ASPEN 3-65 15-14 SOUTH

(ASPEN 3-65 15-14-13 3BH, 4AH, 4BH, QUICKSILVER 3-65 16-17-18-13 2BH, 3AH, 3BH, 4AH, 4BH)

PRELIMINARY DRAINAGE REPORT

W 1/2 SW 1/4, SECTION 15, TOWNSHIP 3 SOUTH, RANGE 65 WEST, 6TH P.M.

APPROVED FOR ONE YEAR FROM THIS DATE:
_____
AURORA WATER – DRAINAGE DIVISION DATE

Date: June 21, 2024

Advisory Note: PDR Approval is required prior to Civil Plan Approval.

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TABLE OF CONTENTS

A. INTRODUCTION

B. Location

The Aspen 3-65 15-14 South oil & gas well site (Aspen South) is located in the W 1/2 SW 1/4 of Section 15, Township 3 South, Range 65 West, 6th P.M. The well site access road will access onto the east side of Monaghan Rd. approximately 0.64 miles south of the intersection of E. 56th Ave. and Monaghan Rd. Reference the Vicinity Map in Appendix 1 of this report.

C. Proposed Development

The proposed improvements will be constructed in two phases in support of drilling a total of eight (8) oil and gas wells. The wellheads are aligned in a north-south direction spaced 20 feet apart. The northern-most wellhead is 3,765-feet south of the north property line and 480-feet east of the west property line. Throughout this report, Phase-1 will be referred to as the drill pad and Phase-2 will be referred to as the interim reclaimed production pad.

Along with constructing the access road, Phase-1 will include constructing the drill pad, which will be a 700' x 570' graded pad with a slope of 0.5%. A temporary sediment basin will be constructed near the northeast corner of the proposed drill pad. The drill pad, access road, and sediment basin will be graded by removing the topsoil and stockpiling it along the east edge of the drill pad. The topsoil stockpile will be 10-ft high with 4H:1V side slopes. The site will then be excavated to the finished grade elevation using the excavated soil as fill to balance the earthwork.

During construction of the drill pad, a 30'W x 678'L access road will be constructed and will be surfaced with granular road-base capable of supporting heavy vehicles. The access road cross section will have a 2% crown to divert stormwater runoff to each side of the road. Runoff from the south side of the road will be treated in a Grass Swale, and runoff from the north side of the road will be treated in a Grass Buffer RPA. As previously mentioned, the access road connects to the east side of Monaghan Rd. and provides access into the north side of the well pad.

The total disturbed area during construction of the drill pad is 19.31 acres, which includes the well site disturbance of 18.26 acres and the access road disturbance of 1.05 acres. Following the drilling and completions operations, the site will be interim reclaimed to a smaller production pad with a total disturbed area of 12.85 acres.

Phase-2 will begin by interim reclaiming the south and east edges of the drill pad, reducing the size of the well pad to a 520' x 385' granular pad to support the production operations of the eight (8) wells, referred to as the production pad throughout this report. During interim reclamation, cut and fill slopes of the drill pad will be pulled in and recontoured in order to return the site to its natural contours, or as close as possible. The temporary sediment basin will be removed and an Extended Detention Basin (EDB) will be constructed near the northeast corner of the production pad to manage stormwater discharging from the site. Topsoil from the stockpile will then be evenly placed over the reclaimed area, and the remaining topsoil will be relocated and stockpiled in a 10-ft high stockpile along the east edge of the production pad until used during final reclamation of the well pad.

Accidental spill containment measures will be implemented on the site around tanks, production equipment, drilling equipment, and completions equipment in the form of berms, mechanical walls, and liners to prevent accidental spills from entering the drainage conveyance through the site. These spill containment measures are not anticipated to impact the drainage conveyance through the site.

Crestone Peak Resources Operating LLC will adhere to the approved Field Wide I&M Plan (EDN 220093)

for maintenance and inspections of the stormwater facilities, Stormwater Control Measures (SCM), and Best Management Practices (BMP) implemented on this site.

3. Changes to MDR

N/A

4. Variances

1. The proposed development is seeking a variance from Section 2.08.1.06 of the 2023 COA Roadway Design and Construction Specification Manual, to allow unlined drainage swales with a flow line grade from 0.5% to 2.0%, provided they have an underdrain. This variance is requested due to limitations of the existing site grades, as the natural grade is less than the 2% minimum drainage swale grade requirement. There is no adjacent development, the flows are minimal at +/- 5 cfs, Crestone Peak Resources Operating LLC will maintain the swales and capacity, and there is no adverse impact on other property and Right-of-Way. The City of Aurora reserves the right at any point to require the construction of the remedial measures should there be any issues with reduced capacity, sedimentation, erosion, ponding, flooding or other items identified by the City Engineer.
2. The proposed development is seeking a variance from the standard requirements, Section 10.7 of the COA November 2023 SDDTCM, to not include a drainage easement around the EDB. The variance is requested due to the implementation of the Field Wide I&M Plan (EDN 220093) that was developed to cover this site, and to provide an alternative to this requirement through detailed maintenance obligations on the part of Crestone Peak Resources Operating LLC. Right-of-Way for ingress and egress for service and emergency vehicles and personnel is granted over, across, on and through any and all private roads and ways, now and hereafter established on the Aspen 3-65 15-14 South oil & gas well site.

B. HISTORIC DRAINAGE

1. Description of Property and Drainage Basin

The location of the proposed Aspen South well pad site is not within any mapped FEMA 100-year floodplain. The historical basin and existing landscape could be characterized as agricultural cropland, and is estimated to have an imperviousness of 5%. The existing topography generally drains from southwest to northeast at an existing grade of approximately 1.5% towards Coyote Run and Box Elder Creek approximately 1.25 miles to the northeast. The nearest edge of the Coyote Run Floodplain is approximately 1.25 miles east of the well site. Reference the Floodplain Exhibit in Appendix-1 for a depiction of the project location in relation to the floodplain.

A small portion of the historical basin near the beginning of the proposed access road at Monaghan Rd. drains north, eventually reaching a culvert under Monaghan Rd. draining to the west into Upper Hayesmount Creek.

No other non-stormwater sources are contemplated at this project site, as there are no springs or irrigation ditches on the site.

Existing flow patterns will be altered by diverting the historic flows around the site, but eventually discharging into the historic drainage path on the downstream side of the site.

Using the US Department of Agriculture's web soil survey, one (1) soil classification is represented onsite.

Table 1 - NRCS Hydrologic Soil Group

Map Symbol	Soil Type	Average Slope	Hydrologic Soil Group	Percent of AOI
WmB	Weld loam	1 to 3 percent slopes	C	100.0%

The soils are categorized as Hydrologic Soil Group C. Hydrologic Soil Group C is classified as having a slow infiltration rate when thoroughly wet.

The soils at the project location have a K factor rating of 0.43. The K factor indicates the susceptibility of a soil to sheet and rill erosion by water and varies from 0.02 (low susceptibility) to 0.69 (high susceptibility). Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water. Refer to the attached soils map in Appendix-1.

C. DESIGN CRITERIA

1. HYDROLOGIC CRITERIA

The site is located in a non-urbanizing area of the City of Aurora and Adams County. Both the minor and major precipitation intensity was obtained from National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 8, Version 2. The 2-Year 1-Hour rainfall intensity for the project location is 0.849 in/hr and the 100-Year 1-Hour rainfall intensity for the project location is 2.52 in/hr. The location of the proposed site is depicted on the accompanying Drainage Plan included with this report submittal.

The Rational Method is used to compute peak runoff flows for the minor (2-year) and major (100-year) storm events for the on-site and off-site drainage basins. Imperviousness values for the site were obtained from Table 5-6 – Imperviousness Values for Urban Surfaces for Site and Small Watershed Analysis of the City of Aurora – November 2023 Storm Drainage Design and Technical Criteria Manual (SDDTCM).

Initially, a runoff coefficient calculation is performed for each of the basins, following the recommended Runoff Coefficient (C) equations from Table 5-7 – Runoff Coefficient Equations Based on NRCS Soil Group and Storm Return Period of the City of Aurora – November 2023 SDDTCM.

The Non-Urban Computed Time of Concentration is calculated following the equations listed in the Mile High Flood District – Urban Storm Drainage Criteria Manual, Volume 1, Chapter 6, latest adopted edition, using the UD-Rational v2.00 excel spreadsheet as provided by the Mile High Flood District (MHFD).

The non-urban Peak Runoff Flow is then calculated using the Rational Method Equation Q = CIA as specified in the Mile High Flood District – Urban Storm Drainage Criteria Manual, Volume 1, Chapter 6, latest adopted edition, and using the UD-Rational v2.00 excel spreadsheet as provided by the Mile High Flood District (MHFD). The peak runoff flow calculation for each basin, at the “Computed Tc”, are printed from the UD-Rational spreadsheet provided by the MHFD, and is included in this report in Appendix-2 for reference.

The Detention Volume was determined following the criteria and guidance provided in Chapter 10 of the City of Aurora – November 2023 SDDTCM, and using the MHFD-Detention Workbook, v4.06.

2. HYDRAULIC CRITERIA

The hydraulic criteria used to evaluate, analyze, and design hydraulic structures follow the criteria and guidance provided in the City of Aurora – November 2023 SDDTCM and Mile High Flood District – Urban Storm Drainage Criteria Manual, Volume 2, latest adopted edition, where referenced.

Culverts were analyzed using the Federal Highway Administration HY-8 Culvert Analysis Program. Proposed culverts are designed to convey the 100-year major storm event without overtopping any roadways nor exceeding 1.5 times the culvert diameter (per section 9.4 of the City of Aurora - November 2023 SDDTCM). The culverts have been evaluated to determine capacity, and the emergency overflow path has been identified on the drainage plans. In the case of available culvert capacity, twice the 100-yr runoff flow was used to show that the emergency overflow will be contained within the designed culvert.

The Detention Volume was determined following the criteria and guidance provided in Chapter 10 of the City of Aurora – November 2023 SDDTCM, and using the MHFD-Detention Workbook, v4.06.

Swales were analyzed using the UD-Channels, v1.05 spreadsheet obtained from MHFD. The Normal Flow Analysis – Trapezoidal Channel tab was used to define the water surface profile in the swale. Proposed swales/diversion ditches are designed to convey the 100-year major storm event providing a minimum of 1-ft of freeboard.

The proposed swales, culverts, and EDB for this site are private and will be maintained by Crestone Peak Resources Operating LLC.

The site is located beyond 10,000-ft of Denver International Airport (DIA), but still within 5-mi of DIA. Therefore, the Extended Detention Basin shall have a 48-hr drain time.

D. DRAINAGE PLAN

1. General Concept

The offsite drainage basins will be diverted and conveyed around the site development and eventually discharge into the historic drainage path downstream of the site. There are four offsite drainage basins OS1 thru OS4. The onsite stormwater runoff from Basins A, B, C, and D will be routed through ditches constructed around the perimeter of the well pad, which will discharge into the Extended Detention Basin located near the northeast corner of the site. These areas include the gravel surfaced production pad, the landscaped and vegetated areas surrounding the production pad, and the EDB water surface.

The outlet structure of the permanent Extended Detention Basin will outfall into the historic drainage path northeast of the site.

2. Specific Details

a. Offsite Basins

There are four offsite drainage basins that surround the site. The offsite basins discussed below are for Phase 2 of the interim reclaimed production pad. These basins have been slightly altered from Phase 1 of the drill pad construction, but both phases provide the same concept as discussed below. Phase 1 will be discussed during the Final Drainage Report.

Basin OS1' includes an area west of the site that flows north along Monaghan Rd. towards the access road and Culvert-2, and an area north of the well pad between the well pad and access road that flows west to Culvert-2. Basin OS1' includes the south half of the graveled 30-ft wide access road and the east half of paved Monaghan Rd. Runoff from the east half of Monaghan Rd. flows into the roadside swale along Monaghan Rd., conveying stormwater northerly to Culvert-2 under the access road approach onto Monaghan Rd. and Design Point 7'. Runoff from the south half of the graveled 30-ft wide access road will flow into a Grass Swale along the south side of the access road, conveying stormwater westerly to Culvert-2 under the access road approach onto Monaghan Rd. and Design Point 7'. The Grass Swale will provide

WQ Treatment, as will be discussed later in this report. Culvert-2 conveys the combined stormwater from Basins OS1' and OS2' from south to north, discharging back into the roadside swale along Monaghan Rd.

Basin OS2' is an area west of the site that flows northeast towards Offsite Ditch-1 and Design Point 8'. Offsite Ditch-1 discharges stormwater northerly into Basin OS1'.

Basin OS3' is an area south of the site that flows northeast towards Offsite Ditch-2 and Design Point 9'. Offsite Ditch-2 discharges stormwater east of the site back into the historic flow path.

Basin OS4' is the north half of the 30-ft wide graveled access road that flows northerly to Design Point 10'. Runoff from the north half of the 30-ft wide graveled access road will flow into a 12.6-ft length of Receiving Pervious Area (RPA) in the form of a Grass Buffer along the north side of the access road. The Grass Buffer will provide Runoff Reduction for WQCV Treatment, as will be discussed later in this report.

Existing flow patterns will be altered, but SCMs will divert the offsite flows around the site, eventually discharging back into the historic drainage path on the downstream side of the site. Discharges from the site will remain on the same property as the proposed development. Reference the Drainage Plans accompanying this report.

b. Onsite Basins

There are four onsite basins within the site. The onsite basins discussed below are for Phase 2 of the interim reclaimed production pad. These basins have been slightly altered from Phase 1 of the drill pad construction, but both phases provide the same concept as discussed below. Phase 1 will be discussed during the Final Drainage Report.

Basin A' includes the onsite runoff from the northwest corner of the sloped graveled well pad. Basin A' runoff flows towards Onsite Ditch-1 along the north edge of the pad to Design Point 1' and Culvert-1. Culvert-1 conveys stormwater from west to east under the access road, discharging to the east into Basin D'.

Basin B' includes the onsite runoff from the southern and eastern areas of the sloped graveled well pad and a portion of the topsoil stockpile. Basin B' runoff flows northeasterly towards Design Point 2' at Basin D'.

Basin C' is a small area east of the well pad, that includes a portion of the topsoil stockpile, and flows northeast towards Onsite Ditch-2 and Design Point 3' at Basin D'.

Basin D' includes the area of the EDB, which includes the water surface of the EDB. The combined flows from Basins A', B', C', and D' are defined at Design Point 4' at the outlet structure, and will flow over the emergency spillway at Design Point 5'. The controlled release of the combined flows is defined at Design Point 6', where the EDB outlets into an outlet ditch that discharges into the historic drainage path northeast of the site.

Existing flow patterns will be altered, but SCMs will divert the onsite flows through the site, eventually discharging back into the historic drainage path on the downstream side of the site. Discharges from the site will remain on the same property as the proposed development. Reference the Drainage Plans accompanying this report.

As will be discussed later in this report in the Extended Detention Basin section, the areas of Basins A', B', C', and D' were used to calculate the WQCV, EURV, the 100-Yr required detention volume, and the 100-yr flow over the emergency spillway for the EDB. The EDB will be privately maintained by Crestone Peak Resources Operating LLC. Reference the Drainage Plans accompanying this report.

The peak runoff flows for each basin are shown in the table below:

Table 2 – Peak Runoff Flow (cfs)

Basin ID	Basin Area (Acres)	Imperv. (%)	2-yr (C)	100-yr (C)	2-yr Peak Runoff Flow (cfs)	100-yr Peak Runoff Flow (cfs)
A' (PROD OPERATIONS)	2.40	41.8	0.31	0.65	1.03	6.40
B' (PROD OPERATIONS)	5.05	46.0	0.35	0.67	2.60	14.88
C' (PROD OPERATIONS)	1.08	20.0	0.14	0.57	0.21	2.61
D' (PROD OPERATIONS)	0.93	100.0	0.83	0.89	2.05	6.53
A'+B'+C'+D'	9.46	47.3	0.36	0.68	4.21	23.49
OS1' (PROD OPERATIONS)	3.06	27.0	0.19	0.59	0.64	5.86
OS2' (PROD OPERATIONS)	2.94	5.0	0.03	0.50	0.10	5.33
OS1'+OS2'	6.00	16.2	0.11	0.55	0.68	10.20
OS3' (PROD OPERATIONS)	12.82	5.3	0.03	0.51	0.31	14.94
OS4' (PROD OPERATIONS)	0.20	80.0	0.65	0.81	0.44	1.63

c. Conveyances

The minor and major storm routing through the site will be managed through the use of trapezoidal swales. The swales are designed to convey the 100-year stormwater runoff flows. The Onsite swales around the perimeter of the sloped graveled well pad will be constructed with a 2-foot-wide flat bottom and 4H:1V side slopes. The depth of the onsite swales will be 24 inches, which will provide a minimum of 1-foot of freeboard above the 100-yr water surface elevation.

The Offsite swales will be constructed with a 2-foot-wide flat bottom and 4H:1V side slopes. The depth of the offsite swales will be 24 inches, which will provide a minimum of 1-foot of freeboard above the 100-yr water surface elevation. Due to the flat grades of the existing ground along the area of the swales, the minimum grade proposed for the swales is 0.5%. During initial construction of the drill pad, offsite and onsite swales will be graded at 0.5% without an underdrain, and onsite swales will convey stormwater to a temporary sediment basin. During interim reclamation to the production pad, newly constructed swales will tie into the existing swales and will be graded at 0.5% with an underdrain, and onsite swales will convey stormwater to the EDB. Underdrains will also be installed in the existing swales during interim reclamation. Reference the typical swale details in the Drainage Plans accompanying this report.

Crestone Peak Resources Operating LLC will maintain the swales and their capacity, and will promptly address any sedimentation issues should that occur. There is no adverse impact on other property and Right-of-Way, and the flows within the swales are minor. The City of Aurora reserves the right at any point to require the construction of remedial measures should there be any issues with reduced capacity, sedimentation, erosion, ponding, flooding or other items identified by the City Engineer.

The emergency overflow path for Culverts-1 and -2 are identified on the drainage plans accompanying this report. Both culverts can convey the 100-yr runoff flow plus the emergency 100-yr runoff overflow. Therefore, the emergency 100-yr runoff overflow path will be contained within and through the culverts. Reference the Drainage Plans accompanying this report for the emergency flow paths.

The hydraulic calculations for the ditch and culvert conveyances are included in Appendix-3 of this report. The geometric and hydraulic details are shown in the table below.

Table 3 – Conveyance Geometric and Hydraulic Details

Conveyance	Tributary Basin(s)	Design Point	Geometric Details	Min Slope (%)	100-Yr Design Flow (cfs)	Depth at Design Flow (ft)	Available Freeboard (ft)
Onsite Ditch 1 (Prod Ops)	A'	1'	4:1 Trapezoidal, 2' Btm, 2'D	0.5	6.40	0.65	1.35
Onsite Ditch 2 (Prod Ops)	C'	3'	4:1 Trapezoidal, 2' Btm, 2'D	1.2	2.61	0.34	1.66
Offsite Ditch 1 (Prod Ops)	OS2'	8'	4:1 Trapezoidal, 2' Btm, 2'D	1.5	5.33	0.46	1.54
Offsite Ditch 2 (Prod Ops)	OS3'	9'	4:1 Trapezoidal, 2' Btm, 2'D	0.5	14.94	0.96	1.04
Conveyance	Tributary Basin(s)	Design Point	Geometric Details	Slope (%)	100-Yr Design Flow (cfs)	Velocity (fps)	HW/D
Culvert-1	A'	1'	24" x 69' CMP	0.5	6.40	4.70	0.76
Culvert-2	OS1'+OS2'	7'	24" x 63' RCP	0.6	10.20	5.69	0.86

The ditch and culvert outlets will be armored with a rip-rap apron to dissipate energy and reduce erosion at the outfall locations. The rip-rap will consist of a Type M rip-rap (D_{50} – 12") minimum. Crestone Peak Resources Operating LLC shall be responsible to fix erosion downstream of swale rip-rap outlets caused by the drainage on the site. For the rip-rap apron locations, refer to the Drainage Plan accompanying this report.

Per Aurora Water criteria, an inlet safety grate is not required on culverts with flows less than 20 cfs and an HW/D ≤ 1.5. Proposed Culverts-1, and -2 meet these criteria, therefore inlet safety grates are not required to be installed on these culverts.

d. Grass Swale

A Grass Swale (GS) will be utilized to treat the stormwater runoff from the south half of the 30-ft wide graveled access road. The tributary area of the GS used to calculate the Q2 (2-year storm runoff) is based on the 500-ft length of graveled road draining to the ditch, and half of the 30-ft graveled roadway width (15-ft). This area and 2-year runoff is equivalent to Offsite Basin OS4' previously discussed in this report, thus the 2-year flow from OS4' was used in the GS design calculations. To provide water quality treatment, the road side ditch is designed as a vegetated V-ditch with 4H:1V side slopes, and a low longitudinal slope of 0.3% to convey the runoff flow in a slow shallow manner to facilitate sedimentation and filtering, while limiting erosion. The low longitudinal slope is also due to site elevation constraints. The grassed swale will outlet into Culvert-2 under the access road approach onto Monaghan Rd. To provide filtration, the swale will be vegetated with the same seeding mixture that will be applied to the disturbed areas of the well site. The grass swale will be privately maintained by Crestone Peak Resources Operating LLC in accordance with their Fieldwide I&M Plan (EDN 220093). Reference the hydrologic calculations for OS4' in Appendix 2 and the hydraulic calculations for the GS in Appendix 3 of this report.

e. Grass Buffer

To treat the stormwater runoff from the north half of the 30-ft wide graveled access road (Offsite Basin OS4' previously discussed in this report), a Grass Buffer will be used along the north side of the access road. A WQCV Runoff Reduction calculation was performed using the UD-BMP spreadsheet to determine the required length of grass buffer to achieve a 100% WQCV Runoff Reduction. The gravel access road

(Unconnected Impervious Area, UIA) and the grass buffer (Receiving Pervious Area, RPA) are modeled as a UIA:RPA Area Type pair, where stormwater flows from the UIA onto the RPA. The UIA Area is the north half of the 30-ft wide graveled access road (15-ft) for the 600-ft length of road draining to the grass buffer. Since the access road has a 2% crown, stormwater will sheet flow across the road for a UIA length of 15-ft, discharging off the north side of the access road into the RPA for the full UIA:RPA Interface Width. The RPA Area was initially modeled as the same area as the UIA, then adjusted at a percentage, assuming the same width but adjusting the length to achieve the desired 100% Runoff Reduction. For the Aspen South access road, the RPA is approximately 84% of the UIA, which calculates to an RPA Length of 12.6-ft and a Width equal to the UIA. The Grass Buffer will run along the north side of the access road to the well pad, and will extend 12.6-ft north of the access road. Reference the Runoff Reduction calculations and hydrologic calculations for OS4' in Appendix-2 and the GB hydraulic calculations in Appendix-3 of this report.

f. Extended Detention Basin

The proposed Extended Detention Basin (EDB) will be located near the northeast corner of the production pad, and will collect onsite stormwater runoff from the sloped graveled pad area and from the slopes of the interim reclaimed well pad. The EDB will be privately maintained by Crestone Peak Resources Operating LLC. The EDB outlet will outfall to the northeast by way of an Outlet Culvert, which will discharge into an outlet ditch that conveys the allowable release into the historic drainage path northeast of the site. The emergency overflow for the EDB will also discharge into the historic drainage path east of the site. The EDB will be constructed with 4H:1V side slopes and a 12-ft wide top for drivable maintenance access.

Basins A', B', C', and D' of the Production Operations Phase are the tributary areas for calculating the WQCV, EURV, 100-yr detention requirement, and the 100-yr flow over the emergency overflow spillway of the EDB. The EDB is sized to capture and treat the onsite stormwater runoff from the gravel surfaced production pad, the bare soil cut and fill slopes of the production pad, the onsite ditches, and the EDB water surface. The EDB shall be only used for drainage and not intentionally for spills and/or containment. The tributary drainage area to the EDB is 9.46 acres. The cut and fill slopes of the pad and ditches were assumed to have an imperviousness of 20%, the graveled area of the pad was assumed to have an imperviousness of 60%, and the EDB water surface was assumed to have an imperviousness of 100%.

Based on a tributary drainage area greater than 5 acres, the EDB is required to detain the 100-yr Detention Volume. The EDB size was calculated using the MHFD – UD-Detention, v4.06 (July 2022) spreadsheet. Reference the EDB calculations included in Appendix-3 of this report.

The following table includes the detention pond design details:

Table 4 – Extended Detention Basin Summary

Tributary Drainage Area:	9.46 Ac.
Percent Imperviousness:	47.3%
WQCV:	0.157 ac-ft
EURV:	0.421 ac-ft
100-Yr Detention Volume, V100 (MHFD):	0.824 ac-ft
Total Provided Detention Volume:	1.335 ac-ft
100-Yr Predevelopment Unit Peak Flow:	1.18 cfs/acre
100-Yr Allowable Release Rate*:	10.10 cfs

100-Yr Emergency Release Rate (over spillway):	23.49 cfs
100-Yr Release Rate (calculated)	10.10 cfs

*90% of 100-Yr Predevelopment Unit Peak Flow

The outlet structure is designed to discharge at the 100-year allowable release rate utilizing a restrictor plate on the outlet pipe. The WQCV will be drained through an orifice plate installed on the outlet structure to drain at a slow rate over 24 hours. The EURV and 100-yr Detention Volume will be drained through the outlet structure orifice plate and restrictor plate, and will drain the volume within 48 hours due to the proposed site being within 5-miles of the Denver International Airport (DIA), (See Reference 5 listed in the References Section).

Since the minimum Micropool depth is 2.5-ft below the EDB bottom, this is often used as the Depth to Invert of Outlet Pipe used in the design of the outlet structure. However, due to elevation constraints of the site, the Depth to Invert of Outlet Pipe is 0.25-ft below the EDB bottom, providing the minimum slope of 0.5% for the Outlet Pipe.

3. Conclusions

The site hydrology and hydraulic conveyances are designed to route and manage the 100-year stormwater runoff around and through the site and discharge into the historic drainage path downstream of the site. As previously discussed in this report, the location of the well pad site is not within a mapped FEMA 100-year floodplain. Onsite stormwater will be stored in an onsite Extended Detention Basin designed in accordance with the City of Aurora Storm Drainage Design and Technical Criteria Manual to include the 100-year Runoff Volume.

No adverse short term or long-term drainage impacts resulting from the construction of the well pad site are anticipated.

If the drainage patterns or imperviousness characteristics substantially deviate from what was considered in this Drainage Report, and the accompanying Drainage Plan, the City of Aurora shall be notified.

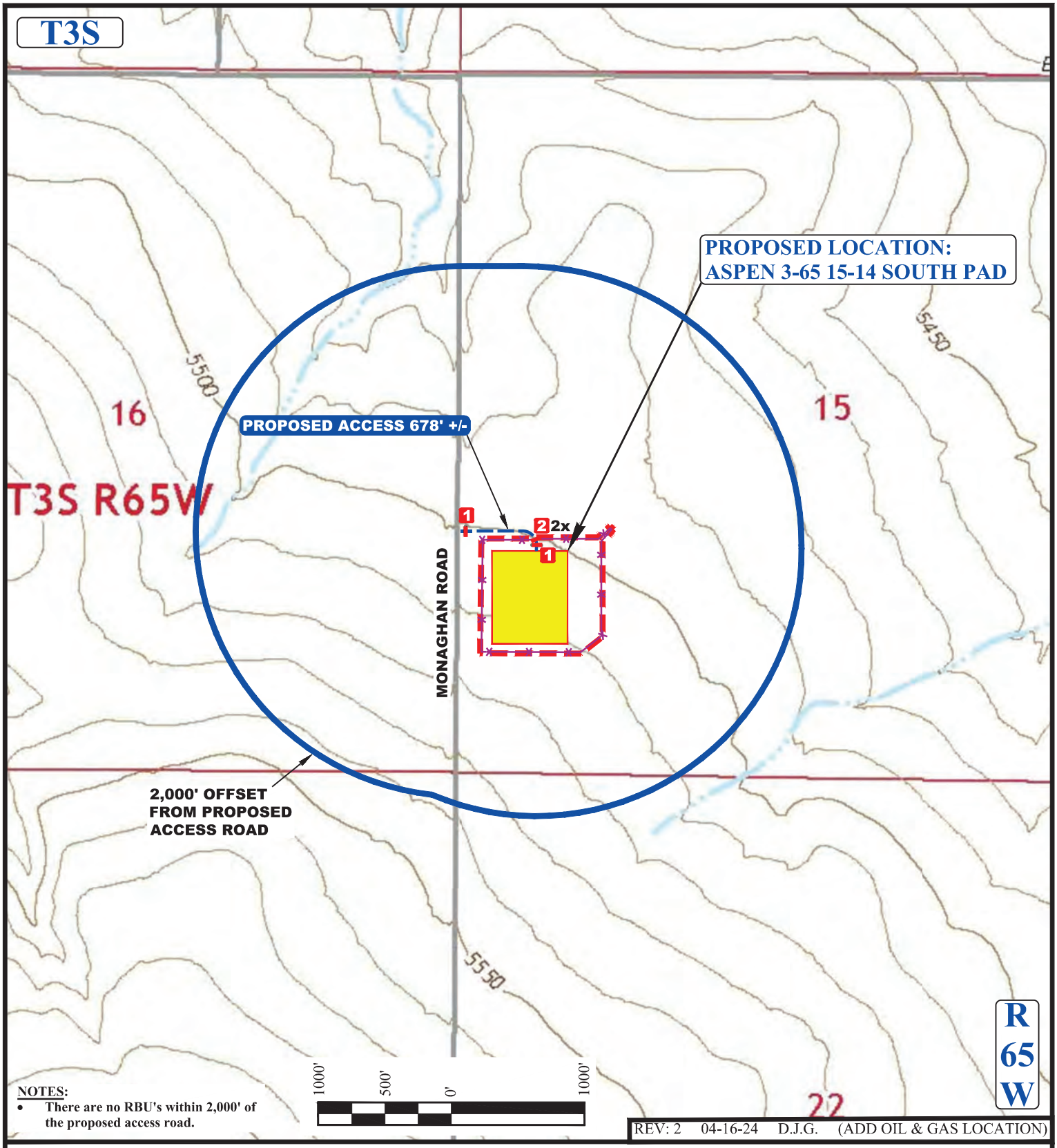
E. LIST OF REFERENCES

This drainage report references the following documents that provide design criteria and calculation methodology for the proposed site development:

1. City of Aurora – Storm Drainage Design and Technical Criteria, dated November 2023.
2. Mile High Flood District (Urban Drainage and Flood Control District) – Urban Drainage Criteria Manual, Vols I-III, most recent edition.
3. Rachael, V., City Engineer, City of Aurora, (December 19, 2019), “Oil and Gas Development Drainage Report and Civil Plans Standards”, memorandum (Reference Appendix-4 of this report).
4. Young, S., P.E., Aurora Water Deputy Director – Planning and Engineering, (September 22, 2022), “New Drainage Criteria, Drainage Review Transition and Other Updates”, email (Reference Appendix-4 of this report).
5. Busch Johansen, H., City Engineer, City of Aurora, (November 16, 2020), “Pond Drain Times for Areas Within or Adjacent to Airports”, memorandum (Reference Appendix-4 of this report).

F. APPENDICES

1. VICINITY MAPS, SOIL, PRECIPITATION, FLOODPLAIN, AND AIRPORT POND BUFFER INFORMATION



NOTES:

- There are no RBU's within 2,000' of the proposed access road.

REV: 2 04-16-24 D.J.G. (ADD OIL & GAS LOCATION)

LEGEND:

- WORKING PAD SURFACE
- EXISTING ROAD
- PROPOSED ACCESS ROAD
- OIL & GAS LOCATION
- PROPOSED FENCE
- 1 INSTALL 24" CULVERT
- 2 INSTALL 12' GATE

UELS, LLC
Corporate Office * 85 South 200 East
Vernal, UT 84078 * (435) 789-1017

CRESTONE PEAK RESOURCES OPERATING LLC

ASPEN 3-65 15-14 SOUTH PAD
W 1/2 SW 1/4, SECTION 15, T3S, R65W, 6th P.M.
ADAMS COUNTY, COLORADO

SURVEYED BY	O.R.	11-23-21	SCALE
DRAWN BY	M.D.	02-08-22	1 : 12,000

ACCESS ROAD MAP

National Flood Hazard Layer FIRMette

FEMA

104°39'45"W 39°47'29"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

104°39'8"W 39°47'1"N

Basemap Imagery Source: USGS National Map 2023

Legend

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

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

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

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

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

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

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

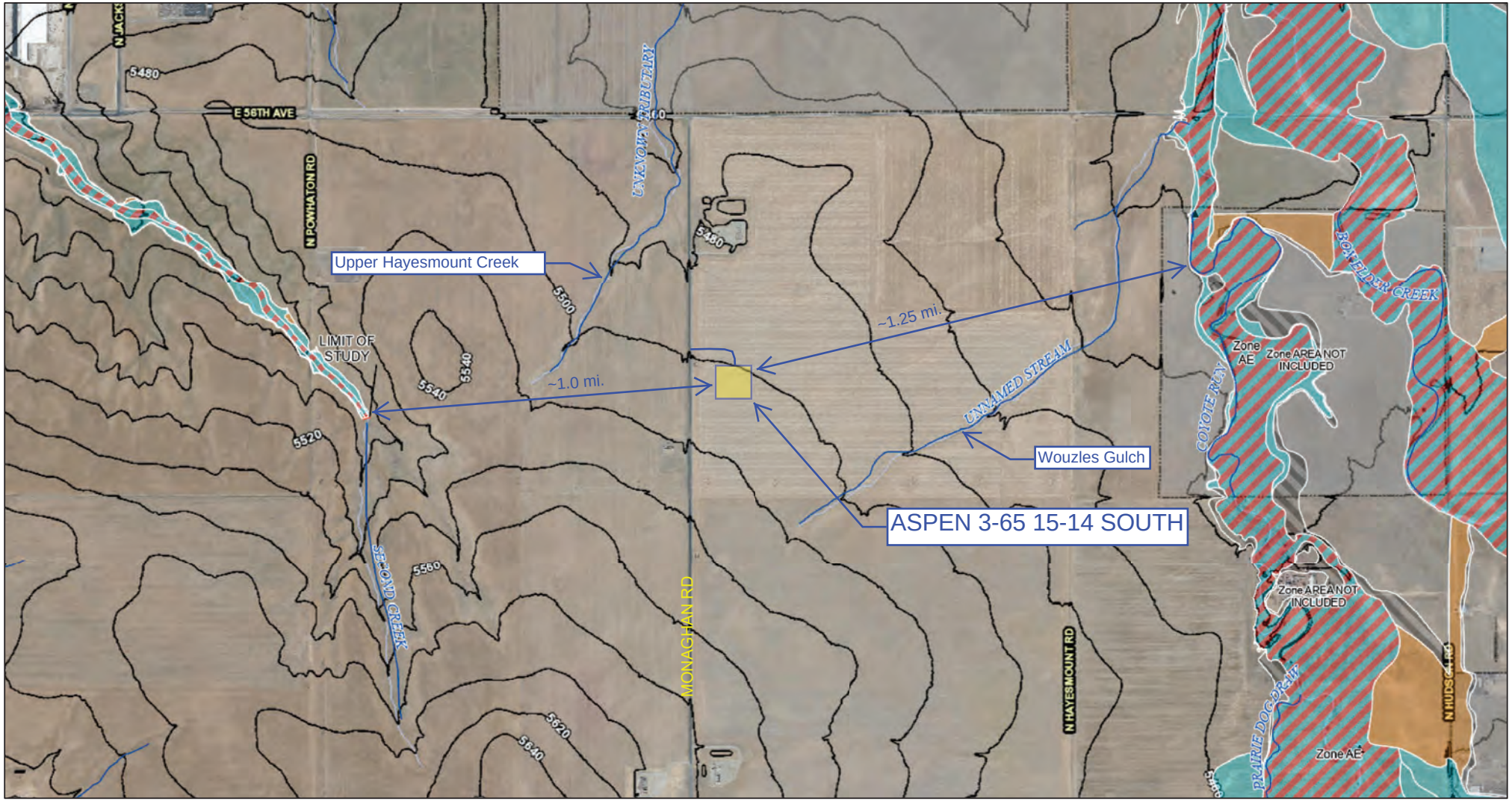
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/13/2024 at 4:05 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

ArcGIS Web Map



6/18/2024, 10:53:48 AM

1:16,000

0 0.2 0.4 0.8 mi

0 0.3 0.6 1.2 km

City of Aurora

- Water Lines
- Station Start Points
- 0.2% Annual Chance Flood Hazard
- Future Conditions 1% Annual Chance Flood Hazard

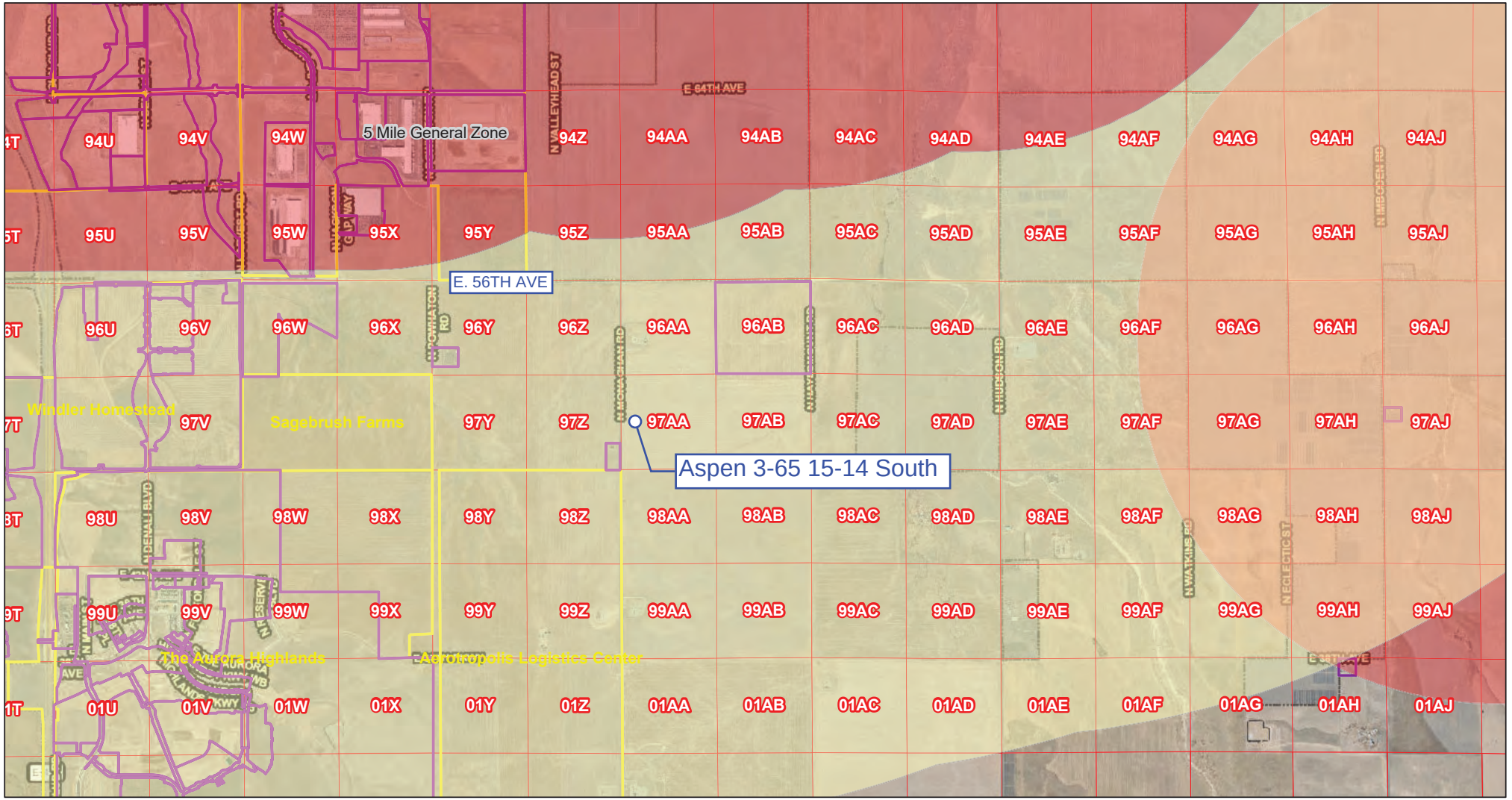
Flood Hazard Zones

- 1% Annual Chance Flood Hazard
- Regulatory Floodway

Flood Hazard Boundaries

- Limit Lines
- SFHA / Flood Zone Boundary

ArcGIS Web Map



6/18/2024, 11:04:21 AM

Airport Detention Pond Buffers

10,000 Foot Critical Zone

5 Mile General Zone

Subdivisions

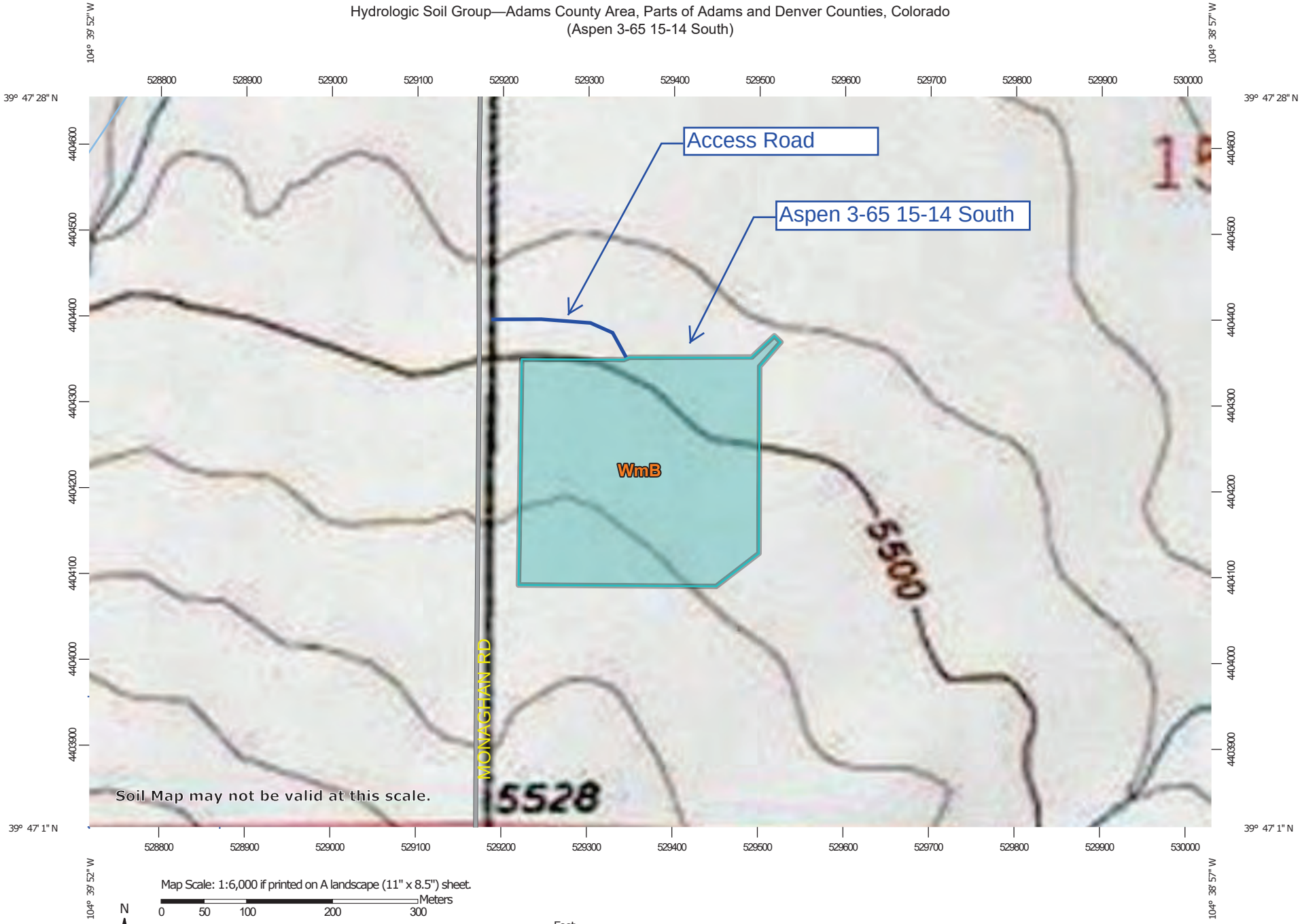
Neighborhoods

Quarter Sections

1:32,000

0 0.4 0.8 1.6 mi

0 0.5 1 2 km



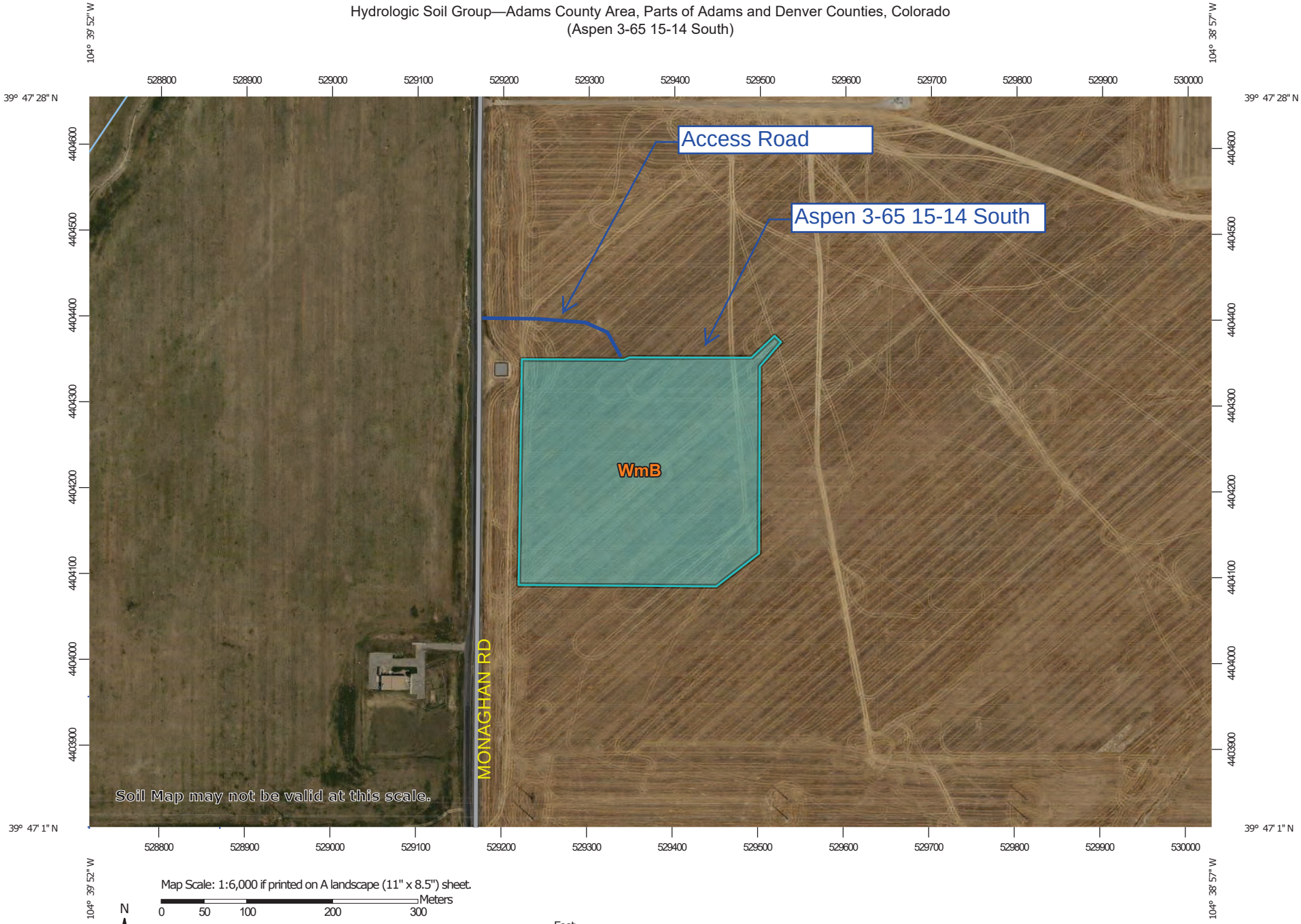
Map Scale: 1:6,000 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84



Map Scale: 1:6,000 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

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 1:20,000.

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: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 20, Aug 24, 2023

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

Date(s) aerial images were photographed: Mar 1, 2023—Sep 1, 2023

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
WmB	Weld loam, 1 to 3 percent slopes	C	18.2	100.0%
Totals for Area of Interest			**18.2**	**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

Map Scale: 1:6,000 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Lines
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Points
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- 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 1:20,000.

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: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 20, Aug 24, 2023

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

Date(s) aerial images were photographed: Mar 1, 2023—Sep 1, 2023

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.

K Factor, Whole Soil

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
WmB	Weld loam, 1 to 3 percent slopes	.43	18.2	100.0%
Totals for Area of Interest			**18.2**	**100.0%**

Description

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Factor K does not apply to organic horizons and is not reported for those layers.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

NOAA Atlas 14, Volume 8, Version 2
Location name: Watkins, Colorado, USA*
Latitude: 39.7876°, Longitude: -104.6574°
Elevation: m/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_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	2.75 (2.21-3.44)	3.40 (2.71-4.26)	4.56 (3.64-5.72)	5.63 (4.46-7.10)	7.25 (5.62-9.64)	8.63 (6.50-11.6)	10.1 (7.34-13.8)	11.7 (8.16-16.5)	14.0 (9.37-20.2)	15.9 (10.3-23.0)
10-min	2.02 (1.61-2.53)	2.48 (1.99-3.11)	3.34 (2.66-4.19)	4.12 (3.26-5.20)	5.31 (4.12-7.06)	6.32 (4.76-8.47)	7.41 (5.38-10.1)	8.59 (5.98-12.1)	10.3 (6.86-14.8)	11.7 (7.54-16.8)
15-min	1.64 (1.31-2.05)	2.02 (1.62-2.53)	2.71 (2.16-3.41)	3.35 (2.66-4.23)	4.32 (3.34-5.74)	5.14 (3.87-6.88)	6.02 (4.37-8.24)	6.98 (4.86-9.80)	8.36 (5.58-12.0)	9.48 (6.12-13.7)
30-min	1.12 (0.900-1.41)	1.38 (1.10-1.73)	1.84 (1.47-2.32)	2.27 (1.80-2.87)	2.92 (2.27-3.89)	3.48 (2.62-4.66)	4.08 (2.96-5.58)	4.73 (3.29-6.64)	5.66 (3.78-8.14)	6.42 (4.15-9.27)
60-min	0.694 (0.556-0.870)	0.849 (0.680-1.07)	1.13 (0.904-1.42)	1.40 (1.11-1.76)	1.80 (1.40-2.40)	2.14 (1.62-2.87)	2.52 (1.83-3.45)	2.92 (2.03-4.10)	3.51 (2.34-5.04)	3.98 (2.57-5.75)
2-hr	0.414 (0.334-0.514)	0.505 (0.407-0.628)	0.672 (0.540-0.838)	0.828 (0.661-1.04)	1.07 (0.835-1.41)	1.27 (0.967-1.69)	1.50 (1.10-2.03)	1.74 (1.22-2.42)	2.09 (1.41-2.98)	2.38 (1.55-3.40)
3-hr	0.301 (0.244-0.372)	0.366 (0.296-0.453)	0.485 (0.391-0.602)	0.597 (0.478-0.744)	0.769 (0.604-1.01)	0.916 (0.699-1.21)	1.08 (0.792-1.46)	1.25 (0.883-1.73)	1.50 (1.02-2.13)	1.71 (1.12-2.43)
6-hr	0.180 (0.147-0.221)	0.217 (0.177-0.266)	0.284 (0.230-0.350)	0.346 (0.280-0.428)	0.442 (0.350-0.576)	0.524 (0.403-0.687)	0.613 (0.455-0.821)	0.710 (0.505-0.974)	0.850 (0.580-1.19)	0.964 (0.637-1.36)
12-hr	0.110 (0.090-0.134)	0.131 (0.107-0.160)	0.169 (0.138-0.206)	0.203 (0.165-0.249)	0.255 (0.203-0.328)	0.299 (0.231-0.388)	0.347 (0.259-0.459)	0.398 (0.285-0.539)	0.471 (0.324-0.653)	0.530 (0.353-0.740)
24-hr	0.067 (0.055-0.080)	0.079 (0.065-0.096)	0.101 (0.083-0.123)	0.121 (0.099-0.147)	0.149 (0.119-0.189)	0.173 (0.134-0.221)	0.197 (0.148-0.258)	0.224 (0.161-0.299)	0.260 (0.180-0.356)	0.289 (0.195-0.400)
2-day	0.038 (0.032-0.046)	0.046 (0.038-0.055)	0.059 (0.049-0.071)	0.070 (0.057-0.084)	0.085 (0.068-0.106)	0.097 (0.076-0.123)	0.110 (0.083-0.142)	0.123 (0.089-0.162)	0.141 (0.098-0.190)	0.154 (0.105-0.211)
3-day	0.028 (0.023-0.033)	0.033 (0.028-0.040)	0.042 (0.035-0.050)	0.049 (0.041-0.059)	0.060 (0.048-0.074)	0.068 (0.053-0.085)	0.077 (0.058-0.098)	0.085 (0.062-0.112)	0.097 (0.068-0.131)	0.107 (0.073-0.145)
4-day	0.022 (0.019-0.026)	0.026 (0.022-0.031)	0.033 (0.027-0.039)	0.038 (0.032-0.046)	0.046 (0.037-0.057)	0.053 (0.041-0.066)	0.059 (0.045-0.076)	0.066 (0.048-0.086)	0.075 (0.053-0.101)	0.082 (0.056-0.112)
7-day	0.014 (0.012-0.017)	0.017 (0.014-0.020)	0.021 (0.017-0.025)	0.024 (0.020-0.029)	0.029 (0.023-0.035)	0.033 (0.026-0.041)	0.037 (0.028-0.046)	0.041 (0.030-0.053)	0.046 (0.033-0.061)	0.050 (0.035-0.068)
10-day	0.011 (0.009-0.013)	0.013 (0.011-0.015)	0.016 (0.013-0.019)	0.018 (0.015-0.022)	0.022 (0.018-0.027)	0.025 (0.019-0.030)	0.027 (0.021-0.035)	0.030 (0.022-0.039)	0.034 (0.024-0.045)	0.037 (0.026-0.050)
20-day	0.007 (0.006-0.008)	0.008 (0.007-0.009)	0.010 (0.008-0.011)	0.011 (0.009-0.013)	0.013 (0.011-0.016)	0.015 (0.012-0.018)	0.016 (0.012-0.020)	0.018 (0.013-0.023)	0.020 (0.014-0.026)	0.021 (0.015-0.028)
30-day	0.005 (0.004-0.006)	0.006 (0.005-0.007)	0.007 (0.006-0.009)	0.008 (0.007-0.010)	0.010 (0.008-0.012)	0.011 (0.009-0.013)	0.012 (0.009-0.015)	0.013 (0.010-0.017)	0.015 (0.010-0.019)	0.016 (0.011-0.021)
45-day	0.004 (0.003-0.005)	0.005 (0.004-0.006)	0.006 (0.005-0.007)	0.007 (0.006-0.008)	0.008 (0.006-0.009)	0.009 (0.007-0.010)	0.009 (0.007-0.012)	0.010 (0.007-0.013)	0.011 (0.008-0.014)	0.012 (0.008-0.016)
60-day	0.003 (0.003-0.004)	0.004 (0.003-0.005)	0.005 (0.004-0.006)	0.006 (0.005-0.006)	0.006 (0.005-0.008)	0.007 (0.006-0.009)	0.008 (0.006-0.010)	0.008 (0.006-0.011)	0.009 (0.007-0.012)	0.010 (0.007-0.013)

[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.

2. HYDROLOGIC COMPUTATIONS

PEAK RUNOFF PREDICTION BY THE RATIONAL METHOD

Version 2.00 released May 2017
Urban Drainage and Flood Control District
Denver, Colorado

Purpose:

This workbook applies the Rational Method to estimate stormwater runoff and peak flows from small urban catchments (typically less than 90 acres)

Function:

1. **To calculate the runoff coefficient, C for a catchment**
2. **To calculate the time of concentration, and then compare with the regional time of concentration limit used for the Denver region. The smaller one is recommended as the rainfall duration for use with the Rational Method.**
3. **To calculate the design rainfall intensity and resulting peak flow rate.**

Content: **The workbook consists of the following five sheets:**

Intro	Describes the purpose of each sheet in the workbook.
Rational Calcs	Performs Rational Method calculations, Q = CIA
Weighted C	Supporting tool to calculate area-weighted runoff coefficients from sub-areas.
Weighted Slope	Supporting tool to calculate length-weighted slope from multiple flow reaches.
Weighted Tc	Supporting tool to calculate reach-weighted time of concentration from multiple flow reaches.
Design Info	Provides background information from the USDCM

Acknowledgements:

Spreadsheet Development Team:
Derek N. Rapp, P.E.
Peak Stormwater Engineering, LLC
Holly Piza, P.E. and Ken MacKenzie, P.E.
Urban Drainage and Flood Control District

Comments? Direct all comments regarding this spreadsheet workbook to: UDFCD email
Revisions? Check for revised versions of this or any other workbook at: Downloads

PRODUCTION PAD CALCULATIONS

WEIGHTED IMPERVIOUS SURFACE CALCULATIONS

ASPEN 3-65 15-14 SOUTH
PRODUCTION OPERATIONS

COA STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA MANUAL, v.NOVEMBER 2023; TABLE 5-6. IMPERVIOUSNESS VALUES FOR URBAN SURFACES FOR SITE AND SMALL WATERSHED ANALYSIS

	SURFACE TYPE											
	Paved Streets	Concrete Drive and Walks	Roofs	Gravel No Traffic Areas (Pedestrian Use)	Gravel Low Traffic Areas (Maintenance Paths and Substations)	Gravel High Traffic Areas (Roadways and Parking)	Landscaping (including water-wise vegetation, active turf, uncompacted gravel, planting beds, residential artificial turf, etc.)	Open Water Areas, including footprint of WQCV	Historic Flow Analysis, Undisturbed Native Grasses, Agricultural	Newly Graded Areas		
Imperviousness	95%	95%	95%	40%	60%	80%	20%	100%	5%	65%		
Basin	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Total Area (Ac)**	**Percent Imperv.**
A'					1.31		1.09				2.40	41.8%
B'					3.28		1.77				5.05	46.0%
C'							1.08				1.08	20.0%
D'								0.93			0.93	100.0%
OS1'	0.61					0.17			2.28		3.06	27.0%
OS2'									2.94		2.94	5.0%
OS3'							0.26		12.56		12.82	5.3%
OS4'						0.20					0.20	80.0%
											0.00	0.0%
OS1' + OS2'	0.61					0.17			5.22		6.00	16.2%
											0.00	0.0%
EDB EURV & 100-Yr											0.00	0.0%
Tributary Area											0.00	0.0%
A'+B'+C'+D'					4.59		3.94	0.93			9.46	47.3%
											0.00	0.0%

Calculation of Peak Runoff using Rational Method

Designer: UELS - cdc
Company: Crestone Peak Resources Operating LLC
Date: 6/19/2024
Project: Aspen 3-65 15-14 South
Location: Production Operations

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = [illegible]$

$t_{minimum}$ = 5 (urban)
$t_{minimum}$ = 10 (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

1-hour rainfall depth, P1 (in) =	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
	0.849	1.13	1.40	1.80	2.14	2.52	3.51

Rainfall Intensity Equation Coefficients =	a	b	c
	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A'	2.40	C	41.8	0.31	0.38	0.44	0.55	0.60	0.65	0.72	300.00	5509.70	5504.80	0.016	19.27	630.00	5504.80	5496.70	0.013	10	1.13	9.26	28.53	25.13	25.13	1.48	1.96	2.43	3.13	3.72	4.38	6.10	1.11	1.77	2.56	4.15	5.35	6.88	10.53
																									28.53	1.37	1.83	2.26	2.91	3.46	4.07	5.67	1.03	1.65	2.38	3.86	4.98	6.40	9.80
B'	5.05	C	46.0	0.35	0.41	0.47	0.58	0.62	0.67	0.73	300.00	5509.70	5504.90	0.016	18.48	425.00	5504.90	5500.00	0.012	10	1.07	6.60	25.08	22.45	22.45	1.57	2.09	2.59	3.33	3.96	4.66	6.49	2.77	4.33	6.15	9.69	12.40	15.82	24.02
																									25.08	1.48	1.97	2.44	3.13	3.72	4.38	6.11	2.60	4.07	5.78	9.12	11.66	14.88	22.60
C'	1.08	C	20.0	0.14	0.20	0.28	0.43	0.49	0.57	0.65	180.00	5507.80	5506.10	0.009	22.27	342.00	5506.10	5499.00	0.021	10	1.44	3.96	26.22	25.95	25.95	1.45	1.93	2.39	3.07	3.65	4.30	5.99	0.21	0.41	0.72	1.43	1.94	2.63	4.21
																									26.22	1.44	1.92	2.37	3.05	3.63	4.27	5.95	0.21	0.41	0.72	1.42	1.93	2.61	4.19
D'	0.93	C	100.0	0.83	0.85	0.87	0.88	0.89	0.89	0.90	34.00	5500.00	5496.40	0.106	1.21	253.00	5496.40	5494.90	0.006	10	0.77	5.48	6.68	10.38	6.68	2.65	3.53	4.37	5.62	6.68	7.86	10.95	2.05	2.79	3.52	4.59	5.51	6.53	9.20
																									6.68	2.65	3.53	4.37	5.62	6.68	7.86	10.95	2.05	2.79	3.52	4.59	5.51	6.53	9.20
OS1'	3.06	C	27.0	0.19	0.26	0.33	0.47	0.53	0.59	0.67	500.00	5530.00	5520.00	0.020	27.14	1215.00	5520.00	5497.10	0.019	10	1.37	14.75	41.89	32.95	32.95	1.26	1.68	2.08	2.67	3.17	3.74	5.21	0.74	1.31	2.10	3.84	5.11	6.80	10.73
																									41.89	1.09	1.45	1.79	2.30	2.74	3.22	4.49	0.64	1.13	1.81	3.31	4.41	5.86	9.24
OS2'	2.94	C	5.0	0.03	0.08	0.17	0.35	0.42	0.50	0.60	330.00	5518.30	5509.80	0.026	24.58	720.00	5509.80	5500.60	0.013	10	1.13	10.62	35.20	28.49	28.49	1.21	1.61	2.00	2.57	3.05	3.59	5.00	0.10	0.36	0.99	2.62	3.75	5.33	8.88
																									35.20	1.21	1.61	2.00	2.57	3.05	3.59	5.00	0.10	0.36	0.99	2.62	3.75	5.33	8.88
OS3'	12.82	C	5.3	0.03	0.08	0.17	0.35	0.42	0.51	0.60	500.00	5530.00	5521.00	0.018	33.98	1357.00	5521.00	5499.00	0.016	5	0.64	35.53	69.50	43.33	43.33	1.06	1.41	1.75	2.25	2.68	3.15	4.39	0.42	1.42	3.84	10.07	14.39	20.45	34.05
																									69.50	0.78	1.03	1.28	1.65	1.96	2.30	3.21	0.31	1.04	2.81	7.36	10.52	14.94	24.88
OS4'	0.20	C	80.0	0.65	0.69	0.72	0.77	0.79	0.81	0.84	14.00			0.020	2.22	1.00			0.020	10	1.41	0.01	2.23	12.41	5.00	2.88	3.83	4.75	6.11	7.26	8.55	11.91	0.37	0.53	0.68	0.94	1.14	1.39	2.00
																									2.23	3.38	4.50	5.57	7.17	8.52	10.03	13.98	0.44	0.62	0.80	1.10	1.34	1.63	2.35
OS1'+OS2'	6.00	C	16.2	0.11	0.17	0.25	0.41	0.47	0.55	0.64	500.00	5530.00	5520.00	0.020	29.96	1215.00	5520.00	5497.10	0.019	10	1.37	14.75	44.71	36.34	36.34	1.19	1.58	1.96	2.52	2.99	3.52	4.91	0.77	1.58	2.95	6.19	8.49	11.63	18.81
																									44.71	1.04	1.39	1.72	2.21	2.62	3.09	4.31	0.68	1.39	2.59	5.43	7.45	10.20	16.51
A'+B'+C'+D'	9.46	C	47.3	0.36	0.42	0.48	0.58	0.63	0.68	0.74	300.00	5509.70	5504.80	0.016	18.07	917.00	5504.80	5496.40	0.009	10	0.96	15.97	34.04	28.18	28.18	1.38	1.84	2.28	2.93	3.48	4.10	5.71	4.71	7.32	10.34	16.18	20.65	26.28	39.83
																									34.04	1.24	1.64	2.04	2.62	3.11	3.67	5.11	4.21	6.54	9.24	14.46	18.45	23.49	35.60

EDB (Emergency Overlow) = A'+B'+C'+D'
Used to calculate the 100-Yr Flow over the emergency spillway.

Basin OS4' used in Grass Buffer and Grass Swale calculations.

City of Aurora - November 2023 Storm Drainage Design and Technical Criteria, Table 5-6 Values for Percent Impervious were used in these calculations.

The project is in the non-urbanizing area of Adams County and the City of Aurora. The Urbanizing Basin check does not apply in this case, and the Computed Tc value is used in the purple User Override box.

Highlighted values indicate result used in follow-on calculations.

3. HYDRAULIC COMPUTATIONS

UDFCD OPEN CHANNEL DESIGN WORKBOOK

Version 1.05 Released October 2013
Urban Drainage and Flood Control District
Denver, Colorado

HYDRAULIC CALCULATIONS
PRODUCTION PHASE DIVERSION DITCHES

Content: **The workbook consists of the following 13 sheets:**

Basics	Applies Manning's formula to analyze the normal flow condition, and applies Froude Number *Fr* = 1.0 to determine the critical flow condition.
Rating	Produces a rating curve for a trapezoidal channel.
SP-Es	Produces a specific energy curve for a given flow in a trapezoidal channel.
SP-Fs	Produces a specific force curve for a given flow in a trapezoidal channel.
D-Step	Applies the Direct Step Method to develop M1, M2, & S2 analyses
S-Step	Applies the Standard Step Method to develop M1, M2, & S2 analyses
Channel Design	Aids in designing a grass channel with drop structures.
SCS Retardance	Employs the SCS vegetal retardance curves for types C and D grass-lined channels.
Riprap	Aids in the design of a riprap-lined channel.
Composite Design	Aids in designing a composite (two-stage) channel section.
Composite Analysis	Aids in analyzing an existing composite (two-stage) channel section.
Steep Channel	Aids in the design of concrete lined supercritical-flow channels.
Design Info	Provides recommended Manning's n value guidance for low-flow section and overbanks in composite channels.

Acknowledgements: ***Spreadsheet Development Team:***
Dr. James C.Y. Guo, P.E.
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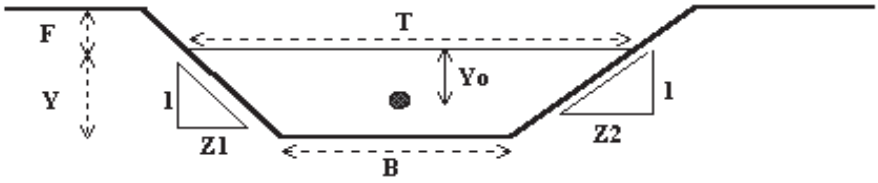
University of Colorado at Denver
Ken A. MacKenzie, P.E., and Katie Farnum
Urban Drainage and Flood Control District
Wright Water Engineers, Inc.
Denver, Colorado

Comments? Direct all comments regarding this spreadsheet workbook to: UDFCD E-Mail
Revisions? Check for revised versions of this or any other workbook at: Downloads

Normal Flow Analysis - Trapezoidal Channel

Project:	**ASPEN 3-65 15-14 SOUTH**
Channel ID:	**Onsite Ditch 1 (Prod Phase) - Q100 = 6.40 cfs (Basin A' Flow, DP 1')**

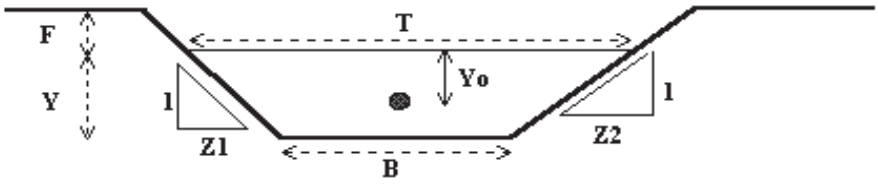


Design Information (Input)			
Channel Invert Slope	So =	0.005	ft/ft
Manning's n	n =	0.027	
Bottom Width	B =	2	ft
Left Side Slope	Z1 =	4	ft/ft
Right Side Slope	Z2 =	4	ft/ft
Freeboard Height	F =	1.35	ft
Design Water Depth	Y =	**0.65**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**6.40**	cfs
Froude Number	**Fr =**	**0.59**	
Flow Velocity	**V =**	**2.14**	fps
Flow Area	A =	2.99	sq ft
Top Width	T =	7.20	ft
Wetted Perimeter	P =	7.36	ft
Hydraulic Radius	R =	0.41	ft
Hydraulic Depth	D =	0.42	ft
Specific Energy	Es =	0.72	ft
Centroid of Flow Area	Yo =	0.26	ft
Specific Force	Fs =	0.08	kip

Normal Flow Analysis - Trapezoidal Channel

Project:	**ASPEN 3-65 15-14 SOUTH**
Channel ID:	**Onsite Ditch 2 (Prod Phase) - Q100 = 2.61 cfs (Basin C' Flow, DP 3')**

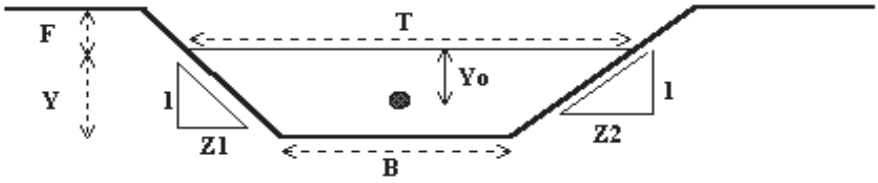


Design Information (Input)			
Channel Invert Slope	So =	0.012	ft/ft
Manning's n	n =	0.027	
Bottom Width	B =	2	ft
Left Side Slope	Z1 =	4	ft/ft
Right Side Slope	Z2 =	4	ft/ft
Freeboard Height	F =	1.66	ft
Design Water Depth	Y =	**0.34**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**2.61**	cfs
Froude Number	**Fr =**	**0.83**	
Flow Velocity	**V =**	**2.31**	fps
Flow Area	A =	1.13	sq ft
Top Width	T =	4.70	ft
Wetted Perimeter	P =	4.78	ft
Hydraulic Radius	R =	0.24	ft
Hydraulic Depth	D =	0.24	ft
Specific Energy	Es =	0.42	ft
Centroid of Flow Area	Yo =	0.15	ft
Specific Force	Fs =	0.02	kip

Normal Flow Analysis - Trapezoidal Channel

Project:	**ASPEN 3-65 15-14 SOUTH**
Channel ID:	**Offsite Ditch 1 (Prod Phase) - Q100 = 5.33 cfs (Basin OS2' Flow, DP 8')**

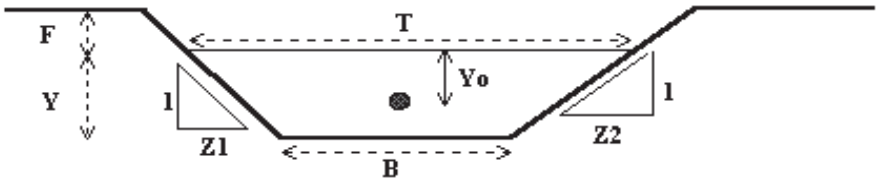


Design Information (Input)			
Channel Invert Slope	So =	0.015	ft/ft
Manning's n	n =	0.027	
Bottom Width	B =	2	ft
Left Side Slope	Z1 =	4	ft/ft
Right Side Slope	Z2 =	4	ft/ft
Freeboard Height	F =	1.54	ft
Design Water Depth	Y =	**0.46**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**5.33**	cfs
Froude Number	**Fr =**	**0.97**	
Flow Velocity	**V =**	**3.05**	fps
Flow Area	A =	1.75	sq ft
Top Width	T =	5.65	ft
Wetted Perimeter	P =	5.77	ft
Hydraulic Radius	R =	0.30	ft
Hydraulic Depth	D =	0.31	ft
Specific Energy	Es =	0.60	ft
Centroid of Flow Area	Yo =	0.19	ft
Specific Force	Fs =	0.05	kip

Normal Flow Analysis - Trapezoidal Channel

Project:	**ASPEN 3-65 15-14 SOUTH**
Channel ID:	**Offsite Ditch 2 (Prod Phase) - Q100 = 14.94 cfs (Basin OS3' Flow, DP 9')**



Design Information (Input)			
Channel Invert Slope	So =	0.005	ft/ft
Manning's n	n =	0.027	
Bottom Width	B =	2	ft
Left Side Slope	Z1 =	4	ft/ft
Right Side Slope	Z2 =	4	ft/ft
Freeboard Height	F =	1.04	ft
Design Water Depth	Y =	**0.96**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**14.94**	cfs
Froude Number	**Fr =**	**0.62**	
Flow Velocity	**V =**	**2.67**	fps
Flow Area	A =	5.60	sq ft
Top Width	T =	9.68	ft
Wetted Perimeter	P =	9.91	ft
Hydraulic Radius	R =	0.57	ft
Hydraulic Depth	D =	0.58	ft
Specific Energy	Es =	1.07	ft
Centroid of Flow Area	Yo =	0.37	ft
Specific Force	Fs =	0.21	kip

PRODUCTION OPERATIONS
CULVERT CALCS

HY-8 Culvert Analysis Report

Project Data

Project Title: ASPEN 3-65 15-14 SOUTH

Designer: UELS-cdc

Project Date: Friday, June 14, 2024

Project Notes: PRODUCTION OPERATIONS

Project Units: U.S. Customary Units

Outlet Control Option: Profiles

Exit Loss Option: Standard Method

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)	HW/D
Q100	6.40 cfs	6.40 cfs	5498.21	1.37	1.524	2-M2c	1.28	0.90	0.90	0.65	4.70	2.14	0.76
EMERGENCY Q100	12.80 cfs	12.80 cfs	5499.15	2.20	2.464	7-M2c	2.00	1.29	1.29	0.90	5.99	2.56	1.23

Flow Control	Length Full	Flow Type		Flow Profiles	Outlet		Outlet Depth
		HW>D	HW<D		TW>D	TW<D	
Inlet	none	5	1	S2		n	Normal
Inlet	none	5	1	S1		t	Tailwater (TW)
Inlet	none	5	1	JS1		t	Jump, S1, TW
Inlet	none	5	1	M3, S3, H3, A3		t	Tailwater
Inlet	none	5	1	H3J, A3J		t	H3, Jump, TW
Inlet	part	5	1	S1	f		Full
Inlet	part	5	1	S1	f		Full
Inlet	part	5	1	JS1	f		Jump, S1, Full
Inlet	part	5	1	H3J, A3J	f		H3, Jump, Full
Outlet	none		2	M2, H2, A2		c	Critical
Outlet	none		3	M2, H2, A2		t	Tailwater
Outlet	none		3	M1		t	Tailwater
Outlet	part		3	M1	f		Full
Outlet	all	4		FF	f		Full
Outlet	most	6		FF		t	Tailwater
Outlet	most	6		FF		c	Critical
Outlet	part	7		M1		t	Tailwater
Outlet	part	7		M2, H2, A2		t	Tailwater
Outlet	part	7		M2, H2, A2		c	Critical

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

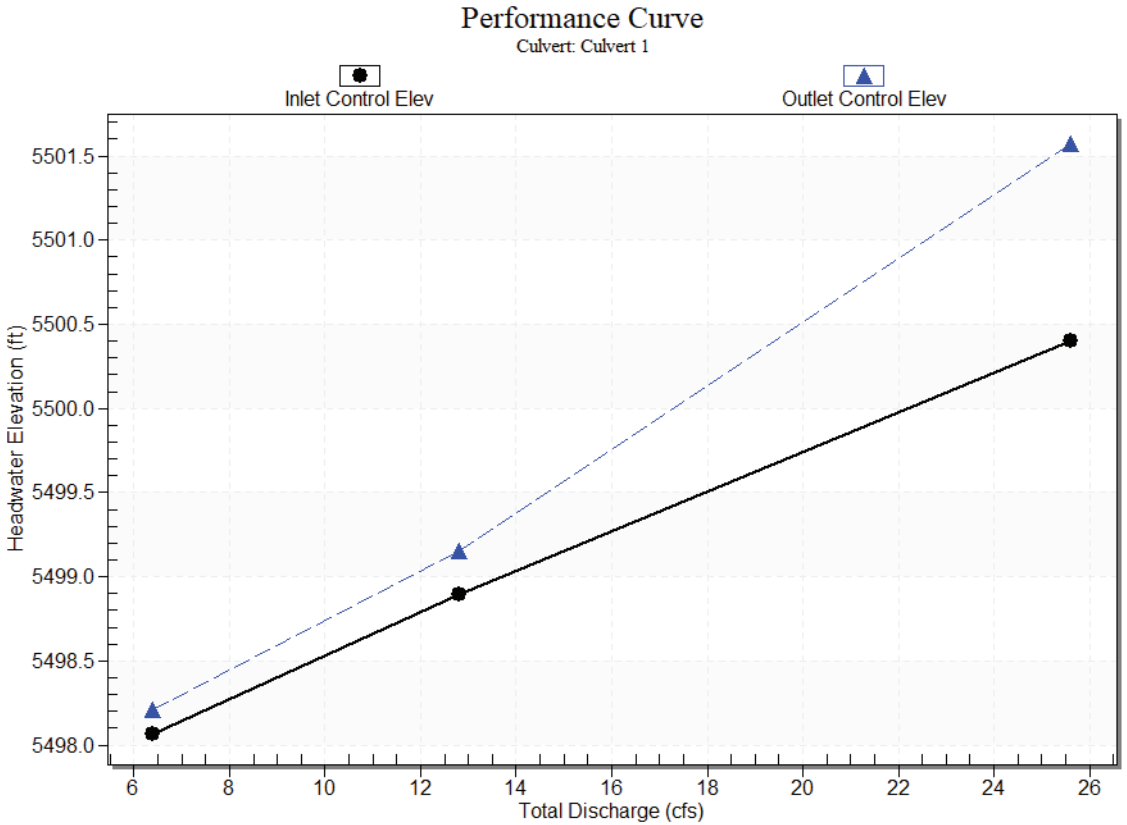
Inlet Elevation (invert): 5496.69 ft,

Outlet Elevation (invert): 5496.35 ft

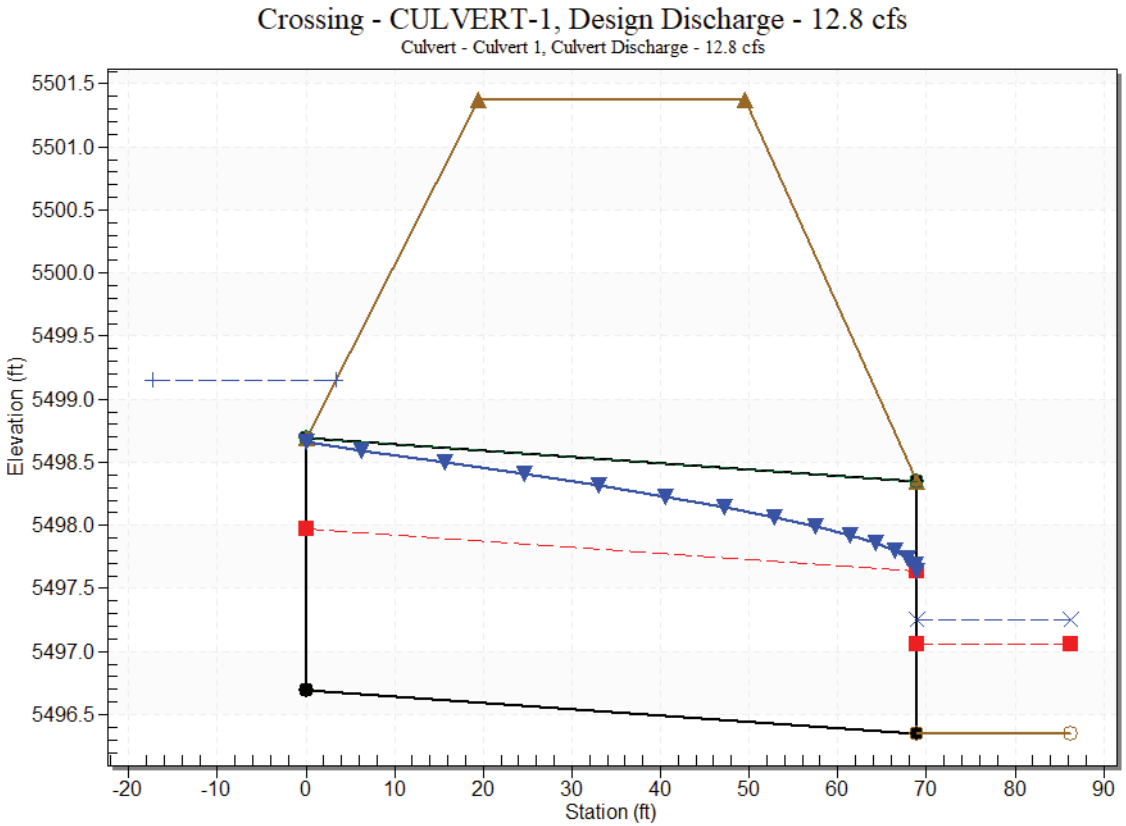
Culvert Length: 69.00 ft,

Culvert Slope: 0.0049

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5496.69 ft

Outlet Station: 69.00 ft

Outlet Elevation: 5496.35 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240 (Table 3, COA SDDTC, v2010)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Tailwater Data for Crossing: CULVERT-1

Table 1 - Downstream Channel Rating Curve (Crossing: CULVERT-1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.40	5497.00	0.65	2.14	0.20	0.58
12.80	5497.25	0.90	2.56	0.28	0.61

Tailwater Channel Data - CULVERT-1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0270 (Table 2, COA SDDTC, v2010)

Channel Invert Elevation: 5496.35 ft

Roadway Data for Crossing: CULVERT-1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 18.00 ft

Crest Elevation: 5501.37 ft

Roadway Surface: Gravel

Roadway Top Width: 30.00 ft

HY-8 Culvert Analysis Report

Project Data

Project Title: ASPEN 3-65 15-14 SOUTH

Designer: UELS-cdc

Project Date: Friday, June 14, 2024

Project Notes: PRODUCTION OPERATIONS

Project Units: U.S. Customary Units

Outlet Control Option: Profiles

Exit Loss Option: Standard Method

Culvert Data: Culvert 2

Table 1 - Culvert Summary Table: Culvert 2

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)	HW/D
Q100	10.20 cfs	10.20 cfs	5498.86	1.72	1.156	1-S2n	1.11	1.14	1.11	0.77	5.69	2.58	0.86
EMERGENCY Q100	20.40 cfs	20.40 cfs	5500.14	3.00	2.923	7-M2c	2.00	1.62	1.62	1.06	7.48	3.09	1.50

Flow Control	Length Full	Flow Type		Flow Profiles	Outlet		Outlet Depth
		HW>D	HW<D		TW>D	TW<D	
Inlet	none	5	1	S2		n	Normal
Inlet	none	5	1	S1		t	Tailwater (TW)
Inlet	none	5	1	JS1		t	Jump, S1, TW
Inlet	none	5	1	M3, S3, H3, A3		t	Tailwater
Inlet	none	5	1	H3J, A3J		t	H3, Jump, TW
Inlet	part	5	1	S1	f		Full
Inlet	part	5	1	S1	f		Full
Inlet	part	5	1	JS1	f		Jump, S1, Full
Inlet	part	5	1	H3J, A3J	f		H3, Jump, Full
Outlet	none		2	M2, H2, A2		c	Critical
Outlet	none		3	M2, H2, A2		t	Tailwater
Outlet	none		3	M1		t	Tailwater
Outlet	part		3	M1	f		Full
Outlet	all	4		FF	f		Full
Outlet	most	6		FF		t	Tailwater
Outlet	most	6		FF		c	Critical
Outlet	part	7		M1		t	Tailwater
Outlet	part	7		M2, H2, A2		t	Tailwater
Outlet	part	7		M2, H2, A2		c	Critical

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

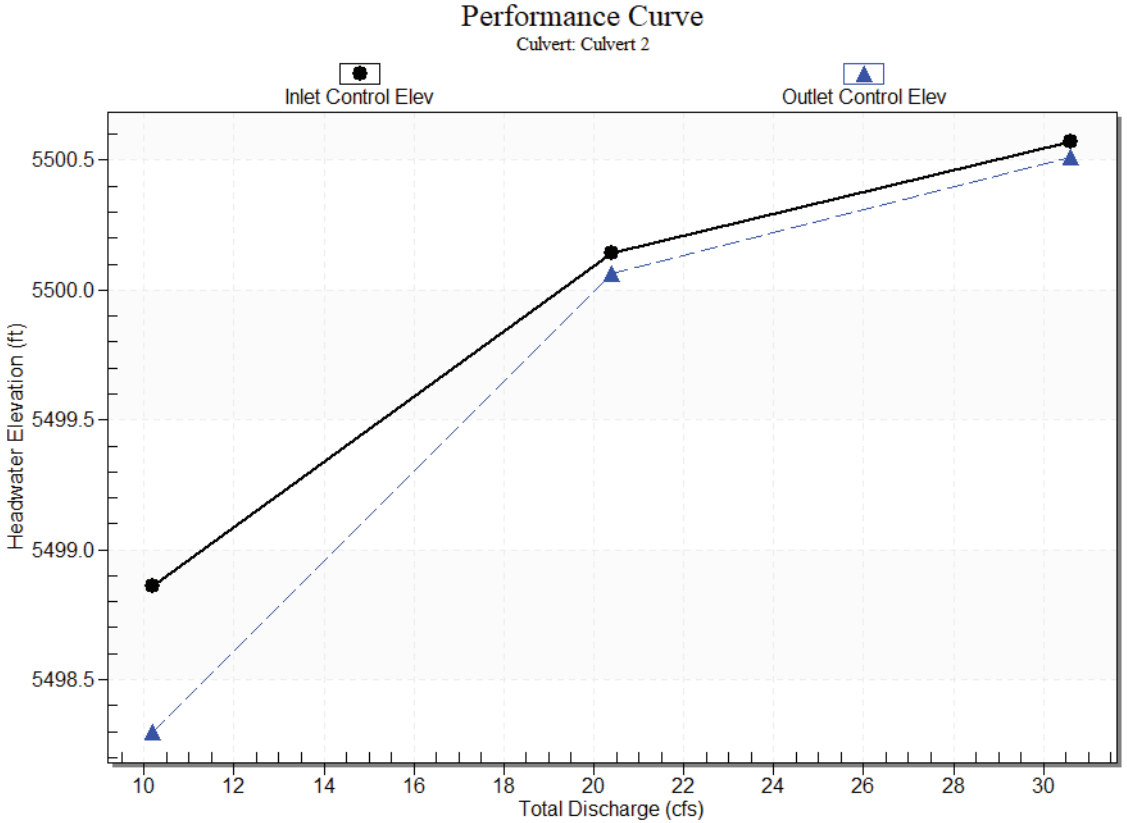
Inlet Elevation (invert): 5497.14 ft,

Outlet Elevation (invert): 5496.78 ft

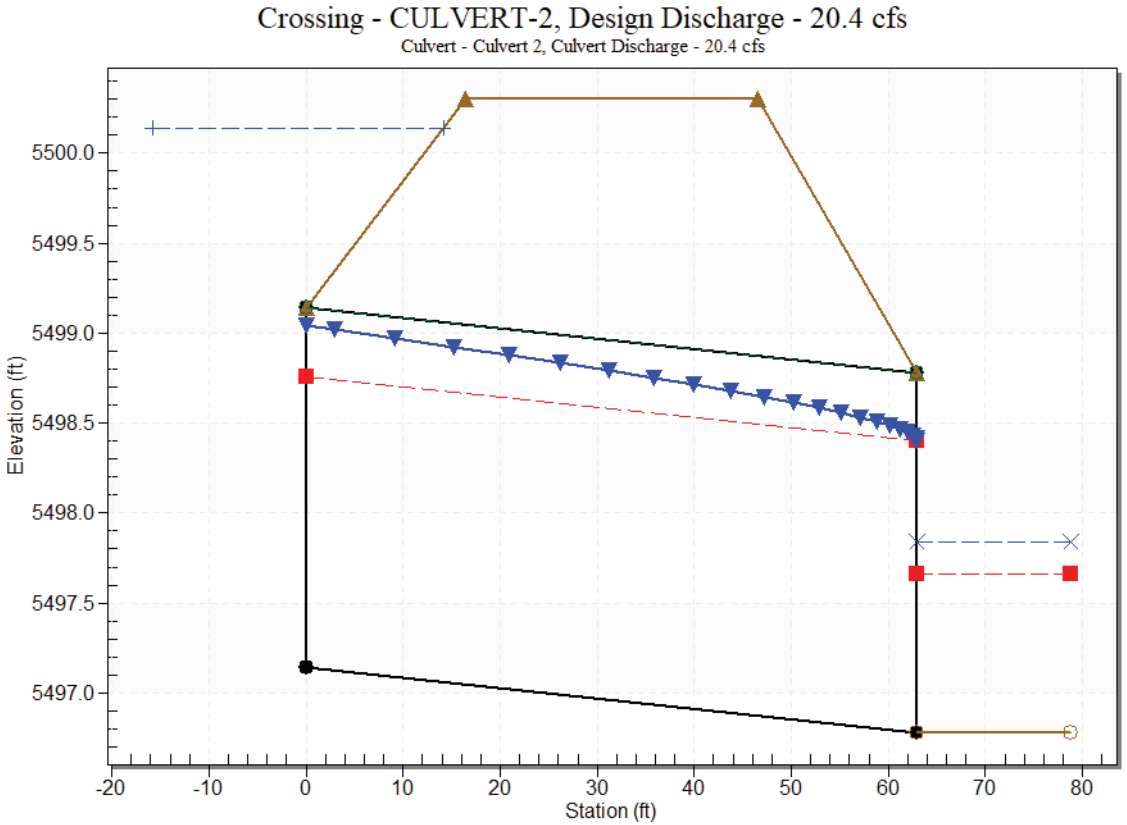
Culvert Length: 63.00 ft,

Culvert Slope: 0.0057

Culvert Performance Curve Plot: Culvert 2



Water Surface Profile Plot for Culvert: Culvert 2



Site Data - Culvert 2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5497.14 ft

Outlet Station: 63.00 ft

Outlet Elevation: 5496.78 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 2

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130 (Table 3, COA SDDTC v2010)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: CULVERT-2

Table 1 - Downstream Channel Rating Curve (Crossing: CULVERT-2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
10.20	5497.55	0.77	2.58	0.29	0.66
20.40	5497.84	1.06	3.09	0.40	0.68

Tailwater Channel Data - CULVERT-2

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0060

Channel Manning's n: 0.0270 (Table 2, COA SDDTC v2010)

Channel Invert Elevation: 5496.78 ft

Roadway Data for Crossing: CULVERT-2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 18.00 ft

Crest Elevation: 5500.30 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

STORMWATER BEST MANAGEMENT PRACTICE DESIGN WORKBOOK

UD-BMP (Version 3.07, March 2018)

Urban Drainage and Flood Control District

Denver, Colorado

www.udfcd.org

Purpose:	**This workbook is to be used as a design aid in the preliminary stages of BMP design.**
Function:	**To provide the designer with built-in tools to incorporate established criteria and sizing into the preliminary design.**
Content:	**The workbook consists of the following 12 design-aid worksheets:**
Deciderator	BMP Selection Tool
Runoff Reduction	Quantifying Runoff Reduction for Unconnected Impervious Area (UIA) across Receiving Pervious Area (RPA)
GB	Grass Buffer
GS	Grass Swale
RG	Rain Garden
SF	Sand Filter
EDB	Extended Detention Basin
RP	Retention Pond
CWP	Constructed Wetland Pond
CWC	Constructed Wetland Channel
PPS	Permeable Pavement Systems
MAP	Mean Storm Depth Map
Comments?	Direct all comments regarding this workbook to: UDFCD E-Mail
Revisions?	Check for revised versions of this or any other workbook at: www.udfcd.org

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer:	**UELS - cdc**
Company:	**CRESTONE PEAK RESOURCES OPERATING LLC**
Date:	**June 19, 2024**
Project:	**ASPEN 3-65 15-14 SOUTH**
Location:	**North 1/2 of Access Road (15'W) - Water Quality Treatment - UIA-RPA Runoff Reduction**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches

Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA											
Area ID	OS4'											
Downstream Design Point ID	10'											
Downstream BMP Type	None											
DCIA (ft^2)	--											
UIA (ft^2)	8,625											
RPA (ft^2)	7,265											
SPA (ft^2)	--											
HSG A (%)	0%											
HSG B (%)	0%											
HSG C/D (%)	100%											
Average Slope of RPA (ft/ft)	0.013											
UIA:RPA Interface Width (ft)	575.00											

Area ID corresponds to the drainage basin that the section of access road runs through.

UIA is the area of the graveled access road within the drainage basin (Area ID). For this case, the UIA is the north half of the access road (15-ft) that will drain onto the RPA.

RPA is a percentage of the UIA, assuming the same Width, but decreasing the Length to achieve the desired runoff reduction. For this case, the RPA is ~84% of the UIA, which calculates to a Length of 12.6-ft and a Width equal to the UIA.

CALCULATED RUNOFF RESULTS

Area ID	OS4'											
UIA:RPA Area (ft^2)	15,890											
L / W Ratio	0.06											
UIA / Area	0.5428											
Runoff (in)	0.00											
Runoff (ft^3)	0											
Runoff Reduction (ft^3)	359											

CALCULATED WQCV RESULTS

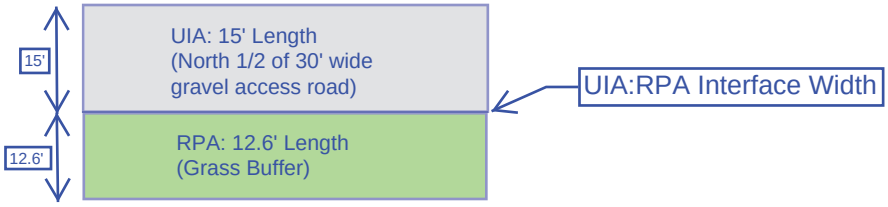
Area ID	OS4'											
WQCV (ft^3)	359											
WQCV Reduction (ft^3)	359											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	10'											
DCIA (ft^2)	0											
UIA (ft^2)	8,625											
RPA (ft^2)	7,265											
SPA (ft^2)	0											
Total Area (ft^2)	15,890											
Total Impervious Area (ft^2)	8,625											
WQCV (ft^3)	359											
WQCV Reduction (ft^3)	359											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	15,890
Total Impervious Area (ft^2)	8,625
WQCV (ft^3)	359
WQCV Reduction (ft^3)	359
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0



Design Procedure Form: Grass Buffer (GB)

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer: UELS - cdc
Company: CRESTONE PEAK RESOURCES OPERATING LLC
Date: June 21, 2024
Project: ASPEN 3-65 15-14 SOUTH
Location: Access Road - UIA Area Tributary to Grass Buffer RPA - OS4'

1. Design Discharge A) 2-Year Peak Flow Rate of the Area Draining to the Grass Buffer	Q_2 = 0.44 cfs
2. Minimum Width of Grass Buffer	W_G = 9 ft
3. Length of Grass Buffer (14' or greater recommended)	L_G = 12.6 ft (increased length will improve treatment)
4. Buffer Slope (in the direction of flow, not to exceed 0.1 ft / ft)	S_G = 0.013 ft / ft
5. Flow Characteristics (sheet or concentrated) A) Does runoff flow into the grass buffer across the entire width of the buffer?	Choose One: (●) Yes ( ) No
B) Watershed Flow Length	F_L = 15 ft
C) Interface Slope (normal to flow)	S_I = 0.020 ft / ft
D) Type of Flow Sheet Flow: $F_L * S_I \leq 1$ Concentrated Flow: $F_L * S_I > 1$	SHEET FLOW
6. Flow Distribution for Concentrated Flows	Choose One: (●) None (sheet flow) ( ) Slotted Curbing ( ) Level Spreader ( ) Other (Explain):
7 Soil Preparation (Describe soil amendment)	Use on-site topsoil, seeding and mulching.
8 Vegetation (Check the type used or describe "Other")	Choose One: ( ) Existing Xeric Turf Grass ( ) Irrigated Turf Grass (●) Other (Explain): Grass from Seed.
9. Irrigation (*Select None if existing buffer area has 80% vegetation AND will not be disturbed during construction.)	Choose One: (●) Temporary ( ) Permanent ( ) None*
10. Outflow Collection (Check the type used or describe "Other")	Choose One: ( ) Grass Swale ( ) Street Gutter ( ) Storm Sewer Inlet (●) Other (Explain): Outflow from GB will continue offsite into historic drainage down stream of the site.

Notes:

Design Procedure Form: Grass Swale (GS)

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer: UELS - cdc
Company: CRESTONE PEAK RESOURCES OPERATING LLC
Date: June 21, 2024
Project: ASPEN 3-65 15-14 SOUTH
Location: ACCESS ROAD - UIA Area Tributary to Grass Swale - OS1'

1. Design Discharge for 2-Year Return Period	Q_2 = 0.44 cfs Same Flow as OS4'.
2. Hydraulic Residence Time	
A) : Length of Grass Swale	L_S = 500.0 ft
B) Calculated Residence Time (based on design velocity below)	T_{HR} = 20.5 minutes
3. Longitudinal Slope (vertical distance per unit horizontal)	
A) Available Slope (based on site constraints)	S_{avail} = 0.003 ft / ft
B) Design Slope	S_D = 0.003 ft / ft
4. Swale Geometry	
A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical)	Z = 4.00 ft / ft
B) Bottom Width of Swale (enter 0 for triangular section)	W_B = 0.00 ft
5. Vegetation A) Type of Planting (seed vs. sod, affects vegetal retardance factor)	Choose One: (●) Grass From Seed ( ) Grass From Sod
6. Design Velocity (1 ft / s maximum)	V_2 = 0.41 ft / s
7. Design Flow Depth (1 foot maximum)	D_2 = 0.52 ft
A) Flow Area	A_2 = 1.1 sq ft
B) Top Width of Swale	W_T = 4.2 ft
C) Froude Number (0.50 maximum)	F = 0.14
D) Hydraulic Radius	R_H = 0.25
E) Velocity-Hydraulic Radius Product for Vegetal Retardance	VR = 0.10
F) Manning's n (based on SCS vegetal retardance curve E for seeded grass)	n = 0.079
G) Cumulative Height of Grade Control Structures Required	H_D = 0.00 ft
8. Underdrain (Is an underdrain necessary?)	Choose One: (●) YES ( ) NO — **AN UNDERDRAIN IS REQUIRED IF THE DESIGN SLOPE < 2.0%**
9. Soil Preparation (Describe soil amendment)	Use on-site topsoil, seeding and mulching.
10. Irrigation	Choose One: (●) Temporary ( ) Permanent

Notes: AN UNDERDRAIN WILL NOT BE INSTALLED IN THIS ROADSIDE SWALE OF THE ACCESS ROAD.

MILE HIGH FLOOD DISTRICT

DETENTION BASIN DESIGN WORKBOOK

MHFD-Detention, Version 4.06 (July 2022)
Mile High Flood District
Denver, Colorado
www.mhfd.org

Purpose:

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

Function:

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.

2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

Content: **This workbook consists of the following sheets:**

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements: ***Spreadsheet Development Team:***
Ken MacKenzie, P.E., Holly Piza, P.E.
Mile High Flood District

Derek N. Rapp, P.E.
Peak Stormwater Engineering, LLC

Dr. James C.Y. Guo, Ph.D., P.E.
Professor, Department of Civil Engineering, University of Colorado at Denver

Comments?
Revisions?

Direct all comments regarding this spreadsheet workbook to: **MHFD E-Mail**
Check for revised versions of this or any other workbook at: **Downloads**

WEIGHTED IMPERVIOUS SURFACE CALCULATIONS

ASPEN 3-65 15-14 SOUTH
EXTENDED DETENTION BASIN

COA STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA MANUAL, v.NOVEMBER 2023; TABLE 5-6. IMPERVIOUSNESS VALUES FOR URBAN SURFACES FOR SITE AND SMALL WATERSHED ANALYSIS

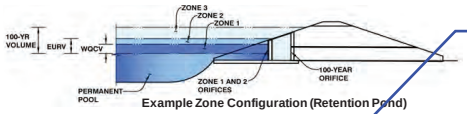
	SURFACE TYPE											
	Paved Streets	Concrete Drive and Walks	Roofs	Gravel No Traffic Areas (Pedestrian Use)	Gravel Low Traffic Areas (Maintenance Paths and Substations)	Gravel High Traffic Areas (Roadways and Parking)	Landscaping (including water-wise vegetation, active turf, uncompacted gravel, planting beds, residential artificial turf, etc.)	Open Water Areas, including footprint of WQCV	Historic Flow Analysis, Undisturbed Native Grasses, Agricultural	Newly Graded Areas		
Imperviousness	95%	95%	95%	40%	60%	80%	20%	100%	5%	65%		
Basin	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Area (Ac)**	**Total Area (Ac)**	**Percent Imperv.**
A'					1.31		1.09				2.40	41.8%
B'					3.28		1.77				5.05	46.0%
C'							1.08				1.08	20.0%
D'								0.93			0.93	100.0%
											0.00	0.0%
EDB EURV & 100-Yr											0.00	0.0%
Tributary Area											0.00	0.0%
A'+B'+C'+D'					4.59		3.94	0.93			9.46	47.3%
											0.00	0.0%

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: ASPEN 3-65 15-14 SOUTH

Basin ID: EDB



Example Zone Configuration (Retention Pond)

EDB WQCV & 100-Yr Detention Tributary Area: A'+B'+C'+D'

Set to 24-hr min. drain time due to the proposed site being within 5-mi. of Denver International Airport.

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	9.46	acres
Watershed Length =	1,252	ft
Watershed Length to Centroid =	430	ft
Watershed Slope =	0.012	ft/ft
Watershed Imperviousness =	47.3%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	24.0	hours
Location for 1-hr Rainfall Depths =	User Input	

Drain Time Too Short

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

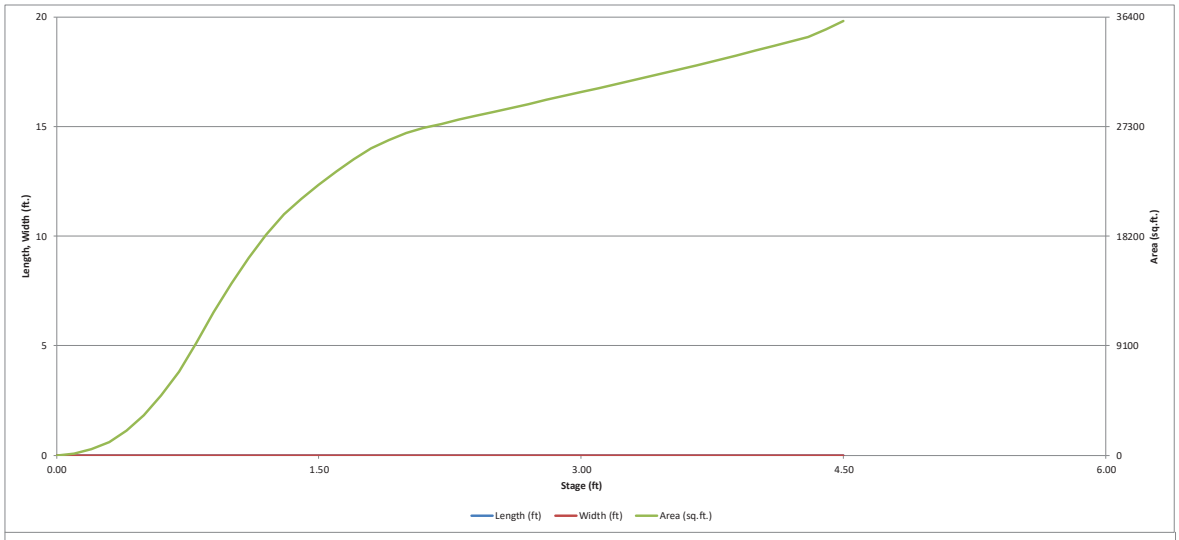
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.157	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.421	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	0.283	acre-feet	0.849	inches
5-yr Runoff Volume (P1 = 1.13 in.) =	0.441	acre-feet	1.13	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	0.632	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.8 in.) =	0.978	acre-feet	1.80	inches
50-yr Runoff Volume (P1 = 2.14 in.) =	1.251	acre-feet	2.14	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.589	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.51 in.) =	2.403	acre-feet	3.51	inches
Approximate 2-yr Detention Volume =	0.265	acre-feet		
Approximate 5-yr Detention Volume =	0.421	acre-feet		
Approximate 10-yr Detention Volume =	0.510	acre-feet		
Approximate 25-yr Detention Volume =	0.623	acre-feet		
Approximate 50-yr Detention Volume =	0.683	acre-feet		
Approximate 100-yr Detention Volume =	0.824	acre-feet		

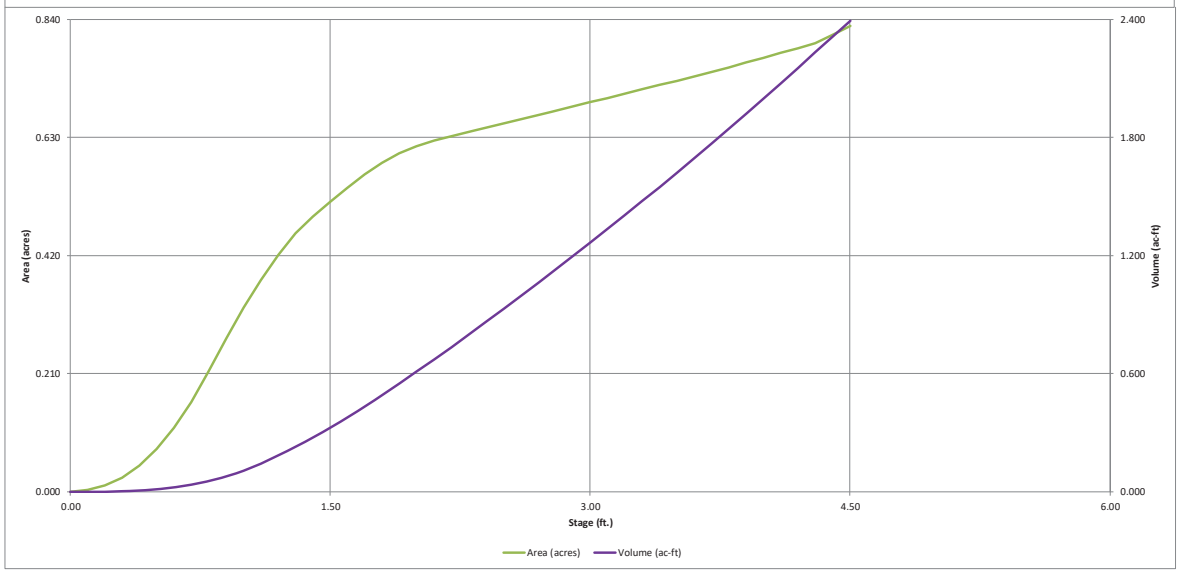
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.157	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.265	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.402	acre-feet
Total Detention Basin Volume =	0.824	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
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_{LW}) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = 0.10 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	4	0.000		
5,495.30	--	0.10	--	--	--	145	0.003	7	0.000
5,495.40	--	0.20	--	--	--	490	0.011	39	0.001
5,495.50	--	0.30	--	--	--	1,070	0.025	117	0.003
5,495.60	--	0.40	--	--	--	2,012	0.046	271	0.006
5,495.70	--	0.50	--	--	--	3,316	0.076	538	0.012
5,495.80	--	0.60	--	--	--	4,954	0.114	951	0.022
5,495.90	--	0.70	--	--	--	6,954	0.160	1,546	0.036
5,496.00	--	0.80	--	--	--	9,320	0.214	2,360	0.054
5,496.10	--	0.90	--	--	--	11,882	0.273	3,420	0.079
5,496.20	--	1.00	--	--	--	14,249	0.327	4,727	0.109
5,496.30	--	1.10	--	--	--	16,396	0.376	6,259	0.144
WQCV 5496.4	--	1.20	--	--	--	18,320	0.421	7,995	0.184
5,496.50	--	1.30	--	--	--	20,020	0.460	9,912	0.228
5,496.60	--	1.40	--	--	--	21,290	0.489	11,977	0.275
5,496.70	--	1.50	--	--	--	22,450	0.515	14,164	0.325
5,496.80	--	1.60	--	--	--	23,559	0.541	16,465	0.378
EURV 5496.9	--	1.70	--	--	--	24,585	0.564	18,872	0.433
5,497.00	--	1.80	--	--	--	25,472	0.585	21,375	0.491
5,497.10	--	1.90	--	--	--	26,205	0.602	23,959	0.550
5,497.20	--	2.00	--	--	--	26,784	0.615	26,608	0.611
5,497.30	--	2.10	--	--	--	27,208	0.625	29,308	0.673
5,497.40	--	2.20	--	--	--	27,536	0.632	32,045	0.736
5,497.50	--	2.30	--	--	--	27,863	0.640	34,815	0.799
100-Yr 5497.6	--	2.40	--	--	--	28,193	0.647	37,618	0.864
5,497.70	--	2.50	--	--	--	28,523	0.655	40,453	0.929
5,497.80	--	2.60	--	--	--	28,853	0.662	43,322	0.995
5,497.90	--	2.70	--	--	--	29,182	0.670	46,224	1.061
5,498.00	--	2.80	--	--	--	29,512	0.678	49,159	1.129
5,498.10	--	2.90	--	--	--	29,843	0.685	52,126	1.197
5,498.20	--	3.00	--	--	--	30,172	0.693	55,127	1.266
Spillway 5498.3	--	3.10	--	--	--	30,498	0.700	58,161	1.335
5,498.40	--	3.20	--	--	--	30,831	0.708	61,227	1.406
5,498.50	--	3.30	--	--	--	31,165	0.715	64,327	1.477
5,498.60	--	3.40	--	--	--	31,500	0.723	67,460	1.549
EM 100-Yr 5498.7	--	3.50	--	--	--	31,835	0.731	70,627	1.621
5,498.80	--	3.60	--	--	--	32,171	0.739	73,827	1.695
5,498.90	--	3.70	--	--	--	32,513	0.746	77,061	1.769
5,499.00	--	3.80	--	--	--	32,864	0.754	80,330	1.844
5,499.10	--	3.90	--	--	--	33,234	0.763	83,635	1.920
5,499.20	--	4.00	--	--	--	33,608	0.772	86,977	1.997
5,499.30	--	4.10	--	--	--	33,986	0.780	90,357	2.074
5,499.40	--	4.20	--	--	--	34,359	0.789	93,774	2.153
5,499.50	--	4.30	--	--	--	34,740	0.798	97,229	2.232
5,499.60	--	4.40	--	--	--	35,398	0.813	100,736	2.313
EDB Top 5499.7	--	4.50	--	--	--	36,120	0.829	104,312	2.395


20
15
10
5
0
Length, Width (ft.)
36400
27300
18200
9100
0
Area (sq.ft.)
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

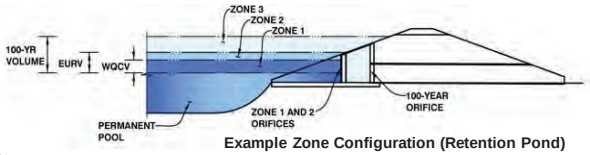

0.840
0.630
0.420
0.210
0.000
Area (acres)
2.400
1.800
1.200
0.600
0.000
Volume (ac-ft)
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: ASPEN 3-65 15-14 SOUTH

Basin ID: EDB



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.14	0.157	Orifice Plate
Zone 2 (EURV)	1.68	0.265	Orifice Plate
Zone 3 (100-year)	2.34	0.402	Weir&Pipe (Restrict)
Total (all zones)		0.824	

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)

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = 1.68 ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = 6.70 inches

Orifice Plate: Orifice Area per Row = N/A sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row = N/A ft^2

Elliptical Half-Width = N/A feet

Elliptical Slot Centroid = N/A feet

Elliptical Slot Area = N/A ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.56	1.12					
Orifice Area (sq. inches)	1.80	1.80	3.10					

	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

THIS SHEET PROVIDED ONLY TO SHOW THE SIZING OF THE SPILLWAY, IS FOR INFORMATIONAL PURPOSES ONLY, AND NOT FOR PRELIMINARY DRAINAGE APPROVAL.

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= 3.1 ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = 35.0 feet

Spillway End Slopes = 4.0 H:V

Freeboard above Max Water Surface = 1.0 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth= 0.3 feet

Stage at Top of Freeboard = 4.4 feet

Basin Area at Top of Freeboard = 0.82 acres

Basin Volume at Top of Freeboard = 2.34 acre-ft

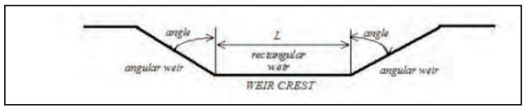
Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.13	1.40	1.80	2.14	2.52	3.51
CUHP Runoff Volume (acre-ft) =	0.157	0.421	0.283	0.441	0.632	0.978	1.251	1.589	2.403
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.283	0.441	0.632	0.978	1.251	1.589	2.403
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.9	2.4	5.9	8.2	11.2	18.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.10	0.26	0.63	0.87	1.18	1.91
Peak Inflow Q (cfs) =	N/A	N/A	3.5	5.6	8.1	13.2	16.7	21.1	31.6
Peak Outflow Q (cfs) =	0.1	0.2	0.2	0.2	1.2	5.2	8.5	10.1	11.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.5	0.9	1.0	0.9	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.7	1.2	1.4	1.6
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) =	23	38	32	40	44	42	41	39	36
Time to Drain 99% of Inflow Volume (hours) =	**24**	41	34	43	48	47	46	45	44
Maximum Ponding Depth (ft) =	1.14	1.68	1.36	1.65	1.88	2.05	2.15	2.36	3.07
Area at Maximum Ponding Depth (acres) =	0.39	0.56	0.47	0.55	0.60	0.62	0.63	0.64	0.70
Maximum Volume Stored (acre-ft) =	0.159	0.422	0.251	0.400	0.538	0.636	0.698	0.831	1.307

STAGE-DISCHARGE SIZING OF THE SPILLWAY

Project: ASPEN 3-65 15-14 SOUTH
Basin ID: PROD PHASE - EDB-1



Design Information (input):

Bottom Length of Weir	L =	35	feet
Angle of Side Slope Weir	Angle =	75.96	degrees
Elev. for Weir Crest	EL. Crest =	5,498.3	feet
Coef. for Rectangular Weir	C_w =	3	
Coef. for Trapezoidal Weir	C_t =	3	

Calculation of Spillway Capacity (output):

Water Surface Elevation ft. (linked)	Rect. Weir Flowrate cfs (output)	Triangle Weir Flowrate cfs (output)	Total Spillway Release cfs (output)	Total Pond Release cfs (output)	
5495.20	0.00	0.00	0.00	0.00	
5495.30	0.00	0.00	0.00	0.00	
5495.70	0.00	0.00	0.00	0.00	
5495.80	0.00	0.00	0.00	0.00	
5495.90	0.00	0.00	0.00	0.00	
5496.00	0.00	0.00	0.00	0.00	
5496.10	0.00	0.00	0.00	0.00	
5496.20	0.00	0.00	0.00	0.00	
5496.30	0.00	0.00	0.00	0.00	
5496.40	0.00	0.00	0.00	0.00	
5496.50	0.00	0.00	0.00	0.00	
5496.60	0.00	0.00	0.00	0.00	
5496.70	0.00	0.00	0.00	0.00	
5496.80	0.00	0.00	0.00	0.00	
5496.90	0.00	0.00	0.00	0.00	
5497.00	0.00	0.00	0.00	0.00	
5497.10	0.00	0.00	0.00	0.00	
5497.20	0.00	0.00	0.00	0.00	
5497.30	0.00	0.00	0.00	0.00	
5497.40	0.00	0.00	0.00	0.00	
5497.50	0.00	0.00	0.00	0.00	
5497.60	0.00	0.00	0.00	0.00	
5497.70	0.00	0.00	0.00	0.00	
5497.80	0.00	0.00	0.00	0.00	
5497.90	0.00	0.00	0.00	0.00	
5498.00	0.00	0.00	0.00	0.00	
5498.10	0.00	0.00	0.00	0.00	
5498.20	0.00	0.00	0.00	0.00	
5498.30	0.00	0.00	0.00	0.00	SPILLWAY
5498.40	3.43	0.04	3.47	3.47	
5498.50	9.70	0.22	9.93	9.93	
5498.60	17.83	0.61	18.44	18.44	
5498.70	27.45	1.25	28.70	28.70	Q100 - 23.49 CFS
5498.80	38.36	2.19	40.55	40.55	(EDB Overflow from
5498.90	50.43	3.46	53.88	53.88	Basins A'+B'+C'+D')
5499.00	63.54	5.08	68.63	68.63	
5499.10	77.64	7.10	84.73	84.73	
5499.20	92.64	9.53	102.16	102.16	
5499.30	108.50	12.40	120.90	120.90	
5499.40	125.18	15.73	140.91	140.91	
5499.50	142.63	19.55	162.18	162.18	
5499.60	160.82	23.89	184.71	184.71	
5499.70	179.73	28.75	208.48	208.48	TOP OF EDB
#N/A	#N/A	#N/A	#N/A	#N/A	

Weir Report

EDB Spillway - Emergency 100-Yr Flow

Trapezoidal Weir

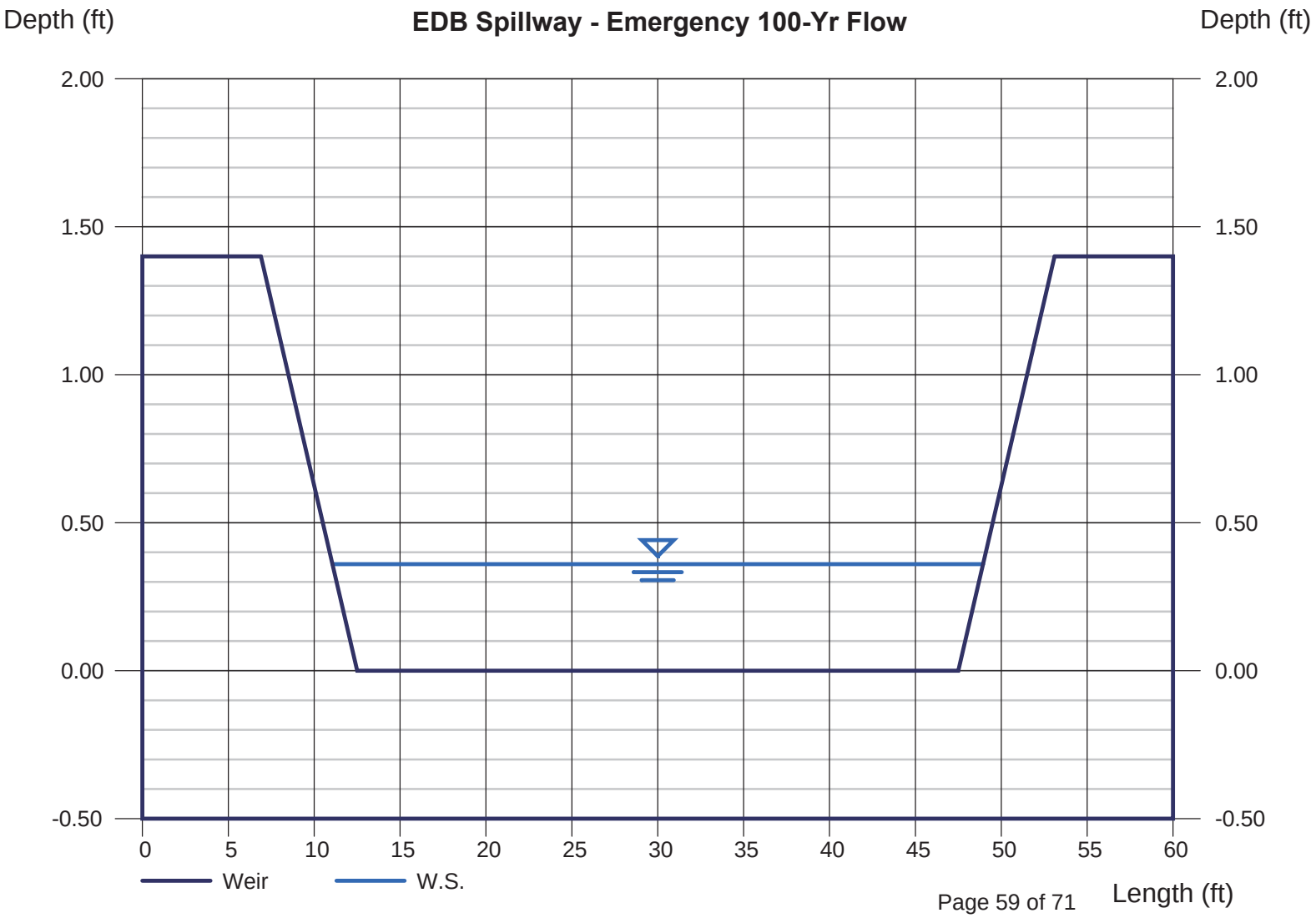
Crest	= Sharp
Bottom Length (ft)	= 35.00
Total Depth (ft)	= 1.40
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 23.49

Highlighted

Depth (ft)	= 0.36
Q (cfs)	= 23.49
Area (sqft)	= 13.12
Velocity (ft/s)	= 1.79
Top Width (ft)	= 37.88



4. SUPPORTING DOCUMENTATION

TABLE 2

Roughness Coefficients ("*n*") for Channel Design

(after Chow 1959)

Channel Type	Roughness Coefficient (*n*)		
	Minimum	Typical	Maximum
I. Excavated or Dredged			
1. Earth, straight and uniform			
a. Gravel, uniform section, clean	0.022	0.025	0.030
b. With short grass, few weeds	0.022	0.027	0.033
2. Earth, winding and sluggish			
a. Grass, some weeds	0.025	0.030	0.033
b. Dense weeds or aquatic plants	0.030	0.035	0.040
c. Earthy bottom and rubble/riprap sides	0.028	0.030	0.035
3. Channels not maintained, weeds and brush uncut			
a. Dense weeds, high as flow depth	0.050	0.080	0.120
b. Clean bottom, brush on sides	0.040	0.050	0.080
II. Natural streams (top width at flood stage 100 ft)			
1. Streams on plain			
a. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. Clean, winding, some pools and shoals, some weeds and stones	0.035	0.045	0.050
c. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
III. Lined or Built-Up Channels			
1. Concrete			
a. Towel/float finish	0.011	0.015	0.016
b. Shotcrete	0.016	0.020	0.025
2. Gravel bottom with sides of:			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
3. Wetland Bottom Channels	See Figure 6		
4. Grass-Lined Channels and Swales	See Figure 7		

(Source: USDCM, Volume 1, Major Drainage, 04/2008)

TABLE 3
MANNING'S n - VALUES FOR CULVERTS

CONCRETE PIPE: n = 0.013

CORRUGATED STEEL PIPE: (1)

Corrugations	Annular 2 2/3 x ½ in. All Diameters	1 ½ x ¼ in. 8 in.	1 ½ x ¼ in. 10 in.	Helical 2 2/3 x ½ in. 12 in.	18 in.	24 in.	36 in.	48 in.	60 in. and Larger
Unpaved	0.024	0.012	0.014	0.011	0.013	0.015	0.018	0.020	0.021
25% Paved	0.021					0.014	0.017	0.020	0.019

	Annular 3 x 1 in.	Helical – 3 x 1 in. 48 in.	54 in.	60 in.	66 in.	72 in.	78 in./Larger
Unpaved	0.027	0.023	0.023	0.024	0.025	0.026	0.027
25% Paved	0.023	0.020	0.020	0.021	0.022	0.022	0.023

	Annular 5 x 1 in.	Helical – 5 x 1 in. 54 in.	60 in.	66 in.	78 in./Larger
Unpaved	0.025	0.022	0.023	0.024	0.025
25% Paved	0.022	0.019	0.020	0.021	0.022

All pipe with smooth interior or fully paved	All Diameters n = 0.012

STRUCTURAL PLATE METAL PIPE: (1)

Corrugations 6 x 2 in.	Diameters 5 ft.	7 ft.	10 ft.	15 ft.
Plain-unpaved	0.033	0.032	0.030	0.028
25% Paved	0.028	0.027	0.026	0.024

(1) Source: Modern Sewer Design, American Iron and Steel Institute, Third Edition 1995

MEMORANDUM

City of Aurora

Worth Discovering • auroragov.org

To: Oil and Gas Applicants Operating in the City of Aurora

From: Victor Rachael, City Engineer, City of Aurora

Date: December 19, 2019

Subject: Oil and Gas Development Drainage Report and Civil Plan Standards

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In order to improve the consistency and efficiency of the review of Oil and Gas development-related Drainage Reports and Civil Plans, the City has updated engineering standards for Oil and Gas Operators, subsidiaries and their consultants seeking permits in the City of Aurora. These standards shall be effective January 1, 2020.

There are three categories of Oil and Gas projects the City is currently reviewing: 1) Permanent Facilities with Drainage Impacts (Pump Stations, Booster Stations, & Central Gathering Facilities) 2) Long-Term but not Permanent Facilities with Drainage Impacts (Well Pad Sites), 3) Permanent Facilities with no Drainage Impacts (Pipelines). Some of the following recommendations pertain to all 3 categories, and some are specific to only certain types.

1) Planning Process & Preliminary Drainage Reports: All three categories of projects listed above are currently required to follow the processes laid out in the Operator Agreements. The Oil and Gas permitting process requires submittal of a Preliminary Drainage Report for Well Pad Sites and Pumping Stations. Preliminary Drainage Letters in place of Report will not be permitted. Pipeline submittals would likely not require a Preliminary Drainage Report, as they normally only involve temporary surface disturbance and no long-term alteration of drainage patterns or flowrates.

2) Civil Plans - Process: For all three categories of Oil and Gas projects, Public Works Engineering will require a civil plan Pre-Submittal Meeting to be held. To set up a meeting please contact Chris Eravelly at 303-739-7457.

3) Civil Plans – Content and Naming Convention: Operator Agreements and associated applications and checklists for Oil and Gas sites have been developed using the term “Storm Water Management Plans (SWMPs)” in reference to the Civil Plans for these sites. The Civil Plans for all 3 categories of Oil & Gas sites include features that go beyond typical SWMPs. It should be recognized that Drainage Reports (both Preliminary and Final) and Civil Plan submittals will be reviewed using standards presented here along with City manuals.

4) Civil Plans – Submittal Package: Civil Plan submittals for Category 1 & 2 shall include; Final Drainage Report, Storm Water Management Report, and an Inspection and Maintenance Plan as outlined at the civil pre-submittal meeting. Category 3 (Pipelines) will be determined on a case by case basis at civil plan pre-submittal meeting. For all categories, any grading within an existing utility easement may require structural loading evaluation as determined at the civil plan pre-submittal meeting. The structural loading evaluation shall be submitted with the first submittal of civil plans.

5) Hydrologic Analyses for Drainage Reports: The City's Storm Drainage Design and Technical Criteria Manual along with Mile High Flood District Urban Storm Drainage Criteria Manual shall be used to develop the hydrology for Oil and Gas sites. For both Permanent and Long-Term Facilities with Drainage Impacts, 100-year precipitation depths shall be used for major storm event analyses. The entire tributary area, including the pad site, draining to Water Quality/Full Spectrum (EURV)/Detention BMPs shall be used to size those BMPs. Gravel surfaced pads shall use imperviousness (40%) and runoff coefficients consistent with the City's SDDTC Table 1.

6) Hydraulic Analyses – Conveyances/Detention/WQ: For Permanent and Long-Term Facilities with Drainage Impacts, WQ/EURV/Detention BMPs will be sized and designed in accordance with the standard requirements of the COA SDDTC (e.g. Extended Detention Basins). Storm Water Detention and Infiltration (SDI) Data Sheets shall be uploaded to the State website prior to civil plan approval. Culverts, Open Channels, and Grass Lined Swales shall satisfy the standard requirements of the COA SDDTC.

7) Subsurface Utility Investigation/Loading Information: For any type of Oil and Gas Civil Plans, the City of Aurora Roadway Specifications SUE note 22 (which refers to SB 18-167 and will be updated to refer to CRS 9-1.5) is a required note to be placed on the plans. In addition, Aurora Water has a new specification that will be effective January 1, 2020, requiring any crossing of existing utilities or tie-ins to provide pre-design potholing.

8) Oil and Gas Pipeline Civil Plans - Content: Civil Plans for Oil and Gas Pipelines shall include Plan & Profile sheets (P&Ps) where such pipelines cross City ROW, utility easements, floodplains, or other critical areas as determined on a case-by-case basis. The Subsurface Utility Investigations described above shall be used to provide depictions of existing utilities on those profiles. The P&Ps shall be included with the SWMP submittal.

9) Drainage Easements/License Agreements: For Permanent Facilities (with or without Drainage Impacts), the need for Easements and License Agreements shall be evaluated on a case-by-case basis. For Long-Term Facilities, where the lease agreement with the property owner includes provisions for removing WQ/Detention BMPs, the I&M Plan for such BMP will negate the need for a Drainage Easement or License Agreement for that BMP. If there is a need for a drainage or license agreement these documents must be executed prior to civil plan approval.

10) Oil and Gas Pipeline CAD Files and As-Builts: 3-D CAD files that include the entire pipeline shall be submitted to the City with the Signature Set of Civil Plans. In addition, as is written in the Operator Agreement, the City requires as-builts for entire pipeline alignments upon construction completion, for pipelines external to pad sites. This shall be noted on the Site Plans, Civil Plans and in Storm Water Permits.

MEMORANDUM

City of Aurora

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To: **Drainage Consultants and the City of Aurora Land Development Community**

From: **Haley Busch Johansen, City Engineer, City of Aurora**

Date: **November 16, 2020**

Subject: **Pond Drain Times for Areas Within or Adjacent to Airports**

Purpose

Pond drain times for sites adjacent to air operations areas are limited by FAA recommendations contained in Advisory Circular 150/5200-33C dated 2/21/2020 and by additional guidance specific to Denver International Airport (DIA). These drain time limitations are intended to minimize wildlife attractants and potential interference with air traffic. The City of Aurora requires all new development and re-development to comply with the FAA and DIA guidelines. The drain time limitations preclude pond designers from obtaining the full drain times recommended by the Mile High Flood District (MHFD) for Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV). The purpose of this memorandum is to provide guidance within the City of Aurora (COA) for pond drain times in areas subject to airport limitations. It is not the intent of this memorandum to impose any new City standards or criteria for the design of ponds but instead, to ensure that existing City and MHFD criteria for drain times are met to the fullest extent possible. In cases where reduced drain times are required (and therefore a variance from City drainage criteria), recommendations for the allocation of available drain time among the various pond volume components are made in order to balance the benefits of water quality, stream stability and flood control.

Background

Pond Drain Times Recommended by MHFD

MHFD recommended pond drain times are 40 hours for WQCV and an additional 12-32 hours for EURV. WQCV is a portion of the total EURV volume making the total drain time for combined WQCV and EURV a minimum of 52 hours and a maximum of 72 hours. Any flood control volume in excess of the EURV would add to this drain time.

Each volume component of pond storage provides a unique benefit to the stream system. WQCV is intended to capture pollutants which are largely delivered to stream systems in the first flush effect of frequently occurring storm events. EURV is intended to slow the release of developed condition flows so that they more closely replicate pre-development flows for the more frequently occurring high flow events (up to approximately the 5-year event). These more frequent high flow events are responsible for the largest fraction of sediment transport and channel erosion that occurs in stream systems. Flood control volumes for less frequent events in excess of the EURV also provide stream stability benefits but are largely intended to provide a level of flood protection for people and property typically up to the 100-year event.

Airport Drain Time Limitations

FAA Advisory Circular 150/5200-33C recommends maximum pond drain times for areas within or adjacent to airports to minimize the attraction of wildlife to areas where they may endanger planes approaching or departing the airport. The FAA recommended maximum time to fully drain the design event from ponds is 48 hours. Within the City of Aurora, the design event for most water quality and flood control ponds is the 100-year storm plus any portion of the WQCV or EURV volumes that have been added to the 100-year storm volume. FAA drain time limitations apply to Buckley Air Force Base, Centennial Airport and Front Range Airport to a distance of 10,000 feet from air operations Surfaces. Mapping of these areas is provided at the website address below where they are referred to as the "10,000 foot Critical Zone". Please refer to the FAA circular for definitions and additional details.

https://arcg.is/1j8eH0

Denver International Airport (DIA) has requested a more stringent requirement be applied to areas within or immediately adjacent to DIA. Within 10,000 feet of the airport, DIA requests drain time be limited to 40 hours. This drain time is shorter than the FAA recommendation with the intent being to allow 8 hours for pumping should an outlet structure become plugged or otherwise fail. In areas beyond 10,000 feet but still within 5 miles of DIA, ponds are requested to drain within 48 hours in accordance with FAA recommendations. DIA has provided mapping of recommended limits for 10,000 ft (40-hour drain time) and 5 miles (48-hour drain time). That map is attached to this memorandum as **Figure 1**. Mapped limits provided by DIA are also available at the above website address.

Recommendations for Drain Time Within the City of Aurora

New Planning of Regional Detention Ponds

Regional detention ponds are those included in regional hydrologic modeling and master planning studies carried out by the Mile High Flood District (MHFD). Generally, these ponds have 130 acres or more tributary to them and are publicly maintained. Occasionally ponds with lesser tributary areas or privately owned/maintained ponds may be included as regional ponds by the MHFD if they provide a regional benefit.

- Newly-planned regional detention ponds within airport zones in the City of Aurora should not incorporate WQCV. Instead, water quality should be provided in separate private facilities which may serve one or more sites. Utilizing separate facilities for WQCV will generally allow longer WQCV drain times to be achieved than would be possible if combined with EURV and detention. WQCV drain times in separate facilities may still need to be less than 40 hours since flood events will generally be routed through the private WQCV ponds and add to drain time. Additionally, on-site water quality-only ponds will also generally be tributary to downstream detention ponds and travel time from the upstream water quality pond may have to be considered in evaluation of the total drain time at the receiving downstream detention pond to avoid its drain time exceeding FAA/DIA guidance.

- Newly-planned off-line regional detention ponds located within airport zones in the City of Aurora may incorporate EURV. Off-line ponds are located on tributaries to the mainstem of a stream system. Total drain time for EURV and flood detention storage shall be 40 or 48 hours as dictated by FAA and/or DIA requirements. To help maximize the drain time available for EURV, the City will waive the requirement for ½ of the EURV to be added to the 100-year volume. Note that where WQCV has been provided in an upstream facility, the EURV volume to be included in the downstream detention pond need only consist of the difference between the WQCV and the total EURV volume. This difference is referred to as "Zone 2" in MHFD workbooks and criteria manuals.

- Newly-planned on-line regional ponds will generally be required to be peak-shaving only and not incorporate either WQCV or EURV. WQCV and EURV are generally not incorporated into on-line regional facilities in order to maintain sediment continuity in the stream system and limit sediment removal costs for the on-line pond. Where on-line regional detention ponds have been approved, the approach to the provision of upstream WQCV and EURV shall be reviewed on a case-by-case basis. Where tributary areas less than 130 acres, WQCV and EURV may be combined in these upstream facilities. A minimum drain time of 24 hours should be provided for WQCV and an additional 12 hours to drain the remainder of the EURV volume (Zone 2). Where tributary areas are 130 acres or more, provision of separate WQ and EURV facilities is strongly encouraged and may be required by the City.

<u>New Planning of Sub-Regional Ponds (Private)</u>

Sub-Regional ponds generally serve areas less than 130 tributary acres and are privately owned and maintained.

- WQCV, EURV and flood detention storage may be combined in single facilities if those facilities service less than 130 tributary acres. For these sub-regional ponds, the City encourages the provision of separate facilities for WQCV but will not require it.

- Where WQCV, EURV and detention are to be combined in a single facility, minimum drain times shall be 24 hours for WQCV and a minimum of 12 additional hours for EURV Zone 2. The minimum drain time for EURV Zone 2 should be increased beyond 12 hours if possible. Further, the City will waive the standard COA requirement for 1.2 times the WQCV or 1/2 of the EURV volume to be added to the 100-year detention volume. WQCV and EURV may instead reside entirely within the 100-year flood volume in order to maximize the drain time available for WQCV and EURV.

<u>Previously Approved City of Aurora Master Drainage Plan Regional Ponds</u>

In cases where previously approved City of Aurora master drainage plans combine WQCV, EURV and/or detention in regional facilities:

- For regional off-line facilities, the City encourages separation of the water quality function and the provision of separate facilities for WQCV but will not require it provided that for MEP-eligible facilities, MHFD is in agreement.

- For regional on-line facilities, the City encourages separation of both the water quality and EURV functions in accordance with the guidance provided in this memorandum for newly planned on-line regional ponds but will not require it provided that for MEP-eligible facilities, MHFD is in agreement.

- Where WQCV, EURV and detention are to be combined in a single facility, minimum drain times shall be 24 hours for WQCV and a minimum of 12 additional hours for EURV Zone 2. Total pond drain time shall be 40 or 48 hours depending on pond location to comply with FAA/DIA guidance. The minimum drain time for EURV Zone 2 should be increased when possible. Further, the City will waive the standard COA requirement for 1.2 times the WQCV or 1/2 of the EURV volume to be added to the 100-year detention volume. WQCV and EURV may instead reside entirely within the 100-year flood volume in order to maximize the drain time available for WQCV and EURV.

Water Quality by Alternative Means

Volume 3 of the MHFD Urban Storm Drainage Criteria Manual discusses a wide range of Best Management Practices (BMP's) intended to minimize water quality and quantity impacts from stormwater runoff. Alternatives to Extended Detention Basin (EDB) ponds that can provide reduced drain times are described along with measures for reducing WQCV and the resulting size of BMPs. The City generally supports and encourages the use of these alternative approaches when designed in accordance with MHFD criteria.

Underground water quality and/or detention facilities may be a viable approach to addressing surface ponding drain time concerns in areas adjacent to airports. Underground facilities should generally be considered only as a last resort though and are approved only on a case-by-case basis within the City.

Proprietary water quality treatment devices are produced by a number of companies. These devices are typically contained within buried manhole-type structures and therefore do not present the drain time concerns of surface water quality ponds. The City does not prohibit the use of these structures and will review their use on a case-by-case basis.

Gmail

Carl Carlson <ccarlson@uintahgroup.com>

Fwd: New Drainage Criteria, Drainage Review Transition and Other Updates

1 message

Chris Clark <cclark@uintahgroup.com> Thu, Sep 22, 2022 at 11:51 AM
Reply-To: cclark@uintahgroup.com
To: Carl Carlson <ccarlson@uintahgroup.com>

FYI Below.

Thanks!

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---------- Forwarded message ---------
From: **Young, Sarah** <syoung@auroragov.org>
Date: Thu, Sep 22, 2022 at 11:46 AM
Subject: New Drainage Criteria, Drainage Review Transition and Other Updates
To:
Cc: Perry, Laura <lperry@auroragov.org>, Brown, Marshall <mbrown@auroragov.org>, Cox, Jacob <jcox@auroragov.org>, Adam, Vern <Vadam@auroragov.org>, Bender, Janet <jbender@auroragov.org>, Perl, Craig <cperl@auroragov.org>, Baker, Gregory <gbaker@auroragov.org>

Hello development and engineering community –

We appreciate your patience while we work through the complex **transition of the drainage responsibilities from Public Works to Aurora Water**. We are in the process of **adding staff** to perform drainage reviews, evaluating **process efficiencies**, and refreshing our drainage criteria manual. Please watch for upcoming opportunities to provide **input on the draft drainage manual** scheduled for completion late Spring, 2023.

Ahead of completing the manual, we are **implementing a few drainage criteria changes effective immediately**. These changes include the following:

- Aurora will no longer require easements for private stormwater pipes/lines. Drainage easements are still required for private stormwater detention/water quality ponds, surface channels and access to these facilities to allow for public maintenance if necessary.
- Aurora will no longer require license agreements for any improvements within private water quality/detention ponds.
- All detention ponds can be designed with water quality/EURV nested within the detention volume (vs. in addition to).

- Aurora will no longer require additional freeboard between the 100-year water surface elevation and the emergency overflow invert (aka spillway crest). Please keep in mind that capacity/elevation certifications will still be required prior to TCO issuance so you will want to ensure your contractor builds the facility *per plan* (aka the freeboard/construction wiggle room has been removed).
- Aurora will use the NOAA Atlas 14 rainfall depths with Rational Method (which may reduce drainage infrastructure sizes in some instances.)

All the changes listed above are also being communicated at Joint Task Force, pre-application and pre-submittal meetings and can be applied by any project currently in the review process. Please note, if significant changes are made to plans already in the review process, additional review time will be required.

Also, to **make the drainage review process more straightforward for both the applicants and our reviewers**, we have created a thorough submittal requirements checklist for both the Master Drainage Plan (MDP) and Preliminary Drainage Report (PDR) as attached. Please note, these **checklists must be completed and signed by a licensed Professional Engineer and included in the initial submittal**. Once your team has completed the checklist and your document is ready for submittal, please email waterengineering@auroragov.org and we will open the Pre-Acceptance portal for you. We will then review the checklist and submittal for accuracy within 2 business days. If the submittal is confirmed complete, the document will then enter the formal review process. If the submittal is incomplete, our team will send the checklist back with comments/corrections. This process will take the place of a Pre-Submittal meeting for these document types.

These checklists can also be found on our website under the Aurora Water Design Standards, Specifications and Fees page here. The submitting engineer is responsible for checking the website for the most current edition.

Similar checklists will be coming for the Civil Plan process. The Civil plan *utility* checklist is attached for reference. Feel free to use ahead of the full Civil Checklist implementation to help ensure a smooth utility review process.

Lastly, for any project that has a significant drainage component, we **will require a stormwater project kick-off meeting** with Aurora Water and MHFD after the Pre-Application meeting. This is a critical component to ensure drainage considerations are included in your site plan development and the following review processes can go smoothly.

Thank you for continuing to help make Aurora a great place to live, work and play,

Aurora Water Planning and Engineering

Sarah Young, P.E.

Preferred pronouns: she, her, hers

Aurora Water Deputy Director – Planning and Engineering | City of Aurora

office 303.739.7279 | *mobile* 303.908.8945

One of Aurora's core values is respect. Sharing personal gender pronouns is one way to practice respect for the diversity that makes Aurora great.

3 attachments

Master Drainage Report Pre-Acceptance Checklist 9-22-22.pdf
1052K

Preliminary Drainage Report Pre-Acceptance Checklist 9-22-22.pdf
1212K

Civil Plans - Utilities - Pre-Acceptance Checklist 9-22-22.pdf
771K