



MONUMENT STEEL STRUCTURES

FINAL DRAINAGE STUDY

APRIL 2019

For:
Steel Structures America Inc.
3635 E. Covington Ave.
Post Falls, ID 83854

By:
Terra Forma Solutions

include contact
information: address,
phone number



Add PCD File No. PPR1919

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ENGINEER'S CERTIFICATION:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Todd Johnson, P.E. #37660

Date

Owner/Developer's Statement:

I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

Justin Sternberg
Steel Structures America Inc.
3635 E. Covington Ave.
Post Falls, ID 83854

Date

El Paso County:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

Jennifer Irvine, P.E.
County Engineer / ECM Administrator

Date

Conditions:

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SCOPE

The purpose of this report is to present the drainage plan for the proposed Monument Steel Structures development. The following includes final analysis and design information for the proposed drainage systems in general conformance with the standards and specifications established by El Paso County, Colorado Springs and the Urban Drainage and Flood Control District (UDFCD).

I. GENERAL LOCATION AND DESCRIPTION

A. Site Location

- The Monument Steel Structures development is located at 18910 Base Camp Road in Section 11, Township 11 South, Range 67 West of the 6th Principal Meridian in El Paso County, State of Colorado.
- Approximate geodetic coordinates for the site are: 39°6'21"N, 104°51'48"W
- The site is bordered to the north by the Greater Europe Missions, to the east by Base Camp Road, to the west by Monument Hill Road and to the south by Deer Creek Road.
- See Site Location Map below for overall site location:



Provide a vicinity map or revise the site location to show a wider area.

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B. Description of Property

- The site is approximately 4.0 acres in size. The site is currently vacant and is covered by native grasses and weeds. Topography generally slopes from northeast to southwest towards a roadside ditch along Monument Hill Road with grades generally varying from 1% to 10%.
- The site is not located within a floodplain as shown on the FEMA FIRM Map No. 08041C0276G dated December 7, 2018.
- The site lies within Zone X which is described as follows: Areas of 0.2% annual chance flood; areas of 1% annual chance of a flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood. See Appendix D for a FEMA Firm panel exhibit.
- The proposed Monument Steel Structures development is proposing a sales office with display structures and Mini Warehouse and RV Boat Storage.
- Soil types on site as identified by the Natural Resources Conservation Service (NRCS) are as follows:

Hydrologic Soil Group				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
92	Tomah – Crowfoot Loamy sands, 3 to 8 percent slopes	B	4.7	80.6%
93	Tomah – Crowfoot complex, 8 to 15 percent slopes	B	1.1	19.4%

- See Appendix D for soils map.
- There are no known irrigation canals or ditches within the project boundaries.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Drainage Basins

- The site is tributary to the Crystal Creek basin within Monument Creek watershed. There are no major drainageways crossing or adjacent to the site. Runoff from the proposed site will release from the on-site extended detention basin at the southwest corner of the site and will enter the proposed 30" RCP flared end section (which is to be constructed with the Monument Hill widening project), matching existing drainage patterns.
- Off-site flow patterns will not be influenced by the development of this site.

B. Minor Drainage Basins

- **Basin OS-1:** Consists of vacant land in between the north boundary of the site and the southern parking lot of the Greater Europe Missions property.
 - Runoff generated in this basin will sheet flow overland from north to south entering the site along the northern property boundary and combine flows with Basin A-4 (See Below)

Provide an existing condition drainage map and narrative.

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- **Basin OS-2:** Consists of vacant land in between the north boundary of the site and the southern parking lot of the Greater Europe Missions property.
 - Runoff generated in this basin will sheet flow overland from north to south entering the site along the northern property boundary and combine flows with Basin A-3.
- **Basin OS-3:** Consists of vacant land between the north boundary of the site and the southern parking lot of the Greater Europe Missions property. This basin also consists of the western half of Base Camp Road from the middle of the eastern property boundary north to the southern access of Greater Europe Missions property.
 - Runoff generated in this basin will sheet flow overland from north to south and east to west entering the site along the northern and eastern property boundary and combine flows with Basin A-2
- **Basin OS-4:** Consists of the western half of Base Camp Road and landscaping from the middle of the eastern property boundary south to the intersection of Base Camp Road and Deer Creek Road.
 - Runoff generated in this basin will sheet flow overland from east to west entering the site along the eastern property boundary and combine flows with Basin A-1.
- **Basin OS-5:** Consists of the north half of the landscaping berm separating the northern roadside ditch of Deer Creek Road and the southern curb and gutter.
 - Runoff generated in this basin will sheet flow overland from south to north entering the site along the southern boundary and combine flows with Basin A-1.
- **Basin OS-6:** Consists of vacant land in between the north boundary of the site and the southern parking lot of the Greater Europe Missions property.
 - Runoff generated in this basin will sheet flow overland from the north to the south entering the site along the northern boundary and be directed west to the Monument Hill Road roadside ditch via a rip-rap rundown.
- **Basin OS-7:** Consists of rooftops and landscaping at the western portion of the site.
 - Runoff generated within this boundary will be released from the rooftops via downspouts and be directed west to the Monument Hill Road roadside ditch. Low Impact Development is being achieved within this basin as impervious and pervious areas are being disconnected along with implementing infiltration and water quality as the flows runs along the earth lined roadside ditch. **The 100-year allowable release for the EDB has been reduced by the derived 100-yr runoff of this basin.**
- **Basin OS-8:** Consists of the Monument Hill roadside ditch and landscaping behind the proposed buildings along the western boundary.
 - Runoff generated in this basin will combine with the flows entering the basin from the Monument Hill roadside ditch to the north and the flows from Basin OS-6 and OS-7 described above. The combined flows will travel south along the earth lined roadside ditch to the 30" FES transporting the flows under Deer Creek Road and off site.

Revise. Water quality capture volume is not provided by the roadside ditch

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- **Basin A-1:** Consist of rooftops, pavement and landscaping at the southeastern corner of the site.
 - Runoff generated in this basin will combine with the flows entering the site from the east (Basin OS-4) and the flows entering the site from the south (Basin OS-5). The flows will travel along the southern curb and gutter from the northeast to the southwest being captured by the proposed on-grade 10' Type R inlet (IN-1) at Design Point 1 where it will combine with flows from Basin A-2. This inlet has been sized to capture the 5-year flows and most of the 100-yr flows
 - Captured flows will be transported to the proposed EDB via concrete pipe.
 - Bypassing flows will travel west to Design Point 3 and be captured by a proposed Double Type 13 Combo inlet (IN-2) before entering the proposed EDB via concrete pipe.
- **Basin A-2:** Consists of rooftops, pavement and landscaping stretching from the northern boundary to the southern boundary encompassing the eastern-middle portion of the site.
 - Runoff generated in this basin will combine with the flows entering the site from the north (Basin OS-3). The flows will be directed towards and transported south via a 4-foot drainage pan being captured by the proposed on-grade 10' Type R inlet (IN-1) at Design Point 1 where it will combine with flows from Basin A-1 (See basin description above).
- **Basin A-3:** Consists of rooftops, pavement, and landscaping stretching from the northern boundary to the southern boundary encompassing the middle portion of the site.
 - Runoff generated in this basin will combine with the flows entering the site from the north (Basin OS-2). The flows will be directed towards and transported south via a modified 2-foot curb and gutter running along the east side of the 48-foot storage building.
 - The said curb is proposed to be modified by having a 1-foot vertical height instead of the typical 0.5-foot vertical height for added capacity and building protection.
 - The flows will flow from the 2-curb and gutter to a 4-foot drainage pan at the south end of the 48-foot storage building directing flows south to Design Point 3. Here the flows will be combined with any bypass flows bypassing the on-grade IN-1 and be captured by a proposed Double Type 13 Combo inlet (IN-2) in sump and be transported to the EDB via concrete pipe.
- **Basin A-4:** Consists of rooftops, pavement, sidewalk and landscaping stretching from the northern boundary to the southern boundary encompassing the western-middle portion of the site.
 - Runoff generated in this basin will combine with the flows entering the site from the north (Basin OS-1). The flows will be directed towards and transported south via a 4-foot drainage pan towards Design Point 4 being captured by a proposed

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Triple Type 13 Combo inlet (IN-3) in sump and be transported to the EDB via concrete pipe.

- **Basin A-5:** Consists of the onsite EDB.
 - Runoff generated in this basin will combine with all flows tributary to the EDB and will be captured and released by a controlled outlet structure.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

- The site has been designed in accordance with the El Paso County *Drainage Design Criteria Manual*, adopted portions of the City of Colorado Springs *Drainage Criteria Manual Volume 1, dated May 2014*, and the *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3 (UDFCD)*, Urban Drainage and Flood Control District, latest revisions. The portions of the City of *Colorado Springs Drainage Criteria Manual* adopted by the County are Chapter 6 (Hydrology) and Chapter 13 Section 3.2.1 (Full Spectrum Detention).

B. Drainage Studies, Outfall Systems Plans, Site Constraints

- The site is included within the limits of the Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study prepared by Kiowa Engineering in September of 1993. There are no drainage way facilities proposed in the study that are located within the limits of the site.

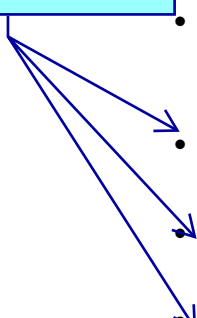
C. Hydrology

- Peak storm runoff was determined using the Rational Formula: $Q=CIA$
- Design storm recurrence intervals are the 5-year storm for the minor event and the 100-year storm for the major event.
- In accordance with the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, dated May 2014, the following 1-hour point rainfall values (in.) were used: 5-yr = 1.50, 100-year = 2.52.
- Runoff coefficients have been determined using the equations in UDFCD Volume 1's Table 6-4.
- Time of Concentration has been calculated using the equations in UDFCD Volume 1, Chapter 6, Section 2.4.
- Rainfall intensities were calculated using UDFCD Volume 1's Equation 5-1.
- See Appendix A for all hydrologic calculations.

D. Hydraulics

- The calculation methods for private improvements are based upon the Manning's Equation and the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, dated May 2014.
- On-Site storm drainage improvements are designed for the 5-year and 100-year events.

Replace reference to City DCM



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- See Appendix B for all hydraulic calculations.

IV. FSTORMWATER MANAGEMENT FACILITY DESIGN

A. Existing Stormwater Drainage

- The existing stormwater runoff for the proposed site flows overland from the northeast corner of the site towards the southwest corner with a fairly uniform grade of 3.5%.
- Historically the runoff from the vacant land between the north boundary of the site and the southern parking lot of the Greater Europe Missions property flows onto the site along the northern boundary of the site.
- Historically the runoff from the western half of Base Camp Road flows onto the site along the eastern boundary of the site.
- The eastern half of the proposed site flows into the roadside ditch north of Deer Creek Road and flows to the southwest corner of the site where it will be captured by the proposed 30" RCP flared end section (which is to be constructed with the Monument Hill widening project)➤
- The western half of the proposed site flows into the reconstructed roadside ditch east of Monument Hill Road (reconstructed with the Monument Hill widening project) and flows to the southwest corner of the site where it will be captured by the proposed 30" RCP flared end section (which is to be constructed with the Monument Hill widening project).

Proposed Stormwater Conveyance Facilities

- The proposed drainage patterns will follow historic flow patterns as closely as possible.
- The general concept for the site drainage will be for storm runoff to surface flow from the building roofs and pavement generally flowing from the north side of the site to the south side of the site via 4-foot v-channel drainage pans and curb and gutter. Runoff will be captured by a series of inlets south of the on-site drive isles and piped to the proposed Extended Detention Basin designed in accordance with City of Colorado Springs criteria.
- The proposed Extended Detention Basin will drain through a modified CDOT Type C outlet structure. The outlet structures released flow will be piped to the roadside ditch east of Monument Hill Road and be captured by the 30" RCP flared end section (which is to be constructed with the Monument Hill widening project.)
- The on-site storm sewers and EDB will be private and will be maintained by the property owner.
- Conveyance of off-site runoff is generated from Basin OS-7. Low Impact Development is being achieved within this basin as impervious and pervious areas are being disconnected along with implementing infiltration and water quality as the flows runs along the earth lined roadside ditch. **The 100-year allowable release for the EDB has been reduced by the derived 100-yr runoff of this basin.**

Provide the expected construction date. What is the expected construction date for this project? If the site is to be constructed prior to the Monument Hill widening project, analyze whether the existing condition of the Monument Hill Road/Deer Creek Road intersection provide for a suitable outfall and drainage?

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C. Proposed Stormwater Storage Facilities

- An Extended Detention Basin is proposed at the southwest corner of the site to treat storm runoff and attenuate peak flows in accordance with the City of Colorado Springs criteria and UDFCD.
- The Extended Detention Basin and outlet structure have been sized and designed with the UDFCD UD-Detention v3.07 spreadsheet to control the Water Quality Capture Volume (WQCV) and 100-year discharge volume.
- The pond will include a trickle channel for low flow conditions, an outlet structure including a 2.5-ft deep micropipe and an emergency spillway with riprap erosion protection.
- See Appendix C for Detention and Water Quality Calculations

Revise. The fourth step is "Consider Need for Industrial and Commercial BMPs. See ECM Appendix I Section 1.7.2."

D. Water Quality Enhancement Best Management Practices

- El Paso County requires the Four Step Process be followed for the selection and siting of structural BMPs for new development to provide water quality for stormwater runoff being discharged into State Waters. The Four Steps are; employ runoff reduction practices, stabilize drainageways, provide water quality capture volume (WQCV) and **implement permanent BMPs.**
 - The design of the site has followed this process as much as possible. Pavement has been minimized to meet only the parking spaces as required by the county and landscaped areas are included to assist in reducing runoff. There are no major drainageways on site. The drainageways adjacent to the site are being improved with riprap protection where concentrated flows may cause erosion. The WQCV is being provided in the permanent BMP which is an Extended Detention Basin designed in accordance with county regulations
- Discharge will be controlled by a standard outlet structure with a flow control plate designed to release the WQCV over 40 hours and release 97% of the 5-year storm in less than 72 hours.
- The 100-year discharge will be limited to be at or below 2.95 cfs (0.85 cfs/acre for Type B soils minus the 100-yr peak runoff from Basin OS-7 which will bypass the EDB) and will be controlled by a circular orifice plate located at the discharge side of the outlet structure prior to the flow entering an 18" RCP flowing to the proposed drainage swale adjacent to Monument Hill Road. This swale flows to the south and will be captured by the 30" FES to be constructed as part of the Monument Hill Road widening Improvements. In the event the outlet structure should become clogged with debris, and emergency overflow weir and swale will be constructed along the west side of the EDB. The emergency overflow swale will be a notched 15' wide by 1' deep cavity in the proposed EDB upper wall. Overflow will go to the proposed drainage swale along Monument Hill Road flowing to the south to the existing 30" FES and will be routed off site.

E. Floodplain Modification

- A floodplain modification is not anticipated for the construction of the Monument Steel Structures development.

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F. Additional Permitting Requirements

- No additional permitting is anticipated for the construction of the Monument Steel Structures development.

V. CONCLUSIONS

A. Compliance with Standards

- The drainage design for the Monument Steel Structures site detailed within this report is in general compliance with the El Paso County, Colorado Springs and UDFCD criteria.

B. Variances

- There are no variances requested for this project at this time.

C. Drainage Concept

- The proposed drainage patterns will follow historic flow patterns as closely as possible. The majority of the site will sheet flow to the southwest into the proposed Extended Detention Basin.
- With the development of the proposed site; there should be no adverse impact to downstream facilities, adjacent properties, channel depths, velocities, or erosion rates, due to release flows being below historic rates.

VI. LIST OF REFERENCES

- El Paso County's *Engineering Criteria Manual*, Revised 07/29/2015 Revision 5.
- City of Colorado Springs *Drainage Criteria Manual Volumes 1 and 2*, dated May 2014.
- *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3*, Urban Drainage and Flood Control District, latest editions.
- Federal Emergency Management Agency Flood Insurance Rate Map Panel Number 08041C0276G, effective December 7, 2018.
- *Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study* prepared by Kiowa Engineering Dated September, 1993.



Provide a section for drainage and bridge fees and calculate the required drainage and bridge fee. See Note 9 of the subdivision plat below. Attached to the right is the subdivision plat.

(9) DRAINAGE FEES FOR LOT 2 SHALL BE PAID PRIOR TO THE ISSUANCE OF A BUILDING PERMIT AND THOSE FEES ARE TO BE CALCULATED ON THE BASIS OF THE FEE STRUCTURE IN EFFECT AT THE TIME OF BUILDING PERMIT APPLICATION.

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APPENDICES

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APPENDIX B – Hydraulic Computations

APPENDIX C – Detention/Water Quality Enhancement BMPs

APPENDIX D – Referenced Information

APPENDIX E – Drainage Maps

APPENDIX A - HYDROLOGIC COMPUTATIONS



NOAA Atlas 14, Volume 8, Version 2
Location name: Monument, Colorado, USA*
Latitude: 39.1061°, Longitude: -104.8634°
Elevation: 7139.11 ft**



* source: ESRI Maps
 ** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.244 (0.200-0.297)	0.312 (0.256-0.379)	0.426 (0.348-0.518)	0.523 (0.424-0.638)	0.659 (0.517-0.830)	0.768 (0.587-0.974)	0.878 (0.648-1.14)	0.993 (0.702-1.31)	1.15 (0.780-1.55)	1.27 (0.839-1.73)
10-min	0.358 (0.293-0.434)	0.457 (0.375-0.555)	0.624 (0.509-0.759)	0.765 (0.621-0.934)	0.966 (0.757-1.22)	1.12 (0.859-1.43)	1.29 (0.949-1.66)	1.45 (1.03-1.92)	1.68 (1.14-2.27)	1.86 (1.23-2.53)
15-min	0.436 (0.358-0.530)	0.558 (0.457-0.677)	0.761 (0.621-0.926)	0.933 (0.757-1.14)	1.18 (0.923-1.48)	1.37 (1.05-1.74)	1.57 (1.16-2.03)	1.77 (1.25-2.34)	2.05 (1.39-2.77)	2.27 (1.50-3.09)
30-min	0.575 (0.471-0.698)	0.736 (0.603-0.894)	1.00 (0.820-1.22)	1.23 (1.00-1.51)	1.56 (1.22-1.96)	1.81 (1.38-2.30)	2.07 (1.53-2.68)	2.34 (1.65-3.09)	2.70 (1.84-3.64)	2.99 (1.97-4.07)
60-min	0.727 (0.596-0.882)	0.897 (0.735-1.09)	1.20 (0.975-1.45)	1.46 (1.18-1.78)	1.85 (1.46-2.35)	2.17 (1.67-2.78)	2.52 (1.86-3.27)	2.88 (2.04-3.82)	3.39 (2.31-4.59)	3.80 (2.51-5.17)
2-hr	0.878 (0.725-1.06)	1.06 (0.872-1.27)	1.38 (1.14-1.67)	1.69 (1.38-2.04)	2.15 (1.71-2.72)	2.54 (1.97-3.23)	2.96 (2.21-3.84)	3.42 (2.45-4.52)	4.08 (2.80-5.50)	4.61 (3.07-6.24)
3-hr	0.987 (0.818-1.18)	1.16 (0.958-1.39)	1.49 (1.22-1.78)	1.80 (1.48-2.17)	2.30 (1.85-2.92)	2.74 (2.14-3.49)	3.22 (2.42-4.18)	3.76 (2.71-4.97)	4.54 (3.14-6.12)	5.19 (3.46-6.99)
6-hr	1.20 (1.00-1.43)	1.39 (1.16-1.65)	1.76 (1.46-2.09)	2.13 (1.75-2.54)	2.72 (2.21-3.43)	3.24 (2.55-4.10)	3.83 (2.90-4.93)	4.48 (3.25-5.89)	5.44 (3.79-7.29)	6.24 (4.19-8.35)
12-hr	1.46 (1.22-1.71)	1.72 (1.44-2.02)	2.20 (1.84-2.60)	2.66 (2.21-3.15)	3.37 (2.74-4.19)	3.99 (3.15-4.98)	4.65 (3.54-5.92)	5.39 (3.92-7.00)	6.44 (4.50-8.55)	7.31 (4.94-9.72)
24-hr	1.76 (1.48-2.05)	2.09 (1.76-2.44)	2.68 (2.25-3.13)	3.22 (2.69-3.77)	4.03 (3.28-4.93)	4.70 (3.73-5.80)	5.43 (4.15-6.83)	6.22 (4.55-8.00)	7.33 (5.15-9.64)	8.23 (5.61-10.9)
2-day	2.09 (1.77-2.41)	2.44 (2.07-2.82)	3.08 (2.60-3.56)	3.65 (3.07-4.24)	4.51 (3.69-5.47)	5.23 (4.17-6.39)	6.00 (4.61-7.48)	6.83 (5.03-8.70)	8.00 (5.65-10.4)	8.94 (6.13-11.7)
3-day	2.26 (1.92-2.59)	2.65 (2.26-3.05)	3.34 (2.83-3.85)	3.95 (3.33-4.57)	4.86 (3.99-5.85)	5.61 (4.49-6.82)	6.41 (4.94-7.95)	7.26 (5.36-9.21)	8.46 (6.00-11.0)	9.42 (6.48-12.3)
4-day	2.39 (2.05-2.74)	2.81 (2.40-3.22)	3.54 (3.01-4.06)	4.18 (3.54-4.82)	5.13 (4.22-6.15)	5.91 (4.74-7.15)	6.73 (5.20-8.31)	7.61 (5.63-9.61)	8.83 (6.28-11.4)	9.81 (6.77-12.8)
7-day	2.79 (2.40-3.17)	3.23 (2.77-3.67)	4.00 (3.42-4.56)	4.68 (3.98-5.36)	5.70 (4.71-6.77)	6.53 (5.26-7.84)	7.42 (5.76-9.10)	8.36 (6.22-10.5)	9.68 (6.92-12.5)	10.7 (7.45-13.9)
10-day	3.15 (2.72-3.56)	3.62 (3.11-4.09)	4.43 (3.80-5.03)	5.15 (4.40-5.87)	6.23 (5.17-7.37)	7.11 (5.75-8.50)	8.05 (6.28-9.83)	9.05 (6.76-11.3)	10.5 (7.50-13.4)	11.6 (8.06-15.0)
20-day	4.17 (3.62-4.67)	4.77 (4.14-5.35)	5.80 (5.01-6.52)	6.69 (5.75-7.55)	7.97 (6.63-9.30)	8.99 (7.31-10.6)	10.1 (7.89-12.1)	11.2 (8.39-13.8)	12.7 (9.17-16.1)	13.9 (9.76-17.9)
30-day	5.00 (4.35-5.57)	5.73 (4.99-6.39)	6.95 (6.03-7.77)	7.98 (6.88-8.96)	9.41 (7.85-10.9)	10.5 (8.58-12.3)	11.7 (9.18-14.0)	12.9 (9.68-15.8)	14.4 (10.4-18.2)	15.7 (11.0-20.0)
45-day	6.03 (5.28-6.69)	6.92 (6.05-7.68)	8.37 (7.29-9.30)	9.55 (8.27-10.7)	11.2 (9.31-12.8)	12.4 (10.1-14.4)	13.6 (10.7-16.2)	14.8 (11.2-18.0)	16.4 (11.9-20.5)	17.6 (12.4-22.4)
60-day	6.90 (6.06-7.62)	7.92 (6.94-8.75)	9.54 (8.33-10.6)	10.8 (9.41-12.1)	12.6 (10.5-14.3)	13.9 (11.3-16.0)	15.1 (11.9-17.8)	16.3 (12.3-19.8)	17.9 (13.0-22.2)	19.0 (13.5-24.1)

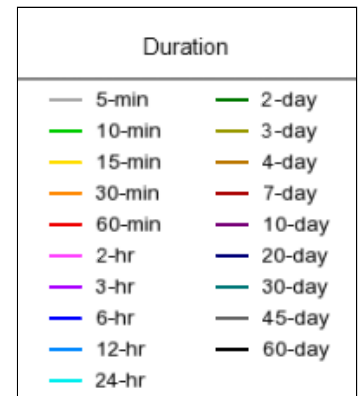
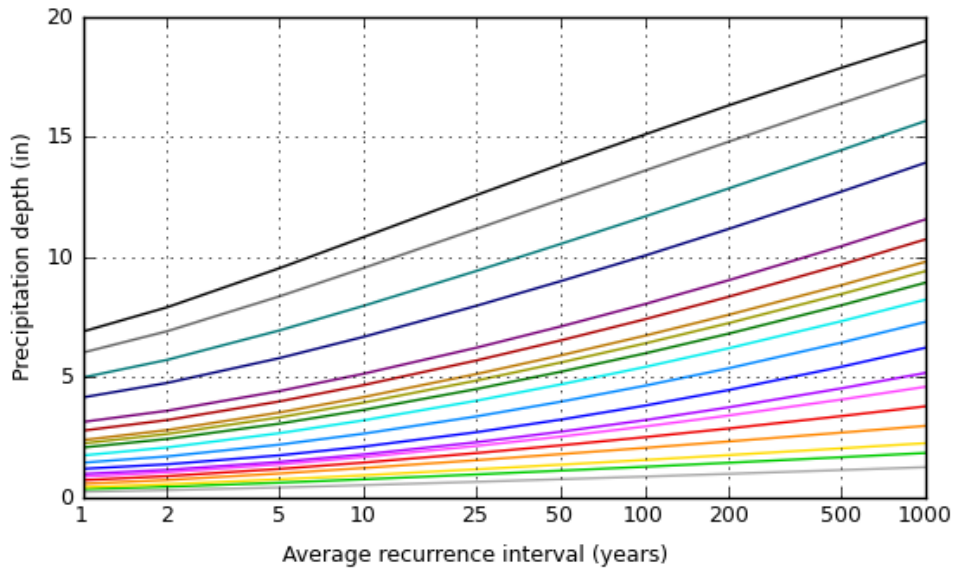
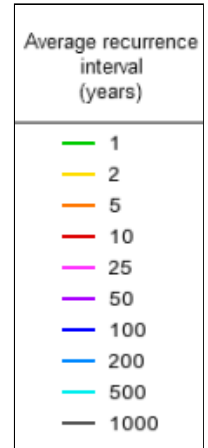
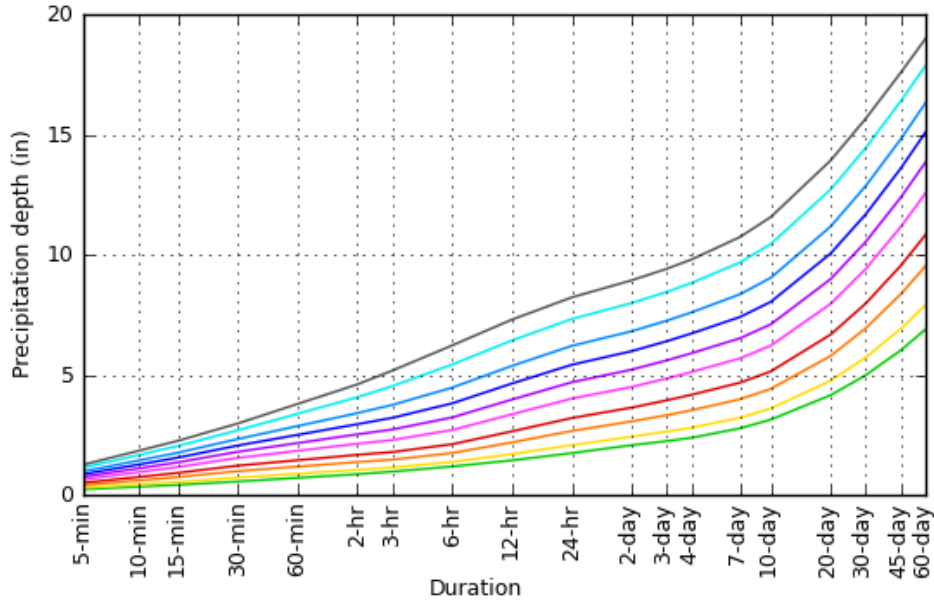
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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PF graphical

PDS-based depth-duration-frequency (DDF) curves

Latitude: 39.1061°, Longitude: -104.8634°



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Maps & arials

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

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[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

Project: Monument Steel Structures
 Location: Monument, CO
 Designer: TAJ
 Date: 4/7/2019
 Latest Revision: 4/7/2019

Use Table 6-6 in the adopted City DCM

¹From Table 6-3 in UDFCD Volume 1
²From Table 6-4 in UDFCD Volume 1

IMPERVIOUSNESS AND RUNOFF COEFFICIENT CALCULATIONS

Basin Designation	NRCS Hydrologic Soil Group	Total Area (ac)	Total Area (sf)	Imperviousness						Percent Impervious	Impervious Area (ac)	Runoff Coefficients, C ²					
				Roofs (sf)	Lawn (sf)	Pavement (sf)	Sidewalk (sf)	Pond HWL (sf)	Misc (sf)			C ₂	C ₅	C ₁₀	C ₁₀₀		
OS-1	B	0.45	19,479		19,479				0	0	2.00%	0.01	0.01	0.07	0.44		
OS-2	B	0.22	9,459		9,459				0	0	2.00%	0.00	0.01	0.01	0.07	0.44	
OS-3	B	0.42	18,281		13,642	4,639			0	0	26.87%	0.11	0.18	0.21	0.27	0.55	
OS-4	B	0.15	6,407		4,225	2,182			0	0	35.38%	0.05	0.25	0.28	0.34	0.59	
OS-5	B	0.02	1,061		1,061				0	0	2.00%	0.00	0.01	0.01	0.07	0.44	
OS-6	B	0.12	5,280		5,280				0	0	2.00%	0.00	0.01	0.01	0.07	0.44	
OS-7	B	0.15	6,508	6,113	395				0	0	84.66%	0.13	0.69	0.72	0.74	0.82	
OS-8	B	0.40	17,418		17,418				0	0	2.00%	0.01	0.01	0.01	0.07	0.44	
A-1	B	0.43	18,530	3,272	4,867	10,392			0	0	72.49%	0.31	0.58	0.61	0.64	0.77	
A-2	B	0.90	39,189	9,409	6,191	23,589			0	0	82.12%	0.74	0.67	0.69	0.72	0.81	
A-3	B	0.79	34,223	10,340	819	23,064					94.63%	0.74	0.79	0.81	0.82	0.87	
A-4	B	1.11	48,547	20,538	825	26,369	815		0	0	93.94%	1.05	0.78	0.80	0.82	0.87	
A-5	B	0.23	9,864		9,064	800			0	0	9.95%	0.02	0.06	0.07	0.14	0.47	
Area Treated by EDB	B	4.71	205,040	Basins (OS-1, OS-2 OS-3, OS-4, OS-5, A-1, A-2, A-3, A-4, A-5)						0	0	64.55%	3.04	0.50	0.53	0.58	0.73
Area Not Treated by EDB	B	0.27	11,788	Basins (OS-6, OS-7, OS-8)						0	0	50.59%	0.14	0.38	0.41	0.47	0.66
Overall		5.38	234,246						0	0	59.05%	3.18					

Label or remove

4.0035
2.95

Project: Monument Steel Structures
 Location: Monument, CO
 Designer: TAJ
 Date: 4/7/2019
 Latest Revision: 4/7/2019

Use the adopted City DCM
 Footnote 1: 100' urban,
 300' rural.
 Footnote 2: Table 6-7

NRCS Conveyance Factors	
Type of Land Surface	
Heavy Meadow	
Tillage/Field	5
Short Pasture/Lawns	7
Nearly Bare Ground	10
Grassed Waterway	15
Paved Areas	20

¹Max 300 ft in Urban areas and 500 ft in rural areas
²From Table 6-2 in UDFCD Volume 1

TIME OF CONCENTRATION CALCULATIONS

Basin Designation	Imperviousness (%)	C _s	Initial/Overland Flow Time, T _i			Channelized Flow/Travel Time, T _t					Time of Concentration, T _c (Check)			
			Length (ft) ¹	Slope (%)	T _i (min)	Land Surface	Length (ft)	Slope (%)	Velocity (ft/sec)	T _t (min)	Computed T _c (min)	First Design Point T _c (min)	Minimum T _c (min)	Selected T _c (min)
OS-1	2.00%	0.01	25	5.00	5.77	Short Pasture/Lawns	175	5.00	1.57	1.86	7.64	27.07	5.00	7.64
OS-2	2.00%	0.01	25	5.00	5.77	Short Pasture/Lawns	110	5.00	1.57	1.17	6.95	26.54	5.00	6.95
OS-3	26.87%	0.21	25	2.00	6.42	Short Pasture/Lawns	130	5.00	1.57	1.38	7.81	22.19	5.00	7.81
OS-4	35.38%	0.28	15	2.00	4.57	Short Pasture/Lawns	20	16.00	2.80	0.12	4.69	20.05	5.00	5.00
OS-5	2.00%	0.01	5	15.00	1.80	Short Pasture/Lawns	5	20.00	3.13	0.03	1.82	25.68	5.00	5.00
OS-6	2.00%	0.01	25	5.00	5.77	Short Pasture/Lawns	163	5.00	1.57	1.74	7.51	26.97	5.00	7.51
OS-7	84.66%	0.72	10	2.00	1.74	Grassed Waterway	25	2.00	2.12	0.20	1.93	11.75	5.00	5.00
OS-8	2.00%	0.01	25	25.00	3.39	Grassed Waterway	392	2.80	2.51	2.60	6.00	29.87	5.00	6.00
A-1	72.49%	0.61	45	3.05	4.14	Paved Areas	292	1.37	2.34	2.08	6.22	15.85	5.00	6.22
A-2	82.12%	0.69	45	4.80	2.93	Paved Areas	412	2.18	2.96	2.32	5.25	14.31	5.00	5.25
A-3	94.63%	0.81	45	2.50	2.60	Paved Areas	433	1.73	2.63	2.74	5.34	12.38	5.00	5.34
A-4	93.94%	0.80	65	1.65	3.66	Paved Areas	365	2.19	2.96	2.05	5.71	11.89	5.00	5.71
A-5	9.95%	0.07	25	10.00	4.35	Paved Areas	140	0.50	1.41	1.65	6.00	27.48	5.00	6.00

2.4.1 Initial or Overland Flow Time

The initial or overland flow time, *t_i*, may be calculated using Equation 6-3:

$$t_i = \frac{0.395(1.1 - C_s)\sqrt{L}}{S_o^{0.33}} \quad \text{Equation 6-3}$$

Where:

- t_i* = overland (initial) flow time (minutes)
- C_s = runoff coefficient for 5-year frequency (from Table 6-4)
- L = length of overland flow (ft)
- S_o = average slope along the overland flow path (ft/ft).

2.4.2 Channelized Flow Time

The channelized flow time (travel time) is calculated using the hydraulic properties of the conveyance element. The channelized flow time, *t_t*, is estimated by dividing the length of conveyance by the velocity. The following equation, Equation 6-4 (Guo 2013), can be used to determine the flow velocity in conjunction with Table 6-2 for the conveyance factor.

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t} \quad \text{Equation 6-4}$$

Where:

- t_t* = channelized flow time (travel time, min)
- L_t = waterway length (ft)
- S_o = waterway slope (ft/ft)
- V_t = travel time velocity (ft/sec) = K√S_o
- K = NRCS conveyance factor (see Table 6-2).

$$t_c = t_i + t_t \quad \text{Equation 6-2}$$

Where:

- t_c* = computed time of concentration (minutes)
- t_i* = overland (initial) flow time (minutes)
- t_t* = channelized flow time (minutes).

2.4.3 First Design Point Time of Concentration in Urban Catchments

Equation 6-4 was solely determined by the waterway characteristics and using a set of empirical formulas. A calibration study between the Rational Method and the Colorado Urban Hydrograph Procedure (CUHP) suggests that the time of concentration shall be the lesser of the values calculated by Equation 6-2 and Equation 6-5 (Guo and Urbanas 2013).

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_o}} \quad \text{Equation 6-5}$$

Where:

- t_c* = minimum time of concentration for first design point when less than *t_c* from Equation 6-1.
- L_t = length of channelized flow path (ft)
- i* = imperviousness (expressed as a decimal)
- S_o = slope of the channelized flow path (ft/ft).

2.4.4 Minimum Time of Concentration

Use a minimum *t_c* value of 5 minutes for urbanized areas and a minimum *t_c* value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

Use the City DCM Ch 6 Section 3.2.3

APPENDIX B - HYDRAULIC COMPUTATIONS

2ft Catch Curb and 24' Drive Isle Capacity

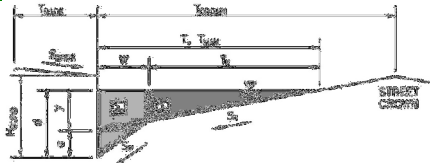
Version 4.05 Released March 2017

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

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

Project: _____
 Inlet ID: _____ **Monument Steel Structures**

IN-1



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	$T_{BACK} = $ <input style="width: 50px;" type="text" value="10.0"/> ft								
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	$S_{BACK} = $ <input style="width: 50px;" type="text" value="0.100"/> ft/ft								
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	$n_{BACK} = $ <input style="width: 50px;" type="text" value="0.015"/>								
Height of Curb at Gutter Flow Line	$H_{CURB} = $ <input style="width: 50px;" type="text" value="6.00"/> inches								
Distance from Curb Face to Street Crown	$T_{CROWN} = $ <input style="width: 50px;" type="text" value="24.0"/> ft								
Gutter Width	$W = $ <input style="width: 50px;" type="text" value="2.00"/> ft								
Street Transverse Slope	$S_X = $ <input style="width: 50px;" type="text" value="0.020"/> ft/ft								
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	$S_W = $ <input style="width: 50px;" type="text" value="0.083"/> ft/ft								
Street Longitudinal Slope - Enter 0 for sump condition	$S_O = $ <input style="width: 50px;" type="text" value="0.008"/> ft/ft								
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	$n_{STREET} = $ <input style="width: 50px;" type="text" value="0.012"/>								
Max. Allowable Spread for Minor & Major Storm	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 30%; text-align: center;">Minor Storm</td> <td style="width: 30%; text-align: center;">Major Storm</td> <td style="width: 10%;"></td> </tr> <tr> <td>$T_{MAX} =$</td> <td style="border: 1px solid black; text-align: center;">24.0</td> <td style="border: 1px solid black; text-align: center;">24.0</td> <td style="text-align: right;">ft</td> </tr> </table>		Minor Storm	Major Storm		$T_{MAX} = $	24.0	24.0	ft
	Minor Storm	Major Storm							
$T_{MAX} = $	24.0	24.0	ft						
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 30%; text-align: center;">Minor Storm</td> <td style="width: 30%; text-align: center;">Major Storm</td> <td style="width: 10%;"></td> </tr> <tr> <td>$d_{MAX} =$</td> <td style="border: 1px solid black; text-align: center;">6.0</td> <td style="border: 1px solid black; text-align: center;">12.0</td> <td style="text-align: right;">inches</td> </tr> </table>		Minor Storm	Major Storm		$d_{MAX} = $	6.0	12.0	inches
	Minor Storm	Major Storm							
$d_{MAX} = $	6.0	12.0	inches						
Allow Flow Depth at Street Crown (leave blank for no)	<input type="checkbox"/> <input type="checkbox"/> check = yes								
MINOR STORM Allowable Capacity is based on Depth Criterion									
MAJOR STORM Allowable Capacity is based on Spread Criterion									
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'	$Q_{allow} = $ <input style="width: 50px;" type="text" value="16.4"/> <input style="width: 50px;" type="text" value="31.1"/> cfs								
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'									

Channel Report

40 Foot Drainage Pan Capacity

User-defined

Invert Elev (ft) = 7131.51
Slope (%) = 1.80
N-Value = Composite

Calculations

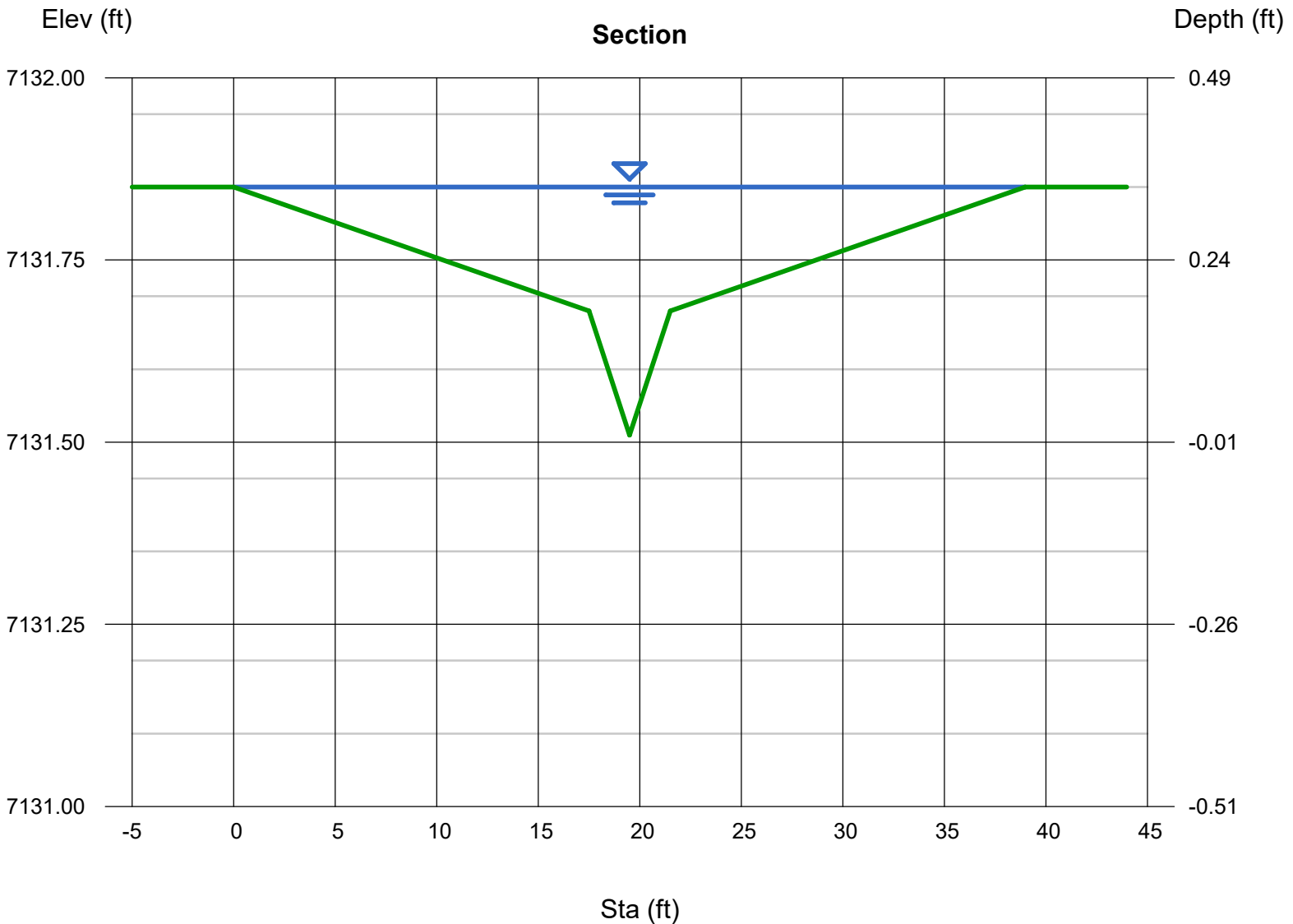
Compute by: Q vs Depth
No. Increments = 10

Highlighted

Depth (ft) = 0.34
Q (cfs) = 14.54
Area (sqft) = 3.99
Velocity (ft/s) = 3.64
Wetted Perim (ft) = 39.00
Crit Depth, Yc (ft) = 0.34
Top Width (ft) = 38.98
EGL (ft) = 0.55

(Sta, El, n)-(Sta, El, n)...

(0.00, 7131.85)-(17.50, 7131.68, 0.012)-(19.50, 7131.51, 0.012)-(21.50, 7131.68, 0.012)-(38.98, 7131.85, 0.012)



Channel Report

60 Foot Drainage Pan Capacity

User-defined

Invert Elev (ft) = 7127.89
Slope (%) = 2.00
N-Value = Composite

Calculations

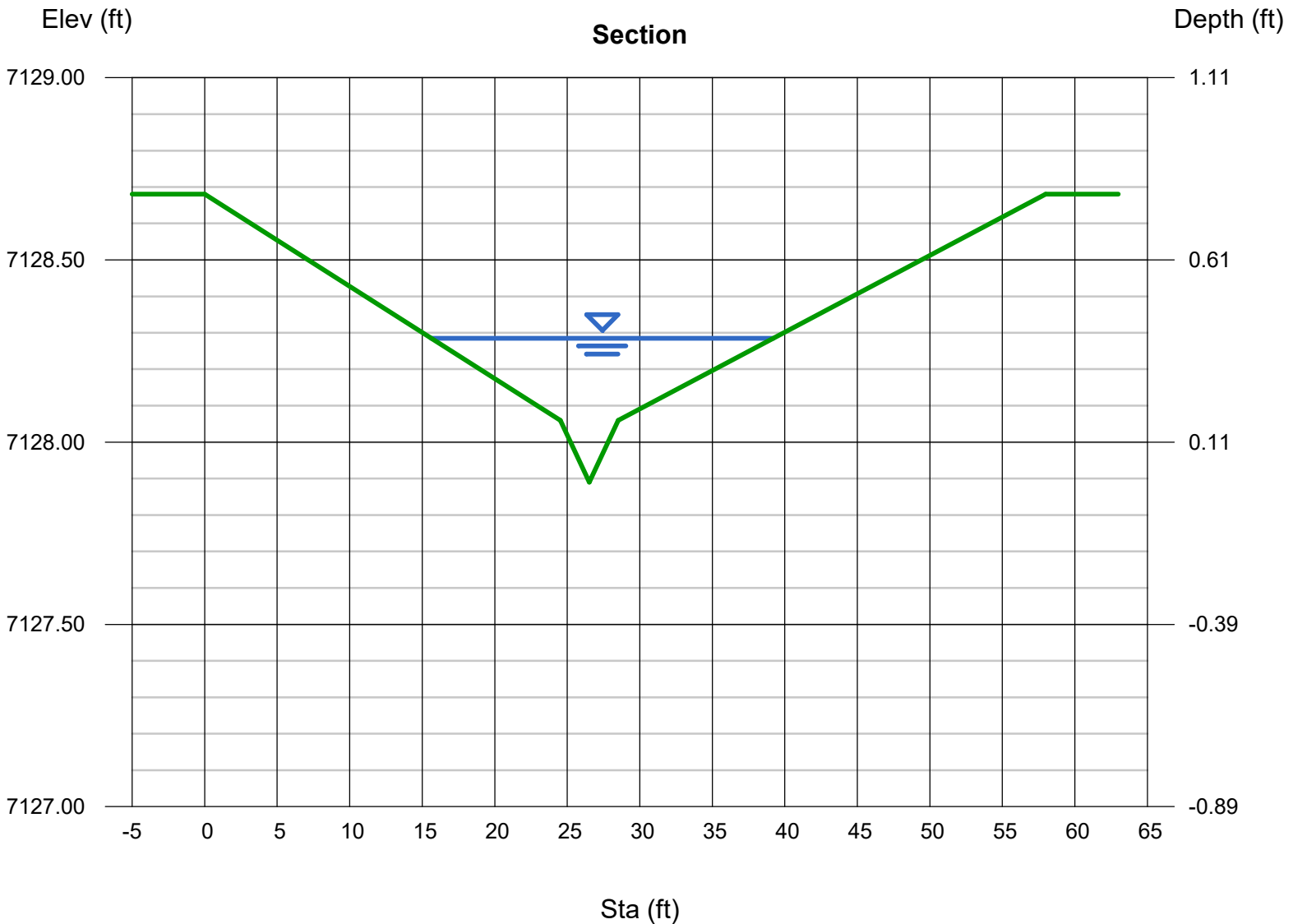
Compute by: Q vs Depth
No. Increments = 10

Highlighted

Depth (ft) = 0.40
Q (cfs) = 16.75
Area (sqft) = 3.45
Velocity (ft/s) = 4.86
Wetted Perim (ft) = 23.61
Crit Depth, Yc (ft) = 0.51
Top Width (ft) = 23.59
EGL (ft) = 0.76

(Sta, El, n)-(Sta, El, n)...

(0.00, 7128.68)-(24.52, 7128.06, 0.012)-(26.52, 7127.89, 0.012)-(28.52, 7128.06, 0.012)-(57.98, 7128.68, 0.012)



Channel Report

12 IN Vertical Curb Alley Capacity

User-defined

Invert Elev (ft) = 7131.32
Slope (%) = 2.00
N-Value = Composite

Calculations

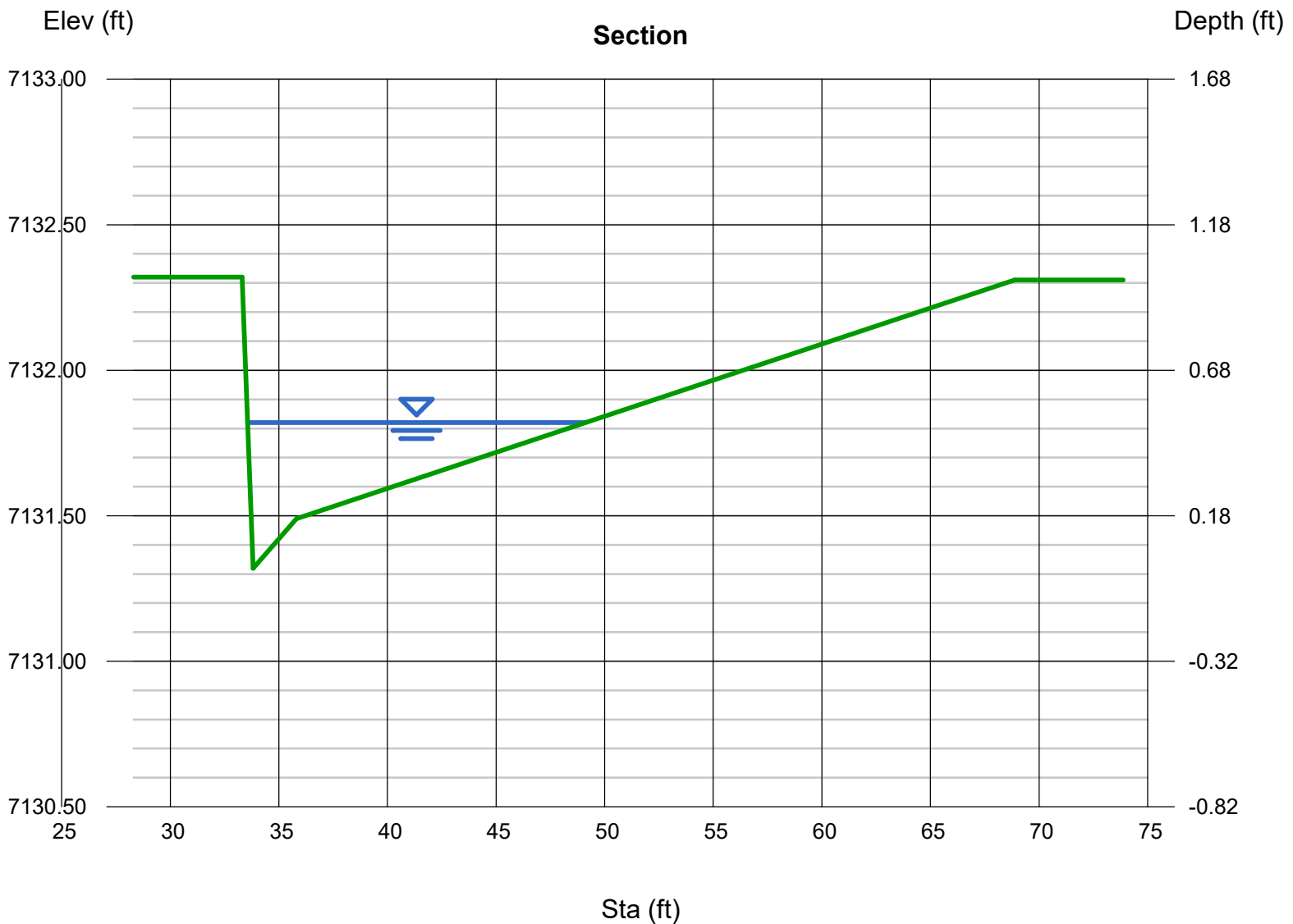
Compute by: Q vs Depth
No. Increments = 10

Highlighted

Depth (ft) = 0.50
Q (cfs) = 18.14
Area (sqft) = 3.08
Velocity (ft/s) = 5.89
Wetted Perim (ft) = 15.87
Crit Depth, Yc (ft) = 0.66
Top Width (ft) = 15.54
EGL (ft) = 1.04

(Sta, El, n)-(Sta, El, n)...

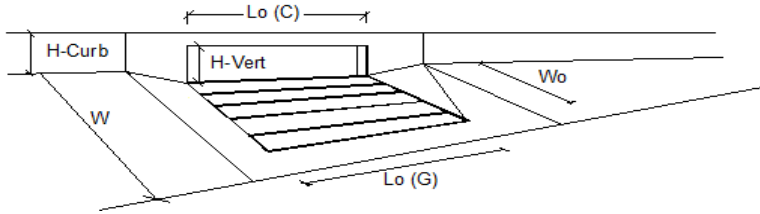
(33.31, 7132.32)-(33.81, 7131.32, 0.012)-(35.81, 7131.49, 0.012)-(68.88, 7132.31, 0.012)



IN - 1 Capacity

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017

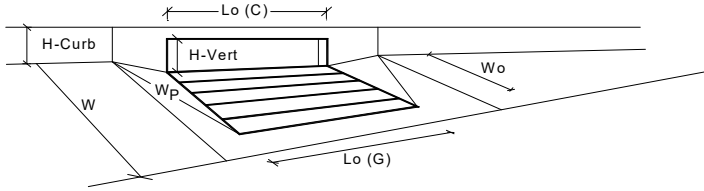


Design Information (Input)	MINOR	MAJOR	
Type of Inlet	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity*			
Total Inlet Interception Capacity	3.9	6.4	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	0.2	2.9	cfs
Capture Percentage = Q_i/Q_c =	96	69	%

IN - 2 Capacity

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



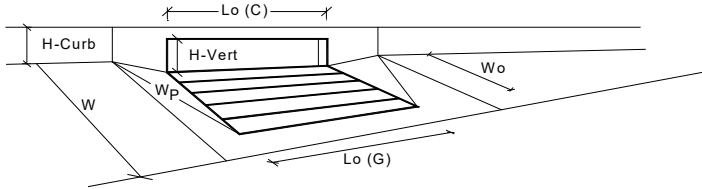
Design Information (Input)	
Type of Inlet	CDOT/Denver 13 Combination
Local Depression (additional to continuous gutter depression 'a' from above)	
Number of Unit Inlets (Grate or Curb Opening)	
Water Depth at Flowline (outside of local depression)	
Grate Information	
Length of a Unit Grate	$L_o (G) = 3.00$ feet
Width of a Unit Grate	$W_o = 1.73$ feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	$A_{ratio} = 0.43$
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	$C_r (G) = 0.50$
Grate Weir Coefficient (typical value 2.15 - 3.60)	$C_w (G) = 3.30$
Grate Orifice Coefficient (typical value 0.60 - 0.80)	$C_o (G) = 0.60$
Curb Opening Information	
Length of a Unit Curb Opening	$L_o (C) = 3.00$ feet
Height of Vertical Curb Opening in Inches	$H_{vert} = 6.50$ inches
Height of Curb Orifice Throat in Inches	$H_{throat} = 5.25$ inches
Angle of Throat (see USDCM Figure ST-5)	$\theta = 0.00$ degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	$W_p = 2.00$ feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	$C_r (C) = 0.10$
Curb Opening Weir Coefficient (typical value 2.3-3.7)	$C_w (C) = 3.70$
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	$C_o (C) = 0.66$
Low Head Performance Reduction (Calculated)	
Depth for Grate Midwidth	$d_{grate} = 0.523$ ft
Depth for Curb Opening Weir Equation	$d_{curb} = 0.33$ ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination} = 0.71$
Curb Opening Performance Reduction Factor for Long Inlets	$RF_{Curb} = 1.00$
Grated Inlet Performance Reduction Factor for Long Inlets	$RF_{Grate} = 0.71$
Total Inlet Interception Capacity (assumes clogged condition)	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	

	MINOR	MAJOR	
Type =	CDOT/Denver 13 Combination		
$a_{local} =$	2.00	2.00	inches
No =	2	2	
Ponding Depth =	6.0	7.3	inches
$L_o (G) =$	3.00	3.00	feet
$W_o =$	1.73	1.73	feet
$A_{ratio} =$	0.43	0.43	
$C_r (G) =$	0.50	0.50	
$C_w (G) =$	3.30	3.30	
$C_o (G) =$	0.60	0.60	
$L_o (C) =$	3.00	3.00	feet
$H_{vert} =$	6.50	6.50	inches
$H_{throat} =$	5.25	5.25	inches
$\theta =$	0.00	0.00	degrees
$W_p =$	2.00	2.00	feet
$C_r (C) =$	0.10	0.10	
$C_w (C) =$	3.70	3.70	
$C_o (C) =$	0.66	0.66	
$d_{grate} =$	0.523	0.629	ft
$d_{curb} =$	0.33	0.44	ft
$RF_{Combination} =$	0.71	0.86	
$RF_{Curb} =$	1.00	1.00	
$RF_{Grate} =$	0.71	0.86	
$Q_a =$	5.3	9.0	cfs
$Q_{PEAK REQUIRED} =$	2.8	8.3	cfs

IN - 3 Capacity

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



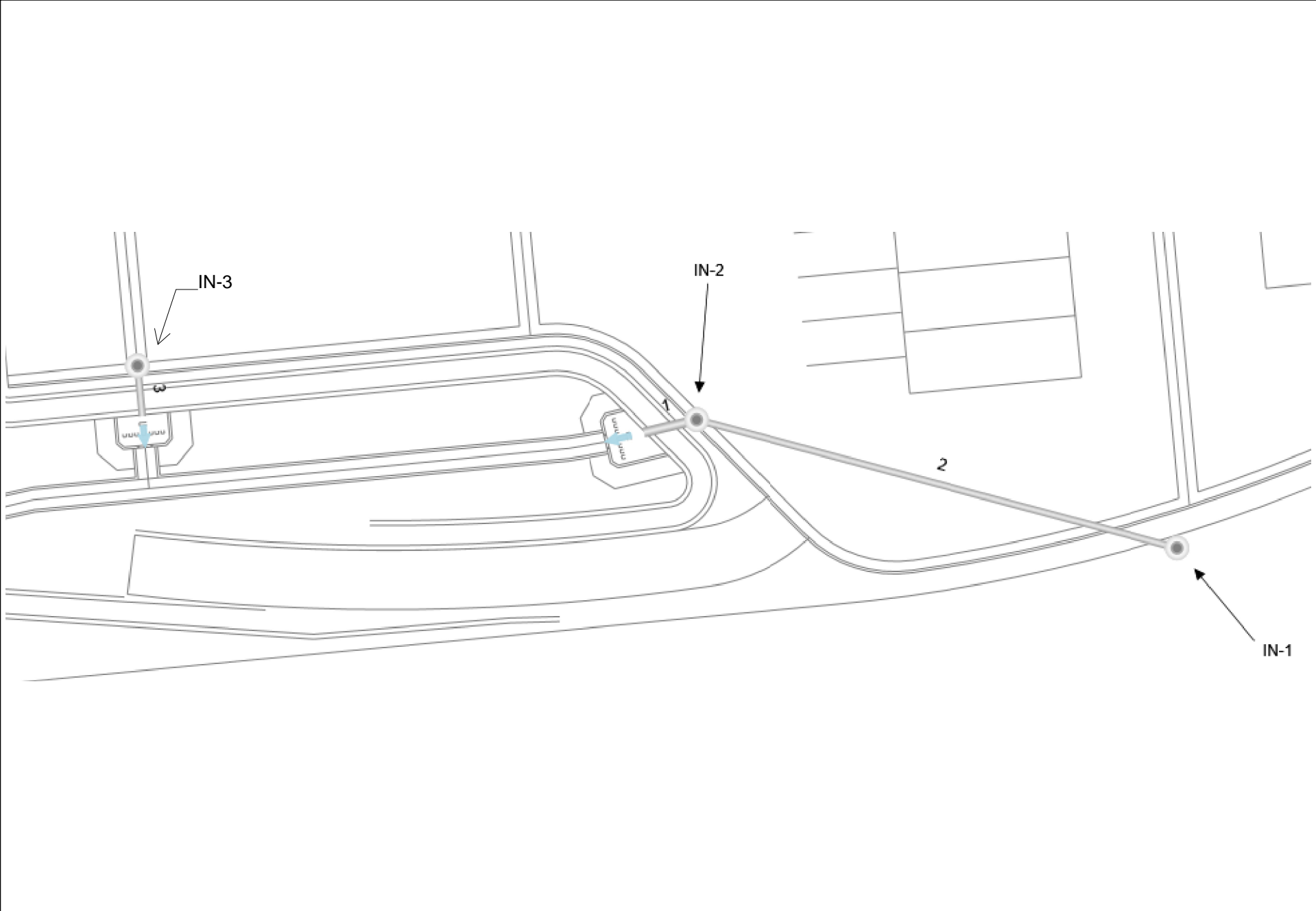
Design Information (Input)	MINOR MAJOR	
Type of Inlet	CDOT/Denver 13 Combination	
Local Depression (additional to continuous gutter depression 'a' from above)	$a_{local} = 2.00$	2.00 inches
Number of Unit Inlets (Grate or Curb Opening)	No = 3	3
Water Depth at Flowline (outside of local depression)	Ponding Depth = 6.0	7.3 inches
Grate Information	MINOR MAJOR	<input type="checkbox"/> Override Depths
Length of a Unit Grate	$L_o (G) = 3.00$	3.00 feet
Width of a Unit Grate	$W_o = 1.73$	1.73 feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	$A_{ratio} = 0.43$	0.43
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	$C_r (G) = 0.50$	0.50
Grate Weir Coefficient (typical value 2.15 - 3.60)	$C_w (G) = 3.30$	3.30
Grate Orifice Coefficient (typical value 0.60 - 0.80)	$C_o (G) = 0.60$	0.60
Curb Opening Information	MINOR MAJOR	
Length of a Unit Curb Opening	$L_o (C) = 3.00$	3.00 feet
Height of Vertical Curb Opening in Inches	$H_{vert} = 6.50$	6.50 inches
Height of Curb Orifice Throat in Inches	$H_{throat} = 5.25$	5.25 inches
Angle of Throat (see USDCM Figure ST-5)	Theta = 0.00	0.00 degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	$W_p = 2.00$	2.00 feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	$C_r (C) = 0.10$	0.10
Curb Opening Weir Coefficient (typical value 2.3-3.7)	$C_w (C) = 3.70$	3.70
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	$C_o (C) = 0.66$	0.66
Low Head Performance Reduction (Calculated)	MINOR MAJOR	
Depth for Grate Midwidth	$d_{grate} = 0.523$	0.629 ft
Depth for Curb Opening Weir Equation	$d_{curb} = 0.33$	0.44 ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination} = 0.57$	0.69
Curb Opening Performance Reduction Factor for Long Inlets	$RF_{Curb} = 0.97$	1.00
Grated Inlet Performance Reduction Factor for Long Inlets	$RF_{Grate} = 0.57$	0.69
Total Inlet Interception Capacity (assumes clogged condition)	MINOR MAJOR	
	$Q_a = 6.4$	11.0 cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK REQUIRED} = 4.2$	8.8 cfs

Plan View

Stormwater Studio 2019 v 3.0.0.7

Project Name: 10StormDesign

04-10-2019



Report Report*

Line No.	Line ID	Inlet ID	Flow Rate (cfs)	Line Length (ft)	Line Size (in)	Line Slope (ft/ft)	n-value Pipe	Capac. Full (cfs)	Vel Ave (ft/s)	Invert Up (ft)	Invert Dn (ft)	Grnd/Rim Elev Up (ft)	Grnd/Rim Elev Dn (ft)	HGL Up (ft)	HGL Dn (ft)	
1	P-1	IN-2	9.20	10.71	24	0.05	0.013	50.58	6.38	7119.76	7119.22	7128.42	0.00	7120.83	7120.05	
2	P-2	IN-1	3.90	100.98	18	0.0325	0.013	18.93	6.09	7124.54	7121.26	7129.32	7128.42	7125.29	7121.74	
3	P-3	IN-3	6.40	9.97	18	0.0501	0.013	23.49	6.36	7119.55	7119.05	7126.35	0.00	7120.51	7119.79	

* Results are not current with inputs.

Report Report

Project Name: 10StormDesign

Stormwater Studio 2019 v 3.0.0.7

04-10-2019

Line No.	Line ID	Inlet ID	Flow Rate (cfs)	Line Length (ft)	Line Size (in)	Line Slope (ft/ft)	n-value Pipe	Capac. Full (cfs)	Vel Ave (ft/s)	Invert Up (ft)	Invert Dn (ft)	Grnd/Rim Elev Up (ft)	Grnd/Rim Elev Dn (ft)	HGL Up (ft)	HGL Dn (ft)	
1	P-1	IN-2	15.40	10.71	24	0.05	0.013	50.58	7.63	7119.76	7119.22	7128.42	0.00	7121.15	7120.32	
2	P-2	IN-1	6.40	100.98	18	0.0325	0.013	18.93	7.10	7124.54	7121.26	7129.32	7128.42	7125.50	7121.90	
3	P-3	IN-3	11.00	9.97	18	0.0501	0.013	23.49	7.94	7119.55	7119.05	7126.35	0.00	7120.81	7120.03	

Notes: IDF File = SampleIDF.idf, Return Period = 100-yrs.

Project File: Monument SSA - 100 yr.sws

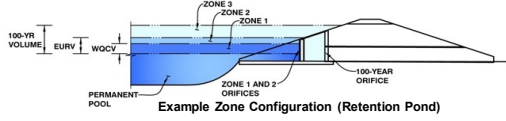
**APPENDIX C - DETENTION/WATER QUALITY
ENHANCEMENT BMPs**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: 18910 Base Camp Road

Basin ID: Lot 2 - SSA



Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	4.71	acres
Watershed Length =	630	ft
Watershed Slope =	0.034	ft/ft
Watershed Imperviousness =	64.55%	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
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		
Water Quality Capture Volume (WQCV) =	0.099	acre-feet
Excess Urban Runoff Volume (EURV) =	0.332	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.274	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.367	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.472	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.609	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.708	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.839	acre-feet
500-yr Runoff Volume (P1 = 3.1 in.) =	1.098	acre-feet
Approximate 2-yr Detention Volume =	0.257	acre-feet
Approximate 5-yr Detention Volume =	0.345	acre-feet
Approximate 10-yr Detention Volume =	0.440	acre-feet
Approximate 25-yr Detention Volume =	0.474	acre-feet
Approximate 50-yr Detention Volume =	0.493	acre-feet
Approximate 100-yr Detention Volume =	0.534	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.10	inches

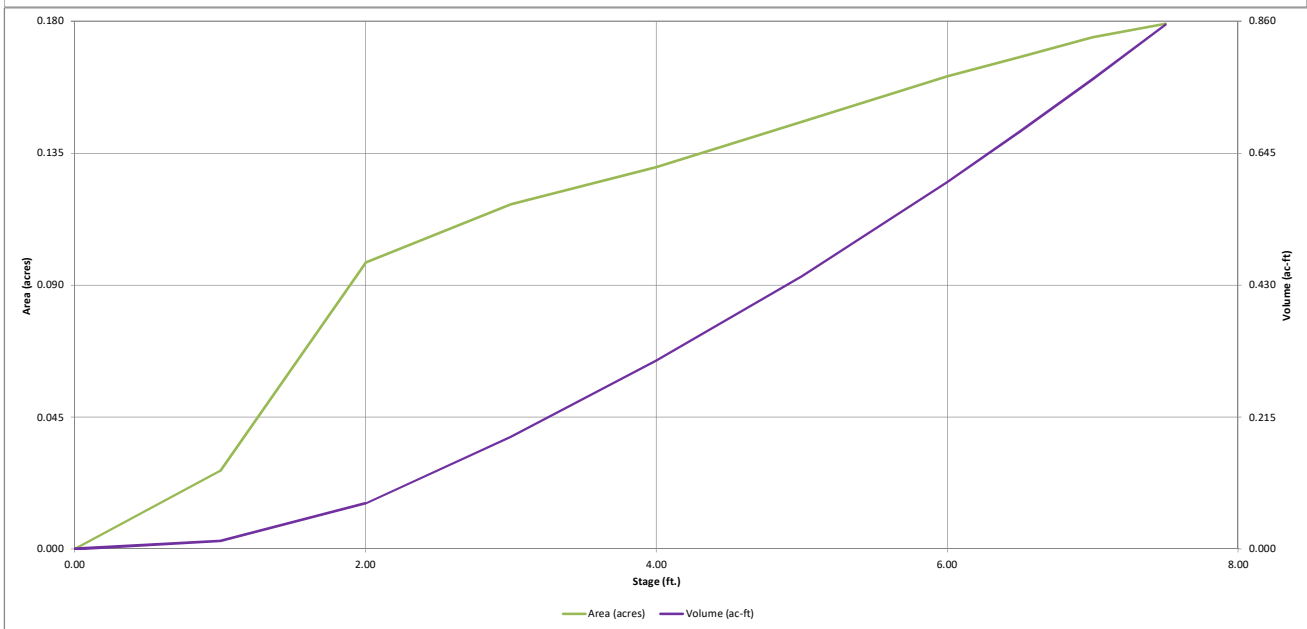
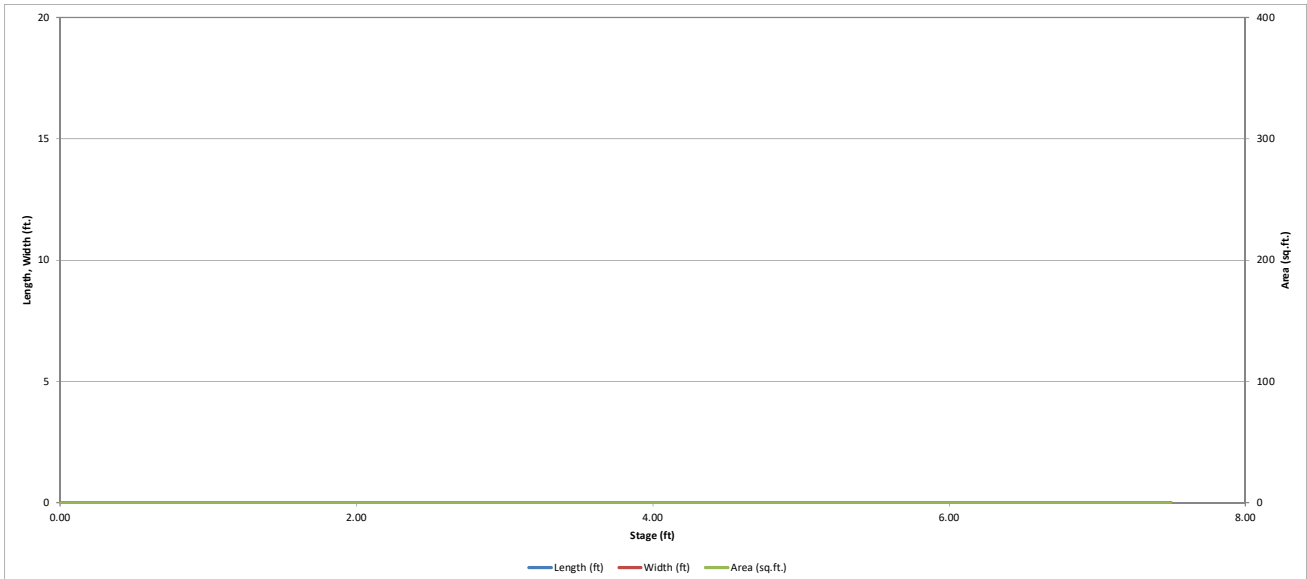
Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.099	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.233	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.202	acre-feet
Total Detention Basin Volume =	0.534	acre-feet
Initial Surcharge Volume (SV) =	user	ft³
Initial Surcharge 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}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{SV}) =	user	ft²
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	ft²
Volume of Basin Floor (V_{FLOOR}) =	user	ft³
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	ft²
Volume of Main Basin (V_{MAIN}) =	user	ft³
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = 1 ft									
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
7118	--	1.00	--	--	--	1,165	0.027	571	0.013
7119	--	2.00	--	--	--	4,249	0.098	3,247	0.075
7120	--	3.00	--	--	--	5,112	0.117	7,970	0.183
7121	--	4.00	--	--	--	5,665	0.130	13,358	0.307
7122	--	5.00	--	--	--	6,345	0.146	19,363	0.445
7123	--	6.00	--	--	--	7,019	0.161	26,045	0.598
7123.5	--	6.50	--	--	--	7,304	0.168	29,626	0.680
7124	--	7.00	--	--	--	7,598	0.174	33,351	0.766
7124.5	--	7.50	--	--	--	7,799	0.179	37,201	0.854
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DETENTION BASIN STAGE-STORAGE TABLE BUILDER

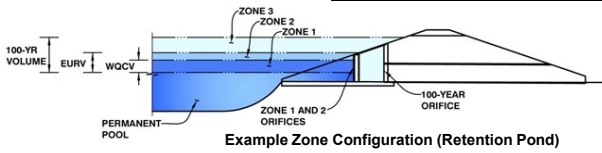
UD-Detention, Version 3.07 (February 2017)



Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: 18910 Base Camp Road
Basin ID: Lot 2 - SSA



	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.24	0.099	Orifice Plate
Zone 2 (EURV)	4.19	0.233	Orifice Plate
Zone 3 (100-year)	5.60	0.202	Weir&Pipe (Circular)
		0.534	Total

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 ²
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 =	4.19	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	15.00	inches
Orifice Plate: Orifice Area per Row =	0.56	sq. inches (diameter = 13/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	3.854E-03	ft ²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft ²

3 orifices are recommended to maximize the orifice diameter

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	1.20	2.40	3.60				
Orifice Area (sq. inches)	0.56	0.56	0.56	0.56				

	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)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft ²
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, H _o =	4.19	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00	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 _i =	4.19	N/A	feet
Over Flow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	26.12	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	6.30	N/A	ft ²
Overflow Grate Open Area w/ Debris =	3.15	N/A	ft ²

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

	Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	6.65	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Circular	Not Selected	
Outlet Orifice Area =	0.24	N/A	ft ²
Outlet Orifice Centroid =	0.28	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	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 =	15.00	feet
Spillway End Slopes =	0.00	H:V
Freeboard above Max Water Surface =	0.50	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.49	feet
Stage at Top of Freeboard =	7.49	feet
Basin Area at Top of Freeboard =	0.18	acres

Revise to 1 ft.

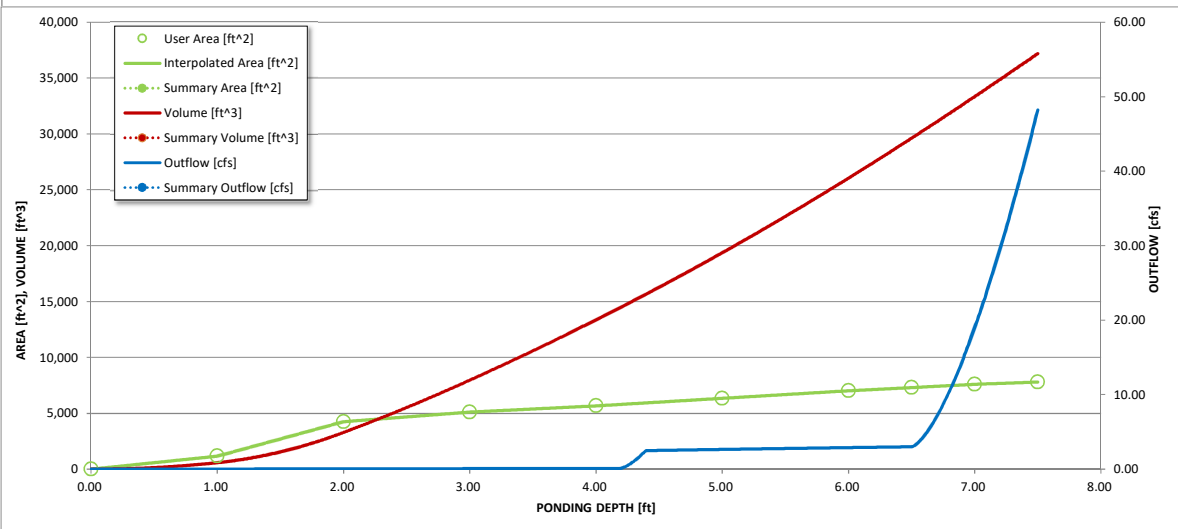
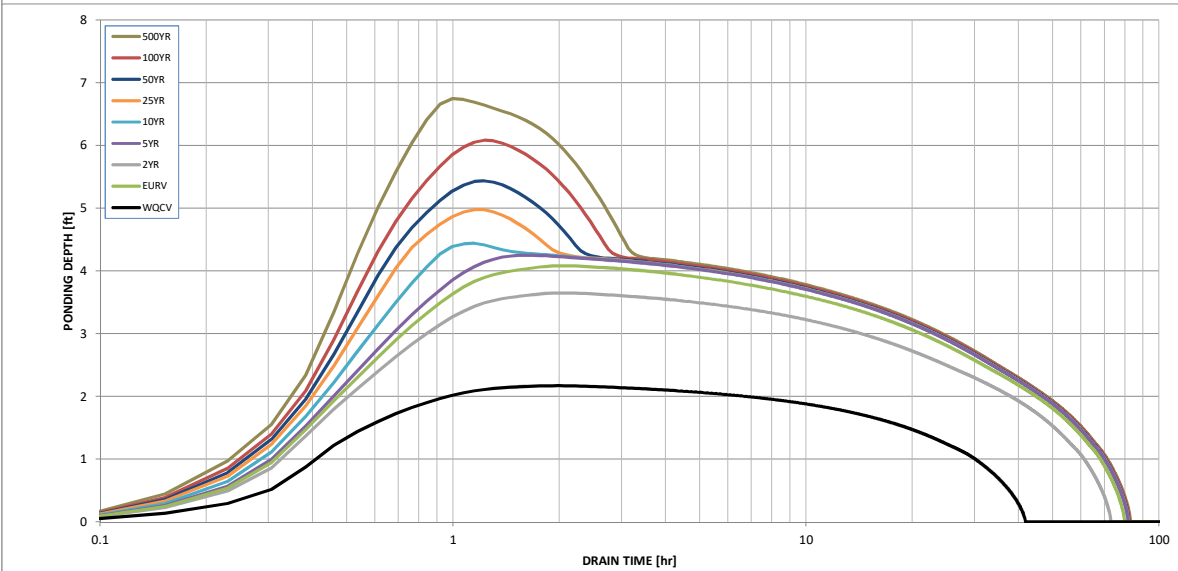
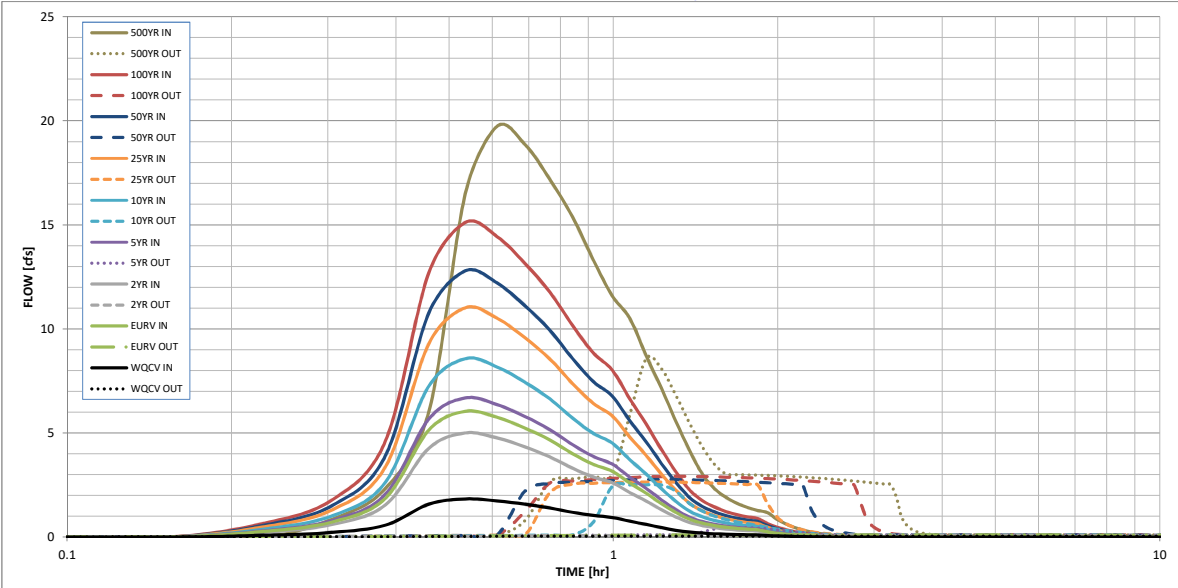
Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.10
One-Hour Rainfall Depth (in) =	0.099	0.332	0.274	0.367	0.472	0.609	0.708	0.839	1.098
Calculated Runoff Volume (acre-ft) =									
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.099	0.331	0.274	0.367	0.472	0.609	0.708	0.839	1.098
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.23	0.74	1.02	1.36	1.99
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.1	1.1	3.5	4.8	6.4	9.3
Peak Inflow Q (cfs) =	1.8	6.0	5.0	6.7	8.6	11.0	12.8	15.1	19.7
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.5	2.5	2.6	2.8	2.9	8.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.2	2.3	0.8	0.6	0.5	0.9
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.4	0.4	0.4	0.4	0.5
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	71	65	72	70	67	66	64	62
Time to Drain 99% of Inflow Volume (hours) =	40	76	70	77	77	76	75	74	73
Maximum Ponding Depth (ft) =	2.17	4.08	3.65	4.25	4.44	4.98	5.44	6.08	6.75
Area at Maximum Ponding Depth (acres) =	0.10	0.13	0.13	0.13	0.14	0.15	0.15	0.16	0.17
Maximum Volume Stored (acre-ft) =	0.091	0.316	0.261	0.338	0.364	0.440	0.509	0.611	0.721

Revise the outlet structure to release at or less than historic.

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



APPENDIX D - REFERENCED INFORMATION

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only to landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The horizontal datum was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date **stream channel configurations** and **floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

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

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

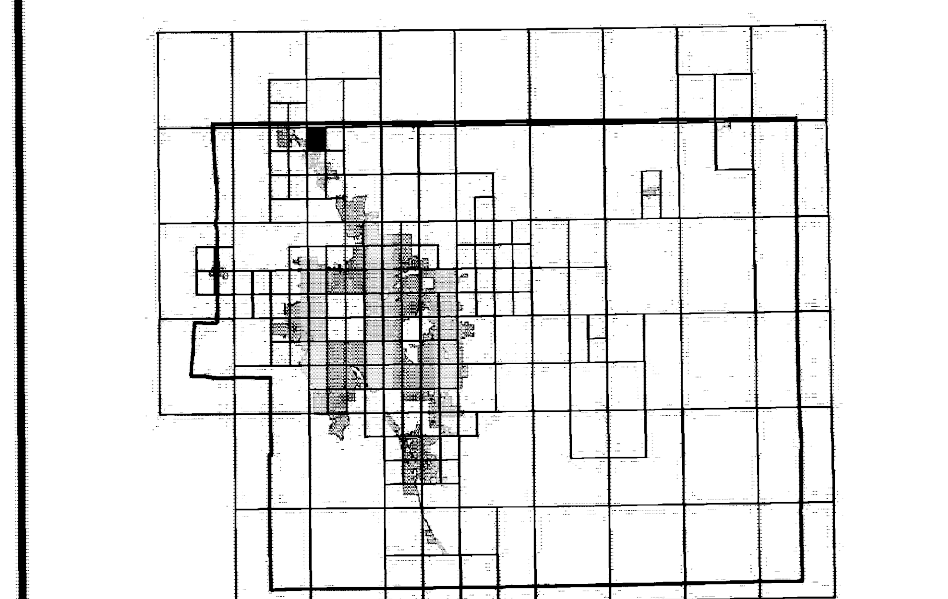
Contact **FEMA Map Service Center (MSC)** via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

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

El Paso County Vertical Datum Offset Table	
Flooding Source	Vertical Datum Offset (ft)
Crystal River	+0.0
Dirty Woman Creek - Lake Fork	+0.0
Dirty Woman Creek - Lake Fork	+0.0
Crystal Creek - Split Flow Channel	+0.0
Crystal Creek	+0.0
Other Areas	+0.0

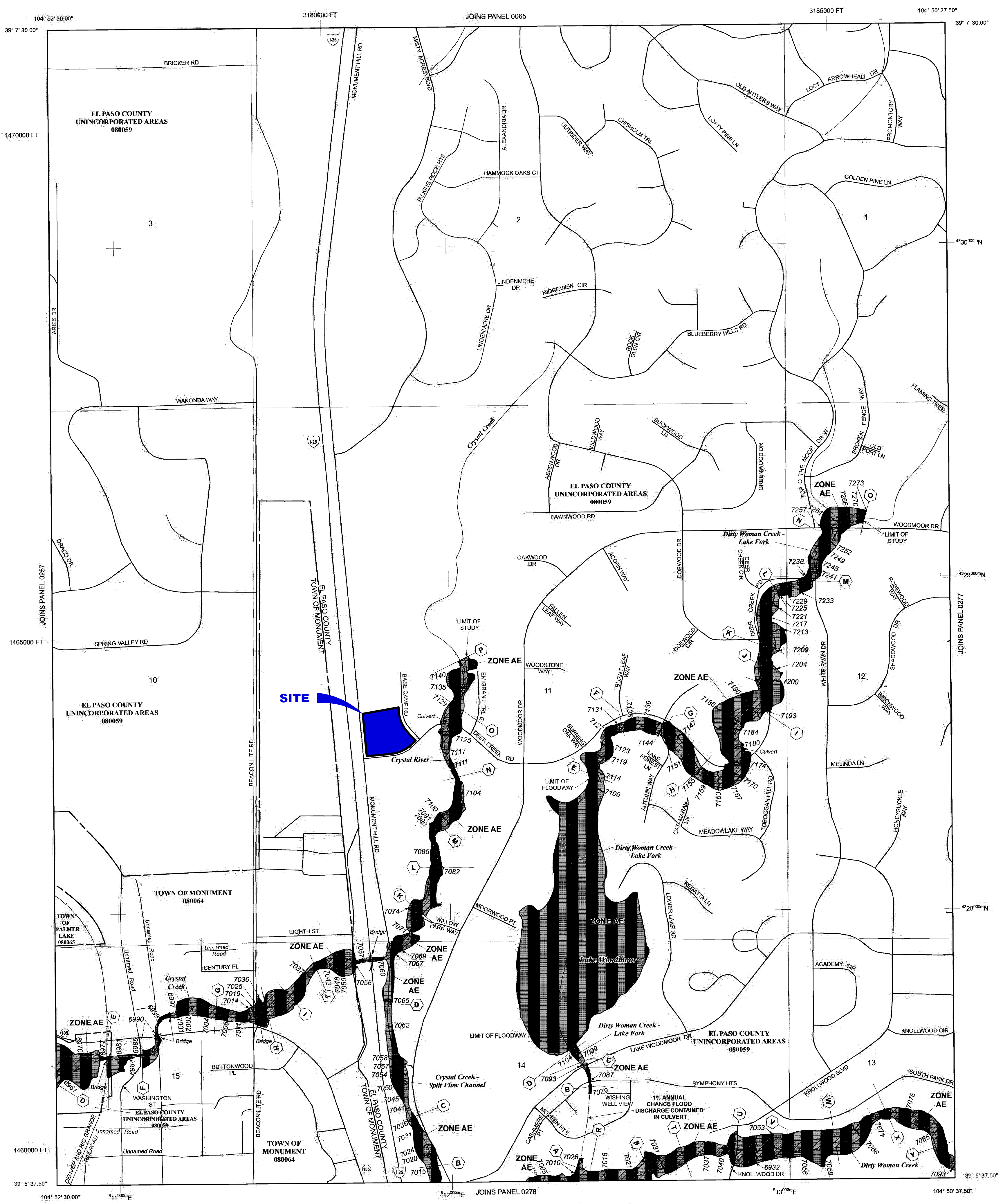
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



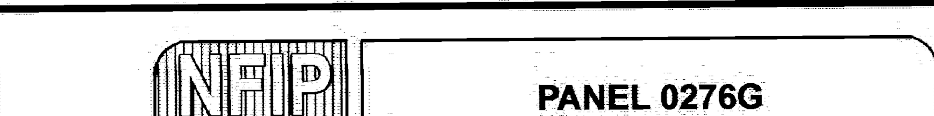
This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



LEGEND

- SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**
 - ZONE A** No Base Flood Elevations determined.
 - ZONE AE** Base Flood Elevations determined.
 - ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
 - ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
 - ZONE AR** Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decommissioned. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
 - ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
 - ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
 - ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.
 - FLOODWAY AREAS IN ZONE AE**
 - The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.
 - OTHER FLOOD AREAS**
 - ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
 - ZONE D** Areas determined to be outside the 0.2% annual chance floodplain. Areas in which flood hazards are undetermined, but possible.
 - OTHER AREAS**
 - COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
 - OTHERWISE PROTECTED AREAS (OPAs)**
- CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.
- Floodplain boundary
 - Floodway boundary
 - Zone D boundary
 - CBRS and OPA boundary
 - Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
 - 513 (EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*
 - * Referenced to the North American Vertical Datum of 1988 (NAVD 88)
 - A — A — Cross section line
 - 23 — 23 — Transect line
 - 97° 07' 30.00" 32° 22' 30.00" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
 - 4750000N 1000-meter Universal Transverse Mercator grid ticks, zone 13
 - 6000000E 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPS ZONE 502); Lambert Conformal Conic Projection
 - DX5510 Bench mark (see explanation in Notes to Users section of this FIRM panel)
 - M1.5 River Mile
- MAP REPOSITORIES
Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.
- For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.
- To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0276G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 276 OF 1300
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080554	0276	G
MONUMENT TOWN OF	080604	0276	G
PALMER LAKE TOWN OF	080605	0276	G

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

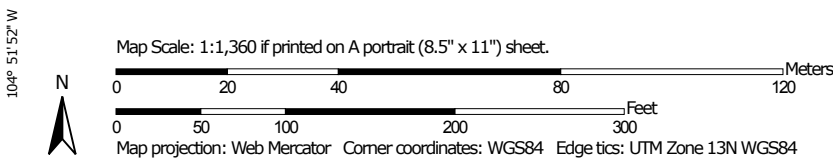
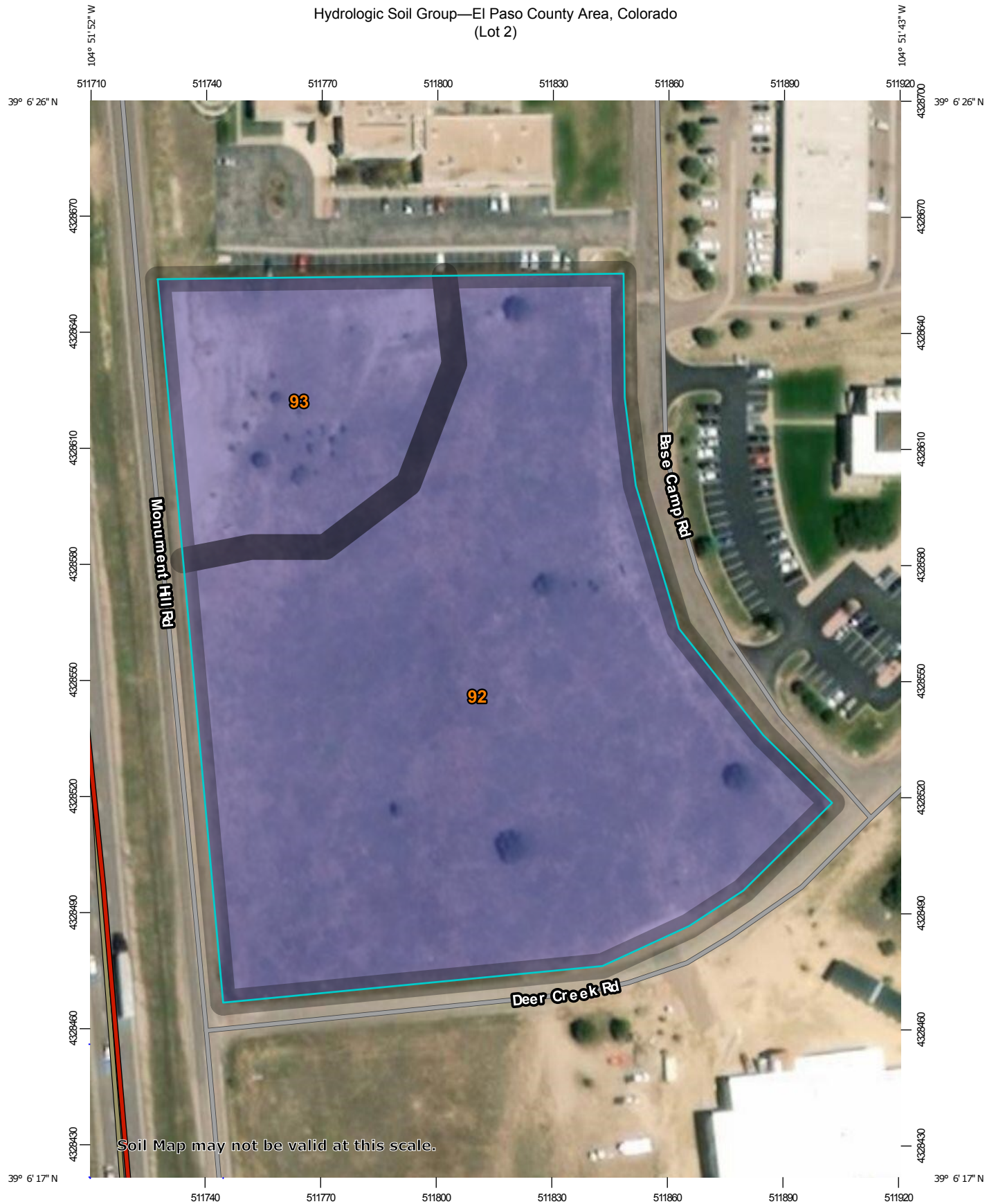
MAP NUMBER
08041C0276G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency


NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 11 SOUTH, RANGE 67 WEST.

Hydrologic Soil Group—El Paso County Area, Colorado
(Lot 2)



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 16, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Oct 16, 2017

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	4.7	80.6%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	1.1	19.4%
Totals for Area of Interest			5.9	100.0%

Description

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.

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.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX E - DRAINAGE MAPS

NOTES:

1. BENCHMARK:
 NGS CONTROL POINT T 395 BEING A STANDARD NGS STEEL ROD IN A LOGO MONUMENT BOX LOCATED 20 MILES NORTH OF COLORADO SPRINGS ON THE EAST SIDE OF I-25, 1,200 FEET NORTH OF THE WEIGH STATION BUILDING, AND 20.5 FEET EAST OF THE EASTERLY EDGE OF OIL OF THE NORTHBOUND LANES OF I-25.

NAVD88 ELEVATION: 7111.32'

BASIN SUMMARY TABLE					
Basin Designation	Area (ac)	Q ₂ (cfs)	Q ₅ (cfs)	Q ₁₀₀ (cfs)	TREATED OR UNTREATED
OS-1	0.45	0.01	0.02	1.47	Treated with Proposed WQ and Detention Facilities
OS-2	0.22	0.01	0.01	0.73	Treated with Proposed WQ and Detention Facilities
OS-3	0.42	0.27	0.38	1.73	Treated with Proposed WQ and Detention Facilities
OS-4	0.15	0.15	0.21	0.74	Treated with Proposed WQ and Detention Facilities
OS-5	0.02	0.00	0.00	0.09	Treated with Proposed WQ and Detention Facilities
OS-6	0.12	0.00	0.01	0.40	Bypasses the site.
OS-7	0.15	0.42	0.55	1.05	Bypasses the site.
OS-8	0.40	0.01	0.02	1.41	Bypasses the site.
A-1	0.43	0.93	1.23	2.62	Treated with Proposed WQ and Detention Facilities
A-2	0.90	2.39	3.14	6.16	Treated with Proposed WQ and Detention Facilities
A-3	0.79	2.45	3.18	5.75	Treated with Proposed WQ and Detention Facilities
A-4	1.11	3.39	4.39	7.97	Treated with Proposed WQ and Detention Facilities
A-5	0.23	0.05	0.08	0.87	Treated with Proposed WQ and Detention Facilities

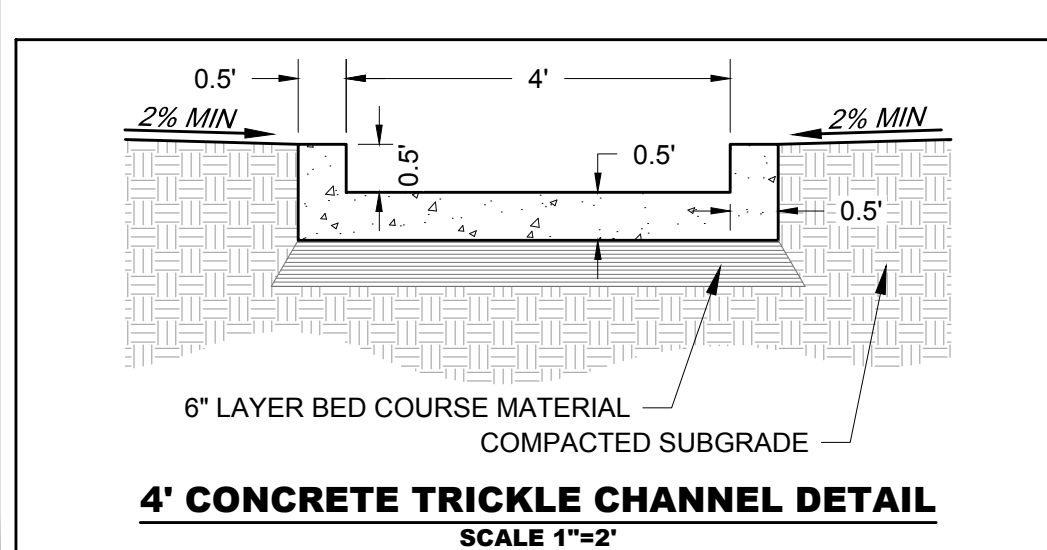
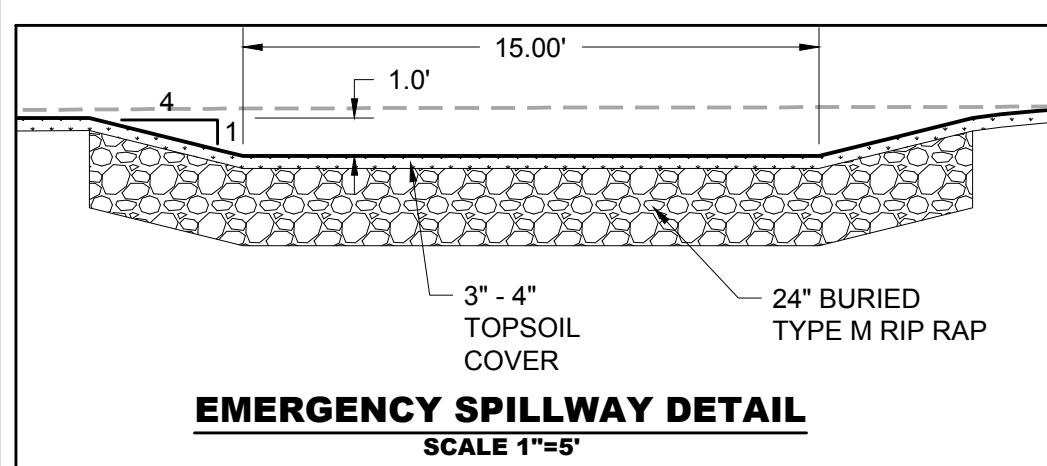
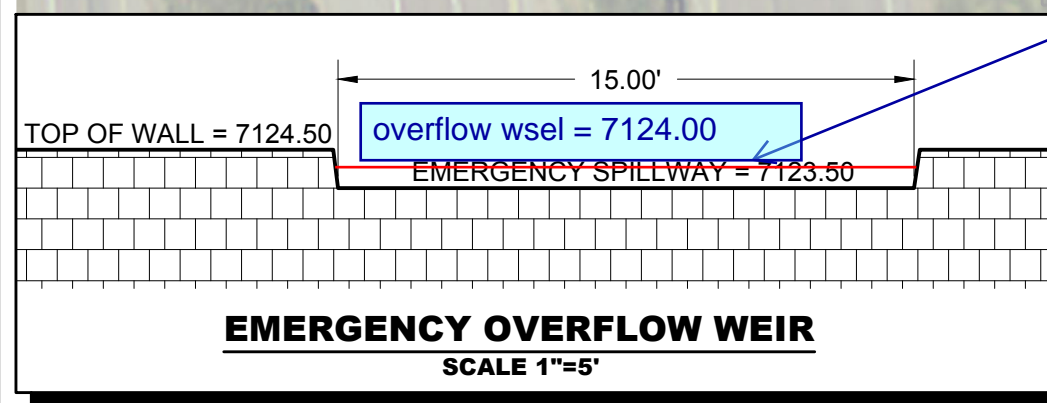
DESIGN POINT SUMMARY TABLE				
Design Point	Contributing Basins	Q ₂ (cfs)	Q ₁₀₀ (cfs)	Structure
1	A-1, OS-4, OS-5	1.43	3.41	IN-1 (10' CDOT Type R Inlet)
2	A-2, OS-3	2.84	6.45	IN-2 (Double CDOT Type 13 Combo Inlet)
3	A-3, OS-2	2.66	5.44	IN-3 (Triple CDOT Type 13 Combo Inlet)
4	A-4, OS-1	3.69	8.00	IN-3 (Triple CDOT Type 13 Combo Inlet)
5	A-1, A-4, OS-1, OS-5	10.18	22.30	Extended Detention Basin (EDB)

Per the ECM Appendix I Section I.7.1.B WQCV shall be provided for the total site. As designed, an approved deviation request is required for Sub-Basin OS-7 & OS-8. For an example see Gardens at North Carefree PUDSP (PCD File No. PUDSP184) which submitted a similar type of deviation request.

Revise. Insufficient freeboard as designed. Provide 1 foot of freeboard above the spillway design-flow depth.

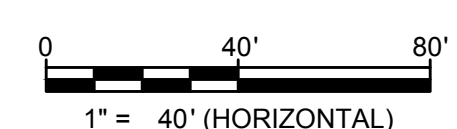
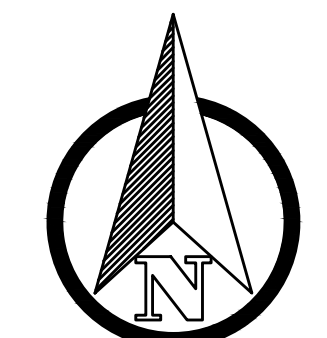
For DP5, provide the Q release.

Provide a pond summary table. Pond volume required vs provided (WQCV, EURV, 100yr)



LEGEND:

- ROW/PROPERTY LINE
- EX. STORM
- PROP. STORM
- HISTORICAL DRAINAGE BASIN
- DRAINAGE BASIN
- DRAINAGE FLOW PATTERN
- OVERFLOW ROUTE
- DESIGN POINT
- DRAINAGE BASIN DESIGNATION
- BASIN DESIGNATION
- BASIN AREA



REV. NO.	DESCRIPTION	DATE

DRAINAGE EXHIBIT
MONUMENT STEEL STRUCTURES
 PROPOSED DRAINAGE MAP
 18910 BASE CAMP ROAD
 MONUMENT, COLORADO

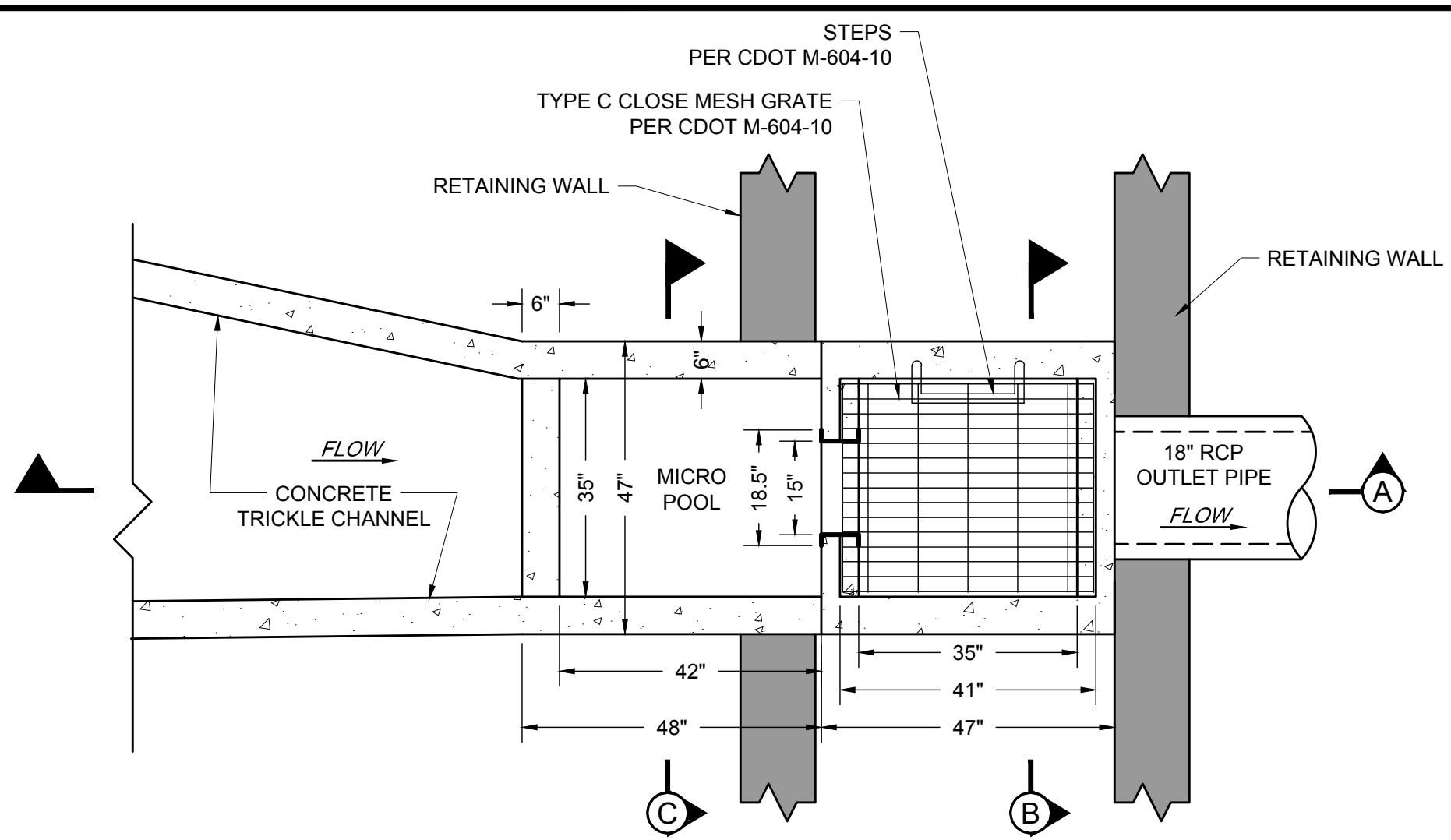
PROJ NO: SSA
 ENG:
 CHKD:
 DATE: 04/08/2019

SHEET NUMBER
PDR
 1 OF 1

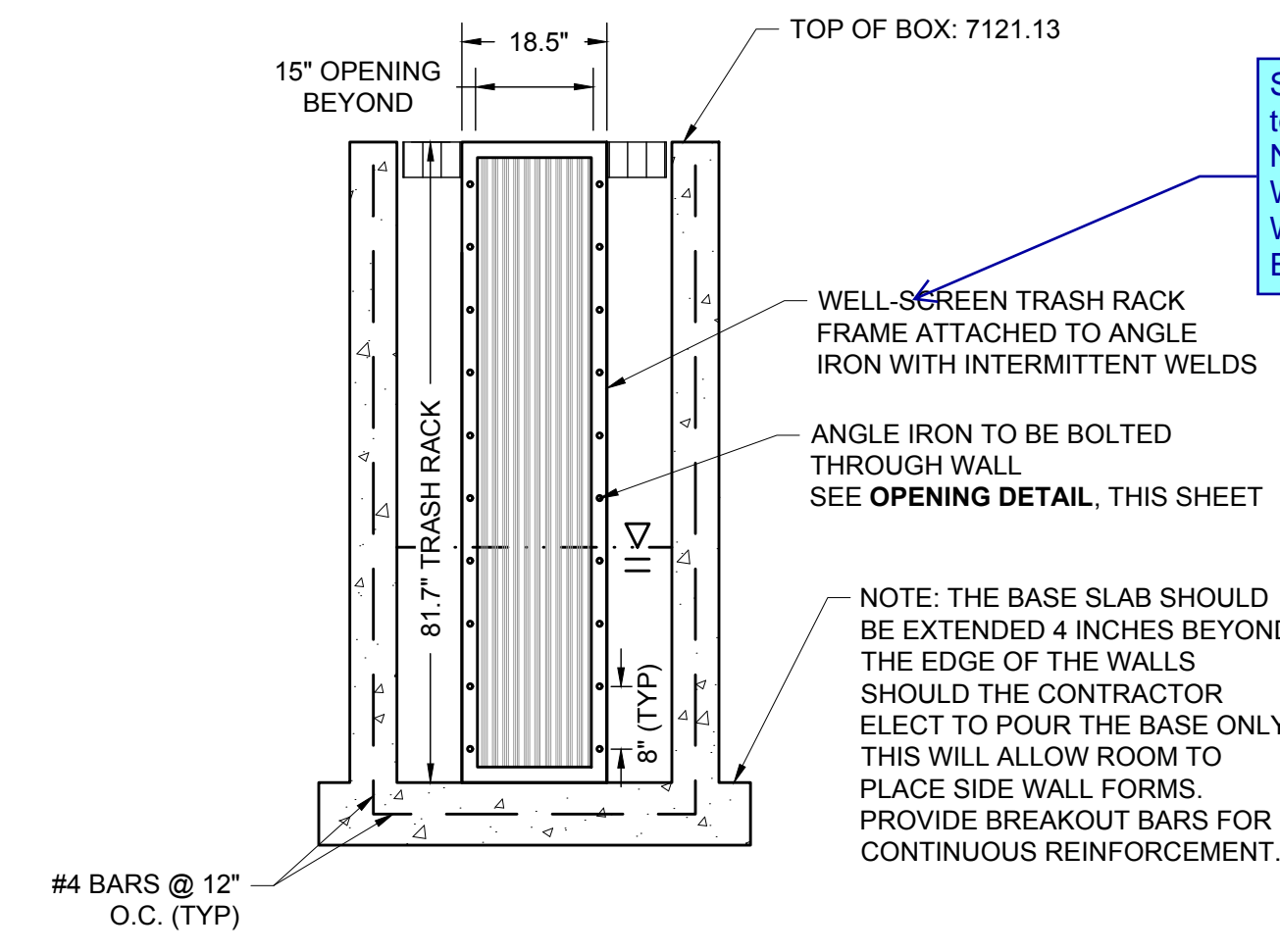
DATE	DESCRIPTION	REV. NO.	DESCRIPTION

CONSTRUCTION DOCUMENTS
MONUMENT STEEL STRUCTURES
OUTLET STRUCTURE
 18910 BASE CAMP ROAD
 MONUMENT, COLORADO

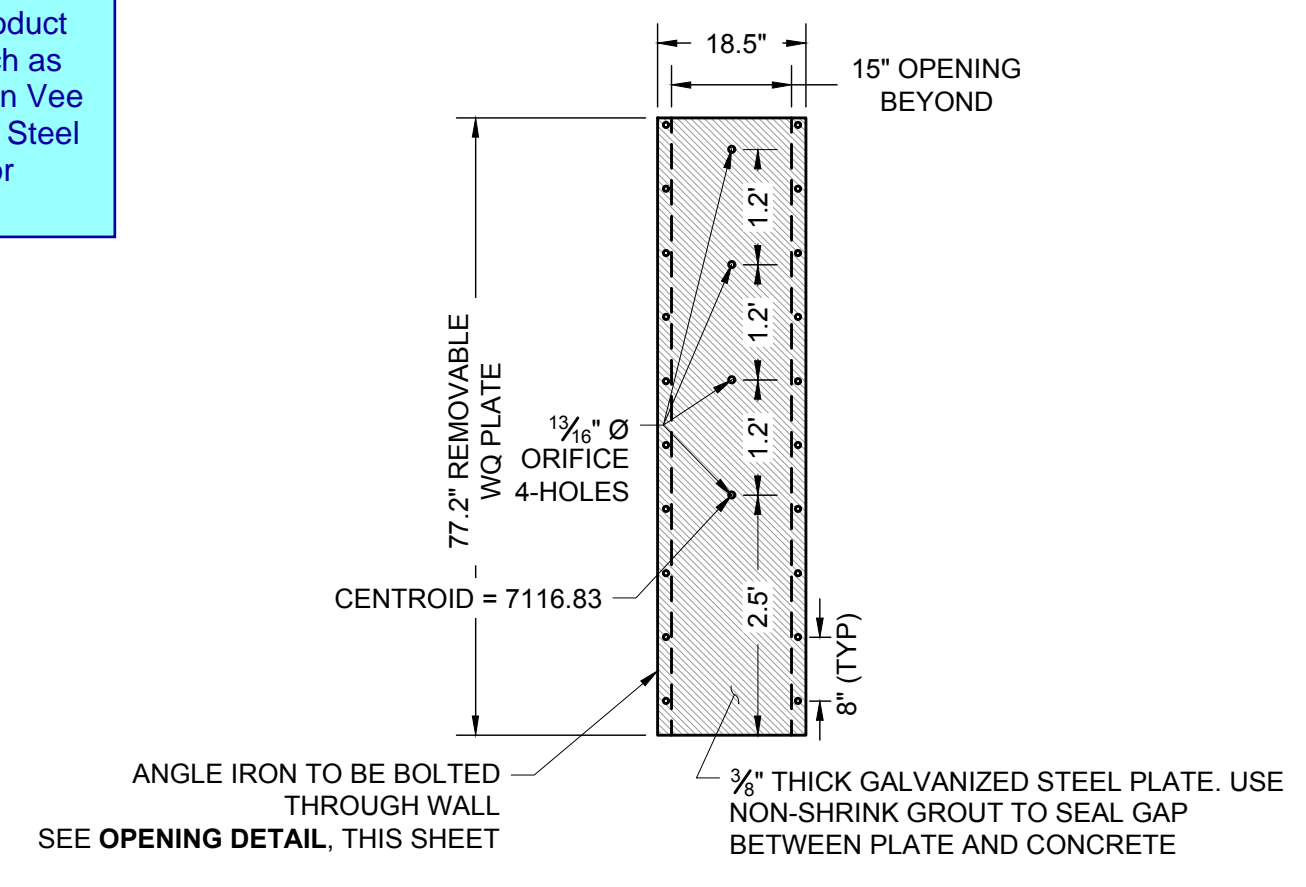
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 ENG :
 CHKD:
 DATE: 04/10/2019



DETENTION POND OUTLET STRUCTURE MODIFIED TYPE C
 SCALE: 1"=2'

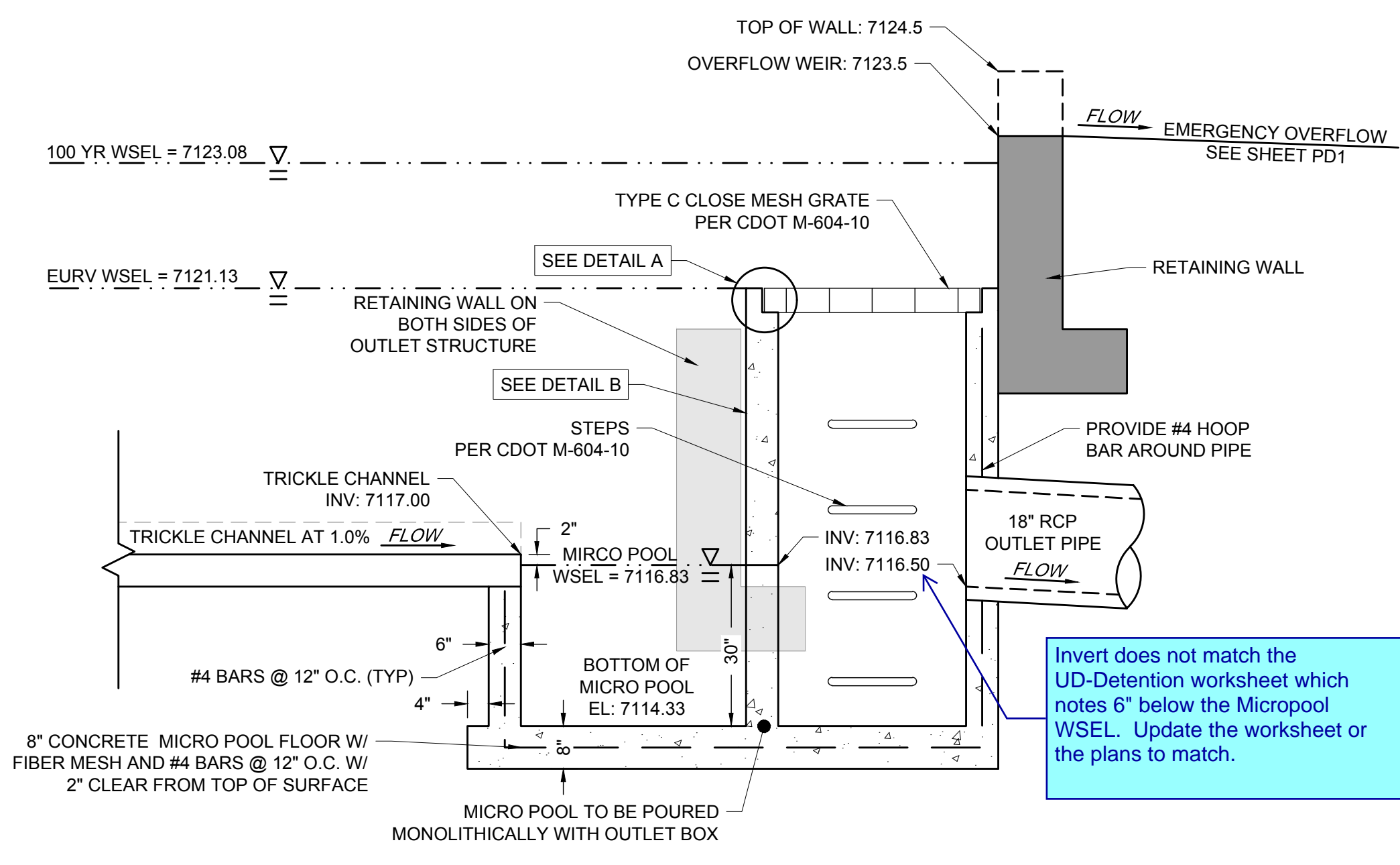


SECTION C
 SCALE: 1"=2'



WATER QUALITY CONTROL PLATE DETAIL
 SCALE: 1"=2'

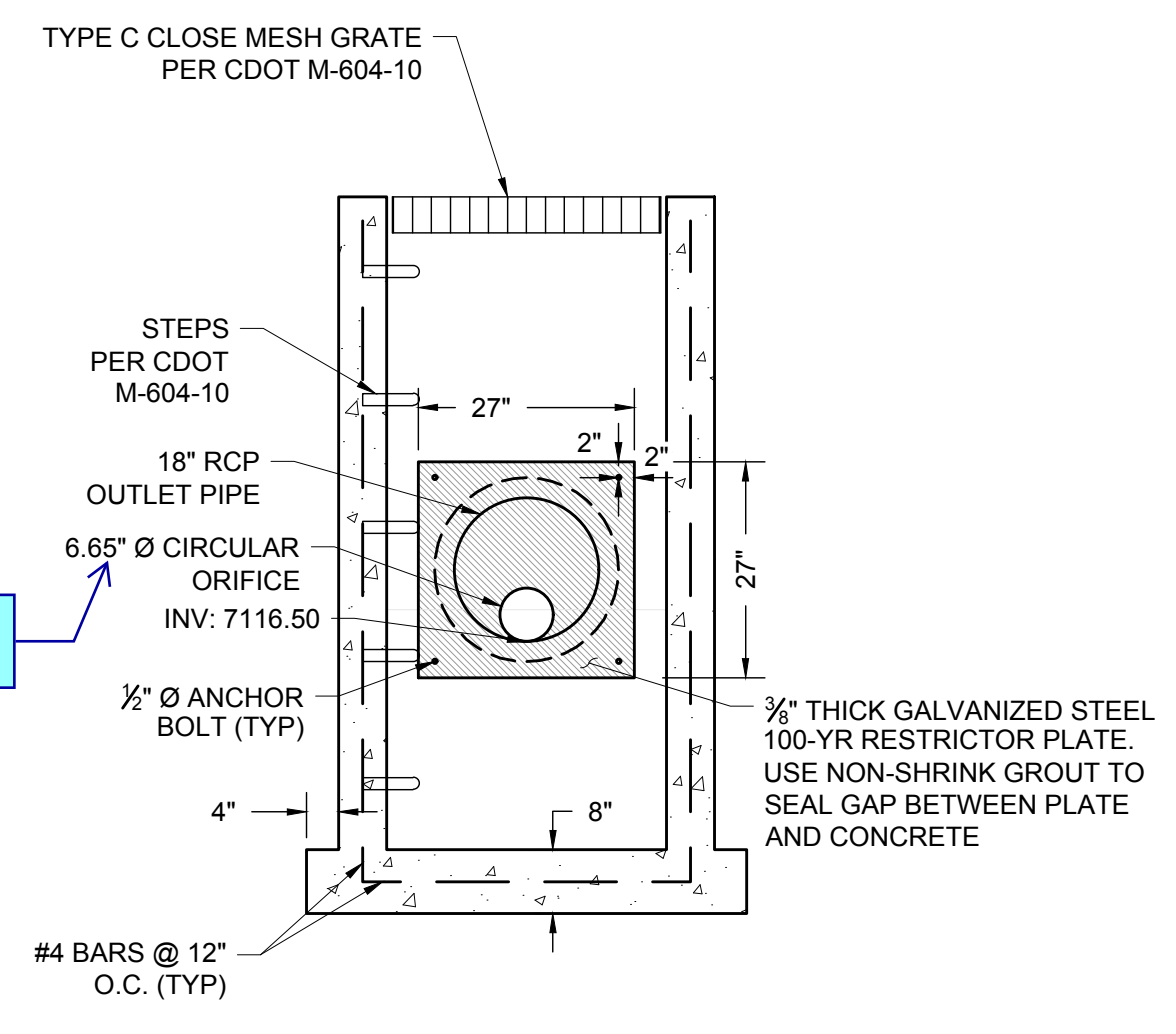
Remove the Outlet Structure details from the drainage report. Include the outlet structure details with the Grading and Erosion Control Plans set.



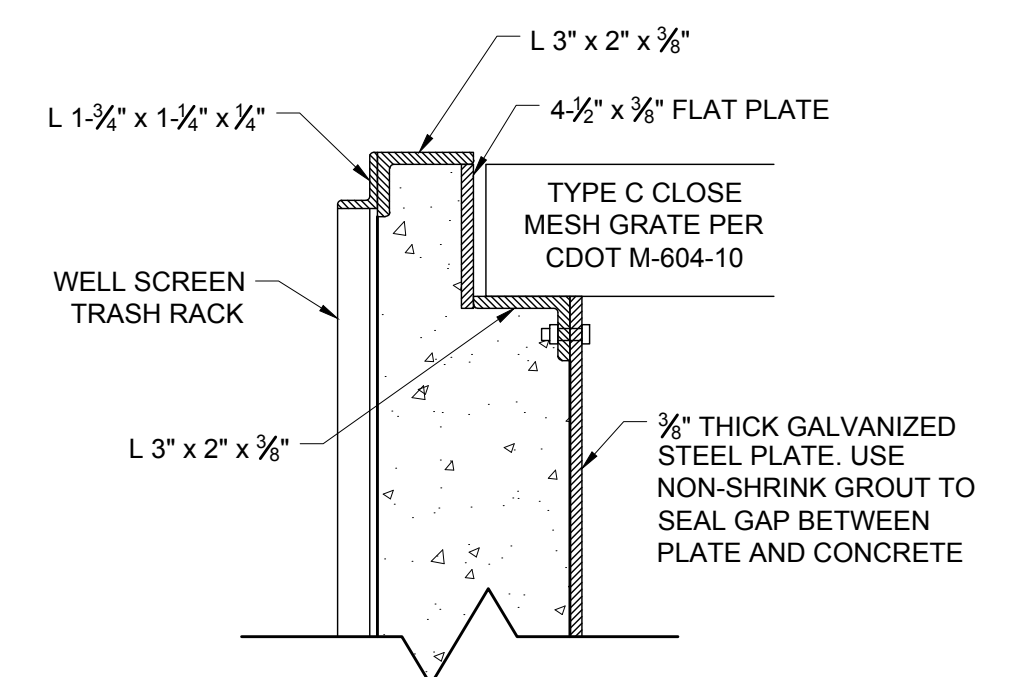
SECTION A
 SCALE: 1"=2'

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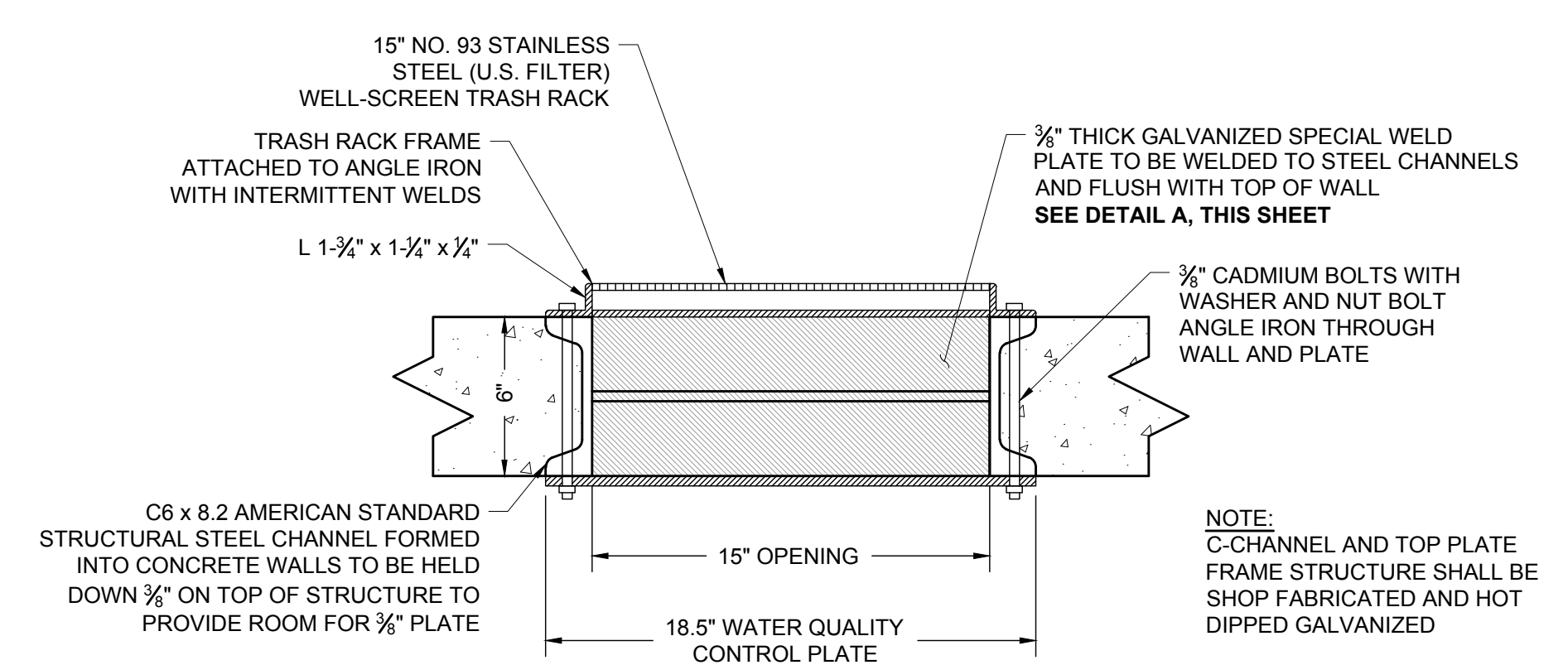
revise the .65 to standard fraction.



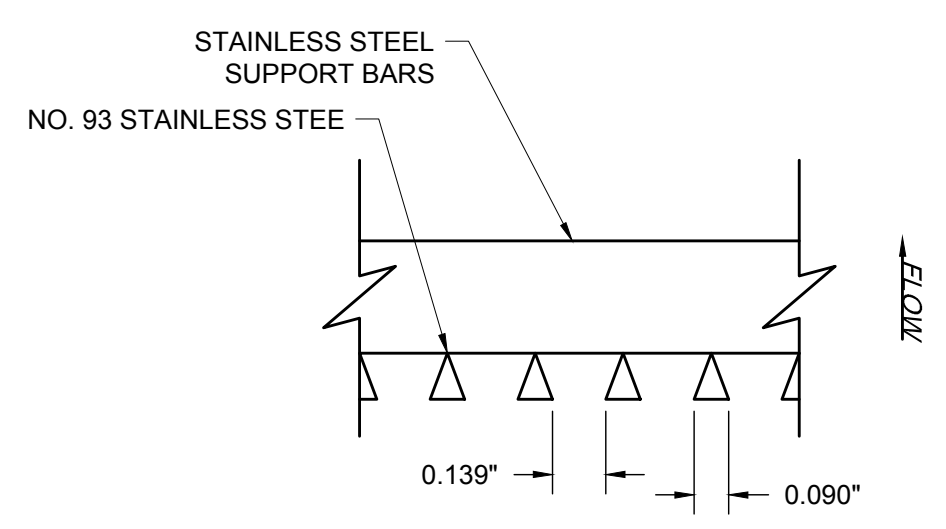
SECTION B
 SCALE: 1"=2'



DETAIL A
 SCALE: 1"=0.5'



OPENING DETAIL
 SCALE: 1"=0.5'

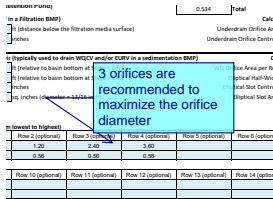


DETAIL B
 n.t.s.

NOTE:
 CONTRACTOR MUST COMPLETE DETENTION POND GRADING AND PROVIDE DETENTION POND CERTIFICATION TO ENGINEER PRIOR TO CONSTRUCTING ANY OUTFALL STRUCTURE (WATER QUALITY PLATE, BOX INLET, WEIR, ETC). DETENTION POND CERTIFICATION NEEDS TO BE DONE AFTER THE SOD IS IN PLACE.

Drainage Report_v1-redline.pdf Markup Summary

3 orifices are recommended to maximize the orifice diameter (1)



Subject: Callout
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Author: dsdlaforce
Date: 5/20/2019 2:05:33 PM
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3 orifices are recommended to maximize the orifice diameter

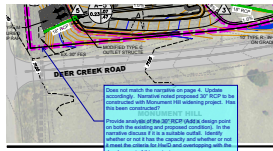
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Add PCD File No. PPR1919

Does not match the narrative on page 4. Update accordingly. Narrative noted proposed 30" RCP to be constructed with Monument Hill widening project. (1)



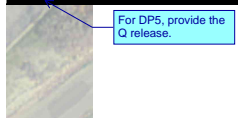
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Does not match the narrative on page 4. Update accordingly. Narrative noted proposed 30" RCP to be constructed with Monument Hill widening project. Has this been constructed?

Provide analysis of the 30" RCP (Add a design point on both the existing and proposed condition). In the narrative discuss if it is a suitable outfall. Identify whether or not it has the capacity and whether or not it meet the criteria for Hw/D and overtopping with the development of this project.

For DP5, provide the Q release. (1)

1	A-1, OS-4, OS-5	1.43	3
2	A-2, OS-3	2.84	6
3	A-3, OS-2	2.66	5
4	A-4, OS-1	3.69	8
5	A-1 - A-4, OS-1 - OS-5	10.18	21



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Author: dsdlaforce
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For DP5, provide the Q release.

implement permanent BMPs (1)

- The attached Detention Basin and outlet structure have been sized and designed with the UD/CD UD Detention UD Design to control the Water Quality Capture Volume (WQCV) and 100-year detention volume.
- The pond will include a visible channel for low flow conditions, an outlet structure including a 24" pipe micropool, and an emergency spillway with spring season protection.
- Site Specific C for Detention and Water Quality Calculations.
- Water Quality Management Best Management Practices.
- If Phase County requires the Four Step Process be followed for the selection and siting of structural BMPs for site development to provide water quality for maximum runoff from impervious areas, then the Basin will employ runoff reduction practices, distributed and point sources. The Four Step will employ runoff reduction practices, distributed and point sources, then the Basin will employ runoff reduction practices, distributed and point sources, then the Basin will employ runoff reduction practices, distributed and point sources.
- The design of the site has followed this process as much as possible. Parameters have been determined to meet only the parking spaces as required by the zoning and impervious areas are included in storm in wetting load. There are no major developments on site. The development adjacent to the site and being improved with spring protection where concentration flows may cause erosion. The WQCV is being provided in accordance with design and approved Detention Basin designed in accordance with design requirements.
- Discharge will be controlled by a distributed outlet structure with flow control gate designed to release the WQCV over 48 hours and release 87% of the 5-year storm in less than 72 hours.
- The 100 year discharge will be limited to be at or below 2.65 cfs (1.65 cfs) for Type B soils unless the 100 year storm from Basin CDF-1000 will require the CDF-1000 and will

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implement permanent BMPs

include contact information: address, phone number (1)

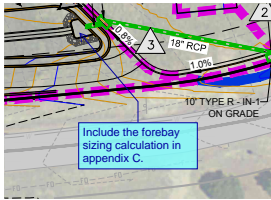
include contact information: address, phone number

Terra Forma

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include contact information: address, phone number

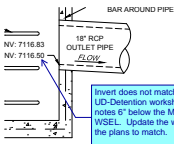
Include the forebay sizing calculation in appendix C. (1)



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Include the forebay sizing calculation in appendix C.

Invert does not match the UD-Detention worksheet which notes 6" below the Micropool WSEL. Update the worksheet or the plans



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Label or remove (1)

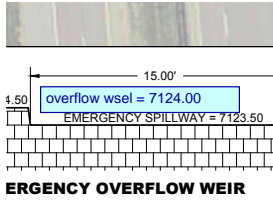
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0.5	0	0.72	14,221	10,960	819
0.5	0	0.72	14,221	10,960	819
Area Truncated by 100%	0	4.71	100,000	100,000	100,000
Area Truncated by 100%	0	0.01	10,000	10,000	10,000

Label or remove

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Label or remove

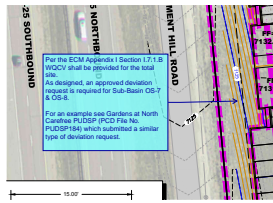
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overflow wsel = 7124.00

Per the ECM Appendix I Section I.7.1.B WQCV shall be provided for the total site. As designed, an approved deviation request is r

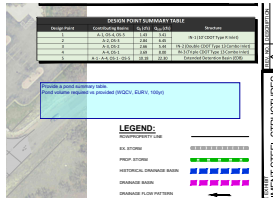


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Per the ECM Appendix I Section I.7.1.B WQCV shall be provided for the total site. As designed, an approved deviation request is required for Sub-Basin OS-7 & OS-8.

For an example see Gardens at North Carefree PUDSP (PCD File No. PUDSP184) which submitted a similar type of deviation request.

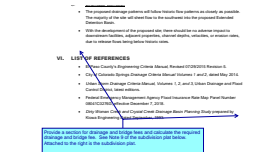
Provide a pond summary table. Pond volume required vs provided (WQCV, EURV, 100yr) (1)



Subject: Text Box
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Author: dsdlaforce
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Provide a pond summary table. Pond volume required vs provided (WQCV, EURV, 100yr)

Provide a section for drainage and bridge fees and calculate the required drainage and bridge fee. See Note 9 of the subdivision p



Subject: Callout
Page Label: 11
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Author: dsdlaforce
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Provide a section for drainage and bridge fees and calculate the required drainage and bridge fee. See Note 9 of the subdivision plat below. Attached to the right is the subdivision plat.

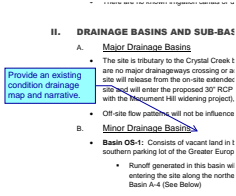
Provide a vicinity map or revise the site location to show a wider area. (1)



Subject: Text Box
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Author: dsdlaforce
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Provide a vicinity map or revise the site location to show a wider area.

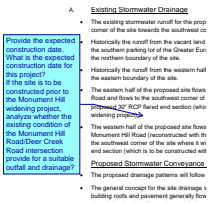
Provide an existing condition drainage map and narrative. (1)



Subject: Callout
Page Label: 5
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Author: dsdlaforce
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Provide an existing condition drainage map and narrative.

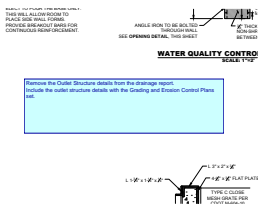
Provide the expected construction date. What is the expected construction date for this project? If the site is to be constructed prior



Subject: Callout
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Author: dsdlaforce
Date: 5/20/2019 1:29:31 PM
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Provide the expected construction date. What is the expected construction date for this project? If the site is to be constructed prior to the Monument Hill widening project, analyze whether the existing condition of the Monument Hill Road/Deer Creek Road intersection provide for a suitable outfall and drainage?

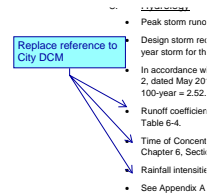
Remove the Outlet Structure details from the drainage report. Include the outlet structure details with the Grading and Erosion Control



Subject: Text Box
Page Label: 48
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Author: dsdlaforce
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Remove the Outlet Structure details from the drainage report. Include the outlet structure details with the Grading and Erosion Control Plans set.

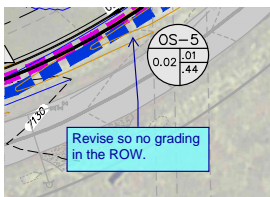
Replace reference to City DCM (1)



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Author: dsdlaforce
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Replace reference to City DCM

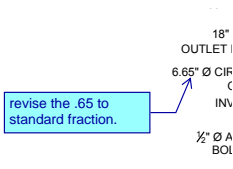
Revise so no grading in the ROW. (1)



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Author: dsdlaforce
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Revise so no grading in the ROW.

revise the .65 to standard fraction. (1)



Subject: Callout
Page Label: 48
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Author: dsdlaforce
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Layer:
Space:

revise the .65 to standard fraction.

Revise the outlet structure to release at or less than historic. (1)

BO	0.1	0.1	1.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	2.1	2.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1
BO	0.1	0.1	0.1	0.1

Revise the outlet structure to release at or less than historic.

Subject: Callout
Page Label: 38
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Author: dsdlaforce
Date: 5/20/2019 2:10:02 PM
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Revise the outlet structure to release at or less than historic.

Revise to 1 ft. (1)

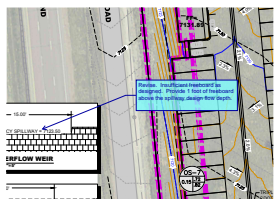
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00
WOCV	0.00	0.00	0.00	0.00

Revise to 1 ft.

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Page Label: 38
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Author: dsdlaforce
Date: 5/20/2019 2:23:47 PM
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Revise to 1 ft.

Revise. Insufficient freeboard as designed. Provide 1 foot of freeboard above the spillway design flow depth. (1)



Subject: Callout
Page Label: 47
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Author: dsdlaforce
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Revise. Insufficient freeboard as designed. Provide 1 foot of freeboard above the spillway design flow depth.

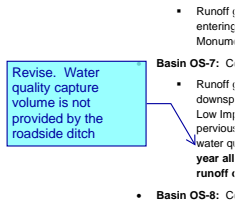
Revise. The fourth step is "Consider Need for Industrial and Commercial BMPs. See ECM Appendix I Section I.7.2. (1)

The fourth step is "Consider Need for Industrial and Commercial BMPs. See ECM Appendix I Section I.7.2."

Subject: Callout
Page Label: 10
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Author: dsdlaforce
Date: 5/20/2019 3:16:35 PM
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Revise. The fourth step is "Consider Need for Industrial and Commercial BMPs. See ECM Appendix I Section I.7.2."

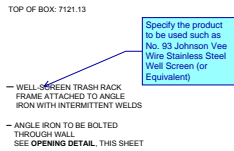
Revise. Water quality capture volume is not provided by the roadside ditch (1)



Subject: Callout
Page Label: 6
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Author: dsdlaforce
Date: 5/20/2019 11:51:33 AM
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Revise. Water quality capture volume is not provided by the roadside ditch

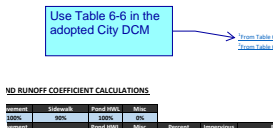
Specify the product to be used such as No. 93 Johnson Vee Wire Stainless Steel Well Screen (or Equivalent) (1)



Subject: Callout
Page Label: 48
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Author: dsdlaforce
Date: 5/20/2019 2:34:41 PM
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Specify the product to be used such as No. 93 Johnson Vee Wire Stainless Steel Well Screen (or Equivalent)

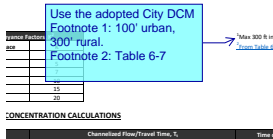
Use Table 6-6 in the adopted City DCM (1)



Subject: Callout
Page Label: 18
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Author: dsdlaforce
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Use Table 6-6 in the adopted City DCM

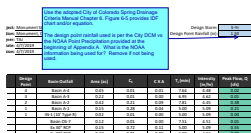
Use the adopted City DCM Footnote 1: 100' urban, 300' rural. Footnote 2: Table 6-7 (1)



Subject: Callout
Page Label: 19
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Author: dsdlaforce
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Use the adopted City DCM Footnote 1: 100' urban, 300' rural. Footnote 2: Table 6-7

Use the adopted City of Colorado Spring Drainage Criteria Manual Chapter 6. Figure 6-5 provides IDF chart and/or equation. The



Subject: Callout
Page Label: 20
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Author: dsdlaforce
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Use the adopted City of Colorado Spring Drainage Criteria Manual Chapter 6. Figure 6-5 provides IDF chart and/or equation.

The design point rainfall used is per the City DCM vs the NOAA Point Precipitation provided at the beginning of Appendix A. What is the NOAA information being used for? Remove if not being used.

Use the City DCM Ch 6 Section 3.2.3 (1)

Use the City DCM Ch 6 Section 3.2.3

High Point Time of Concentration in Urban Catchments
 which depends on the roadway characteristics and using a set of empirical formulas. It is known as the Rational Method and is commonly known as the Rational Method. The Rational Method is used to estimate the peak runoff rate (Q) from a catchment area (A) and is defined by Equation 6-1:

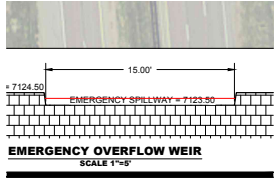
$$Q = C \cdot I \cdot A$$

 where:
 Q = Peak runoff rate (cfs)
 C = Runoff coefficient (dimensionless)
 I = Intensity (in/hr)
 A = Catchment area (ac)
 Equation 6-1

Use the City DCM Ch 6 Section 3.2.3

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(7)



Subject: Line
Page Label: 47
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Author: dsdlaforce
Date: 5/20/2019 2:26:12 PM
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PF Calculator

PF	Area (sqft)	Wetted Perim (ft)	Crit Depth, Yc (ft)	Top Width (ft)	EGL (ft)
1.00	3.99	36.64	0.34	38.98	0.55
1.50	3.99	36.64	0.34	38.98	0.55
2.00	3.99	36.64	0.34	38.98	0.55
2.50	3.99	36.64	0.34	38.98	0.55
3.00	3.99	36.64	0.34	38.98	0.55
3.50	3.99	36.64	0.34	38.98	0.55
4.00	3.99	36.64	0.34	38.98	0.55
4.50	3.99	36.64	0.34	38.98	0.55
5.00	3.99	36.64	0.34	38.98	0.55
5.50	3.99	36.64	0.34	38.98	0.55
6.00	3.99	36.64	0.34	38.98	0.55
6.50	3.99	36.64	0.34	38.98	0.55
7.00	3.99	36.64	0.34	38.98	0.55
7.50	3.99	36.64	0.34	38.98	0.55
8.00	3.99	36.64	0.34	38.98	0.55
8.50	3.99	36.64	0.34	38.98	0.55
9.00	3.99	36.64	0.34	38.98	0.55
9.50	3.99	36.64	0.34	38.98	0.55
10.00	3.99	36.64	0.34	38.98	0.55

Subject: Rectangle
Page Label: 14
Lock: Unlocked
Author: epearson
Date: 4/7/2019 10:07:27 PM
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Monday, Apr 8 2011

Highlighted
 Depth (ft) = 0.34
 Q (cfs) = 14.54
 Area (sqft) = 3.99
 Velocity (ft/s) = 3.64
 Wetted Perim (ft) = 39.00
 Crit Depth, Yc (ft) = 0.34
 Top Width (ft) = 38.98
 EGL (ft) = 0.55

Subject: Rectangle
Page Label: 26
Lock: Unlocked
Author: epearson
Date: 4/8/2019 11:40:58 PM
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Monday, Apr 8 2019

Highlighted
 Depth (ft) = 0.50
 Q (cfs) = 18.14
 Area (sqft) = 3.08
 Velocity (ft/s) = 5.89
 Wetted Perim (ft) = 15.87
 Crit Depth, Yc (ft) = 0.66
 Top Width (ft) = 15.54
 EGL (ft) = 1.04

Subject: Rectangle
Page Label: 28
Lock: Unlocked
Author: epearson
Date: 4/8/2019 11:46:32 PM
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Monday, Apr 8 2015

Highlighted
 Depth (ft) = 0.40
 Q (cfs) = 16.75
 Area (sqft) = 3.45
 Velocity (ft/s) = 4.86
 Wetted Perim (ft) = 23.61
 Crit Depth, Yc (ft) = 0.51
 Top Width (ft) = 23.59
 EGL (ft) = 0.76

Subject: Rectangle
Page Label: 27
Lock: Unlocked
Author: epearson
Date: 4/8/2019 11:52:25 PM
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• Annotate Layers (Layering) with the Annotate Layers tool
• Use the Layer Properties dialog box to change the layer's name, color, and line style
• Use the Layer Properties dialog box to change the layer's name, color, and line style
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Subject: Image
Page Label: 11
Lock: Unlocked
Author: dsdlaforce
Date: 5/20/2019 3:27:00 PM
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Subject: File Attachment
Page Label: 11
Lock: Unlocked
Author: dsdlaforce
Date: 5/20/2019 3:30:37 PM
Status:
Color: ■
Layer:
Space: