoo Street where curb and gutter will convey channelized flows downstream to DP 12-2. One 10-foot at-grade CDOT Type R curb inlet will capture flows from this sub-basin. Captured flows will be conveyed via storm sewer to the manhole at DP 12-3. From DP-3, flows will continue via storm sewer to the manhole at DP 12-7 where the flows will combine with flows from DP 12-6. Bypass flows will continue via curb and gutter to the 15-foot sump inlet at DP 12-4

Sub-basin 12d represents the south and west halves of Padden Drive, as well as the north half of Lummi Road. Flows in this sub-basin will sheet flow to adjacent curb and gutter which will convey the channelized flows downstream to the 15-foot sump CDOT Type R curb inlet located at DP 12-4. This inlet is sized for full capture, but any flows in excess of the crown of Padden Drive will equalize across the road to the 10-foot sump CDOT Type R curb inlet at DP 12-5

which size is adequate to handle the additional flows. Captured flows in DP-4 will be conveyed via storm sewer to the manhole at DP 12-6.

Sub-basin 12c represents the north and east halves of Padden Drive. Flows in this sub-basin will sheet flow off of the lots towards Padden Drive where the curb and gutter will convey channelized flows downstream to DP 12-5. The 10-foot sump CDOT Type R curb inlet at this design point will capture the flow from this sub-basin as well as any surcharge flows from DP 12-4. Once captured flows will be conveyed downstream via storm sewer to the manhole at DP 12-6. At this design point flows will be combined with flows from DP 12-4 and will continue via storm sewer to another manhole at DP 12-7. This DP combines flows from DPs 12-6 and 12-3 and conveys the combined flows downstream into DF-7 for treatment and detention.

Sub-basin 12f represents the back half of the lots along the east half of Padden Drive, proposed open space, and detention facility DF-7. Flows in this sub-basin will sheet flow to the east towards a proposed swale running along the east boundary between Corvallis Phase I and Cottonwood Grove Filing No. 1. Channelized flows will be conveyed south by the swale into the detention pond for treatment and detention. Df-7 will combine with flows from DF-6 at DP M2 which will then discharge to the east into a swale running along the boundary between the north of Corvallis Phase I and the south of Cottonwood Grove Filing No. 1. The swale will discharge flows into the Marksheffel Road ditch at DP MK1.

Sub-basin 14g runs along the west half of Selway Street and the north half of Rivers Boulevard. Rainfall in this sub-basin will sheet flow off the lots towards adjacent streets where channelized flows will be conveyed downstream via curb and gutter to the 15-foot sump CDOT Type R curb inlet at DP 14-7. Captured flows will be conveyed downstream via storm sewer to the manhole at DP 14-9.

Sub-basin 14h is the west half of Lorson Boulevard north of Rivers Boulevard and south of Padden Drive. Runoff from this basin will sheet flow to the curb and gutter which will convey the channelized flows to four at-grade CDOT Type R curb inlets at DP 16-1 just upstream of the proposed roundabout. Captured flows will be conveyed via storm sewer to the east towards DP 16-2.

Sub-basin 14i is the sub-basin along the south half of Rivers Boulevard between the divide with the Central Basin on the west and Lorson Boulevard on the east. Flows in this basin will sheet flow to the curb and gutter which will convey the channelized flows down stream to the 5-foot sump CDOT Type R curb inlet at DP 14-8. Captured flows will be conveyed downstream via storm sewer to the manhole at DP 14-9. At this manhole flows from DP 14-8 and 14-7 will be combined and conveyed onwards via storm sewer to DF-8 for detention and water quality treatment.

Sub-basin 15a is the north half of the north leg of Iron Creek Loop and the south half of the adjacent lots. Runoff from this basin will sheet flow to the curb and gutter which will convey the channelized flows to the at-grade CDOT Type R curb inlet at DP 15-2a.

Sub-basin 15b is the south half of the north leg of Iron Creek Loop and the north portion of the adjacent lots. Runoff from this basin will sheet flow to the curb and gutter which will convey the channelized flows to the at-grade CDOT Type R curb inlet at DP 15-1.

Sub-basin 15c is the north half of the south leg of Iron Creek Loop and the adjacent lots. Runoff from this basin will sheet flow to the curb and gutter which will convey the channelized flows to the at-grade CDOT Type R curb inlet at DP 15-1. Captured flows at this location will be conveyed to DP 15-2b via storm sewer where they will combine with flows captured by the inlet at DP 15-2a.

Sub-basin 15d is the south half of the south leg of Iron Creek Loop and the north portion of the adjacent lots. Runoff from this basin will sheet flow to the curb and gutter which will convey the channelized flows to the at-grade CDOT Type R curb inlet at DP 15-2a. The combined flows at this location (DP 15-2b) will be directed to DF-8 via storm sewer for treatment and detention.

Sub-basin 15e represents the back of lots along Lorson Boulevard. Runoff from this sub-basin will sheet flow off the back half of these lots, be captured by a shallow swale and directed into DF-8.

Sub-basin 15f is the sub-basin containing DF-8. This sub-basin is mostly open space, but it does contain the back portion of some of the lots along the south leg of Iron Creek Loop. Runoff from this sub-basin will sheet flow off these back lots towards a proposed swale which will capture and direct the flows into detention facility DF-8. At this point the flows will be combined with the rest of the tributary runoff to the detention facility and will be treated and released to the existing swale running along the north boundary of Glen at Widefield. These flows are a portion of the flows represented by Design Point 4010 or 8 in **GAW-MDDP**.

Sub-basin 15g is the south and west half of Lorson Boulevard. Runoff in this basin will sheet flow towards the Lorson Boulevard Curb and Gutter. The flows will be captured in the 5-foot CDOT Type R sump inlet at DP 15-3. Captured flows will be conveyed downstream via 24-inch storm pipe to DP 14-11.

Sub-basin 16a1 is the east portion of a proposed commercial development. Developed runoff will drain to the southeast via internal curb, gutter, and storm drain until reaching the onsite water quality and detention facility, DF-9. This pond will release the treated flow via storm drain into the Marksheffel Road ditch just north of its intersection with Lorson Boulevard combining with flows from Marksheffel Road at DP MK2.

Sub-basin 16a2 is the west portion of a proposed commercial development. Developed runoff will drain to the southeast via internal curb, gutter, and storm drain combining with flows from DP 16-2 at DP 16-3 eventually reaching the onsite water quality and detention facility, DF-8. This pond will release the treated flow via storm drain to DP 16 at the south side of the property. These flows are another portion of the flows represented by Design Point 4010 or 8 in **GAW-MDDP**.

Sub-basin 16b is the north and east half of Lorson Boulevard between Rivers Boulevard and a high point just west of the Lorson Boulevard and Marksheffel Road intersection. Flows in this basin will sheet flow to the curb and gutter which will convey the channelized flows to a 5-foot CDOT Type R sump inlet at the low point (DP 16-3) in Lorson Boulevard near detention facility DF-8. Flows will be conveyed downstream via storm sewer into DF-8 for treatment and detention.

Sub-basin 16c is the east half of Lorson Boulevard north of Rivers Boulevard and south of Padden Drive. Flows will sheet flow to the curb and gutter which will channelize the flows and convey them to the 10-foot at-grade CDOT Type R curb inlet at DP 16-2. The captured flows will be combined with flows from DP 16-1 and conveyed onwards via storm sewer to DP 16-3 where they will combine with flows from Sub-basin 16a2. The combined flows will continue onwards to DF-8 for treatment and detention.

Sub-basin 16d is a small sub-basin in Lorson Boulevard that is captured to maximize the treated impervious surfaces for the proposed development. Runoff in this sub-basin will sheet flow to curb and gutter where channelized flows will be conveyed downstream via curb and gutter to 10-foot at-grade CDOT Type R curb inlets on either side of Lorson boulevard. Captured flows will be conveyed via storm sewer to DF-9 for treatment and detention.

Stormwater treated in DF-9 will discharge via storm sewer to the Marksheffel Road ditch at DP MK2. From here flows will continue on as they have historically, crossing Lorson Boulevard via two 36-inch storm pipes. Culvert calculations included in Appendix A indicate that there is adequate capacity in these culverts to convey the flows without overtopping Lorson Boulevard at this location.

Sub-basin 16e is the uncapturable portion of Lorson Boulevard located at the southeast corner of the Corvallis Phase I development. This area is impracticable to detain and treat because it is at an elevation below what is feasible to detain and direct into detention facility DF-9. This falls under the MS4 exclusion in Section 4.a.iv.(A).1) as the area which is impracticable to treat is less than an acre and less than 20% of the overall development area. Runoff from this sub-basin will run through an existing sand filter along Marksheffel Road. Estimated area of untreated impervious is approximately 0.3 acres which is approximately 0.2% of the overall area of this phase of the development. The sub-basin also includes some spaces which will return to green space after the site is stabilized.

Sub-basin OS-CG is the existing Cottonwood Grove Filing No. 1 single-family residential area located to the northeast of the Corvallis Phase I development. This subdivision appears to have detention, but this is not corroborated in any of the reports available on the El Paso County website. As such, the development has been modeled as 1/3 acre residential based on the average lot size. This sub-basin also contains the portions of Marksheffel Road and Fontaine Boulevard which are adjacent to the development. Generally, runoff will sheet flow off lots or roads to curb and gutter. Internal storm sewer will capture and convey the runoff from the development. The ultimate discharge of the storm sewer is at DP MK1 at the southeast corner of Cottonwood Grove Filing No. 1. At this location the flows will combine with discharge from DP M2 which includes flows from DF-6 and DF-7 as well as OS-7. The Marksheffel Road ditch will convey the combined runoff downstream to DP MK2.

Sub-basin OS-MK is the west half of Marksheffel Road between Lorson Boulevard and the south side of Cottonwood Grove Filing No. 1 and includes the additional impervious surfaces associated with the anticipated road improvements. Flows within this sub-basin will sheet flow off of Marksheffel Road to the adjacent road ditch which will convey the flows to DP MK2. Water quality treatment for the proposed turn lane improvements to Marksheffel Road will be provided by the existing Sand Filter located just south of the proposed intersection of Lorson

Boulevard and Marksheffel Road. Please see the excerpt from the HDR Marksheffel Road improvement drainage report included in Appendix C.

Sub-basin 17 was previously intended to be the site of a safety facility. Grading for the site made this intended use infeasible and the sub-basin is now within DF-8.

Sub-basin OS-7 is a large acre, single-family subdivision located at the Corvallis site's northeastern corner. Stormwater from the backs of these lots will drain through side lot swales until discharging into the swale running along the north side of Sub-basin's 16-a1 and 16-a2. Flows from this sub-basin will combine with the discharge from DP M2 and will enter the Marksheffel Road ditch at DP MK1.

### **East Basin Site Discharge**

Design Point DP16 is the ultimate discharge for the East Basin. The combined flows calculated for this design point result in 38 cfs in the minor storm event and 140 cfs in the major storm event. The previously approved ***MDDP-GAW*** and ***WFJCC DBPS*** for the area specify an allowable release of 38 cfs for the 5-year storm and 153 cfs in the 100-year storm providing compliance with the previous studies.

The current report in process with El Paso County for the Glen at Widefield Filing No. 11, which receives the discharge from Corvallis DP MK2 has proposed two 36-inch culverts to convey the drainage from the Corvallis East Basin to the roadside swale being constructed as a part of the Marksheffel Road improvements. These culverts will be relocated and extended to match the final Marksheffel Road ditch location and match the Lorson Boulevard road width. According to the culvert calculations included in Appendix A, these culverts have adequate capacity to handle the combined flows at DP MK2 in the Marksheffel Road ditch without overtopping Lorson Boulevard.

A summary of the sub-basins and design points within the East Basin are summarized below:

CORVALLIS PHASE I			
East Basin Proposed Conditions Sub-basin Summary			
Basin	Area	Q5	Q100
	acres	cfs	cfs
8a	5.4	20.9	38.4
8b	0.9	3.2	6.3
8c	1.0	3.4	6.7
12a	1.3	2.1	4.7
12b	3.6	7.0	15.3
12c	1.5	3.1	6.9
12d	5.9	9.8	21.6
12e	3.2	5.1	11.3
12f	5.9	3.7	13.2
14a	4.1	4.7	13.4
14b	2.0	3.5	7.7
14c	0.9	1.9	4.1
14d	2.9	5.8	12.7
14e	1.1	2.2	4.8
14f	3.7	6.9	15.2
14g	4.9	7.9	17.4
14h	1.9	3.8	8.3
14i	1.4	2.7	5.9
15a	3.5	5.7	12.5
15b	2.0	3.5	7.8
15c	3.5	6.4	14.0
15d	2.8	4.6	10.1
15e	1.4	1.8	5.1
15f	3.9	3.1	10.9
15g	1.3	5.0	9.6

CORVALLIS PHASE I			
East Basin Proposed Conditions Sub-basin Summary			
Basin	Area	Q5	Q100
	acres	cfs	cfs
16a1	16.0	46.8	92.2
16a2	8.4	29.7	54.1
16b	1.7	6.0	11.6
16c	0.9	3.2	6.3
16d	0.2	0.8	1.5
16e	1.8	2.7	9.9
17.0	1.6	1.3	6.9
OS-CG	36.2	20.5	57.4
OS-MK	2.6	3.1	6.7
OS-5	1.2	4.8	8.4
OS-6	1.3	5.3	9.3
OS-7	3.8	4.2	14.3

Proposed Design Point Summary East Basin				
CORVALLIS PHASE I				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
8-1	8c	0.97	3.43	6.70
8-2a	8b (Inlet)	0.92	3.19	6.27
8-2b	8b, 8c	1.89	6.61	12.96
8-3	DF-6 Inflow	7.32	28.40	53.10
M1	DF-6 Discharge	7.32	0.20	10.90
12-1	12b	3.62	6.96	15.33
12-2	12c	1.50	3.11	6.86



Proposed Design Point Summary East Basin				
CORVALLIS PHASE I				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
12-3	12b, 12c	5.12	9.75	21.48
12-4	12a, 12d	7.24	11.71	25.80
12-5	12e	3.24	5.15	11.34
12-6	12a, 12d, 12e	10.48	16.97	37.37
12-7	12a-12e	15.60	25.25	55.62
12-8	OS-6, 12f	7.25	4.84	13.42
12-9	Total into pond	22.84	29.80	70.30
12-10	Pond DF-7 Discharge	22.84	1.00	14.80
M2	12-10 & M1 (DF-6 & 7)	30.17	1.20	25.70
DF-9 in	16a1	16.00	44.81	88.24
DF-9 out	DF-9 Outlet Structure	16.00	2.20	11.80
MK1	OS-7, OS-CG, M2	70.20	25.87	97.45
MK2	MK1, OS-MK, DF-9 out	88.76	31.20	115.99
M3	Combined Outflows: DF-6, DF-7 and DF-9, OS-MK, OS-CG	88.76	31.20	115.99
14-7	14g	4.86	7.89	17.37
14-8	14i	1.36	2.67	5.89
14-9	14g-14i	6.22	10.10	22.24
15-1	15b, 15c	5.46	9.68	21.31
15-2a	15a, 15d (Inlet)	6.39	10.73	23.63
15-2b	15a-15d	11.85	20.16	44.42
16-1	14h	1.95	4.18	9.20
16-2a	16c	0.89	2.76	5.46

Proposed Design Point Summary East Basin				
CORVALLIS PHASE I				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
16-2b	14h, 16c, 16a2	11.27	33.82	63.39
16-3	16b	1.67	5.75	11.09
16-4a	15g	1.33	3.86	7.49
16-4b	15g, 16b	3.00	9.19	17.75
DF-8 in	16-2b, 16-4b, 14-9, 15-2, 15e, 15f, 17	39.25	64.54	139.27
DF-8 out	16-2b, 16-4b, 14-9, 15-2, 15e, 15f, 17	39.25	4.40	14.20
DP16	Total Site Discharge to SE Corner	129.81	38.30	140.04

DP16 Summary							
Approved DBPS/MDDP		Glen at Widefield FDR 11		MDDP (Ex. Cond.)		PDR (Pr. Cond.)	
5-Year	100-Year	5-Year	100-Year	5-Year	100-Year	5-Year	100-Year
38.0	153.0	N/A	87.1	16.5	93.1	38.3	140.4

### Full Spectrum Detention Facilities

In accordance with the City of Fountain drainage criteria, the proposed Corvallis development will provide onsite full spectrum detention facilities to mitigate developed drainage impacts. Detained flows will release at historic rates and drainage patterns. In order to provide flows at or below the values indicated in previous reports, there is some over detention within the ponds on the East Basin (DF-7, 8, & 9). A breakdown of the required storage volume and historic release rates for each of the water quality and detention facilities are summarized below:

Proposed Pond Summary											
CORVALLIS PHASE I											
Pond	Tributary Area	% Impervious	Pre-Development Peak		Pond Outflow		Ratio Pre vs. Post		Detention Volume (Acre-feet)		
			Q5	Q100	Q5	Q100	Q5	Q100	WQCV	EURV	Q100
DF-4/5*	92.88	55.96%	22.3	100.7	10.5	79.6	0.5	0.8	1.731	5.62	10.135
DF-6	7.32	89.02%	3.6	14.2	0.2	10.9	0.1	0.8	0.241	0.732	0.838
DF-7*	22.84	55.88%	4.9	22.4	1.0	14.8	0.2	0.7	0.426	1.386	3.081
DF-8*	39.25	65.26%	11.5	49.9	4.4	14.2	0.4	0.3	0.742	2.418	4.379
DF-9	16.00	78.20%	4.3	16.7	2.2	11.8	0.5	0.7	0.428	1.313	2.265

*Asterisk \* denotes "Sub-Regional" Detention. The other ponds are considered "Onsite" Detention.*

### Discharge

As previously described, the site has two main discharge points. The ponds listed above have been designed to provide detention and, if necessary, over detention in order to provide compliance with the historic flow values indicated by the Glen at Widefield drainage reports. The east basin, due to undetained offsite flows from Cottonwood Grove Filing No. 1 and Marksheffel Road initially indicated a discharge in excess of the flows indicated for DP 16 so the detention facilities in this basin (DF 6, 7, 8, and 9) provide over detention to accommodate these flows and provide compliance with the previous study of that basin in FDR-F11.

### Suitable Outfall

To avoid causing issues downstream the suitability of the outfall locations has been evaluated. DF-4/5 ties into existing storm sewer designed for approximately twice the projected flows, therefore has an adequate outfall.

The ultimate discharges for the ponds in the East Basin area all analyzed in the swale section of this report and the Pipe Outfall Protection calculations included in appendix A. These calculations indicate that the receiving channels will have adequate capacity, receiving the design flows at velocities which the DCM indicates should be stable. The outlet protection provided at the pipe outfalls will further provide protection from erosion as the flows expand from the pipe discharges to the flow areas provided in the receiving swales.

## Hydraulic Analysis

### ***A. OVERVIEW, METHODOLOGY & DESIGN***

Developed sub-basins and proposed drainage improvements are depicted on the attached Developed Drainage Basin Map (DR02) in Appendix D. Preliminary hydraulic design calculations for sizing of onsite facilities are provided for in Appendix A. In general, the hydraulic criteria and intent are summarized as follows:

In accordance with City of Fountain drainage criteria, major drainage will be conveyed through the Corvallis development using a combination of open channels, underground storm sewer capacity and allowable street capacity. For local residential streets, the maximum allowable depth used for the 100-year event is 8-inches or the extent of the street right-of-way such that buildings are not inundated at the ground line.

Curb inlets (CDOT Type R or equivalent City approved 6-inch curb inlet type) will be specified where required for at-grade and sump collection point locations. Inlets will convey runoff to a storm sewer consisting of reinforced concrete pipes (RCP) with a minimum pipe diameter of 18-inches. Preliminary storm sewer sizing has been provided and can be referenced in Appendix A. Riprap stilling basins or spill pads will be utilized at storm pipe outfalls as recommended by USDCM formulae. Detailed inlet, storm sewer and riprap sizing calculations will be provided with the construction drawings.

A preliminary hydraulic analysis been completed as part of this study to determine the required storm pipe sizing for the site trunk mains. Hydraulic grade lines (calculated in StormCAD and using head loss coefficients from Table 9-4 of the DCM) will be provided along with construction drawings. Sizing of the onsite detention ponds was completed using UDFCD Detention Pond software for Extended Detention Basins. The ponds have been evaluated to determine the peak release rates from the proposed detention ponds and the storage required for the 100-year storm event. Most proposed storm pipes have been upsized to accommodate larger flows as a conservative design.

## B. ROAD CAPACITIES

Streets internal to the development will have a face of curb to face of curb width of 34.33 feet. The table below describes the various street capacities within each sub-basin and the associated storm water loading for this development. Street Capacities are analyzed based on the higher anticipated flow at a given slope for parallel sub-basins along the road:

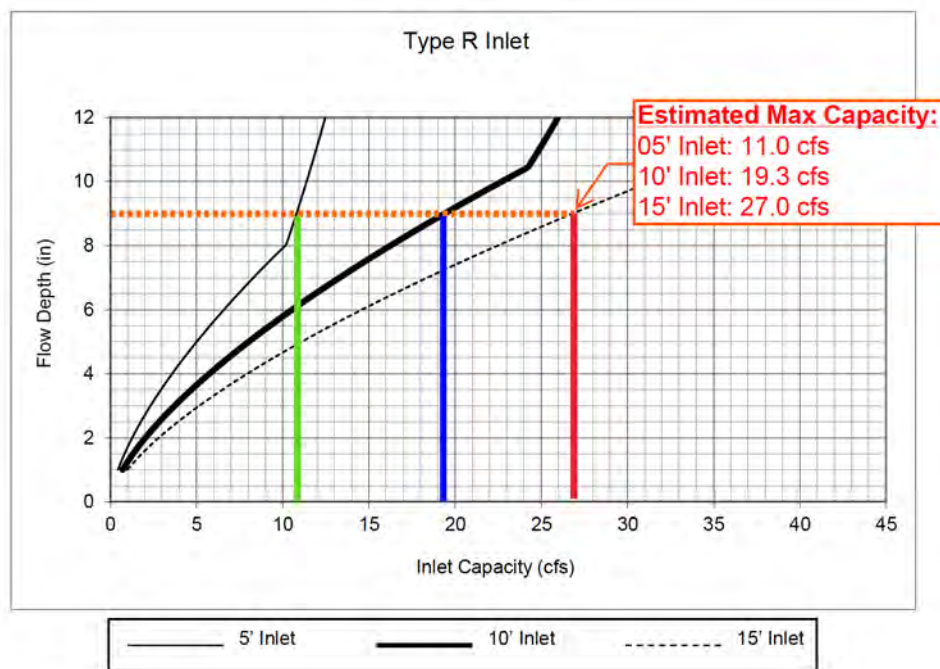
<b>STREET CAPACITIES</b>									
<b>CORVALLIS PHASE I</b>									
<b>Street</b>	<b>Road Section</b>	<b>Sub-basin</b>	<b>BYPASS SOURCE (Design Point)</b>	<b>Slope %</b>	<b>ROAD CAPACITY MINOR STORM (cfs)</b>	<b>Q(5) TOTAL FLOW</b>	<b>Q(100) BYPASS FLOWS RECEIVED (cfs)</b>	<b>ROAD CAPACITY MAJOR STORM (cfs)</b>	<b>Q(100) TOTAL FLOW (cfs)</b>
WALLOOSKEE ST.	Minor Residential	9a	N/A	2.0%	10	8.3	0.0	41	18.3
WALLOOSKEE ST.	Minor Residential	9b	N/A	2.2%	10.5	7.5	0.0	39	17.6
WALLOOSKEE ST.	Minor Residential	10a	9d	2.0%	10	4.0	4.3	41	13.0
EDDY DR.	Minor Residential	9d	N/A	3.0%	12	6.3	0.0	37	13.9
SELWAY ST.	Minor Residential	14a	N/A	2.9%	11.9	4.7	0.0	37.1	13.4
NACHES RD.	Minor Residential	14b	N/A	2.9%	11.9	3.5	0.0	37.1	7.7
SPRING BASIN DR.	Minor Residential	14a	N/A	1.0%	7.0	4.7	0.0	37.0	13.4
LOST RIVER RD.	Minor Residential	14f	N/A	1.3%	9.0	6.9	0.0	42.0	15.2
RIVERS BLVD	Collector	14g	N/A	1.9%	12.5	7.9	0.0	60.0	17.4
IRON CREEK LOOP	Minor Residential	15a	N/A	1.2%	7.5	5.7	0.0	38	12.5
IRON CREEK LOOP	Minor Residential	15c	N/A	1.6%	9.0	6.4	0.0	43	14.0
LORSON BLVD	Arterial	16b	N/A	2.1%	23.0	6.0	0.0	45	11.6
LORSON BLVD	Minor Arterial	12a	N/A	4.0%	21.0	2.1	0.0	37	4.7
LORSON BLVD	Minor Arterial	8c	N/A	1.1%	17.0	3.4	0.0	38	6.7
LUMMI RD	Minor Residential	12d	N/A	2.0%	10.0	9.8	0.0	41.0	21.6
PADDEN DR.	Minor Residential	12d	N/A	2.0%	10.0	9.8	0.0	41	21.6
TIPSOO ST.	Minor Residential	12b	N/A	3.3%	13.0	7.0	0.0	35.0	15.3
OMAK RD.	Minor Residential	12b	N/A	1.9%	9.5	7.0	0.0	42.0	15.3

### C. INLET SIZING

The table below describes the inlet capacities and sizes for the proposed development by design point or sub-basin.

INLET SUMMARY												
CORVALLIS PHASE I												
DESIGN POINT or SUB-BASIN	SUB-BASINS	TOTAL AREA (AC)	INLET			Q(5) BYPASS FLOWS (cfs)	Q(5) TOTAL INFLOW	Q5 INLET CAPACITY	Q(100) BYPASS FLOWS (cfs)	Q(100) TOTAL INFLOW (cfs)	MAX INLET CAPACITY	NOTES:
			SIZE (Ft.)	TYPE	CONDITION							
8-1	8c	0.97	2x10	R	AT-GRADE		3.43	4.0		6.70	7.7	
8-2a	8b (Inlet)	0.92	2x10	R	AT-GRADE		3.19	4.0		6.27	7.7	
9-1	9c	1.18	15	R	AT-GRADE		2.30	2.3		5.07	5.2	
9-2	9b	4.46	15X2	R	AT-GRADE		7.52	7.6	0.2	17.56	17.4	Bypass to Sub-basin 10a
9-4	9d	3.17	15	R	AT-GRADE	0.1	6.29	6.2	3.7	13.86	10.2	Bypass to Sub-basin 10a
9-5	n/a	0.12	5	R	AT-GRADE		0.49	0.5		0.90	0.9	
10a	10a	1.94	10	R	AT-GRADE	0.3	3.98	3.7	5.6	12.59	7.0	BYPASS TO 10-2 FUT / 10-2
10b	10b	0.78	10	R	AT-GRADE		1.68	1.7	0.2	3.70	3.5	BYPASS TO 10-2 FUT / 10-2
10e (Developed)	10e (Developed)	7.10	2X10	R	SUMP		11.13	11.1		32.00	38.0	FUTURE DP 10-2 FUT EQUALIZES ACROSS CROWN
10f (Developed)	10f (Developed)	2.78	2x15	R	AT-GRADE		5.30	5.3		11.66	11.7	FUTURE DP 10-3 FUT
10-3a	10g	3.62	10	R	AT-GRADE	1.5	7.07	5.6	7.3	15.58	8.3	
10-4	10g	3.62	10	R	SUMP		7.07	7.1		15.58	19.0	Design ignores DP 10-3a
10-5	11b	0.81	10	R	SUMP		3.40	7.0		6.20	19.0	
10-9	11e	0.59	2x10	R	AT-GRADE		2.35	2.5		4.29	4.3	Negligible bypass continues to GAW F9. 15.5 to 15.7 cfs, Capacity: 17.9 cfs
10-10	11d	0.58	2x10	R	AT-GRADE		2.46	2.5		4.49	4.5	No Bypass to GAW F9
12-1	12b	3.62	2x10	R	AT-GRADE		6.96	7.0	2.1	15.33	13.2	
12-2	12c	1.50	10	R	AT-GRADE		3.11	3.1	1.7	6.86	5.2	
12-4	12a, 12d	7.24	15	R	SUMP		11.71	13.0	2.6	29.59	27.0	Equalize to 12-5

DESIGN POINT or SUB-BASIN	SUB-BASINS	TOTAL AREA (AC)	INLET			Q(5) BYPASS FLOWS (cfs)	Q(5) TOTAL INFLOW	Q5 INLET CAPACITY	Q(100) BYPASS FLOWS (cfs)	Q(100) TOTAL INFLOW (cfs)	MAX INLET CAPACITY	NOTES:
			SIZE (Ft.)	TYPE	CONDITION							
12-5	12e	3.24	10	R	SUMP		5.15	6.0		13.93	19.0	Overflow from 12-4
14-1	14b	2.03	10	R	AT-GRADE	0.1	3.49	3.4	2.2	7.69	5.5	Bypass to 14-4
14-2	14c	0.93	10	R	AT-GRADE		1.86	1.9	0.3	4.11	3.8	Bypass to 14-4
14-4	14d, 14a	7.03	15	R	SUMP		9.26	13.0		25.79	27.0	Bypass from 14-1 & 14-2
14-5	14e, 14f	4.81	10	R	SUMP		9.01	13.0		19.84	20.4	Slightly over 9" sump and/or Equalize to 14-4 in Q100
14-7	14g	4.86	15	R	SUMP		7.89	13.0		17.37	27.0	
14-8	14i	1.36	5	R	SUMP		2.67	2.7		5.89	11.0	
15-1	15b, 15c	5.46	15	R	SUMP		9.68	13.0		21.31	27.0	
15-2a	15a, 15d (Inlet)	6.39	15	R	SUMP		10.73	13.0		23.63	27.0	
16-1	14h	1.95	4x10	R	AT-GRADE		4.18	4.2		9.20	9.2	
16-2a	16c	0.89	10	R	SUMP		2.76	10.0		5.46	19.3	
16d	Lorson Boulevard	0.23	10	R	SUMP		0.80	10.0		1.55	19.3	
OS-5	FONTAINE	1.21	2x10	R	AT-GRADE		4.82	5.4		8.38	9.3	
OS-6	FONTAINE	1.34	2x10	R	AT-GRADE		5.35	5.3		9.30	9.3	



<i>Design Point</i>	<i>Inlet Overflow Pathing</i>
10-5 / 10-5	In the case of blockage of one or both of these inlets, storm water will equalize between the inlets across the road. If both are blocked, the stormwater will then backup around the corner to Spring Glen Drive and continue to the at grade inlets at DP 10-10
12-4 / 12-5	In the case of blockage of either of these inlets, flows will equalize across the road between the two inlets. If both are blocked, the flows will surcharge the curb and gutter to a swale along the storm sewer easement towards Pond DF-7.
14-4 / 14-5	In the case of blockage of either of these inlets, flows will equalize across the road to the other inlet. If both are blocked, the flows will continue south to Rivers Boulevard via a swale through the tract to the south continuing to the sump inlets at DP 14-7 and 14-8.
14-7 / 14-8	In the case of blockage, flows will equalize between the two inlets. If both inlets become blocked, flows will either surcharge the curb and gutter and run along the back of the residential lots in Sub-basin 15e or back up through the roundabout and continue southeast along Lorson Boulevard.
15-1 / 15-2	In the case of blockage, flows will equalize between the two inlets. If both are blocked, flows will surcharge the curb and gutter and continue south to DF-8 via a swale running through the adjacent utility tract.
16-3 / 16-4	In the case of blockage, flows will equalize between the two inlets. If both become blocked, the storm water will surcharge either to the north or the south and will enter either DF-8 to the south or DF-9 to the northeast.



## D. SWALE ANALYSIS

Swales are designed to comply with table 12-3 of the DCM. According to Section I.F more than 77 percent of soils in the developed area are designated a “sandy loam”. Therefore, swale design for the development will comply with the criteria for erosive soils.

**Table 12-3. Hydraulic Design Criteria for Natural Unlined Channels**

Design Parameter	Erosive Soils or Poor Vegetation	Erosion Resistant Soils and Vegetation
Maximum Low-flow Velocity (ft/sec)	3.5 ft/sec	5.0 ft/sec
Maximum 100-year Velocity (ft/sec)	5.0 ft/sec	7.0 ft/sec
Froude No., Low-flow	0.5	0.7
Froude No., 100-year	0.6	0.8
Maximum Tractive Force, 100-year	0.60 lb/sf	1.0 lb/sf

<sup>1</sup> Velocities, Froude numbers and tractive force values listed are average values for the cross section.

<sup>2</sup> “Erosion resistant” soils are those with 30% or greater clay content. Soils with less than 30% clay content shall be considered “erosive soils.”

The table below describes the various swales included in the project:

<b>Swale Capacities</b>								
<b>Aspen Ranch Filing No. 1</b>								
<i>Design Point</i>	<i>Sub-basin</i>	<i>Slope %</i>	<i>SWALE CAPACITY MINOR STORM (cfs)</i>	<i>Q(5) TOTAL FLOW (cfs)</i>	<i>Q(5) VELOCITY (FT/S)</i>	<i>SWALE CAPACITY MAJOR STORM (cfs)</i>	<i>Q(100) TOTAL FLOW (cfs)</i>	<i>Q(100) VELOCITY (FT/S)</i>
OS-5	Vegetation	1.3%	77.0	4.8	1.7	434.0	8.4	1.9
OS-6	Vegetation	2.0%	29.0	5.3	2.2	72.0	9.3	2.6
9-8	Vegetation	0.5%	237.0	12.7	1.3	237.0	31.4	2.4
9-7	Vegetation	0.5%	237.0	16.8	2.2	237.0	38.0	2.7
9-9	TYPE M RIP RAP	6.6%	30.4	30.3	4.2	88.0	87.7	5.5
15e	Vegetation	2.0%	9.5	1.8	2.1	35.0	5.1	2.9
15f	TYPE VL RIP RAP	6.0%	34.0	3.1	1.9	143.0	10.9	2.6
12-7	Vegetation, EO	2.0%	25.3	25.3	4.6	55.6	55.6	5.7
12-8	Vegetation	2.0%	29.0	5.3	2.2	72.0	9.3	2.6
14-6	Vegetation, EO	2.0%	21.5	21.5	4.4	50.4	50.4	5.5
15-2b	Vegetation, EO	2.0%	20.2	20.2	4.3	44.4	44.4	5.3

NOTE:

- Capacities determined by maximum allowable velocity (Erosive Soils: Minor Storm: 3.5 ft/s, Major Storm: 5ft/s).
- channel stability calculations are included in Appendix A.
- (EO=Sump Inlet Emergency Overflow-Because of rare flows, not subject to channel velocity limitations)

### ***E. FLOODPLAINS***

Per the ***Flood Insurance Rate Map (FIRM) 08041C 0956 G and 08041C 0957 G***, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), a portion of the overall Corvallis development lies within the designated 100-year floodplain of Jimmy Camp Creek West Tributary. A FIRMette of the project area is included in Appendix D. Phase I of the development will not develop any regulatory floodplain areas and does not develop parcels which would trigger improvements to West Fork Jimmy Camp Creek.

### ***F. WATER TABLE CONSIDERATIONS***

Construction of development in this area will be required to comply with the recommendations provided in the geotechnical reports for the development. It is anticipated that construction will likely provide an underdrain with the proposed sanitary sewer. Drain tiles or other means of drainage constructed with the future development will tie into the underdrain and thereby mitigate potential water table issues. It is also anticipated that provision of RCP conveyance of the FMIC flows through the site will reduce the potential for water table issues.

## **IV. ENVIRONMENTAL EVALUATIONS**

### ***A. WETLAND IMPACTS***

Per the U.S. Fish and Wildlife National Wetlands Inventory, there are freshwater emergent wetlands located onsite. *Wetland delineation is not triggered by this phase of the development.*

### ***B. STORMWATER QUALITY***

All onsite detention facilities shall be designed to accommodate water quality requirements. As the development of each parcel progresses, the detention guidelines outlined in this report are to be upheld.

Per the DCM Chapter 1, Section 4, the City of Fountain requires the UDFCD Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

Step 1: ***Reduce runoff by disconnecting impervious area, eliminating “unnecessary” impervious area and encouraging infiltration into soils that are suitable.***

Site specific landscaping will be done on each lot to decrease the connectivity of impervious areas. Grass lined swales will be used where possible to allow ground infiltration. The open space running along the existing gas right of way is a site-specific example of disconnection between impervious surfaces on this project.

Step 2: ***Treat and slowly release the WQCV.***

The proposed detention ponds meet or exceed the DCM standards for the release rates of Full Spectrum Detention Ponds for Water Quality Capture Volumes.

Step 3:     ***Stabilize stream channels.***

Drainage fees paid at the time of platting will be utilized in the construction of the future stream improvements in the City. The Metro district covering this development will acquire funding necessary for future stream improvements for the future phase of Corvallis which triggers the stream improvements. The trigger for channel improvements is indicated by the DCM to be development of parcels within Corvallis which are perpendicularly adjacent to the unimproved channel. See the DCM for further explanation. This does not occur as part of this phase of development.

Construction costs for channel improvements will be paid for by the Metropolitan District and provided by the developer. The Metropolitan District will be reimbursed via mill levees. To the extent possible, acquisition of easements, tracts or land will be the responsibility of the developer.

Step 4:     ***Implement source controls.***

During construction, the contractor will have designated concrete washout areas and will implement sediment control logs and inlet protection in order to control pollutants at their source. If long term stockpiling of materials is desired, further source controls must be designed to comply with the GEC and SWMP criteria.

### ***C. WATER QUALITY EXCLUSIONS***

Water quality treatment will be provided for the vast majority of proposed new pavement. A few minor exclusions will apply. A small area of 0.3 acres at the southeast termination of Lorson Boulevard at its intersection with Marksheffel Road is impracticable to detain and will therefore be excluded from treatment. This area is approximately 0.2% of the overall development and less than an acre. Therefore, this exclusion is within the provisions for exclusion listed in section 4.a.iv.(A).1) of the MS4.

Improvements to Marksheffel Road will be treated within existing Sand Filter facilities along Marksheffel Road just south of its intersection with Lorson Boulevard. The HDR study appears to show adequate capacity to treat the Marksheffel Road runoff for water quality. The calculation (See appendix A) indicates 113,700 square feet of impervious areas tributary to the Marksheffel Road sand filter. The tributary Marksheffel Road impervious areas including the proposed improvements are anticipated to be approximately 86,275 sq. ft. which indicates that the existing facility likely has capacity for treatment of the improvements. This tributary area includes the west half of Marksheffel Road from Lorson Boulevard north to its intersection with Fontaine Boulevard.

### ***D. PERMITTING REQUIREMENTS***

No additional permitting requirements are anticipated for this phase of the development.

## V. FEE DEVELOPMENT

### A. CONSTRUCTION COST OPINION

Engineer's Estimate of Probable Construction Costs				
Corvallis Phase I				
Public Non-Reimbursable				
Item	Unit	Quantity	Unit Cost	Extension
18" RCP	LF	1742	\$67.00	\$116,742.81
24" RCP	LF	1152.26	\$81.00	\$93,333.06
30" RCP	LF	1225.18	\$100.00	\$122,518.00
36" RCP	LF	2887.4	\$124.00	\$358,037.60
48" RCP	LF	1137.06	\$155.00	\$176,244.30
60" RCP	LF	2600	\$400.00	\$1,040,000.00
18" FES	EA	2	\$402.00	\$804.00
30" FES	EA	1	\$600.00	\$600.00
36" FES	EA	4	\$744.00	\$2,976.00
60" FES	EA	2	\$2,400.00	\$4,800.00
TYPE I MANHOLE	EA	10	\$12,034.00	\$120,340.00
TYPE II MANHOLE	EA	33	\$6,619.00	\$218,427.00
5' TYPE R INLET	EA	3	\$5,736.00	\$17,208.00
10' TYPE R INLET	EA	25	\$7,894.00	\$197,350.00
15' TYPE R INLET	EA	12	\$10,265.00	\$123,180.00
DETENTION/WQ POND (Private: Corvallis Metro Dist.)	EA	5	\$200,000.00	\$1,000,000.00
			.	\$3,592,560.77
			10% Contingency	\$359,256.08
			<b>TOTAL:</b>	\$3,951,816.85

Since the engineer has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor's method of determining prices, or over the competitive bidding or market conditions, the opinion of probable construction costs provided herein are made on the basis of the engineer's experience and qualifications and represents the best judgment as an experienced and qualified professional familiar with the construction industry. The engineer cannot, and does not guarantee that proposals, bid or actual construction costs will not vary from the opinion of probable costs.

### **B. DRAINAGE BASIN FEES**

The parcel is located within the West Fork Jimmy Camp Creek Drainage Basin, which has a drainage fee requirement based on City of Fountain drainage policies. The City of Fountain Municipal Code has established the 2021 Drainage Fees for Jimmy Camp Creek Drainage Basin Fees at a rate of \$12,509.69 per impervious acre and a Bridge Fee at a rate of \$2,036.29 per impervious acre.

#### Impervious Area Calculations

Land Use Type	% Impervious	Area (Acres)	Impervious Acres
<b>West Fork Jimmy Camp Creek</b>			
Residential (1/8 acre or less)	65%	91.435	59.432
Commercial	95%	23.605	22.424
Open Space	2%	26.099	0.522
Total		141.138	82.379

<b>CORVALLIS PHASE I</b>						
Preliminary/Final Drainage Report						
2021 Drainage and Bridge Fees						
	Impervious Area (ac.)	Fee/ Imp. Acre	Fee Due	Reimbursable Const. Costs	Fee Due at Platting	Drainage Fee Credit
<b>West Fork Jimmy Camp Creek</b>						
Drainage Fee	82.379	\$12,509.69	\$1,030,533.56	\$0.00	\$1,030,533.56	\$0.00
Bridge Fee	82.379	\$2,036.29	\$167,747.18	\$0.00	\$167,747.18	\$0.00
<b>TOTAL</b>					<u>\$1,198,280.74</u>	

## **VI. SUMMARY**

This report has demonstrated that the proposed Corvallis Phase I development will not have negative effects on the receiving drainage ways, nor will it negatively affect downstream developments. Proposed discharges will be at or below historic levels indicated in previous studies of the area and the WQCV will be treated for impervious surfaces in compliance with the MS4. This project maintains compliance with previous studies of the area and the governing DCM.

## VII. REFERENCES

1. *City of Colorado Springs Drainage Criteria Manual*, City of Colorado Springs, May 2014
2. *Web Soil Survey of El Paso County Area, Colorado. Unites States Department of Agriculture Soil Conservation Service*, November 2015.
3. *Flood Insurance Rate Maps for El Paso County, Colorado and Incorporated Areas, Panel 958 of 1300, Federal Emergency Management Agency*, Effective Date December 7, 2018.
4. *Urban Storm Drainage Criteria Manual, Vol. 1-3* by Urban Drainage and Flood Control District (UDFCD), January 2016
5. *West Fork Jimmy Camp Creek Drainage Basin Planning Study (WFJCC DBPS)*, by Kiowa Engineering Corp. October 2003.
6. *Master Drainage Development Plan (MDDP) The Glen at Widefield*, by Kiowa Engineering Corp. December 1999.
7. *Master Drainage Development Plan Amendment (MDDPA) The Glen at Widefield*, by Kiowa Engineering Corp. June 2007.
8. *Final Drainage Report (FDR F9) The Glen at Widefield Filing No. 9*, by Kiowa Engineering Corp. July 2018.
9. *Final Drainage Report (FDR F11) The Glen at Widefield Filing No. 11*, by Kiowa Engineering Corp. December 2019.
10. *Master Drainage Development Plan (MDDP) Corvallis*, by Matrix Design Group. September 2021.

# **APPENDIX A**

## ***HYDROLOGIC AND HYDRAULIC CALCULATIONS***

Project Name:

Corvallis

Project Location:

Fountain, CO

Designer

NMS

Notes:

Existing Conditions



Average Channel Velocity		5	ft/s	(If specific channel vel is used, this will be ignored)																																					
Average Slope for Initial Flow		0.04	ft/ft	(If Elevations are used, this will be ignored)																																					
		Impervious %		7		2		65		100																															
Basin	Description	Area		Rational 'C' Values												Flow Lengths				Initial Flow				Channel Flow						Tc	Rainfall Intensity & Rational Flow Rate								% Imp		
		SF	Acres	Surface Type 1 (Single-Family 1 & 1/3 Ac. Lots)			Surface Type 2 (Greenbelts & Agriculture)			Surface Type 3 (Single-Family 1/8 Ac. Lots & Multi-Family)			Surface Type 4 (Impervious)			Weighted C-Factor		Initial	True Initial	Channel	True Channel	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Channel Flow Type (See Key above)	Velocity	Channel	Total	i2	Q2	i5	Q5	i10	Q10		i100	Q100
				C5	C100	Area (SF)	C5	C100	Area (SF)	C5	C100	Area	C5	C100	Area	C5	C100	ft	Length ft	ft	Length ft	Elevation	Elevation	Slope	Tc (min)	Elevation	Elevation	Slope	Ground Type	(ft/s)	Tc (min)	(min)	in/hr	cfs	in/hr	cfs	in/hr	cfs		in/hr	cfs
OS-1a	Single Family > 2.5 Acre Lots (12% Impervious (min.))	1,675,407	38.46	0.20	0.44		0.09	0.36	1474358	0.45	0.59		0.90	0.96	201049	0.19	0.44	300	300	2,290	2290	5,807	5,800	0.023	22.2	5800	5,725	3.28	4	1.3	30.5	52.7	1.4	10.1	1.7	12.7	2.0	14.8	2.9	49.3	13.8%
OS-1b	Single Family > 2.5 Acre Lots (12% Impervious (min.))	1,668,351	38.30	0.20	0.44		0.09	0.36	1468149	0.45	0.59		0.90	0.96	200202	0.19	0.44	900	300	1,871	2471	5,894	5,820	0.082	14.6	5820	5,780	2.14	4	1.0	40.6	55.2	1.3	9.7	1.7	12.3	1.9	14.3	2.8	47.7	13.8%
OS-2	Fontaine Boulevard to crown of road	42809	0.98	0.20	0.44		0.09	0.36		0.45	0.59		0.90	0.96	42809	0.90	0.96	25	25	1362	1362	5758	5757	0.040	1.2	5757	5719	2.79	7	3.3	6.9	8.1	3.5	3.1	4.4	3.9	5.2	4.6	7.4	7.1	100.0%
OS-3	Offsite undeveloped parcel	80878	1.86	0.20	0.44		0.09	0.36	80878	0.45	0.59		0.90	0.96		0.09	0.36	170	170	275	275	5739	5718	0.124	10.7	5718	5703	5.45	3	1.2	3.9	14.6	2.8	0.5	3.5	0.6	4.1	0.7	5.9	4.0	2.0%
OS-4	Offsite undeveloped parcel	797941	18.32	0.20	0.44		0.09	0.36	797941	0.45	0.59		0.90	0.96		0.09	0.36	301	300	1018	1019	5732	5719	0.043	20.1	5719	5696	2.26	3	0.7	22.9	43.0	1.6	2.6	2.0	3.3	2.3	3.8	3.3	21.8	2.0%
OS-5	Fontaine Boulevard to crown of road	32917	0.76	0.20	0.44		0.09	0.36		0.45	0.59		0.90	0.96	32917	0.90	0.96	25	25	1100	1100	5771	5770	0.040	1.2	5770	5740	2.73	7	3.3	5.6	6.8	3.7	2.6	4.7	3.2	5.5	3.8	7.9	5.8	100.0%
OS-6	Fontaine Boulevard to crown of road	33529	0.77	0.20	0.44		0.09	0.36		0.45	0.59		0.90	0.96	33529	0.90	0.96	25	25	1100	1100	5771	5770	0.040	1.2	5770	5743	2.45	7	3.1	5.9	7.1	3.7	2.6	4.6	3.2	5.4	3.8	7.8	5.8	100.0%
OS-7	Single Family Residential to east	126529	2.90	0.20	0.44	126529	0.09	0.36		0.45	0.59		0.90	0.96		0.20	0.44	40	40	160	160	5708	5706	0.050	6.2	5706	5702	2.50	4	1.1	2.4	8.6	3.4	2.0	4.3	2.5	5.1	3.0	7.3	9.4	7.0%
OS-8	Offsite undeveloped parcel	961463	22.07	0.20	0.44		0.09	0.36	961463	0.45	0.59		0.90	0.96		0.09	0.36	300	300	1055	1055	5731	5715	0.053	18.7	5715	5682	3.13	3	0.9	20.0	38.7	1.7	3.3	2.1	4.2	2.4	4.9	3.5	28.1	2.0%
EX-1	West side of site	2959892	67.95	0.20	0.44		0.09	0.36	2959892	0.45	0.59		0.90	0.96		0.09	0.36	300	300	2266	2266	5753	5736	0.057	18.3	5736	5682	2.38	3	0.8	49.8	68.2	1.2	7.1	1.5	9.0	1.7	10.5	2.4	60.3	2.0%
EX-2	Northwest corner	449242	10.31	0.20	0.44		0.09	0.36	449242	0.45	0.59		0.90	0.96		0.09	0.36	300	300	350	350	5752	5738	0.047	19.6	5738	5719	5.43	3	1.2	5.0	24.6	2.1	2.0	2.7	2.5	3.2	3.0	4.5	17.0	2.0%
EX-3	Central-west	2262585	51.94	0.20	0.44		0.09	0.36	2262585	0.45	0.59		0.90	0.96		0.09	0.36	300	300	1530	1530	5740	5728	0.040	20.6	5728	5688	2.61	3	0.8	31.6	52.2	1.4	6.5	1.7	8.2	2.0	9.5	2.9	54.8	2.0%
EX-4	Central-east	2551274	58.57	0.20	0.44		0.09	0.36	2551274	0.45	0.59		0.90	0.96		0.09	0.36	300	300	2710	2710	5768	5756	0.040	20.6	5756	5685	2.62	3	0.8	56.0	76.6	1.1	5.7	1.3	7.2	1.6	8.3	2.3	48.1	2.0%
EX-5	East side of site	3769253	86.53	0.20	0.44		0.09	0.36	3769253	0.45	0.59		0.90	0.96		0.09	0.36	300	300	1830	1830	5770	5765	0.017	27.6	5765	5686	4.32	3	1.0	29.4	57.0	1.3	10.2	1.6	12.8	1.9	15.0	2.7	86.3	2.0%
Rational 'C' Values																																									
DESIGN POINT	Description	Area		Surface Type 1 (Single-Family 1 & 1/3 Ac. Lots)			Surface Type 2 (Greenbelts & Agriculture)			Surface Type 3 (Single-Family 1/8 Ac. Lots & Multi-Family)			Surface Type 4 (Impervious)			Weighted C-Factor		Initial	True Initial	Channel	True Channel	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Channel Flow Type (See Key above)	Velocity	Channel	Total	i2	Q2	i5	Q5	i10	Q10	i100	Q100	% Imp
		SF	Acres	C5	C100	Area (SF)	C5	C100	Area (SF)	C5	C100	Area	C10	C100	Area	C5	C100	ft	Length ft	ft	Length ft	Elevation	Elevation	Slope	Tc (min)	Elevation	Elevation	Slope	Ground Type	(ft/s)	Tc (min)	(min)	in/hr	cfs	in/hr	cfs	in/hr	cfs	in/hr	cfs	
E1	OS-1, OS-2	3343757	76.76	0.20	0.44	0	0.09	0.36	2942507	0.45	0.59	0	0.90	0.96	401251	0.19	0.44	300	300	2290	2290	5807	5800	0.023	22.2	5800	5725	3.28	4	1.3	30.5	52.7	1.4	20.1	1.7	25.3	2.0	29.5	2.9	98.5	13.8%
E2	OS-2, EX-2	492051	11.30	0.20	0.44	0	0.09	0.36	449242	0.45	0.59	0	0.90	0.96	42809	0.17	0.42	300	300	350	350	5752	5738	0.047	18.0	5738	5719	5.43	3	1.2	5.0	23.0	2.2	4.3	2.8	5.4	3.3	6.3	4.7	22.5	10.5%
E3	E2, OS-3, OS-4	1370870	31.47	0.20	0.44	0	0.09	0.36	1328061	0.45	0.59	0	0.90	0.96	42809	0.12	0.38	300	300	1550	1550	5752	5738	0.047	19.0	5738	5703	2.26	3	0.7	34.8	53.8	1.3	5.1	1.7	6.5	2.0	7.5	2.9	34.4	5.1%
E4	E1, E3, EX-1, OS-3	8635982	198.25	0.20	0.44	0	0.09	0.36	8191923	0.45	0.59	0	0.90	0.96	444060	0.14	0.40	300	300	2290	2290	5807	5800	0.023	22.2	5800	5682	5.15	3	1.1	33.8	56.0	1.3	36.7	1.7	46.3	1.9	54.0	2.8	222.3	7.0%
E5	OS-5, EX-3	2295502	52.70	0.20	0.44	0	0.09	0.36	2262585	0.45	0.59	0	0.90	0.96	32917	0.11	0.37	300	300	1530	1530	5740	5728	0.040	20.2	5728	5688	2.61	3	0.8	31.6	51.8	1.4	8.1	1.7	10.2	2.0	11.9	2.9	57.5	3.4%
E6	EX4	2551274	58.57	0.20	0.44	0	0.09	0.36	2551274	0.45	0.59	0	0.90	0.96	0	0.09	0.36	300	300	2710	2710	5768	5756	0.040	20.6	5756	5685	2.62	3	0.8	56.0	76.6	1.1	5.7	1.3	7.2	1.6	8.3	2.3	48.1	2.0%
E7	EX-5, OS-6, OS-7	3929311	90.20	0.20	0.44	126529	0.09	0.36	3769253	0.45	0.59	0	0.90	0.96	33529	0.11	0.37	300	300	1830	1830	5770	5765	0.017	27.0	5765	5686	4.32	3	1.0	29.4	56.5	1.3	13.1	1.6	16.5	1.9	19.2	2.8	93.1	3.0%
E8	E4, E5 + MDDP-A R3030	10931485	250.95	0.20	0.44	0	0.09	0.36	10454508	0.45	0.59	0	0.90	0.96	476977	0.13	0.39	300	300	2290	2290	5807	5800	0.023	23.7	5800	5682	5.15	3	1.1	33.8	57.5	1.3	42.5	1.6	483.5	1.9	62.5	2.7	2040.7	6.3%

Note: Q2, Q5 & Q10 are based on C5; Q25, Q50 & Q100 are based on C100

Channel Flow Type Key						
Heavy Meadow	2					
Tillage/Field	3					
Short Pasture and Lawns	4					
Nearly Bare Ground	5					
Grassed Waterway	6					
Paved Areas	7					



Rational Method - Proposed Conditions

Project Name:	CORVALLIS PHASE I
Project Location:	FOUNTAIN, EL PASO COUNTY, CO
Designer:	JTS
Notes:	Proposed Condition

Average Channel Velocity 4.00 ft/s (If specific channel vel is used, this will be ignored)

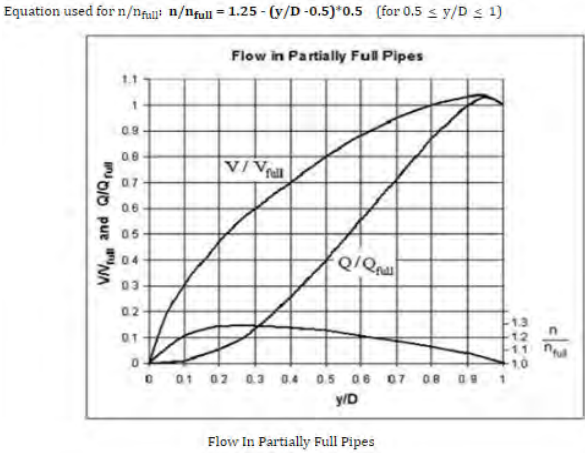
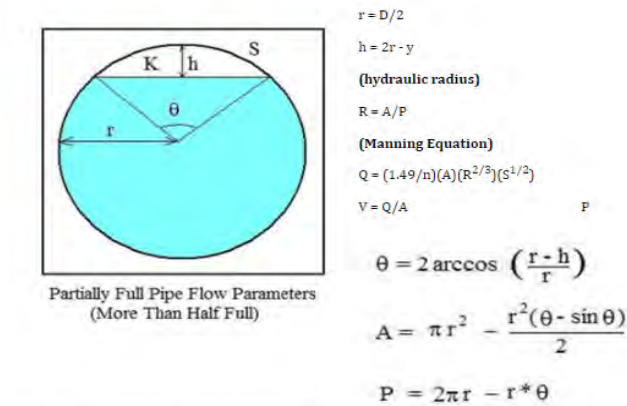
Average Slope for Initial Flow 0.08 ft/ft (If Elevations are used, this will be ignored)

Channel Flow Type Key
Heavy Meadow 2
Tillage/Field 3
Short Pasture and Lawns 4
Nearly Bare Ground 5
Grooved Waterway 6
Paved Areas 7

Sub-basin	Comments	Area		Rational 'C' Values																			Percent Impervious	Flow Lengths				Tc		Rainfall Intensity & Rational Flow Rate									
		sf	acres	Commercial Areas (95% Impervious)			Residential (1/8 or less) (65% Impervious)			Pavement (100% Impervious)			Neighborhoods/Multi-Family (70% Impervious)			Residential (1/3 Acre) (30% Impervious)			Undeveloped/Previous Areas (2% Impervious)			Composite		Initial	True Initial	Channel	True Channel	Average (decimal)	Initial	Average (%)	Channel Flow Type (See Key above)	Velocity	Channel	Total	i5	Q5	i100	Q100	
				C5	C100	Area	C5	C100	Area (SF)	C5	C100	Area (SF)	C5	C100	Area	C5	C100	Area	C5	C100	Area	C5																	C100
4	School (West Portion)	415901	9.53	0.82	0.89		0.45	0.59		0.86	0.89		0.53	0.68	379521	0.30	0.50		0.16	0.51	36380	0.30	0.67	64.05	100	100	800	800	0.05	6.34	3.16	4.22	10.55	4.02	19.2	6.75	43.2		
5	School (East Portion)	193524	4.44	0.82	0.89		0.45	0.59		0.86	0.89		0.53	0.68	148103	0.30	0.50		0.16	0.51	45421.00	0.44	0.64	54.04	100	100	500	500	0.05	6.91	3.00	7	3.46	2.41	9.31	4.21	8.4	7.08	20.3
8a	Commercial	236528	5.43	0.82	0.89	216644.00	0.45	0.59	19984.00	0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51		0.79	0.86	92.48	100	100	704	704	0.05	3.27	4.20	0.86	4.10	2.86	6.13	4.83	20.9	8.12	38.4
8b	Lorson Boulevard	39975	0.92	0.82	0.89	32935	0.45	0.59		0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51	7040	0.70	0.82	78.62	50	50	692	692	0.05	2.95	4.0	7	4.00	2.88	5.83	4.90	3.2	8.23	6.3
8c	Lorson Boulevard	42458	0.97	0.82	0.89	35418	0.45	0.59		0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51	7040	0.71	0.83	79.58	50	50	692	692	0.05	2.90	4.0	7	4.00	2.88	5.78	4.91	3.4	8.25	6.7
9a	Single-Family Residential	190833	4.38	0.82	0.89		0.45	0.59	190833.00	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	50	50	803	803	0.05	4.84	2.00	7	2.83	4.73	9.56	4.17	8.3	7.01	18.3
9b	Single-Family Residential	194223	4.46	0.82	0.89		0.45	0.59	172891.00	0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51	21332.00	0.42	0.58	58.08	50	50	951	951	0.05	5.08	2.00	7	2.83	5.60	10.67	4.00	7.5	6.72	17.6
9c	Single-Family Residential	51338	1.18	0.82	0.89		0.45	0.59	51338.00	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	50	50	669	669	0.05	4.84	2.00	7	2.83	5.94	8.78	4.30	2.3	7.23	5.1
9d	Single-Family Residential	138196	3.17	0.82	0.89		0.45	0.59	138196.20	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	50	50	818	818	0.05	4.84	3.70	7	3.85	3.54	8.38	4.37	6.3	7.35	13.9
10a	Single-Family Residential	84485	1.94	0.82	0.89		0.45	0.59	84485	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	20	20	766	766	0.05	3.06	2.0	7	2.83	4.51	7.57	4.53	4.0	7.60	8.8
10b	Single-Family Residential	34127	0.78	0.82	0.89		0.45	0.59	34127	0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51		0.45	0.59	65.00	20	20	599	599	0.05	3.06	2.0	7	2.83	5.53	6.58	4.73	1.7	7.95	3.7
10c	Interim Open Space/ Single-Family Res.	159716	3.67	0.82	0.89		0.45	0.59	26905	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51	132811	0.21	0.52	12.61	100	100	483	483	0.05	9.38	2.0	4	0.99	8.13	17.51	3.22	2.5	5.41	10.5
10d (Undeveloped)	Interim Open Space/ Single-Family Res.	385771	8.86	0.82	0.89		0.45	0.59	33781	0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51	351990	0.19	0.52	7.52	100	100	1065	1065	0.05	9.63	1.0	4	0.70	25.36	54.98	2.22	3.7	3.72	17.2
10e (Undeveloped)	Interim Open Space/ Single-Family Res.	309267	7.10	0.82	0.89		0.45	0.59	31463	0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51	277804	0.19	0.52	8.41	100	100	1020	1020	0.05	9.58	3.0	4	1.21	14.02	23.60	2.77	3.8	4.65	17.2
10f (Undeveloped)	Interim Open Space/ Single-Family Res.	121232	2.78	0.82	0.89		0.45	0.59	0	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51	121232	0.16	0.51	2.00	100	100	620	620	0.05	9.89	4.0	4	1.40	7.38	17.27	3.24	1.5	5.44	7.8
10g (Developed)	Single-Family Res.	385771	8.86	0.82	0.89		0.45	0.59	220300	0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51	88967	0.29	0.45	37.58	100	100	1065	1065	0.05	8.49	1.0	7	2.00	8.88	17.36	3.23	8.5	5.43	22.0
10h (Developed)	Single-Family Res.	309267	7.10	0.82	0.89		0.45	0.59	256691	0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51	52576	0.40	0.58	54.29	100	100	1020	1020	0.05	7.56	3.0	7	3.46	4.91	12.26	3.78	10.8	6.35	26.2
10i (Developed)	Single-Family Res.	121232	2.78	0.82	0.89		0.45	0.59	121232	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	100	100	620	620	0.05	6.84	4.0	7	4.00	2.58	9.42	4.19	5.3	7.05	11.7
10j	Single-Family Residential	157676	3.62	0.82	0.89		0.45	0.59	157676	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	50	50	775	775	0.05	4.84	2.7	7	3.29	3.93	8.76	4.31	7.1	7.24	15.6
10h	Future Phase Single-Family Res.	282050	6.47	0.82	0.89		0.45	0.59	282050	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	100	100	805	805	0.05	6.84	4.0	7	4.00	3.35	10.19	4.07	12.0	6.84	26.3
11a	Multi-Family	518724	11.91	0.82	0.89		0.45	0.59		0.86	0.89		0.53	0.68	312068	0.19	0.52		0.16	0.51		0.39	0.61	44.27	50	50	888	888	0.05	5.29	2.0	7	2.83	5.23	10.52	4.02	18.8	6.76	49.8
11b	Rivers Boulevard	35197	0.81	0.82	0.89	35197	0.45	0.59		0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.82	0.89	95.00	20	20	775	775	0.05	1.32	3.0	7	3.46	3.73	5.04	5.09	3.4	8.56	6.2
11c	Rivers Boulevard	25282	0.58	0.82	0.89	25282	0.45	0.59		0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51		0.82	0.89	95.00	20	20	995	995	0.05	1.32	2.0	7	2.83	5.86	7.18	4.60	2.2	7.74	4.0
11d	Spring Glen Drive	25430	0.58	0.82	0.89	25430	0.45	0.59		0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.82	0.89	95.00	20	20	500	500	0.05	1.32	3.0	7	3.46	2.41	5.00	5.10	2.5	8.58	4.5
11e	Spring Glen Drive	25833	0.59	0.82	0.89	25833	0.45	0.59		0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51		0.82	0.89	95.00	20	20	500	500	0.05	1.32	1.0	7	2.00	4.17	5.48	4.98	2.4	8.57	4.5
12a	Single-Family Residential	56842	1.30	0.82	0.89		0.45	0.59	56842	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	134	100	1432	1466	0.05	7.92	4.0	7	4.00	4.31	14.02	3.37	2.1	6.00	4.7
12b	Single-Family Residential	157565	3.62	0.82	0.89		0.45	0.59	157565	0.86	0.89		0.53	0.68		0.19	0.52		0.16	0.51		0.45	0.59	65.00	50	50	968	968	0.05	4.84	3.5	7	3.74	4.31	9.14	4.24	7.0	7.13	15.3
12c	Single-Family Residential	65312	1.50	0.82	0.89		0.45	0.59	65312	0.86	0.89		0.53	0.68		0.30	0.50		0.16	0.51		0.45	0.59	65.00	55	55	488	488	0.05	5.0									

DESIGN POINTS	Sub-basins		42458	0.97	0.82	0.89	35418	0.45	0.59	0	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	7040	0.71	0.83	79.58	50	50	692	692	0.05	2.90	4.0	7	4.00	2.88	5.78	4.91	3.4	8.25	6.7
	8-1	8c	39975	0.92	0.82	0.89	32935	0.45	0.59	0	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	7040	0.70	0.82	78.62	50	50	692	692	0.05	2.95	4.0	7	4.00	2.88	5.83	4.90	3.2	8.23	6.3
8-2a	8b (Inlet)		82433	1.89	0.82	0.89	68353	0.45	0.59	0	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	14080	0.71	0.83	79.12	50	50	704	704	0.05	2.92	4.1	7	4.05	2.90	5.82	4.90	6.6	8.24	13.0
8-3	DF-6 Inflow		318961	7.32	0.82	0.89	284997	0.45	0.59	19884	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	14080	0.77	0.85	89.02	50	50	704	704	0.05	2.47	4.1	7	4.05	2.90	5.37	5.01	28.4	8.42	53.1
M1	DF-6 Discharge		318961	7.32	0.82	0.89	284997	0.45	0.59	19884	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	14080	0.77	0.85	89.02												0.2		10.9	
9-1	9c		51338	1.18	0.82	0.89	0	0.45	0.59	51338	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	50	50	669	669	0.05	4.84	2.0	7	2.83	3.94	8.78	4.30	2.3	7.23	5.1
9-2	9b, 9c		194223	4.46	0.82	0.89	0	0.45	0.59	172891	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	21332	0.42	0.58	58.08	50	50	951	951	0.05	5.08	2.0	7	2.83	5.60	10.67	4.00	7.5	6.72	17.6
9-3	9b, 9c		245561	5.64	0.82	0.89	0	0.45	0.59	224229	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	21332	0.42	0.58	59.53	50	50	951	951	0.05	5.03	2.0	7	2.83	5.60	10.62	4.01	9.7	6.73	22.3
9-4	9d		138196	3.17	0.82	0.89	0	0.45	0.59	138196	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	50	50	818	818	0.05	4.84	3.7	7	3.85	3.54	8.36	4.37	6.3	7.38	13.9
9-5	9e		5106	0.12	0.82	0.89	5106	0.45	0.59	0	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.82	0.89	95.00	50	50	193	193	0.05	2.08	3.7	7	3.85	0.84	5.00	3.10	0.5	8.58	0.9
9-6	9d		143302	3.29	0.82	0.89	5106	0.45	0.59	138196	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.46	0.60	66.07	50	50	818	818	0.05	4.74	3.7	7	3.85	3.54	8.28	4.39	6.7	7.38	14.7
9-7	9b, 9d		388663	8.93	0.82	0.89	5106	0.45	0.59	362425	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	21332	0.47	0.59	61.94	50	50	951	951	0.05	4.92	3.7	7	3.85	4.12	9.04	4.26	16.8	7.15	38.0
9-8	9a, 9b, OS-5		403144	9.25	0.82	0.89	0	0.45	0.59	217738	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	128211	0.41	0.60	48.81	50	50	1903	1903	0.05	5.15	2.0	7	2.83	11.21	16.36	3.33	12.7	5.59	31.4
9-9	9a-9d, 9b, 10d, 10f, OS-3		1299010	29.82	0.82	0.89	5106	0.45	0.59	619944	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	627565	0.33	0.56	36.11	50	50	1903	1903	0.25	3.36	1.0	7	2.00	15.86	19.21	3.08	30.3	5.17	87.7
10-1	10b, 10b		118612	2.72	0.82	0.89	0	0.45	0.59	118612	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	20	20	766	766	0.05	3.06	2.0	7	2.83	4.51	7.57	4.53	5.6	7.60	12.3
10-2	9a-9d, 9b, OS-5		1698277	36.92	0.82	0.89	5106	0.45	0.59	645407	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	905169	0.30	0.56	30.78	50	50	2400	2400	0.05	5.94	2.8	7	3.35	11.95	17.89	3.19	35.7	5.35	100.7
10-3a	10b		157676	3.62	0.82	0.89	0	0.45	0.59	157676	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	50	50	775	775	0.05	4.84	2.7	7	3.29	3.93	8.76	4.31	7.1	7.24	15.6
10-3b	9a-9d, 9b, 10d, 10g, OS-5		1884565	43.26	0.82	0.89	5106	0.45	0.59	921695	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	905169	0.32	0.56	35.80	50	50	2450	2450	0.05	5.78	2.8	7	3.35	12.20	17.98	3.18	44.8	5.34	130.6
14-1	14b		88447	2.03	0.82	0.89	0	0.45	0.59	88447	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	100	100	951	951	0.05	6.84	2.2	7	2.97	5.34	12.18	3.79	3.5	6.37	7.7
14-2	14c		40446	0.93	0.82	0.89	0	0.45	0.59	40446	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	50	50	653	653	0.05	4.84	2.8	7	3.35	3.25	8.09	4.43	1.9	7.44	4.1
14-3	14b, 14c		128993	2.36	0.82	0.89	0	0.45	0.59	128993	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	100	100	951	951	0.05	6.84	2.8	7	3.35	4.74	11.57	3.87	3.5	6.51	11.5
14-4	14d, 14e		306041	7.03	0.82	0.89	0	0.45	0.59	228565	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	77476	0.38	0.57	49.05	100	100	1478	1478	0.05	7.62	2.6	7	3.22	7.64	15.23	3.44	9.2	5.77	23.3
14-5	14c, 14f		209713	4.81	0.82	0.89	0	0.45	0.59	209713	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	50	50	1110	1110	0.05	4.84	3.4	7	3.69	5.02	9.85	4.13	9.0	6.93	19.8
14-6	14a-14f		644647	14.80	0.82	0.89	0	0.45	0.59	567171	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	77476	0.42	0.58	57.45	100	100	1500	1500	0.05	7.21	2.6	7	3.22	7.75	14.96	3.47	21.5	5.82	50.4
10-1 FUT	DP 14-6, 10a, 10b		763259	17.52	0.82	0.89	0	0.45	0.59	685783	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	77476	0.42	0.58	58.61	100	100	2000	2000	0.05	7.15	2.0	7	2.83	11.79	18.93	3.10	23.0	5.21	53.5
10-2 FUT	DP 14-6, 10a, 10b, 10c		1072526	24.62	0.82	0.89	0	0.45	0.59	942474	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	130052	0.41	0.58	57.36	100	100	2800	2800	0.05	7.21	2.0	7	2.83	16.50	23.71	2.76	28.4	4.63	66.7
9-3 FUT	9a, 9b, OS-5		403144	9.25	0.82	0.89	0	0.45	0.59	217738	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	125811	0.41	0.60	48.81	100	100	1740	1740	0.05	7.28	2.0	7	2.83	10.25	17.53	3.22	12.2	5.41	30.4
10-1 FUT	9a-9d, 9b, 10d		1299010	29.82	0.82	0.89	5106	0.45	0.59	619944	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	243110	0.38	0.53	49.47	100	100	2557	2557	0.05	7.17	2.0	7	2.83	15.07	22.63	2.83	29.3	4.75	71.2
10-3 FUT	9-9 FUT, 10f		1299010	29.82	0.82	0.89	5106	0.45	0.59	921695	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	243110	0.39	0.55	50.92	100	100	3221	3221	0.05	7.50	2.0	7	2.83	18.98	26.48	2.60	30.2	4.36	72.6
10-4 FUT	10b		282050	6.47	0.82	0.89	0	0.45	0.59	282050	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	100	100	805	805	0.05	6.84	4.0	7	4.00	3.35	10.19	4.07	12.0	6.84	26.3
10-5 FUT	10-1 FUT, 10-3 FUT, 10-2 FUT		2653586	60.92	0.82	0.89	5106	0.45	0.59	2146219	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	373162	0.41	0.57	55.02	100	100	3687	3687	0.05	7.32	2.0	7	2.83	21.73	29.04	2.47	61.4	4.15	144.6
10-5c	14a-14f, 9a-9d, 9b, 10d, 10g, OS-5		2529212	58.06	0.82	0.89	5106	0.45	0.59	1488866	0.86	0.89	52595	0.53	0.68	0	0.30	0.50	0	0.16	0.51	982645	0.35	0.57	41.31	100	100	3800	3800	0.05	7.93	2.6	7	3.22	19.64	27.56	2.54	51.5	4.27	141.4
10-6	10b		157676	3.62	0.82	0.89	0	0.45	0.59	157676	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.45	0.59	65.00	50	50	775	775	0.05	4.84	2.7	7	3.29	3.93	8.76	4.31	7.1	7.24	15.6
10-6	10b		0.01	0.03	0.82	0.89	33197	0.45	0.59	0	0.86	0.89	0	0.53	0.68	0	0.30	0.50	0	0.16	0.51	0	0.82	0.89	95.00	20	20	775	775	0.05	1.32	3.0	7	3.46	3.73	5.04	5.09	3.4	8.56	4.2
10-6	9a-9d, 9b, 10d, 10g, 10b, OS-5		2564409	58.87	0.82	0.89	40303	0.45	0.59	1488866	0.86	0.89																												

INITIAL STORM SEWER CAPACITY CALCULATIONS - MANNINGS CHANNEL FLOW METHOD					Storm Pipe												
Design Point	Notes		Max Q (Q100) Proposed	Flow Type / Capacity Analysis	Calculated Max Q for Pipe (CFS)	Percent of Pipe Channel Capacity Used	n(full)	Slope (ft/ft)	n	Pipe Diameter (ft)	Width (ft) Box Culvert Only	Pipe Depth (inches)	Optimum Flow Depth (+/- 0.94 x D)	Θ (Radians)	A (Sq. Ft.)	Wetted Perimeter (ft)	Velocity at Max Pipe Capacity
8-1			6.7	Channel/Adequate	15.6	43%	0.013	0.020	0.013	1.5		18	1.41	0.990	1.724	3.970	9.02
8-2b			13.0	Channel/Adequate	15.6	83%	0.013	0.020	0.013	1.5		18	1.41	0.990	1.724	3.970	9.02
8-3			53.1	Channel/Adequate	60.7	87%	0.013	0.020	0.013	2.5		30	2.35	0.990	4.788	6.617	12.69
M1			10.9	Channel/Adequate	14.8	74%	0.013	0.018	0.013	1.5		18	1.41	0.990	1.724	3.970	8.56
9-1			5.1	Channel/Adequate	11.0	46%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
9-2			17.6	Channel/Adequate	23.7	74%	0.013	0.010	0.013	2		24	1.88	0.990	3.065	5.293	7.73
9-3			22.3	Channel/Adequate	23.7	94%	0.013	0.010	0.013	2		24	1.88	0.990	3.065	5.293	7.73
9-4			13.9	Channel/Adequate	23.7	59%	0.013	0.010	0.013	2		24	1.88	0.990	3.065	5.293	7.73
9-5			0.9	Channel/Adequate	11.0	8%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
9-6			14.7	Channel/Adequate	23.7	62%	0.013	0.010	0.013	2		24	1.88	0.990	3.065	5.293	7.73
9-7			38.0	Channel/Adequate	43.0	88%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
10-2	Temporary condition. Future Phase will reroute		110.7	Pressure	85.9	129%	0.013	0.040	0.013	2.5		30	2.35	0.990	4.788	6.617	17.94
10-3b	Temporary condition. Future Phase will reroute		130.6	Pressure	114.8	114%	0.013	0.027	0.013	3		36	2.82	0.990	6.895	7.940	16.64
14-1			7.7	Channel/Adequate	11.0	70%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
14-2			4.1	Channel/Adequate	11.0	37%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
14-3			11.5	Channel/Adequate	23.7	48%	0.013	0.0100	0.013	2		24	1.88	0.990	3.065	5.293	7.73
14-4			23.3	Channel/Adequate	43.0	54%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
14-5			19.8	Channel/Adequate	43.0	46%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
14-6			50.4	Channel/Adequate	78.1	65%	0.013	0.0125	0.013	3		36	2.82	0.990	6.895	7.940	11.32
10-1 FUT	SIZE CHANGE AFTER GAS CROSSING		53.5	Channel/Adequate	90.3	59%	0.013	0.0167	0.013	3		36	2.82	0.990	6.895	7.940	13.09
10-1 FUT	SIZE CHANGE AFTER GAS CROSSING		53.5	Channel/Adequate	94.2	57%	0.013	0.0080	0.013	3.5		42	3.29	0.990	9.385	9.263	10.04
10-2 FUT			66.7	Channel/Adequate	94.2	71%	0.013	0.008	0.013	3.5		42	3.29	0.990	9.385	9.263	10.04
9-8 FUT			30.4	Channel/Adequate	67.9	45%	0.013	0.025	0.013	2.5		30	2.35	0.990	4.788	6.617	14.18
9-9 FUT			71.2	Channel/Adequate	110.4	64%	0.013	0.025	0.013	3		36	2.82	0.990	6.895	7.940	16.02
10-3 FUT			72.6	Channel/Adequate	105.4	69%	0.013	0.010	0.013	3.5		42	3.29	0.990	9.385	9.263	11.23
10-4 FUT	SUB-BASIN 10h		26.3	Channel/Adequate	43.0	61%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
10-5 FUT			144.6	Channel/Adequate	150.4	96%	0.013	0.010	0.013	4		48	3.76	0.990	12.259	10.587	12.27
10-4			15.6	Channel/Adequate	23.7	66%	0.013	0.010	0.013	2		24	1.88	0.990	3.065	5.293	7.73
10-5			6.2	Channel/Adequate	11.0	56%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
10-6	Temporary condition. Future Phase will reroute much of the tributary area		141.0	Pressure	114.8	123%	0.013	0.027	0.013	3		36	2.82	0.990	6.895	7.940	16.64
10-7			144.6	Channel/Adequate	150.4	96%	0.013	0.010	0.013	4		48	3.76	0.990	12.259	10.587	12.27
10-8			174.4	Channel/Adequate	178.0	98%	0.013	0.014	0.013	4		48	3.76	0.990	12.259	10.587	14.52
10-9			4.3	Channel/Adequate	7.8	55%	0.013	0.005	0.013	1.5		18	1.41	0.990	1.724	3.970	4.51
10-10			4.5	Channel/Adequate	7.8	58%	0.013	0.005	0.013	1.5		18	1.41	0.990	1.724	3.970	4.51
10-11			184.2	Channel/Adequate	184.2	100%	0.013	0.015	0.013	4		48	3.76	0.990	12.259	10.587	15.03
DF-5 in	Stub for Multi-Family in Sub-basin 11a		49.8	Channel/Adequate	69.8	71%	0.013	0.010	0.013	3		36	2.82	0.990	6.895	7.940	10.13
DF-4/5 out / DP 11			79.6	Channel/Adequate	106.4	75%	0.013	0.005	0.013	4		48	3.76	0.990	12.259	10.587	8.68



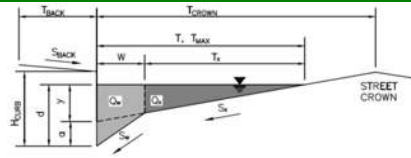
Design Point	Notes		Max Q (Q100) Proposed	Flow Type / Capacity Analysis	Calculated Max Q for Pipe (CFS)	Percent of Pipe Channel Capacity Used	n(full)	Slope (ft/ft)	n	Pipe Diameter (ft)	Width (ft) Box Culvert Only	Pipe Depth (inches)	Optimum Flow Depth (+/- 0.94 x D)	Θ (Radians)	A (Sq. Ft.)	Wetted Perimeter (ft)	Velocity at Max Pipe Capacity
12-1			15.3	Channel/Adequate	23.7	65%	0.013	0.0100	0.013	2		24	1.88	0.990	3.065	5.293	7.73
12-2			6.9	Channel/Adequate	11.0	62%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
12-3			21.5	Channel/Adequate	43.0	50%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
12-4			25.8	Channel/Adequate	43.0	60%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
12-5			11.3	Channel/Adequate	43.0	26%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
12-6			37.4	Channel/Adequate	69.8	54%	0.013	0.010	0.013	3		36	2.82	0.990	6.895	7.940	10.13
12-7			55.6	Channel/Adequate	69.8	80%	0.013	0.010	0.013	3		36	2.82	0.990	6.895	7.940	10.13
12-10			14.8	Channel/Adequate	23.7	62%	0.013	0.010	0.013	2		24	1.88	0.990	3.065	5.293	7.73
M2			25.7	Channel/Adequate	46.5	55%	0.013	0.039	0.013	2		24	1.88	0.990	3.065	5.293	15.17
16-1			9.2	Channel/Adequate	11.0	84%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
16-2a			5.5	Channel/Adequate	11.0	50%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
16-2b	Assumes all of 16a2 to the manhole east of the at-grade inlet		63.4	Pressure	38.3	166%	0.013	0.003	0.013	3		36	2.82	0.990	6.895	7.940	5.55
16-3			11.1	Channel/Adequate	23.7	47%	0.013	0.0100	0.013	2		24	1.88	0.990	3.065	5.293	7.73
16-4b			17.8	Channel/Adequate	23.7	75%	0.013	0.010	0.013	2		24	1.88	0.990	3.065	5.293	7.73
DF-9 in	Stub for commercial		88.2	Pressure	82.4	107%	0.013	0.003	0.013	4		48	3.76	0.990	12.259	10.587	6.72
DF-9 out			11.8	Channel/Adequate	16.8	70%	0.013	0.005	0.013	2		24	1.88	0.990	3.065	5.293	5.47
MK2	See culvert calcs		55.3	Pressure	49.4	112%	0.013	0.005	0.013	3		36	2.82	0.990	6.895	7.940	7.16
14-7			17.4	Channel/Adequate	23.7	73%	0.013	0.010	0.013	2		24	1.88	0.990	3.065	5.293	7.73
14-8			5.9	Channel/Adequate	11.0	54%	0.013	0.010	0.013	1.5		18	1.41	0.990	1.724	3.970	6.38
14-9			22.2	Channel/Adequate	43.0	52%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
15-1			21.3	Channel/Adequate	43.0	50%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
15-2a			23.6	Channel/Adequate	43.0	55%	0.013	0.010	0.013	2.5		30	2.35	0.990	4.788	6.617	8.97
15-2b			44.4	Channel/Adequate	60.7	73%	0.013	0.020	0.013	2.5		30	2.35	0.990	4.788	6.617	12.69
DF-8 out			14.2	Channel/Adequate	16.8	85%	0.013	0.005	0.013	2		24	1.88	0.990	3.065	5.293	5.47

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 12-1

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_O$	=	0.035	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.0	6.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

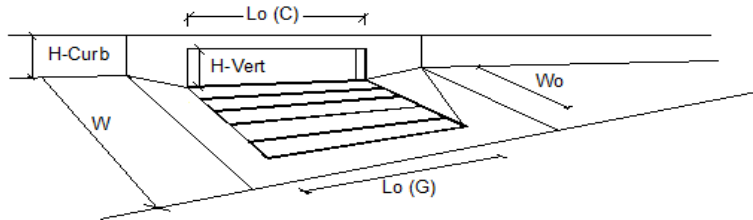
	Minor Storm	Major Storm	
$Q_{allow}$	14.0	24.9	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



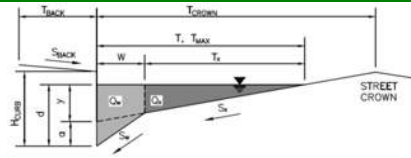
Design Information (Input)		MINOR		MAJOR
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0 inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_u$ =	2	2
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_u$ =	10.00	10.00 ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_u$ =	N/A	N/A ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_{r-G}$ =	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_{r-C}$ =	0.10	0.10
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>		MINOR		MAJOR
Total Inlet Interception Capacity		$Q$ =	7.0	13.2 cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =	0.0	2.1 cfs
Capture Percentage = $Q_u/Q_s$ =		$C\%$ =	100	86 %

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 12-2

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_x$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_0$	=	0.033	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.0	8.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

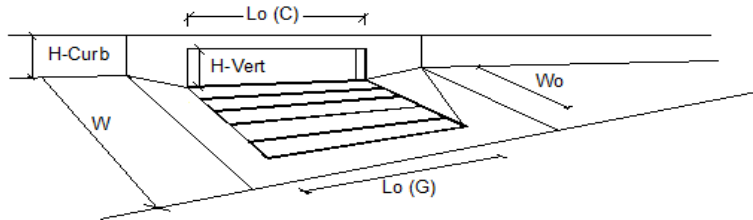
	Minor Storm	Major Storm	
$Q_{allow}$	13.6	22.4	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR		MAJOR
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')		a <sub>LOCAL</sub> =	3.0	3.0 inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1
Length of a Single Unit Inlet (Grate or Curb Opening)		L <sub>u</sub> =	10.00	10.00 ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W <sub>u</sub> =	N/A	N/A ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C <sub>r-G</sub> =	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C <sub>r-C</sub> =	0.10	0.10
<b>Street Hydraulics: OK - Q &lt; Allowable Street Capacity</b>		MINOR		MAJOR
Total Inlet Interception Capacity		Q =	3.1	5.2 cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q <sub>s</sub> =	0.0	1.7 cfs
Capture Percentage = Q <sub>i</sub> /Q <sub>a</sub> =		C% =	99	75 %

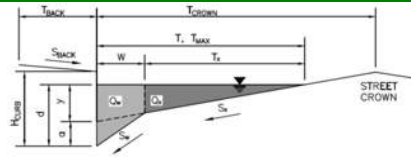


**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: Sub-Basin 12a (Road)

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_0$	=	0.031	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.0	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

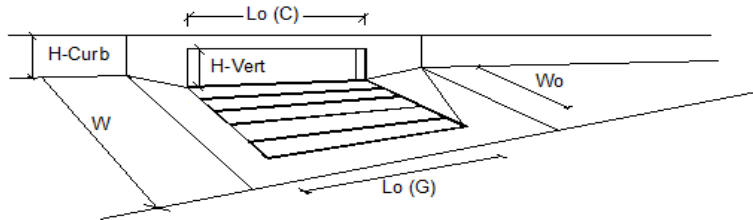
	Minor Storm	Major Storm	
$Q_{allow}$	13.2	55.2	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



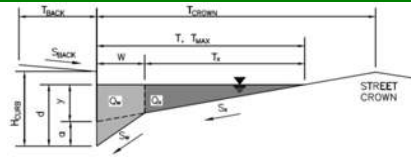
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	<input type="text"/>	Type =			
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =			inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =			
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =			ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =			ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =			
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =			
Total Inlet Interception Capacity		$Q$ =			cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =			cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =			%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: 15a &amp; 15b worst case

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$$\begin{aligned} T_{BACK} &= 5.0 \text{ ft} \\ S_{BACK} &= 0.020 \text{ ft/ft} \\ n_{BACK} &= 0.020 \end{aligned}$$

$$\begin{aligned} H_{CURB} &= 6.00 \text{ inches} \\ T_{CROWN} &= 17.0 \text{ ft} \\ W &= 0.83 \text{ ft} \\ S_X &= 0.020 \text{ ft/ft} \\ S_W &= 0.083 \text{ ft/ft} \\ S_O &= 0.020 \text{ ft/ft} \\ n_{STREET} &= 0.013 \end{aligned}$$

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.0	6.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

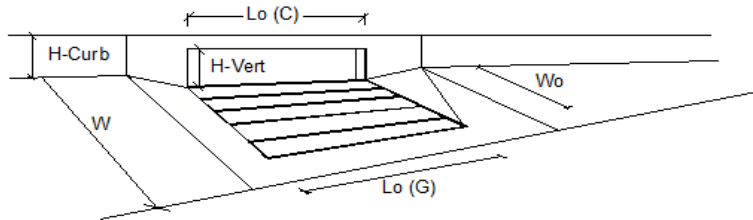
$$Q_{allow} = \begin{matrix} \text{Minor Storm} & \text{Major Storm} \\ 10.6 & 29.4 \end{matrix} \text{ cfs}$$

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



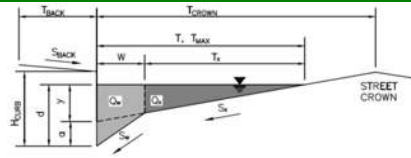
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	<input type="text"/>	Type =			
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =			inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =			
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =			ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =			ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =			
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =			
Total Inlet Interception Capacity		$Q$ =			cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =			cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =			%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: 15c &amp; 15d worst case

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK} =$	5.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	17.0	ft
$W =$	0.83	ft
$S_x =$	0.020	ft/ft
$S_y =$	0.083	ft/ft
$S_o =$	0.018	ft/ft
$n_{STREET} =$	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	17.0	17.0	ft
$d_{MAX} =$	4.0	6.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

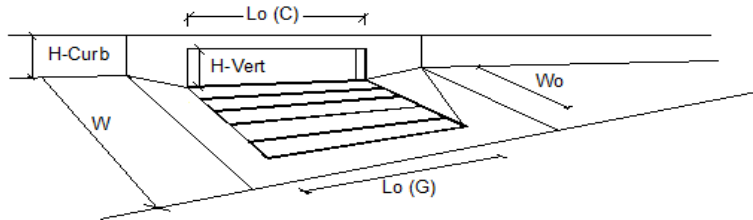
	Minor Storm	Major Storm	
$Q_{allow} =$	10.0	30.4	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



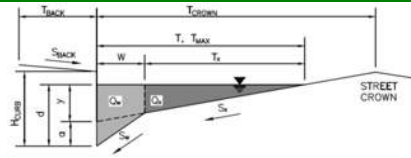
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	<input type="text"/>	Type =			
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =			inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =			
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =			ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =			ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =			
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =			
Total Inlet Interception Capacity		$Q$ =			cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =			cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =			%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: 12d &amp; 12e worst case

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK} =$	5.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	17.0	ft
$W =$	0.83	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.029	ft/ft
$n_{STREET} =$	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	17.0	17.0	ft
$d_{MAX} =$	4.0	6.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

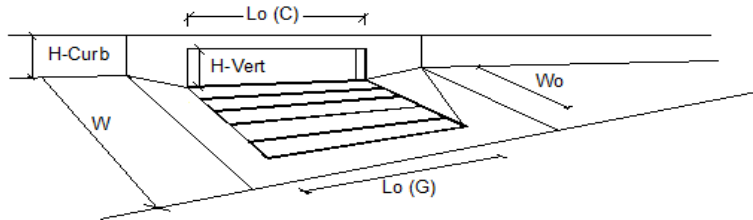
	Minor Storm	Major Storm	
$Q_{allow} =$	12.7	26.3	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	<input type="text"/>	Type =			
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =			inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =			
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =			ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =			ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =			
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =			
Total Inlet Interception Capacity		$Q$ =			cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =			cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =			%

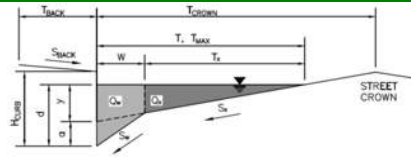


**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 16-1

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	34.0	ft
$W$	=	2.00	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_0$	=	0.010	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	20.0	34.0	ft
$d_{MAX}$	5.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

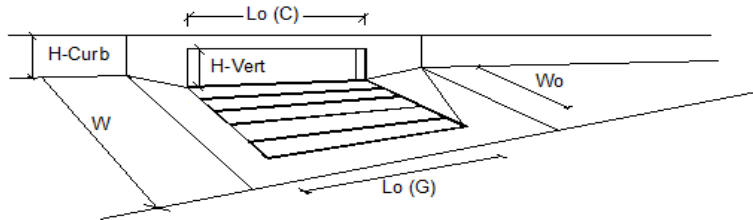
	Minor Storm	Major Storm	
$Q_{allow}$	15.1	44.6	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



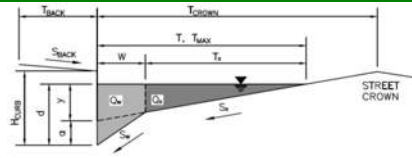
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL} = 3.0$	$3.0$	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o = 4$	$4$	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o = 10.00$	$10.00$	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o = N/A$	$N/A$	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G = N/A$	$N/A$	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C = 0.10$	$0.10$	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>				
Total Inlet Interception Capacity		$Q = 4.2$	$9.2$	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s = 0.0$	$0.0$	cfs
Capture Percentage = $Q_i/Q_o =$		$C\% = 100$	$100$	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 14-1

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.013	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_o$	=	0.030	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

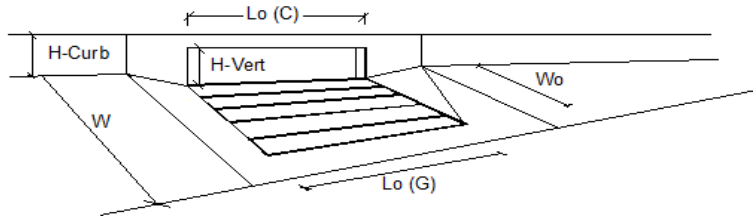
	Minor Storm	Major Storm	
$Q_{allow}$	21.4	56.4	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



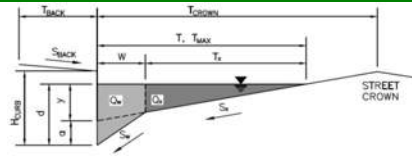
Design Information (Input)		MINOR		MAJOR
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0 inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_u$ =	1	1
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_u$ =	10.00	10.00 ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_u$ =	N/A	N/A ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>		MINOR		MAJOR
Total Inlet Interception Capacity		$Q$ =	3.4	5.5 cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =	0.1	2.2 cfs
Capture Percentage = $Q_u/Q_s$ =		$C\%$ =	97	71 %

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 14-2

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.013	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_x$	=	0.020	ft/ft
$S_y$	=	0.083	ft/ft
$S_o$	=	0.030	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

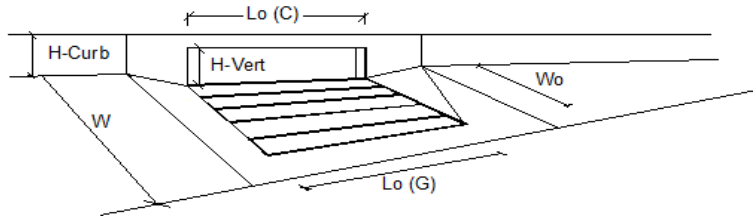
	Minor Storm	Major Storm	
$Q_{allow}$	21.4	56.4	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



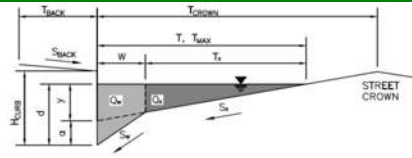
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	1.9	3.8	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =	0.0	0.3	cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =	100	92	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: OS-6

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	58.0	ft
$W$	=	2.00	ft
$S_x$	=	0.020	ft/ft
$S_y$	=	0.083	ft/ft
$S_0$	=	0.040	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	20.0	58.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

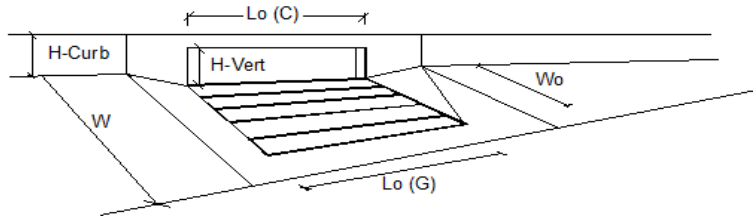
	Minor Storm	Major Storm	
$Q_{allow}$	15.8	42.8	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	5.3	9.3	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_b$ =	0.0	0.0	cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =	100	100	%

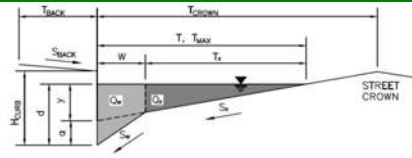


**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 9-1

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_x$	=	0.020	ft/ft
$S_y$	=	0.083	ft/ft
$S_o$	=	0.020	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

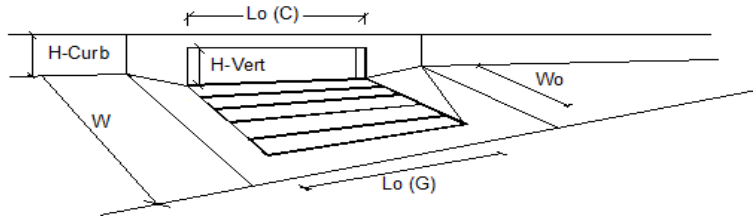
	Minor Storm	Major Storm	
$Q_{allow}$	17.4	63.0	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



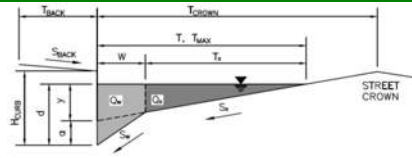
Design Information (Input)		MINOR		MAJOR
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')		a <sub>LOCAL</sub> =	3.0	3.0 inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1
Length of a Single Unit Inlet (Grate or Curb Opening)		L <sub>u</sub> =	15.00	15.00 ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W <sub>u</sub> =	N/A	N/A ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C <sub>r-G</sub> =	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C <sub>r-C</sub> =	0.10	0.10
<b>Street Hydraulics: OK - Q &lt; Allowable Street Capacity</b>		MINOR		MAJOR
Total Inlet Interception Capacity		Q =	2.3	5.1 cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q <sub>s</sub> =	0.0	0.0 cfs
Capture Percentage = Q <sub>i</sub> /Q <sub>a</sub> =		C% =	100	100 %

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 9-2

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_x$	=	0.020	ft/ft
$S_y$	=	0.083	ft/ft
$S_o$	=	0.020	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

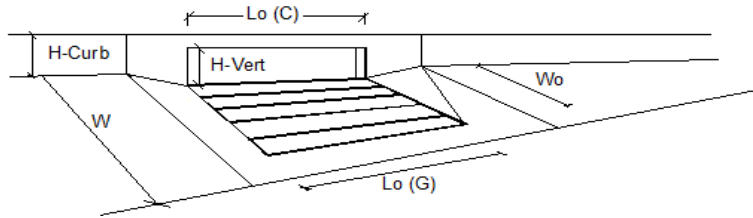
	Minor Storm	Major Storm	
$Q_{allow}$	17.4	63.0	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



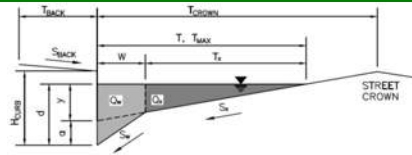
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_u$ =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_u$ =	15.00	15.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_u$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	7.6	17.4	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =	0.0	0.2	cfs
Capture Percentage = $Q_u/Q_s$ =		$C\%$ =	100	99	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 9-4

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_0$	=	0.037	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

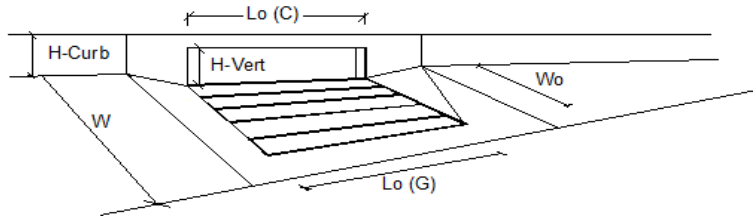
	Minor Storm	Major Storm	
$Q_{allow}$	23.7	52.4	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



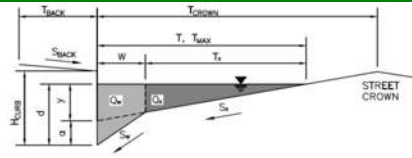
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =	15.00	15.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	6.2	10.2	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =	0.1	3.7	cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =	98	73	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 9-5

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_0$	=	0.037	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

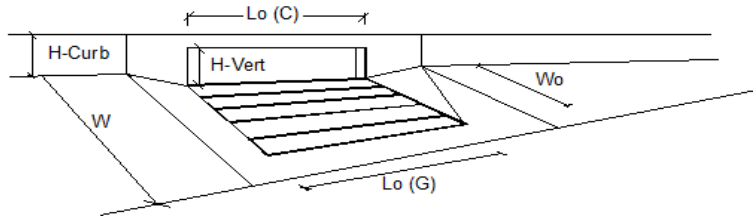
	Minor Storm	Major Storm	
$Q_{allow}$	23.7	52.4	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	0.5	0.9	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =	0.0	0.0	cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =	100	100	%

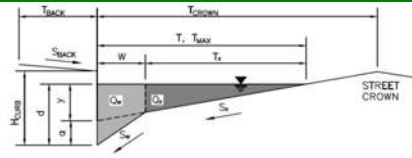


**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 10-3

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK} =$	10.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	25.5	ft
$W =$	2.00	ft
$S_X =$	0.020	ft/ft
$S_W =$	0.083	ft/ft
$S_O =$	0.027	ft/ft
$n_{STREET} =$	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	12.0	25.5	ft
$d_{MAX} =$	4.8	8.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

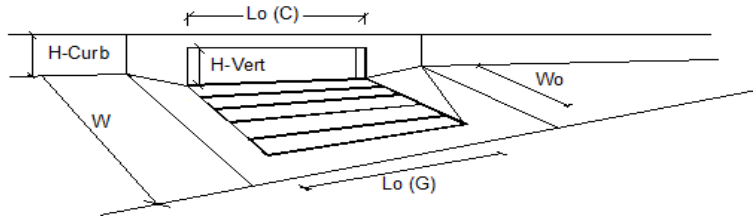
	Minor Storm	Major Storm	
$Q_{allow} =$	9.5	48.1	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



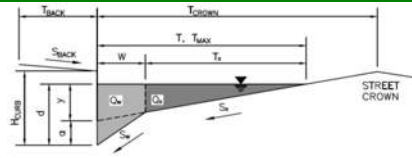
Design Information (Input)		MINOR		MAJOR
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0 inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =	1	1
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =	10.00	10.00 ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =	N/A	N/A ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>		MINOR		MAJOR
Total Inlet Interception Capacity		$Q$ =	5.6	8.3 cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =	1.3	6.9 cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =	81	55 %

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: DP 10-9a

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	25.5	ft
$W$	=	2.00	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_o$	=	0.024	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm		
$T_{MAX}$	=	12.0	25.5	ft
$d_{MAX}$	=	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>		

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

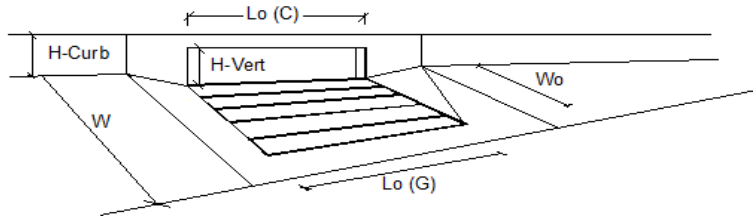
	Minor Storm	Major Storm		
$Q_{allow}$	=	8.9	50.1	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



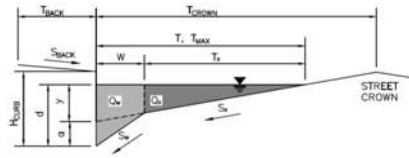
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	2.3	4.3	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_b$ =	0.0	0.0	cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =	100	100	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: 10-10

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	21.0	ft
$W$	=	2.00	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_O$	=	0.024	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	20.8	21.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

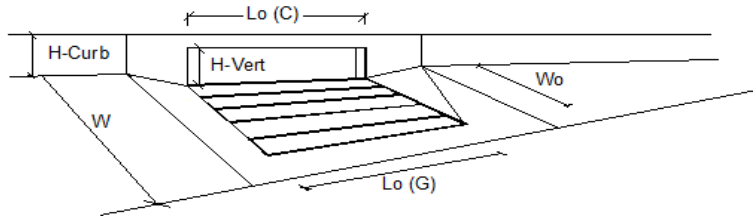
	Minor Storm	Major Storm	
$Q_{allow}$	12.2	49.2	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



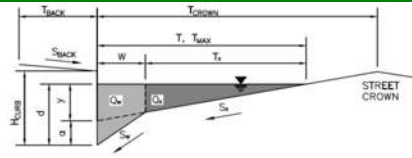
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	2.5	4.5	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_b$ =	0.0	0.0	cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =	100	100	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: dp 8-1

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	38.0	ft
$W$	=	2.00	ft
$S_x$	=	0.020	ft/ft
$S_y$	=	0.083	ft/ft
$S_o$	=	0.011	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	20.0	38.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

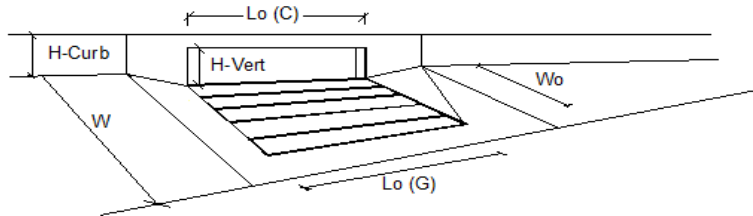
	Minor Storm	Major Storm	
$Q_{allow}$	8.3	46.8	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_o$ =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_o$ =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_o$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	4.0	7.7	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_b$ =	0.0	0.0	cfs
Capture Percentage = $Q_i/Q_o$ =		$C\%$ =	100	100	%

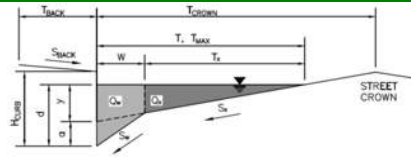


**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: 10a

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_O$	=	0.020	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

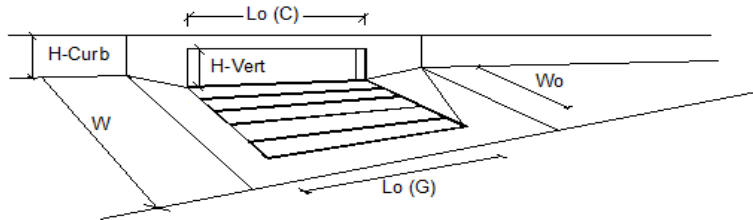
	Minor Storm	Major Storm	
$Q_{allow}$	17.4	62.9	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



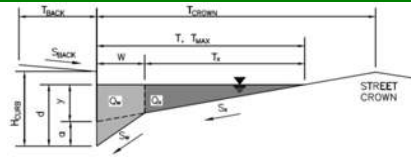
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_u$ =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_u$ =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_u$ =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_r-G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_r-C$ =	0.10	0.10	
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>					
Total Inlet Interception Capacity		$Q$ =	3.7	7.0	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_b$ =	0.3	5.7	cfs
Capture Percentage = $Q_u/Q_a$ =		$C\%$ =	93	55	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: 10b

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_O$	=	0.020	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

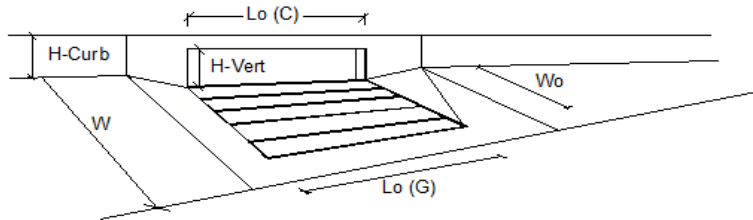
	Minor Storm	Major Storm	
$Q_{allow}$	17.4	63.0	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



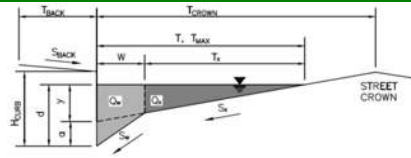
Design Information (Input)		MINOR		MAJOR
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')		a <sub>LOCAL</sub> =	3.0	3.0 inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1
Length of a Single Unit Inlet (Grate or Curb Opening)		L <sub>u</sub> =	10.00	10.00 ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W <sub>u</sub> =	N/A	N/A ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C <sub>r-G</sub> =	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C <sub>r-C</sub> =	0.10	0.10
<b>Street Hydraulics: OK - Q &lt; Allowable Street Capacity</b>		MINOR		MAJOR
Total Inlet Interception Capacity		Q =	1.7	3.5 cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q <sub>s</sub> =	0.0	0.2 cfs
Capture Percentage = Q <sub>i</sub> /Q <sub>a</sub> =		C% =	100	95 %

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CORVALLIS PHASE I

Inlet ID: 10f

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	10.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	17.0	ft
$W$	=	0.83	ft
$S_x$	=	0.020	ft/ft
$S_y$	=	0.083	ft/ft
$S_o$	=	0.040	ft/ft
$n_{STREET}$	=	0.013	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	17.0	17.0	ft
$d_{MAX}$	4.8	8.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

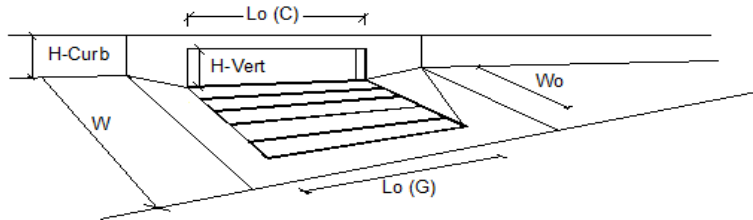
	Minor Storm	Major Storm	
$Q_{allow}$	24.7	51.2	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

# INLET ON A CONTINUOUS GRADE

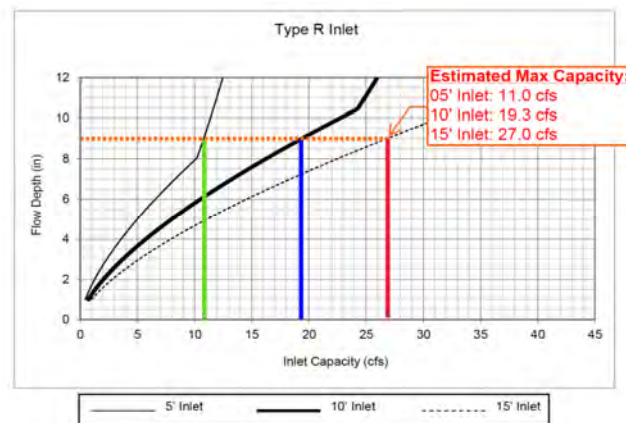
MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR		MAJOR
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')		$a_{LOCAL}$ =	3.0	3.0 inches
Total Number of Units in the Inlet (Grate or Curb Opening)		$N_u$ =	2	2
Length of a Single Unit Inlet (Grate or Curb Opening)		$L_u$ =	15.00	15.00 ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		$W_u$ =	N/A	N/A ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_{r-G}$ =	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_{r-C}$ =	0.10	0.10
<b>Street Hydraulics: OK - <math>Q &lt; \text{Allowable Street Capacity}</math></b>			MINOR	MAJOR
Total Inlet Interception Capacity		$Q$ =	5.3	11.7 cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		$Q_s$ =	0.0	0.0 cfs
Capture Percentage = $Q_u/Q_a$ =		$C\%$ =	100	100 %

**INLET SUMMARY**  
**CORVALLIS PHASE I**

DESIGN POINT or SUB-BASIN	SUB-BASINS	TOTAL AREA (AC)	INLET			Q(5) BYPASS FLOWS (cfs)	Q(5) TOTAL INFLOW	Q5 INLET CAPACITY	Q(100) BYPASS FLOWS (cfs)	Q(100) TOTAL INFLOW (cfs)	MAX INLET CAPACITY	NOTES:
			SIZE (Ft.)	TYPE	CONDITION							
8-1	8c	0.97	2x10	R	AT-GRADE	0.0	3.43	4.0	0.0	6.70	7.7	
8-2a	8b (Inlet)	0.92	2x10	R	AT-GRADE	0.0	3.19	4.0	0.0	6.27	7.7	
9-1	9c	1.18	15	R	AT-GRADE	0.0	2.30	2.3	0.0	5.07	5.2	
9-2	9b	4.46	15X2	R	AT-GRADE	0.0	7.52	7.6	0.2	17.56	17.4	Bypass to Sub-basin 10a
9-4	9d	3.17	15	R	AT-GRADE	0.1	6.29	6.2	3.7	13.86	10.2	Bypass to Sub-basin 10a
9-5	n/a	0.12	5	R	AT-GRADE	0.0	0.49	0.5	0.0	0.90	0.9	
10a	10a	1.94	10	R	AT-GRADE	0.3	3.98	3.7	5.6	12.59	7.0	BYPASS TO 10-2 FUT / 10-2
10b	10b	0.78	10	R	AT-GRADE	0.0	1.68	1.7	0.2	3.70	3.5	BYPASS TO 10-2 FUT / 10-2
10e (Developed)	10e (Developed)	7.10	2X10	R	SUMP	0.0	11.13	11.1	0.0	32.00	38.0	DP 10-2 FUT EQUALIZES ACROSS CROWN
10f (Developed)	10f (Developed)	2.78	2x15	R	AT-GRADE	0.0	5.30	5.3	0.0	11.66	11.7	FUTURE DP 10-3 FUT
10-3a	10g	3.62	10	R	AT-GRADE	1.5	7.07	5.6	7.3	15.58	8.3	
10-4	10g	3.62	10	R	SUMP	0.0	7.07	7.1	0.0	15.58	19.0	Design ignores DP 10-3a
10-5	11b	0.81	10	R	SUMP	0.0	3.40	7.0	0.0	6.20	19.0	
10-9	11e	0.59	2x10	R	AT-GRADE	0.0	2.35	2.5	0.0	4.29	4.3	Negligible bypass continues to GAW F9. 15.5 to 15.7 cfs, Capacity: 17.9 cfs
10-10	11d	0.58	2x10	R	AT-GRADE	0.0	2.46	2.5	0.0	4.49	4.5	No Bypass to GAW F9
12-1	12b	3.62	10X2	R	AT-GRADE	0.0	6.96	7.0	2.1	15.33	13.2	
12-2	12c	1.50	10	R	AT-GRADE	0.0	3.11	3.1	1.7	6.86	5.2	
12-4	12a, 12d	7.24	15	R	SUMP	0.0	11.71	13.0	2.6	29.59	27.0	Equalize to 12-5
12-5	12e	3.24	10	R	SUMP	0.0	5.15	6.0	0.0	13.93	19.0	Overflow from 12-4
14-1	14b	2.03	10	R	AT-GRADE	0.1	3.49	3.4	2.2	7.69	5.5	Bypass to 14-4
14-2	14c	0.93	10	R	AT-GRADE	0.0	1.86	1.9	0.3	4.11	3.8	Bypass to 14-4
14-4	14d, 14a	7.03	15	R	SUMP	0.0	9.26	13.0	0.0	25.79	27.0	Bypass from 14-1 & 14-2
14-5	14e, 14f	4.81	10	R	SUMP	0.0	9.01	13.0	0.0	19.84	20.4	Slightly over 9" sump and/or Equalize to 14-4 in Q100
14-7	14g	4.86	15	R	SUMP	0.0	7.89	13.0	0.0	17.37	27.0	
14-8	14i	1.36	5	R	SUMP	0.0	2.67	2.7	0.0	5.89	11.0	
15-1	15b, 15c	5.46	15	R	SUMP	0.0	9.68	13.0	0.0	21.31	27.0	
15-2a	15a, 15d (Inlet)	6.39	15	R	SUMP	0.0	10.73	13.0	0.0	23.63	27.0	
16-1	14h	1.95	4x10	R	AT-GRADE	0.0	4.18	4.2	0.0	9.20	9.2	
16-2a	16c	0.89	10	R	SUMP	0.0	2.76	10.0	0.0	5.46	19.3	
16d	Lorson Boulevard	0.23	10	R	SUMP	0.0	0.80	10.0	0.0	1.55	19.3	
OS-5	FONTAINE	1.21	2x10	R	AT-GRADE	0.0	4.82	5.4	0.0	8.38	9.3	
OS-6	FONTAINE	1.34	2x10	R	AT-GRADE	0.0	5.35	5.3	0.0	9.30	9.3	



# OUTFALL PROTECTION CALCULATIONS

	OS-5		OS-6		MK2		DF-8 OUT		DF-9 OUT		9-7	
Pipe Size (D)	18	Inches	18	Inches	36	Inches	24	Inches	24	Inches	30	Inches
Q	8.4	cfs	9.3	cfs	110.6	cfs	14.2	cfs	11.8	cfs	38.0	cfs
L	4.5	Feet	4.5	Feet	9	Feet	6	Feet	6	Feet	7.5	Feet
W	4.5	Feet	4.5	Feet	9	Feet	6	Feet	6	Feet	7.5	Feet
D	0	Feet	0	Feet	0	Feet	0	Feet	0	Feet	0	Feet
d50	0.15	Feet	0.14	Feet	0.43	Feet	0.14	Feet	0.15	Feet	0.26	Feet
	1.74	Inches	1.71	Inches	5.13	Inches	1.69	Inches	1.75	Inches	3.07	Inches
Depth of Flow	1.14	Feet	1.27	Feet	3.36	Feet	1.70	Feet	1.41	Feet	2.21	Feet
Q/D <sup>1.5</sup>	4.56		5.06		21.29		5.02		4.17		9.60	
Y <sub>t</sub> /D	0.762		0.845		1.120		0.848		0.704		0.884	
Rip Rap	Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream	
Length of Rock	4.5	Feet	4.5	Feet	9	Feet	6	Feet	6	Feet	7.5	Feet
Width of Rock	4.5	Feet	4.5	Feet	9.0	Feet	6.0	Feet	6.0	Feet	7.5	Feet

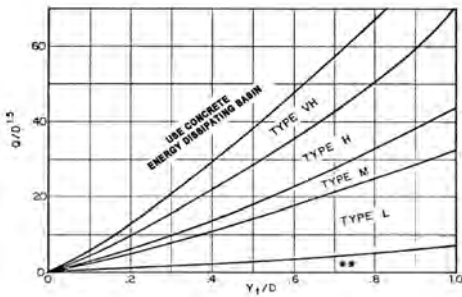


Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for  $Q/D^{2.5} \leq 6.0$ )

CLASSIFICATION AND GRADATION OF ORDINARY RIP RAP			
Rip Rap Designation by Weight	% Smaller Than Given Size (Inches)	Intermediate Rock Dimension	d50* (Inches)
Type VL	70 - 100	12	6**
	50 - 70	9	
	35 - 50	6	
	2 - 10	2	
Type L	70 - 100	15	9**
	50 - 70	12	
	35 - 50	9	
	2 - 10	3	
Type M	70 - 100	21	12
	50 - 70	18	
	35 - 50	12	
	2 - 10	4	
Type H	70 - 100	30	18
	50 - 70	24	
	35 - 50	18	
	2 - 10	6	
Type VH	70 - 100	42	24
	50 - 70	33	
	35 - 50	24	
	2 - 10	9	

\* d50 = Mean particle size  
 \*\* Bury types VL and L with native top soil and revegetate to protect from vandalism.

	Inputs
	calculations



### 3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for  $Q/D_c^{3/2}$  of 6.0 or less and Figure 9-39 is valid for  $Q/WH^{3/2}$  of 8.0 or less. The parameters in these two figures are:

1.  $Q/D_c^{3/2}$  or  $Q/WH^{3/2}$  in which  $Q$  is the design discharge in cfs,  $D_c$  is the diameter of a circular conduit in feet, and  $W$  and  $H$  are the width and height of a rectangular conduit in feet.
2.  $Y_t/D_c$  or  $Y_t/H$  in which  $Y_t$  is the tailwater depth in feet,  $D_c$  is the diameter of a circular conduit in feet, and  $H$  is the height of a rectangular conduit in feet. In cases where  $Y_t$  is unknown or a hydraulic jump is suspected downstream of the outlet, use  $Y_t/D_c = Y_t/H = 0.40$  when using Figures 9-38 and 9-39.
3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_s = \frac{0.023Q}{Y_t^{1/3} D_c^{2/3}} \quad \text{Equation 9-16}$$

Rectangular culvert:

$$d_s = \frac{0.014H^{2/3}Q}{Y_t W} \quad \text{Equation 9-17}$$

### 3.2.2 Low Tailwater Basin

The design of low tailwater riprap basins is necessary when the receiving channel may have little or no flow or tailwater at time when the pipe or culvert is in operation. Figure 9-37 provides a plan and profile view of a typical low tailwater riprap basin.

By providing a low tailwater basin at the end of a storm drain conduit or culvert, the kinetic energy of the discharge dissipates under controlled conditions without causing scour at the channel bottom.

Low tailwater is defined as being equal to or less than  $\frac{1}{3}$  of the height of the storm drain, that is:

$$Y_t \leq \frac{D}{3} \quad \text{or} \quad Y_t \leq \frac{H}{3}$$

Where:

$Y_t$  = tailwater depth at design flow (feet)

$D$  = diameter of circular pipe (feet)

$H$  = height of rectangular pipe (feet)

#### Rock Size

The procedure for determining the required riprap size downstream of a conduit outlet is in Section 3.2.3.

After selecting the riprap size, the minimum thickness of the riprap layer,  $T$ , in feet, in the basin is defined as:

$$T = 2D_{50} \quad \text{Equation 9-15}$$

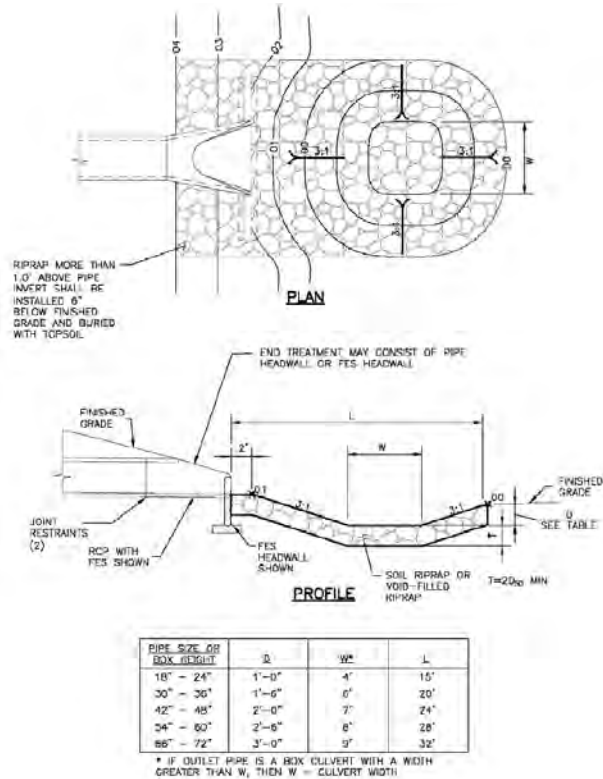


Figure 9-37. Low tailwater riprap basin

# Proposed Pond Summary

## CORVALLIS PHASE I

Pond	Tributary Area	% Impervious	Pre-Development Peak		Pond Outflow		Pre vs. Post Ratio		Detention Volume (Acre-feet)		
			Q5	Q100	Q5	Q100	Q5	Q100	WQCV	EURV	Q100
DF-4/5	92.88	55.96%	22.3	100.7	10.5	79.6	0.5	0.8	1.731	5.62	10.135
DF-6	7.32	89.02%	3.6	14.2	0.2	10.9	0.1	0.8	0.241	0.732	0.838
DF-7	22.84	55.88%	4.9	22.4	1.0	14.8	0.2	0.7	0.426	1.386	3.081
DF-8	39.25	65.26%	11.5	49.9	4.4	14.2	0.4	0.3	0.742	2.418	4.379
DF-9	16.00	78.20%	4.3	16.7	2.2	11.8	0.5	0.7	0.428	1.313	2.265

# Hydraulic Analysis Report

## Project Data

Project Title: CORVALLIS PHASE I  
Designer: JTS  
Project Date: Tuesday, August 31, 2021  
Project Units: U.S. Customary Units  
Notes:

## Channel Analysis: CHANNEL ANALYSIS (CA) OS-5

Notes:

## Input Parameters

Channel Type: Trapezoidal  
Side Slope 1 (Z1): 4.0000 ft/ft  
Side Slope 2 (Z2): 4.0000 ft/ft  
Channel Width: 4.0000 ft  
Longitudinal Slope: 0.0130 ft/ft  
Manning's n: 0.0522  
Flow: 8.4000 cfs

## Result Parameters

Depth: 0.6545 ft  
Area of Flow: 4.3316 ft<sup>2</sup>  
Wetted Perimeter: 9.3972 ft  
Hydraulic Radius: 0.4609 ft  
Average Velocity: 1.9392 ft/s  
Top Width: 9.2361 ft  
Froude Number: 0.4990  
Critical Depth: 0.4416 ft  
Critical Velocity: 3.2985 ft/s  
Critical Slope: 0.0580 ft/ft  
Critical Top Width: 7.53 ft  
Calculated Max Shear Stress: 0.5309 lb/ft<sup>2</sup>  
Calculated Avg Shear Stress: 0.3739 lb/ft<sup>2</sup>

## **Channel Lining Analysis: CHANNEL LINING DESIGN ANALYSIS (CLDA) OS-5**

Notes:

### **Lining Input Parameters**

Channel Lining Type: Vegetation

Specific Weight of Water: 62.4 lb/ft<sup>3</sup>

Height of Vegetation: 0.333 ft

Vegetation Condition is good

Growth Form of Vegetation is mixed

Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)

soil is noncohesive

D75: 0.1

Safety Factor: 1

### **Lining Results**

Cn: 0.165205

Permissible Soil Shear Stress: 0.04 lb/ft<sup>2</sup>

Mean Boundary Shear Stress: 0.373916 lb/ft<sup>2</sup>

Maximum Shear Stress on the Channel Bottom: 0.530939 lb/ft<sup>2</sup>

Manning's n: 0.0521547

Soil Grain Roughness: 0.0177136

Effective Shear Stress: 0.0124922 lb/ft<sup>2</sup>

Permissible Shear Stress on Vegetation: 1.38705 lb/ft<sup>2</sup>

This value is compared with the maximum shear stress times the safety factor to determine lining stability

### **Channel Bottom Shear Results**

channel bottom is stable

### **Channel Lining Stability Results**

the channel is stable

### **Channel Summary**

Name of Selected Channel: CHANNEL ANALYSIS (CA) OS-5

## Channel Analysis: CA 9-8

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0593

Flow: 21.9000 cfs

### Result Parameters

Depth: 1.4087 ft

Area of Flow: 13.5731 ft<sup>2</sup>

Wetted Perimeter: 15.6167 ft

Hydraulic Radius: 0.8691 ft

Average Velocity: 1.6135 ft/s

Top Width: 15.2699 ft

Froude Number: 0.3016

Critical Depth: 0.7560 ft

Critical Velocity: 4.1244 ft/s

Critical Slope: 0.0650 ft/ft

Critical Top Width: 10.05 ft

Calculated Max Shear Stress: 0.4395 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.2712 lb/ft<sup>2</sup>

## **Channel Lining Analysis: CLDA 9-8**

Notes:

### **Lining Input Parameters**

Channel Lining Type: Vegetation

Specific Weight of Water: 62.4 lb/ft<sup>3</sup>

Height of Vegetation: 0.333 ft

Vegetation Condition is good

Growth Form of Vegetation is mixed

Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)

soil is noncohesive

D75: 0.1

Safety Factor: 1

### **Lining Results**

Cn: 0.165205

Permissible Soil Shear Stress: 0.04 lb/ft<sup>2</sup>

Mean Boundary Shear Stress: 0.271171 lb/ft<sup>2</sup>

Maximum Shear Stress on the Channel Bottom: 0.439525 lb/ft<sup>2</sup>

Manning's n: 0.059307

Soil Grain Roughness: 0.0177136

Effective Shear Stress: 0.00799745 lb/ft<sup>2</sup>

Permissible Shear Stress on Vegetation: 1.79357 lb/ft<sup>2</sup>

This value is compared with the maximum shear stress times the safety factor to determine lining stability

### **Channel Bottom Shear Results**

channel bottom is stable

### **Channel Lining Stability Results**

the channel is stable

### **Channel Summary**

Name of Selected Channel: CA 9-8

## Channel Analysis: CA 9-7

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0113 ft/ft

Manning's n: 0.0441

Flow: 37.0000 cfs

### Result Parameters

Depth: 1.2965 ft

Area of Flow: 11.9103 ft<sup>2</sup>

Wetted Perimeter: 14.6916 ft

Hydraulic Radius: 0.8107 ft

Average Velocity: 3.1066 ft/s

Top Width: 14.3723 ft

Froude Number: 0.6014

Critical Depth: 0.9992 ft

Critical Velocity: 4.6307 ft/s

Critical Slope: 0.0333 ft/ft

Critical Top Width: 11.99 ft

Calculated Max Shear Stress: 0.9102 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.5691 lb/ft<sup>2</sup>

## **Channel Lining Analysis: CLDA 9-7**

Notes:

### **Lining Input Parameters**

Channel Lining Type: Vegetation

Specific Weight of Water: 62.4 lb/ft<sup>3</sup>

Height of Vegetation: 0.333 ft

Vegetation Condition is good

Growth Form of Vegetation is mixed

Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)

soil is noncohesive

D75: 0.1

Safety Factor: 1

### **Lining Results**

Cn: 0.165205

Permissible Soil Shear Stress: 0.04 lb/ft<sup>2</sup>

Mean Boundary Shear Stress: 0.569103 lb/ft<sup>2</sup>

Maximum Shear Stress on the Channel Bottom: 0.910173 lb/ft<sup>2</sup>

Manning's n: 0.0440886

Soil Grain Roughness: 0.0177136

Effective Shear Stress: 0.0299675 lb/ft<sup>2</sup>

Permissible Shear Stress on Vegetation: 0.991196 lb/ft<sup>2</sup>

This value is compared with the maximum shear stress times the safety factor to determine lining stability

### **Channel Bottom Shear Results**

channel bottom is stable

### **Channel Lining Stability Results**

the channel is stable

### **Channel Summary**

Name of Selected Channel: CA 9-7



## Channel Analysis: CA 9-9

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0660 ft/ft

Manning's n: 0.0654

Flow: 84.0000 cfs

### Result Parameters

Depth: 1.5119 ft

Area of Flow: 15.1917 ft<sup>2</sup>

Wetted Perimeter: 16.4678 ft

Hydraulic Radius: 0.9225 ft

Average Velocity: 5.5293 ft/s

Top Width: 16.0956 ft

Froude Number: 1.0030

Critical Depth: 1.5141 ft

Critical Velocity: 5.5166 ft/s

Critical Slope: 0.0655 ft/ft

Critical Top Width: 16.11 ft

Calculated Max Shear Stress: 6.2268 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 3.7993 lb/ft<sup>2</sup>

## Channel Lining Analysis: CLDA 9-9

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 1 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.33544

### Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.943845

Manning's n method: Bathurst

Manning's n: 0.0653982

### Channel Bottom Shear Results

V\*: 1.79254

Reynold's Number: 147292

Shield's Parameter: 0.116069

shear stress on channel bottom: 6.22681 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 10.4219 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.79789 ft

### Channel Side Shear Results

K1: 0.934

K2: 1

Kb: 0

shear stress on side of channel: 6.22681 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 10.4219 lb/ft<sup>2</sup>

Stable Side D50: 0.745229 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: CA 9-9

## Channel Analysis: CA Basin 15e

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0300

Flow: 5.1000 cfs

### Result Parameters

Depth: 0.3327 ft

Area of Flow: 1.7738 ft<sup>2</sup>

Wetted Perimeter: 6.7438 ft

Hydraulic Radius: 0.2630 ft

Average Velocity: 2.8752 ft/s

Top Width: 6.6619 ft

Froude Number: 0.9819

Critical Depth: 0.3293 ft

Critical Velocity: 2.9130 ft/s

Critical Slope: 0.0208 ft/ft

Critical Top Width: 6.63 ft

Calculated Max Shear Stress: 0.4153 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.3283 lb/ft<sup>2</sup>

## Channel Analysis: CA DF-7 emergency discharge

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0020 ft/ft

Manning's n: 0.0685

Flow: 54.0000 cfs

### Result Parameters

Depth: 2.3958 ft

Area of Flow: 42.1262 ft<sup>2</sup>

Wetted Perimeter: 27.7564 ft

Hydraulic Radius: 1.5177 ft

Average Velocity: 1.2819 ft/s

Top Width: 27.1665 ft

Froude Number: 0.1814

Critical Depth: 0.9513 ft

Critical Velocity: 4.8087 ft/s

Critical Slope: 0.0777 ft/ft

Critical Top Width: 15.61 ft

Calculated Max Shear Stress: 0.2990 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.1894 lb/ft<sup>2</sup>

## Channel Lining Analysis: CLDA DF-7

Notes:

### Lining Input Parameters

Channel Lining Type: Vegetation

Specific Weight of Water: 62.4 lb/ft<sup>3</sup>

Height of Vegetation: 0.333 ft

Vegetation Condition is good

Growth Form of Vegetation is mixed

Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)

soil is noncohesive

D75: 0.1

Safety Factor: 1

### Lining Results

Cn: 0.165205

Permissible Soil Shear Stress: 0.04 lb/ft<sup>2</sup>

Mean Boundary Shear Stress: 0.18941 lb/ft<sup>2</sup>

Maximum Shear Stress on the Channel Bottom: 0.298998 lb/ft<sup>2</sup>

Manning's n: 0.0684607

Soil Grain Roughness: 0.0177136

Effective Shear Stress: 0.00408287 lb/ft<sup>2</sup>

Permissible Shear Stress on Vegetation: 2.38995 lb/ft<sup>2</sup>

This value is compared with the maximum shear stress times the safety factor to determine lining stability

### Channel Bottom Shear Results

channel bottom is stable

### Channel Lining Stability Results

the channel is stable

### Channel Summary

Name of Selected Channel: CA DF-7 emergency discharge

## Channel Analysis: CA MK1

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Channel Width: 5.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0475

Flow: 92.1000 cfs

### Result Parameters

Depth: 2.5191 ft

Area of Flow: 31.6336 ft<sup>2</sup>

Wetted Perimeter: 20.9323 ft

Hydraulic Radius: 1.5112 ft

Average Velocity: 2.9115 ft/s

Top Width: 20.1147 ft

Froude Number: 0.4091

Critical Depth: 1.5992 ft

Critical Velocity: 5.8781 ft/s

Critical Slope: 0.0337 ft/ft

Critical Top Width: 14.60 ft

Calculated Max Shear Stress: 0.7860 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.4715 lb/ft<sup>2</sup>

## **Channel Lining Analysis: CLDA MK1**

Notes:

### **Lining Input Parameters**

Channel Lining Type: Vegetation

Specific Weight of Water: 62.4 lb/ft<sup>3</sup>

Height of Vegetation: 0.333 ft

Vegetation Condition is good

Growth Form of Vegetation is mixed

Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)

soil is noncohesive

D75: 0.1

Safety Factor: 1

### **Lining Results**

Cn: 0.165205

Permissible Soil Shear Stress: 0.04 lb/ft<sup>2</sup>

Mean Boundary Shear Stress: 0.471504 lb/ft<sup>2</sup>

Maximum Shear Stress on the Channel Bottom: 0.785966 lb/ft<sup>2</sup>

Manning's n: 0.0475345

Soil Grain Roughness: 0.0177136

Effective Shear Stress: 0.0222621 lb/ft<sup>2</sup>

Permissible Shear Stress on Vegetation: 1.15219 lb/ft<sup>2</sup>

This value is compared with the maximum shear stress times the safety factor to determine lining stability

### **Channel Bottom Shear Results**

channel bottom is stable

### **Channel Lining Stability Results**

the channel is stable

### **Channel Summary**

Name of Selected Channel: CA MK1



## Channel Analysis: CA MK2

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 12.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0488

Flow: 110.6000 cfs

### Result Parameters

Depth: 2.0241 ft

Area of Flow: 40.6774 ft<sup>2</sup>

Wetted Perimeter: 28.6912 ft

Hydraulic Radius: 1.4178 ft

Average Velocity: 2.7190 ft/s

Top Width: 28.1929 ft

Froude Number: 0.3989

Critical Depth: 1.2008 ft

Critical Velocity: 5.4813 ft/s

Critical Slope: 0.0361 ft/ft

Critical Top Width: 21.61 ft

Calculated Max Shear Stress: 0.6315 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.4423 lb/ft<sup>2</sup>

## **Channel Lining Analysis: CLDA MK2**

Notes:

### **Lining Input Parameters**

Channel Lining Type: Vegetation

Specific Weight of Water: 62.4 lb/ft<sup>3</sup>

Height of Vegetation: 0.333 ft

Vegetation Condition is good

Growth Form of Vegetation is mixed

Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)

soil is noncohesive

D75: 0.1

Safety Factor: 1

### **Lining Results**

Cn: 0.165205

Permissible Soil Shear Stress: 0.04 lb/ft<sup>2</sup>

Mean Boundary Shear Stress: 0.442342 lb/ft<sup>2</sup>

Maximum Shear Stress on the Channel Bottom: 0.631522 lb/ft<sup>2</sup>

Manning's n: 0.048764

Soil Grain Roughness: 0.0177136

Effective Shear Stress: 0.0169969 lb/ft<sup>2</sup>

Permissible Shear Stress on Vegetation: 1.21257 lb/ft<sup>2</sup>

This value is compared with the maximum shear stress times the safety factor to determine lining stability

### **Channel Bottom Shear Results**

channel bottom is stable

### **Channel Lining Stability Results**

the channel is stable

### **Channel Summary**

Name of Selected Channel: CA MK2

## Channel Analysis: CA OS-6

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0458

Flow: 9.3000 cfs

### Result Parameters

Depth: 0.5767 ft

Area of Flow: 3.6373 ft<sup>2</sup>

Wetted Perimeter: 8.7557 ft

Hydraulic Radius: 0.4154 ft

Average Velocity: 2.5569 ft/s

Top Width: 8.6137 ft

Froude Number: 0.6934

Critical Depth: 0.4684 ft

Critical Velocity: 3.3806 ft/s

Critical Slope: 0.0440 ft/ft

Critical Top Width: 7.75 ft

Calculated Max Shear Stress: 0.7197 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.5184 lb/ft<sup>2</sup>

## **Channel Lining Analysis: CLDA OS-6**

Notes:

### **Lining Input Parameters**

Channel Lining Type: Vegetation

Specific Weight of Water: 62.4 lb/ft<sup>3</sup>

Height of Vegetation: 0.333 ft

Vegetation Condition is good

Growth Form of Vegetation is mixed

Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)

soil is noncohesive

D75: 0.1

Safety Factor: 1

### **Lining Results**

Cn: 0.165205

Permissible Soil Shear Stress: 0.04 lb/ft<sup>2</sup>

Mean Boundary Shear Stress: 0.518438 lb/ft<sup>2</sup>

Maximum Shear Stress on the Channel Bottom: 0.719739 lb/ft<sup>2</sup>

Manning's n: 0.045764

Soil Grain Roughness: 0.0177136

Effective Shear Stress: 0.0219941 lb/ft<sup>2</sup>

Permissible Shear Stress on Vegetation: 1.06796 lb/ft<sup>2</sup>

This value is compared with the maximum shear stress times the safety factor to determine lining stability

### **Channel Bottom Shear Results**

channel bottom is stable

### **Channel Lining Stability Results**

the channel is stable

### **Channel Summary**

Name of Selected Channel: CA OS-6

## Channel Analysis: CD 15f

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 5.0000 ft/ft

Side Slope 2 (Z2): 5.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0820

Flow: 10.9000 cfs

### Result Parameters

Depth: 0.9155 ft

Area of Flow: 4.1903 ft<sup>2</sup>

Wetted Perimeter: 9.3358 ft

Hydraulic Radius: 0.4488 ft

Average Velocity: 2.6013 ft/s

Top Width: 9.1545 ft

Froude Number: 0.6776

Critical Depth: 0.7835 ft

Critical Velocity: 3.5516 ft/s

Critical Slope: 0.1377 ft/ft

Critical Top Width: 7.83 ft

Calculated Max Shear Stress: 3.4275 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 1.6804 lb/ft<sup>2</sup>

## Channel Lining Analysis: CLDA 15f

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.13132

### Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.610532

Manning's n method: Bathurst

Manning's n: 0.0820295

### Channel Bottom Shear Results

V\*: 1.33016

Reynold's Number: 81973.6

Shield's Parameter: 0.0740205

shear stress on channel bottom: 3.42875 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 5.17095 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.562617 ft

### Channel Side Shear Results

K1: 1

K2: 1

Kb: 0

shear stress on side of channel: 3.42875 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 5.17095 lb/ft<sup>2</sup>

Stable Side D50: 0.562617 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: CD 15f

## Channel Analysis: CD 12-7

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0300

Flow: 55.6000 cfs

### Result Parameters

Depth: 1.1427 ft

Area of Flow: 9.7942 ft<sup>2</sup>

Wetted Perimeter: 13.4232 ft

Hydraulic Radius: 0.7296 ft

Average Velocity: 5.6768 ft/s

Top Width: 13.1418 ft

Froude Number: 1.1588

Critical Depth: 1.2320 ft

Critical Velocity: 5.0552 ft/s

Critical Slope: 0.0146 ft/ft

Critical Top Width: 13.86 ft

Calculated Max Shear Stress: 1.4261 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.9106 lb/ft<sup>2</sup>



## Channel Analysis: CD 14-6

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0300

Flow: 50.4000 cfs

### Result Parameters

Depth: 1.0901 ft

Area of Flow: 9.1135 ft<sup>2</sup>

Wetted Perimeter: 12.9891 ft

Hydraulic Radius: 0.7016 ft

Average Velocity: 5.5302 ft/s

Top Width: 12.7207 ft

Froude Number: 1.1514

Critical Depth: 1.1719 ft

Critical Velocity: 4.9502 ft/s

Critical Slope: 0.0148 ft/ft

Critical Top Width: 13.38 ft

Calculated Max Shear Stress: 1.3604 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.8756 lb/ft<sup>2</sup>

## Channel Analysis: CD 15-2b

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0300

Flow: 44.4000 cfs

### Result Parameters

Depth: 1.0251 ft

Area of Flow: 8.3037 ft<sup>2</sup>

Wetted Perimeter: 12.4532 ft

Hydraulic Radius: 0.6668 ft

Average Velocity: 5.3470 ft/s

Top Width: 12.2008 ft

Froude Number: 1.1422

Critical Depth: 1.0982 ft

Critical Velocity: 4.8173 ft/s

Critical Slope: 0.0150 ft/ft

Critical Top Width: 12.79 ft

Calculated Max Shear Stress: 1.2793 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.8322 lb/ft<sup>2</sup>

**Selected Profile: FHWA Profile (read-only)**

**Culvert Assessment Profiles**

**Culvert Assessment Profile Name: Standard (read-only)**

Maximum Excavation Depth: 20 ft

Maximum Shallow Cover: 4 ft

Maximum Small Pipe Size: 36 in

Minimum Manned Entry Size: 48 in

## **Riprap Classes**

### **Riprap Name: CLASS I**

Riprap Class: I

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 12 in

d85: 9 in

d50: 6.5 in

d15: 4.5 in

### **Riprap Name: CLASS II**

Riprap Class: II

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 18 in

d85: 13 in

d50: 9.5 in

d15: 7 in

### **Riprap Name: CLASS III**

Riprap Class: III

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 24 in

d85: 17 in

d50: 12.5 in

d15: 9 in

### **Riprap Name: CLASS IV**

Riprap Class: IV

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 30 in

d85: 21 in

d50: 15.5 in

d15: 10.5 in

### **Riprap Name: CLASS V**

Riprap Class: V

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 36 in

d85: 25.5 in

d50: 18.5 in

d15: 13 in

**Riprap Name: CLASS VI**

Riprap Class: VI

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 42 in

d85: 30 in

d50: 21.5 in

d15: 15 in

**Riprap Name: CLASS VII**

Riprap Class: VII

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 49.5 in

d85: 35 in

d50: 25.5 in

d15: 17.5 in

**Riprap Name: CLASS VIII**

Riprap Class: VIII

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 60 in

d85: 42.5 in

d50: 31.5 in

d15: 22 in

**Riprap Name: CLASS IX**

Riprap Class: IX

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 72 in

d85: 51 in

d50: 38 in

d15: 26 in

**Riprap Name: CLASS X**

Riprap Class: X

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 84 in

d85: 59.5 in

d50: 44.5 in

d15: 31 in

# Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Monday, Sep 27 2021

## Marksheffel Road Ditch at Corvallis' Lorson Blvd

Invert Elev Dn (ft) = 5684.62  
Pipe Length (ft) = 173.00  
Slope (%) = 0.30  
Invert Elev Up (ft) = 5685.14  
Rise (in) = 36.0  
Shape = Circular  
Span (in) = 36.0  
No. Barrels = 2  
n-Value = 0.013  
Culvert Type = Circular Concrete  
Culvert Entrance = Square edge w/headwall (C)  
Coeff. K,M,c,Y,k = 0.0098, 2, 0.0398, 0.67, 0.5

### Embankment

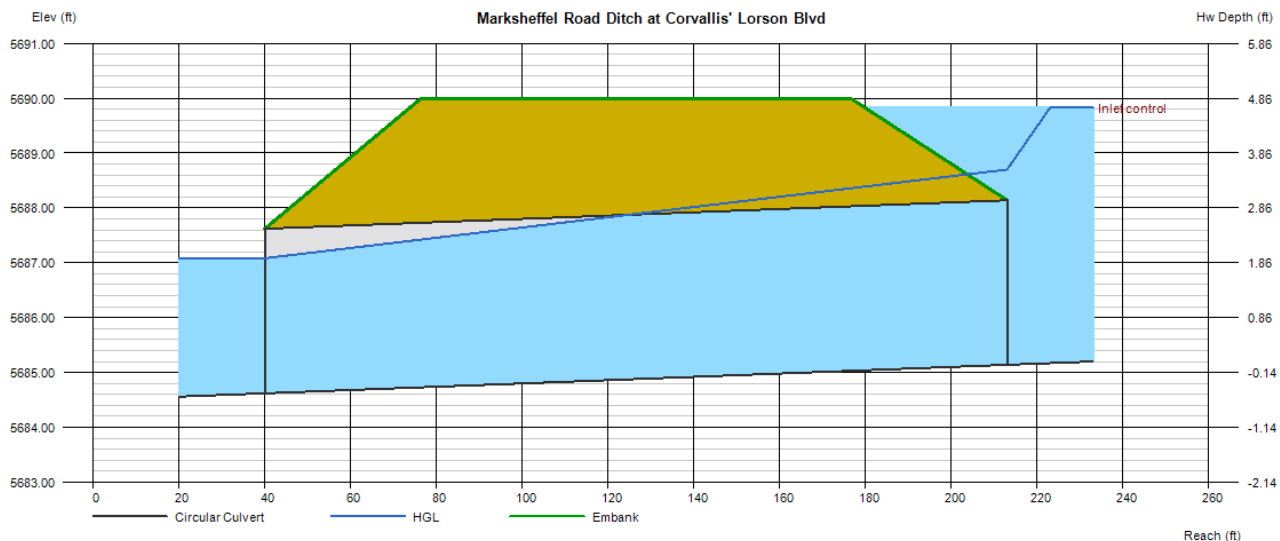
Top Elevation (ft) = 5690.00  
Top Width (ft) = 100.00  
Crest Width (ft) = 50.00

### Calculations

Qmin (cfs) = 116.00  
Qmax (cfs) = 116.00  
Tailwater Elev (ft) = 0.00

### Highlighted

Qtotal (cfs) = 116.00  
Qpipe (cfs) = 116.00  
Qovertop (cfs) = 0.00  
Veloc Dn (ft/s) = 9.34  
Veloc Up (ft/s) = 8.21  
HGL Dn (ft) = 5687.08  
HGL Up (ft) = 5688.70  
Hw Elev (ft) = 5689.83  
Hw/D (ft) = 1.56  
Flow Regime = Inlet Control



# Culvert Calculator Report

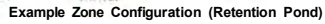
## CV177

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	5,688.70 ft	Headwater Depth/Height	1.13
Computed Headwater Elevation	5,688.17 ft	Discharge	87.06 cfs
Inlet Control HW Elev.	5,688.06 ft	Tailwater Elevation	5,684.52 ft
Outlet Control HW Elev.	5,688.17 ft	Control Type	Outlet Control
Grades			
Upstream Invert	5,684.78 ft	Downstream Invert	5,684.52 ft
Length	77.00 ft	Constructed Slope	0.003377 ft/ft
Hydraulic Profile			
Profile	M2	Depth, Downstream	2.15 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	2.15 ft
Velocity Downstream	8.03 ft/s	Critical Slope	0.005723 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	2		
Outlet Control Properties			
Outlet Control HW Elev.	5,688.17 ft	Upstream Velocity Head	0.74 ft
Ke	0.20	Entrance Loss	0.15 ft
Inlet Control Properties			
Inlet Control HW Elev.	5,688.06 ft	Flow Control	Transition
Inlet Type	Beveled ring, 33.7° bevels	Area Full	14.1 ft <sup>2</sup>
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

*MHFD-Detention, Version 4.02 (February 2020)*

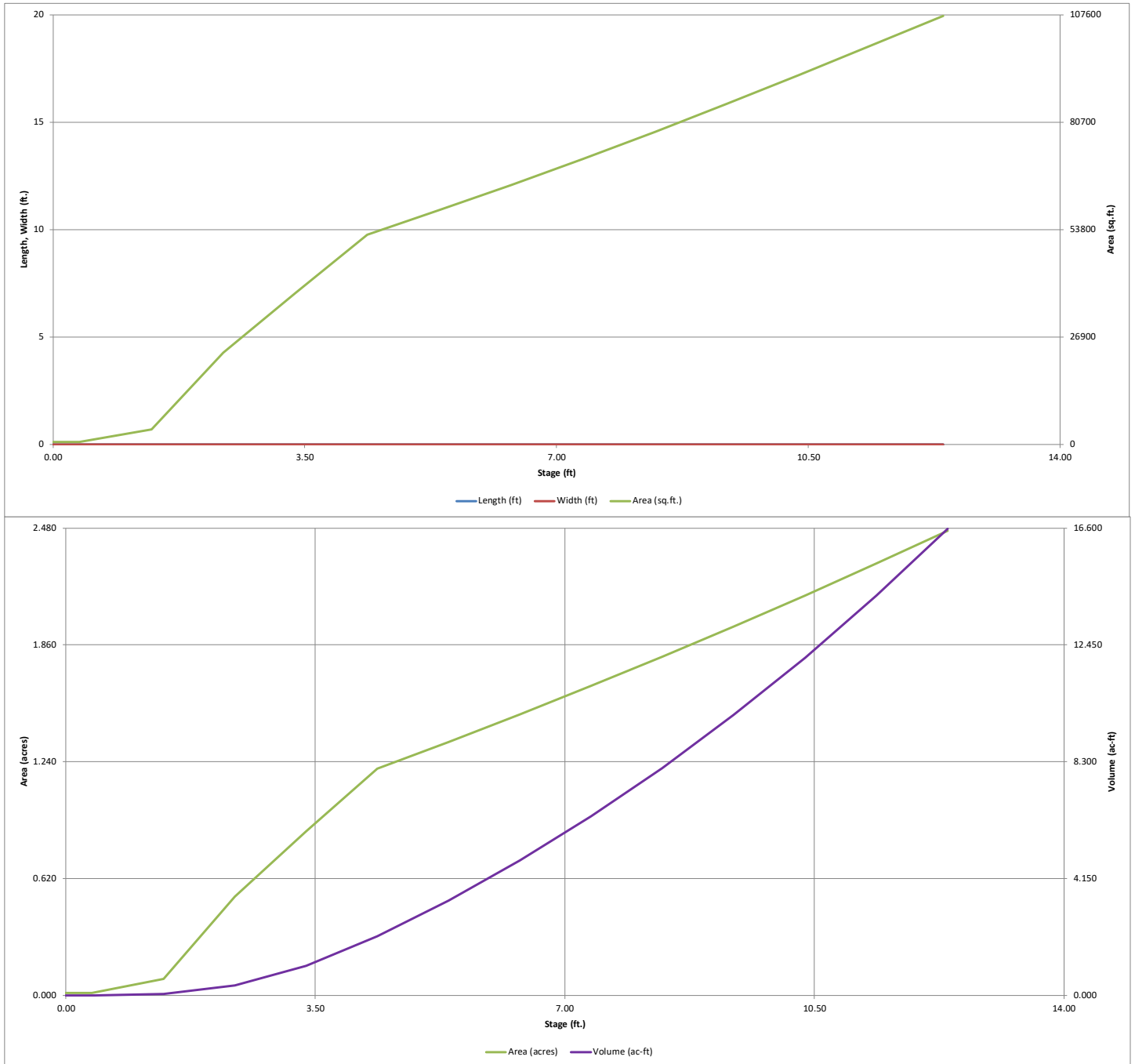
**Basin ID: DF-4/5 (Single/Multi-Family & School Pond)**





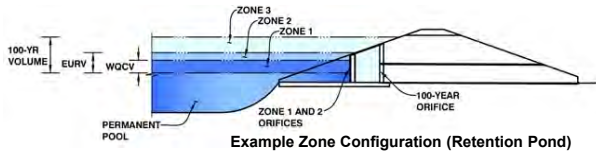
# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)



*MHFD-Detention, Version 4.02 (February 2020)*

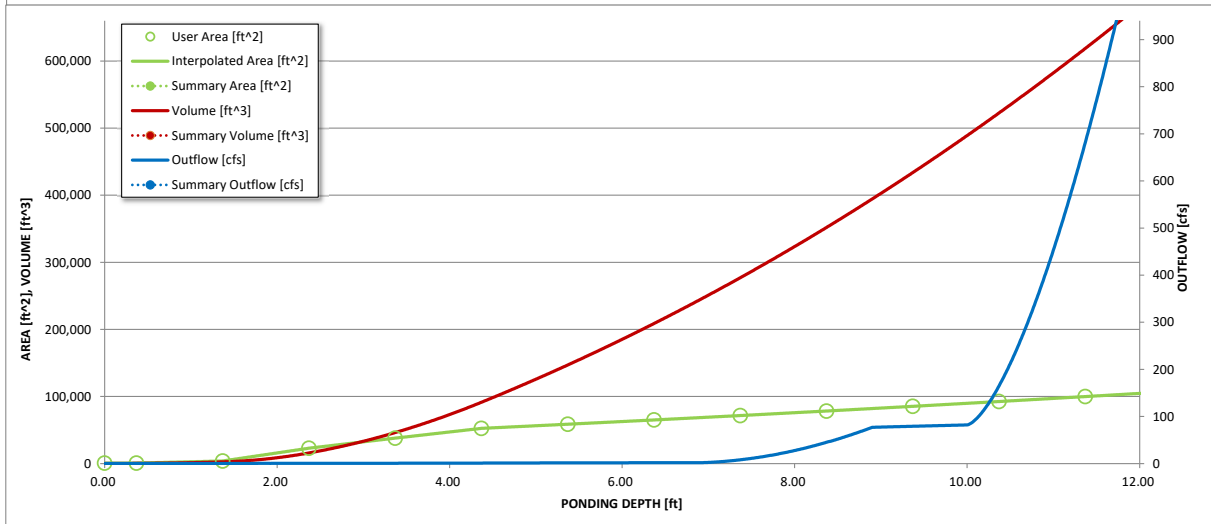
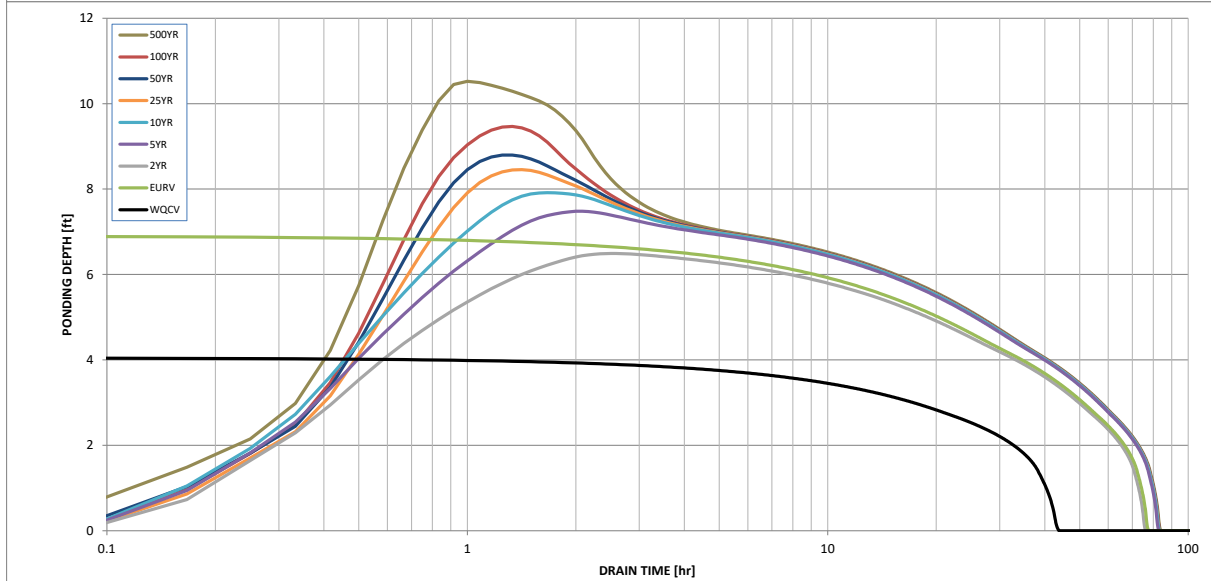
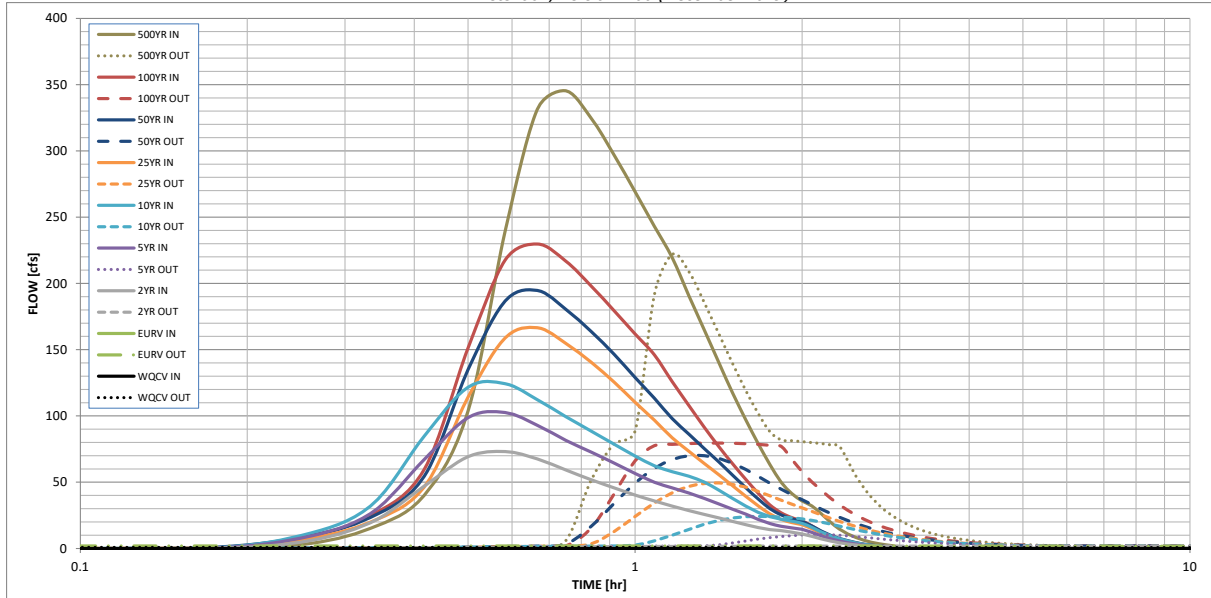
**Basin ID: DF-4/5 (Single/Multi-Family & School Pond)**



	Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.55	
CUHP Runoff Volume (acre-ft)	1.728	5.607	5.280	7.386	9.212	11.578	13.541	15.993	24.410	
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	5.280	7.386	9.212	11.578	13.541	15.993	24.410	
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	7.9	22.3	34.4	62.8	78.8	100.7	168.8	
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A								
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.09	0.24	0.37	0.68	0.85	1.08	1.82	
Peak Inflow Q (cfs)	N/A	N/A	73.1	102.6	124.3	166.5	194.7	229.7	345.3	
Peak Outflow Q (cfs)	0.8	1.9	1.8	10.5	24.2	49.4	70.0	79.6	222.0	
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.5	0.7	0.8	0.9	0.8	1.3	
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway	
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	0.2	0.5	1.1	1.6	1.8	1.9	
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Time to Drain 97% of Inflow Volume (hours)	39	68	67	71	70	68	66	64	58	
Time to Drain 99% of Inflow Volume (hours)	41	72	71	77	76	76	75	74	71	
Maximum Ponding Depth (ft)	4.05	6.91	6.49	7.48	7.91	8.46	8.80	9.47	10.52	
Area at Maximum Ponding Depth (acres)	1.10	1.57	1.51	1.66	1.73	1.81	1.86	1.97	2.15	
Maximum Volume Stored (acre-ft)	1.731	5.620	4.973	6.542	7.270	8.224	8.849	10.135	12.318	

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

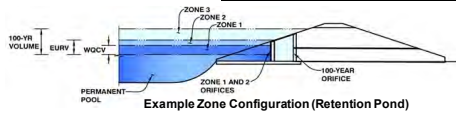


# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-DETENTION, Version 4.02 (February 2020)

Project: **Singer Ranch**

Basin ID: **DF-6 (NE Commercial Pond)**



Example Zone Configuration (Retention Pond)

## Watershed Information

Selected BMP Type =	<b>EDB</b>	
Watershed Area =	<b>7.32</b>	acres
Watershed Length =	<b>660</b>	ft
Watershed Length to Centroid =	<b>175</b>	ft
Watershed Slope =	<b>0.030</b>	ft/ft
Watershed Imperviousness =	<b>89.02%</b>	percent
Percentage Hydrologic Soil Group A =	<b>0.0%</b>	percent
Percentage Hydrologic Soil Group B =	<b>100.0%</b>	percent
Percentage Hydrologic Soil Groups C/D =	<b>0.0%</b>	percent
Target WQCV Drain Time =	<b>40.0</b>	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click "Run CUHP" to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

Water Quality Capture Volume (WQCV) =	<b>0.240</b>	acre-feet
Excess Urban Runoff Volume (EURV) =	<b>0.730</b>	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	<b>0.569</b>	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	<b>0.742</b>	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	<b>0.883</b>	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	<b>1.031</b>	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	<b>1.174</b>	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	<b>1.333</b>	acre-feet
500-yr Runoff Volume (P1 = 3.55 in.) =	<b>1.926</b>	acre-feet
Approximate 2-yr Detention Volume =	<b>0.584</b>	acre-feet
Approximate 5-yr Detention Volume =	<b>0.763</b>	acre-feet
Approximate 10-yr Detention Volume =	<b>0.936</b>	acre-feet
Approximate 25-yr Detention Volume =	<b>1.003</b>	acre-feet
Approximate 50-yr Detention Volume =	<b>1.041</b>	acre-feet
Approximate 100-yr Detention Volume =	<b>1.082</b>	acre-feet

## Optional User Overrides

		acre-feet
		acre-feet
	<b>1.19</b>	inches
	<b>1.50</b>	inches
	<b>1.75</b>	inches
	<b>2.00</b>	inches
	<b>2.25</b>	inches
	<b>2.52</b>	inches
	<b>3.55</b>	inches

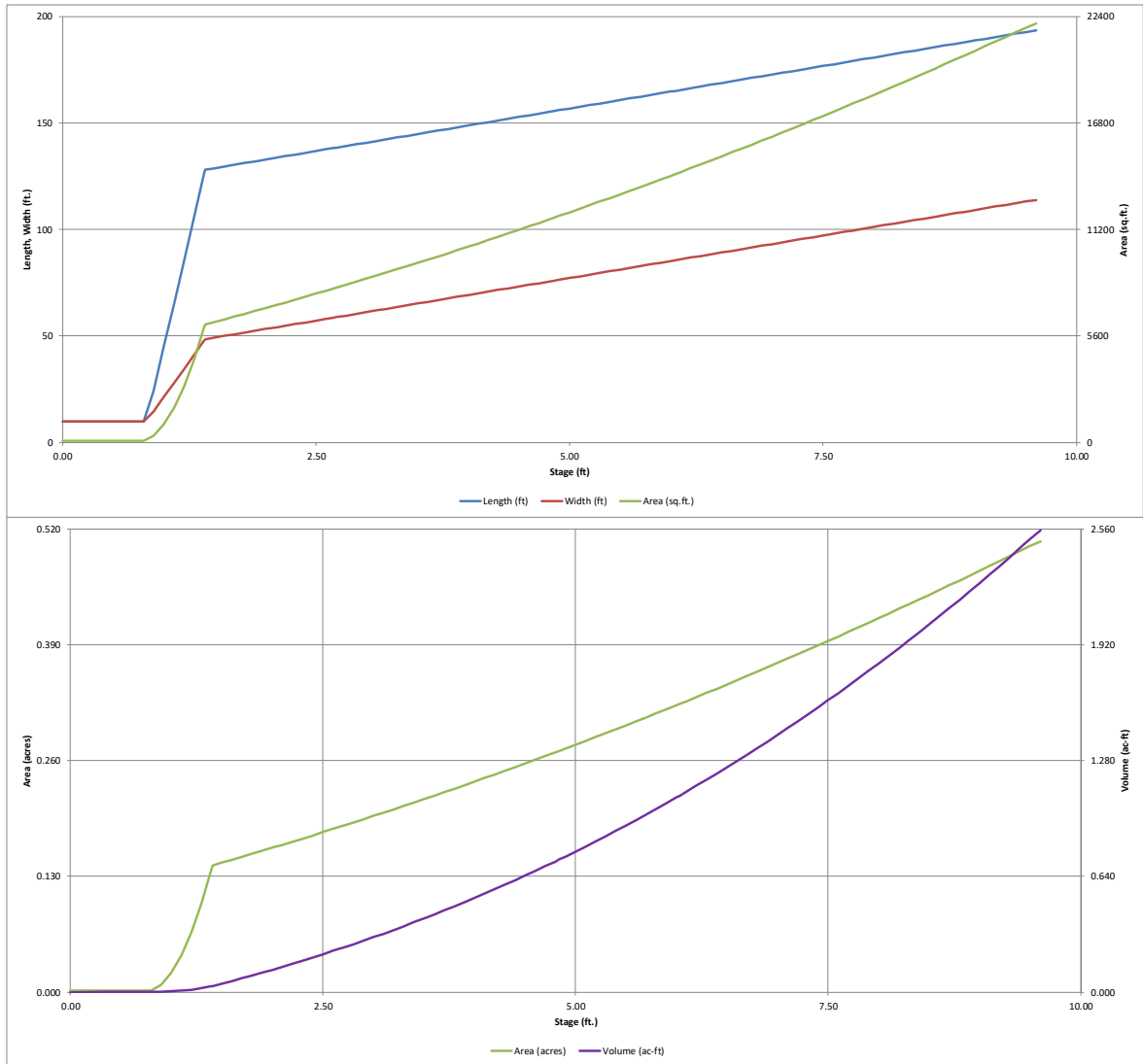
## Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	<b>0.240</b>	acre-feet
Zone 2 Volume (EURV - Zone 1) =	<b>0.490</b>	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	<b>0.353</b>	acre-feet
Total Detention Basin Volume =	<b>1.082</b>	acre-feet
Initial Surcharge Volume (ISV) =	<b>31</b>	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	<b>0.33</b>	ft
Total Available Detention Depth (H <sub>total</sub> ) =	<b>6.00</b>	ft
Depth of Trickle Channel (H <sub>TC</sub> ) =	<b>0.50</b>	ft
Slope of Trickle Channel (S <sub>TC</sub> ) =	<b>0.005</b>	ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	<b>4</b>	H:V
Basin Length-to-Width Ratio (R <sub>L/W</sub> ) =	<b>3</b>	
Initial Surcharge Area (A <sub>ISV</sub> ) =	<b>95</b>	ft <sup>2</sup>
Surcharge Volume Length (L <sub>SV</sub> ) =	<b>9.7</b>	ft
Surcharge Volume Width (W <sub>SV</sub> ) =	<b>9.7</b>	ft
Depth of Basin Floor (H <sub>FLOOR</sub> ) =	<b>0.58</b>	ft
Length of Basin Floor (L <sub>FLOOR</sub> ) =	<b>128.1</b>	ft
Width of Basin Floor (W <sub>FLOOR</sub> ) =	<b>48.4</b>	ft
Area of Basin Floor (A <sub>FLOOR</sub> ) =	<b>6,200</b>	ft <sup>2</sup>
Volume of Basin Floor (V <sub>FLOOR</sub> ) =	<b>1,365</b>	ft <sup>3</sup>
Depth of Main Basin (H <sub>MAIN</sub> ) =	<b>4.59</b>	ft
Length of Main Basin (L <sub>MAIN</sub> ) =	<b>164.8</b>	ft
Width of Main Basin (W <sub>MAIN</sub> ) =	<b>85.1</b>	ft
Area of Main Basin (A <sub>MAIN</sub> ) =	<b>14,029</b>	ft <sup>2</sup>
Volume of Main Basin (V <sub>MAIN</sub> ) =	<b>45,220</b>	ft <sup>3</sup>
Calculated Total Basin Volume (V <sub>total</sub> ) =	<b>1,071</b>	acre-feet

Depth Increment =	0.10								
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft <sup>2</sup> )	Optional Override Area (ft <sup>2</sup> )	Area (acre)	Volume (ft <sup>3</sup> )	Volume (ac-ft)
Top of Micropool	0.00		9.7	9.7	95		0.002		
ISV	0.33		9.7	9.7	95		0.002	31	0.001
	0.40		9.7	9.7	95		0.002	38	0.001
	0.50		9.7	9.7	95		0.002	48	0.001
	0.60		9.7	9.7	95		0.002	57	0.001
	0.70		9.7	9.7	95		0.002	67	0.002
	0.80		9.7	9.7	95		0.002	76	0.002
	0.90		24.0	14.4	346		0.008	94	0.002
	1.00		44.4	21.1	937		0.021	155	0.004
	1.10		64.8	27.7	1,799		0.041	290	0.007
	1.20		85.2	34.4	2,933		0.067	524	0.012
	1.30		105.6	41.1	4,339		0.100	886	0.020
	1.40		126.0	47.7	6,017		0.138	1,401	0.032
Floor	1.41		128.1	48.4	6,200		0.142	1,462	0.034
	1.50		128.8	49.1	6,328		0.145	2,026	0.047
	1.60		129.6	49.9	6,471		0.149	2,666	0.061
	1.70		130.4	50.7	6,615		0.152	3,320	0.076
	1.80		131.2	51.5	6,761		0.155	3,989	0.092
	1.90		132.0	52.3	6,907		0.159	4,672	0.107
	2.00		132.8	53.1	7,055		0.162	5,370	0.123
	2.10		133.6	53.9	7,205		0.165	6,083	0.140
	2.20		134.4	54.7	7,355		0.169	6,811	0.156
	2.30		135.2	55.5	7,507		0.172	7,555	0.173
	2.40		136.0	56.3	7,661		0.176	8,313	0.191
	2.50		136.8	57.1	7,815		0.179	9,087	0.209
Zone 1 (WQCV)	2.60		137.6	57.9	7,971		0.183	9,876	0.227
	2.68		138.2	58.6	8,096		0.186	10,519	0.241
	2.70		138.4	58.7	8,128		0.187	10,681	0.245
	2.80		139.2	59.5	8,286		0.190	11,502	0.264
	2.90		140.0	60.3	8,446		0.194	12,338	0.283
	3.00		140.8	61.1	8,607		0.198	13,191	0.303
	3.10		141.6	61.9	8,769		0.201	14,060	0.323
	3.20		142.4	62.7	8,932		0.205	14,945	0.343
	3.30		143.2	63.5	9,097		0.209	15,846	0.364
	3.40		144.0	64.3	9,263		0.213	16,764	0.385
	3.50		144.8	65.1	9,430		0.216	17,699	0.406
	3.60		145.6	65.9	9,599		0.220	18,650	0.428
	3.70		146.4	66.7	9,769		0.224	19,619	0.450
	3.80		147.2	67.5	9,940		0.228	20,604	0.473
	3.90		148.0	68.3	10,112		0.232	21,607	0.496
	4.00		148.8	69.1	10,286		0.236	22,627	0.519
	4.10		149.6	69.9	10,461		0.240	23,664	0.543
	4.20		150.4	70.7	10,637		0.244	24,719	0.567
	4.30		151.2	71.5	10,815		0.248	25,792	0.592
	4.40		152.0	72.3	10,994		0.252	26,882	0.617
	4.50		152.8	73.1	11,174		0.257	27,990	0.643
	4.60		153.6	73.9	11,355		0.261	29,117	0.668
	4.70		154.4	74.7	11,538		0.265	30,261	0.695
Zone 2 (EURV)	4.80		155.2	75.5	11,722		0.269	31,424	0.721
	4.84		155.5	75.9	11,796		0.271	31,895	0.732
	4.90		156.0	76.3	11,907		0.273	32,606	0.749
	5.00		156.8	77.1	12,094		0.278	33,806	0.776
	5.10		157.6	77.9	12,281		0.282	35,025	0.804
	5.20		158.4	78.7	12,470		0.286	36,262	0.832
	5.30		159.2	79.5	12,661		0.291	37,519	0.861
	5.40		160.0	80.3	12,852		0.295	38,794	0.891
	5.50		160.8	81.1	13,045		0.299	40,089	0.920
	5.60		161.6	81.9	13,239		0.304	41,403	0.950
	5.70		162.4	82.7	13,435		0.308	42,737	0.981
	5.80		163.2	83.5	13,632		0.313	44,090	1.012
	5.90		164.0	84.3	13,830		0.317	45,464	1.044
Zone 3 (100-year)	6.00		164.8	85.1	14,029		0.322	46,856	1.076
	6.03		165.0	85.4	14,089		0.323	47,278	1.084
	6.10		165.6	85.9	14,229		0.327	48,269	1.108
	6.20		166.4	86.7	14,431		0.331	49,702	1.141
	6.30		167.2	87.5	14,634		0.336	51,156	1.174
	6.40		168.0	88.3	14,839		0.341	52,629	1.208
	6.50		168.8	89.1	15,045		0.345	54,123	1.243
	6.60		169.6	89.9	15,252		0.350	55,638	1.277
	6.70		170.4	90.7	15,460		0.355	57,174	1.313
	6.80		171.2	91.5	15,669		0.360	58,730	1.348
	6.90		172.0	92.3	15,880		0.365	60,308	1.384
	7.00		172.8	93.1	16,092		0.369	61,906	1.421
	7.10		173.6	93.9	16,306		0.374	63,526	1.458
	7.20		174.4	94.7	16,520		0.379	65,168	1.496
	7.30		175.2	95.5	16,736		0.384	66,830	1.534
	7.40		176.0	96.3	16,953		0.389	68,515	1.573
	7.50		176.8	97.1	17,172		0.394	70,221	1.612
	7.60		177.6	97.9	17,392		0.399	71,949	1.652
	7.70		178.4	98.7	17,613		0.404	73,699	1.692
	7.80		179.2	99.5	17,835		0.409	75,472	1.733
	7.90		180.0	100.3	18,059		0.415	77,267	1.774
	8.00		180.8	101.1	18,284		0.420	79,084	1.816
	8.10		181.6	101.9	18,510		0.425	80,923	1.858
	8.20		182.4	102.7	18,737		0.430	82,786	1.900
	8.30		183.2	103.5	18,966		0.435	84,671	1.944
	8.40		184.0	104.3	19,196		0.441	86,579	1.988
	8.50		184.8	105.1	19,427		0.446	88,510	2.032
	8.60		185.6	105.9	19,660		0.451	90,464	2.077
	8.70		186.4	106.7	19,894		0.457	92,442	2.122
	8.80		187.2	107.5	20,129		0.462	94,443	2.168
	8.90		188.0	108.3	20,365		0.468	96,468	2.215
	9.00		188.8	109.1	20,603		0.473	98,516	2.262
	9.10		189.6	109.9	20,842		0.478	100,589	2.309
	9.20		190.4	110.7	21,082		0.484	102,685	2.357
	9.30		191.2	111.5	21,324		0.490	104,805	2.406
	9.40		192.0	112.3	21,567		0.495	106,950	2.455
	9.50		192.8	113.1	21,811		0.501	109,118	2.505
	9.60		193.6	113.9	22,056		0.506	111,312	2.555

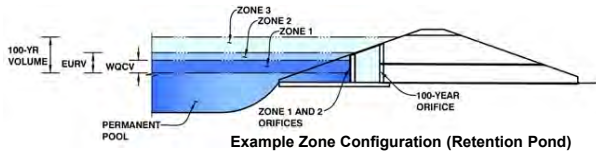
# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)



*MHFD-Detention, Version 4.02 (February 2020)*

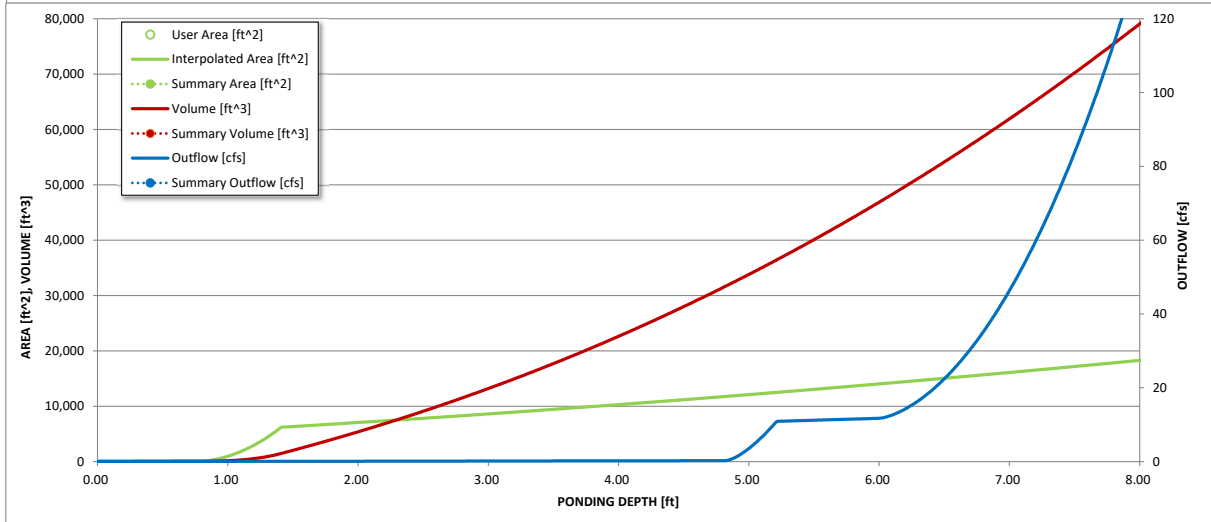
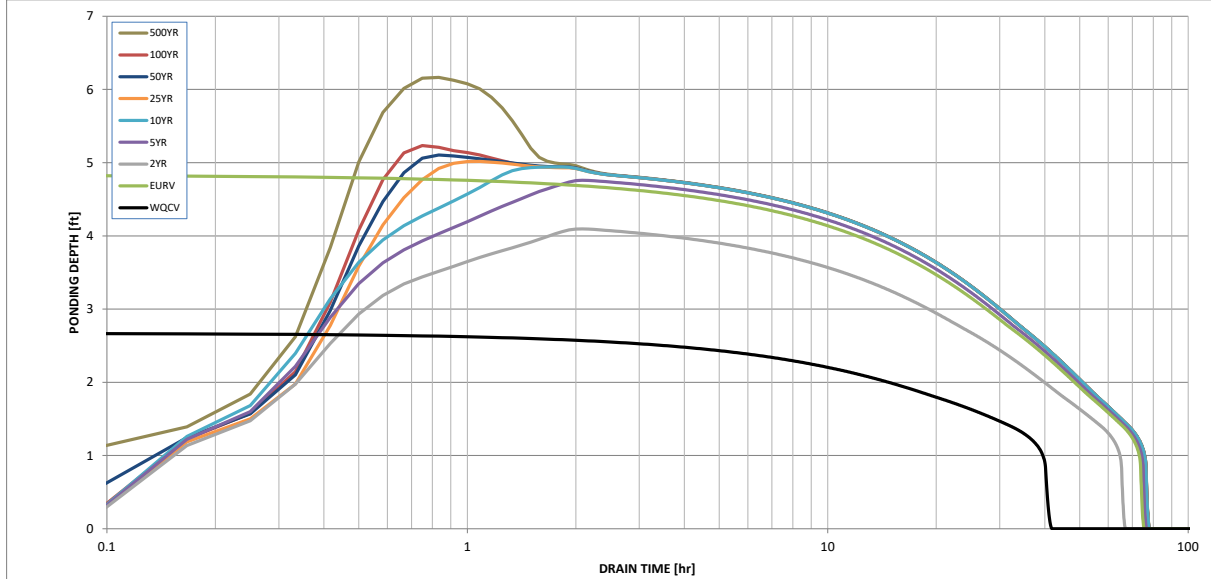
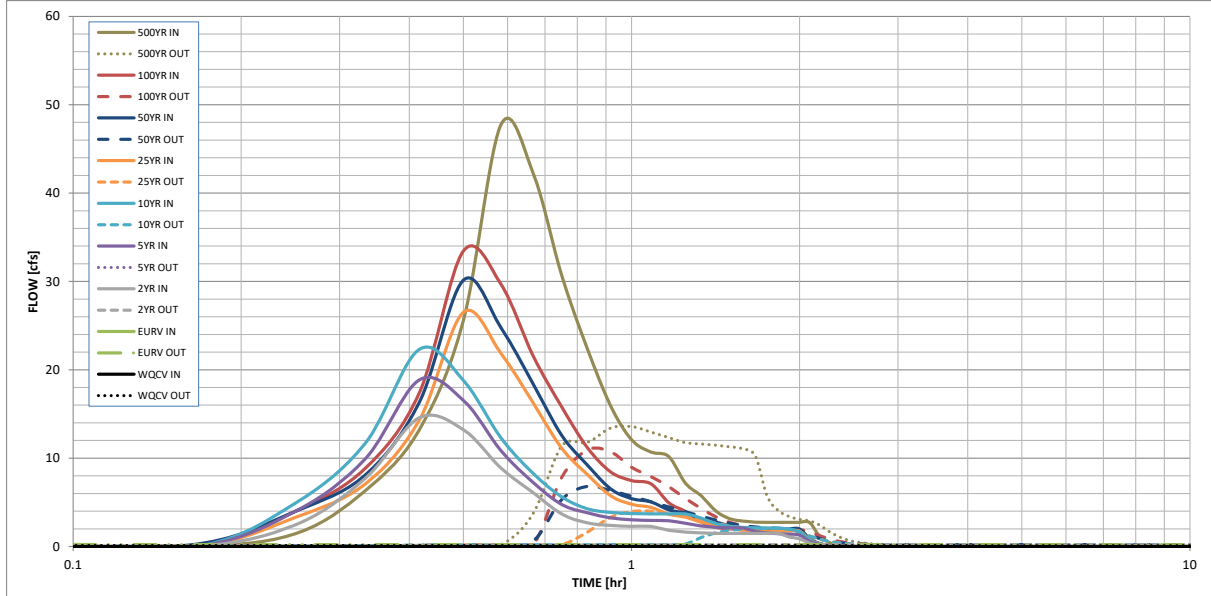
**Basin ID: DF-6 (NE Commercial Pond)**



Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.55
CUHP Runoff Volume (acre-ft)	0.240	0.730	0.569	0.742	0.883	1.031	1.174	1.333	1.926
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.569	0.742	0.883	1.031	1.174	1.333	1.926
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	1.3	3.6	5.4	9.1	11.3	14.2	23.7
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.18	0.49	0.74	1.24	1.54	1.95	3.24
Peak Inflow Q (cfs)	N/A	N/A	14.6	18.8	22.3	26.5	30.2	33.4	47.7
Peak Outflow Q (cfs)	0.1	0.3	0.2	0.2	2.1	4.0	6.8	10.9	13.6
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.1	0.4	0.4	0.6	0.8	0.6
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps)	N/A	0.01	N/A	N/A	0.1	0.2	0.4	0.6	0.7
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	39	68	61	69	70	69	68	67	63
Time to Drain 99% of Inflow Volume (hours)	40	72	64	73	74	74	73	73	72
Maximum Ponding Depth (ft)	2.68	4.84	4.10	4.76	4.94	5.02	5.11	5.23	6.16
Area at Maximum Ponding Depth (acres)	0.19	0.27	0.24	0.27	0.28	0.28	0.28	0.29	0.33
Maximum Volume Stored (acre-ft)	0.241	0.732	0.541	0.708	0.759	0.779	0.804	0.841	1.128

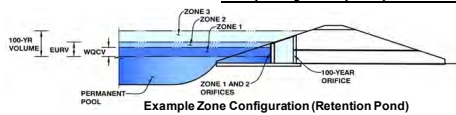
# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



*MHFD-Detention, Version 4.02 (February 2020)*

**Basin ID: DF-7 (NE Single-Family Pond)**



### Watershed Information

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

### Optional User Overrides

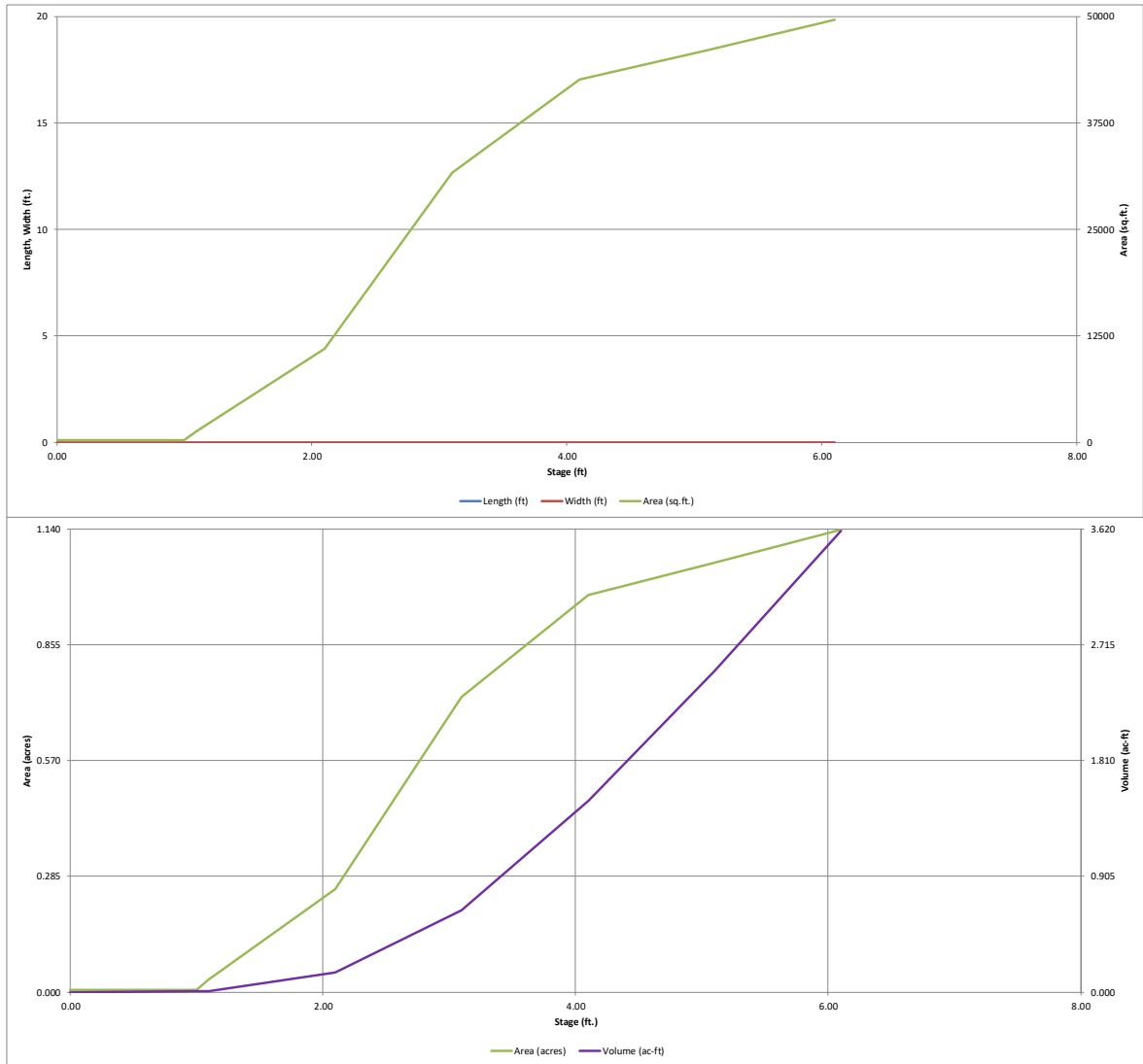
Initial Surcharge Area ( $A_{SV}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{SV}$ )	=	user	ft
Surcharge Volume Width ( $W_{SV}$ )	=	user	ft
Depth of Basin Floor ( $H_{FLOOR}$ )	=	user	ft
Length of Basin Floor ( $L_{FLOOR}$ )	=	user	ft
Width of Basin Floor ( $W_{FLOOR}$ )	=	user	ft
Area of Basin Floor ( $A_{FLOOR}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	user	ft
Length of Main Basin ( $L_{MAIN}$ )	=	user	ft
Width of Main Basin ( $W_{MAIN}$ )	=	user	ft
Area of Main Basin ( $A_{MAIN}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	user	acre-feet

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# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

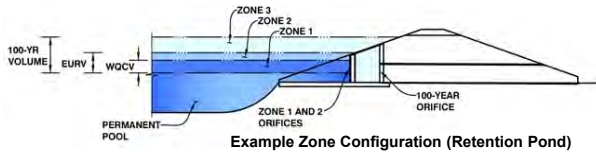


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: **Singer Ranch**

Basin ID: **DF-7 (NE Single-Family Pond)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.77	0.425	Orifice Plate
Zone 2 (EURV)	3.99	0.952	Circular Orifice
Zone 3 (100-year)	4.92	0.942	Weir&Pipe (Restrict)
Total (all zones)		2.319	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 1-1/4 inches)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.92	1.85					
Orifice Area (sq. inches)	1.25	1.25	1.25					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	2.77	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.99	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	5.00	N/A	inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.92	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	50%	N/A	% , grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.30	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	11.25		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	50.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway  
Spillway Design Flow Depth=  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

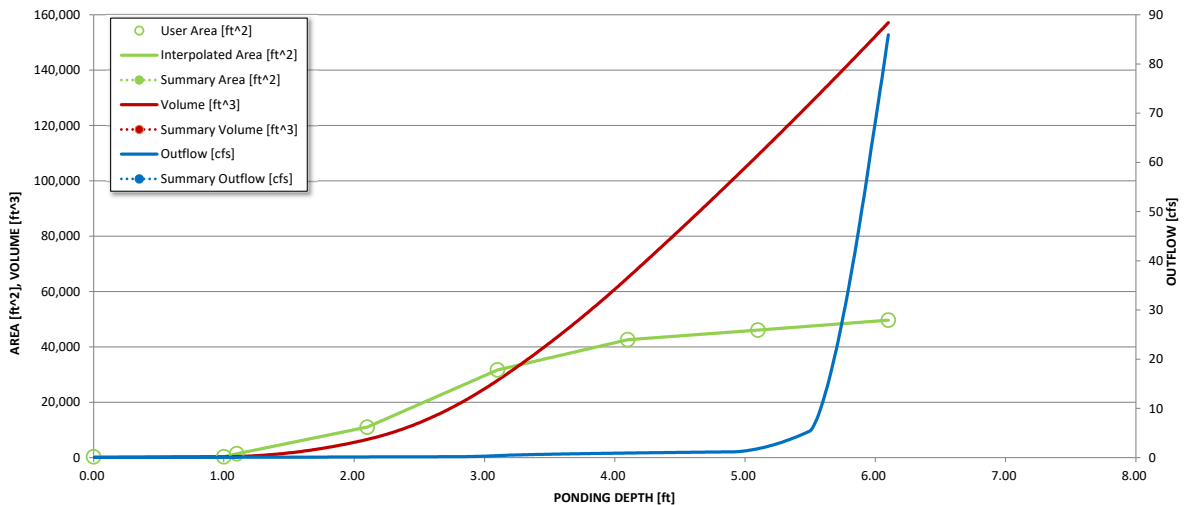
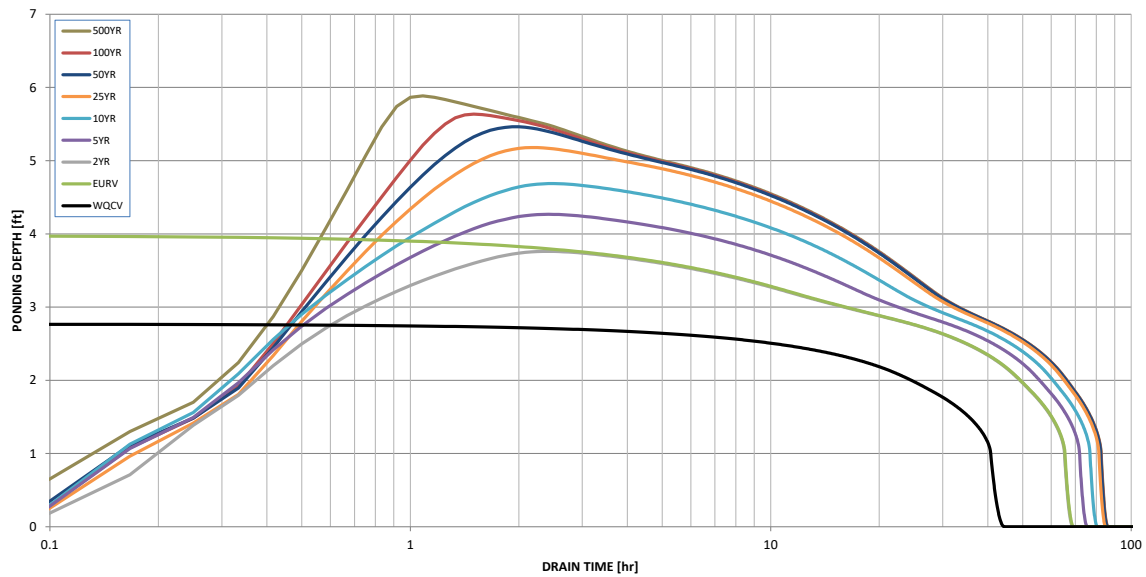
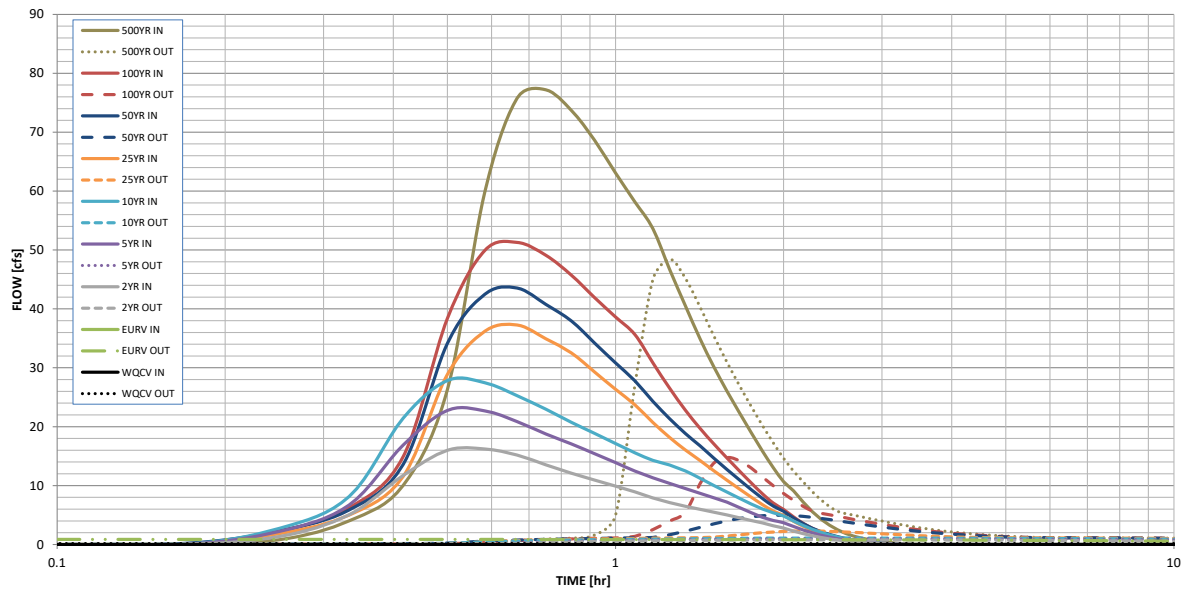
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.55
One-Hour Rainfall Depth (in) =	0.425	1.377	1.295	1.812	2.260	2.841	3.323	3.925	5.992
CUHP Runoff Volume (acre-ft) =	N/A	N/A	1.295	1.812	2.260	2.841	3.323	3.925	5.992
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.7	4.9	7.5	13.9	17.5	22.4	37.5
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.7	4.9	7.5	13.9	17.5	22.4	37.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.08	0.22	0.33	0.61	0.76	0.98	1.64
Peak Inflow Q (cfs) =	N/A	N/A	16.2	22.8	27.8	37.3	43.5	51.3	77.2
Peak Outflow Q (cfs) =	0.2	0.9	0.8	1.0	1.1	2.3	5.0	14.8	48.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.1	0.2	0.3	0.7	1.3
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.3	0.5	0.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	60	60	64	68	70	69	67	61
Time to Drain 99% of Inflow Volume (hours) =	42	64	64	70	74	78	78	77	74
Maximum Ponding Depth (ft) =	2.77	3.99	3.76	4.27	4.69	5.18	5.46	5.63	5.89
Area at Maximum Ponding Depth (acres) =	0.57	0.95	0.89	0.99	1.02	1.06	1.09	1.10	1.12
Maximum Volume Stored (acre-ft) =	0.426	1.386	1.174	1.649	2.072	2.584	2.895	3.081	3.359

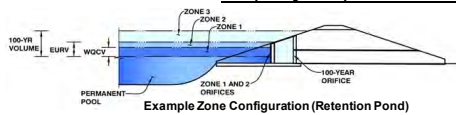
# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



## MHFD-Detention, Version 4.02 (February 2020)

**Basin ID: DF-8 (SE Single-Family & Commercial Pond)**



### Example Zone Configuration (Retention Pond)

Selected BMP Type =	EDB	
Watershed Area =	39.25	acres
Watershed Length =	2,120	ft
Watershed Length to Centroid =	1,000	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	65.26%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

### Optional User Overrides

Water Quality Capture Volume (WQCV) =	0.835	acre-feet
Excess Urban Runoff Volume (EURV) =	2.797	acre-feet
5-yr Runoff Volume ( $P_1 = 1.19$ in.) =	2.573	acre-feet
5-yr Runoff Volume ( $P_1 = 1.5$ in.) =	3.506	acre-feet
10-yr Runoff Volume ( $P_1 = 1.75$ in.) =	4.300	acre-feet
25-yr Runoff Volume ( $P_1 = 2$ in.) =	5.269	acre-feet
50-yr Runoff Volume ( $P_1 = 2.25$ in.) =	6.107	acre-feet
100-yr Runoff Volume ( $P_1 = 2.52$ in.) =	7.122	acre-feet
500-yr Runoff Volume ( $P_1 = 3.55$ in.) =	10.685	acre-feet
Approximate 2-yr Detention Volume =	2.170	acre-feet
Approximate 5-yr Detention Volume =	2.909	acre-feet
Approximate 10-yr Detention Volume =	3.705	acre-feet
Approximate 25-yr Detention Volume =	3.991	acre-feet
Approximate 50-yr Detention Volume =	4.156	acre-feet
Approximate 100-yr Detention Volume =	4.490	acre-feet

	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.55	inches

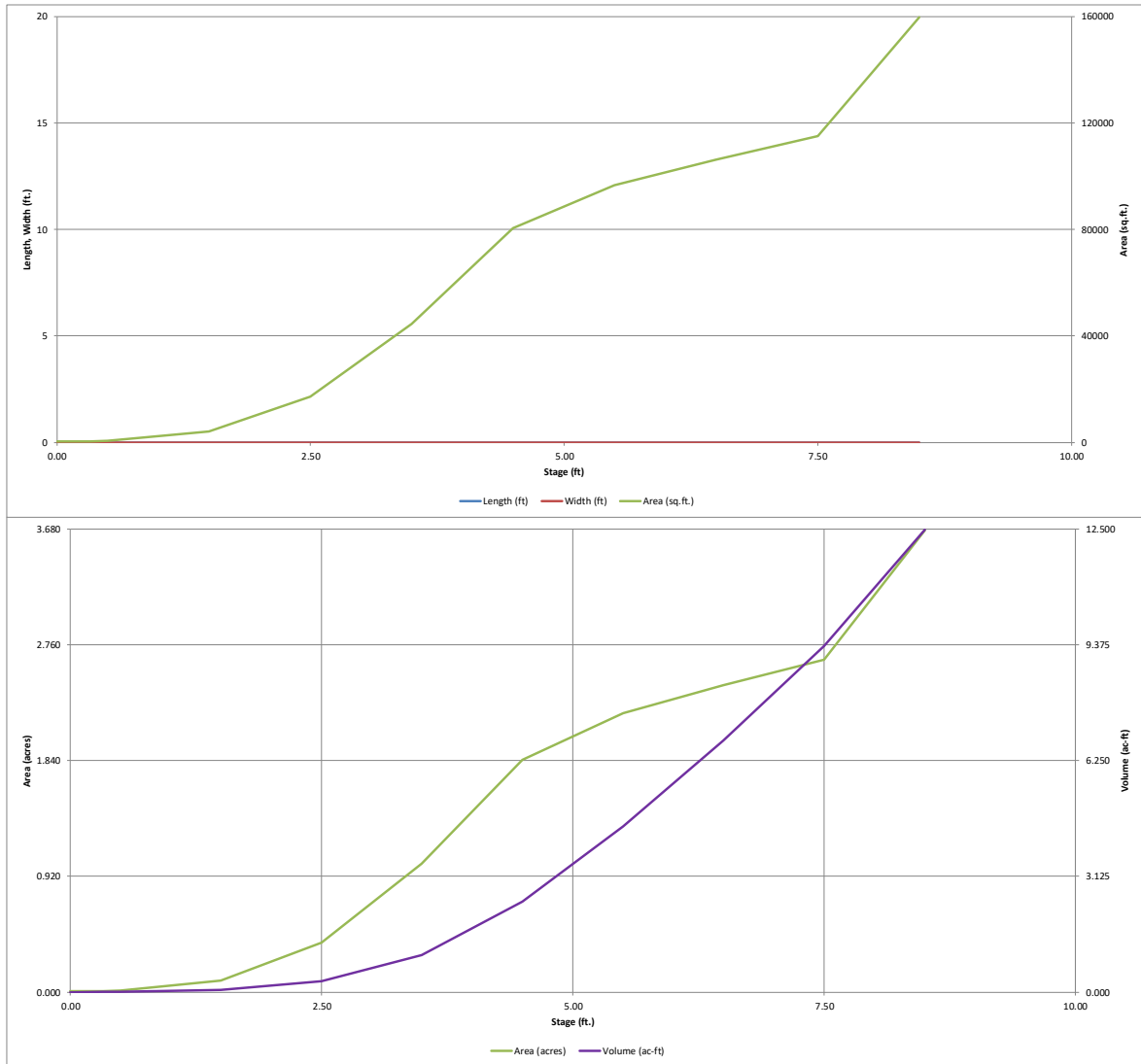
Zone 1 Volume (WQCV) =	0.835	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.963	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.693	acre-feet
Total Detention Basin Volume =	4.490	acre-feet
Initial Surge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surge Depth (ISD) =	user	ft
Total Available Detention Depth ( $H_{total}$ ) =	user	ft
Depth of Trickle Channel ( $H_{TC}$ ) =	user	ft
Slope of Trickle Channel ( $S_{TC}$ ) =	user	ft/ft
Slopes of Main Basin Sides ( $S_{main}$ ) =		H:V
Basin Length-to-Width Ratio ( $R_{L/W}$ ) =	user	

Initial Surcharge Area ( $A_{SV}$ ) =	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{SV}$ ) =	user	ft
Surcharge Volume Width ( $W_{SV}$ ) =	user	ft
Depth of Basin Floor ( $H_{FLOOR}$ ) =	user	ft
Length of Basin Floor ( $L_{FLOOR}$ ) =	user	ft
Width of Basin Floor ( $W_{FLOOR}$ ) =	user	ft
Area of Basin Floor ( $A_{FLOOR}$ ) =	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ ) =	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ ) =	user	ft
Length of Main Basin ( $L_{MAIN}$ ) =	user	ft
Width of Main Basin ( $W_{MAIN}$ ) =	user	ft
Area of Main Basin ( $A_{MAIN}$ ) =	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ ) =	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ ) =	user	acre-feet

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# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

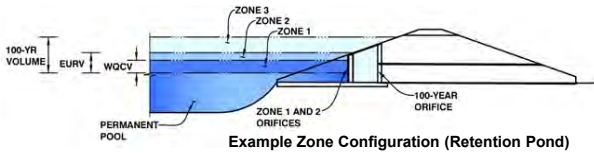


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-DETENTION, Version 4.02 (February 2020)

Project: **Singer Ranch**

Basin ID: **DF-8 (SE Single-Family & Commercial Pond)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.33	0.835	Orifice Plate
Zone 2 (EURV)	4.70	1.963	Circular Orifice
Zone 3 (100-year)	5.52	1.693	Weir&Pipe (Restrict)
Total (all zones)		4.490	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft <sup>2</sup>
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.33	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.90	inches
Orifice Plate: Orifice Area per Row =	2.38	sq. inches (diameter = 1-3/4 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.653E-02	ft <sup>2</sup>
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft <sup>2</sup>

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.11	2.22					
Orifice Area (sq. inches)	2.38	2.38	2.38					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	3.33	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	4.70	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	4.40	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.11	N/A	ft <sup>2</sup>
Vertical Orifice Centroid =	0.18	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe))

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.70	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	25.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H <sub>u</sub> =	5.70	N/A	feet
Overflow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	58.48	N/A	
Overflow Grate Open Area w/o Debris =	72.15	N/A	ft <sup>2</sup>
Overflow Grate Open Area w/ Debris =	36.08	N/A	ft <sup>2</sup>

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	11.85		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.23	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	0.56	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.89	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	6.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	119.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.46	feet
Stage at Top of Freeboard =	7.96	feet
Basin Area at Top of Freeboard =	3.11	acres
Basin Volume at Top of Freeboard =	10.66	acre-ft

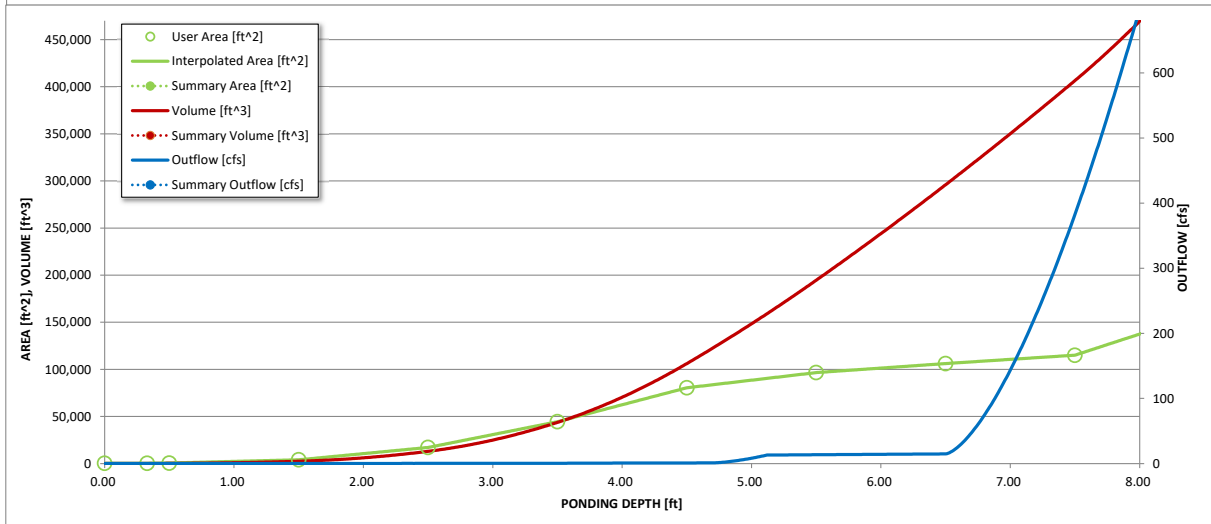
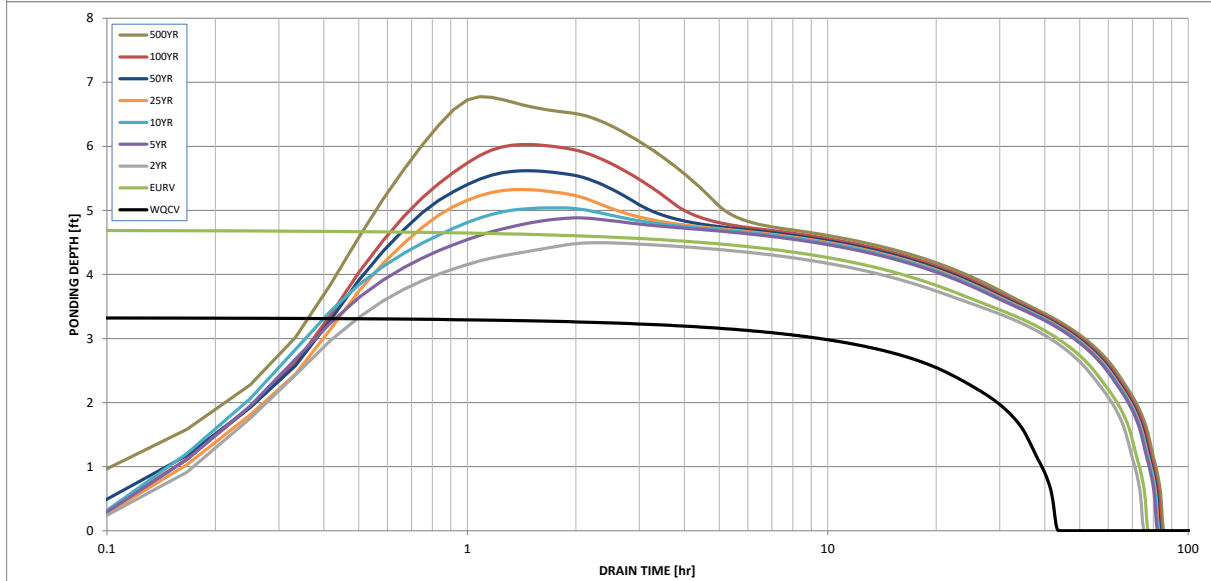
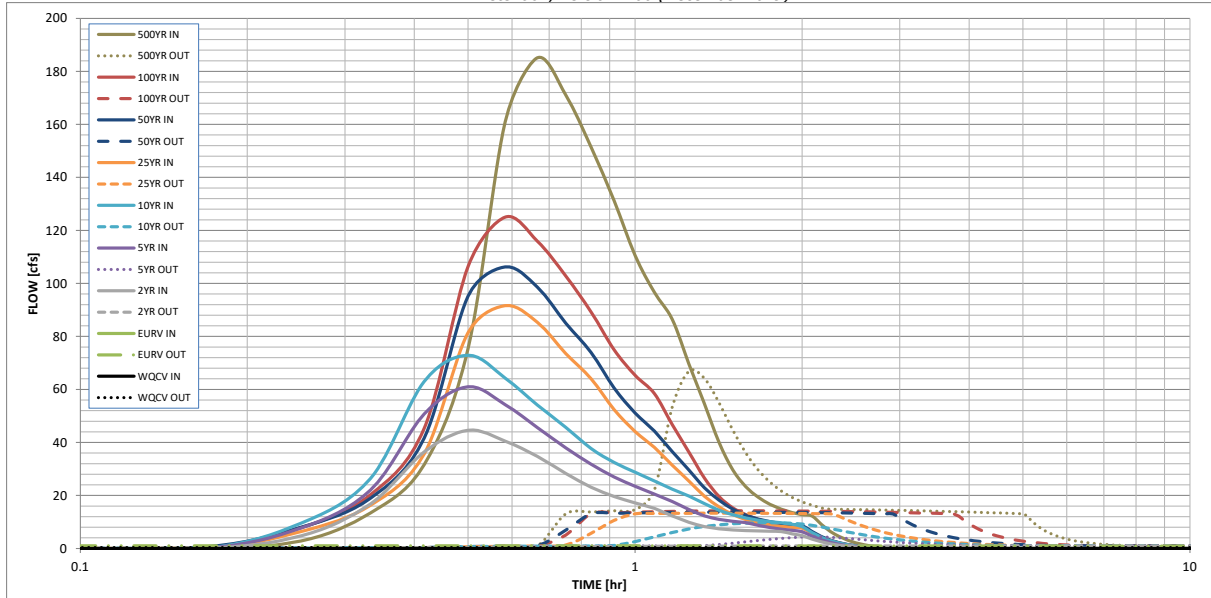
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.55
One-Hour Rainfall Depth (in) =	0.835	2.797	2.573	3.506	4.300	5.269	6.107	7.122	10.685
CUHP Runoff Volume (acre-ft) =	N/A	N/A	2.573	3.506	4.300	5.269	6.107	7.122	10.685
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	4.2	11.7	17.6	31.7	39.8	50.7	84.4
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.11	0.30	0.45	0.81	1.01	1.29	2.15
Peak Inflow Q (cfs) =	N/A	N/A	44.6	61.0	72.9	91.6	106.3	125.0	185.1
Peak Outflow Q (cfs) =	0.3	1.0	0.9	4.4	9.7	13.3	13.7	14.2	66.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.5	0.4	0.3	0.3	0.8
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.1	0.2	0.2	0.2	0.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	67	66	71	69	68	67	66	62
Time to Drain 99% of Inflow Volume (hours) =	41	72	70	76	76	75	75	75	74
Maximum Ponding Depth (ft) =	3.33	4.70	4.50	4.88	5.04	5.33	5.62	6.03	6.77
Area at Maximum Ponding Depth (acres) =	0.91	1.92	1.84	1.99	2.05	2.15	2.24	2.33	2.49
Maximum Volume Stored (acre-ft) =	0.839	2.813	2.418	3.164	3.487	4.074	4.712	5.649	7.459

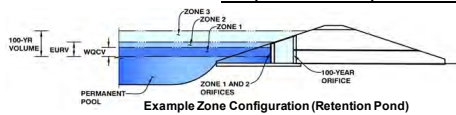
# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



## MHFD-Detention, Version 4.02 (February 2020)

**Basin ID: DF-9 (SE Commercial Pond)**



### Example Zone Configuration (Retention Pond)

Selected BMP Type =	EDB	
Watershed Area =	16.00	acres
Watershed Length =	2,068	ft
Watershed Length to Centroid =	1,000	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	78.20%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	50.0%	percent
Percentage Hydrologic Soil Groups C/D =	50.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

Water Quality Capture Volume (WQCV) =	0.423	acre-feet
Excess Urban Runoff Volume (EURV) =	1.307	acre-feet
2-yr Runoff Volume ( $P1 = 1.19$ in.) =	1.264	acre-feet
5-yr Runoff Volume ( $P1 = 1.5$ in.) =	1.679	acre-feet
10-yr Runoff Volume ( $P1 = 1.75$ in.) =	2.025	acre-feet
25-yr Runoff Volume ( $P1 = 2$ in.) =	2.399	acre-feet
50-yr Runoff Volume ( $P1 = 2.25$ in.) =	2.752	acre-feet
100-yr Runoff Volume ( $P1 = 2.52$ in.) =	3.156	acre-feet
500-yr Runoff Volume ( $P1 = 3.35$ in.) =	4.630	acre-feet
Approximate 2-yr Detention Volume =	1.103	acre-feet
Approximate 5-yr Detention Volume =	1.482	acre-feet
Approximate 10-yr Detention Volume =	1.773	acre-feet
Approximate 25-yr Detention Volume =	1.891	acre-feet
Approximate 50-yr Detention Volume =	1.951	acre-feet
Approximate 100-yr Detention Volume =	2.065	acre-feet

Zone 1 Volume (WQVQ) =	0.423	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.883	acre-feet
Zone 3 (100yr + 1 / 2 WQVQ - Zones 1 & 2) =	0.971	acre-feet
Total Detention Basin Volume =	2.277	acre-feet
Initial Surcharge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth ( $H_{DAB}$ ) =	user	ft
Depth of Trickle Channel ( $H_{TC}$ ) =	user	ft
Slope of Trickle Channel ( $S_{TC}$ ) =	user	ft/ft
Slopes of Main Basin Sides ( $S_{main}$ ) =	user	Ht/V
Basin Length-to-Width Ratio ( $R_{L/W}$ ) =	user	

Initial Surcharge Area ( $A_{SIV}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{SV}$ )	=	user	ft
Surcharge Volume Width ( $W_{SV}$ )	=	user	ft
Depth of Basin Floor ( $H_{FLOOR}$ )	=	user	ft
Length of Basin Floor ( $L_{FLOOR}$ )	=	user	ft
Width of Basin Floor ( $W_{FLOOR}$ )	=	user	ft
Area of Basin Floor ( $A_{FLOOR}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	user	ft
Length of Main Basin ( $L_{MAIN}$ )	=	user	ft
Width of Main Basin ( $W_{MAIN}$ )	=	user	ft
Area of Main Basin ( $A_{MAIN}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	user	acre-feet

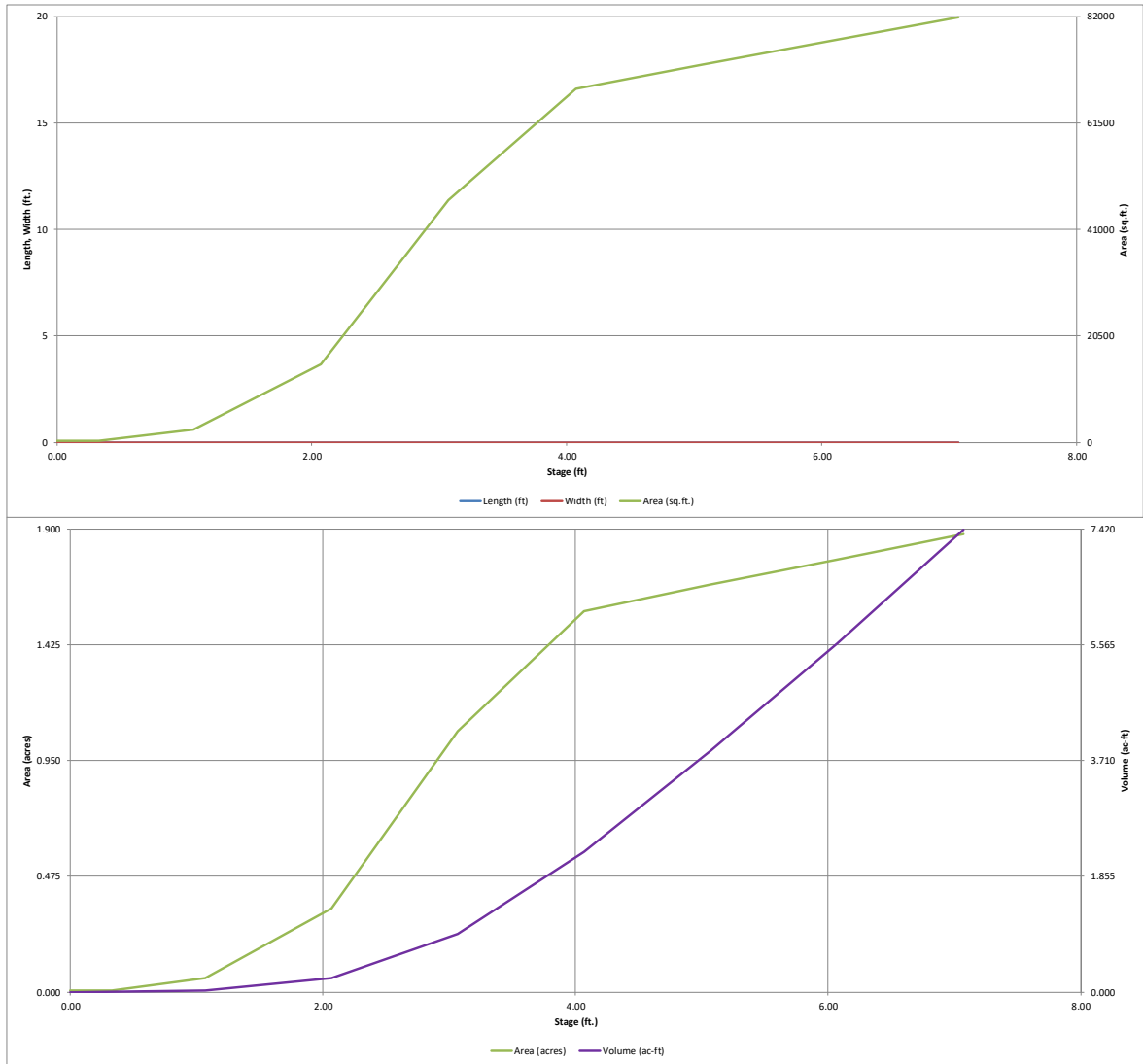
	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.55	inches

[illegible]



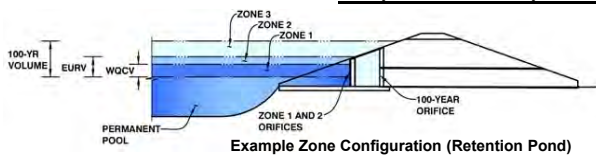
# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)



*MHFD-Detention, Version 4.02 (February 2020)*

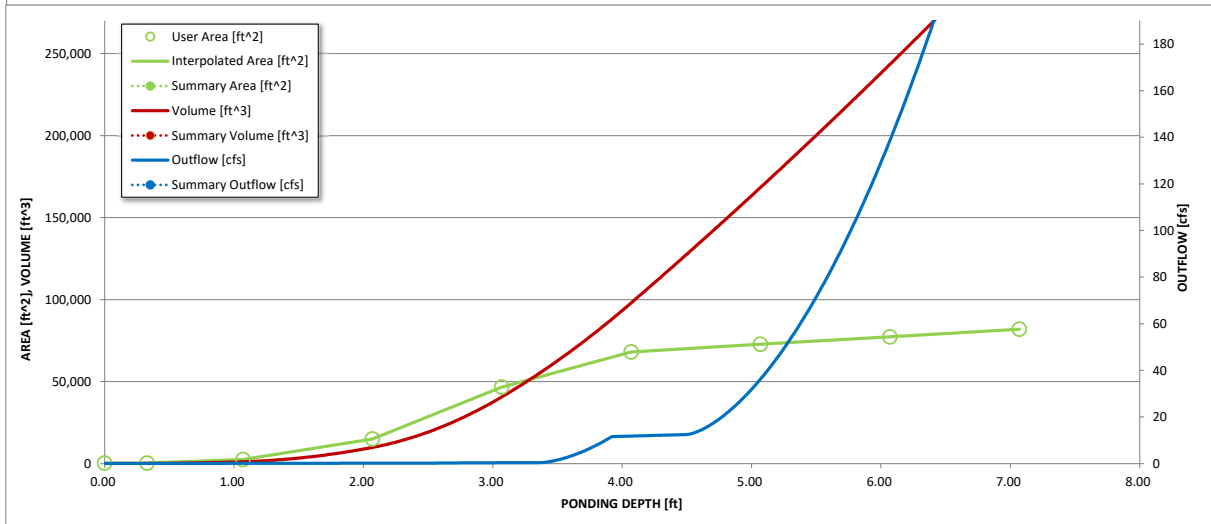
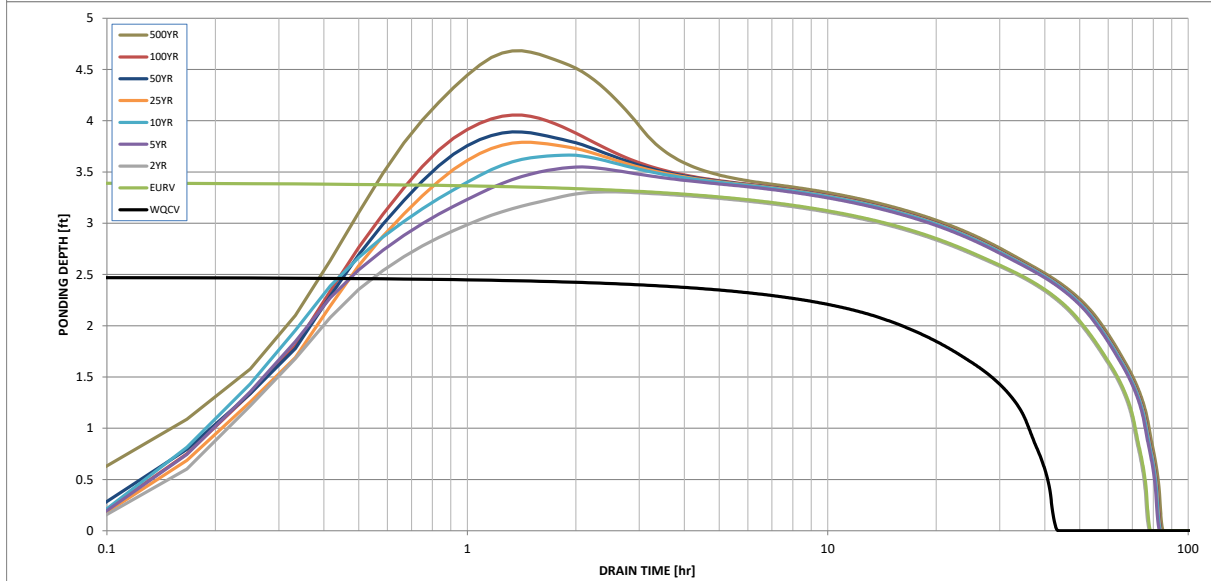
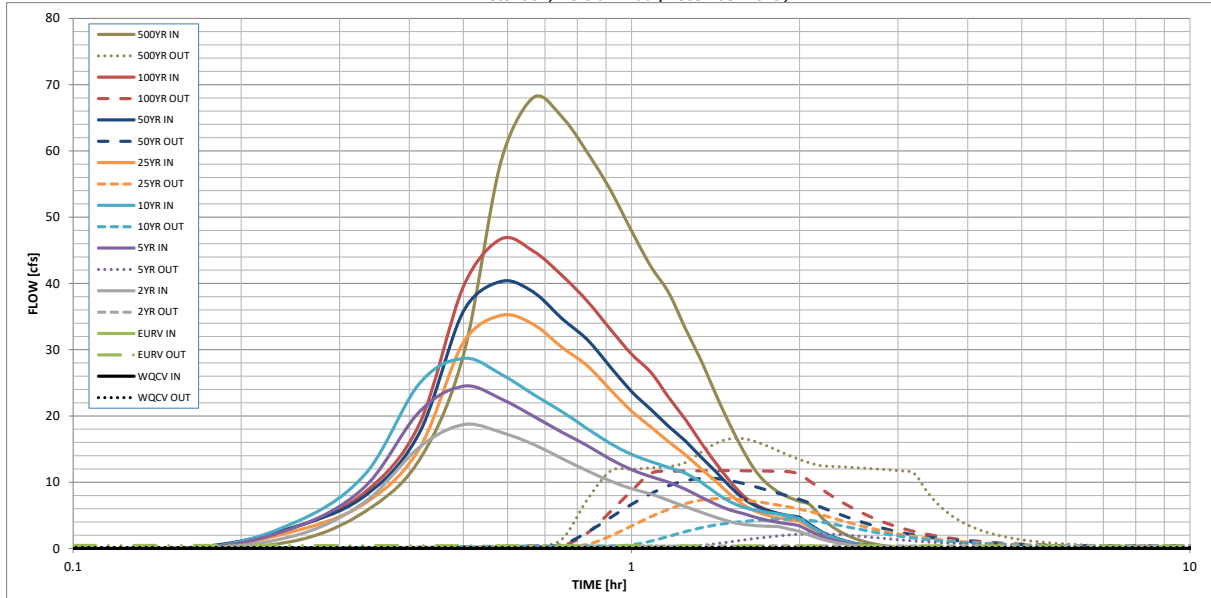
**Basin ID: DF-9 (SE Commercial Pond)**



Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.55
CUHP Runoff Volume (acre-ft)	0.423	1.307	1.264	1.679	2.025	2.399	2.752	3.156	4.630
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	1.264	1.679	2.025	2.399	2.752	3.156	4.630
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	1.8	4.3	6.3	10.7	13.2	16.7	27.8
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.11	0.27	0.39	0.67	0.82	1.04	1.74
Peak Inflow Q (cfs)	N/A	N/A	18.7	24.5	28.7	35.2	40.3	46.7	68.0
Peak Outflow Q (cfs)	0.2	0.5	0.4	2.2	4.5	7.5	10.6	11.8	16.6
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.5	0.7	0.7	0.8	0.7	0.6
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps)	N/A	0.00	N/A	0.0	0.1	0.2	0.3	0.3	0.3
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	38	69	68	72	71	70	68	67	63
Time to Drain 99% of Inflow Volume (hours)	<b>41</b>	73	73	77	77	76	76	75	74
Maximum Ponding Depth (ft)	2.48	3.40	3.31	3.55	3.67	3.79	3.89	4.06	4.68
Area at Maximum Ponding Depth (acres)	0.64	1.23	1.18	1.30	1.36	1.42	1.47	1.55	1.63
Maximum Volume Stored (acre-ft)	0.428	1.313	1.192	1.490	1.650	1.817	1.976	2.218	3.222

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



## **APPENDIX B**

### ***STANDARD DESIGN CHARTS AND TABLES***

**Table 6-6. Runoff Coefficients for Rational Method**

(Source: UDFCD 2001)

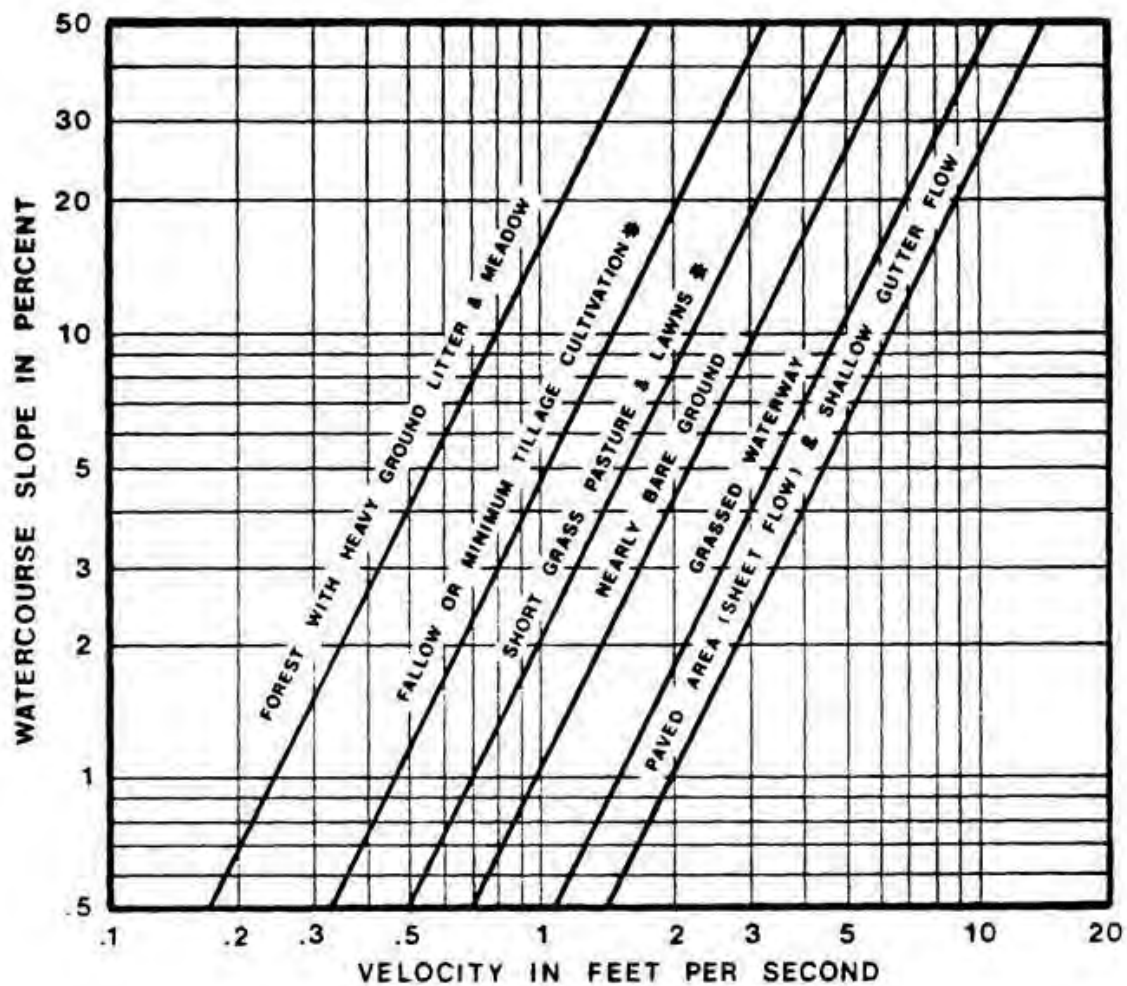
Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

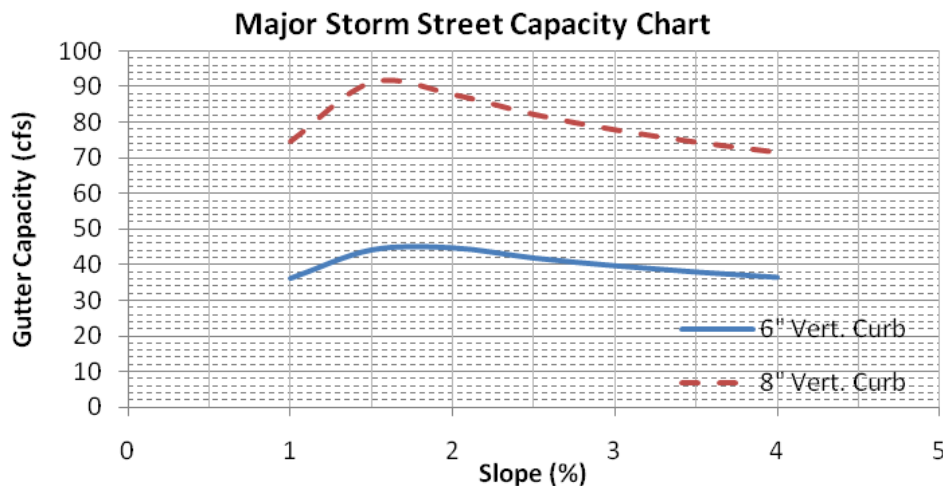
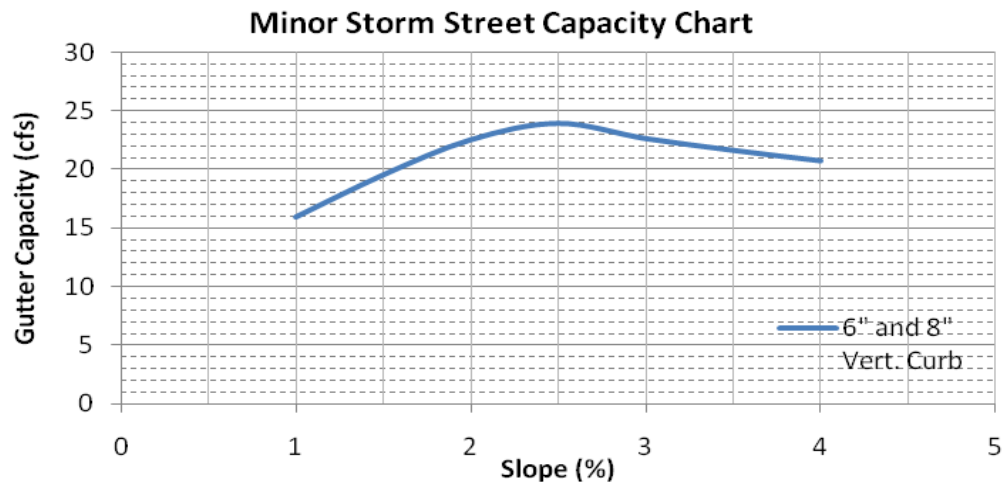
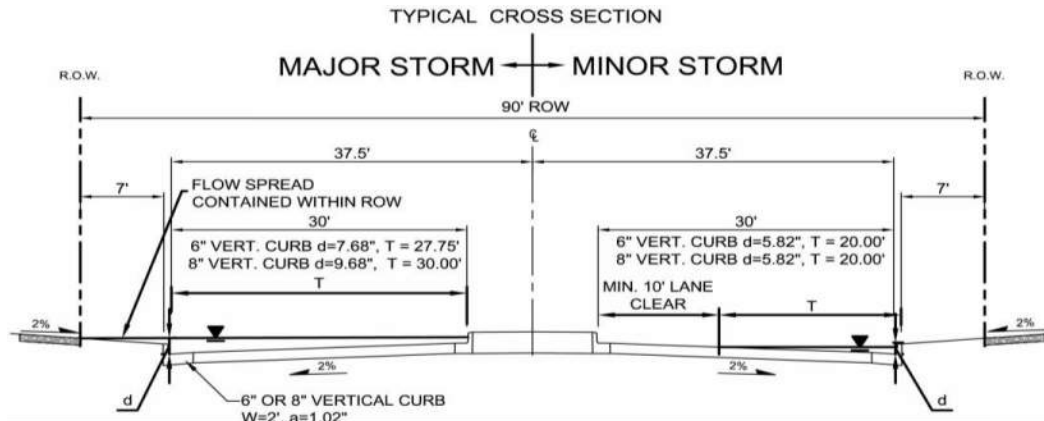
### 3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration ( $t_c$ ) consists of an initial time or overland flow time ( $t_i$ ) plus the travel time ( $t_t$ ) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time ( $t_i$ ) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion ( $t_t$ ) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

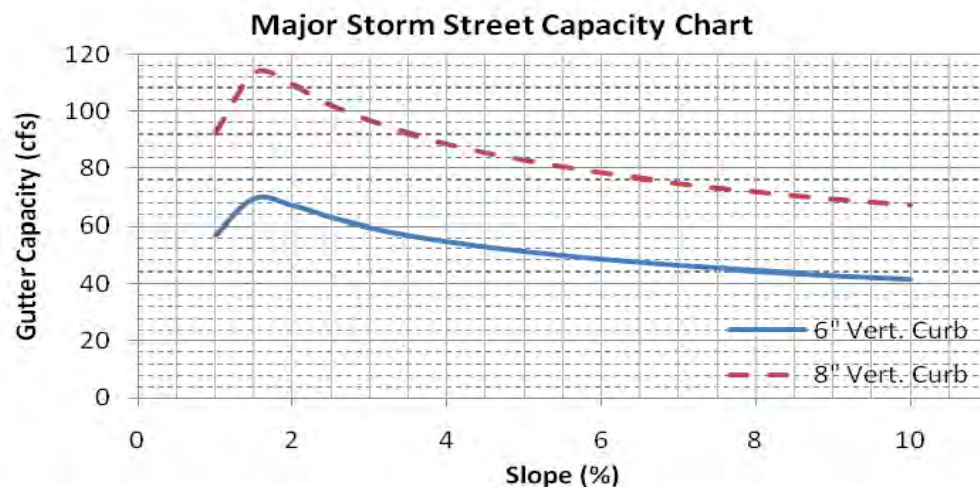
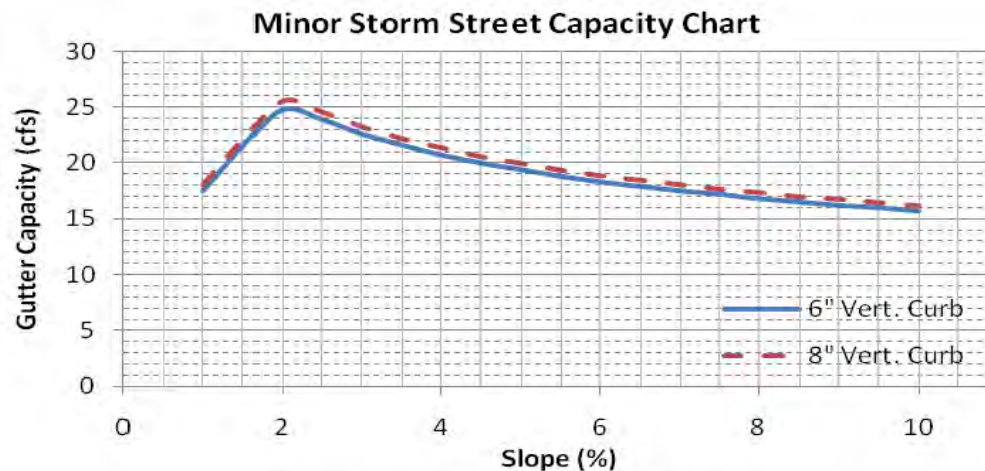
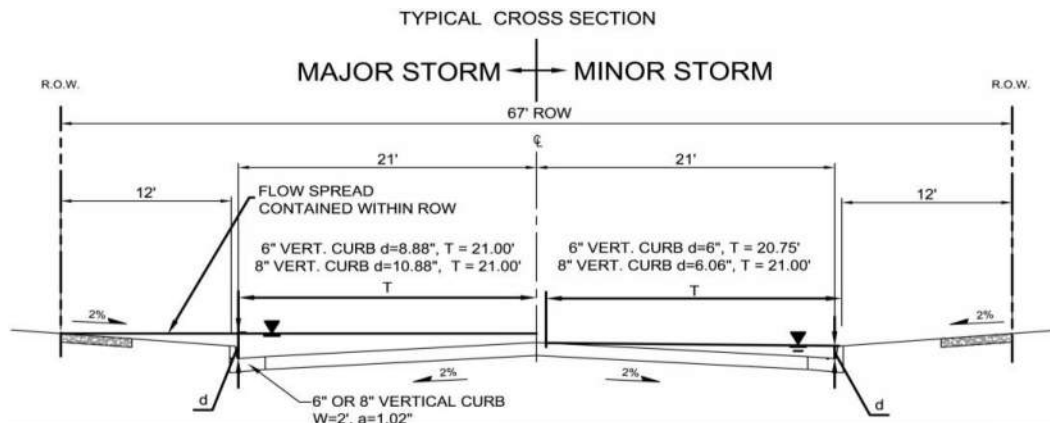
Figure 6-25. Estimate of Average Concentrated Shallow Flow



**Figure 7-3. Street Capacity Charts Minor Arterial**

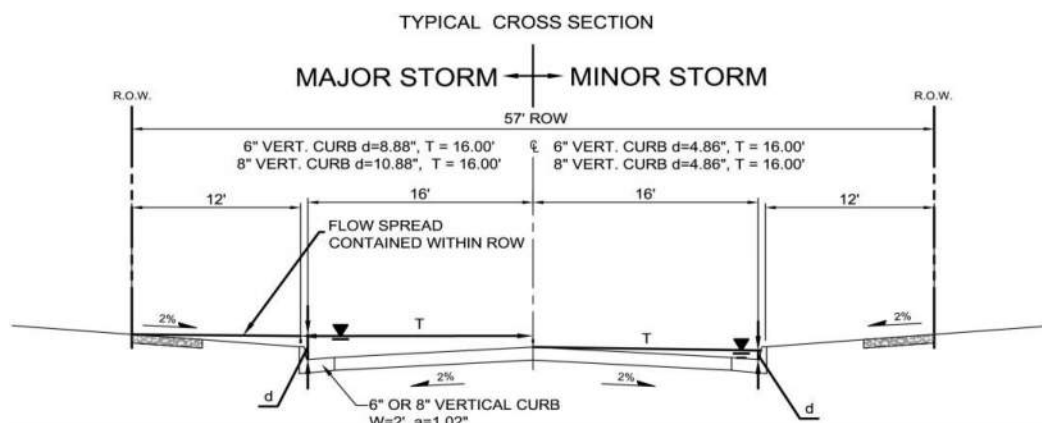
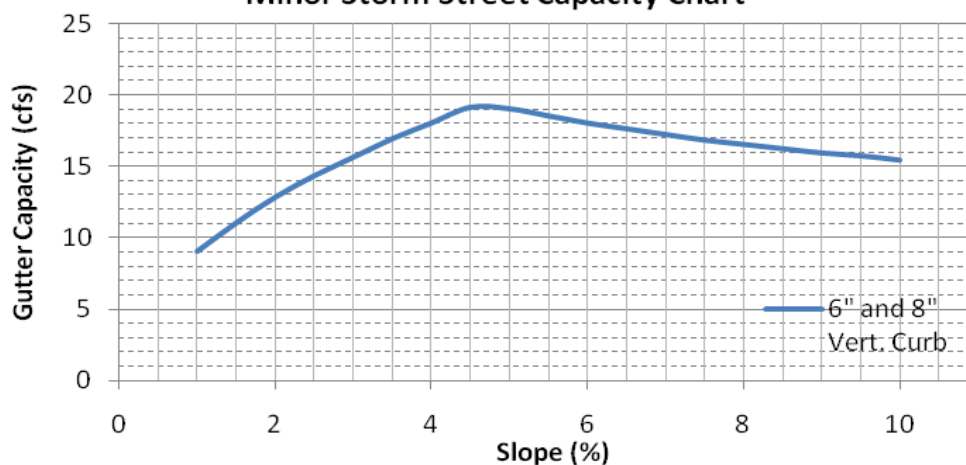
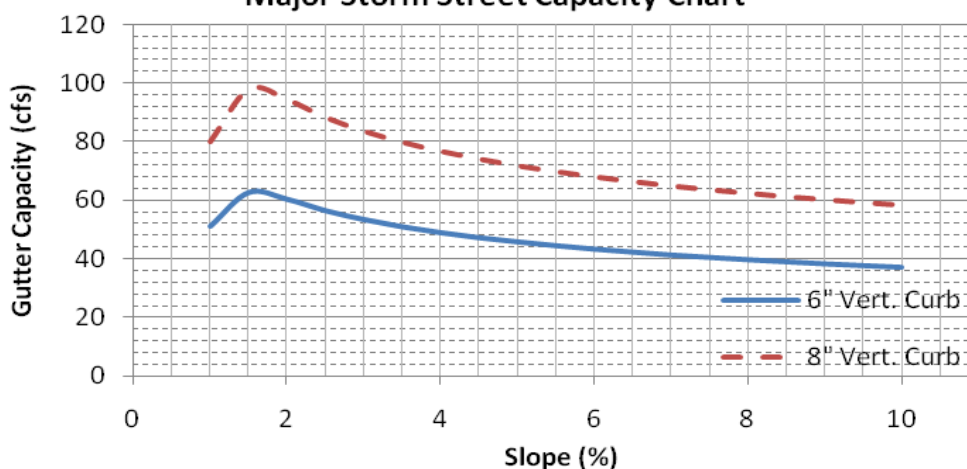
These charts shall only be used for the standard street sections as shown. The capacity shown is based on ½ the street section as calculated by the UD-Inlet spreadsheets. Minor storm capacities are based on no crown overtopping, curb height or maximum allowable spread widths. Major storm capacities are based on flow being contained within the public right-of-way, including conveyance capacity behind the curb. The UDFCD Safety Reduction Factor was applied. An 'n<sub>STREET</sub>' of 0.016 and 'n<sub>BACK</sub>' of 0.020 was used. Calculations were done using UD-Inlet 3.00.xls, March, 2011.

### Figure 7-5. Street Capacity Charts Collector (with Parking)

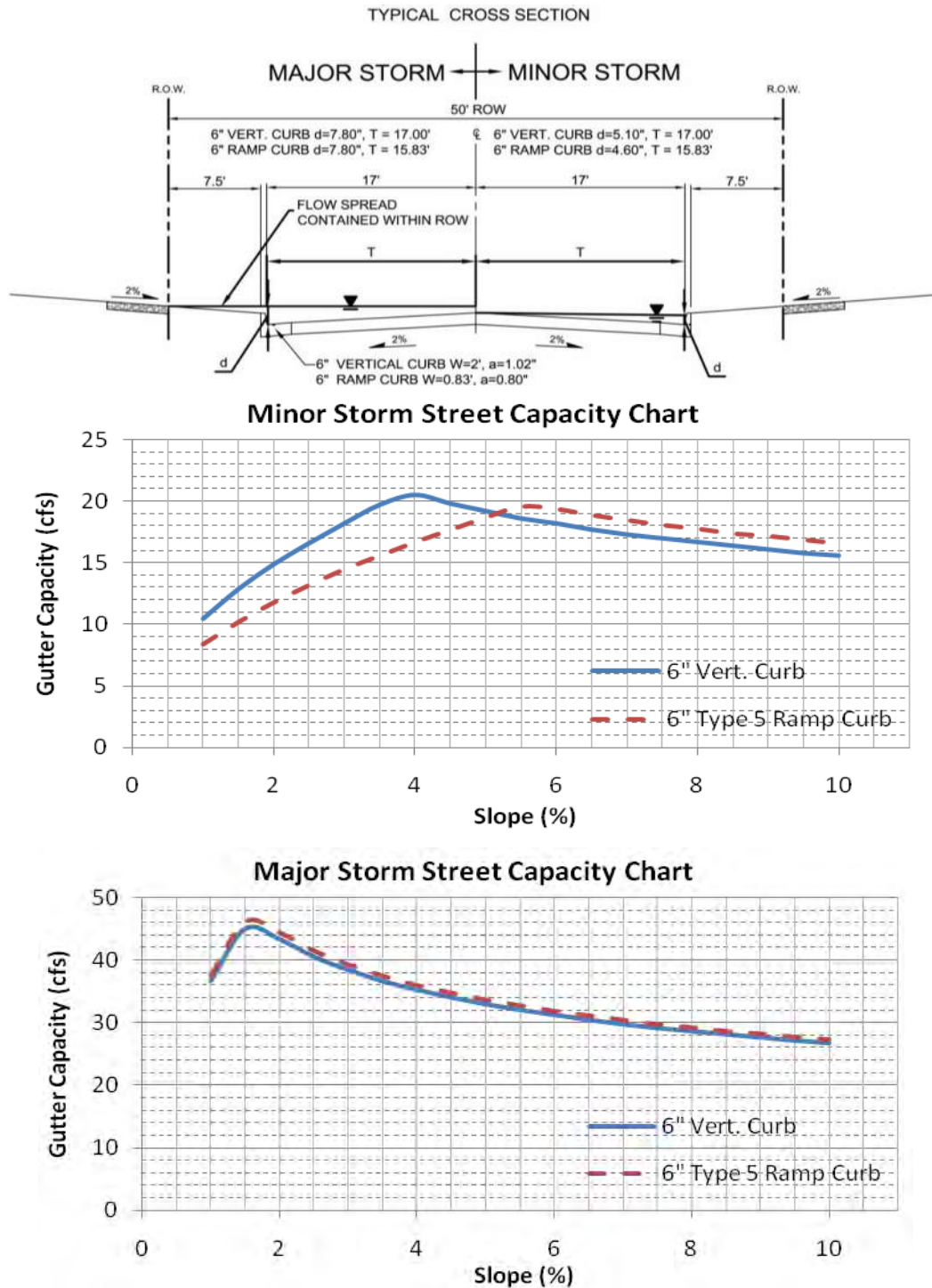


These charts shall only be used for the standard street sections as shown. The capacity shown is based on ½ the street section as calculated by the UD-Inlet spreadsheets. Minor storm capacities are based on no crown overtopping, curb height or maximum allowable spread widths. Major storm capacities are based on flow being contained within the public right-of-way, including conveyance capacity behind the curb. The UDFCD Safety Reduction Factor was applied. An 'n<sub>STREET</sub>' of 0.016 and 'n<sub>BACK</sub>' of 0.020 was used. Calculations were done using UD-Inlet 3.00.xls, March, 2011.



**Figure 7-6. Street Capacity Charts Collector (without Parking)****Minor Storm Street Capacity Chart****Major Storm Street Capacity Chart**

These charts shall only be used for the standard street sections as shown. The capacity shown is based on ½ the street section as calculated by the UD-Inlet spreadsheets. Minor storm capacities are based on no crown overtopping, curb height or maximum allowable spread widths. Major storm capacities are based on flow being contained within the public right-of-way, including conveyance capacity behind the curb. The UDFCD Safety Reduction Factor was applied. An 'n<sub>STREET</sub>' of 0.016 and 'n<sub>BACK</sub>' of 0.020 was used. Calculations were done using UD-Inlet 3.00.xls, March, 2011.

**Figure 7-7. Street Capacity Charts Residential (Detached Sidewalk)**

These charts shall only be used for the standard street sections as shown. The capacity shown is based on  $\frac{1}{2}$  the street section as calculated by the UD-Inlet spreadsheets. Minor storm capacities are based on no crown overtopping, curb height or maximum allowable spread widths. Major storm capacities are based on flow being contained within the public right-of-way, including conveyance capacity behind the curb. The UDFCD Safety Reduction Factor was applied. An 'n<sub>STREET</sub>' of 0.016 and 'n<sub>BACK</sub>' of 0.020 was used. Calculations were done using UD-Inlet 3.00.xls, March, 2011.

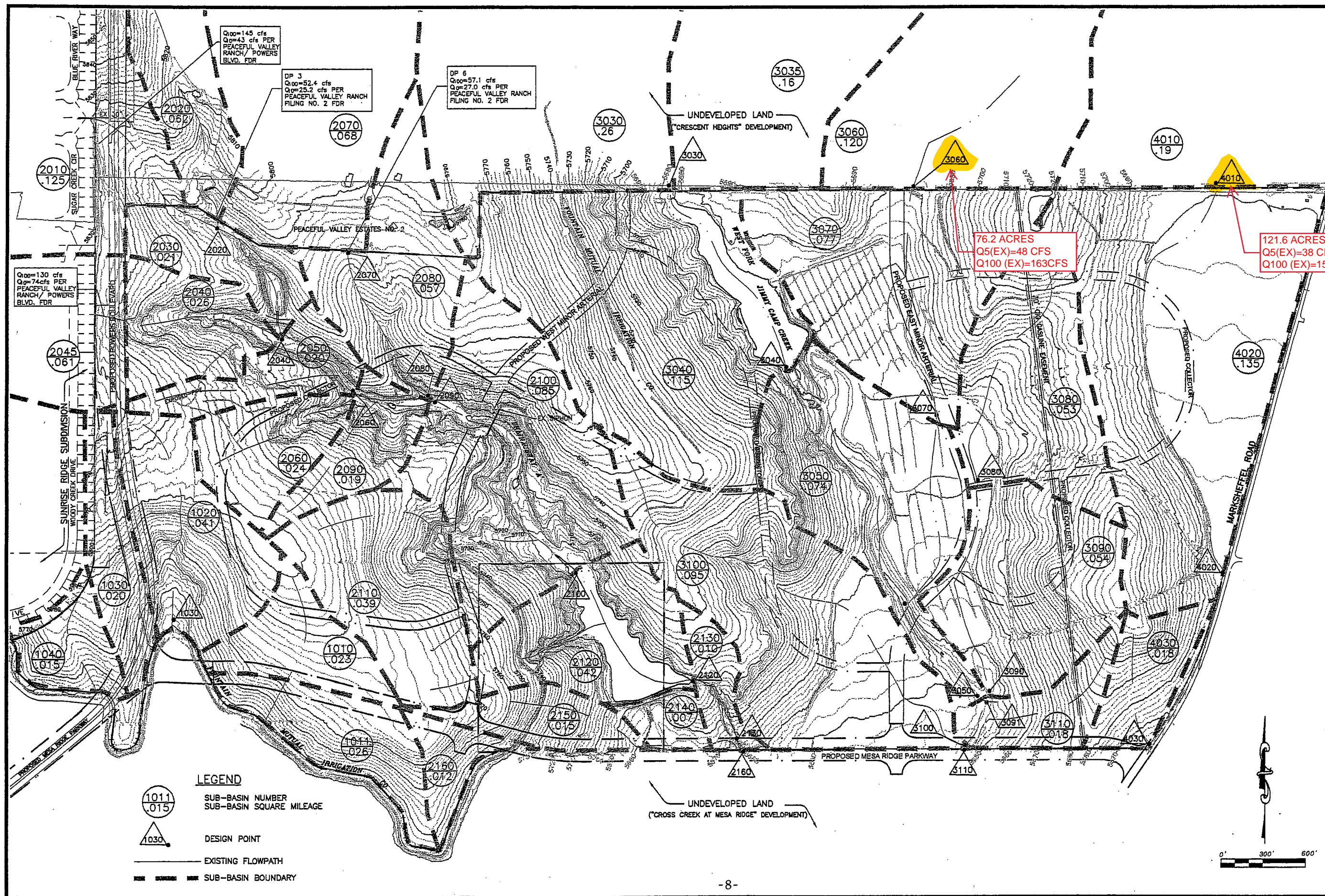
**Table 6-3. Recommended percentage imperviousness values**

Land Use or Surface Characteristics	Percentage Imperviousness (%)
<b>Business:</b>	
Downtown Areas	95
Suburban Areas	75
<b>Residential lots (lot area only):</b>	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
<b>Industrial:</b>	
Light areas	80
Heavy areas	90
<b>Parks, cemeteries</b>	10
<b>Playgrounds</b>	25
<b>Schools</b>	55
<b>Railroad yard areas</b>	50
<b>Undeveloped Areas:</b>	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
<b>Streets:</b>	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

## **APPENDIX C**

### ***REPORT REFERENCES***





**Kiowa Engineering Corporation**

1604 S. 21st Street  
Colorado Springs, Colorado  
80904  
(719) 630-7342

**West Fork Jimmy Camp Creek  
Drainage Basin Planning Study  
HYDROLOGIC SUB-BASIN MAP  
EL PASO COUNTY, COLORADO**

Project No.: 9893  
Date: 7/00  
Design: RNW  
Drawn: CAD  
Check: RNW  
Revisions:

**FIG.3A**

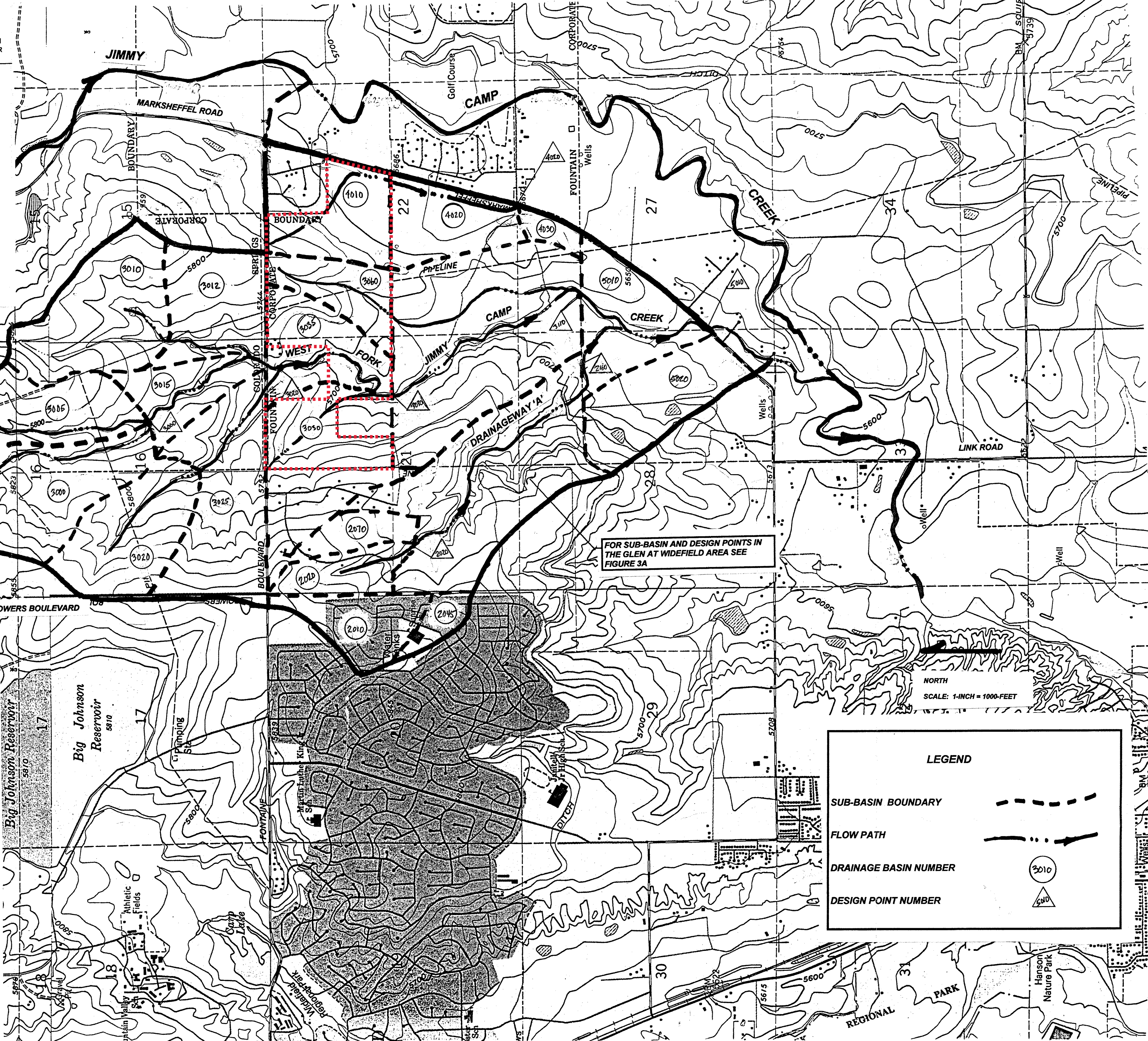


TABLE 3: SUMMARY OF DESIGN POINT DISCHARGES  
WEST FORK JIMMY CAMP CREEK DRAINAGE BASIN PLANNING STUDY

DESIGN POINT NUMBER	EX/FUT DRAINAGE AREA (sqm)	EX/FUT DRAINAGE AREA (acres)	EXISTING CONDITION 5 YR cfs	EXISTING CONDITION 100 YR cfs	FUTURE CONDITION 5 YR cfs	FUTURE CONDITION 100YR cfs
2020	0.190	121.6	47	189	57	210
2040	0.300	192.0	97	335	109	362
2060	0.340	217.6	105	372	120	406
2080	0.130	83.2	17	88	28	113
2090	0.480	307.2	123	473	152	535
2100	0.610	390.4	140	558	181	651
2120	0.660	422.4	148	600	189	692
2130	0.670	428.8	145	594	186	687
2160	0.700	448.0	151	624	196	723
3000	0.660	422.4	147	233	317	935
3020	1.650	1056.0	528	1857	1059	2737
3030	2.070	1324.8	601	2216	1209	3267
3040	2.180	1395.2	618	2316	1239	3364
3050	2.28/2.23	1446/1427	627	2351	1275	3444
3070	0.200	128.0	67	235	86	270
3080	25/05	160/32	82	290	23	72
3090	33/11	211/70	106	373	44	138
3091	2.560	1638.4	732	2722	1380	3843
3100	2.660	1702.4	757	2828	1428	3990
3110	2.670	1708.8	761	2845	1442	4022
4020	0.320	204.8	63	238	145	383
5010	3.530	2259.2	943	3550	1722	4904

TABLE 2: SUMMARY OF SUB-BASIN DISCHARGES  
WEST FORK JIMMY CAMP CREEK DRAINAGE BASIN PLANNING STUDY

SUB-BASIN NUMBER	EX/FUT DRAINAGE AREA (sqm)	EX/FUT DRAINAGE AREA (ac)	EXISTING CONDITION 5 YR	EXISTING CONDITION 100 YR	FUTURE CONDITION 5 YR	FUTURE CONDITION 100YR
2010	0.125	80.0	40	142	40	142
2020	0.082	36.7	9	47	19	68
2030	0.021	13.4	5	22	6	24
2040	0.026	16.6	5	26	7	29
2045	0.061	39.0	4	17	4	19
2050	0.020	12.8	4	17	4	19
2060	0.024	15.4	5	24	8	30
2070	0.088	43.5	12	58	15	64
2080	0.057	36.5	3	14	5	19
2090	0.019	12.2	3	14	5	19
2100	0.036	60.8	13	64	24	89
2110	0.034	21.8	6	29	8	33
2120	0.047	30.1	9	45	9	45
2130	0.010	6.4	2	11	2	11
2140	0.007	4.5	2	4	2	9
2150	0.015	9.6	6	20	6	21
2160	0.012	7.7	8	18	17	35
3000	0.420	268.8	140	474	190	598
3005	0.240	153.6	107	347	144	407
3010	0.220	140.8	81	288	138	393
3012	0.210	134.4	54	199	94	272
3015	0.110	70.4	55	181	75	212
3020	0.190	121.6	89	231	204	428
3025	0.290	186.4	82	324	347	712
3030	0.290	186.4	85	262	116	361
3035	0.180	102.4	63	234	106	306
3040	0.115	73.6	23	110	31	129
3050	0.049/074	31.447/4	18	61	56	136
3060	0.119	76.2	48	163	63	189
3070	0.077	49.3	23	78	27	87
3080	0.050	32.0	16	58	23	68
3090	0.062/05	52.532/0	27	93	21	67
3100	0.095	60.8	35	123	61	196
3110	0.018	11.5	5	17	14	31
4010	0.190	121.6	38	153	108	279
4020	0.135	86.4	28	90	39	114
4030	0.018	11.5	7	25	20	44
5010	0.156	99.8	35	133	101	248
5020	0.200	128.0	52	200	151/4	362



Kiowa Engineering Corporation  
1604 South 21st Street  
Colorado Springs, Colorado  
80904  
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West Fork Jimmy Camp Creek  
Drainage Basin Planning Study  
HYDROLOGIC SUB-BASIN MAP  
EL PASO COUNTY, COLORADO

Project No.: 9893  
Date: 6/99  
Design: RNW  
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Check: RNW  
Revisions:

FIGURE 3



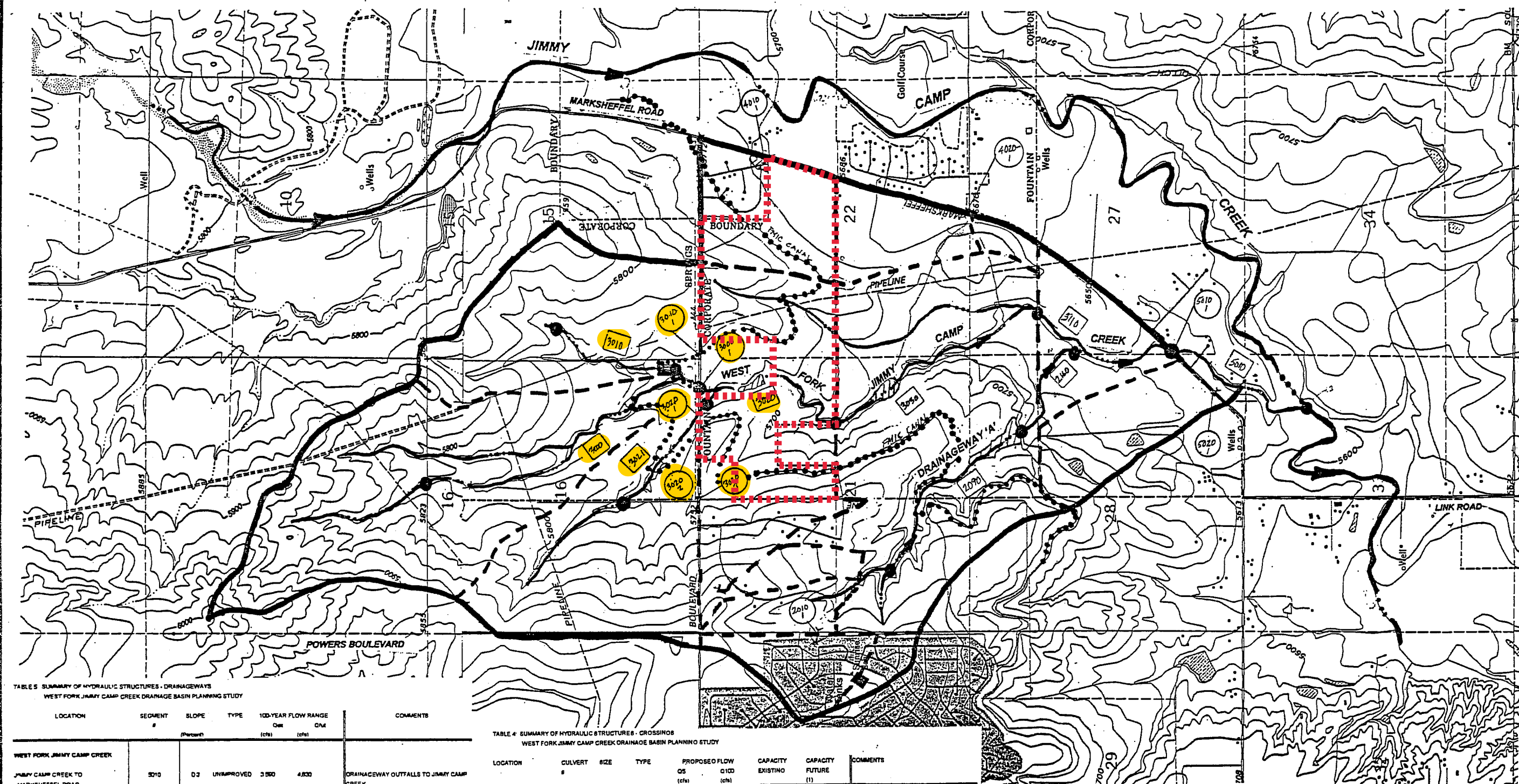


TABLE 5 SUMMARY OF HYDRAULIC STRUCTURES - DRAINAGEWAYS  
WEST FORK JIMMY CAMP CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	SEGMENT #	SLOPE (Percent)	TYPE	100-YEAR FLOW RANGE Q <sub>100</sub> (cfs) Q <sub>10</sub> (cfs)	COMMENTS
WEST FORK JIMMY CAMP CREEK					
JIMMY CAMP CREEK TO MARKSHEFFEL ROAD	3010	0.3	UNIMPROVED	3,500 4,800	DRAINAGEWAY OUTFALLS TO JIMMY CAMP CREEK
MARKSHEFFEL ROAD TO MESA RIDGE PARKWAY	3110	0.6	UNIMPROVED	2,400 3,300 3,500 4,800	WIDE AND SHALLOW FLOODPLAIN
MESA RIDGE PARKWAY TO N PL OF THE GLEN	3000	0.7	UNIMPROVED	2,275 3,100 2,800 3,300	CHANNEL STABLE AND WELL VEGETATED WITH WETLAND AND NATIVE GRASSES
NORTH PL OF THE GLEN TO FOUNTAIN BOULEVARD	3000	0.8	UNIMPROVED	1,900 2,710 2,275 3,100	
FOUNTAIN BLVD TO STUDY LOTS	3000	1.0	UNIMPROVED	800 1,050	CHANNEL LIES WITHIN COLORADO CENTRE DEVELOPMENT
FOUNTAIN BLVD TO STUDY LOTS	3010	1.0	UNIMPROVED	400 640	CHANNEL LIES WITHIN COLORADO CENTRE DEVELOPMENT
FOUNTAIN BLVD TO STUDY LOTS	3021	0.8	UNIMPROVED	600 1,100	CHANNEL LIES WITHIN COLORADO CENTRE DEVELOPMENT
DRAINAGEWAY A					
CONFLUENCE WITH WEST FORK JIMMY TO LAKE	2180	2.8	UNIMPROVED	600 700	
LAKE TO DESIGN POINT 0.0700	3300	1.8	UNIMPROVED	305-600 390-700	CHANNEL STABLE AND WELL VEGETATED WITH WETLAND AND NATIVE GRASSES

TABLE 4 SUMMARY OF HYDRAULIC STRUCTURES - CROSSINGS  
WEST FORK JIMMY CAMP CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	CULVERT #	SIZE	TYPE	PROPOSED FLOW Q <sub>100</sub> (cfs)	CAPACITY EXISTING	CAPACITY FUTURE (I)	COMMENTS
FOUNTAIN BLVD	3000-1	12'-0"	CS C	770	1,870	ADEQUATE	STRUCTURE HAS ADEQUATE CAPACITY TO PASS THE PROPOSED 100-YEAR FLOW
FOUNTAIN BLVD	3010-1	30'-54"	CMP ARCH	N/A	N/A	N/A	FOUNTAIN MUTUAL IRRIGATION DITCH ROADWAY CROSSING
FOUNTAIN BLVD	3020-1	30'	CMP	500	1,100	INADEQUATE	CULVERT CAN CONVEY ONLY LOCALIZED ROADWAY DRAINAGE WHICH REACHES IT
FOUNTAIN BLVD	3020-2	30'-54"	CMP ARCH	N/A	N/A	N/A	FOUNTAIN MUTUAL IRRIGATION DITCH ROADWAY CROSSING
FOUNTAIN BLVD	3020-3	30'	CMP	N/A	N/A	ADEQUATE	CULVERT CAN CONVEY ONLY LOCALIZED ROADWAY DRAINAGE WHICH REACHES IT
MARKSHEFFEL ROAD	3010-1	30'	CMP	1,700	4,800	INADEQUATE	PARTIALLY PLUGGED
MARKSHEFFEL ROAD	3020-1	30'	CMP	150	300	INADEQUATE	PARTIALLY PLUGGED
POWERS BOULEVARD	2010-1	30'	CMP	40	142	ADEQUATE	CULVERT TO BE REPLACED WITH CONSTRUCTION OF POWERS BOULEVARD
MARKSHEFFEL ROAD	4010-1	N/A	DETENTION BASIN	N/A	N/A	ADEQUATE	DETENTION BASIN SERVES THE COTTONWOOD GROVE SUBDIVISION
MARKSHEFFEL ROAD	4020-1	30' (wall)	CMP	145	383	INADEQUATE	PARTIALLY PLUGGED

**LEGEND**

ROADWAY CROSSING DESIGNATION

DRAINAGEWAY DESIGNATION

FOUNTAIN MUTUAL IRRIGATION DITCH

EXISTING IMPOUNDMENT



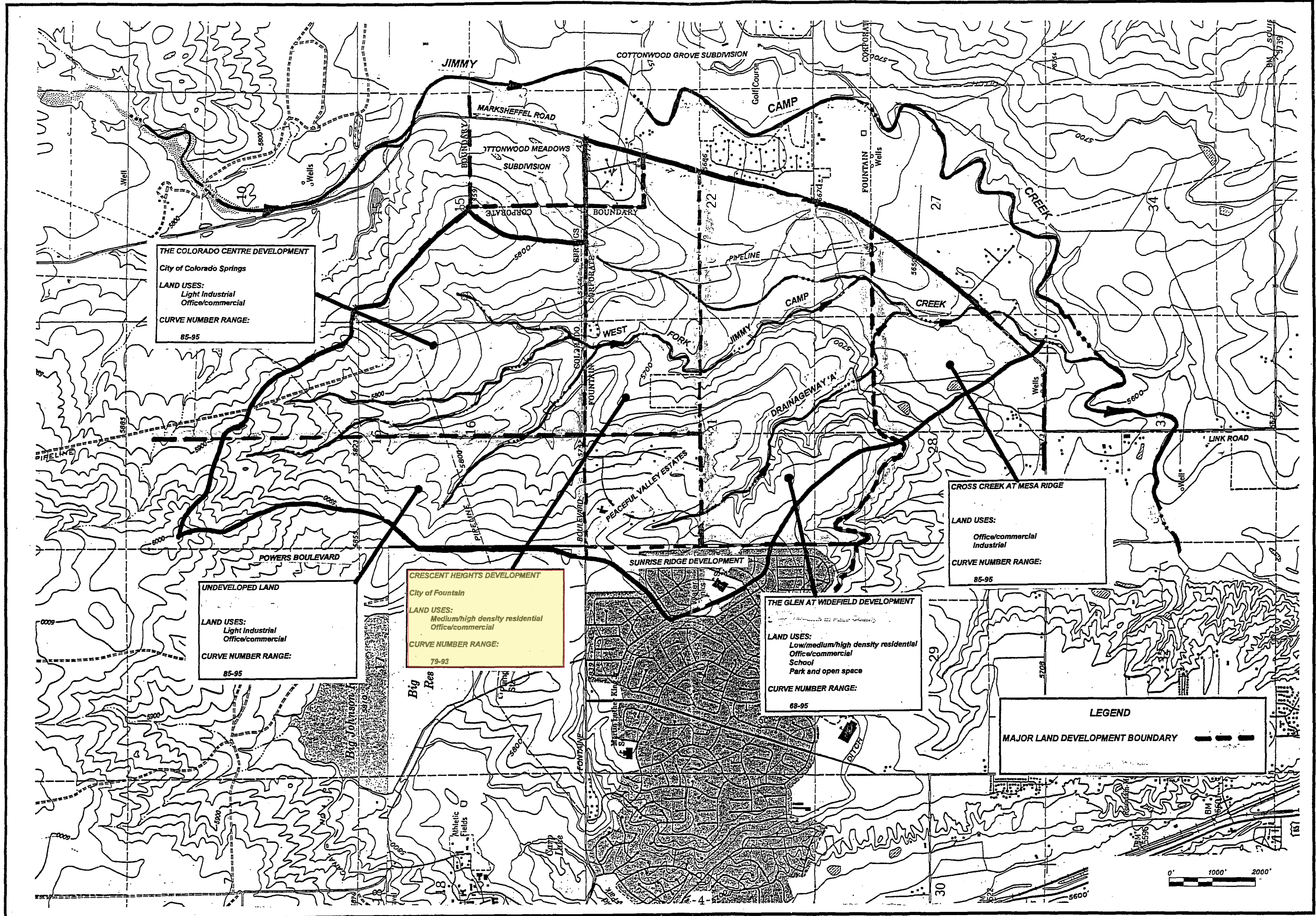
**Kiowa Engineering Corporation**  
1604 South 21st Street  
Colorado Springs, Colorado  
80904  
(719) 630-7342

**West Fork Jimmy Camp Creek  
Drainage Basin Planning Study  
INVENTORY OF EXISTING DRAINAGE STRUCTURES  
EL PASO COUNTY, COLORADO**

Project No.: 9893  
Date: 6/99  
Design: RNW  
Drawn: CAD  
Check: RNW  
Revision:

**FIGURE 4**





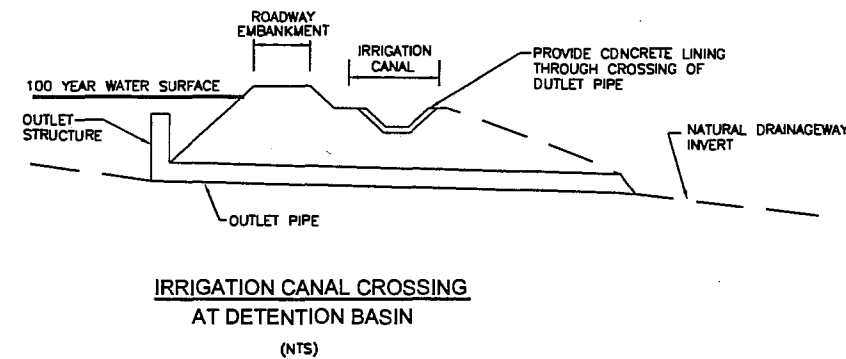
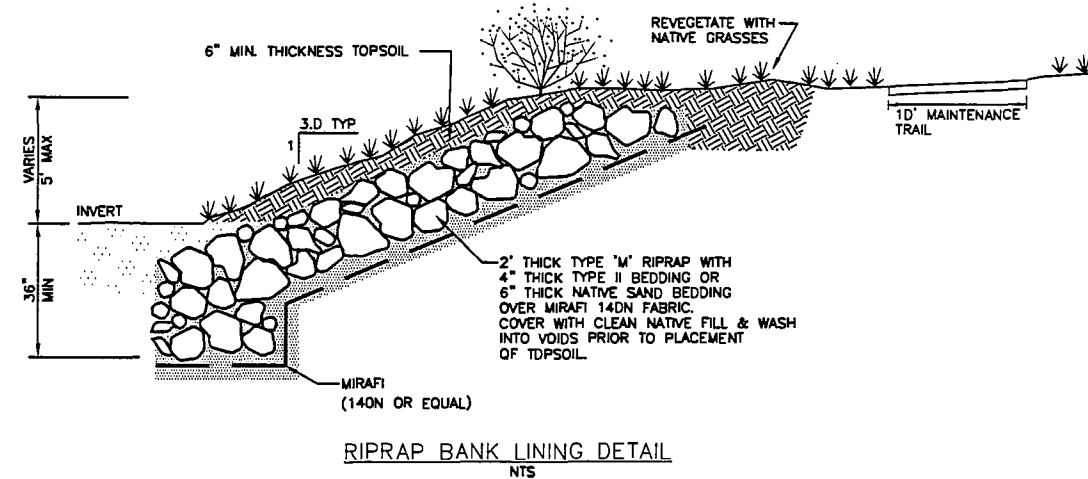
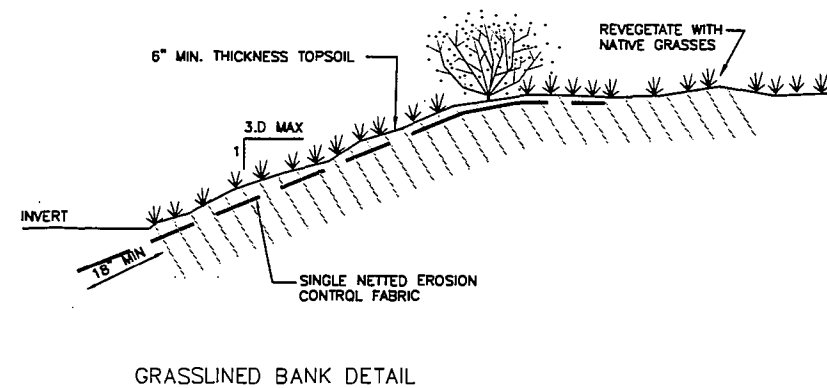
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Colorado Springs, Colorado  
80904  
(719) 630-7342

**West Fork Jimmy Camp Creek  
Drainage Basin Planning Study  
MAJOR DEVELOPMENT & LAND USE MAP**  
EL PASO COUNTY, COLORADO

Project No.: 9893  
Date: 6/99  
Design: RNW  
Drawn: CAD  
Check: RNW  
Revisions:

**FIGURE 2**





#### RIPRAP GRADATIONS

TYPE H RIPRAP INTERMEDIATE ROCK DIMENSION IN INCHES	% SMALLER THAN GIVEN SIZE BY WEIGHT	D 50 INCHES
30	100	18
24	50-70	
18	35-50	
6	2-10	

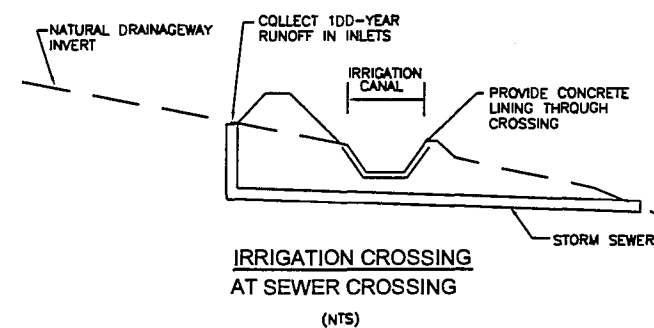
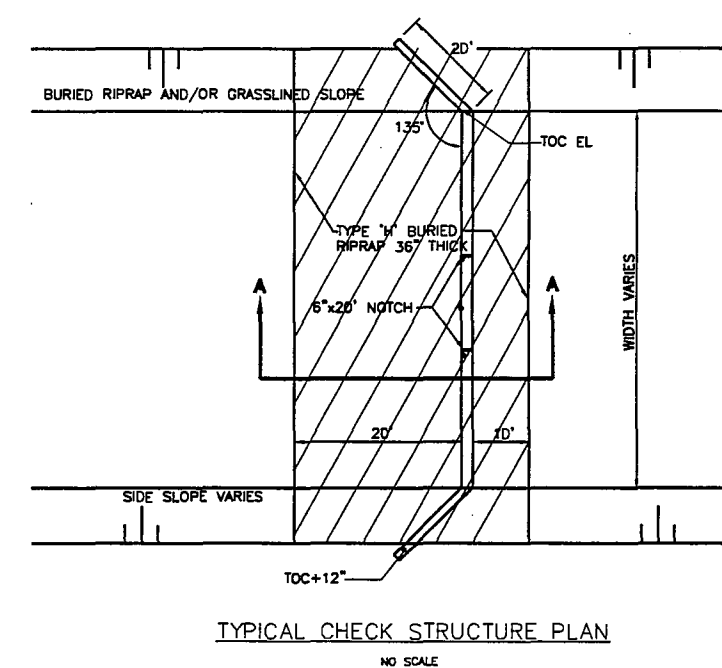
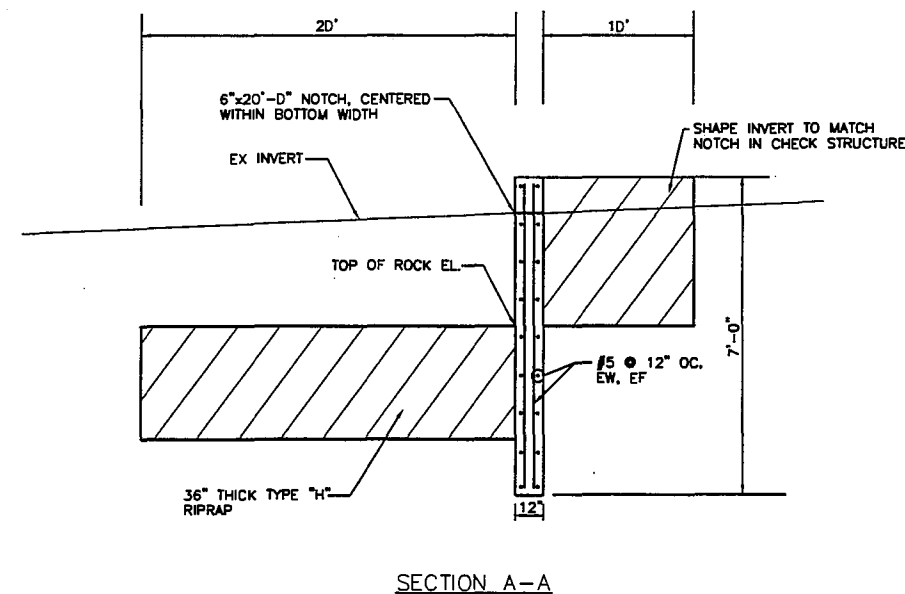
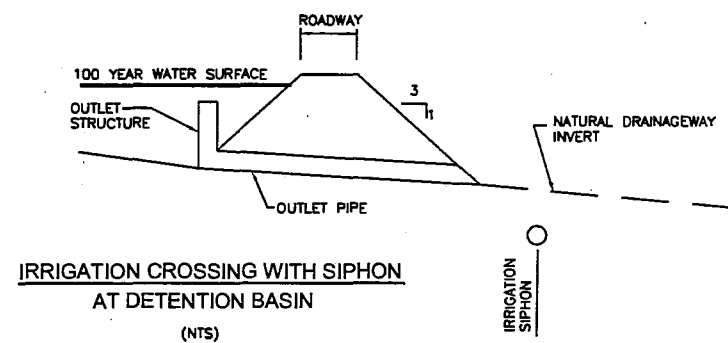
  

TYPE M RIPRAP INTERMEDIATE ROCK DIMENSION IN INCHES	% SMALLER THAN GIVEN SIZE BY WEIGHT	D 50 INCHES
21	100	12
18	50-70	
12	35-50	
4	2-10	

#### SEED MIX

AREAS DISTURBED BY THE EARTHWORK SHALL BE PERMANENTLY REVEGETATED WITH NATIVE GRASSES. NATIVE SEED MIX FOR THIS PROJECT SHALL BE AS FOLLOWS:

NATIVE SEED MIX		pls/acre
BLUE GRAMA	<i>Chondrosium hirsutum</i>	2.0
SIDEOTS GRAMA	<i>Bouteloua curtipendula</i>	3.0
SLENDER WHEATGRASS	<i>Agropyron trachycalum trachycalum</i>	2.0
WESTERN WHEATGRASS	<i>Agropyron smithii</i>	4.0
		11.0 lbs



Kiowa Engineering Corporation  
1604 South 21st Street  
Colorado Springs, Colorado 8004  
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West Fork Jimmy Camp Creek  
Drainage Basin Planning Study  
TYPICAL DRAINAGEWAY DETAILS  
EL PASO COUNTY, COLORADO

Project No.: 9893  
Date: 7/00  
Design: RNW  
Drawn: CAO  
Check: RNW  
Revisions:

SHEET 7

TABLE 2: SUMMARY OF SUB- BASIN DISCHARGES  
WEST FORK JIMMY CAMP CREEK DRAINAGE BASIN PLANNING STUDY

SUB-BASIN NUMBER	EX/FUT DRAINAGE		EXISTING CONDITION (cfs)		FUTURE CONDITION (cfs)	
	AREA (sm)	AREA (ac)	5 YR	100 YR	5 YR	100YR
2010	0.125	80.0	40	142	40	142
2020	0.062	39.7	9	47	19	68
2030	0.021	13.4	5	22	6	24
2040	0.026	16.6	5	26	7	29
2045	0.061	39.0	48	124	48	124
2050	0.020	12.8	4	17	4	19
2060	0.024	15.4	5	24	8	30
2070	0.068	43.5	8	44	17	65
2080	0.057	36.5	12	58	15	64
2090	0.019	12.2	3	14	5	19
2100	0.095	60.8	13	64	24	89
2110	0.034	21.8	6	29	8	33
2120	0.047	30.1	9	45	9	45
2130	0.010	6.4	2	11	2	11
2140	0.007	4.5	2	4	2	9
2150	0.015	9.6	6	20	6	21
2160	0.012	7.7	8	18	17	35
3000	0.420	268.8	140	474	190	568
3005	0.240	153.6	107	347	144	407
3010	0.220	140.8	81	288	138	383
3012	0.210	134.4	54	199	94	272
3015	0.110	70.4	55	181	75	212
3020	0.190	121.6	69	231	204	428
3025	0.260	166.4	82	324	347	712
3030	0.260	166.4	65	262	116	361
3035	0.160	102.4	63	234	106	306
3040	0.115	73.6	23	110	31	129
3050	0.049/074	31.4/47.4	18	61	56	136
3060	0.119	76.2	48	163	63	189
3070	0.077	49.3	23	78	27	87
3080	0.050	32.0	16	58	23	68
3090	0.082/05	52.5/32.0	27	93	21	67
3100	0.095	60.8	35	123	61	166
3110	0.018	11.5	5	17	14	31
4010	0.190	121.6	38	153	108	279
4020	0.135	86.4	26	90	39	114
4030	0.018	11.5	7	25	20	44
5010	0.156	99.8	35	133	101	246
5020	0.200	128.0	52	200	1514	362

WFCC FLOWS @  
SITE ENTRANCE

WFCC FLOWS @  
SITE EXIT

TABLE 3: SUMMARY OF DESIGN POINT DISCHARGES  
WEST FORK JIMMY CAMP CREEK DRAINAGE BASIN PLANNING STUDY

DESIGN POINT NUMBER	EX/FUT DRAINAGE		EXISTING CONDITION		FUTURE CONDITION	
	AREA (sm)	AREA (acres)	5 YR cfs	100 YR cfs	5 YR cfs	100YR cfs
2020	0.190	121.6	47	189	57	210
2040	0.300	192.0	97	335	109	362
2060	0.340	217.6	105	372	120	406
2080	0.130	83.2	17	88	28	113
2090	0.480	307.2	123	473	152	535
2100	0.610	390.4	140	558	181	651
2120	0.660	422.4	148	600	189	692
2130	0.670	428.8	145	594	186	687
2160	0.700	448.0	151	624	196	723
3000	0.660	422.4	147	233	317	935
3020	1.650	1056.0	528	1857	1059	2737
3030	2.070	1324.8	601	2216	1209	3267
3040	2.180	1395.2	618	2316	1239	3364
3050	2.26/2.23	1446/1427	627	2351	1275	3444
3070	0.200	128.0	67	235	86	270
3080	.25/.05	160/32	82	290	23	72
3090	.33/.11	211/70	106	373	44	138
3091	2.560	1638.4	732	2722	1380	3843
3100	2.660	1702.4	757	2828	1428	3990
3110	2.670	1708.8	761	2845	1442	4022
4020	0.320	204.8	63	238	145	383
5010	3.730	2387.2	943	3550	1722	4904

**Amended Master Development Drainage Plan  
The Glen at Widefield**

**El Paso County, Colorado**

Prepared for:  
New Generation Homes  
3 Widefield Boulevard  
Colorado Springs, Colorado 80911

Prepared by:  
Kiowa Engineering Corporation  
1604 South 21<sup>st</sup> Street  
Colorado Springs, Colorado 80904-4208

Kiowa Project No. 06026

June 21, 2007

```

1*****
*
*   FLOOD HYDROGRAPH PACKAGE (HEC-1)
*       JUN   1998
*       VERSION 4.1
*
*   RUN DATE   04MAY07   TIME   17:33:30
*
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*****
*
*   U.S. ARMY CORPS OF ENGINEERS
*   HYDROLOGIC ENGINEERING CENTER
*   609 SECOND STREET
*   DAVIS, CALIFORNIA 95616
*   (916) 756-1104
*
*****

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X   X XXXXXXXX XXXXX      X
X   X X      X      X    XX
X   X X      X      X    X
XXXXXXX XXXX      X      XXXXX X
X   X X      X      X    X
X   X X      X      X    X
X   X XXXXXXXX XXXXX      XXX

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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION  
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,  
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION  
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT

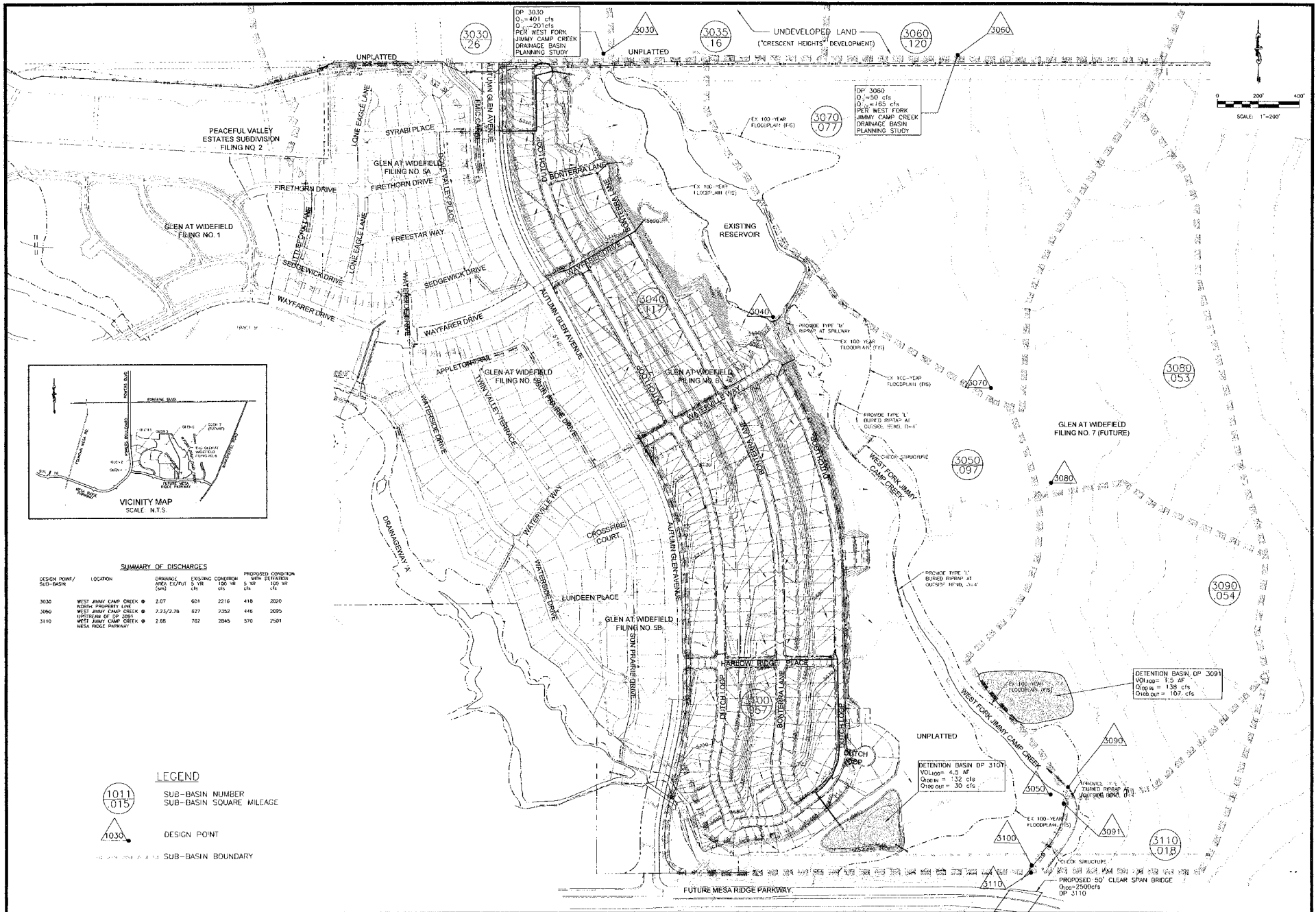
PAGE 1

LINE	ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1	ID THE GLEN AT WIDFIELD FILING NO. 6
2	ID KIOWA ENGINEERING - PROJECT NO. 06026
3	ID 2, 5, 10 & 100 YEAR STORMS FILENAME: GLEN6DET.DAT DEV COND WITH DETENTION
4	ID 24HR STORM DURATION
	*DIAGRAM
5	IT 5 0 0 250
6	IO 5
7	JR PREC .47 .56 .70 1
8	KK E1010
9	BA .05
10	IN 15
11	PB 4.4
12	PC 0.0 .0005 .0015 .0030 .0045 .0060 .0080 .0100 .0120 .0143

2 COMBINED AT								
+	DP3000	.66	1	FLOW TIME	215. 6.25	317. 6.25	493. 6.25	935. 6.17
ROUTED TO								
+	R3015	.66	1	FLOW TIME	210. 6.33	313. 6.25	493. 6.25	925. 6.25
HYDROGRAPH AT								
+	E3015	.11	1	FLOW TIME	51. 6.08	75. 6.08	115. 6.08	212. 6.08
2 COMBINED AT								
+	DP3020	.77	1	FLOW TIME	245. 6.25	365. 6.25	570. 6.25	1077. 6.17
HYDROGRAPH AT								
+	E3010	.22	1	FLOW TIME	96. 6.17	138. 6.17	211. 6.17	383. 6.17
ROUTED TO								
+	R3012	.22	1	FLOW TIME	93. 6.25	134. 6.25	204. 6.17	378. 6.17
HYDROGRAPH AT								
+	E3012	.21	1	FLOW TIME	64. 6.33	94. 6.33	147. 6.33	272. 6.33
HYDROGRAPH AT								
+	E3020	.19	1	FLOW TIME	159. 6.17	204. 6.17	275. 6.17	428. 6.17
ROUTED TO								
+	R3025	.19	1	FLOW TIME	158. 6.25	201. 6.25	270. 6.25	418. 6.25
HYDROGRAPH AT								
+	E3025	.26	1	FLOW TIME	273. 6.08	347. 6.08	463. 6.08	712. 6.08
5 COMBINED AT								
+	DP3020	1.65	1	FLOW TIME	761. 6.17	1059. 6.17	1562. 6.17	2737. 6.17
ROUTED TO								
+	DB3021	1.65	1	FLOW TIME	255. 6.75	348. 6.75	554. 6.67	1808. 6.42

\*\* PEAK STAGES IN FEET \*\*

1	STAGE	102.94	103.58	105.54	108.68
	TIME	6.75	6.75	6.67	6.42



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THE GLEN AT WIDEFIELD  
 AMENDED MASTER DEVELOPMENT DRAINAGE PLAN  
 WEST FORK JIMMY CAMP CREEK DEVELOPED CONDITION  
 EL PASO COUNTY, COLORADO

Project No.: 06026  
 Date: June 21, 2007  
 Design: JGO  
 Drawn: JGO  
 Check: AWM  
 Revisions:

SHEET

FIG. 3



United States  
Department of  
Agriculture

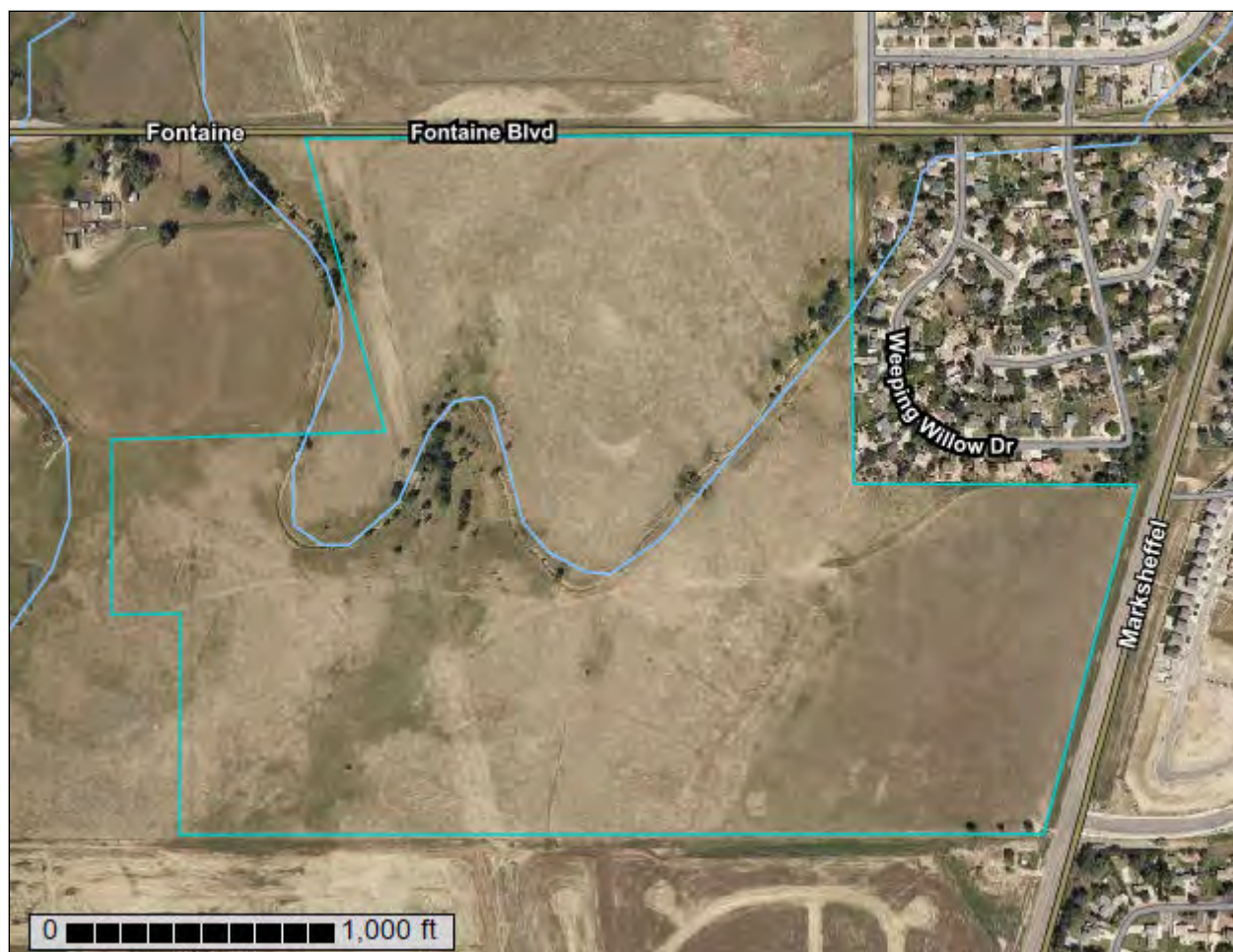
**NRCS**

Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for **El Paso County Area, Colorado**

## Corvallis Phase I



August 25, 2021

# Preface

---

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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# How Soil Surveys Are Made

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Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

## Custom Soil Resource Report

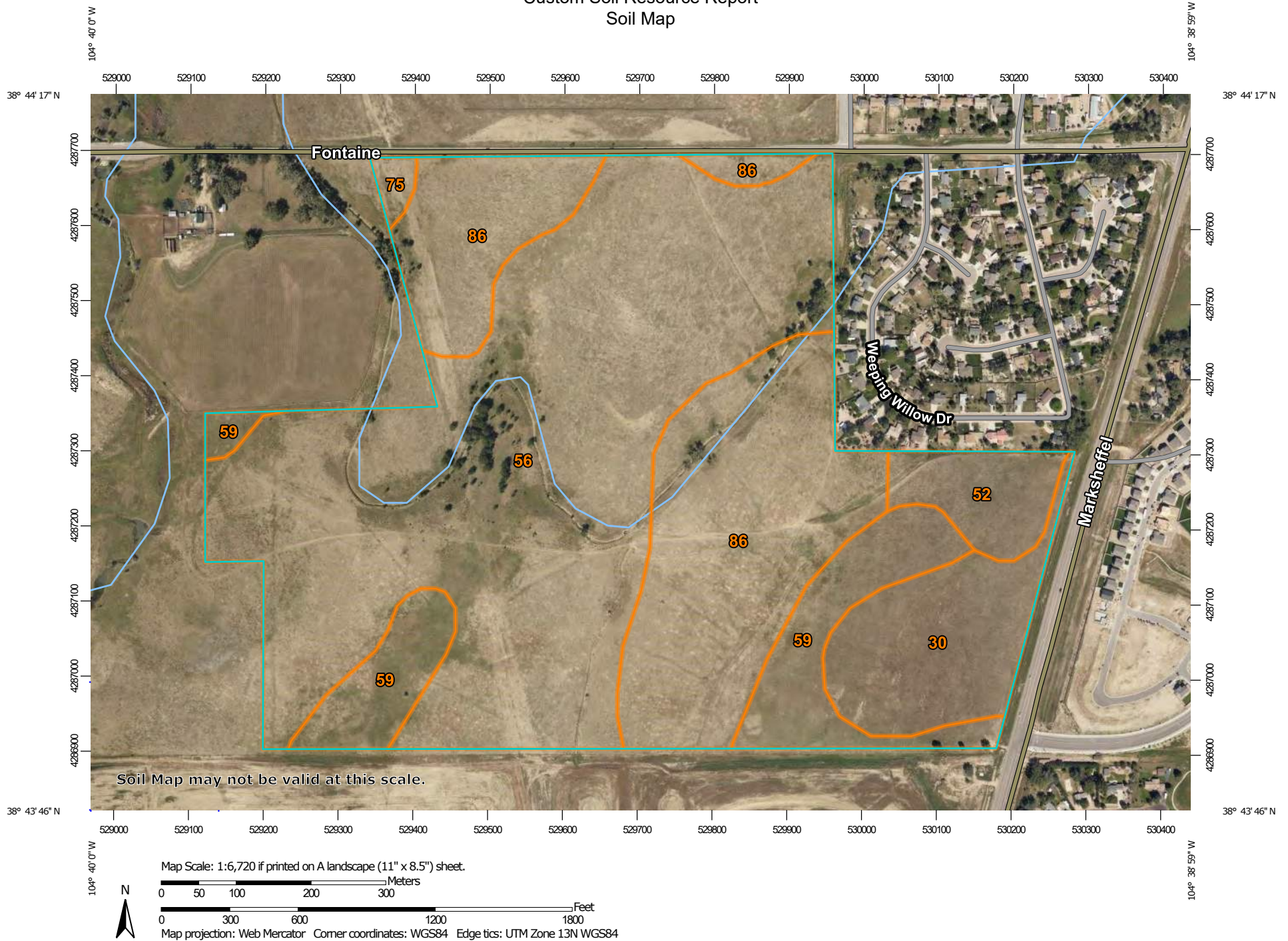
identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

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The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report Soil Map






# Custom Soil Resource Report

## MAP LEGEND




















### Area of Interest (AOI)







Area of Interest (AOI)

### Soils


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

### Special Point Features






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

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


### Water Features

-  Streams and Canals

### Transportation

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

### Background

-  Aerial Photography

## MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service  
Web Soil Survey URL:  
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 14, 2018—Sep 23, 2018

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



## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
30	Fort Collins loam, 0 to 3 percent slopes	13.4	8.2%
52	Manzanst clay loam, 0 to 3 percent slopes	6.0	3.7%
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	85.5	52.1%
59	Nunn clay loam, 0 to 3 percent slopes	16.6	10.1%
75	Razor-Midway complex	1.0	0.6%
86	Stoneham sandy loam, 3 to 8 percent slopes	41.5	25.3%
<b>Totals for Area of Interest</b>		<b>164.2</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it

was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## El Paso County Area, Colorado

### 30—Fort Collins loam, 0 to 3 percent slopes

#### Map Unit Setting

*National map unit symbol:* 3683  
*Elevation:* 5,200 to 6,500 feet  
*Mean annual precipitation:* 14 to 16 inches  
*Mean annual air temperature:* 48 to 52 degrees F  
*Frost-free period:* 135 to 155 days  
*Farmland classification:* Prime farmland if irrigated

#### Map Unit Composition

*Fort collins and similar soils:* 98 percent  
*Minor components:* 2 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Fort Collins

##### Setting

*Landform:* Flats  
*Landform position (three-dimensional):* Talf  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Loamy alluvium

##### Typical profile

*A - 0 to 9 inches:* loam  
*Bt - 9 to 16 inches:* clay loam  
*Bk - 16 to 21 inches:* clay loam  
*Ck - 21 to 60 inches:* loam

##### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.57 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water supply, 0 to 60 inches:* High (about 10.1 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 2e  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* B  
*Ecological site:* R067BY002CO - Loamy Plains  
*Other vegetative classification:* LOAMY PLAINS (069AY006CO)  
*Hydric soil rating:* No

**Minor Components**

**Other soils**

*Percent of map unit:* 1 percent  
*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:* 1 percent  
*Landform:* Depressions  
*Hydric soil rating:* Yes

**52—Manzanst clay loam, 0 to 3 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 2w4nr  
*Elevation:* 4,060 to 6,660 feet  
*Mean annual precipitation:* 14 to 16 inches  
*Mean annual air temperature:* 50 to 54 degrees F  
*Frost-free period:* 130 to 170 days  
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Manzanst and similar soils:* 85 percent  
*Minor components:* 15 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Manzanst**

**Setting**

*Landform:* Terraces, drainageways  
*Landform position (three-dimensional):* Tread  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear, concave  
*Parent material:* Clayey alluvium derived from shale

**Typical profile**

*A - 0 to 3 inches:* clay loam  
*Bt - 3 to 12 inches:* clay  
*Btk - 12 to 37 inches:* clay  
*Bk1 - 37 to 52 inches:* clay  
*Bk2 - 52 to 79 inches:* clay

**Properties and qualities**

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None

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*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Gypsum, maximum content:* 3 percent  
*Maximum salinity:* Slightly saline (4.0 to 7.0 mmhos/cm)  
*Sodium adsorption ratio, maximum:* 10.0  
*Available water supply, 0 to 60 inches:* High (about 9.0 inches)

### Interpretive groups

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 4c  
*Hydrologic Soil Group:* C  
*Ecological site:* R067BY037CO - Saline Overflow  
*Hydric soil rating:* No

### Minor Components

#### Ritoazul

*Percent of map unit:* 7 percent  
*Landform:* Interfluves, drainageways  
*Landform position (three-dimensional):* Rise  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Ecological site:* R067BY042CO - Clayey Plains  
*Hydric soil rating:* No

#### Arvada

*Percent of map unit:* 6 percent  
*Landform:* Drainageways, interfluves  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Ecological site:* R067BY033CO - Salt Flat  
*Hydric soil rating:* No

#### Wiley

*Percent of map unit:* 2 percent  
*Landform:* Interfluves  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Ecological site:* R067BY002CO - Loamy Plains  
*Hydric soil rating:* No

## 56—Nelson-Tassel fine sandy loams, 3 to 18 percent slopes

### Map Unit Setting

*National map unit symbol:* 3690  
*Elevation:* 5,600 to 6,400 feet  
*Mean annual precipitation:* 12 to 14 inches  
*Mean annual air temperature:* 48 to 52 degrees F  
*Frost-free period:* 135 to 155 days  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Nelson and similar soils: 55 percent*

*Tassel and similar soils: 40 percent*

*Minor components: 5 percent*

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Nelson

#### Setting

*Landform: Hills*

*Landform position (three-dimensional): Crest, side slope*

*Down-slope shape: Linear*

*Across-slope shape: Linear*

*Parent material: Calcareous residuum weathered from interbedded sedimentary rock*

#### Typical profile

*A - 0 to 5 inches: fine sandy loam*

*Ck - 5 to 23 inches: fine sandy loam*

*Cr - 23 to 27 inches: weathered bedrock*

#### Properties and qualities

*Slope: 3 to 12 percent*

*Depth to restrictive feature: 20 to 40 inches to paralithic bedrock*

*Drainage class: Well drained*

*Runoff class: Medium*

*Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)*

*Depth to water table: More than 80 inches*

*Frequency of flooding: None*

*Frequency of ponding: None*

*Calcium carbonate, maximum content: 10 percent*

*Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)*

*Available water supply, 0 to 60 inches: Very low (about 2.8 inches)*

#### Interpretive groups

*Land capability classification (irrigated): 4e*

*Land capability classification (nonirrigated): 6e*

*Hydrologic Soil Group: B*

*Ecological site: R067BY045CO - Shaly Plains*

*Other vegetative classification: SHALY PLAINS (069AY046CO)*

*Hydric soil rating: No*

### Description of Tassel

#### Setting

*Landform: Hills*

*Landform position (three-dimensional): Crest, side slope*

*Down-slope shape: Linear*

*Across-slope shape: Linear*

*Parent material: Calcareous slope alluvium over residuum weathered from sandstone*

#### Typical profile

*A - 0 to 4 inches: fine sandy loam*

*C - 4 to 10 inches: fine sandy loam*

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*Cr - 10 to 14 inches: weathered bedrock*

### Properties and qualities

*Slope: 3 to 18 percent*

*Depth to restrictive feature: 6 to 20 inches to paralithic bedrock*

*Drainage class: Well drained*

*Runoff class: Medium*

*Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)*

*Depth to water table: More than 80 inches*

*Frequency of flooding: None*

*Frequency of ponding: None*

*Calcium carbonate, maximum content: 10 percent*

*Available water supply, 0 to 60 inches: Very low (about 1.2 inches)*

### Interpretive groups

*Land capability classification (irrigated): None specified*

*Land capability classification (nonirrigated): 6s*

*Hydrologic Soil Group: D*

*Ecological site: R067BY045CO - Shaly Plains*

*Other vegetative classification: SHALY PLAINS (069AY046CO)*

*Hydric soil rating: No*

### Minor Components

#### Other soils

*Percent of map unit: 4 percent*

*Hydric soil rating: No*

#### Pleasant

*Percent of map unit: 1 percent*

*Landform: Depressions*

*Hydric soil rating: Yes*

## 59—Nunn clay loam, 0 to 3 percent slopes

### Map Unit Setting

*National map unit symbol: 3693*

*Elevation: 5,400 to 6,500 feet*

*Mean annual precipitation: 13 to 15 inches*

*Mean annual air temperature: 46 to 50 degrees F*

*Frost-free period: 135 to 155 days*

*Farmland classification: Prime farmland if irrigated*

### Map Unit Composition

*Nunn and similar soils: 95 percent*

*Minor components: 5 percent*

*Estimates are based on observations, descriptions, and transects of the mapunit.*

## Description of Nunn

### Setting

*Landform:* Fans, terraces  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Mixed alluvium

### Typical profile

*A - 0 to 12 inches:* clay loam  
*Bt - 12 to 26 inches:* clay loam  
*BC - 26 to 30 inches:* clay loam  
*Bk - 30 to 58 inches:* sandy clay loam  
*C - 58 to 72 inches:* clay

### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Gypsum, maximum content:* 2 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water supply, 0 to 60 inches:* High (about 9.8 inches)

### Interpretive groups

*Land capability classification (irrigated):* 2e  
*Land capability classification (nonirrigated):* 3c  
*Hydrologic Soil Group:* C  
*Ecological site:* R069XY042CO - Clayey Plains LRU's A & B  
*Other vegetative classification:* CLAYEY PLAINS (069AY042CO)  
*Hydric soil rating:* No

## Minor Components

### Other soils

*Percent of map unit:* 4 percent  
*Hydric soil rating:* No

### Pleasant

*Percent of map unit:* 1 percent  
*Landform:* Depressions  
*Hydric soil rating:* Yes



## 75—Razor-Midway complex

### Map Unit Setting

*National map unit symbol:* 369p  
*Elevation:* 5,300 to 6,100 feet  
*Mean annual precipitation:* 12 to 14 inches  
*Mean annual air temperature:* 48 to 52 degrees F  
*Frost-free period:* 135 to 155 days  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Razor and similar soils:* 60 percent  
*Midway and similar soils:* 35 percent  
*Minor components:* 5 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Razor

#### Setting

*Landform:* Hills  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Concave, linear  
*Across-slope shape:* Linear  
*Parent material:* Clayey slope alluvium over residuum weathered from shale

#### Typical profile

*A - 0 to 4 inches:* stony clay loam  
*Bw - 4 to 22 inches:* cobbly clay loam  
*Bk - 22 to 29 inches:* cobbly clay  
*Cr - 29 to 33 inches:* weathered bedrock

#### Properties and qualities

*Slope:* 3 to 15 percent  
*Depth to restrictive feature:* 20 to 40 inches to paralithic bedrock  
*Drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Gypsum, maximum content:* 5 percent  
*Maximum salinity:* Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)  
*Sodium adsorption ratio, maximum:* 15.0  
*Available water supply, 0 to 60 inches:* Low (about 4.7 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 6e  
*Land capability classification (nonirrigated):* 6e

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*Hydrologic Soil Group:* D

*Ecological site:* R069XY047CO - Alkaline Plains LRU's A & B

*Other vegetative classification:* ALKALINE PLAINS (069AY047CO)

*Hydric soil rating:* No

### Description of Midway

#### Setting

*Landform:* Hills

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Slope alluvium over residuum weathered from shale

#### Typical profile

*A - 0 to 4 inches:* clay loam

*C - 4 to 13 inches:* clay

*Cr - 13 to 17 inches:* weathered bedrock

#### Properties and qualities

*Slope:* 3 to 25 percent

*Depth to restrictive feature:* 6 to 20 inches to paralithic bedrock

*Drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 15 percent

*Gypsum, maximum content:* 15 percent

*Maximum salinity:* Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)

*Sodium adsorption ratio, maximum:* 15.0

*Available water supply, 0 to 60 inches:* Very low (about 2.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 7e

*Hydrologic Soil Group:* D

*Ecological site:* R069XY046CO - Shaly Plains LRU's A & B

*Other vegetative classification:* SHALY PLAINS (069AY045CO)

*Hydric soil rating:* No

### Minor Components

#### Other soils

*Percent of map unit:* 4 percent

*Hydric soil rating:* No

#### Pleasant

*Percent of map unit:* 1 percent

*Landform:* Depressions

*Hydric soil rating:* Yes

## 86—Stoneham sandy loam, 3 to 8 percent slopes

### Map Unit Setting

*National map unit symbol:* 36b2  
*Elevation:* 5,100 to 6,500 feet  
*Mean annual precipitation:* 13 to 15 inches  
*Mean annual air temperature:* 48 to 52 degrees F  
*Frost-free period:* 135 to 155 days  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Stoneham and similar soils:* 95 percent  
*Minor components:* 5 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Stoneham

#### Setting

*Landform:* Hills  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Calcareous loamy alluvium

#### Typical profile

*A - 0 to 4 inches:* sandy loam  
*Bt - 4 to 8 inches:* sandy clay loam  
*Btk - 8 to 11 inches:* sandy clay loam  
*Ck - 11 to 60 inches:* loam

#### Properties and qualities

*Slope:* 3 to 8 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.60 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water supply, 0 to 60 inches:* High (about 9.5 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* B  
*Ecological site:* R067BY024CO - Sandy Plains

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*Other vegetative classification:* SANDY PLAINS (069AY026CO)

*Hydric soil rating:* No

### Minor Components

#### Other soils

*Percent of map unit:* 4 percent

*Hydric soil rating:* No

#### Pleasant

*Percent of map unit:* 1 percent

*Landform:* Depressions

*Hydric soil rating:* Yes

# **Soil Information for All Uses**

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## **Soil Properties and Qualities**

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

## **Soil Qualities and Features**

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

## **Hydrologic Soil Group**

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

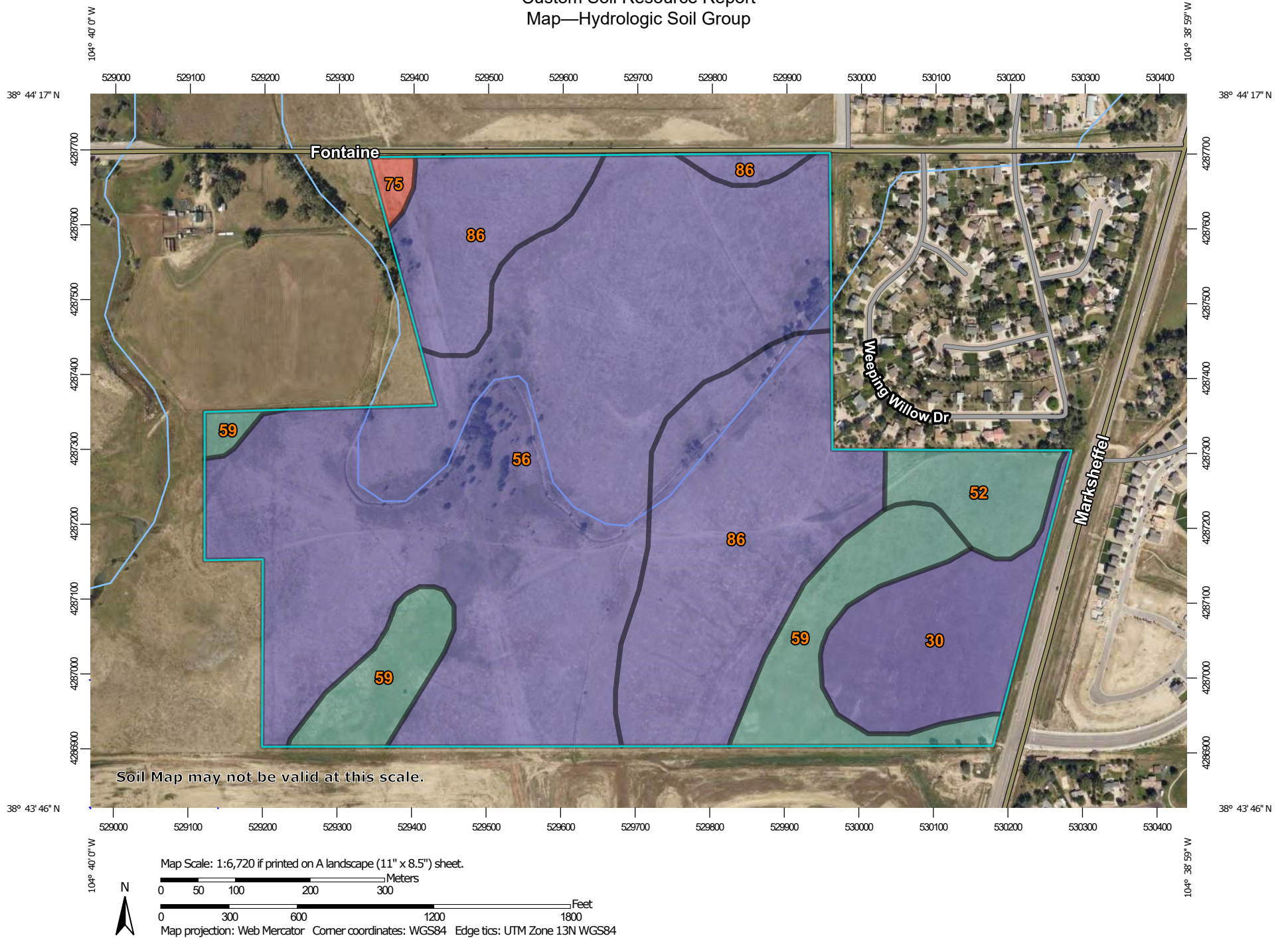
## Custom Soil Resource Report

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

# Custom Soil Resource Report Map—Hydrologic Soil Group



## Custom Soil Resource Report









### MAP LEGEND

#### Area of Interest (AOI)









Area of Interest (AOI)

#### Soils

##### Soil Rating Polygons





	A
	A/D
	B
	B/D
	C
	C/D
	D
	Not rated or not available

##### Soil Rating Lines


	A
	A/D
	B
	B/D
	C
	C/D
	D
	Not rated or not available

##### Soil Rating Points






	A
	A/D
	B
	B/D

	C
	C/D
	D
	Not rated or not available


#### Water Features

 Streams and Canals

#### Transportation

	Rails
	Interstate Highways
	US Routes
	Major Roads
	Local Roads

#### Background

 Aerial Photography

### MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service  
Web Soil Survey URL:  
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 14, 2018—Sep 23, 2018

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



**Table—Hydrologic Soil Group**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
30	Fort Collins loam, 0 to 3 percent slopes	B	13.4	8.2%
52	Manzanst clay loam, 0 to 3 percent slopes	C	6.0	3.7%
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	B	85.5	52.1%
59	Nunn clay loam, 0 to 3 percent slopes	C	16.6	10.1%
75	Razor-Midway complex	D	1.0	0.6%
86	Stoneham sandy loam, 3 to 8 percent slopes	B	41.5	25.3%
<b>Totals for Area of Interest</b>			<b>164.2</b>	<b>100.0%</b>

**Rating Options—Hydrologic Soil Group***Aggregation Method:* Dominant Condition*Component Percent Cutoff:* None Specified*Tie-break Rule:* Higher

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- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053580](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580)
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- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

## Custom Soil Resource Report

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United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053624](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624)

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**Final Drainage Report**

# Marksheffel Road South

Link Road to US-24

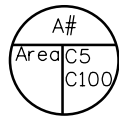
*El Paso County, CO*

**April 1, 2015**



sacosta 9/14/05 All c:\pwworking\oma\1266573\North-Marksheffel\_BASINS\_Plan008.dgn

LEGEND



BASIN LABEL



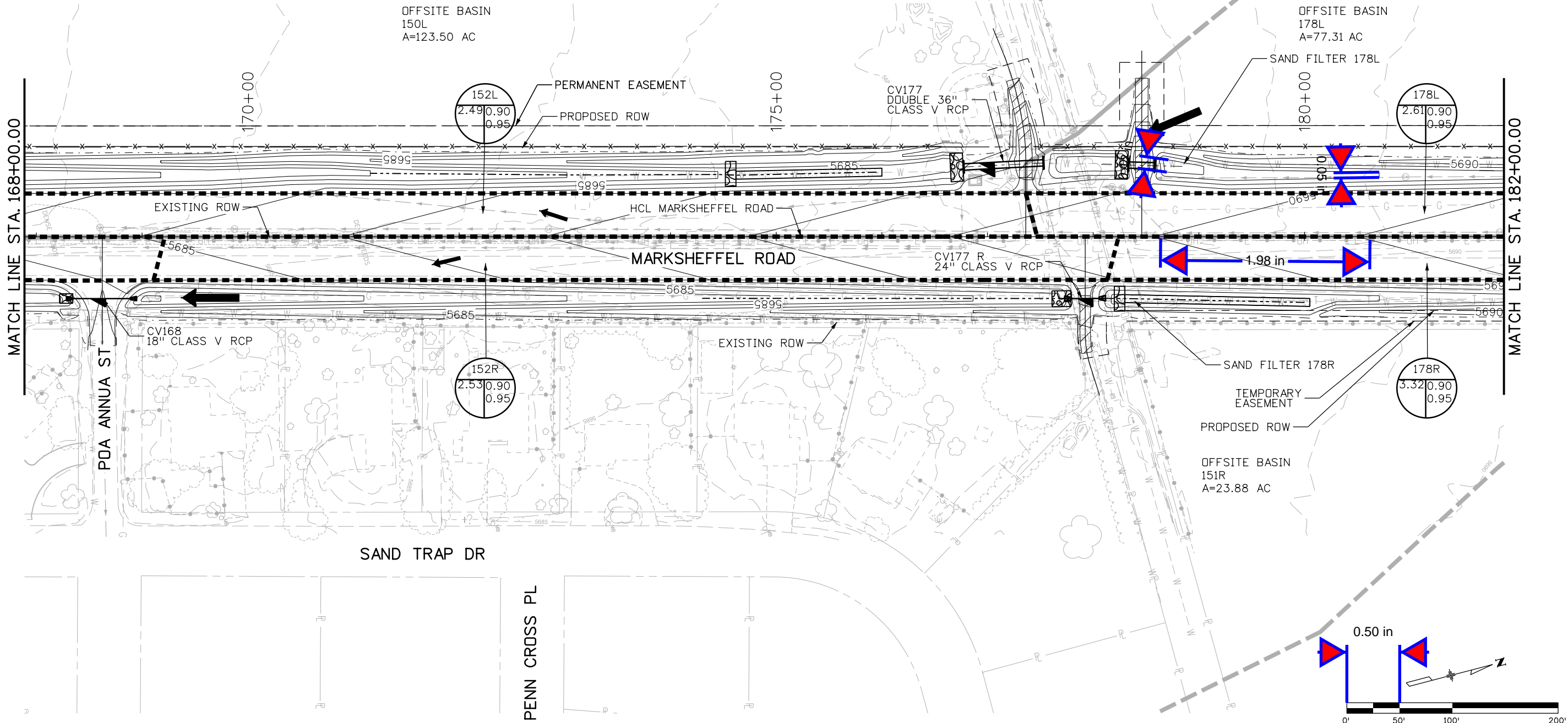
OFFSITE BASIN BOUNDARY



PAVEMENT BASIN BOUNDARY



FLOW DIRECTION



Print Date: 4/2/2015

File Name: North-Marksheffel\_BASINS\_Plan008.dgn

Horiz. Scale: 1:100

Vert. Scale: As Noted

Unit Information

Unit Leader Initials



Sheet Revisions

Date:	Comments	Init.

EL PASO



COUNTY

COLORADO



As Constructed

No Revisions:

Revised:

Void:

MARKSHEFFEL ROAD  
DRAINAGE BASINS PLAN  
168+00.00 TO 182+00.00

Designer: E. STATEN

Detailer: D. MADDOCK

Sheet Subset: BASINS

Structure

Numbers

Subset Sheets: 8 of 36

Project No./Code

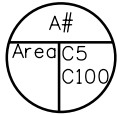
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8

sacosta 9/14/19 AM c:\pwworking\oma\dl266573 North-Marksheffel\_BASINS\_Plan009.dgn

LEGEND



BASIN LABEL



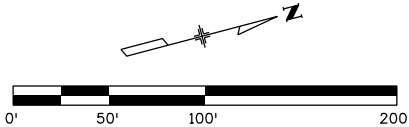
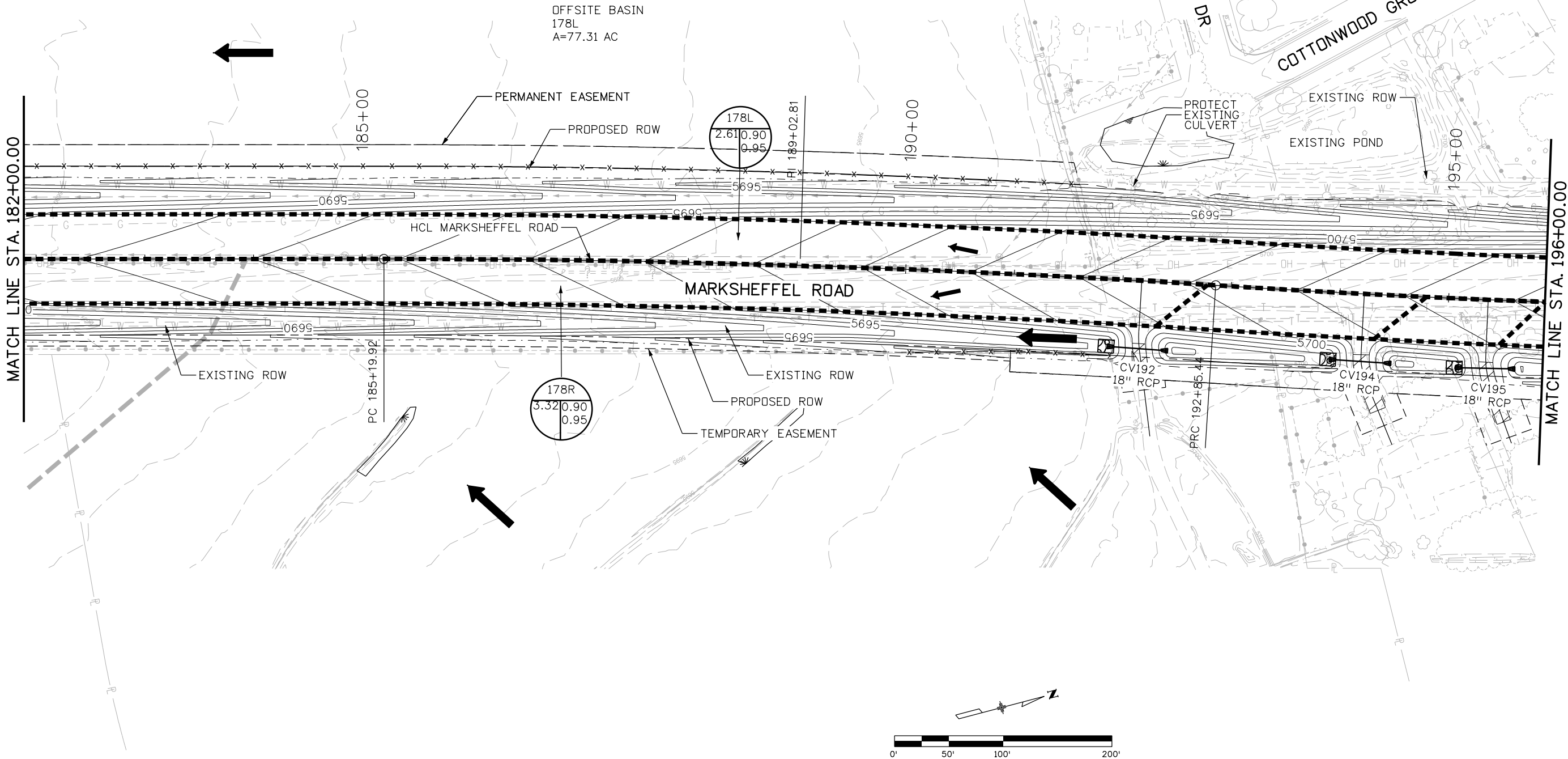
OFFSITE BASIN BOUNDARY



PAVEMENT BASIN BOUNDARY



FLOW DIRECTION



Print Date: 4/2/2015

File Name: North-Marksheffel\_BASINS\_Plan009.dgn

Horiz. Scale: 1:100

Vert. Scale: As Noted

Unit Information

Unit Leader Initials



Sheet Revisions

Date:	Comments	Init.

EL PASO



COUNTY

COLORADO



As Constructed

No Revisions:

Revised:

Void:

MARKSHEFFEL ROAD  
DRAINAGE BASINS PLAN  
182+00.00 TO 196+00.00

Designer: E. STATEN

Detailer: D. MADDOCK

Sheet Subset: BASINS

Structure

Numbers

Subset Sheets: 9 of 36

Project No./Code

....

....

# Design Procedure Form: Sand Filter (SF)

Sheet 1 of 2

Designer: M. Johnson  
 Company: HDR  
 Date: March 5, 2015  
 Project: Marksheffel  
 Location: Basin 178L

## 1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area,  $I_a$   
 (100% if all paved and roofed areas upstream of sand filter)
- B) Tributary Area's Imperviousness Ratio ( $i = I_a/100$ )
- C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time  
 $WQCV = 0.9 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$
- D) Contributing Watershed Area (including sand filter area)
- E) Water Quality Capture Volume (WQCV) Design Volume  
 $V_{WQCV} = WQCV / 12 * \text{Area}$
- F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume  
 (Only if a different WQCV Design Volume is desired)

$I_a =$  100.0 %

$i =$  1.000

WQCV = 0.45 watershed inches

Area = 113,692 sq ft

$V_{WQCV} =$  4,263 cu ft

$d_e =$  \_\_\_\_\_ in

$V_{WQCV \text{ OTHER}} =$  \_\_\_\_\_ cu ft

$V_{WQCV \text{ USER}} =$  \_\_\_\_\_ cu ft

## 2. Basin Geometry

- A) WQCV Depth
- B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.
- C) Minimum Filter Area (Flat Surface Area)
- D) Actual Filter Area
- E) Volume Provided

$D_{WQCV} =$  2.0 ft

$Z =$  4.00 ft / ft

$A_{Min} =$  947 sq ft

$A_{Actual} =$  1035 sq ft

$V_T =$  4278 cu ft

## 3. Filter Material

Choose One

- ☒ 18" CDOT Class C Filter Material  
☐ Other (Explain): \_\_\_\_\_

## 4. Underdrain System

- A) Are underdrains provided?
- B) Underdrain system orifice diameter for 12 hour drain time
- i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice
- ii) Volume to Drain in 12 Hours
- iii) Orifice Diameter, 3/8" Minimum

Choose One

- ☒ YES  
☐ NO

$y =$  3.8 ft

$Vol_{12} =$  4,263 cu ft

$D_o =$  1 - 5 / 16 in



## Design Procedure Form: Sand Filter (SF)

Sheet 2 of 2

Designer: M. Johnson

Company: HDR

Date: March 5, 2015

Project: Marksheffel

Location: Basin 178L

### 5. Impermeable Geomembrane Liner and Geotextile Separator Fabric

A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?

Choose One

☐

YES

☒

NO

### 6-7. Inlet / Outlet Works

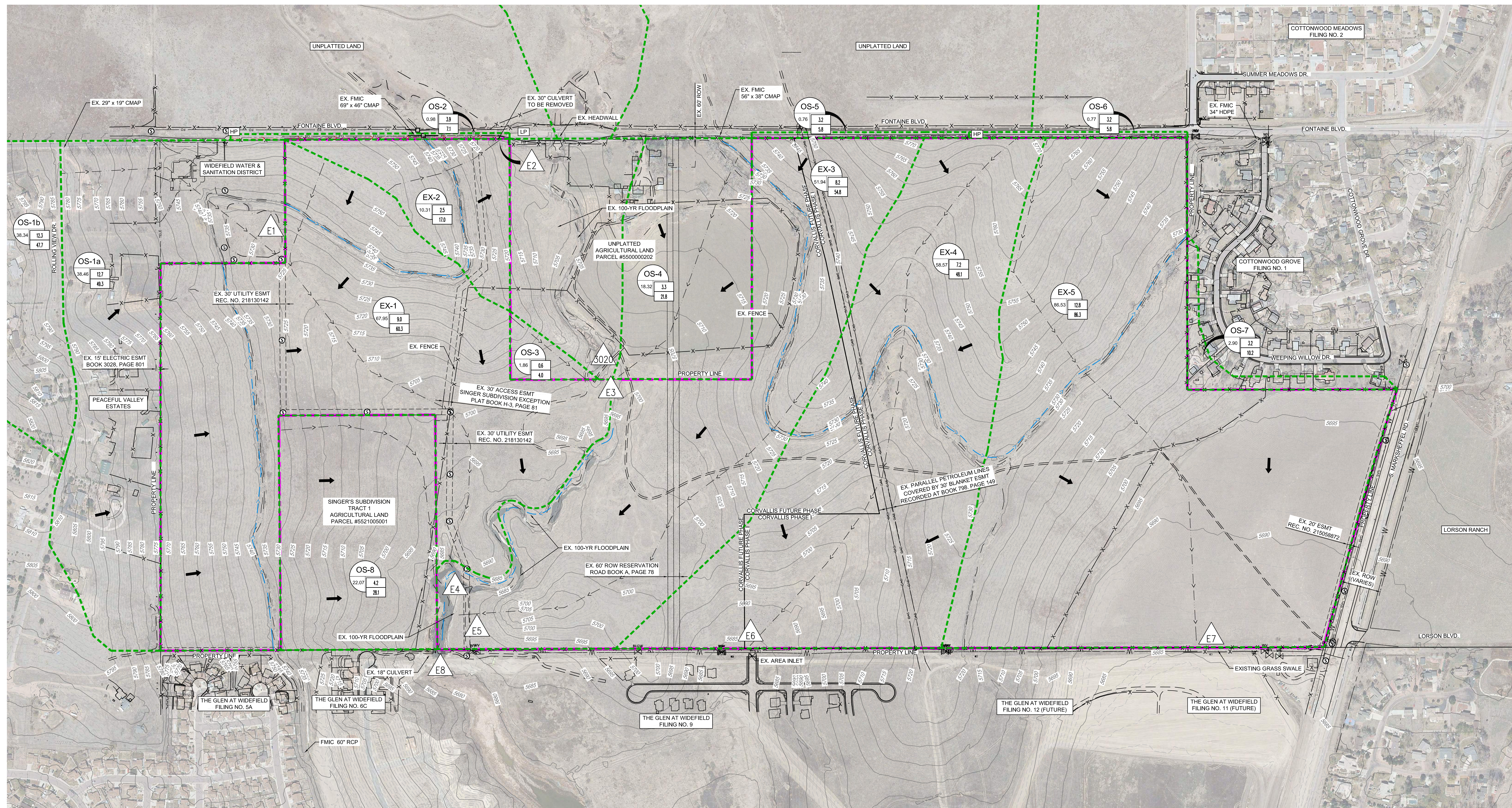
A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet

Notes:

## **APPENDIX D**

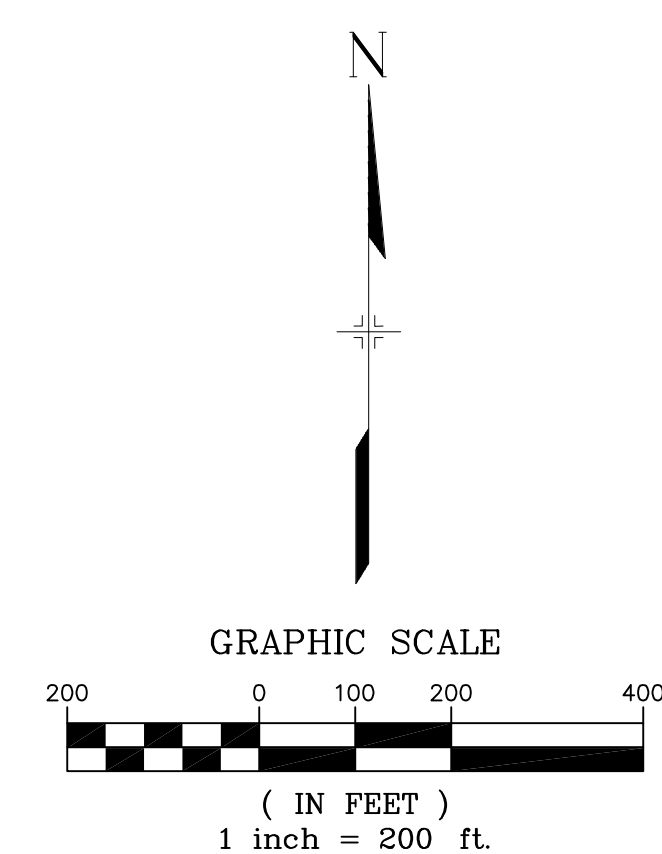
### ***MAPS***





# LEGEND

- EXISTING BASIN BOUNDARY
- - - EXISTING CONTOUR
- - - DRAINAGE CHANNEL
- - - PROPOSED PROPERTY LINE
- EXISTING FLOW DIRECTION
- - - EXISTING FLOW PATH
- △ DESIGN POINT
- EX-2 SUB BASIN DESIGNATION
- ### 5-YEAR STORM EVENT PEAK FLOW (CFS)
- ### 100-YEAR STORM EVENT PEAK FLOW (CFS)
- ### SUB BASIN AREA (AC.)



Area ID	Area (Acres)	Q5 (cfs)	Q100 (cfs)
OS-1a	38.5	12.7	49.3
OS-1b	38.3	12.3	47.7
OS-2	1.0	3.9	7.1
OS-3	1.9	0.6	4.0
OS-4	18.3	3.3	21.8
OS-5	0.8	3.2	5.8
OS-6	0.8	3.2	5.8
OS-7	2.9	2.5	9.4
OS-8	22.1	4.2	28.1
EX-1	67.9	9.0	60.3
EX-2	10.3	2.5	17.0
EX-3	51.9	8.2	54.8
EX-4	58.6	7.2	48.1
EX-5	86.5	12.8	86.3

Area ID	Area (Acres)	Q5 (cfs)	Q100 (cfs)
E1: OS-1	76.8	25.3	98.5
E2: OS-2, EX-2	11.3	5.4	22.5
E3: E2, OS-3, OS-4	31.5	6.5	34.4
E4: E1, E3, EX-1, OS-8	198.3	46.3	222.3
E5: OS-5, EX-3	52.7	10.2	57.5
E6: EX-4	58.6	7.2	48.1
E7: EX-5, OS-6, OS-7	90.2	16.5	93.1
E8: E4, E5, +DPBS R3030	251.0	403.5	2040.7

PREPARED BY:



2435 Research Pkwy, Suite 300  
Colorado Springs, CO 80920  
Phone: 719.575.0100

## CORVALLIS

MASTER DRAINAGE DEVELOPMENT PLAN  
FOUNTAIN, CO

## EXISTING CONDITIONS

DESIGNED BY: NMS SCALE: DATE ISSUED: SEPTEMBER 2021 DRAWING NO: DR01  
DRAWN BY: JTS HORIZ. 1" = 200' SHEET 01 OF 04  
CHECKED BY: NMS VERT. N/A



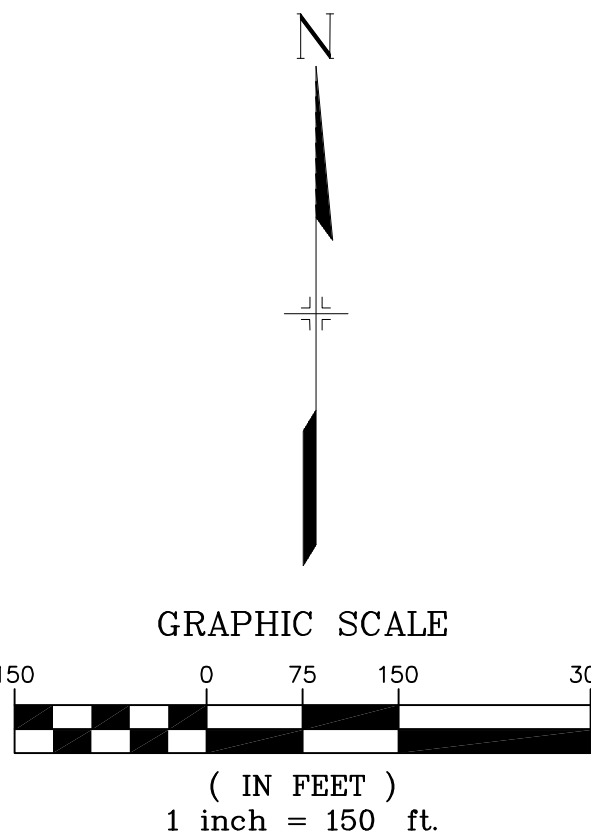
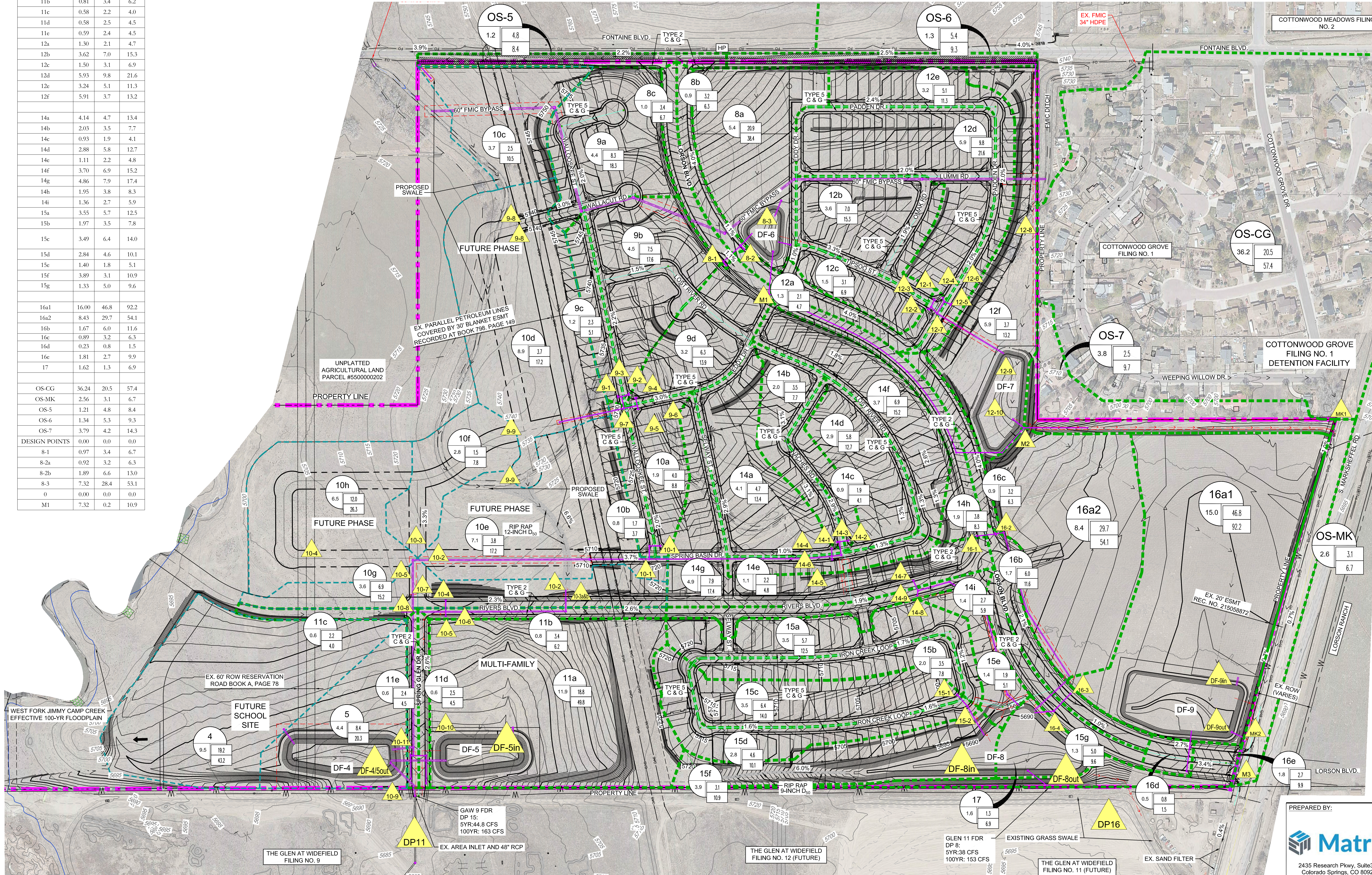
8a	5.43	20.9	38.4
8b	0.92	3.2	6.3
8c	0.97	3.4	6.7
9a	4.38	8.3	18.3
9b	4.46	7.5	17.6
9c	1.18	2.3	5.1
9d	3.17	6.3	13.9
10a	1.94	4.0	8.8
10b	0.78	1.7	3.7
10c	3.67	2.5	10.5
10d (Undeveloped)	8.86	3.7	17.2
10e (Undeveloped)	7.10	3.8	17.2
10f (Undeveloped)	2.78	1.5	7.8
10d (Developed)	8.86	8.5	22.0
10e (Developed)	7.10	10.8	26.2
10f (Developed)	2.78	5.3	11.7
10g	3.62	7.1	15.6
10h	6.47	12.0	26.3
11a	11.91	18.8	49.8
11b	0.81	3.4	6.2
11c	0.58	2.2	4.0
11d	0.58	2.5	4.5
11e	0.59	2.4	4.5
12a	1.30	2.1	4.7
12b	3.62	7.0	15.3
12c	1.50	3.1	6.9
12d	5.93	9.8	21.6
12e	3.24	5.1	11.3
12f	5.91	3.7	13.2
14a	4.14	4.7	13.4
14b	2.03	3.5	7.7
14c	0.93	1.9	4.1
14d	2.88	5.8	12.7
14e	1.11	2.2	4.8
14f	3.70	6.9	15.2
14g	4.86	7.9	17.4
14h	1.95	3.8	8.3
14i	1.36	2.7	5.9
15a	3.55	5.7	12.5
15b	1.97	3.5	7.8
15c	3.49	6.4	14.0
15d	2.84	4.6	10.1
15e	1.40	1.8	5.1
15f	3.89	3.1	10.9
15g	1.33	5.0	9.6
16a1	16.00	46.8	92.2
16a2	8.43	29.7	54.1
16b	1.67	6.0	11.6
16c	0.89	3.2	6.3
16d	0.23	0.8	1.5
16e	1.81	2.7	9.9
17	1.62	1.3	6.9
OS-CG	36.24	20.5	57.4
OS-MK	2.56	3.1	6.7
OS-5	1.21	4.8	8.4
OS-6	1.34	5.3	9.3
OS-7	3.79	4.2	14.3
DESIGN POINTS	0.00	0.0	0.0
8-1	0.97	3.4	6.7
8-2a	0.92	3.2	6.3
8-2b	1.89	6.6	13.0
8-3	7.32	28.4	53.1
0	0.00	0.0	0.0
M1	7.32	0.2	10.9

Proposed Design Point Summary - Central Basin				
CORVALLIS PHASE I				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
9-1	9c	1.18	2.30	5.07
9-2	9b	4.46	7.52	17.56
9-3	9b, 9c	5.64	9.68	22.31
9-4	9d	3.17	6.29	13.86
9-5	n/a	0.12	0.49	0.90
9-6	9d	3.29	6.75	14.70
9-7	9b-9d	8.93	16.82	37.95
9-8	9a, 10c, OS-5	9.25	12.66	31.42
9-9	9a-9d, 10c, 10d, 10f, OS-5	29.82	30.33	87.72
10-1	10a, 10b	2.72	5.59	12.31
10-2	9a-9d, 10c-10e, OS-5	36.92	35.73	110.70
10-3a	10g	3.62	7.07	15.58
10-3b	9a-9d, 10a-10d, 10g, OS-5	43.26	44.79	130.57
14-1	14b	2.03	3.49	7.69
14-2	14c	0.93	1.86	4.11
14-3	14b, 14c	2.96	5.20	11.45
14-4	14d, 14a	7.03	9.16	23.29
14-5	14c, 14f	4.81	9.01	19.84
14-6	14a-14f	14.80	21.47	50.42
10-1 FUT	DP 14-6, 10a, 10b	17.52	23.02	53.50
10-2 FUT	DP 14-6, 10a, 10b, 10c	24.62	28.40	66.75

Proposed Design Point Summary - Central Basin				
CORVALLIS PHASE I				
9-8 FUT	9a, 10c, OS-5	9.25	12.25	30.40
9-9 FUT	9-7, 9-8 FUT, 10d	27.04	29.35	71.19
10-3 FUT	9-9 FUT, 10f	29.82	30.24	72.63
10-4 FUT	10h	6.47	11.96	26.35
10-5 FUT	10-4 FUT, 10-3 FUT, 10-2 FUT	60.92	61.37	144.65
10-3c	14a-14f, 9a-9d, 10a-10d, 10g, OS-5	58.06	51.55	141.35
10-4	10g	3.62	7.07	15.58
10-5	11b	0.81	3.40	6.20
10-6	9a-9d, 10a-10d, 10g, 11b, OS-5	58.87	51.97	141.01
10-7	10-4 FUT, 10-3 FUT, 10-2 FUT	60.92	61.37	144.65
10-8	9a-9d, 10a, 10b, 10f, 10g, 11b, OS-5	65.81	74.92	174.35
10-9	11c	0.59	2.35	4.29
10-10	11d	0.58	2.46	4.49
10-11	9a-9d, 10a-10f, 11b-11d, OS-5	66.99	79.74	184.20
DF-5 in	11a	11.91	18.78	49.81
DF-4 in	4, 5, DP 10-11	80.98	89.05	205.51
DF-4/5 in	DF-4 in & DF-5 in	92.88	100.70	236.44
DF-4/5 out / DP 11	DF-4 in & DF-5 in	92.88	10.50	79.60
Proposed Design Point Summary - East Basin				
CORVALLIS PHASE I				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)

Proposed Design Point Summary - Central Basin				
CORVALLIS PHASE I				
8-1	8c	0.97	3.43	6.70
8-2a	8b (Inlet)	0.92	3.19	6.27
8-2b	8b, 8c	1.89	6.61	12.96
8-3	DF-6 Inflow	7.32	28.40	53.10
M1	DF-6 Discharge	7.32	0.20	10.90
12-1	12b	3.62	6.96	15.33
12-2	12c	1.50	3.11	6.86
12-3	12b, 12c	5.12	9.75	21.48
12-4	12a, 12d	7.24	11.71	25.80
12-5	12e	3.24	5.15	11.34
12-6	12a, 12d, 12e	10.48	16.97	37.37
12-7	12a-12e	15.60	25.25	55.62
12-8	OS-6, 12f	7.25	4.84	13.42
12-9	Total into pond	22.84	29.80	70.30
12-10	Pond DF-7 Discharge	22.84	1.00	14.80
M2	12-10 & M1 (DF-6 & 7)	30.17	1.20	25.70
DF-9 in	16a1	16.00	44.81	88.24
DF-9 out	DF-9 Outlet Structure	16.00	2.20	11.80

Proposed Design Point Summary - Central Basin				
CORVALLIS PHASE I				
MK1	OS-7, OS-CG, M2	70.20	25.87	97.45
MK2	MK1, OS-MK, DF-9 out	88.76	31.20	115.99
M3	Combined Outflows: DF-6, DF-7 and DF-9; OS-MK, OS-CG	88.76	31.20	115.99
14-7	14g	4.86	7.89	17.37
14-8	14i	1.36	2.67	5.89
14-9	14g-14i	6.22	10.10	22.24
15-1	15b, 15c	5.46	9.68	21.31
15-2a	15a, 15d (Inlet)	6.39	10.73	23.63
15-2b	15a-15d	11.85	20.16	44.42
16-1	14h	1.95	4.18	9.20
16-2a	16c	0.89	2.76	5.46
16-2b	14h, 16c, 16a2	11.27	33.82	63.39
16-3	16b	1.67	5.75	11.09
16-4a	15g	1.33	3.86	7.49
16-4b	15g, 16b	3.00	9.19	17.75



### LEGEND

- PROPOSED BASIN BOUNDARY
- FUTURE BASIN BOUNDARY
- EXISTING CONTOUR
- DRAINAGE CHANNEL
- PROPOSED PROPERTY LINE
- PROPOSED FLOW DIRECTION
- PROPOSED FLOW PATH
- DESIGN POINT - FUTURE PHASE
- DESIGN POINT - CURRENT PHASE
- SUB BASIN DESIGNATION
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- SUB BASIN AREA (AC.)

PREPARED BY:  
**Matrix**  
2435 Research Pkwy, Suite 300  
Colorado Springs, CO 80920  
Phone 719.575.0100

### CORVALLIS PHASE I

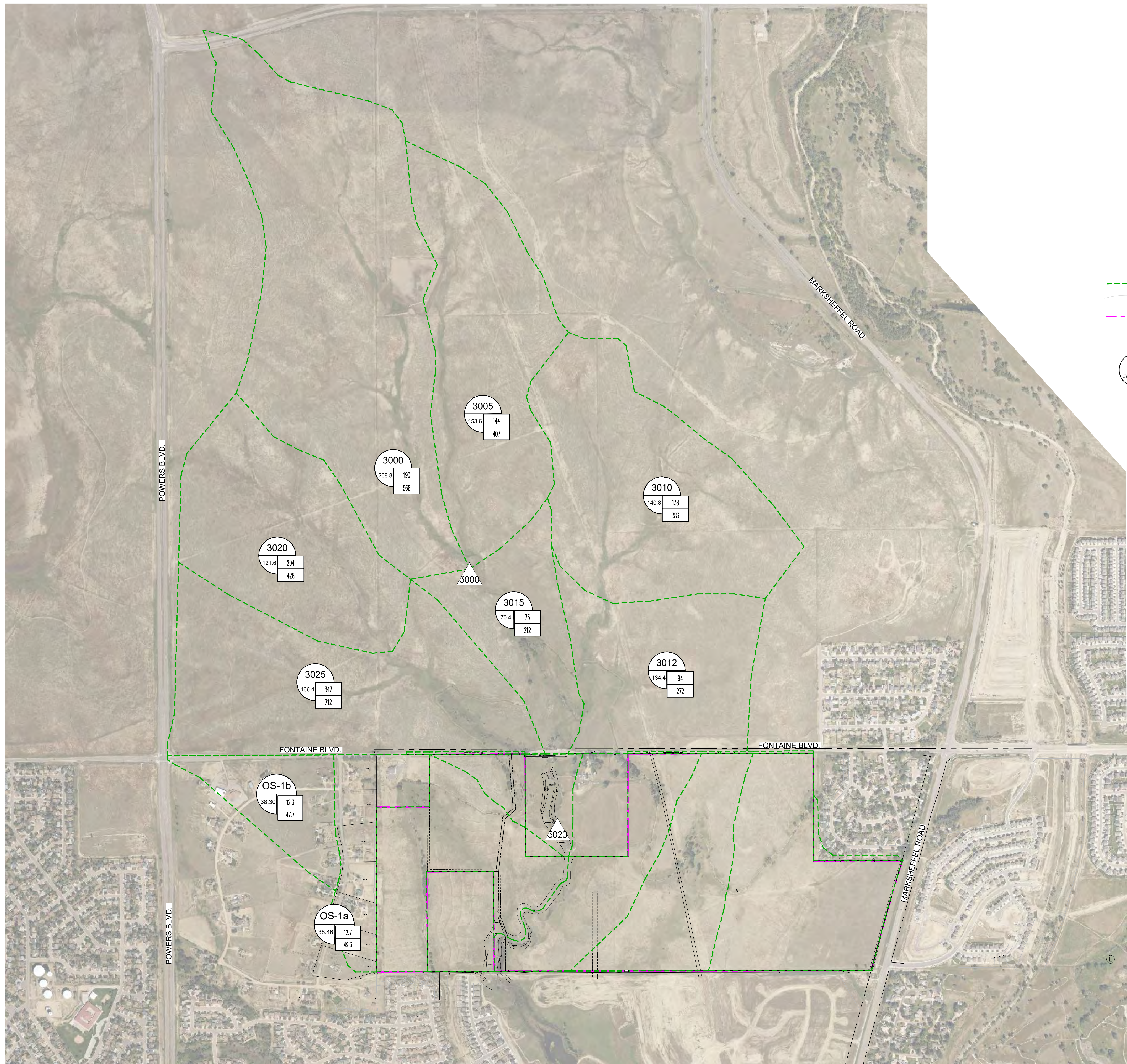
PRELIMINARY/FINAL DRAINAGE REPORT  
FOUNTAIN, CO

### PROPOSED CONDITIONS

DESIGNED BY: JAO  
DRAWN BY: JTS  
CHECKED BY: JAO  
SCALE: HORIZ. 1" = 150'  
VERT. N/A  
DATE ISSUED: SEPTEMBER 2021  
SHEET 02 OF 04  
DRAWING No: DR02

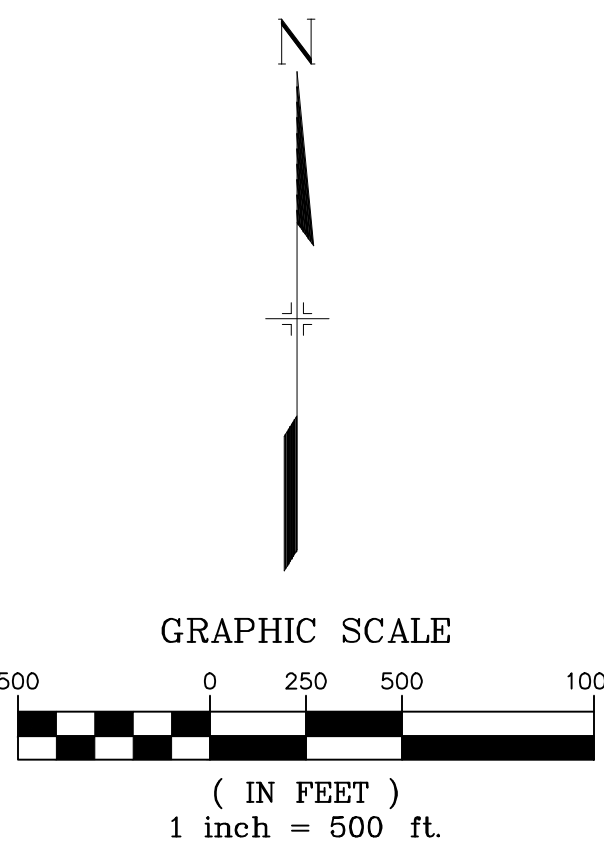
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.  
September 28, 2021 10:11 AM  
S:\20.1105.002 Singer Ranch\200 Drainage\201 Drainage Reports\PD\DWG\DR02-Corvallis Phase I-v4.dwg





LEGEND

- EXISTING BASIN BOUNDARY
- EXISTING CONTOUR
- PROPOSED PROPERTY LINE
- DESIGN POINT
- SUB BASIN DESIGNATION
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- SUB BASIN AREA (AC.)



PREPARED BY:  
**Matrix**  
2435 Research Pkwy, Suite 300  
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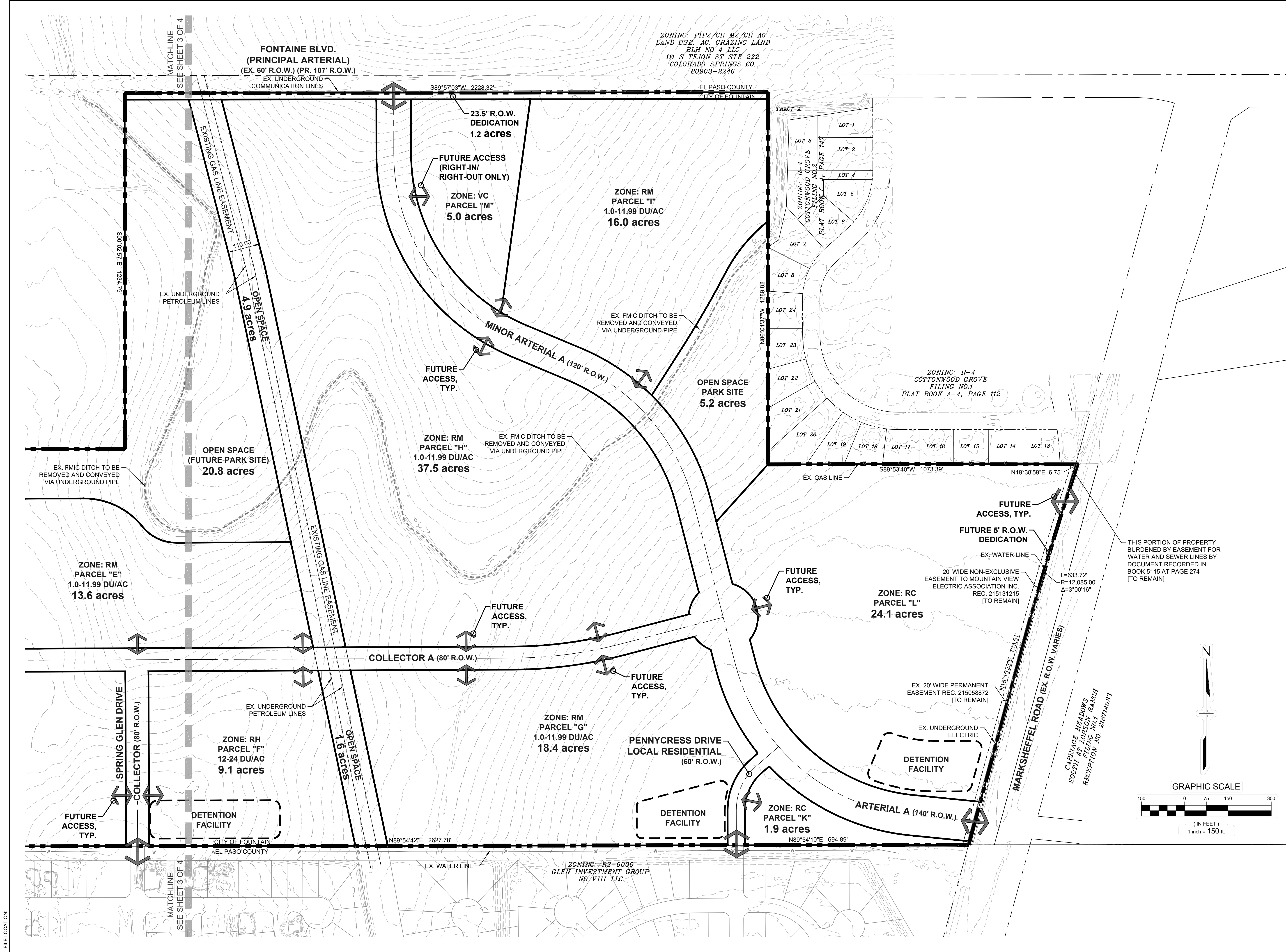
CORVALLIS

MASTER DRAINAGE DEVELOPMENT PLAN  
FOUNTAIN, CO

OFFSITE EXISTING CONDITIONS


DESIGNED BY:	NMS	SCALE:	DATE ISSUED:	JANUARY 2021	DRAWING No.
DRAWN BY:	JTS	HORIZ. 1" = 200'	SHEET	04 OF 04	DROS
CHECKED BY:	NMS	VERT. N/A			





CONSULTANTS:

PLANNER/ LANDSCAPE ARCHITECT/ CIVIL ENGINEER:

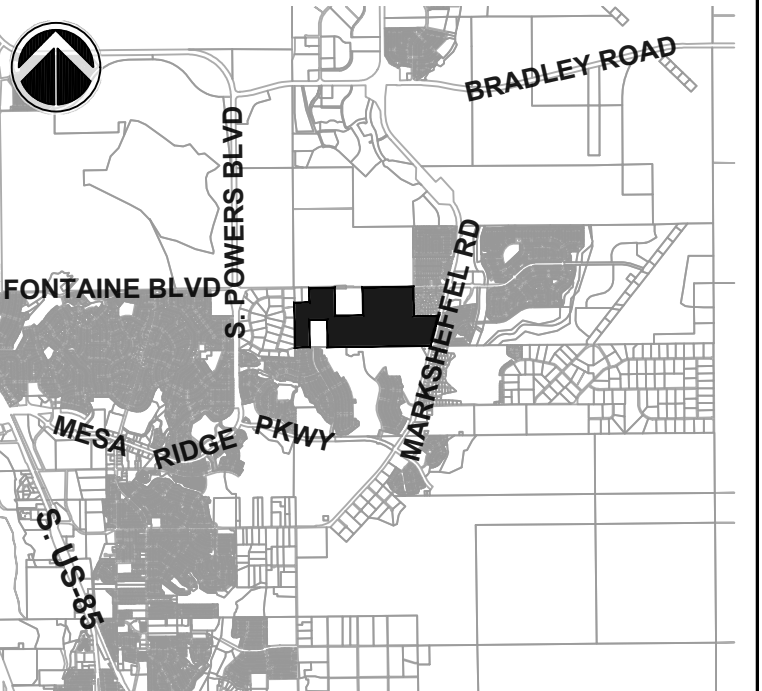
**Matrix**

2435 RESEARCH PARKWAY,  
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PHONE: (719) 575-0100  
FAX : (719) 575-0208

OWNER/DEVELOPER:

HPHR PROPERTIES, LLC  
14160 GLENEAGLE DRIVE  
COLORADO SPRINGS, CO 80921

VICINITY MAP:



PROJECT:

**CORVALLIS**  
CITY OF FOUNTAIN  
**OVERALL DEVELOPMENT PLAN**

DATE:

THIRD SUBMITTAL: 03/15/2021

REVISION HISTORY:

NO.	DATE	DESCRIPTION	BY
0	09/15/2020	INITIAL SUBMITTAL	RAF
1	01/08/2021	REVISED PER CITY COMMENTS	RAF
2	03/15/2021	REVISED PER CITY COMMENTS	RAF

DRAWING INFORMATION:

PROJECT NO: 20.1105.002

DRAWN BY: RAF

CHECKED BY: JAA

APPROVED BY: JAA

SHEET TITLE:

**OVERALL  
DEVELOPMENT  
PLAN (2)**

**ODP04**  
**SHEET 04 OF 04**

PCD FILE NO.: