



RULE 304.E. SUBSTANTIALLY EQUIVALENT INFORMATION COVER SHEET

Blehm 18-I Pad Oil and Gas Development Plan, Docket #210300017

Blehm 18-I Pad: Lot 3, Section 18, Township 7 North, Range 66 West

Form 2A Doc #402580742

Weld County, Colorado

The attached 1041 WOGLA Application is being submitted as a substantially equivalent document to the Stormwater Management Plan required by COGCC Rule 304.c.(15).

This document was developed for the Weld County 1041 WOGLA.

This document does not conform to COGCC rules or guidance in the following ways:

None.

This document should be accepted as substantially equivalent:

The Weld County Department of Public Works approved the attached Preliminary Drainage Report on January 5, 2021 (Pages 74-105 of the 1041 WOGLA Application). This report contains in narrative and shows graphically where and how stormwater control BMP of COGCC rule 1002.f.(2) will be installed. The location is not a Tier 1 Oil and Gas Location and will comply with Post-Construction Stormwater Program requirements of Rule 1002.f.(3). Bayswater also has a fieldwide Stormwater Management Permit filed with CDPHE, which the certification for which is also attached.

Bayswater will install stormwater controls, constructed in a manner that is consistent with good engineering practices, that will prevent offsite migration of sediment/contaminant, into the nearby sensitive areas. Stormwater controls shall be installed prior to construction activities. Gas, oil, and water gathering lines will be co-located to minimize potential of erosion associated with construction of any pipeline(s). The stormwater system for the Blehm 18-I Pad includes two onsite swales, one offsite swale, one offsite diversion berm, and one pond with an outlet structure to protect the Pierce Lateral ditch.

Final Drainage Report

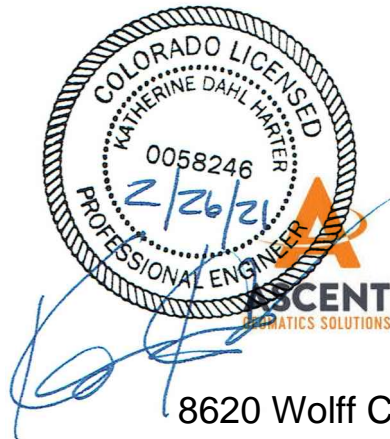
Blehm 18-I Pad

Created for
Bayswater Exploration & Production, LLC



Weld Co Case Number: 1041WOGLA20-0083
Project Number: B20.BEP.0002
Report Number: FDR 01 Rev 0

Issue Date
February 2021



8620 Wolff Court
Westminster, CO 80031
303-928-7128

REFERENCE CONTRACT

This work has been conducted by Ascent Geomatic Solutions (Ascent) for Bayswater Exploration & Production, LLC (BEP) under contract number B20.BEP.0002 – CO1-C1. This work has been performed under Ascent project number B20.BEP.0002. The BEP project manager for Blehm 18-I Pad is Mr. Mark Brown; Ms. Kristi McRedmond is the project manager for Ascent.

DOCUMENT REVISION HISTORY

Rev	Date	Issued	Prepared	Reviewed	Approved
0	02/26/2021	Issued for Construction	RMC	KH	KH

This report, and all associated materials, has been prepared by Ascent Geomatic Solutions for the exclusive use of Bayswater Exploration & Production, LLC for Blehm 18-I Pad. No other party is an intended beneficiary of this report or any of the information, opinions, and conclusions contained herein. The use of this report shall be at the sole risk of the user regardless of any fault or negligence of Bayswater Exploration & Production, LLC or Ascent Geomatic Solutions. Ascent Geomatic Solutions accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions based on this report. Note that this report is a controlled document and any reproductions are uncontrolled and may not be the most recent version.



EXECUTIVE SUMMARY

A drainage analysis was performed for the project site in accordance with the Weld County requirements for a Final drainage report. It was determined that a detention pond is required to maintain historic release rates off site. A grading and stormwater management system has been designed based on the hydrological analysis. The design implements a detention pond during the construction phase, which will remain to service the site through the life of the facility.

TABLE OF CONTENTS

REFERENCE CONTRACT	i
DOCUMENT REVISION HISTORY	i
EXECUTIVE SUMMARY	ii
TABLE OF CONTENTS	iii
WELD COUNTY FINAL DRAINAGE REPORT CHECKLIST	1
CERTIFICATE OF COMPLIANCE	2
1. INTRODUCTION AND PURPOSE	3
2. PROJECT DESCRIPTION AND BACKGROUND	3
3. DESIGN CRITERIA	4
4. DESIGN CONDITIONS	4
4.1 Existing Conditions	5
4.2 Proposed Conditions	6
4.2.1 Stormwater System Design	6
5. MAINTENANCE PLAN	8
7. SUMMARY AND CONCLUSIONS	10
7.1 Design Summary	10
Appendix A – REFERENCE DOCUMENTS, SOFTWARE AND WEBSITES	A.1
Appendix B – ABBREVIATIONS AND ACRONYMS	B.1
Appendix C – DRAINAGE REPORT CHECKLIST	C.1
Appendix D – VICINITY MAP	D.1
Appendix E – FEMA MAP	E.1
Appendix F – NOAA ATLAS 14 PRECIPITATION FREQUENCY TABLE	F.1
Appendix G – SOILS MAP	G.1
Appendix H – GROUND SURFACE IMPERVIOUS CALCULATIONS	H.1
Appendix I – HYDROLOGIC CALCULATIONS	I.1
Appendix J – DETENTION / WQCV CALCULATIONS	J.1

Appendix K – HYDRAULIC CALCULATIONS	K.1
Appendix L - DRAINAGE DRAWINGS	L.1

WELD COUNTY FINAL DRAINAGE REPORT CHECKLIST

Weld County Preliminary Drainage Report Checklist	
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/> Is the project in the MS4?
Report Content	Section
<input checked="" type="checkbox"/> Weld County Case Number	Cover Page
<input checked="" type="checkbox"/> Certificate of Compliance Signed and Stamped by a Colorado Licensed PE	Certificate of Compliance
<input checked="" type="checkbox"/> Description/Scope of Work	1 & 2
<input checked="" type="checkbox"/> Location (County Roads, S-T-R)	2
<input checked="" type="checkbox"/> Nearby Water Features and Ownership	2
<input checked="" type="checkbox"/> Total Acres vs. Developed Acres	2
<input checked="" type="checkbox"/> Hydrological Soil Types/Maps	4 & Appendix G
<input checked="" type="checkbox"/> FEMA Flood Zones	4 & Appendix E
<input checked="" type="checkbox"/> Urbanizing or Non-urbanizing	2
<input checked="" type="checkbox"/> Methodologies Used For Report & Analysis (Full Spectrum is not accepted)	3
<input checked="" type="checkbox"/> Discussion of Offsite Drainage Routing	4.2
<input checked="" type="checkbox"/> Conclusion Statement indicating that the design will adequately protect public health, safety, and general welfare and have no adverse impacts on public rights-of-way or offsite properties	6
Hydrology and Hydraulic Analysis	
<input checked="" type="checkbox"/> Design Storm / Rainfall Information (NOAA Atlas or Local Data)	4, Appendix F
<input checked="" type="checkbox"/> Release Rate Calculations	4.2 & Appendix H, I & J
<input checked="" type="checkbox"/> Post Construction Site Imperviousness	Appendix H
<input checked="" type="checkbox"/> Hydrologic calculations (historic & developed basins)	4.1 & 4.2, Appendix H, I & J
<input checked="" type="checkbox"/> Hydraulic Calculations for Proposed Drainage Improvements (Swales, Culverts, Riprap, Pond, Outlet, Spillway, WQCV Outlet, etc.)	Appendix K
<input checked="" type="checkbox"/> Detention WQCV calculations	Appendix J
Construction Drawings	
<input checked="" type="checkbox"/> Stamped by PE	Appendix L
<input checked="" type="checkbox"/> Engineering scale and north arrow	Appendix L
<input checked="" type="checkbox"/> Property lines, rights-of-way and easements	Appendix L
<input checked="" type="checkbox"/> 1' contours & elevations (existing and proposed)	Appendix L
<input checked="" type="checkbox"/> Pre- and post-development drainage basins	Appendix L
<input checked="" type="checkbox"/> Arrows depicting flow direction	Appendix L
<input checked="" type="checkbox"/> Time of Concentration Critical Path	Appendix L
<input checked="" type="checkbox"/> Drainage Design Points	Appendix L
<input checked="" type="checkbox"/> Improvements Labeled	Appendix L
<input checked="" type="checkbox"/> Permanent Control Measure and Associated Drainage Features Labeled 'No Build/No Storage', Include Design Volume	Appendix L
<input checked="" type="checkbox"/> Cross Sections for Open Channel, Profiles for Pipes	Appendix L
<input checked="" type="checkbox"/> Elevations for Inverts, Flow Lines, Top of Grates, Orifice(s), etc.	Appendix L
<input checked="" type="checkbox"/> Pipe Specs (Size, Material, Length, Slope)	Appendix L
<input checked="" type="checkbox"/> Outlet and Spillway Details	Appendix L
Maintenance Plan	
<input checked="" type="checkbox"/> Frequency of Onsite Inspections	5
<input checked="" type="checkbox"/> Repairs, If Needed	5
<input checked="" type="checkbox"/> Cleaning of Sediment and Debris	5
<input checked="" type="checkbox"/> Vegetation Maintenance	5
<input checked="" type="checkbox"/> Manufacturer Maintenance Specifications, If Applicable	5
Other Required Documents (If applicable)	
<input checked="" type="checkbox"/> Variance Request and Documentation - Explain hardship, applicable code section, and proposed mitigation.	Certificate of Compliance

A copy of the Weld County issued Final drainage report checklist can be found in Appendix C.



CERTIFICATE OF COMPLIANCE

Weld County Drainage Code Certificate of Compliance



Weld County Case Number: 1041WOGLA20-0083

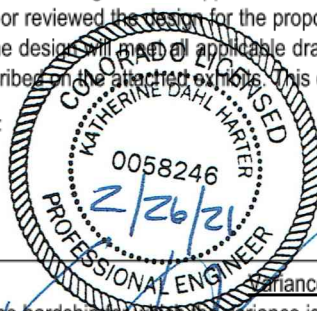
Parcel Number: 070718300004 & 070718000051

Legal Description, Section/Township/Range: PT E2 SW4 18 7 66 LYING N OF PIERCE LATERAL DITCH

Date: February 23, 2021

I, Katherine D. Harter, Consultant Engineer for Bayswater Exploration & Production, LLC (Applicant), understand and acknowledge that the applicant is seeking land use approval of the case and parcel in the description above. I have designed or reviewed the design for the proposed land use set for in the application. I hereby certify, on behalf of the applicant, that the design will meet all applicable drainage requirements of the Weld County Code with the exception of the variance(s) described on the attached exhibits. This certification is not a guarantee or warranty either expressed or implied.

Engineer's Stamp:



Engineer of Record Signature

Variance Request (If Applicable)

1. Describe the hardship for which the variance is being requested.
2. List the design criteria of the Weld County Code of which a variance is being requested.
3. Describe the proposed alternative with engineering rationale which supports the intent of the Weld County Code. Demonstrate that granting of the variance will still adequately protect public health, safety, and general welfare and that there are no adverse impacts from stormwater runoff to the public rights-of-way and/or offsite properties as a result of the project.

Public Works Director/Designee Review (If Applicable)

Public Works Director/Designee Name

Signature

Date of Signature

☐ Approved

☐ Denied

Comments:

Department of Public Works | Development Review
1111 H Street, Greeley, CO 80631 | Ph: 970-304-6496 | www.weldgov.com/departments/public_works/development_review

8/02/2019

1. INTRODUCTION AND PURPOSE

Bayswater Exploration & Production, LLC (BEP) is constructing a new oil and gas well site in Weld County, Colorado. The project is referred to as the Blehm 18-I Pad. As part of the project, a drilling and production pad will need to be constructed.

Ascent Geomatic Solutions (Ascent) has been contracted to perform the grading, drainage analysis and drainage report for the Blehm 18-I Pad. This report presents the findings and recommendations for the grading and stormwater management for the project.

2. PROJECT DESCRIPTION AND BACKGROUND

The Blehm 18-I Pad is located in Lot 3 of Section 18 Township 7 North, Range 66 West of the 6th Principal Meridian in Weld County, Colorado¹. Figure 1 shows an aerial photo of the project site location. A vicinity map showing the project location relative to the surrounding area can be found in Appendix D.

Figure 1: Aerial of Project Location



Aerial photo from Google Earth®

¹ The project site is located at latitude: 40.574363° N, longitude: 104.825924° W.

The proposed oil and gas facility is located on a 11.68 acre site² which is a portion of two parcels, combined for 173.25 acres in size, owned by Linda D Blehm Trust and David L Drake Trust and at a mean elevation 5,079 ft. amsl. The site is located 2137' south of County Road 82 and 1.7 miles west of County Road 29. The site is in an urbanizing area and is approximately 1322' east of the Town of Severance limits. The site is bounded on the north and west sides by farmland and bounded on the east and south sides by the Pierce Lateral ditch. There are no major water features on the site however the Pierce Lateral ditch is directly adjacent to the southern and eastern edges of the proposed pad location³.

A geotechnical investigation was not included with this project.

3. DESIGN CRITERIA

The proposed drainage plan follows Weld County Code requirements⁴ and Weld County Engineering and Construction Guidelines (WC-ECG)⁵. Weld County Charter and County Code (WC-CCC)⁶ incorporates many of the requirements from Urban Drainage and Flood Control district (UDFCD) by reference into its code and as such UDFCD requirements have been included in the design and analysis for the Blehm 18-I Pad project.

UDFCD Rational Method (UD-Rational)⁶, channel sizing (UD-Channel)⁶ and pond sizing software (UD-Detention⁷)⁶ spread sheets were used to perform most of the calculations for the drainage analysis. The runoff coefficients used in the UD-Rational calculations are taken from USDCM-1-2008 in accordance with WC-PW requirements.

The overall design directives include mitigation of stormwater so as not to negatively impact adjacent properties.

4. DESIGN CONDITIONS

The existing conditions ground cover of the project site and the ground cover of the farmland adjacent to the pad can be described as tillage/field⁸. Figure 2 provides a photograph of the existing surface conditions and the basin delineation map is presented in Appendix L.

² Acreage per Surface Use Agreement (SUA). A portion of the SUA area is diverted around the site, resulting in the total drainage basin area of 9.26 acres used in the hydrologic calculations.

³ Reference Figure 1 on Page 4

⁴ Particular attention to Weld County Code Chapter 8 (Public Works), Article XI (Storm Drainage Criteria) has been given for this project designs.

⁵ Reference Appendix A, Table 2: Reference Documents for more information.

⁶Reference Appendix A Table 3: Reference Software and Websites for more information.

⁷ The current version of UD Detention (a.k.a. MHFD Detention 4.00) utilizes a "full spectrum" design approach which is not accepted by WC, hence UD-Detention 2.35 which utilizes the modified FAA Method was used to perform the pond sizing analysis, as this method is accepted by WC.

⁸ The "tillage/field" condition has a corresponding Conveyance Factor (K) of 5 within UD-Rational.

The hydrologic soil classifications for the project were obtained from the NRCS Web Soil Survey (NRCS⁸). Appendix G presents the NRCS soils map used to perform the analysis. Basin 1 Design Point 1 was assumed to be 100% Type B soils.

Selection of imperviousness values for the project site are based on whether the conditions are existing or proposed; the specific imperviousness values selected for the hydrologic analysis are discussed in Sections 4.1 and 4.2.

The design storm data used to analyze both existing and proposed conditions were taken from NOAA Atlas 14 (NOAA-14)⁹. The NOAA-14 precipitation frequency data used for the hydrologic analysis is provided in Appendix F.

The proposed site is not located within the FEMA 100-yr floodplain. The mean groundwater depth at this location is > 6.56 ft (200 cm) below grade¹⁰.

4.1 Existing Conditions

The existing conditions design values are provided in Table 1. Tillage/field conditions cover the project area (reference Figure 2). Stormwater from the project site travels down gradient towards the southeast where it reports to the existing Pierce Lateral ditch approximately 10 ft. from the southeastern edge of the limits of disturbance (reference Sheet L.1 in Appendix L for limits of disturbance).

Figure 2: Project Site Existing Conditions



⁹Reference Appendix A Table 3: Reference Software and Websites for more information.

¹⁰ Groundwater elevation taken from NRCS soil survey.

Table 1: Existing Conditions Design Values

Parameter	Value
Average Slope	1-4%
Existing Condition Flow Direction	Northwest to Southeast
Coverage Type	Tillage/Field
Conveyance Factor	5

4.2 Proposed Conditions

The proposed drainage drawings located in Appendix L shows the proposed project site with construction disturbance area and grading. The stormwater management systems for the drilling phase were designed based on the drilling phase conditions with equipment, which provides a hydrologic “worst case” design.

The proposed pad will be capped with 6” of CDOT class 6 of aggregate base course (ABC) or similar compacted to 95% standard proctor. The well pad was assigned an assumed imperviousness of 40%. Piers, concrete pads and/or footers are expected and were assigned an assumed imperviousness of 100%. The detention pond was assigned an assumed imperviousness of 2%. Reference Appendix H for composite value for total imperviousness calculations¹¹.

The onsite drainage basin (Basin 1) varies from the existing conditions. The offsite basins effectively did not change. See Drainage Plan Drawing Sheet L.1 and L.2 in Appendix L for basin delineations.

4.2.1 Stormwater System Design

The stormwater system for the Blehm 18-H Pad includes two onsite swales, two offsite swales, and one pond with a PVC standpipe outlet structure. Sheet L.2 in Appendix L identifies the stormwater design elements for this project.

4.2.1.1 Well Pad Drainage Features

During the drilling phase, rainfall that lands on the pad will generally flow northeast to southwest to one of two onsite swales on the west and south sides of the pad, which is then conveyed to the detention pond, or flow directly to the detention pond located in the southwest corner of the site. Runoff in the detention pond will flow through the PVC standpipe outlet structure and be released into a channel southwest of the site. The channel conveys released runoff to the west, where it will resume historic flow patterns. The offsite swale along the west edge of the site diverts offsite flows

¹¹ Imperviousness calculations were performed by referencing USDCM-1 Table 6-3 “Recommended Percentage Imperviousness Values” (see Appendix A for more information on USDCM-1)

around the project site to the southwest. Additionally, the offsite swale along the north edge of the site intercepts runoff and diverts it northeast of the site.

4.2.1.2 Detention Pond

Stormwater for Basin 1 will flow southwest across the well pad surface and collect in the detention pond located southwest of the well pad. The UD Detention spreadsheet¹² was used to size the detention pond (Design Point 1). The required stormwater detention volume is 0.898 ac-ft (39,095 cu-ft). The total detention pond volume provided is 1.22 ac-ft (51,344 cu-ft). The depth of the proposed pond is 1.3' plus 1.0' (minimum) of freeboard and is graded at 4:1 interior side slopes. The detention pond will utilize a PVC standpipe outlet structure system with a maximum design release rate (approximately 0.83 cfs) less than the 5-year historical release rate of 1.63 cfs. The detention pond design also includes a 13' wide emergency spillway.

The detention pond will be reshaped during the production phase in order to maximize the reclamation area. The UD Detention spreadsheet was used to size the detention pond for the production phase. The required stormwater detention volume during the production phase is 0.811 ac-ft (35,343 cu-ft). The total detention pond volume provided is 1.14 ac-ft (49,545 cu-ft). The production phase detention pond will utilize the drilling phase PVC standpipe outlet structure and 13' wide emergency spillway in their original location.

¹²Reference Appendix A Table 3: Reference Software and Websites for more information. The current version of UD Detention (a.k.a. MHFD Detention 4.02) utilizes a "full spectrum" design approach which is not accepted by WC, hence UD-Detention 2.35 which utilizes the modified FAA Method was used to perform the pond sizing analysis, as this method is accepted by WC.

5. MAINTENANCE PLAN

Drainage Basin

Detention ponds have low to moderate maintenance requirements on a routine basis but may require significant maintenance once every 15 to 25 years. Maintenance frequency depends on the amount of construction activity within the tributary watershed, the erosion control measures implemented, the size of the watershed, and the design of the facility.

Inspection of the surface system will include functional and aesthetic needs. Functional maintenance is important for performance and safety reasons and aesthetic is important primarily for public acceptance of stormwater facilities. The removal of debris, sediment, overgrown or weedy vegetation will be prioritized based upon the inspection results.

Inspection

Inspect the drainage structures at least once annually, generally in the Spring, observing the amount of sediment where the ditches discharge into the pond (i.e. design points 2 and 3) and checking for debris at the outlet structure

Maintenance

Debris and Litter- Removal Remove debris and litter from the detention area as required to minimize clogging of the outlet.

Mowing and Plant Care- When starting from seed, mow native/drought tolerant grasses only when required to deter weeds during the first three years. Following this period, mowing of native/drought tolerant grass may stop or be reduced to maintain a height of no less than 6 inches (higher mowing heights are associated with deeper roots and greater drought tolerance). In general, mowing should be done as needed to maintain appropriate height and control weeds. Mowing of manicured grasses may vary from as frequently as weekly during the summer, to no mowing during the winter.

Sediment Removal from the Forebay, Trickle Channel, and Micropool (when applicable) - Remove sediment from the forebay and trickle channel annually. If portions of the watershed are not developed or if roadway or landscaping projects are taking place in the watershed, the required frequency of sediment removal in the forebay may be as often as after each storm event. The forebay should be maintained in such a way that it does not provide a significant source of resuspended sediment in the stormwater runoff.

Sediment removal from the micropool is required about once every, one to four years, and should occur when the depth of the pool has been reduced to approximately 18 inches. Small micropools may be vacuumed and larger pools may need to be pumped in order to remove all sediment from

the micropool bottom. Removing sediment from the micropool will benefit mosquito control. Ensure that the sediment is disposed of properly and not placed elsewhere in the basin.

Sediment Removal from the Basin Bottom- Remove sediment from the bottom of the basin when accumulated sediment occupies about 20% of the water quality design volume or when sediment accumulation results in poor drainage within the basin. The required frequency may be every 15 to 25 years or more frequently in basins where construction activities are occurring.

Erosion and Structural Repairs- Repair basin inlets, outlets, trickle channels, and all other structural components required for the basin to operate as intended. Repair and vegetate eroded areas as needed following inspection.

The following is a more detailed guideline for detention pond maintenance considerations:

Action	Maintenance Objective	Frequency of Action
Lawn mowing and lawn care	Occasional mowing to limit unwanted vegetation. Maintain irrigated turf grass as 2 to 4 inches tall and non-irrigated natives grasses at 4 to 6 inches.	Routine - Depending on aesthetic requirements.
Debris and litter removal	Remove debris and litter from the entire pond to minimize outlet clogging and improve aesthetics.	Routine - Including annual, pre-storm season (April and May) and following significant rainfall events.
Erosion and sediment control	Repair and revegetate eroded areas in the basins and channels.	Non-routine - Periodic and repair as necessary based on inspection.
Structural	Repair pond inlets, outlets, forebays, low flow channel liners, and energy dissipaters as needed.	Non-routine - Repair as needed based on regular inspections.
Inspections	Inspect basins to insure that the basin continues to function as initially intended. Examine the outlet for clogging, erosion, slumping, excessive sedimentation levels, overgrowth, embankment and spillway integrity, and damage to any structural element.	Routine - Annual inspection of hydraulic and structural facilities. Also check for obvious problems during routine maintenance visits, especially for plugging of outlets.
Nuisance control	Address odor, insects, and overgrowth issues associated with stagnant or standing water in the bottom zone.	Non-routine - Handle as necessary per inspection or complaints.
Sediment Removal	Remove accumulated sediment from the forebay and the bottom of the basin.	Non-routine - Performed when sediment accumulation occupies 20 percent of the WQCV. This may vary considerably, but expect to do this as necessary per inspection. The forebay will require more frequent cleanout than other areas of the pond.

7. SUMMARY AND CONCLUSIONS

7.1 Design Summary

The proposed drainage plan follows Weld County's Charter and County Code (WC-CCC) and the Weld County Engineering and Construction Criteria (WCECC). UDFCD Rational (UD-Rational) and pond sizing software (UD-Detention) spread sheet were used to perform many of the calculations for drainage analysis. The drainage system with detention pond was designed to be in place from start of construction phase and will remain to service the site through its life.

This report and the calculations have been produced after proper due diligence for the site and surrounding adjacent offsite areas. The drainage design is adequate to protect public health, safety, and general welfare and has no adverse impacts on public rights-of-way or offsite properties. The stormwater management designs provided in this report have been performed in accordance with Weld County Requirements.

Raejanna Church
Project Engineer
February 26, 2021

Katie Harter, P.E.
Lead Engineer



APPENDIX A – REFERENCE DOCUMENTS, SOFTWARE AND WEBSITES

Table 2: Reference Documents

Document	Abbreviation
<i>“Urban Storm Drainage Criteria Manual: Volume 1 – Management, Hydrology, and Hydraulics”</i> , by Urban Drainage & Flood Control District; Revised August 2018; Originally Published September 1969	USDCM-1
<i>“Urban Storm Drainage Criteria Manual: Volume 1”</i> , by Urban Drainage & Flood Control District; Revised April 2008; Originally Published June 2001	USDCM-1-2008
<i>“Urban Storm Drainage Criteria Manual: Volume 2 – Structures, Storage, and Recreation”</i> , by Urban Drainage & Flood Control District; Updated September 2017; Originally Published September 1969	USDCM-2
<i>“Urban Storm Drainage Criteria Manual: Volume 3 – Best Management Practices”</i> , by Urban Drainage & Flood Control District; Updated October 2019; Originally Published September 1992	USDCM-3
<i>“Weld County Charter and County Code – Supplement 63”</i> , by Weld County, CO; Codified through Ordinance No. 2019-14, adopted September 23, 2019; Updated December 19, 2019.	WC-CCC
<i>“Weld County Engineering and Construction Guidelines”</i> , by Weld County, CO; Updated July 2017; Originally Published April 2012.	WC-ECG

Table 3: Reference Software and Websites

Document	Abbreviation
“ <i>Channel Design – UD Channel 1.05</i> ”, XLS. file by Urban Drainage & Flood Control District; released October 2013. https://udfcd.org/software	UD-Channel
“ <i>Culvert Design – UD Culvert 3.05</i> ”, XLS. file by Urban Drainage & Flood Control District; released November 2017. https://udfcd.org/software	UD-Culvert
“ <i>Detention Design – UD Detention 2.35</i> ”, XLS. file by Urban Drainage & Flood Control District; released January 2015. https://udfcd.org/software	UD-Detention
“ <i>Peak Runoff Prediction by Rational Method – UD Rational 2.00</i> ”, XLS. file by Urban Drainage & Flood Control District; released May 2017. https://udfcd.org/software	UD-Rational
“ <i>AutoCAD Civil 3D - 2018</i> ”, by Autodesk; released 2018.	CAD-C3D
“ <i>NOAA Atlas 14</i> ”, by the National Oceanic and Atmospheric Administration, Updated April 21, 2017 https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html	NOAA-14
“ <i>USDA/NRCS Web Soil Survey</i> ”, by National Resource Conservation Society. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx	NRCS

APPENDIX B – ABBREVIATIONS AND ACRONYMS

ABC	Aggregate Base Course
ac	acres
AMSL	Above Mean Sea Level
Avg.	Average
BEP	Bayswater Exploration and Production, LLC
BMP	Best Management Practice
C	Runoff Coefficient
CDOT	Colorado Department of Transportation
cfs	Cubic feet per second
COGCC	Colorado Oil and Gas Commission
cm	Centimeters
CM	Criteria Manual
ECD	Emissions Control Device
EURV	Excess Urban Runoff Volume
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft.	feet
fps	Feet Per Second
HEC-HMS	Hydrologic Engineering Center - Hydrologic Modeling System
hr.	hour
K	Conveyance Factor (UD-Rational) ¹³
LACT	Lease Automatic Custody Transfer
MHFD	Mile High Flood District
MLVT	Modular Large Volume Tanks
min.	minutes
RG	Rough Grade
RI	Recurrence interval (rainstorm)
TOC	Top of Concrete
UD	Urban Drainage

¹³Reference Table 3: Reference Software and Websites for additional information on this engineering reference document.

UDFCD	Urban Drainage and Flood Control District
USDCM-1	Urban Storm Drainage Criteria Manual – Volume 1 ¹⁴
USDCM-2	Urban Storm Drainage Criteria Manual – Volume 2 ¹⁴
USDCM-3	Urban Storm Drainage Criteria Manual – Volume 3 ¹⁴
WC	Weld County
WC-CCC	Weld County Charter and County Code ¹⁴
WC-ECG	Weld County Engineering and Construction Guidelines ¹⁴
WC-ED	Weld County Energy Department
WC-SDC	Weld County Storm Drainage Criteria ¹⁴
WC-SDC	Weld County Storm Drainage Criteria Addendum ¹⁴
WOGLA	Weld County Oil & Gas Location Assessment (permit)
WQCV	Water Quality Capture Volume

¹⁴ Reference Table 2: Reference Documents for additional information on this engineering reference document.

APPENDIX C – DRAINAGE REPORT CHECKLIST

Drainage Report Checklist



Project Name:

The purpose of this checklist is to assist the applicant's Engineer with developing a drainage report that supports the intent of the Weld County Code using commonly accepted engineering practices and methodologies.

Is the project in the MS4? ☐ Yes ☐ No If yes, the following requirements in blue apply. See Chapter 8, Article IX of the Weld County Code.

Report Content

- ☐ Weld County Case Number
- ☐ Certificate of Compliance signed and stamped by a Colorado Licensed PE
- ☐ Description/Scope of Work
- ☐ Location (County Roads, S-T-R)
- ☐ Nearby water features and ownership
- ☐ Total acres vs. developed acres
- ☐ Hydrological soil types/maps
- ☐ FEMA Flood Zones
- ☐ Urbanizing or non-urbanizing
- ☐ Methodologies used for report & analysis (full spectrum is not accepted)
- ☐ Base Design Standard used for permanent control measure design in the MS4
- ☐ Discussion of offsite drainage routing
- ☐ Conclusion statement indicating that the design will adequately protect public health, safety, and general welfare and have no adverse impacts on public rights-of-way or offsite properties

Hydrology and Hydraulic Analysis

- ☐ Design Storm / Rainfall Information (NOAA Atlas or Local Data)
- ☐ Release Rate calculations
- ☐ Post construction site imperviousness
- ☐ Hydrologic calculations (historic & developed basins)
- ☐ Hydraulic calculations for proposed drainage improvements (swales, culverts, riprap, pond, outlet, spillway, WQCV outlet, etc.)
- ☐ Detention/WQCV calculations

Construction Drawings

- ☐ Stamped by PE
- ☐ Engineering scale & north arrow
- ☐ Property lines, rights-of-way, and easements
- ☐ 1' Contours & elevations (existing & proposed)
- ☐ Pre- and post-development drainage basins
- ☐ Arrows depicting flow direction
- ☐ Time of concentration critical path
- ☐ Drainage design points
- ☐ Improvements labeled
- ☐ Permanent control measure and associated drainage features labeled 'No Build/No Storage', include design volume
- ☐ Cross sections for open channels, profiles for pipes
- ☐ Elevations for inverts, flow lines, top of grates, orifice(s), etc.
- ☐ Pipe specs (size, material, length, slope)
- ☐ Outlet and spillway details

Maintenance Plan

- ☐ Frequency of onsite inspections
- ☐ Repairs, if needed
- ☐ Cleaning of sediment and debris
- ☐ Vegetation maintenance
- ☐ Manufacturer maintenance specifications, if applicable

Other Required Documents (If Applicable)

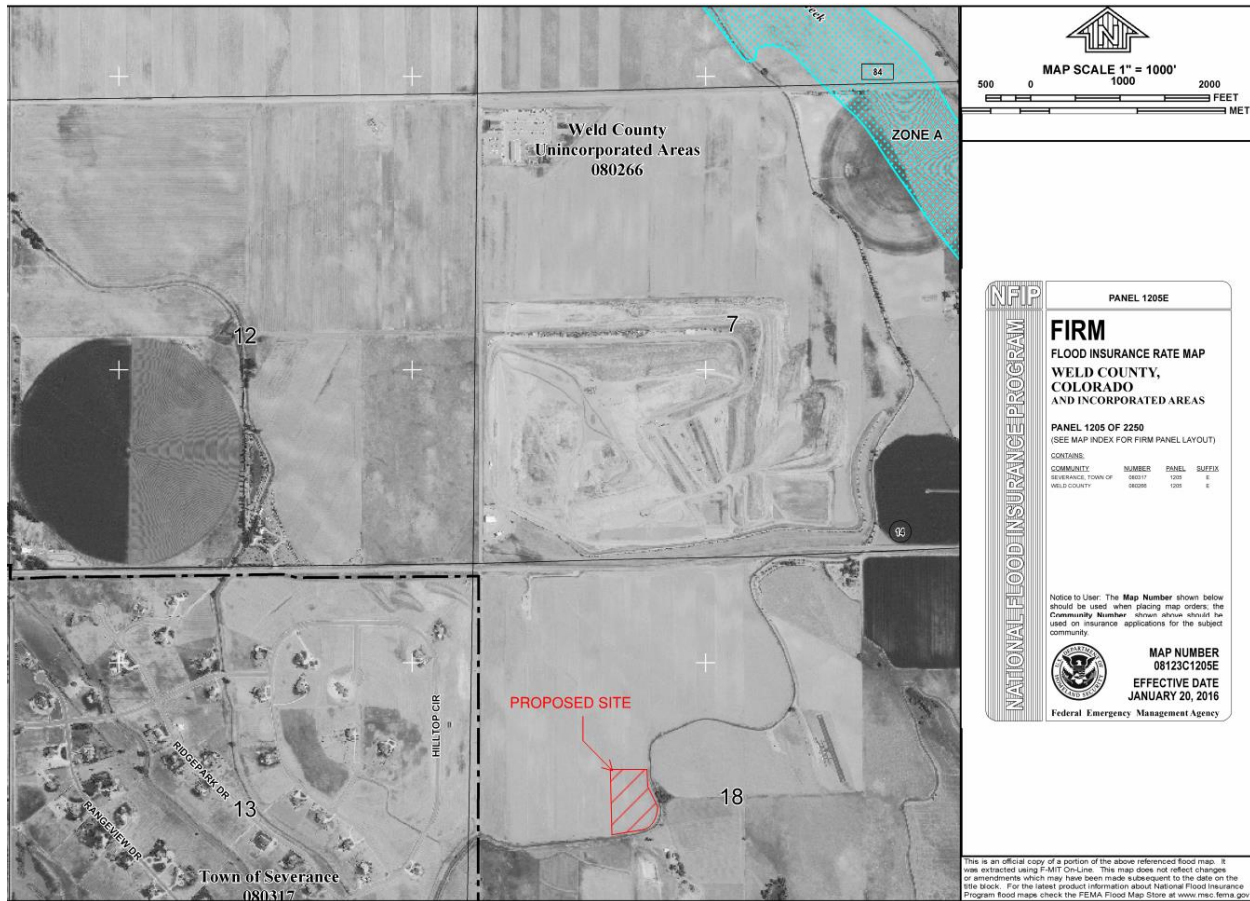
- ☐ Variance Request and documentation– explain hardship, applicable code section, and proposed mitigation. Variances will not be granted for the Base Design Standard requirement in the MS4.

Highlighted Items = Minimum Requirements for Preliminary Drainage Report
Note: Additional information may be necessary on a case by case basis

APPENDIX D – VICINITY MAP



APPENDIX E – FEMA MAP



APPENDIX F – NOAA ATLAS 14 PRECIPITATION FREQUENCY TABLE



NOAA Atlas 14, Volume 8, Version 2
Location name: Ault, Colorado, USA*
Latitude: 40.5746°, Longitude: -104.8263°
Elevation: 5078.88 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, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

PF tabular

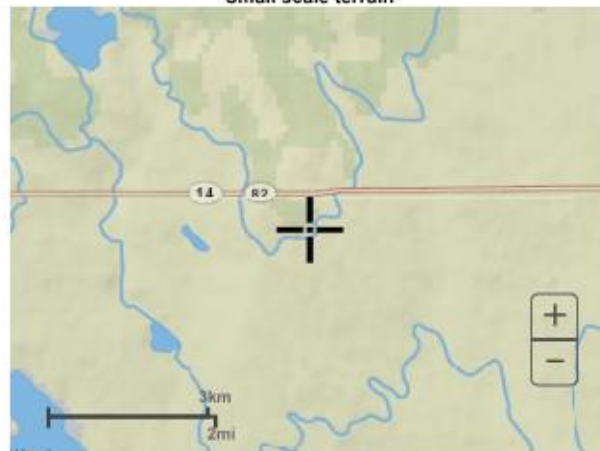
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.241 (0.193-0.301)	0.291 (0.232-0.363)	0.387 (0.307-0.484)	0.481 (0.379-0.604)	0.632 (0.490-0.846)	0.765 (0.573-1.03)	0.913 (0.657-1.25)	1.08 (0.740-1.52)	1.32 (0.867-1.90)	1.52 (0.963-2.19)
10-min	0.354 (0.282-0.441)	0.426 (0.339-0.531)	0.566 (0.450-0.709)	0.704 (0.555-0.885)	0.925 (0.717-1.24)	1.12 (0.839-1.51)	1.34 (0.962-1.84)	1.58 (1.08-2.22)	1.93 (1.27-2.78)	2.23 (1.41-3.21)
15-min	0.431 (0.344-0.538)	0.519 (0.414-0.648)	0.691 (0.548-0.864)	0.859 (0.677-1.08)	1.13 (0.874-1.51)	1.37 (1.02-1.84)	1.63 (1.17-2.24)	1.93 (1.32-2.71)	2.36 (1.55-3.39)	2.72 (1.72-3.91)
30-min	0.585 (0.467-0.729)	0.702 (0.559-0.876)	0.931 (0.739-1.16)	1.16 (0.912-1.45)	1.52 (1.18-2.04)	1.84 (1.38-2.48)	2.20 (1.59-3.03)	2.60 (1.79-3.66)	3.19 (2.10-4.59)	3.68 (2.33-5.30)
60-min	0.720 (0.574-0.898)	0.863 (0.688-1.08)	1.15 (0.912-1.44)	1.43 (1.13-1.80)	1.90 (1.48-2.55)	2.31 (1.74-3.12)	2.78 (2.00-3.82)	3.30 (2.27-4.64)	4.07 (2.67-5.85)	4.71 (2.98-6.77)
2-hr	0.855 (0.686-1.06)	1.02 (0.821-1.27)	1.37 (1.09-1.70)	1.71 (1.36-2.13)	2.28 (1.78-3.04)	2.78 (2.11-3.72)	3.35 (2.44-4.58)	3.99 (2.77-5.58)	4.94 (3.28-7.05)	5.73 (3.66-8.16)
3-hr	0.928 (0.748-1.14)	1.11 (0.893-1.37)	1.48 (1.19-1.83)	1.86 (1.48-2.30)	2.47 (1.95-3.29)	3.03 (2.30-4.04)	3.66 (2.67-4.97)	4.37 (3.05-6.07)	5.41 (3.62-7.69)	6.29 (4.05-8.91)
6-hr	1.06 (0.860-1.30)	1.28 (1.04-1.57)	1.72 (1.38-2.10)	2.14 (1.72-2.63)	2.82 (2.23-3.69)	3.42 (2.61-4.49)	4.08 (3.00-5.48)	4.83 (3.39-6.63)	5.92 (3.98-8.30)	6.82 (4.43-9.57)
12-hr	1.26 (1.02-1.52)	1.51 (1.23-1.82)	1.97 (1.60-2.40)	2.42 (1.95-2.95)	3.11 (2.46-4.01)	3.72 (2.85-4.82)	4.38 (3.24-5.79)	5.11 (3.62-6.92)	6.16 (4.19-8.54)	7.03 (4.62-9.77)
24-hr	1.51 (1.24-1.82)	1.76 (1.45-2.12)	2.24 (1.83-2.70)	2.69 (2.19-3.25)	3.40 (2.71-4.33)	4.01 (3.11-5.15)	4.69 (3.50-6.15)	5.43 (3.88-7.29)	6.51 (4.47-8.94)	7.40 (4.91-10.2)
2-day	1.74 (1.43-2.07)	2.04 (1.68-2.43)	2.58 (2.12-3.08)	3.07 (2.51-3.68)	3.82 (3.05-4.78)	4.44 (3.45-5.62)	5.11 (3.84-6.60)	5.84 (4.20-7.72)	6.87 (4.75-9.30)	7.70 (5.17-10.5)
3-day	1.90 (1.57-2.25)	2.21 (1.83-2.61)	2.76 (2.27-3.27)	3.26 (2.67-3.88)	4.01 (3.21-4.99)	4.64 (3.62-5.83)	5.32 (4.01-6.83)	6.05 (4.38-7.96)	7.09 (4.94-9.55)	7.93 (5.36-10.7)
4-day	2.02 (1.68-2.38)	2.34 (1.94-2.76)	2.91 (2.41-3.44)	3.42 (2.81-4.07)	4.19 (3.37-5.19)	4.83 (3.78-6.04)	5.51 (4.17-7.05)	6.25 (4.54-8.18)	7.30 (5.10-9.77)	8.14 (5.52-11.0)
7-day	2.28 (1.91-2.68)	2.68 (2.24-3.15)	3.36 (2.79-3.95)	3.94 (3.26-4.65)	4.78 (3.84-5.84)	5.45 (4.28-6.73)	6.15 (4.67-7.75)	6.87 (5.02-8.88)	7.87 (5.53-10.4)	8.66 (5.92-11.6)
10-day	2.52 (2.11-2.94)	2.98 (2.49-3.48)	3.74 (3.12-4.37)	4.37 (3.63-5.14)	5.26 (4.23-6.36)	5.95 (4.68-7.29)	6.65 (5.07-8.32)	7.37 (5.40-9.45)	8.34 (5.88-10.9)	9.08 (6.25-12.1)
20-day	3.26 (2.75-3.77)	3.79 (3.19-4.38)	4.65 (3.90-5.39)	5.35 (4.47-6.24)	6.32 (5.10-7.54)	7.05 (5.58-8.52)	7.78 (5.97-9.61)	8.51 (6.28-10.8)	9.46 (6.74-12.3)	10.2 (7.08-13.4)
30-day	3.84 (3.25-4.42)	4.42 (3.74-5.09)	5.35 (4.52-6.18)	6.12 (5.13-7.09)	7.14 (5.80-8.47)	7.92 (6.30-9.51)	8.68 (6.69-10.7)	9.44 (7.01-11.9)	10.4 (7.46-13.4)	11.1 (7.81-14.6)
45-day	4.52 (3.84-5.18)	5.19 (4.41-5.95)	6.25 (5.29-7.18)	7.11 (5.99-8.19)	8.24 (6.71-9.70)	9.09 (7.26-10.8)	9.91 (7.68-12.1)	10.7 (8.00-13.4)	11.7 (8.46-15.0)	12.5 (8.81-16.3)
60-day	5.05 (4.31-5.77)	5.82 (4.96-6.64)	7.02 (5.96-8.04)	7.98 (6.74-9.17)	9.24 (7.54-10.8)	10.2 (8.14-12.1)	11.1 (8.58-13.4)	11.9 (8.91-14.8)	13.0 (9.37-16.5)	13.7 (9.73-17.8)

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.

[Back to Top](#)

Maps & aerals

Small scale terrain



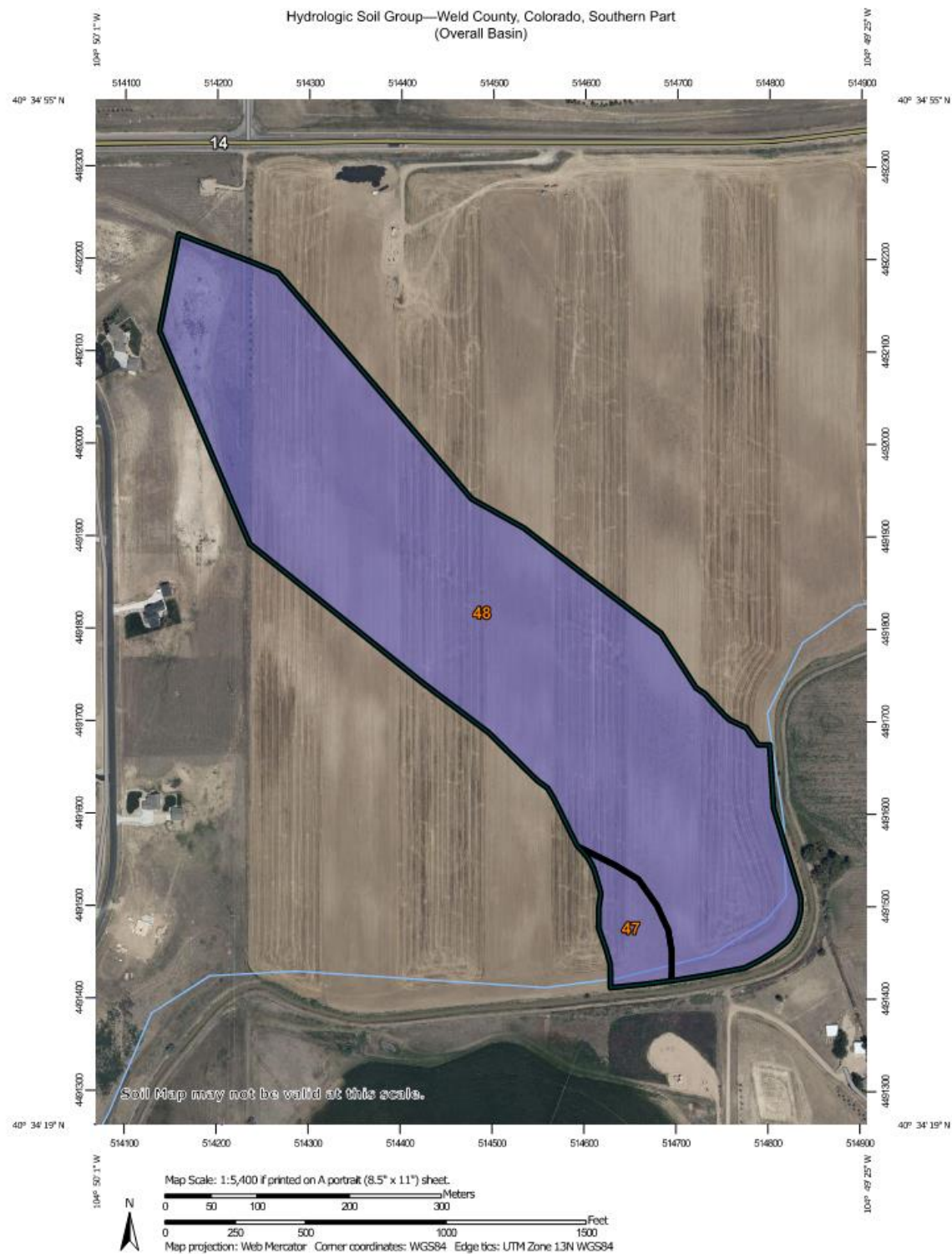
Large scale terrain



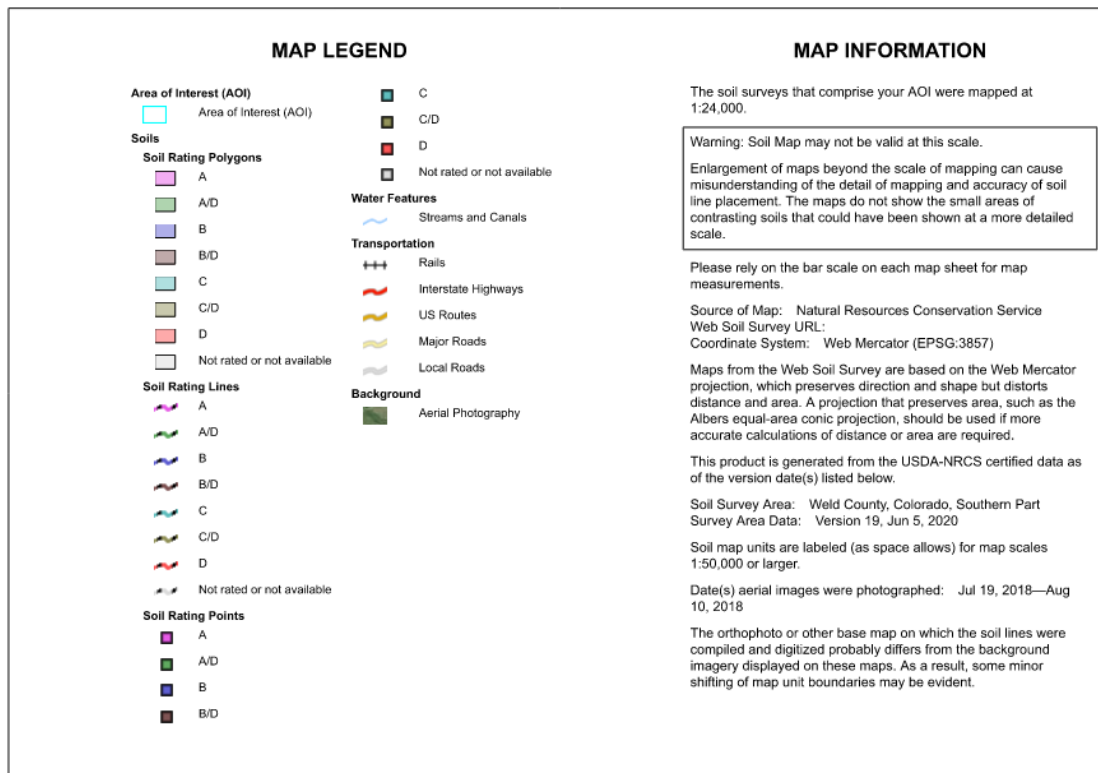
Large scale map



APPENDIX G – SOILS MAP



Hydrologic Soil Group—Weld County, Colorado, Southern Part
(Overall Basin)



Hydrologic Soil Group—Weld County, Colorado, Southern Part

Overall Basin

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
47	Olney fine sandy loam, 1 to 3 percent slopes	B	2.0	4.3%
48	Olney fine sandy loam, 3 to 5 percent slopes	B	45.1	95.7%
Totals for Area of Interest			47.1	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

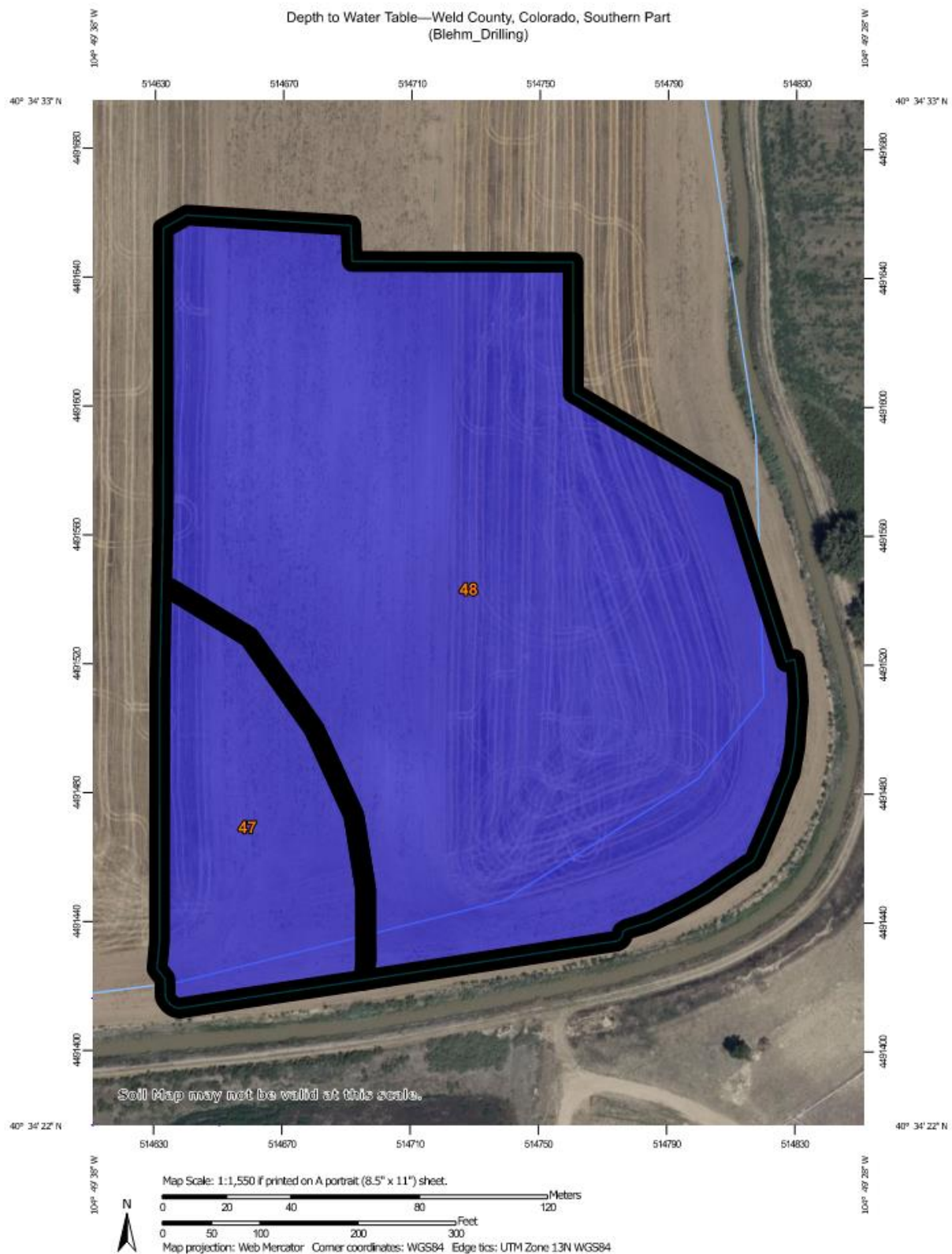


Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

2/19/2021
Page 3 of 4





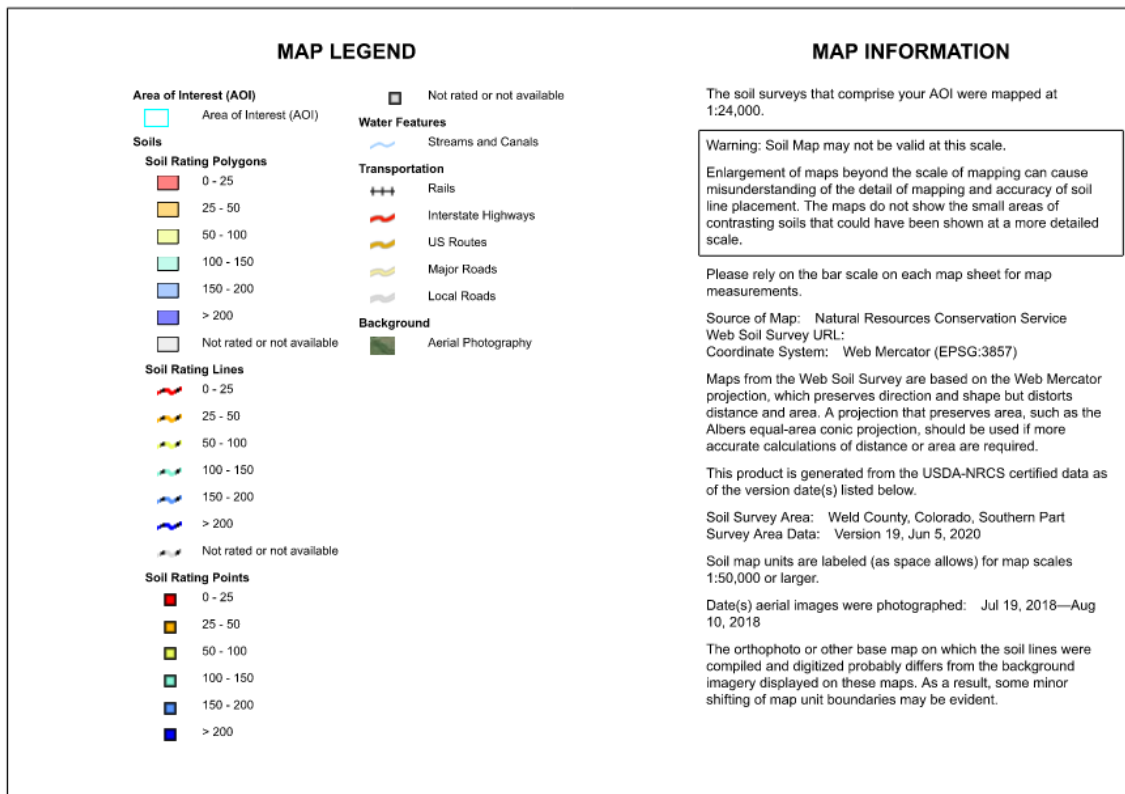
Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey



9/13/2020
Page 1 of 3

Depth to Water Table—Weld County, Colorado, Southern Part
(Blehm_Drilling)



Depth to Water Table

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
47	Olney fine sandy loam, 1 to 3 percent slopes	>200	1.6	16.5%
48	Olney fine sandy loam, 3 to 5 percent slopes	>200	7.9	83.5%
Totals for Area of Interest			9.5	100.0%

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

Appendix H – GROUND SURFACE IMPERVIOUS CALCULATIONS

COMPOSITE BASIN-WEIGHTED "% IMPERVIOUS" CALCULATIONS
-REFERENCE :UDFCD USDCM VI Table 6-3 Recommended Percentage Imperviousness Values-

		Undeveloped areas			Street						
		Historic flow analysis	Greenbelts, Agricultural	Off-site flow analysis (when land use not defined)	Paved	Gravel	Recycled asphalts	Drives and walks	Roofs		
CONSTRUCTION (DRILLING) PHASE	% Imperv.	2.00%	2.00%	45.00%	100.00%	40.00%	75.00%	90.00%	90.00%		
	BASIN 1 DESIGN POINT 1	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 1 - AREA 1A					6.33				6.33	40.00%
	DESIGN POINT 1 - AREA 1B				0.61					0.61	100.00%
	DESIGN POINT 1 - AREA 1C		2.32							2.32	2.00%
		0.00	2.32	0.00	0.61	6.33	0.00	0.00	0.00	9.26	34.41%
	BASIN 1 DESIGN POINT 2	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 2 - AREA 2A					0.76				0.76	40.00%
	DESIGN POINT 2 - AREA 2B				0.20					0.20	100.00%
	DESIGN POINT 2 - AREA 2C		0.59							0.59	2.00%
		0.00	0.59	0.00	0.20	0.76	0.00	0.00	0.00	1.55	33.35%
	BASIN 1 DESIGN POINT 3	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 3 - AREA 3A					5.56				5.56	40.00%
	DESIGN POINT 3 - AREA 3B				0.15					0.15	100.00%
	DESIGN POINT 3 - AREA 3C		0.40							0.40	2.00%
		0.00	0.40	0.00	0.15	5.56	0.00	0.00	0.00	6.11	36.53%
	BASIN OS-1 DESIGN POINT 4	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 4 - AREA 4A		2.96							2.96	2.00%
	DESIGN POINT 4 - AREA 4B									0.00	0.00%
		0.00	2.96	0.00	0.00	0.00	0.00	0.00	0.00	2.96	2.00%
	BASIN OS-2 DESIGN POINT 5	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 5 - AREA 5A					33.30				33.30	2.00%
	DESIGN POINT 5 - AREA 5B		0.00							0.00	0.00%
		0.00	0.00	0.00	0.00	33.30	0.00	0.00	0.00	33.30	2.00%
INTERIM-RECLAMATION (PRODUCTION) PHASE	BASIN 1 DESIGN POINT 6	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 6 - AREA 6A					4.65				4.65	40.00%
	DESIGN POINT 6 - AREA 6B				0.61					0.60	100.00%
	DESIGN POINT 6 - AREA 6C		4.01							4.01	2.00%
		0.00	4.01	0.00	0.61	4.65	0.00	0.00	0.00	9.26	20.95%
	BASIN 1 DESIGN POINT 7	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 7 - AREA 7A					0.76				0.76	40.00%
	DESIGN POINT 7 - AREA 7B				0.20					0.20	100.00%
	DESIGN POINT 7 - AREA 7C		0.37							0.37	2.00%
		0.00	0.37	0.00	0.20	0.76	0.00	0.00	0.00	1.33	23.41%
	BASIN 1 DESIGN POINT 8	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 8 - AREA 8A					3.88				3.88	40.00%
	DESIGN POINT 8 - AREA 8B				0.40					0.40	
	DESIGN POINT 8 - AREA 8C		0.05							0.05	2.00%
		0.00	0.05	0.00	0.40	3.88	0.00	0.00	0.00	4.33	35.87%
	BASIN OS-3 DESIGN POINT 9	Area	Area	Area	Area	Area	Area	Area	Area	Total Area	Percent Imperv.
	DESIGN POINT 9 - AREA 5A		1.53							1.53	2.00%
		0.00	1.53	0.00	0.00	0.00	0.00	0.00	0.00	1.53	2.00%



APPENDIX I – HYDROLOGIC CALCULATIONS

EXISTING CONDITIONS

Calculation of Peak Runoff using Rational Method																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
Designer: Raejanna Church				Version 2.00 released May 2017				<div>Clear Worksheet</div>				<div>$t_1 = \frac{0.395(1.1 - C_s)\sqrt{L_1}}{S_1^{0.33}}$</div>				<div>Computed $t_c = t_1 + t_i$</div>				<div>$t_{\text{minimum}} = 5 \text{ (urban)}$ $t_{\text{minimum}} = 10 \text{ (non-urban)}$</div>				<div>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)</div>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Company: Ascent Geomatics Solutions				<div>Date: 2/22/2021</div>				<div>Cells of this color are for required user-input</div>				<div>$t_i = \frac{L_1}{60K\sqrt{S_1}} = \frac{L_1}{60V_1}$</div>				<div>Regional $t_c = (26 - 17i) + \frac{L_1}{60(14i + 9)\sqrt{S_1}}$</div>				<div>Selected $t_c = \max\{t_{\text{minimum}}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$</div>				<div>1-hour rainfall depth, P1 (in) = <div><div>2-yr</div><div>5-yr</div><div>10-yr</div><div>25-yr</div><div>50-yr</div><div>100-yr</div><div>500-yr</div></div><div><div>1.15</div><div>1.43</div><div></div><div></div><div></div><div>2.78</div><div></div></div><div>User Input</div></div>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Project: Blehm 18-I Pad - Existing Conditions				<div>Cells of this color are for optional override values</div>				<div>Cells of this color are for calculated results based on overrides</div>																<div>Rainfall Intensity Equation Coefficients = <div><div>a</div><div>b</div><div>c</div></div><div><div>28.50</div><div>10.00</div><div>0.786</div></div><div>$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$</div><div>Use Denver Area Intensity Equation Coefficients</div><div>$Q(cfs) = CIA$</div></div>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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PROPOSED CONDITIONS

Calculation of Peak Runoff using Rational Method																																						
Designer: Raejanna Church				Version 2.00 released May 2017				<div>Clear Worksheet</div>				<div>$t_1 = \frac{0.395(1.1 - C_s)\sqrt{L_1}}{S_1^{0.33}}$</div>				<div>Computed $t_c = t_1 + t_i$</div>				<div>$t_{\text{minimum}} = 5$ (urban) $t_{\text{minimum}} = 10$ (non-urban)</div>				<div>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)</div>														
Company: Ascent Geomatics Solutions				<div>Date: 2/22/2021</div>				<div>Cells of this color are for required user-input</div>				<div>$t_i = \frac{L_1}{60K\sqrt{S_c}} = \frac{L_1}{60V_t}$</div>				<div>Regional $t_c = (26 - 17i) + \frac{L_1}{60(14i + 9)\sqrt{S_c}}$</div>				<div>Selected $t_c = \max\{t_{\text{minimum}}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$</div>				<div>1-hour rainfall depth, P1 (in) = <div><div>2-yr</div><div>5-yr</div><div>10-yr</div><div>25-yr</div><div>50-yr</div><div>100-yr</div><div>500-yr</div></div><div><div>1.15</div><div>1.43</div><div></div><div></div><div></div><div>2.78</div><div></div></div><div>User Input</div></div>														
Project: Blehm 18-I Pad - Proposed Conditions				<div>Cells of this color are for optional override values</div>				<div>Cells of this color are for calculated results based on overrides</div>				<div>Rainfall Intensity Equation Coefficients = <div><div>a</div><div>b</div><div>c</div></div><div><div>28.50</div><div>10.00</div><div>0.786</div></div></div>				<div>$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$</div>				<div>Use Denver Area Intensity Equation Coefficients</div>				<div>$Q(cfs) = CIA$</div>														
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 ₁ (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S ₁ (ft/ft)	Overland Flow Time t ₁ (min)	Channelized Flow Length L ₁ (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S ₁ (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V ₁ (ft/sec)	Channelized Flow Time t ₁ (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
Basin 1 Design Point 1	9.26	B	34.4	0.24	0.27	0.33	0.47	0.52	0.59	0.66	100.00	5076.50	5076.21	0.003	22.59	1079.64	5076.21	5073.70	0.002	10	0.48	37.32	59.91	47.16	47.16		1.36	1.69			3.29		3.39	5.25			17.88	
Basin 1 Design Point 2	1.55	B	33.4	0.23	0.26	0.33	0.46	0.51	0.58	0.66	100.00	5076.70	5076.50	0.002	25.81	722.21	5076.50	5074.50	0.003	10	0.53	22.87	59.87	47.16	59.87		1.16	1.45			2.81		2.91	4.56			12.51	
Basin 1 Design Point 3	6.11	B	36.5	0.26	0.29	0.35	0.48	0.53	0.60	0.67	100.00	5076.50	5076.21	0.003	22.11	658.78	5076.21	5074.20	0.003	10	0.55	19.88	48.68	37.06	48.36		1.59	1.97			3.84		0.64	1.00			3.46	
Basin OS-1 Design Point 4	2.96	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	5101.75	5101.50	0.003	31.03	2026.85	5101.50	5074.70	0.013	5	0.57	58.75	41.98	57.32	41.98		1.34	1.67			3.24		0.56	0.88			2.41	
Basin OS-2 Design Point 5	33.30	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	5103.50	5103.00	0.005	24.69	2831.54	5103.00	5069.00	0.012	5	0.55	86.13	94.84	65.32	94.84		1.03	1.28			2.48		0.41	3.11			35.94	
Basin 1 Design Point 6	9.26	B	21.0	0.13	0.16	0.23	0.38	0.44	0.52	0.61	100.00	5076.70	5076.65	0.001	45.78	1406.23	5076.65	5073.70	0.002	10	0.46	51.17	96.95	65.32	94.84		0.77	0.95			1.85		2.29	5.39			22.80	
Basin 1 Design Point 7	1.33	B	23.4	0.15	0.18	0.25	0.40	0.46	0.53	0.62	100.00	5076.70	5076.50	0.002	43.67	1047.67	5076.50	5074.20	0.002	10	0.47	37.27	94.84	65.32	94.84		1.10	1.36			2.65		1.59	2.86			12.86	
Basin 1 Design Point 8	4.33	B	35.9	0.25	0.28	0.35	0.47	0.53	0.59	0.67	100.00	5076.50	5076.21	0.003	27.02	468.96	5076.21	5074.20	0.004	10	0.65	11.94	65.62	52.37	64.29		1.27	1.58			3.08		0.30	0.52			2.19	
Basin OS-3 Design Point 9	1.53	B	2.0	0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	5081.50	5079.72	0.018	22.55	290.26	5079.72	5075.35	0.015	5	0.61	7.89	34.19	28.42	34.49		1.66	2.06			4.01		1.94	3.04			8.34	
				0.01	0.01	0.07	0.26	0.34	0.44	0.54	100.00	5081.50	5079.72	0.018	16.24	290.26	5079.72	5075.35	0.015	5	0.61	7.89	24.12	29.91	24.12		2.04	2.54			4.94		0.04	0.28			3.29	
				0.09	0.17				0.37																		2.10	2.61			5.08		0.29	0.68			2.87	

APPENDIX J – DETENTION / WQCV CALCULATION

Clear Worksheet

DETENTION VOLUME BY THE MODIFIED FAA METHOD

Project: **Blehm 18-I Pad - Drilling**

Basin ID: **Basin 1 Design Point 1 Drilling**

(For catchments less than 160 acres only. For larger catchments, use hydrograph routing method)
(NOTE: for catchments larger than 90 acres, CUHP hydrograph and routing are recommended)

Determination of MINOR Detention Volume Using Modified FAA Method										Determination of MAJOR Detention Volume Using Modified FAA Method									
Design Information (Input): Catchment Drainage Imperviousness $I_p = 34.41$ percent Catchment Drainage Area $A = 9.260$ acres Predevelopment NRCS Soil Group $Type = B$ A, B, C, or D Return Period for Detention Control $T = 5$ years (2, 5, 10, 25, 50, or 100) Time of Concentration of Watershed $T_c = 60$ minutes Allowable Unit Release Rate $q = 0.18$ cfs/acre One-hour Precipitation $P_1 = 1.15$ inches Design Rainfall IDF Formula $i = C_1 \cdot P_1 / (C_2 + T_c) \cdot C_3$ Coefficient One $C_1 = 28.50$ Use this side of the worksheet for the MINOR (e.g. 2-year, 5-year, or 10-year) storage volume. Coefficient Two $C_2 = 10$ Coefficient Three $C_3 = 0.786$										Design Information (Input): Catchment Drainage Imperviousness $I_p = 34.41$ percent Catchment Drainage Area $A = 9.260$ acres Predevelopment NRCS Soil Group $Type = B$ A, B, C, or D Return Period for Detention Control $T = 100$ years (2, 5, 10, 25, 50, or 100) Time of Concentration of Watershed $T_c = 60$ minutes Allowable Unit Release Rate $q = 0.18$ cfs/acre One-hour Precipitation $P_1 = 2.78$ inches Design Rainfall IDF Formula $i = C_1 \cdot P_1 / (C_2 + T_c) \cdot C_3$ Coefficient One $C_1 = 28.50$ Use this side of the worksheet for the MAJOR (e.g. 25-year, 50-year, or 100-year) storage volume. Coefficient Two $C_2 = 10$ Coefficient Three $C_3 = 0.786$									
Determination of Average Outflow from the Basin (Calculated): Runoff Coefficient $C = 0.27$ Inflow Peak Runoff $Q_{p-in} = 2.91$ cfs Allowable Peak Outflow Rate $Q_{p-out} = 1.63$ cfs Mod. FAA Minor Storage Volume = 5.214 cubic feet Mod. FAA Minor Storage Volume = 0.120 acre-ft 1. Enter Rainfall Duration Incremental Increase Value Here (e.g. 5 for 5-Minutes)										Determination of Average Outflow from the Basin (Calculated): Runoff Coefficient $C = 0.48$ Inflow Peak Runoff $Q_{p-in} = 12.51$ cfs Allowable Peak Outflow Rate $Q_{p-out} = 1.63$ cfs Mod. FAA Major Storage Volume = 39.095 cubic feet Mod. FAA Major Storage Volume = 0.898 acre-ft Recalculate Results									
Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume acre-feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume acre-feet (output)	Storage Volume acre-feet (output)	Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume acre-feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume acre-feet (output)	Storage Volume acre-feet (output)						
0	0.00	0.000	0.00	0.00	0.000	0.000	0	0.00	0.000	0.00	0.00	0.000	0.000						
1	4.98	0.017	1.00	1.63	0.002	0.015	1	12.03	0.074	1.00	1.63	0.002	0.071						
2	4.65	0.032	1.00	1.63	0.004	0.028	2	11.24	0.138	1.00	1.63	0.004	0.133						
3	4.36	0.045	1.00	1.63	0.007	0.038	3	10.55	0.194	1.00	1.63	0.007	0.187						
4	4.12	0.057	1.00	1.63	0.009	0.048	4	9.95	0.244	1.00	1.63	0.009	0.235						
5	3.90	0.067	1.00	1.63	0.011	0.056	5	9.43	0.289	1.00	1.63	0.011	0.277						
6	3.71	0.077	1.00	1.63	0.013	0.063	6	8.96	0.329	1.00	1.63	0.013	0.316						
7	3.54	0.085	1.00	1.63	0.016	0.070	7	8.55	0.366	1.00	1.63	0.016	0.351						
8	3.38	0.093	1.00	1.63	0.018	0.075	8	8.17	0.400	1.00	1.63	0.018	0.382						
9	3.24	0.100	1.00	1.63	0.020	0.080	9	7.83	0.431	1.00	1.63	0.020	0.411						
10	3.11	0.107	1.00	1.63	0.022	0.085	10	7.52	0.460	1.00	1.63	0.022	0.438						
11	2.99	0.113	1.00	1.63	0.025	0.089	11	7.24	0.487	1.00	1.63	0.025	0.463						
12	2.89	0.119	1.00	1.63	0.027	0.092	12	6.98	0.513	1.00	1.63	0.027	0.486						
13	2.79	0.125	1.00	1.63	0.029	0.096	13	6.74	0.536	1.00	1.63	0.029	0.507						
14	2.70	0.130	1.00	1.63	0.031	0.099	14	6.52	0.559	1.00	1.63	0.031	0.527						
15	2.61	0.135	1.00	1.63	0.034	0.101	15	6.31	0.580	1.00	1.63	0.034	0.546						
16	2.53	0.139	1.00	1.63	0.036	0.104	16	6.12	0.599	1.00	1.63	0.036	0.564						
17	2.46	0.144	1.00	1.63	0.038	0.106	17	5.94	0.618	1.00	1.63	0.038	0.580						
18	2.39	0.148	1.00	1.63	0.040	0.108	18	5.77	0.636	1.00	1.63	0.040	0.596						
19	2.32	0.152	1.00	1.63	0.043	0.109	19	5.62	0.653	1.00	1.63	0.043	0.611						
20	2.26	0.156	1.00	1.63	0.045	0.111	20	5.47	0.670	1.00	1.63	0.045	0.625						
21	2.20	0.159	1.00	1.63	0.047	0.112	21	5.33	0.685	1.00	1.63	0.047	0.638						
22	2.15	0.163	1.00	1.63	0.049	0.114	22	5.20	0.700	1.00	1.63	0.049	0.651						
23	2.10	0.166	1.00	1.63	0.052	0.115	23	5.07	0.714	1.00	1.63	0.052	0.663						
24	2.05	0.169	1.00	1.63	0.054	0.116	24	4.96	0.728	1.00	1.63	0.054	0.674						
25	2.00	0.173	1.00	1.63	0.056	0.116	25	4.84	0.741	1.00	1.63	0.056	0.685						
26	1.96	0.176	1.00	1.63	0.058	0.117	26	4.74	0.754	1.00	1.63	0.058	0.696						
27	1.92	0.178	1.00	1.63	0.061	0.118	27	4.64	0.767	1.00	1.63	0.061	0.706						
28	1.88	0.181	1.00	1.63	0.063	0.118	28	4.54	0.778	1.00	1.63	0.063	0.716						
29	1.84	0.184	1.00	1.63	0.065	0.119	29	4.45	0.790	1.00	1.63	0.065	0.725						
30	1.80	0.186	1.00	1.63	0.067	0.119	30	4.36	0.801	1.00	1.63	0.067	0.734						
31	1.77	0.189	1.00	1.63	0.070	0.119	31	4.28	0.812	1.00	1.63	0.070	0.742						
32	1.74	0.191	1.00	1.63	0.072	0.120	32	4.20	0.822	1.00	1.63	0.072	0.751						
33	1.70	0.194	1.00	1.63	0.074	0.120	33	4.12	0.833	1.00	1.63	0.074	0.758						
34	1.67	0.196	1.00	1.63	0.076	0.120	34	4.05	0.842	1.00	1.63	0.076	0.766						
35	1.64	0.198	1.00	1.63	0.079	0.120	35	3.98	0.852	1.00	1.63	0.079	0.773						
36	1.62	0.200	1.00	1.63	0.081	0.120	36	3.91	0.861	1.00	1.63	0.081	0.781						
37	1.59	0.203	1.00	1.63	0.083	0.119	37	3.84	0.870	1.00	1.63	0.083	0.787						
38	1.56	0.205	1.00	1.63	0.085	0.119	38	3.78	0.879	1.00	1.63	0.085	0.794						
39	1.54	0.207	1.00	1.63	0.088	0.119	39	3.72	0.888	1.00	1.63	0.088	0.800						
40	1.51	0.209	1.00	1.63	0.090	0.119	40	3.66	0.896	1.00	1.63	0.090	0.807						
41	1.49	0.210	1.00	1.63	0.092	0.118	41	3.60	0.905	1.00	1.63	0.092	0.813						
42	1.47	0.212	1.00	1.63	0.094	0.118	42	3.55	0.913	1.00	1.63	0.094	0.818						
43	1.45	0.214	1.00	1.63	0.097	0.118	43	3.50	0.920	1.00	1.63	0.097	0.824						
44	1.43	0.216	1.00	1.63	0.099	0.117	44	3.45	0.928	1.00	1.63	0.099	0.829						
45	1.40	0.218	1.00	1.63	0.101	0.117	45	3.40	0.936	1.00	1.63	0.101	0.835						
46	1.39	0.219	1.00	1.63	0.103	0.116	46	3.35	0.943	1.00	1.63	0.103	0.840						
47	1.37	0.221	1.00	1.63	0.106	0.116	47	3.30	0.950	1.00	1.63	0.106	0.845						
48	1.35	0.223	1.00	1.63	0.108	0.115	48	3.26	0.957	1.00	1.63	0.108	0.849						
49	1.33	0.224	1.00	1.63	0.110	0.114	49	3.21	0.964	1.00	1.63	0.110	0.854						
50	1.31	0.226	1.00	1.63	0.112	0.114	50	3.17	0.971	1.00	1.63	0.112	0.859						
51	1.30	0.227	1.00	1.63	0.115	0.113	51	3.13	0.977	1.00	1.63	0.115	0.863						
52	1.28	0.229	1.00	1.63	0.117	0.112	52	3.09	0.984	1.00	1.63	0.117	0.867						
53	1.26	0.230	1.00	1.63	0.119	0.111	53	3.05	0.990	1.00	1.63	0.119	0.871						
54	1.25	0.232	1.00	1.63	0.121	0.111	54	3.01	0.997	1.00	1.63	0.121	0.875						
55	1.23	0.233	1.00	1.63	0.123	0.110	55	2.98	1.003	1.00	1.63	0.123	0.879						
56	1.22	0.235	1.00	1.63	0.126	0.109	56	2.94	1.009	1.00	1.63	0.126	0.883						
57	1.20	0.236	1.00	1.63	0.128	0.108	57	2.91	1.015	1.00	1.63	0.128	0.887						
58	1.19	0.237	1.00	1.63	0.130	0.107	58	2.87	1.021	1.00	1.63	0.130	0.890						
59	1.18	0.239	1.00	1.63	0.132	0.106	59	2.84	1.026	1.00	1.63	0.132	0.894						
60	1.16	0.240	1.00	1.63	0.135	0.106	60	2.81	1.032	1.00	1.63	0.135	0.898						

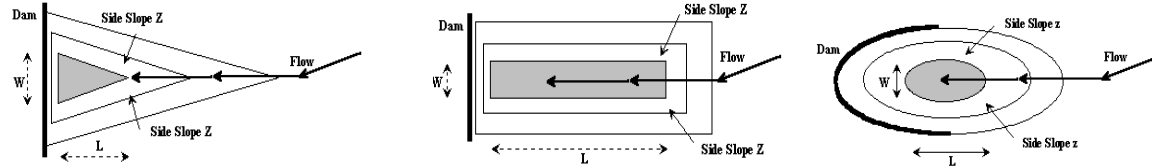
Mod. FAA Minor Storage Volume (cubic ft) = 5.214
Mod. FAA Minor Storage Volume (acre-ft) = 0.1197

Mod. FAA Major Storage Volume (cubic ft) = 39.095
Mod. FAA Major Storage Volume (acre-ft) = 0.8975

UDFCD DETENTION BASIN VOLUME ESTIMATING WORKBOOK Version 2.35, Released January 2015

Clear Worksheet **STAGE-STORAGE SIZING FOR DETENTION BASINS**

Project: **Blehm 18-I Pad**
Basin ID: **Basin 1**



Design Information (Input):

Width of Basin Bottom, W = ft
Length of Basin Bottom, L = ft
Dam Side-slope (H:V), Z_d = ft/ft

Check Basin Shape

Right Triangle OR...
Isosceles Triangle OR...
Rectangle OR...
Circle / Ellipse OR...
Irregular (Use Override values in cells G32:G52)

Auto-Fill Water Surface Elev.
Column

Storage Requirement from Sheet 'Modified FAA': **MINOR** 0.12 **MAJOR** 0.90 acre-ft.
Storage Requirement from Sheet 'Hydrograph': acre-ft.
Storage Requirement from Sheet 'Full-Spectrum': acre-ft.

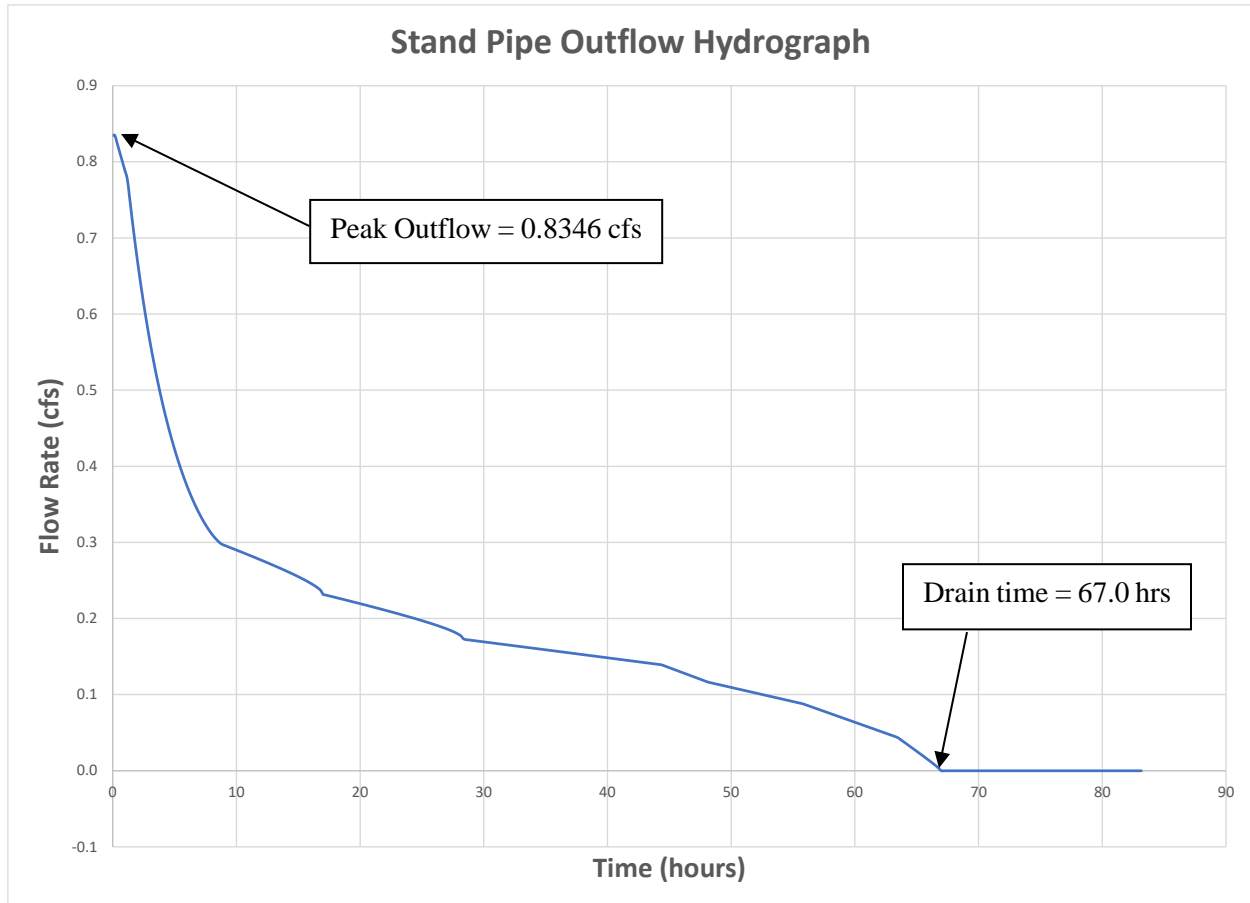
Labels for WQCV, Minor, & Major Storage Stages (input)	Water Surface Elevation ft (input)	Side Slope (H:V) ft/ft Below El. (input)	Basin Width at Stage ft (output)	Basin Length at Stage ft (output)	Surface Area at Stage ft ² (output)	Surface Area at Stage ft ² User Override	Volume Below Stage ft ³ (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
	5073.70					7	0	0.000	0.000	
	5073.80	4.00	0.00	0.00		3,666	184	0.084	0.004	
	5073.90	4.00	0.00	0.00		14,662	1,100	0.337	0.025	
	5074.00	4.00	0.00	0.00		21,941	2,930	0.504	0.067	
MINOR	5074.08	4.00	0.00	0.00		34,698	5,214	0.797	0.120	5,214.000
WQCV	5074.11	4.00	0.00	0.00		49,680	6,638	1.140	0.152	6,638.000
	5074.30	4.00	0.00	0.00		50,118	15,899	1.151	0.365	
	5074.40	4.00	0.00	0.00		50,556	20,933	1.161	0.481	
	5074.50	4.00	0.00	0.00		50,996	26,010	1.171	0.597	
	5074.60	4.00	0.00	0.00		51,437	31,132	1.181	0.715	
	5074.70	4.00	0.00	0.00		51,879	36,298	1.191	0.833	
MAJOR	5074.75	4.00	0.00	0.00		52,321	39,095	1.201	0.897	39,095.000
	5074.90	4.00	0.00	0.00		52,765	46,783	1.211	1.074	
	5075.00	4.00	0.00	0.00		53,209	52,081	1.222	1.196	
	5075.10	4.00	0.00	0.00		53,659	57,425	1.232	1.318	
	5075.20	4.00	0.00	0.00		54,105	62,813	1.242	1.442	
	5075.30	4.00	0.00	0.00		54,553	68,246	1.252	1.567	
	5075.40	4.00	0.00	0.00		55,001	73,724	1.263	1.692	
	5075.50	4.00	0.00	0.00		55,450	79,246	1.273	1.819	
	5075.60	4.00	0.00	0.00		55,901	84,814	1.283	1.947	
	5075.70	4.00	0.00	0.00		56,352	90,426	1.294	2.076	
	5075.80	4.00	0.00	0.00		56,805	96,084	1.304	2.206	
	5075.90	4.00	0.00	0.00		57,258	101,787	1.314	2.337	

Water Quality Capture Volume (WQCV)			
Imperviousness	I	34.41%	
BMP coefficient	a	1.0	
Watershed area	A	9.26 ac	
Water Quality Capture Volume	WQCV	0.1646 watershed-in	
Required storage volume	V_R	0.1270 ac-ft	5,532 ft ³
Design Volume	V_D	0.1524 ac-ft	6,638 ft³

Standpipe Geometry					
Pipe OD	4.500 in	0.375 ft	BOP	0.000	Pipe on Grade
Δ_{D-TOP}	0.375 ft		ToF	0.555 ft	6.7 in
Datum	0.0 ft		Bottom Orifice Min. Elev.	0.68 ft	8.2 in
Fitting "A" dimension	4.4 in	0.367 ft	Separation Δ_{BO-ToF}	1.198 ft	14.4 in
Required Separation between ToF/Pond Bottom and BO	0.125 ft	1.5 in	Orifice Rows for calculation	1	
Required Separation between top orifice row and cap	0.125 ft	1.5 in	Elev. Top Orifice Row	0.85	
Bottom Orifice Elev.	0.68 ft		Min. Elev. Cap	0.97 ft	
Standpipe Cap Elev.	1.00 ft		Lowest Orifice (required for pipe on grade)	0.17 ft	
Spillway Crest Elev.	1.30 ft				
Number of Pipes	2				

WQ Orifices		Lowest Orifice (Required for pipe on grade)	100-year Standpipe Cap Orifice	
# of Orifice Rows	2	1	Standpipe Height	1.00 ft
# of Orifices per row	2	6	Discharge Coefficient C_0	0.60
Orifice Spacing	2.0 in	3.0 in	Orifice Diameter D_0	4.000 in
Discharge Coefficient C_0	0.60	0.60	Cap Orifice Hole Factor	1.00
Orifice Diameter D_0	0.875 in	0.875 in	Orifice Area A_0	0.17453 ft ²
Orifice Area A_0	0.00835 ft ²	0.00835 ft ²	Wier Coefficient C_w	3.3

Outlet Pipe Maximum Capacity		
Manning Roughness Coefficient	n	0.013
Diameter	D	8 in
Slope	S	0.00770
Area	A	0.349 ft ²
Hydraulic Radius (full flow)	R	0.167 ft
Maximum Flow Rate Pipe	Q	1.06 cfs



Buoyancy Calculations				
Standpipe Horizontal Leg Length under Water		6.0 ft		
Standpipe Vertical Leg Length		1.3 ft		
Design Factor of Safety		1.5		
Standpipe Vertical Leg Centroid Elevation		0.650 ft		
Standpipe Horizontal Leg Buoyance Force		152 lb		
Standpipe Vertical Leg Buoyance Force		15 lb		
Standpipe Total Buoyance Force		166 lb		
Standpipe Weight (Resisting Force)		41 lb		
Required Anchor Weight		250 lb		
Required Volume of Rock for Anchor		1.6 ft^3		
Slope	S _U	4	4H:1V	Upstream Embankment
Starting Point Height	H ₁	0.0 ft	ft	
End Point Height	H ₂	1.30 ft		
Pipe Length	L	11.2 ft		
Slope	S _M	0	0H:1V	Middle Embankment
Starting Point Height	H ₃	0.00 ft		
End Point Height	H ₄	1.30 ft		
Pipe Length	L	14.5 ft		
Slope	S _D	3	3H:1V	Downstream Embankment
Starting Point Height	H ₅	1.30 ft		
End Point Height	H ₆	0.00 ft		
Pipe Length	L	12.6 ft		
Upstream Total Resisting Weight		510 lb		
Middle Embankment Total Resisting Weight		1321 lb		
Downstream Total Resisting Weight		574 lb		
Total Weight		2406 lb		
Upstream Buoyance Force		284 lb	U/S F.S.	1.8
Middle Embankment Buoyance Force		367 lb	M/B F.S.	3.6
Downstream Buoyance Force		319 lb	D/S F.S.	1.8
Total Buoyance Force		970 lb	Total F.S.	2.5
Buoyancy Parameters				
Pipe Diameter	D ₀	8.625 in		
Length of Pipe	L	44.0 ft		
Design depth of water		1.30 ft		
Pipe weight	P _w	5.62 lb/ft		
Unit weight of dry soil	Uw _d	120.0 lbs/ft^3		
Unit weight of water	Uw _w	62.4 lbs/ft^3		
Soil Porosity	ϕ	0.36		
Unit Weight of Rock for Anchor	Υ _R	160.0 lbs/ft^3		
Sectional Area of the pipe		0.41 ft^2		

Outlet Pipe Riprap

Ref: UDFCD V2. Hydraulic Structures and V1 Open Channel

BASIN 1

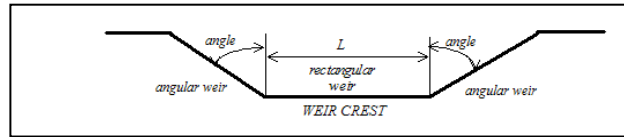
Outlet pipe	One 8 inch Pipe	
Pipe D (ft)	0.67	
Q(cfs)	0.835	
$Q/D^{2.5} =$	2.271	
$Q/D^{1.5} =$	1.522	
Yt/D (Tailwater Depth / Pipe Diameter)	0.4	(Ref: USDCM V2. CH 9 Hydraulic Structures Sec 3.2.3)
Riprap Type Min Requirement	Type L for a distance of 3D	Ref: Figure 9-38
Selected Riprap Type	Type L	
$Y_t = D \cdot 0.4$	0.268	Ref: USDCM V2 Hydraulic Structure Figure 9-35
Expansion Factor $1/2 \tan \theta$	5	Ref: USDCM V2 Hydraulic Structure Figure 9-35
V_{allowed}	5	Ref: USDCM V2 Hydraulic Structure Sec 3.2.1
$A_t = Q_{12\text{inch}} / V_{\text{allowed}}$	0.17	Ref: Equation MD-23
$L_{p\text{calculated}}$	1.38	Ref: USDCM V2 Hydraulic Structure Eqn 9-11
Check if $3D < L_{p\text{calculated}} < 10D$	NO	Ref: UDFCD V1 Major Drainage Sec 7.3
Select value such that $3D < L_p < 10D$	9D	
Use L_p	6	
$T_{\text{calculated}}$	2.21	
Use T	3.0	

Clear Worksheet

STAGE-DISCHARGE SIZING OF THE SPILLWAY

Project: **Blehm 18-I**

Basin ID: **Basin 1**



Design Information (input):

Bottom Length of Weir
Angle of Side Slope Weir
Elev. for Weir Crest
Coef. for Rectangular Weir
Coef. for Trapezoidal Weir

L = 13.00 feet
Angle = 75.96 degrees
EL. Crest = 5,075.00 feet
C_w = 3.00
C_t = 3.00

Degree Calcula

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)
5073.70	0.00	0.00	0.00	0.00
5073.80	0.00	0.00	0.00	0.00
5073.90	0.00	0.00	0.00	0.00
5074.00	0.00	0.00	0.00	0.00
5074.12	0.00	0.00	0.00	0.00
5074.13	0.00	0.00	0.00	0.00
5074.30	0.00	0.00	0.00	0.00
5074.40	0.00	0.00	0.00	0.00
5074.50	0.00	0.00	0.00	0.00
5074.60	0.00	0.00	0.00	0.00
5074.70	0.00	0.00	0.00	0.00
5074.80	0.00	0.00	0.00	0.00
5074.90	0.00	0.00	0.00	0.00
5075.00	0.00	0.00	0.00	0.00
5075.10	1.23	0.04	1.27	1.27
5075.20	3.49	0.21	3.70	3.70
5075.30	6.41	0.59	7.00	7.00
5075.40	9.87	1.21	11.08	11.08
5075.50	13.79	2.12	15.91	15.91
5075.60	18.13	3.35	21.47	21.47
5075.70	22.84	4.92	27.76	27.76
5075.80	27.91	6.87	34.77	34.77
5075.90	33.30	9.22	42.52	42.52

Q₁₀₀ = 12.51 cfs

DETENTION VOLUME BY THE MODIFIED FAA METHOD

Project: **Blehm 18-I Pad Production**

Basin ID: **Basin 1 - Design Point 6**

(For catchments less than 160 acres only. For larger catchments, use hydrograph routing method)
(NOTE: for catchments larger than 90 acres, CUHP hydrograph and routing are recommended)

Determination of MINOR Detention Volume Using Modified FAA Method										Determination of MAJOR Detention Volume Using Modified FAA Method									
Design Information (Input): Catchment Drainage Imperviousness $I_p = 20.95$ percent Catchment Drainage Area $A = 9.260$ acres Predevelopment NRCS Soil Group $Type = B$ A, B, C, or D Return Period for Detention Control $T = 5$ years (2, 5, 10, 25, 50, or 100) Time of Concentration of Watershed $T_c = 95$ minutes Allowable Unit Release Rate $q = 0.18$ cfs/acre One-hour Precipitation $P_1 = 1.15$ inches Design Rainfall IDF Formula $i = C_1 \cdot P_1 / (C_2 + T_c)^{C_3}$ Coefficient One $C_1 = 28.50$ Coefficient Two $C_2 = 10$ Coefficient Three $C_3 = 0.786$ (Use this side of the worksheet for the MINOR (e.g. 2-year, 5-year, or 10-year) storage volume.)										Design Information (Input): Catchment Drainage Imperviousness $I_p = 20.95$ percent Catchment Drainage Area $A = 9.260$ acres Predevelopment NRCS Soil Group $Type = B$ A, B, C, or D Return Period for Detention Control $T = 100$ years (2, 5, 10, 25, 50, or 100) Time of Concentration of Watershed $T_c = 95$ minutes Allowable Unit Release Rate $q = 0.18$ cfs/acre One-hour Precipitation $P_1 = 2.78$ inches Design Rainfall IDF Formula $i = C_1 \cdot P_1 / (C_2 + T_c)^{C_3}$ Coefficient One $C_1 = 28.50$ Coefficient Two $C_2 = 10$ Coefficient Three $C_3 = 0.786$ (Use this side of the worksheet for the MAJOR (e.g. 25-year, 50-year, or 100-year) storage volume.)									
Determination of Average Outflow from the Basin (Calculated): Runoff Coefficient $C = 0.20$ Inflow Peak Runoff $Qp-in = 1.57$ cfs Allowable Peak Outflow Rate $Qp-out = 1.63$ cfs Mod. FAA Minor Storage Volume = 3.122 cubic feet Mod. FAA Minor Storage Volume = 0.072 acre-ft										Determination of Average Outflow from the Basin (Calculated): Runoff Coefficient $C = 0.44$ Inflow Peak Runoff $Qp-in = 8.33$ cfs Allowable Peak Outflow Rate $Qp-out = 1.63$ cfs Mod. FAA Major Storage Volume = 35.343 cubic feet Mod. FAA Major Storage Volume = 0.811 acre-ft									
1 <- Enter Rainfall Duration Incremental Increase Value Here (e.g. 5 for 5-Minutes)										Recalculate Results									
Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume acre-feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume acre-feet (output)	Storage Volume acre-feet (output)	Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume acre-feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume acre-feet (output)	Storage Volume acre-feet (output)						
0	0.00	0.000	0.00	0.00	0.000	0.000	0	0.00	0.000	0.00	0.00	0.000	0.000						
1	4.98	0.013	1.00	1.63	0.002	0.010	1	12.03	0.068	1.00	1.63	0.002	0.065						
2	4.65	0.024	1.00	1.63	0.004	0.019	2	11.24	0.126	1.00	1.63	0.004	0.122						
3	4.36	0.033	1.00	1.63	0.007	0.027	3	10.55	0.178	1.00	1.63	0.007	0.171						
4	4.12	0.042	1.00	1.63	0.009	0.033	4	9.95	0.223	1.00	1.63	0.009	0.214						
5	3.90	0.050	1.00	1.63	0.011	0.039	5	9.43	0.265	1.00	1.63	0.011	0.253						
6	3.71	0.057	1.00	1.63	0.013	0.043	6	8.96	0.302	1.00	1.63	0.013	0.288						
7	3.54	0.063	1.00	1.63	0.016	0.047	7	8.55	0.336	1.00	1.63	0.016	0.320						
8	3.38	0.069	1.00	1.63	0.018	0.051	8	8.17	0.367	1.00	1.63	0.018	0.349						
9	3.24	0.074	1.00	1.63	0.020	0.054	9	7.83	0.396	1.00	1.63	0.020	0.375						
10	3.11	0.079	1.00	1.63	0.022	0.057	10	7.52	0.422	1.00	1.63	0.022	0.400						
11	2.99	0.084	1.00	1.63	0.025	0.059	11	7.24	0.447	1.00	1.63	0.025	0.422						
12	2.89	0.088	1.00	1.63	0.027	0.061	12	6.98	0.470	1.00	1.63	0.027	0.443						
13	2.79	0.092	1.00	1.63	0.029	0.063	13	6.74	0.492	1.00	1.63	0.029	0.462						
14	2.70	0.096	1.00	1.63	0.031	0.065	14	6.52	0.512	1.00	1.63	0.031	0.481						
15	2.61	0.100	1.00	1.63	0.034	0.066	15	6.31	0.531	1.00	1.63	0.034	0.498						
16	2.53	0.103	1.00	1.63	0.036	0.067	16	6.12	0.549	1.00	1.63	0.036	0.514						
17	2.46	0.107	1.00	1.63	0.038	0.068	17	5.94	0.567	1.00	1.63	0.038	0.529						
18	2.39	0.110	1.00	1.63	0.040	0.069	18	5.77	0.583	1.00	1.63	0.040	0.543						
19	2.32	0.113	1.00	1.63	0.043	0.070	19	5.62	0.599	1.00	1.63	0.043	0.556						
20	2.26	0.115	1.00	1.63	0.045	0.071	20	5.47	0.614	1.00	1.63	0.045	0.569						
21	2.20	0.118	1.00	1.63	0.047	0.071	21	5.33	0.628	1.00	1.63	0.047	0.581						
22	2.15	0.121	1.00	1.63	0.049	0.071	22	5.20	0.642	1.00	1.63	0.049	0.592						
23	2.10	0.123	1.00	1.63	0.052	0.072	23	5.07	0.655	1.00	1.63	0.052	0.603						
24	2.05	0.126	1.00	1.63	0.054	0.072	24	4.96	0.668	1.00	1.63	0.054	0.614						
25	2.00	0.128	1.00	1.63	0.056	0.072	25	4.84	0.680	1.00	1.63	0.056	0.624						
26	1.96	0.130	1.00	1.63	0.058	0.072	26	4.74	0.691	1.00	1.63	0.058	0.633						
27	1.92	0.132	1.00	1.63	0.061	0.072	27	4.64	0.703	1.00	1.63	0.061	0.642						
28	1.88	0.134	1.00	1.63	0.063	0.071	28	4.54	0.714	1.00	1.63	0.063	0.651						
29	1.84	0.136	1.00	1.63	0.065	0.071	29	4.45	0.724	1.00	1.63	0.065	0.659						
30	1.80	0.138	1.00	1.63	0.067	0.071	30	4.36	0.734	1.00	1.63	0.067	0.667						
31	1.77	0.140	1.00	1.63	0.070	0.070	31	4.28	0.744	1.00	1.63	0.070	0.675						
32	1.74	0.142	1.00	1.63	0.072	0.070	32	4.20	0.754	1.00	1.63	0.072	0.682						
33	1.70	0.144	1.00	1.63	0.074	0.069	33	4.12	0.763	1.00	1.63	0.074	0.689						
34	1.67	0.145	1.00	1.63	0.076	0.069	34	4.05	0.772	1.00	1.63	0.076	0.696						
35	1.64	0.147	1.00	1.63	0.079	0.068	35	3.98	0.781	1.00	1.63	0.079	0.702						
36	1.62	0.148	1.00	1.63	0.081	0.068	36	3.91	0.790	1.00	1.63	0.081	0.709						
37	1.59	0.150	1.00	1.63	0.083	0.067	37	3.84	0.798	1.00	1.63	0.083	0.715						
38	1.56	0.152	1.00	1.63	0.085	0.066	38	3.78	0.806	1.00	1.63	0.085	0.721						
39	1.54	0.153	1.00	1.63	0.088	0.065	39	3.72	0.814	1.00	1.63	0.088	0.726						
40	1.51	0.154	1.00	1.63	0.090	0.065	40	3.66	0.822	1.00	1.63	0.090	0.732						
41	1.49	0.156	1.00	1.63	0.092	0.064	41	3.60	0.829	1.00	1.63	0.092	0.737						
42	1.47	0.157	1.00	1.63	0.094	0.063	42	3.55	0.837	1.00	1.63	0.094	0.742						
43	1.45	0.159	1.00	1.63	0.097	0.062	43	3.50	0.844	1.00	1.63	0.097	0.747						
44	1.43	0.160	1.00	1.63	0.099	0.061	44	3.45	0.851	1.00	1.63	0.099	0.752						
45	1.40	0.161	1.00	1.63	0.101	0.060	45	3.40	0.858	1.00	1.63	0.101	0.757						
46	1.39	0.163	1.00	1.63	0.103	0.059	46	3.35	0.864	1.00	1.63	0.103	0.761						
47	1.37	0.164	1.00	1.63	0.106	0.058	47	3.30	0.871	1.00	1.63	0.106	0.765						
48	1.35	0.165	1.00	1.63	0.108	0.057	48	3.25	0.877	1.00	1.63	0.108	0.770						
49	1.33	0.166	1.00	1.63	0.110	0.056	49	3.21	0.884	1.00	1.63	0.110	0.774						
50	1.31	0.167	1.00	1.63	0.112	0.055	50	3.17	0.890	1.00	1.63	0.112	0.778						
51	1.30	0.168	1.00	1.63	0.115	0.054	51	3.13	0.896	1.00	1.63	0.115	0.782						
52	1.28	0.170	1.00	1.63	0.117	0.053	52	3.09	0.902	1.00	1.63	0.117	0.785						
53	1.26	0.171	1.00	1.63	0.119	0.052	53	3.05	0.908	1.00	1.63	0.119	0.789						
54	1.25	0.172	1.00	1.63	0.121	0.051	54	3.01	0.914	1.00	1.63	0.121	0.792						
55	1.23	0.173	1.00	1.63	0.123	0.049	55	2.98	0.919	1.00	1.63	0.123	0.796						
56	1.22	0.174	1.00	1.63	0.126	0.048	56	2.94	0.925	1.00	1.63	0.126	0.799						
57	1.20	0.175	1.00	1.63	0.128	0.047	57	2.91	0.930	1.00	1.63	0.128	0.802						
58	1.19	0.176	1.00	1.63	0.130	0.046	58	2.87	0.936	1.00	1.63	0.130	0.805						
59	1.18	0.177	1.00	1.63	0.132	0.044	59	2.84	0.941	1.00	1.63	0.132	0.808						
60	1.16	0.178	1.00	1.63	0.135	0.043	60	2.81	0.946	1.00	1.63	0.135	0.811						

Mod. FAA Minor Storage Volume (cubic ft.) = 3.122
Mod. FAA Minor Storage Volume (acre-ft.) = 0.0717

Mod. FAA Major Storage Volume (cubic ft.) = 35.343
Mod. FAA Major Storage Volume (acre-ft.) = 0.8114

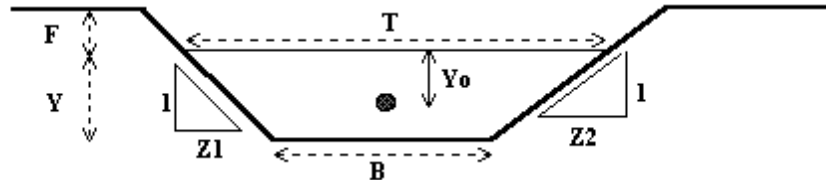
UDFCD DETENTION BASIN VOLUME ESTIMATING WORKBOOK Version 2.35, Released January 2015



APPENDIX K – HYDRAULIC CALCULATIONS

Normal Flow Analysis - Trapezoidal Channel

Project: **Blehm 18-I Pad**
Channel ID: **Channel 1 - Design Point 2 ($Q_{100} = 2.41$ cfs)**



Design Information (Input)

Channel Invert Slope	$S_o =$	0.0050 ft/ft
Manning's n	$n =$	0.025
Bottom Width	$B =$	0.00 ft
Left Side Slope	$Z1 =$	3.00 ft/ft
Right Side Slope	$Z2 =$	3.00 ft/ft
Freeboard Height	$F =$	1.00 ft
Design Water Depth	$Y =$	0.65 ft

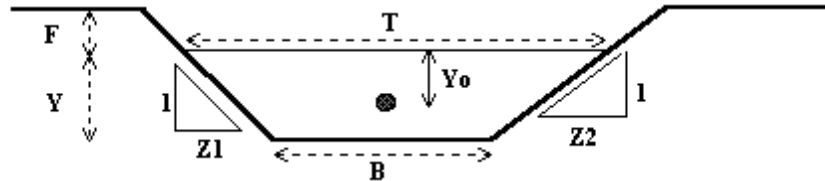
Clear a

Normal Flow Condition (Calculated)

Discharge	$Q =$	2.41 cfs
Froude Number	$Fr =$	0.59
Flow Velocity	$V =$	1.92 fps
Flow Area	$A =$	1.26 sq ft
Top Width	$T =$	3.88 ft
Wetted Perimeter	$P =$	4.09 ft
Hydraulic Radius	$R =$	0.31 ft
Hydraulic Depth	$D =$	0.32 ft
Specific Energy	$E_s =$	0.70 ft
Centroid of Flow Area	$Y_o =$	0.21 ft
Specific Force	$F_s =$	0.03 kip

Normal Flow Analysis - Trapezoidal Channel

Project: **Blehm 18-I Pad**
Channel ID: **Channel 2 - Design Point 3 ($Q_{100} = 10.34$ cfs)**



Design Information (Input)

Channel Invert Slope	$S_o =$	0.0050	ft/ft
Manning's n	$n =$	0.025	
Bottom Width	$B =$	0.00	ft
Left Side Slope	$Z1 =$	3.00	ft/ft
Right Side Slope	$Z2 =$	3.00	ft/ft
Freeboard Height	$F =$	1.00	ft
Design Water Depth	$Y =$	1.12	ft

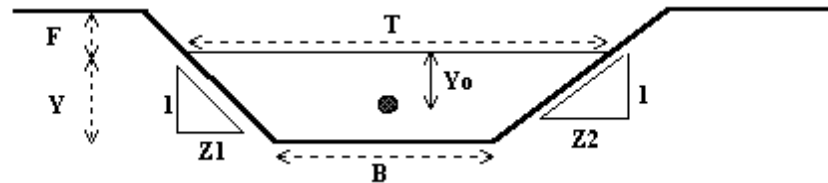
Clear

Normal Flow Condition (Calculated)

Discharge	$Q =$	10.34	cfs
Froude Number	$Fr =$	0.65	
Flow Velocity	$V =$	2.76	fps
Flow Area	$A =$	3.75	sq ft
Top Width	$T =$	6.70	ft
Wetted Perimeter	$P =$	7.07	ft
Hydraulic Radius	$R =$	0.53	ft
Hydraulic Depth	$D =$	0.56	ft
Specific Energy	$E_s =$	1.24	ft
Centroid of Flow Area	$Y_o =$	0.37	ft
Specific Force	$F_s =$	0.14	kip

Normal Flow Analysis - Trapezoidal Channel

Project: **Blehm 18-I Pad**
Channel ID: **Channel 3 - Design Point 4 ($Q_{100} = 2.37$ cfs)**



Design Information (Input)

Channel Invert Slope	$S_o =$	0.0050 ft/ft
Manning's n	$n =$	0.025
Bottom Width	$B =$	0.00 ft
Left Side Slope	$Z1 =$	3.00 ft/ft
Right Side Slope	$Z2 =$	3.00 ft/ft
Freeboard Height	$F =$	1.00 ft
Design Water Depth	$Y =$	0.64 ft

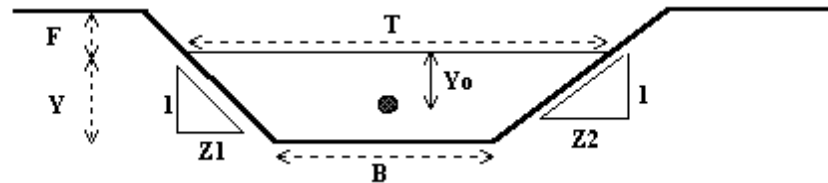
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Normal Flow Condition (Calculated)

Discharge	$Q =$	2.37 cfs
Froude Number	$Fr =$	0.59
Flow Velocity	$V =$	1.91 fps
Flow Area	$A =$	1.24 sq ft
Top Width	$T =$	3.86 ft
Wetted Perimeter	$P =$	4.07 ft
Hydraulic Radius	$R =$	0.31 ft
Hydraulic Depth	$D =$	0.32 ft
Specific Energy	$E_s =$	0.70 ft
Centroid of Flow Area	$Y_o =$	0.21 ft
Specific Force	$F_s =$	0.03 kip

Normal Flow Analysis - Trapezoidal Channel

Project: **Blehm 18-I Pad**
Channel ID: **Channel 4 - Design Point 5 ($Q_{100} = 22.80$ cfs)**



Design Information (Input)

Channel Invert Slope	$S_o =$	0.0050	ft/ft
Manning's n	$n =$	0.025	
Bottom Width	$B =$	0.00	ft
Left Side Slope	$Z1 =$	3.00	ft/ft
Right Side Slope	$Z2 =$	3.00	ft/ft
Freeboard Height	$F =$	1.00	ft
Design Water Depth	$Y =$	1.50	ft

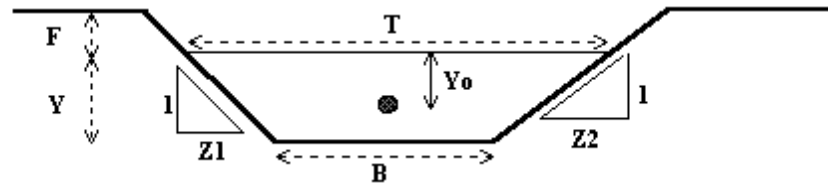
Clear

Normal Flow Condition (Calculated)

Discharge	$Q =$	22.80	cfs
Froude Number	$Fr =$	0.68	
Flow Velocity	$V =$	3.36	fps
Flow Area	$A =$	6.78	sq ft
Top Width	$T =$	9.02	ft
Wetted Perimeter	$P =$	9.51	ft
Hydraulic Radius	$R =$	0.71	ft
Hydraulic Depth	$D =$	0.75	ft
Specific Energy	$E_s =$	1.68	ft
Centroid of Flow Area	$Y_o =$	0.50	ft
Specific Force	$F_s =$	0.36	kip

Normal Flow Analysis - Trapezoidal Channel

Project: **Blehm 18-I Pad**
Channel ID: **Outlet Channel ($Q_{100} = 16.03$ cfs)**



Design Information (Input)

Channel Invert Slope	$S_o =$	0.0050	ft/ft
Manning's n	$n =$	0.025	
Bottom Width	$B =$	0.00	ft
Left Side Slope	$Z1 =$	3.00	ft/ft
Right Side Slope	$Z2 =$	3.00	ft/ft
Freeboard Height	$F =$	1.00	ft
Design Water Depth	$Y =$	1.32	ft

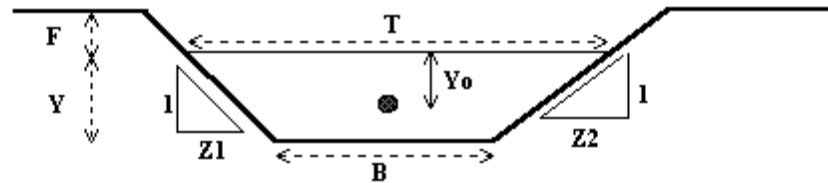
Clear a

Normal Flow Condition (Calculated)

Discharge	$Q =$	16.03	cfs
Froude Number	$Fr =$	0.67	
Flow Velocity	$V =$	3.08	fps
Flow Area	$A =$	5.20	sq ft
Top Width	$T =$	7.90	ft
Wetted Perimeter	$P =$	8.33	ft
Hydraulic Radius	$R =$	0.62	ft
Hydraulic Depth	$D =$	0.66	ft
Specific Energy	$E_s =$	1.46	ft
Centroid of Flow Area	$Y_o =$	0.43	ft
Specific Force	$F_s =$	0.24	kip

Normal Flow Analysis - Trapezoidal Channel

Project: **Blehm 18-I Pad - Production**
Channel ID: **Channel 5 - Design Point 7 ($Q_{100} = 1.64$ cfs)**



Design Information (Input)

Channel Invert Slope	$S_o =$	0.0050	ft/ft
Manning's n	$n =$	0.025	
Bottom Width	$B =$	0.00	ft
Left Side Slope	$Z1 =$	3.00	ft/ft
Right Side Slope	$Z2 =$	3.00	ft/ft
Freeboard Height	$F =$	1.00	ft
Design Water Depth	$Y =$	0.56	ft

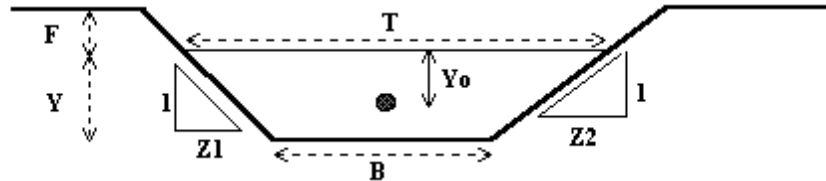
Clear

Normal Flow Condition (Calculated)

Discharge	$Q =$	1.64	cfs
Froude Number	$Fr =$	0.58	
Flow Velocity	$V =$	1.74	fps
Flow Area	$A =$	0.94	sq ft
Top Width	$T =$	3.36	ft
Wetted Perimeter	$P =$	3.54	ft
Hydraulic Radius	$R =$	0.27	ft
Hydraulic Depth	$D =$	0.28	ft
Specific Energy	$E_s =$	0.61	ft
Centroid of Flow Area	$Y_o =$	0.18	ft
Specific Force	$F_s =$	0.02	kip

Normal Flow Analysis - Trapezoidal Channel

Project: **Blehm 18-I Pad - Production**
Channel ID: **Channel 6 - Design Point 8 ($Q_{100} = 8.34$ cfs)**



Design Information (Input)

Channel Invert Slope	$S_o =$	0.0050	ft/ft
Manning's n	$n =$	0.025	
Bottom Width	$B =$	0.00	ft
Left Side Slope	$Z1 =$	3.00	ft/ft
Right Side Slope	$Z2 =$	3.00	ft/ft
Freeboard Height	$F =$	1.00	ft
Design Water Depth	$Y =$	1.03	ft

Clear

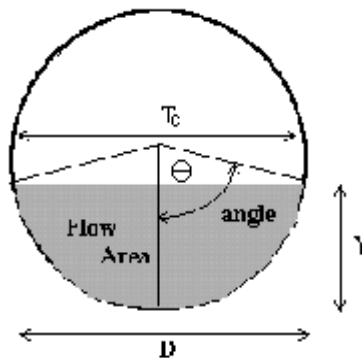
Normal Flow Condition (Calculated)

Discharge	$Q =$	8.34	cfs
Froude Number	$Fr =$	0.64	
Flow Velocity	$V =$	2.62	fps
Flow Area	$A =$	3.19	sq ft
Top Width	$T =$	6.19	ft
Wetted Perimeter	$P =$	6.52	ft
Hydraulic Radius	$R =$	0.49	ft
Hydraulic Depth	$D =$	0.52	ft
Specific Energy	$E_s =$	1.14	ft
Centroid of Flow Area	$Y_o =$	0.34	ft
Specific Force	$F_s =$	0.11	kip

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **Blehm 18-I Pad**

Pipe ID: **Culvert A**



Clear all cells

Design Information (Input)

Pipe Invert Slope	So =	0.0130	ft/ft
Pipe Manning's n-value	n =	0.0250	*
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	2.87	cfs

Full-flow Capacity (Calculated)

Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	6.24	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \text{Theta} < 3.14$)	Theta =	1.52	radians
Flow area	An =	0.83	sq ft
Top width	Tn =	1.50	ft
Wetted perimeter	Pn =	2.29	ft
Flow depth	Yn =	0.71	ft
Flow velocity	Vn =	3.46	fps
Discharge	Qn =	2.87	cfs
Percent Full Flow	Flow =	46.0%	of full flow
Normal Depth Froude Number	Fr _n =	0.82	subcritical

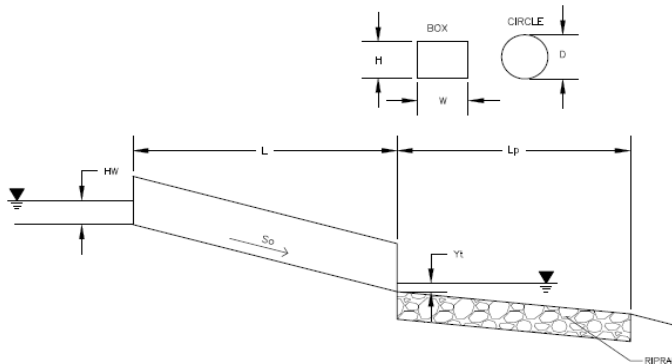
Calculation of Critical Flow Condition

Half Central Angle ($0 < \text{Theta-c} < 3.14$)	Theta-c =	1.43	radians
Critical flow area	Ac =	0.72	sq ft
Critical top width	Tc =	1.48	ft
Critical flow depth	Yc =	0.64	ft
Critical flow velocity	Vc =	3.96	fps
Critical Depth Froude Number	Fr _c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: **Blehm 18-I Pad**

Basin ID: **Culvert A**



Clear Worksheet

Clear Results

Calculate

Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

Design Information (Input):

Design Discharge

Q = 2.87 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 18 inches

Inlet Edge Type (Choose from pull-down list)

Square End with Headwall

Box Culvert:

Barrel Height (Rise) in Feet

Height (Rise) =

Barrel Width (Span) in Feet

Width (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

No = 1

Inlet Elevation

Elev IN = 5074.59 ft

Outlet Elevation OR Slope

Elev OUT = 5074.38 ft

Culvert Length

L = 16 ft

Manning's Roughness

n = 0.025

Bend Loss Coefficient

k_b = 0

Exit Loss Coefficient

k_x = 1

Tailwater Surface Elevation

Elev Y_t =

Max Allowable Channel Velocity

V = 5 ft/s

Required Protection (Output):

Tailwater Surface Height

Y_t = 0.60 ft

Flow Area at Max Channel Velocity

A_t = 0.57 ft²

Culvert Cross Sectional Area Available

A = 1.77 ft²

Entrance Loss Coefficient

k_e = 0.50

Friction Loss Coefficient

k_f = 1.07

Sum of All Losses Coefficients

k_s = 2.57

Culvert Normal Depth

Y_n = 0.71 ft

Culvert Critical Depth

Y_c = 0.64 ft

Tailwater Depth for Design

d = 1.07 ft

Adjusted Diameter OR Adjusted Rise

D_a = -

Expansion Factor

1/(2*tan(θ)) = 6.66

Flow/Diameter^{2.5} OR Flow/(Span * Rise^{1.5})

Q/D^{2.5} = 1.04 ft^{0.5}/s

Froude Number

Fr = 0.82

Tailwater/Adjusted Diameter OR Tailwater/Adjusted Rise

Y_t/D = 0.40

Inlet Control Headwater

HW_i = 0.91 ft

Outlet Control Headwater

HW_o = 0.97

Design Headwater Elevation

HW = 5.075.56 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 0.64

Minimum Theoretical Riprap Size

d₅₀ = 1 in

Nominal Riprap Size

d₅₀ = 6 in

UDFCD Riprap Type

Type = VL

Length of Protection

L_p = 5 ft

Width of Protection

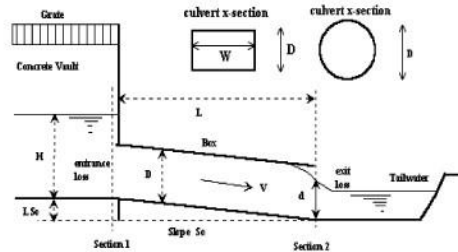
T = 3 ft

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Blehm 18-I Pad**

Basin ID: **Culvert A**

Status:



Clear Worksheet

Clear Results

Calculate

Design Information (Input):

Circular Culvert: Barrel Diameter in Inches

Inlet Edge Type (choose from pull-down list)

D = 18 inches

Square End with Headwall

OR:

Box Culvert: Barrel Height (Rise) in Feet

Barrel Width (Span) in Feet

Inlet Edge Type (choose from pull-down list)

Height (Rise) =

Width (Span) =

Square Edge w/ 30-78 deg. Flared Wingwall

Number of Barrels

Inlet Elevation at Culvert Invert

Outlet Elevation at Culvert Invert OR Slope of Culvert (ft v./ft h.)

Culvert Length in Feet

Manning's Roughness

Bend Loss Coefficient

Exit Loss Coefficient

No = 1

Inlet Elev = 5074.59 ft. elev.

Outlet Elev = 5074.38 ft. elev.

L = 16 ft.

n = 0.025

K_b = 0

K_x = 1

Design Information (calculated):

Entrance Loss Coefficient

Friction Loss Coefficient

Sum of All Loss Coefficients

Orifice Inlet Condition Coefficient

Minimum Energy Condition Coefficient

K_e = 0.50

K_f = 1.07

K_s = 2.57

C_d = 0.85

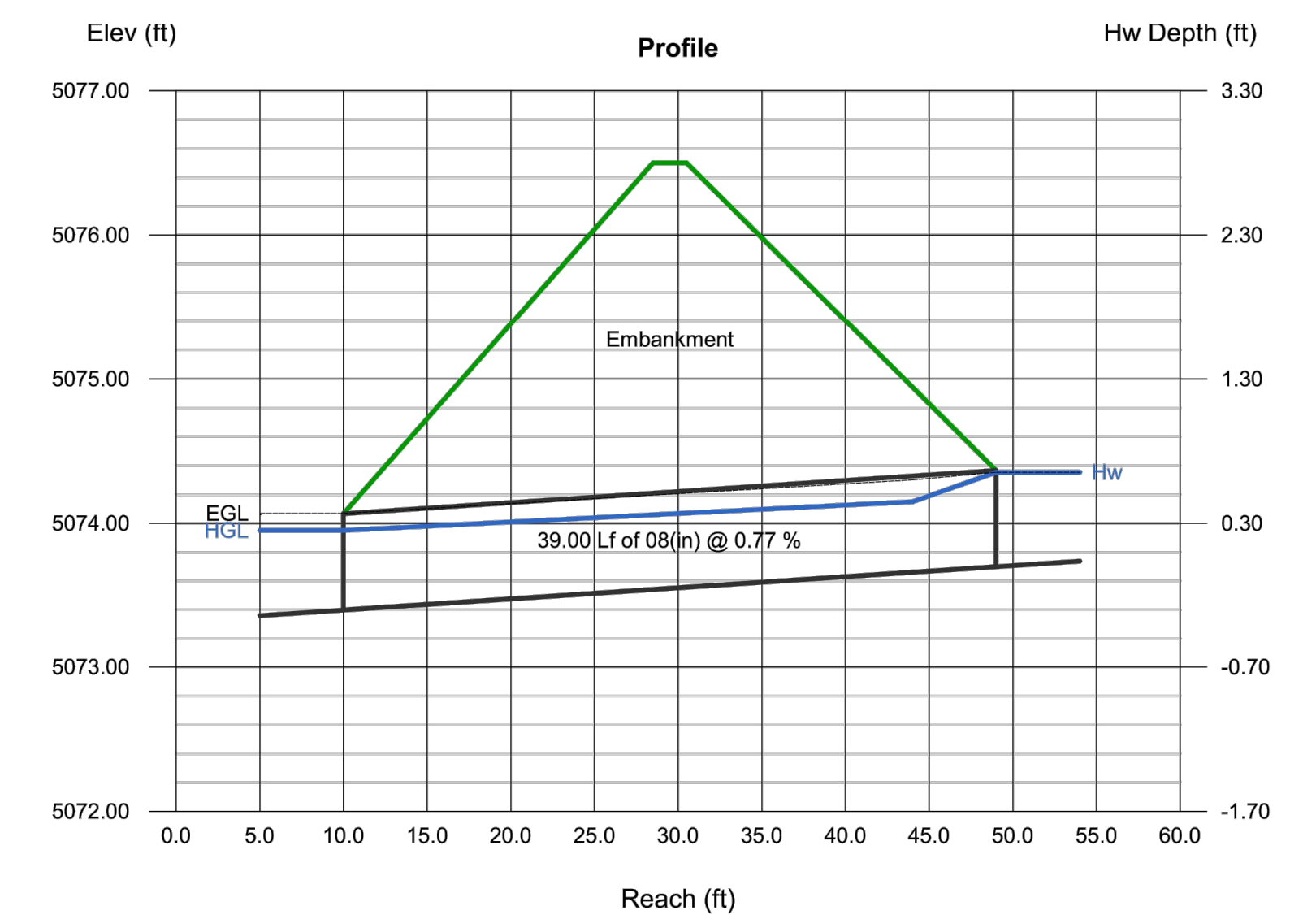
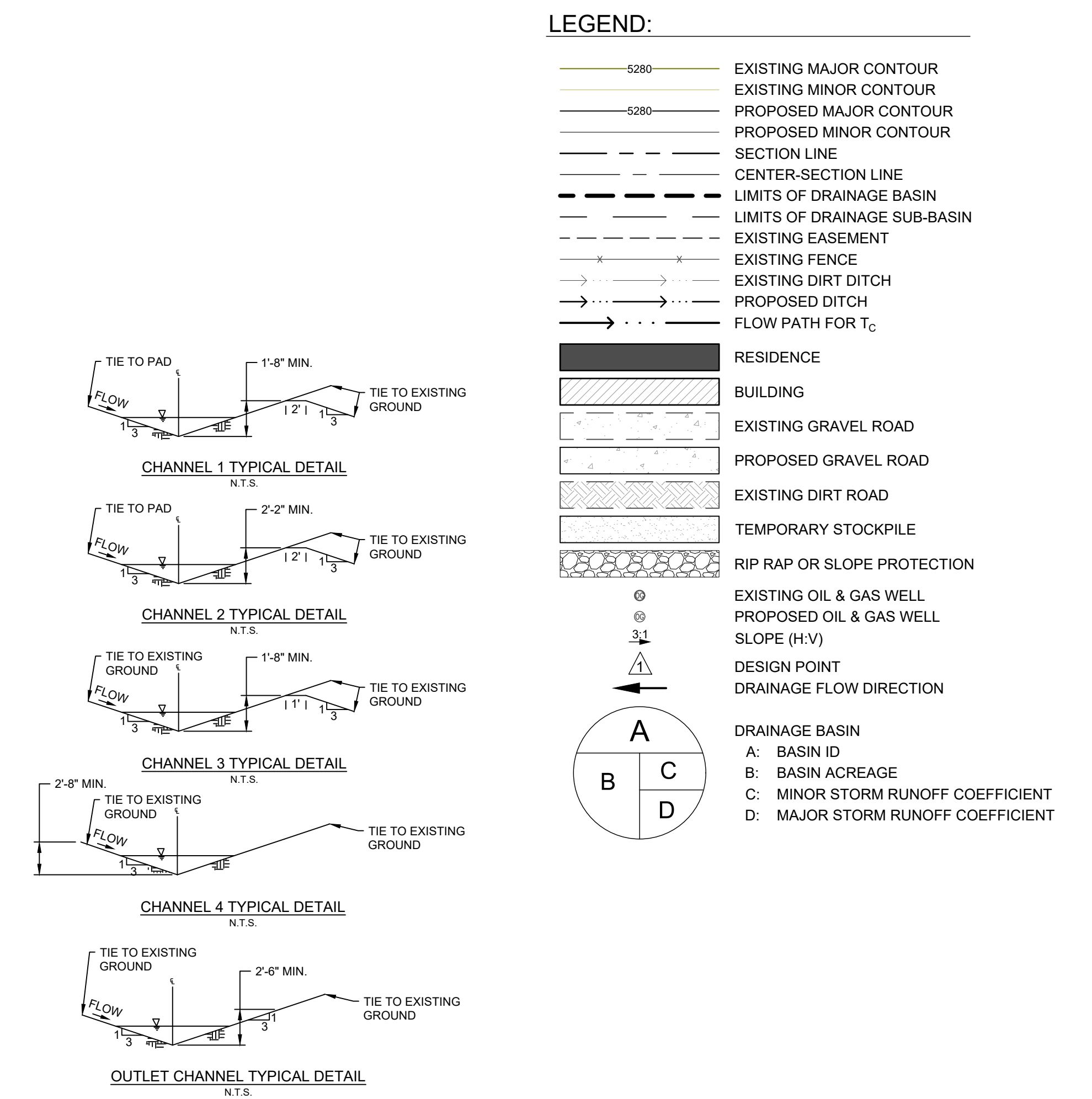
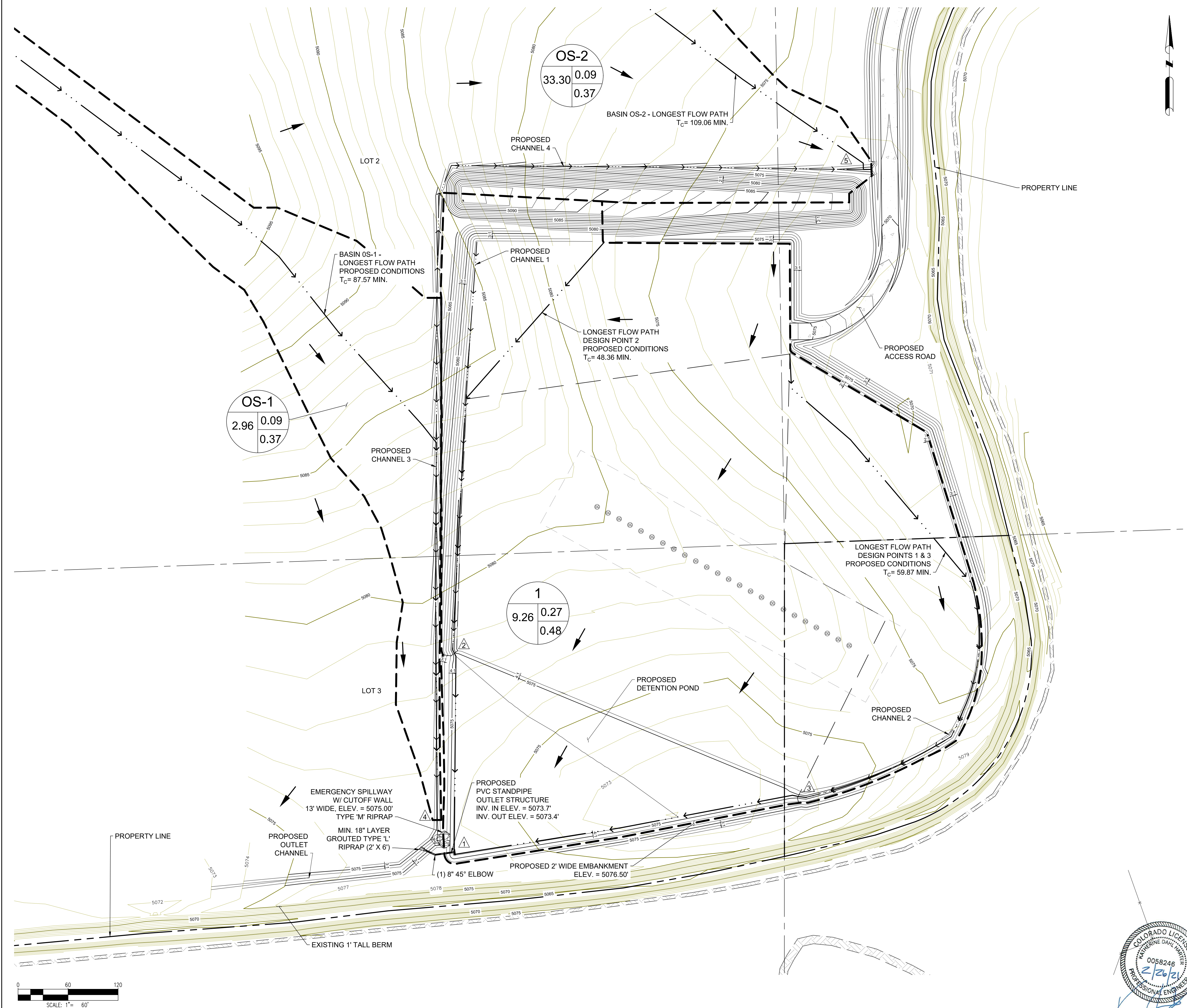
KE_{low} = -0.0860

Calculations of Culvert Capacity (output):

Recalculate

Water Surface Elevation Enter HW Elev (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5075.50		2.90	3.91	2.90	Regression Eqn.	INLET
5075.51		2.90	3.94	2.90	Regression Eqn.	INLET
5075.52		3.00	3.94	3.00	Regression Eqn.	INLET
5075.53		3.00	3.94	3.00	Regression Eqn.	INLET
5075.54		3.10	3.94	3.10	Regression Eqn.	INLET
5075.55		3.10	3.97	3.10	Regression Eqn.	INLET
5075.56		3.20	3.97	3.20	Regression Eqn.	INLET
5075.57		3.30	3.97	3.30	Regression Eqn.	INLET
5075.58		3.30	3.97	3.30	Regression Eqn.	INLET
5075.59		3.40	4.01	3.40	Regression Eqn.	INLET
5075.60		3.40	4.01	3.40	Regression Eqn.	INLET
5075.61		3.50	4.01	3.50	Regression Eqn.	INLET
5075.62		3.50	4.04	3.50	Regression Eqn.	INLET
5075.63		3.60	4.04	3.60	Regression Eqn.	INLET
5075.64		3.60	4.04	3.60	Regression Eqn.	INLET
5075.65		3.70	4.04	3.70	Regression Eqn.	INLET
5075.66		3.70	4.07	3.70	Regression Eqn.	INLET
5075.67		3.80	4.07	3.80	Regression Eqn.	INLET
5075.68		3.90	4.10	3.90	Regression Eqn.	INLET
5075.69		3.90	4.10	3.90	Regression Eqn.	INLET
5075.70		4.00	4.10	4.00	Regression Eqn.	INLET
5075.71		4.00	4.13	4.00	Regression Eqn.	INLET
5075.72		4.10	4.13	4.10	Regression Eqn.	INLET
5075.73		4.10	4.16	4.10	Regression Eqn.	INLET
5075.74		4.20	4.16	4.16	Regression Eqn.	OUTLET
5075.75		4.30	4.16	4.16	Regression Eqn.	OUTLET
5075.76		4.30	4.19	4.19	Regression Eqn.	OUTLET
5075.77		4.40	4.19	4.19	Regression Eqn.	OUTLET
5075.78		4.40	4.22	4.22	Regression Eqn.	OUTLET
5075.79		4.50	4.22	4.22	Regression Eqn.	OUTLET

Processing Time: 01.80 Seconds



**Know what's below.
Call before you dig.**

NOTES:

REFERENCE DRAWINGS		REVISIONS					
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	0	ISSUED FOR CONSTRUCTION	RC	02/10/21	KH	02/17/21
DWG. NO.	TITLE	NO.	DESCRIPTION	BY	DATE	BY	DATE



BAYSWATER
EXPLORATION & PRODUCTION, LLC



8620 Wolff Court
Westminster, CO 80031
(303) 928-7128
www.ascentgeomatics.com

APPENDIX L - DRAINAGE DRAWINGS
PROPOSED CONDITIONS - DRILLING PHASE
BLEHM 18-I PAD

DRAWN BY: R.CHURCH

CREATION DATE: 02/10/2021

PROJECT No.: B20.BEP.0002

SCALE: 1" = 60'

CHECKED BY: K. HARTER

CHECKED DATE: 02/17/2021

DWG. No.:	10
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L.2

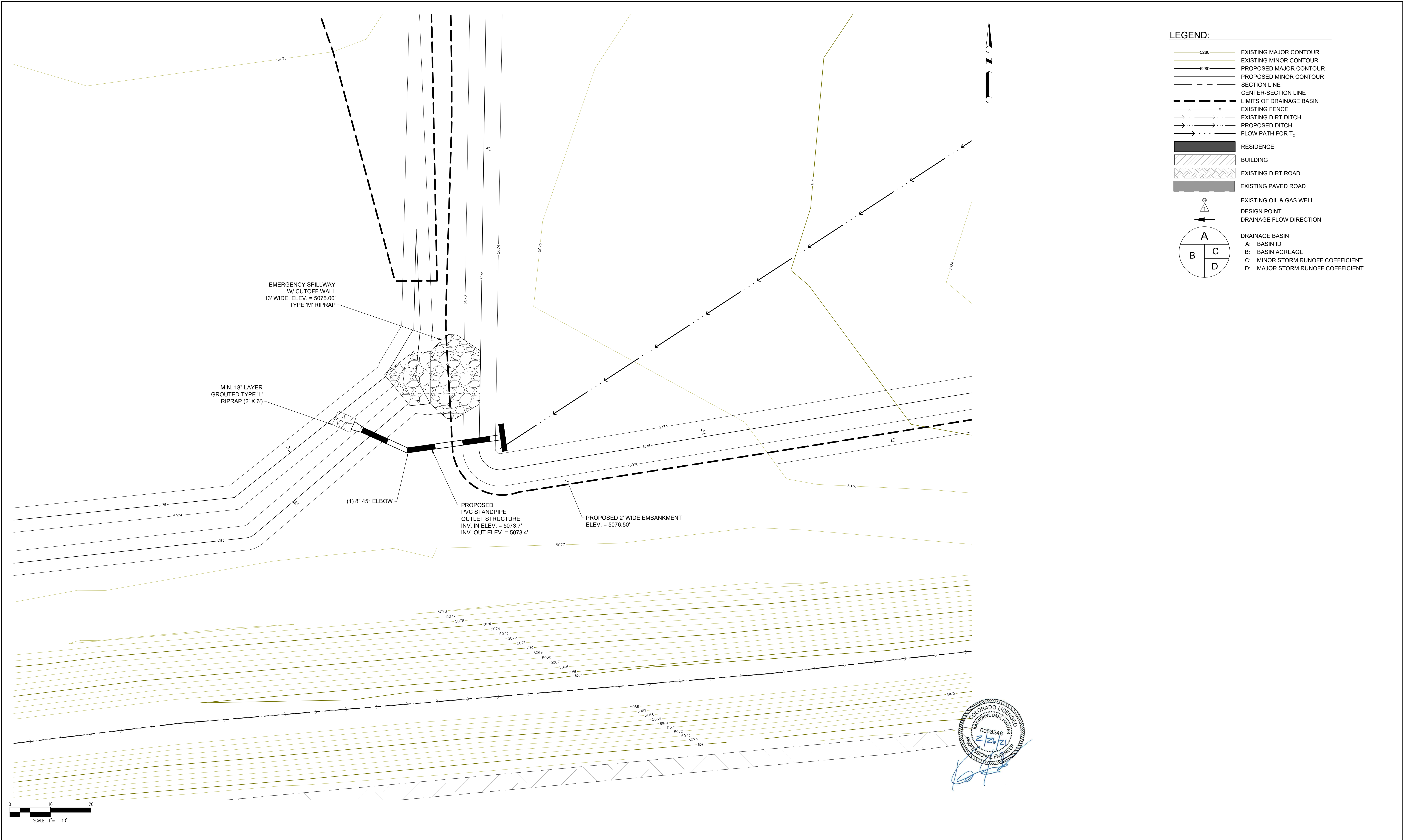
APPROVED: K. HARTER



APPROVED DATE: 02/23/2021



SHEET No.:	
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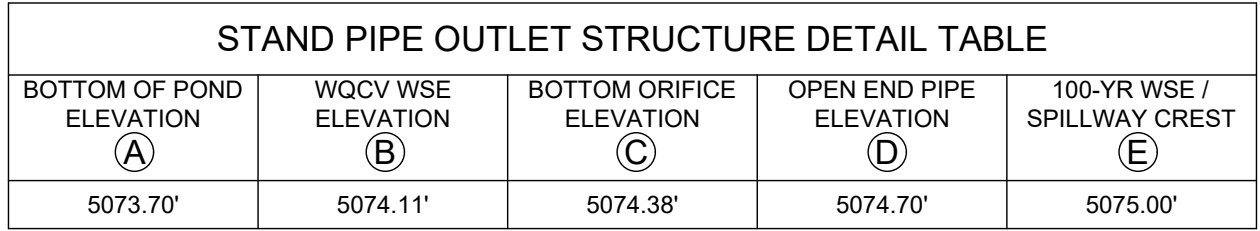
2 OF 5 /





 Know what's below. Call before you dig.	NOTES:	REFERENCE DRAWINGS		REVISIONS						 BAYSWATER EXPLORATION & PRODUCTION, LLC	APPENDIX L - DRAINAGE DRAWINGS								
											PROPOSED CONDITIONS - DRILLING PHASE								
											BLEHM 18-I PAD								
DWG. NO.		TITLE		NO.		DESCRIPTION		BY		DATE		BY		DATE		BY		DATE	
				0		ISSUED FOR CONSTRUCTION		RC		02/10/20		KH		02/17/21		KH		02/17/21	

 8620 Wolff Court Westminster, CO 80031 (303) 928-7128 www.ascentgeomatics.com		DRAWN BY: R.CHURCH		CHECKED BY: K. HARTER		APPROVED BY: K. HARTER	
		CREATION DATE: 02/10/2021		CHECKED DATE: 02/17/2021		APPROVED DATE: 02/17/2021	
		PROJECT No.: B20.BEP.0002		DWG. No.: L.3		SHEET No.: 3 OF 5	
		SCALE: 1" = 10'					



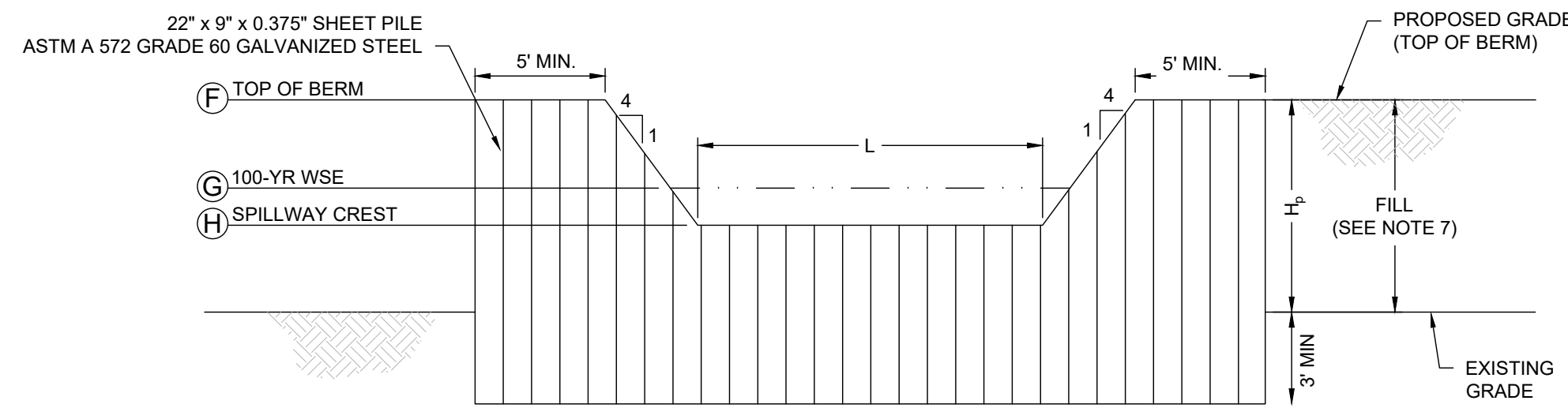
1. CONTRACTOR TO PLACE ROCKS AROUND THE ELBOW FITTING AND PIPE IN SUCH A WAY THAT THE VERTICAL PORTION OF THE STANDPIPE CANNOT BE MOVED FROM THE VERTICAL POSITION. (I.E. CANNOT BE TILTED). ROCKS TO BE PLACED DIRECTLY ADJACENT TO BOTH SIDES OF THE VERTICAL SEGMENT OF THE STANDPIPE. GOOD CONTACT BETWEEN ROCKS AND STANDPIPE MUST BE ACHIEVED (I.E. NO GAPS).

2. LARGE, HEAVY ROCKS TO BE PLACED DIRECTLY OVER THE CENTERLINE OF THE PIPE. THE PORTION OF THE PIPE THAT IS EXPOSED TO THE WATER SURFACE OF THE STANDPIPE FROM FLOATING TO THE TOP OF THE WATER SURFACE (I.E. TO NEGATE THE BUOYANCY FORCE) SHOULD THE ORIFICES BECOME OBSTRUCTED. A MINIMUM OF 250 LBS OF ROCK TO BE PLACED OVER CENTERLINE OF PIPE.

3. CONTRACTOR TO DRILL HOLES AS SHOWN IN THESE DETAILS.

4. SPILLWAY GREST ELEVATION IS PREPARED TO SECTION. FOR ACTUAL SPILLWAY LOCATION REFER TO PLAN VIEW ON SHEET L.2.

SCALE: N.T.S.



SPILLWAY DETAIL TABLE			
TOP OF BERM ELEVATION (F)	100-YR WATER SURFACE ELEVATION (G)	SPILLWAY CREST ELEVATION (H)	CREST LENGTH (L)
5076.50'	5075.50'	5075.0'	13.0'

SECTION A-A




5. PIPE IS PROJECTED TO SECTION. FOR ACTUAL PIPE LOCATION, REFER TO PLAN VIEW ON SHEET L.2.
6. ANTI-SEEP COLLAR IS COMMERCIALY AVAILABLE. COLLAR SPACING AND MINIMUM DIMENSIONS AS INDICATED IN THE ABOVE DETAIL.
7. CONTRACTOR TO INSTALL SHEET PILES FIRST, THEN PLACE THE EMBANKMENT FILL AROUND THE SHEET PILE CUTOFF WALL HAS BEEN INSTALLED. CONTRACTOR TO ENSURE THE FILL MATERIAL AROUND THE SHEET PILE WALL HAS THE REQUIRED LEVEL OF COMPACTION IN ACCORDANCE WITH THE SPECIFICATIONS INDICATED IN THESE PLANS.
8. PVC PIPE AND FITTINGS TO BE ASTM D3034, SDR 35.
9. JOINTS TO BE SOLVENT CEMENTED PER ASTM D2564.

SCALE: N.T.S.



APPROVED: K. HARTER
APPROVED DATE: 02/23/202

	SHEET No.: 5 OF 5	
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REFERENCE DRAWINGS		REVISIONS					
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—	—	—	—	—	—	—	—
—	—	0	ISSUED FOR CONSTRUCTION	RC	02/10/22	KH	02/17/22
DWG. NO.	TITLE	NO.	DESCRIPTION	BY	DATE	BY	DATE



COLORADO
Department of Public
Health & Environment

**CERTIFICATION TO DISCHARGE
UNDER
CDPS GENERAL PERMIT COR400000
STORMWATER ASSOCIATED WITH CONSTRUCTION ACTIVITIES**

Certification Number: **COR400369**

This Certification to Discharge specifically authorizes:

**Owner Bayswater Exploration and Production LLC
Operator Bayswater Exploration and Production LLC**

to discharge stormwater from the facility identified as

NE 4 Sec 29 Well pad and Tank Battery

To the waters of the State of Colorado, including, but not limited to:

to Ditch to Cache la Poudre River

Facility Activity : Oil and gas production
Disturbed Acres: 35 acres
Facility Located at: CR 66 and CR 41 Uninc CO 80631
Weld County
Latitude 40.465 Longitude -104.679

**Specific Information
(if applicable):**

Certification is issued 4/1/2019

Certification is effective 4/1/2019

Expiration date of general permit : 3/31/2024

This certification under the permit requires that specific actions be performed at designated times. The certification holder is legally obligated to comply with all terms and conditions of the permit.

This certification was approved by:
Meg Parish, Unit Manager
Permits Section
Water Quality Control Division

