FINAL DRAINAGE REPORT
FOR
ABTR STORAGE
UNPLATTED
415 N FRANCEVILLE COAL MINE ROAD
COLORADO SPRINGS, COLORADO

MARCH 2023

Prepared For:
FLYING HORSE REALTY
2748 North Gate Blvd
Colorado Springs, CO 80921
719.235.8195

Prepared By:

TERRA NOVA ENGINEERING, INC.
721 S. 23RD Street
Colorado Springs, CO 80904
719.635.6422

TNE Job No. 2309.00
County Job No. ###

PPR2319

FINAL DRAINAGE REPORT
FOR
ABTR STORAGE

TABLE OF CONTENTS

APPENDICIES

FINAL DRAINAGE REPORT
FOR
ABTR STORAGE

DESIGN ENGINEER'S STATEMENT:

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

_____ _____

Dane Frank, P.E. 50207 Date

On behalf of Terra Nova Engineering, Inc.

OWNER/DEVELOPER'S STATEMENT:

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

_____ _____

Authorized Signature Date

_____

Printed Name, Title

_____

Business Name

_____

Address

EL PASO COUNTY:

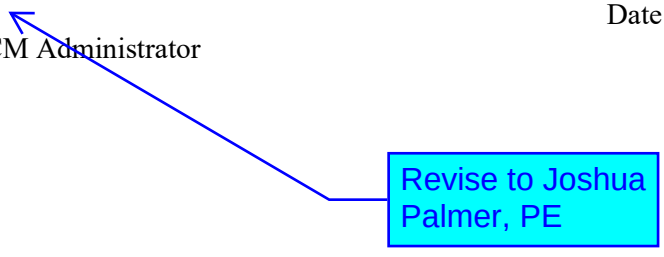
Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ _____

Jennifer Irvine, P.E. Date

County Engineer / ECM Administrator

Conditions:



FINAL DRAINAGE REPORT
FOR
ABTR STORAGE

PURPOSE

The purpose of this Final Drainage Report (FDR) is to identify and analyze the proposed drainage patterns, determine proposed runoff quantities, size drainage structures for conveyance of developed runoff, and present solutions to drainage impacts on-site and off-site resulting from this development. The site has not been previously platted or studied.

GENERAL DESCRIPTION

This FDR is an analysis of approximately 38.5 acres of undeveloped land located at 415 n Franceville Coal Mine Road. A portion of this site is being developed as vehicle/trailer parking. The site is in the northeast quarter of Section 18, Township 14 South, Range 65 West and the northwest quarter of Section 17, Township 14 South, Range 65 West of the 6th Principal Meridian within El Paso County. The parcel is bounded to the north by Highway 94, to the east and south by unplatted land, and to the west by North Franceville Coal Mine Road (See vicinity map in appendix).

The site lies within the Jimmy Camp Creek Basin, with storm runoff surface draining from the east to the west, with most of the runoff flowing onto North Franceville Coal Mine Road and some runoff flowing off the site to the south. There is one culvert on the west side of the site that crosses North Franceville Coal Mine Road and drains to the neighboring property to the west.

Soils for this project are delineated by the map in the appendix as Nelson-Tassel fine sandy loams, 3 to 18 percent slopes (56). Soils in the study area are shown as mapped by S.C.S. in the "Soils Survey of El Paso County Area" and contains soils of Hydrologic Group B.

The site is largely undeveloped with mostly grass and dirt surfaces, and occasional shrubs/trees. There is one building with a fence and gravel yard in the northwest corner that is owned by Cherokee Metro District. The site drains to the southeast, with an average slope of 3.8%.

Please confirm, previous statements imply drainage of the site to west and south.

EXISTING DRAINAGE CONDITIONS

There are six drainage basins, three of which are offsite. See attached Existing Drainage Map (in appendix).

Basin OS-X is 7.12 acres and drains to Design Point X on the east side of the site. This basin is offsite and runoff from this basin flows onto the site and into basin EX-A. Basin OS-X has flows of Q_5 = 2.1 cfs and Q_{100} = 13.4 cfs.

Basin OS-Y is 21.4 acres and drains to Design Point Y at the east side of the site. This basin is offsite and runoff from this basin flows onto the site and into basin EX-C. Basin OS-Y has flows of Q_5 = 7.7 cfs and Q_{100} = 34.5 cfs.

Basin OS-Z is 1.84 acres and drains to Design Point Z at the north side of the site. This basin is offsite and runoff from this basin flows onto the site and into basin EX-C. Basin OS-Z has flows of Q_5 = 3.1 cfs and Q_{100} = 7.8 cfs.

Basin EX-A is 13.4 acres and drains to Design Point A near the southwest corner of the site. Runoff flows off the site and onto the adjacent property. Basin EX-A has flows of Q_5 = 3.1 cfs and Q_{100} = 19.1 cfs. Design Point A has combined flows of Q_5 = 5.2 cfs and Q_{100} = 32.5 cfs from basins OS-X and EX-A.

Basin EX-B is 1.96 acres and drains to Design Point B at the west side of the site. Runoff flows off the site and onto North Franceville Coal Mine Road. Basin EX-B has flows of Q_5 = 0.6 cfs and Q_{100} = 4.0 cfs.

Basin EX-C is 23.2 acres and drains to Design Point C at the west side of the site. Runoff flows into a 54" CMP culvert, under North Franceville Coal Mine Road, and onto the neighboring property to the west. Basin EX-C has flows of Q_5 = 5.0 cfs and Q_{100} = 30.2 cfs. Design Point C has combined flows of Q_5 = 15.8 cfs and Q_{100} = 72.5 cfs from basins OS-z, OS-Y, and EX-C.

Note: After the culvert crosses the road and ends, there is a retaining wall that appears to have a RCP pipe opening of similar size that continues west. No plans or reports containing this pipe have been found and the discharge point is not known. Based on historic aerial photos, this pipe may discharge approximately 500 feet west-southwest of the retaining wall, but this has not been confirmed.

Discuss/state suitability (hydrologically and hydraulically adequate) of the existing culvert under Franceville Rd to convey flows to west based on analysis completed.

PROPOSED DRAINAGE CONDITIONS

Runoff in the developed conditions consists of 11 basins; one existing basin, seven onsite basins, and three offsite basins. Below is a description of the runoff in the developed conditions and how it will be safely routed, treated and detained. See appendix for calculations.

Existing Basins

Basin EX-B is 1.96 acres and drains to Design Point B at the west side of the site. Runoff flows off the site and onto North Franceville Coal Mine Road. Basin EX-B has flows of Q_5 = 0.6 cfs and Q_{100} = 4.0 cfs.

Offsite Basins

Basin OS-X is 7.12 acres and drains to Design Point X on the east side of the site. This basin is offsite and runoff from this basin flows onto the site and into basin EX-A. Basin OS-X has flows of Q_5 = 2.1 cfs and Q_{100} = 13.4 cfs.

Basin OS-Y is 21.4 acres and drains to Design Point Y at the east side of the site. This basin is offsite and runoff from this basin flows onto the site and into basin EX-C. Basin OS-Y has flows of Q_5 = 7.7 cfs and Q_{100} = 34.5 cfs.

Basin OS-Z is 1.84 acres and drains to Design Point Z at the north side of the site. This basin is offsite and runoff from this basin flows onto the site and into basin EX-C. Basin OS-Z has flows of Q_5 = 3.1 cfs and Q_{100} = 7.8 cfs.

Onsite Basins

Basin PR-1 is 9.92 acres and drains to Design Point 1 at the southwest EDB. Basin PR-1 is the

southern portion of the asphalt millings parking area. Basin PR-1 has flows of Q_5 = 11.4 cfs and Q_{100} = 27.3 cfs.

Basin PR-2 is 9.30 acres and drains to Design Point 2 at the northeast corner of the asphalt millings parking area. Basin PR-2 has flows of Q_5 = 10.6 cfs and Q_{100} = 25.6 cfs.

Basin PR-3 is 8.78 acres and drains to Design Point 3 at the west end of the basin. Basin PR-3 has flows of Q_5 = 32.9 cfs and Q_{100} = 62.8 cfs. This basin has been calculated with the future commercial development runoff, which has also been used to determine the volume of the northwest EDB.

Basin PR-4 is 3.27 acres and drains to Design Point 4 at the northwest EDB. Basin PR-4 has flows of Q_5 = 1.1 cfs and Q_{100} = 7.1 cfs. Design Point 4 has combined flows of Q_5 = 44.7 cfs and Q_{100} = 95.5 cfs from basins PR-4, PR-3, and PR-2.

Basin PR-5 is 1.78 acres and drains to Design Point 5 at the west edge of the site. This basin is mostly undeveloped area, plus the Cherokee Metro District facility, that includes the culvert that drains the north portion of the site across N Franceville Coal Mine Road. Basin PR-5 has flows of Q_5 = 1.0 cfs and Q_{100} = 4.5 cfs. Design Point 5 has combined flows of Q_5 = 4.6 cfs and Q_{100} = 34.4 cfs from basins PR-5 and the pond outlet.

Since there is grading proposed in Basin PR-5, WQ treatment or an applicable exclusion must be discussed in this section.

Basin PR-6 is 0.42 acres and drains to Design Point 6 on the south edge of the site. This basin is a landscaping area that flows offsite to the south. Basin PR-6 has flows of Q_5 = 0.2 cfs and Q_{100} = 1.1 cfs.

Basin PR-7 is 3.03 acres and drains to Design Point 7 at the south edge of the site. This basin is landscaping area, driveway, and the portion of the asphalt millings parking area that is below the southwest EDB. Basin PR-7 has flows of Q_5 = 1.9 cfs and Q_{100} = 8.1 cfs. Water quality treatment for this basin is provided by the landscaping area south of the driveway and parking area (runoff reduction by grass buffer).

Revise. Approximately 97% of the basin is ashalt millings. This value needs to be significantly larger.

At Design Point 1 the runoff from basin PR-1 will be captured in a 0.794 acre-foot Southwest EDB. Runoff sheet flows into the EDB from three sides. Two 117 cu-ft concrete lined forebays with 1.5 feet high concrete cutoff walls have been placed in the east corners of the EDB where most of the flow will enter. A 3 inch notch in the wall drains the flow to a 1' concrete trickle channel, then the runoff is routed to the 3.0' deep micropool which has a 6" deep initial surcharge area. The 9.92 acres tributary to the EDB are 40% impervious. Based upon this we need a WQCV of 0.149 ac-ft, an EURV volume of 0.268 ac-ft and 100-year volume of 0.377 ac-ft, for a total volume needed of 0.794 ac-ft. The bottom of the micropool elevation is at 6233.00 while the top of the ISV elevation is at 6236.00. The WQCV orifice plate has four rows of 1 inch diameter holes spaced irregularly. A 4'x4' outlet structure is set at 6238.75. The 100-year elevation tops out at 6239.63. A 18" HDPE outlet with a restrictor plate will release Q_5=1.7 cfs and Q_{100}=14.2 cfs discharge south, to a riprap settling basin near that south property line that will provide energy dissipation and allow smaller flows to infiltrate. Larger flows will overtop the settling basin and follow the existing drainage path south of the site.

At Design Point 4 the runoff from basins PR-2, PR-3, and PR-4 will be captured in a 2.293 acre-foot Northwest EDB. This EDB has been sized for the volume from the future commercial development of basing PR-3, while the proposed structures (such as forebay and outlet structure) have been sized based on the currently proposed design. Runoff sheet flows into the EDB from three sides. A 300 cu-ft concrete lined forebay with 1.5 feet high concrete cutoff walls has been placed in the southeast corner of the EDB where most of the proposed flow will enter (another forebay will be required for the future commercial development). A 3 inch notch in the wall drains the flow to a 2' concrete trickle channel, then the runoff is routed to the 3.0' deep micropool which has a 6" deep initial surcharge area. The 21.4 acres tributary to the EDB are 20% impervious (not including the future commercial development). Based upon this we need a WQCV of 0.206 ac-ft, an EURV volume of 0.219 ac-ft and 100-year volume of 0.697 ac-ft, for a total volume needed of 1.122 ac-ft. The bottom of the micropool elevation is at 6219.00 while the top of the ISV elevation is at 6222.00. The WQCV orifice plate has three rows of 15/16 inch diameter holes spaced irregularly. A 4'x5' outlet structure is set at 6224.05. The 100-year elevation tops out at 6225.19. A 24" HDPE outlet with a restrictor plate will release Q_5=4.8 cfs and Q_{100}=27.0 cfs discharge west, to an outfall point near the existing culvert under N Franceville Coal Mine Road.

In an effort to protect receiving water and as part of the "four-step process to minimize adverse impacts of urbanization" this site was analyzed in the following manner:

1. Reduce Runoff- The proposed impervious areas on the site are surrounded by landscaping and green space areas. Also, the proposed parking area is being surface with asphalt millings, which slow runoff and allow for infiltration compared to pavement. Additionally, the new improvements and impervious areas on the site are being routed to proposed EDBs. These items will reduce the volume of runoff using ponding and infiltration.
2. Stabilize Drainageways- There are no existing drainageways onsite. The proposed swales have been designed to be stable.
3. Provide Water Quality Capture Volume (WQCV)- The EDBs has been sized and designed to sufficiently capture the required WQCV and slowly release it though the orifice plate, thereby allowing solids and contaminants to settle out.
4. Consider Need for Industrial and Commercial BMPs- The proposed development is a vehicle/trailer parking lot; therefore, no Industrial and Commercial BMPs have been proposed.

HYDROLOGIC CALCULATIONS

Hydrologic calculations were performed using the El Paso County Storm Drainage Design Criteria Manual - Volumes 1 & 2, latest editions. The Rational Method was used to estimate storm water runoff anticipated from design storms with 5-year and 100-year recurrence intervals. The Urban Drainage Criteria Manual was used to calculate the detention and water quality volume.

HYDRAULIC CALCULATIONS

Hydraulic calculations were estimated using the Manning's Formula and the methods described in the El Paso County Storm Drainage Design Criteria Manual – Volumes 1 & 2, latest editions. The pertinent data sheets are included in the appendix of this report.

The existing culvert under N Franceville Coal Mine Road has been evaluated for capacity. The calculation have been included in the appendix.

Explain if offsite flows from HWY 94 and Franceville Coal Mine contribute to the culvert from the ditch adjacent to the site.

Revise to include any recommendations for culvert. Include whether it meets criteria for overtopping per DCM table 6-1. Per ECM 3.2.4 a suitable outfall is required for developed flows.

FLOODPLAIN STATEMENT

No portion of this site is within a designated F.E.M.A. floodplain, as determined by Flood Insurance Rate Map No. 08041C0780 G, dated December 7, 2018 (see appendix).

WATER QUALITY

The proposed EDBs provides water quality treatment for most of the proposed development.

Runoff from the impervious areas in basin PR-7 is being treated by the landscaping areas to the south (runoff reduction from grass buffers).

If proposed ponds are going to provide water quality for the current proposed development and future development, add an explanation stating so. Ponds should be sized for commercial development now.

CONSTRUCTION COST OPINION

Public Reimbursable

None

Public Non-Reimbursable

None

Private Non-Reimbursable

1. 18" HDPE	120 LF	$ 60	$ 7,200
2. 24" HDPE	1605 LF	$ 70	$ 112,350
3. CDOT Type C Area Inlet	2 EA	$ 5,000	$ 10,000
4. 5' Manhole	2 EA	$ 7,700	$ 15,400
5. EDB	2 EA	$ 75,000	$ 150,000
		Total	**$ 294,950**

DRAINAGE FEES

This drainage report is part of a site development application; therefore, no drainage fees are due.

MAINTENANCE

Add:
"and runoff reduction RPA's"

The Extended Detention Basins are private and will be maintained by the property owner. The proposed storm sewers and swales are private and will be maintained by the property owner.

Headwalls and Wingwalls: Given the erodible soils onsite, provide a headwall and/or wingwall for the inlet and outlet of culverts/piping as necessary given flowrate, slope, and length (per MHFD USDCM Vol 2, Chapter 9, Section 3.0). Or based on engineering judgement, state that based on the site conditions, they are not necessary.

Per DCMv2 – Chap 4.2, trickle channel should at a minimum provide capacity equal to twice the release capacity at the upstream forebay outlet. Provide these calcs in the drainage report and revise plans as needed.

SUMMARY

Development of this site will not adversely affect the surrounding development. This report is in general conformance with the previous reports which included this site. Site runoff and storm drain appurtenances from the development will not adversely affect the downstream and surrounding developments and will be safely routed to the proposed extended detention basins and runoff reduced to the allowable pre-developed rates while slowly treating the water quality capture volume. Runoff leaving the proposed extended detention basins is then routed to the existing drainage paths.

PREPARED BY:
TERRA NOVA ENGINEI

Revise to include how much runoff increases by with the addition of the development flows.

Revise to include what information was included from other reports. Include those reports in the reference list.

Dane Frank, P.E.
Project Engineer

Jobs/2309.00/Drainage/230900 FDR.doc

Page #4 say site has not been studied before

BIBLIOGRAPHY

El Paso County Drainage Criteria Manual-Volumes 1 & 2, latest edition

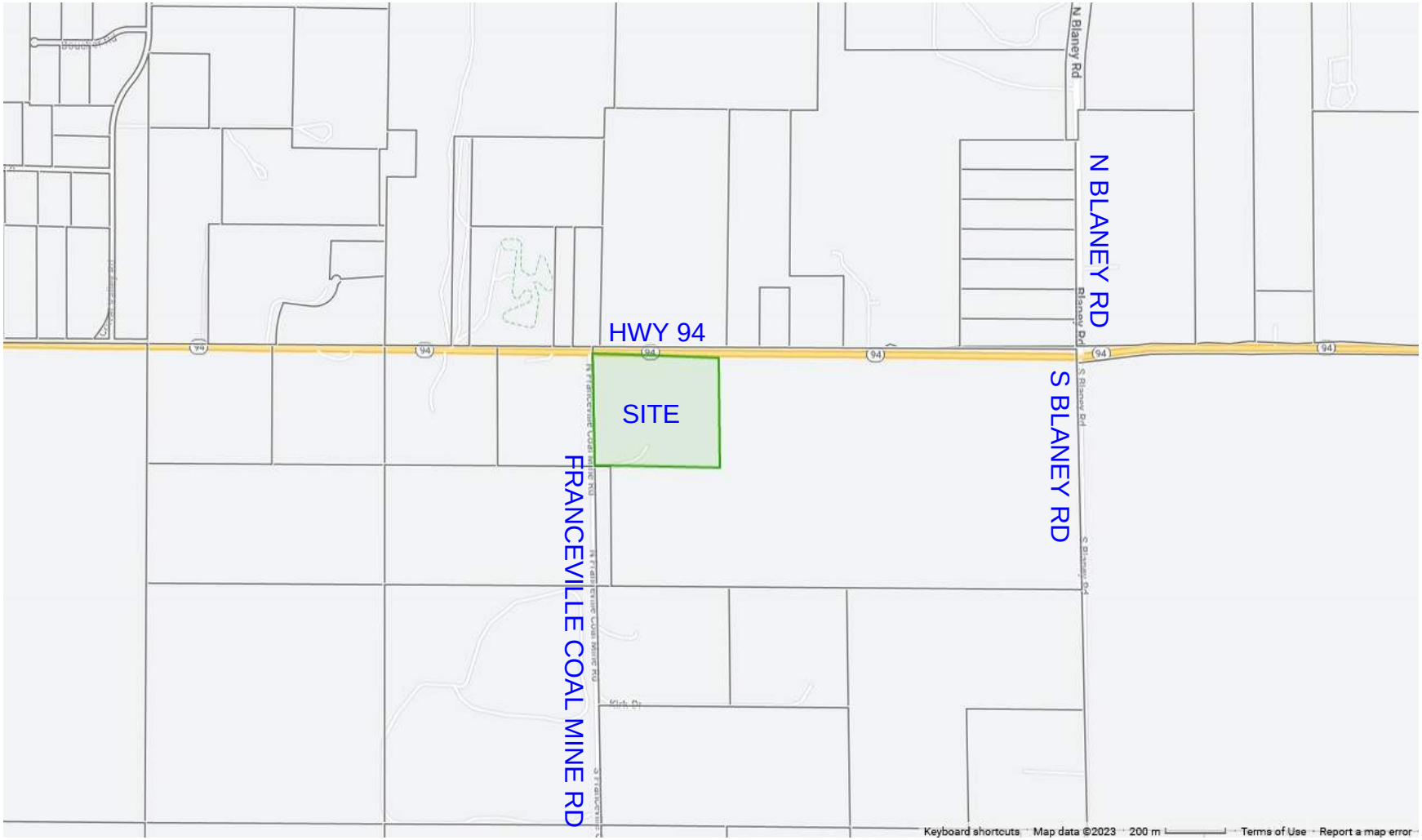
El Paso County Board Resolution No 15-042 (Adoption of Chapter 6 and Section 3.2.1 Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014, Hydrology and Full Spectrum Detention)

VICINITY MAP

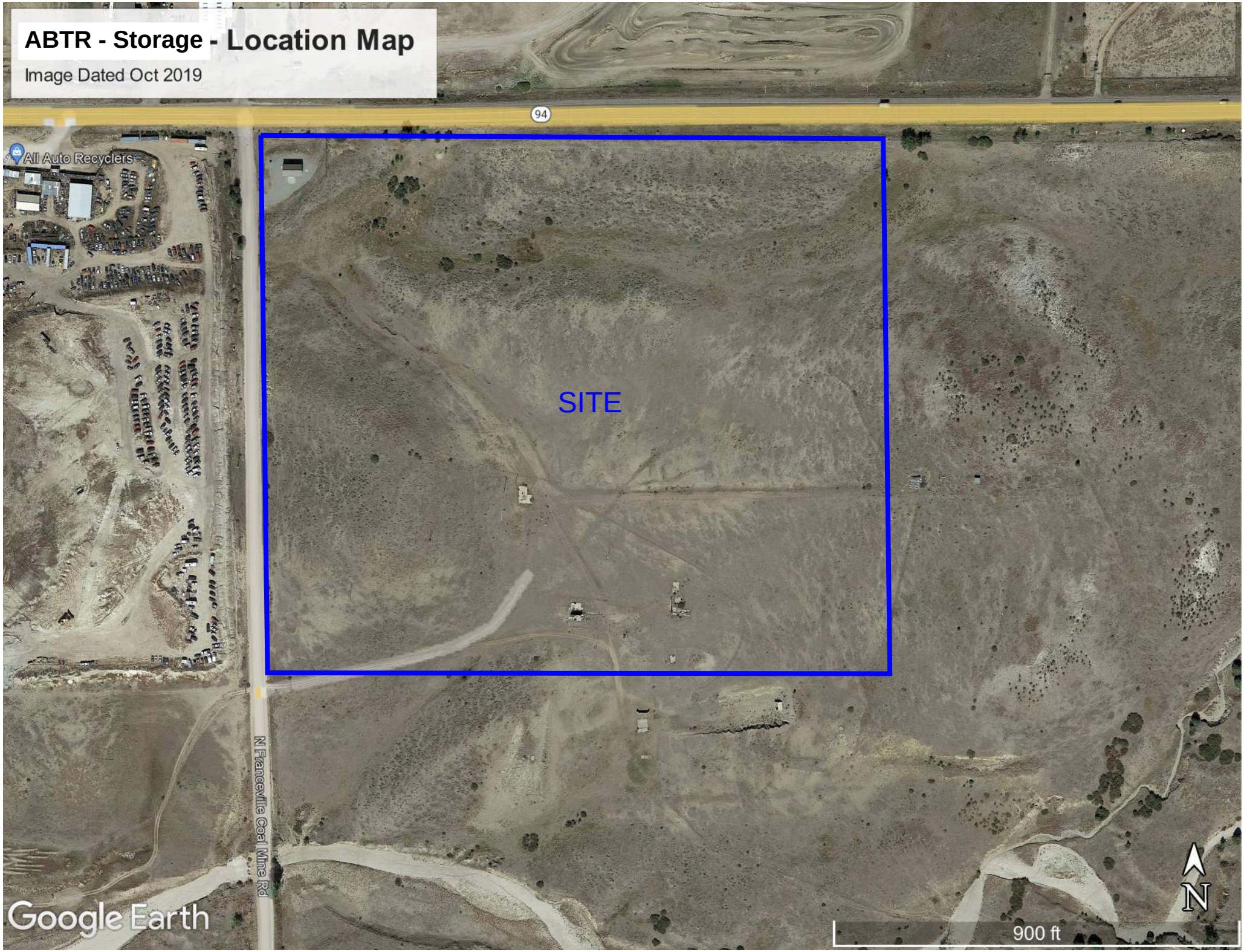
El Paso County - Community: Property Search

Schedule Number: 4400000565

2309.00 ABTR Storage
Vicinity Map



North is up ^^^


ABTR - Storage - Location Map
Image Dated Oct 2019
94
All Auto Recyclers
SITE
N Francevile Coal Mine Rd
Google Earth
N
900 ft

S.C.S. SOILS MAP

Soil Map—El Paso County Area, Colorado
(BTR Storage)

Map Scale: 1:3,120 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

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

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	38.7	100.0%
Totals for Area of Interest		**38.7**	**100.0%**

El Paso County Area, Colorado

56—Nelson-Tassel fine sandy loams, 3 to 18 percent slopes

Map Unit Setting

National map unit symbol: 3690
Elevation: 5,600 to 6,400 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Nelson and similar soils: 55 percent
Tassel and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nelson

Setting

Landform: Hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous residuum weathered from interbedded sedimentary rock

Typical profile

A - 0 to 5 inches: fine sandy loam
Ck - 5 to 23 inches: fine sandy loam
Cr - 23 to 27 inches: weathered bedrock

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: B
Ecological site: R067BY045CO - Shaly Plains
Other vegetative classification: SHALY PLAINS (069AY046CO)
Hydric soil rating: No

Description of Tassel

Setting

Landform: Hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous slope alluvium over residuum weathered from sandstone

Typical profile

A - 0 to 4 inches: fine sandy loam
C - 4 to 10 inches: fine sandy loam
Cr - 10 to 14 inches: weathered bedrock

Properties and qualities

Slope: 3 to 18 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: R067BY045CO - Shaly Plains
Other vegetative classification: SHALY PLAINS (069AY046CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 4 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions

Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 20, Sep 2, 2022

FEMA FIRM MAP

NOTES TO USERS

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

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

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

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

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

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

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

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

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

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

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

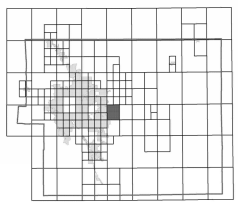
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

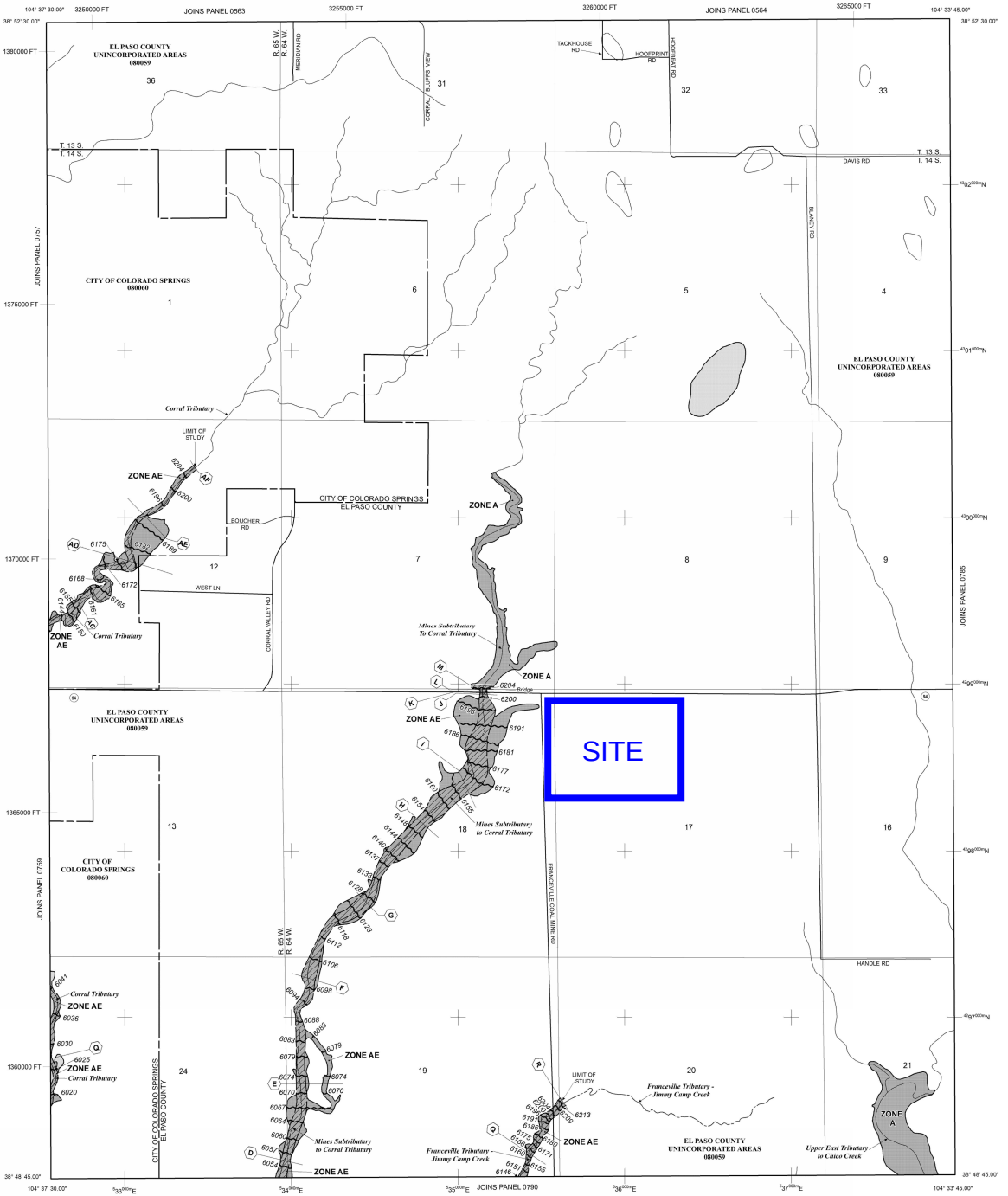
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



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

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



LEGEND

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

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

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

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

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

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

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A Cross section line
23 — 23 Transect line
97° 07' 30.00" / 32° 22' 30.00" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4278000mN 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0780G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 780 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0780	G
EL PASO COUNTY	080059	0780	G

Notice: This map was released on 05/15/2020 to make a correction.This version replaces any previous versions. See the Notice-to-User Letter that accompanied this correction for details.

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

MAP NUMBER 08041C0780G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

HYDROLOGIC CALCULATIONS

ABTR STORAGE
AREA RUNOFF COEFFICIENT (C) SUMMARY

EXISTING

		DEVELOPED / IMPERVIOUS			*UNDEVELOPED / NON-IMPERVIOUS*			*WEIGHTED*		*WEIGHTED CA*	
BASIN	**TOTAL AREA**	**AREA**	**C5**	**C100**	**AREA**	**C5**	**C100**	**C5**	**C100**	**CA5**	**CA100**
	(Acres)	*(Acres)*			*(Acres)*						
OS-X	7.12	0.14	0.90	0.96	6.98	0.08	0.35	0.10	0.36	0.68	2.58
OS-Y	21.40	1.71	0.90	0.96	19.69	0.08	0.35	0.15	0.40	3.11	8.53
OS-Z	1.84	0.74	0.90	0.96	1.10	0.08	0.35	0.41	0.60	0.75	1.10
EX-A	13.40	0.27	0.90	0.96	13.13	0.08	0.35	0.10	0.36	1.29	4.85
EX-B	1.96	0.04	0.90	0.96	1.92	0.08	0.35	0.10	0.36	0.19	0.71
EX-C	23.20	0.46	0.90	0.96	22.74	0.08	0.35	0.10	0.36	2.23	8.40

DEVELOPED

		DEVELOPED / IMPERVIOUS			*UNDEVELOPED / NON-IMPERVIOUS*			*WEIGHTED*		*WEIGHTED CA*	
BASIN	**TOTAL AREA**	**AREA**	**C5**	**C100**	**AREA**	**C5**	**C100**	**C5**	**C100**	**CA5**	**CA100**
	(Acres)	*(Acres)*			*(Acres)*						
EX-B	1.96	0.04	0.90	0.96	1.92	0.08	0.35	0.10	0.36	0.19	0.71
PR-1	9.92	3.97	0.90	0.96	5.95	0.08	0.35	0.41	0.59	4.05	5.89
PR-2	9.30	3.72	0.90	0.96	5.58	0.08	0.35	0.41	0.59	3.79	5.52
PR-3	8.78	8.34	0.90	0.96	0.44	0.08	0.35	0.86	0.93	7.54	8.16
PR-4	3.27	0.07	0.90	0.96	3.20	0.08	0.35	0.10	0.36	0.32	1.19
PR-5	1.78	0.18	0.90	0.96	1.60	0.08	0.35	0.16	0.41	0.29	0.73
PR-6	0.42	0.01	0.90	0.96	0.41	0.08	0.35	0.10	0.36	0.04	0.15
PR-7	3.03	0.30	0.90	0.96	2.73	0.08	0.35	0.16	0.41	0.49	1.24

Calculated by: DLF
Date: 2/20/2023
Checked by:

Revise. It appears that almost the entire basin will be covered by asphalt millings. Revise to reflect accurate numbers based on what is being proposed.

Revise. PR-2 appears to be 100% impervious covered by asphalt millings. Weighted coefficients should be higher.

ABTR STORAGE
RUNOFF SUMMARY

EXISTING

		WEIGHTED		*OVERLAND*				*STREET / CHANNEL FLOW*				T_C	*INTENSITY*		*TOTAL FLOWS*	
BASIN	**AREA TOTAL** *(Acres)*	C_5	C_{100}	C_5	**Length** *(ft)*	**Slope** *(ft/ft)*	T_t *(min)*	**Length** *(ft)*	**Slope** *(%)*	**Velocity** *(fps)*	T_t *(min)*	**TOTAL** *(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
		** For Calcs See Runoff Summary*														
OS-X	7.12	0.10	0.36	0.10	300	0.08	15.8	300	8%	1.4	3.5	19.3	3.1	5.2	2.1	13.4
OS-Y	21.40	0.15	0.40	0.15	300	0.06	16.5	1000	6%	1.2	13.6	30.1	2.5	4.0	7.7	34.5
OS-Z	1.84	0.41	0.60	0.41	30	0.10	3.2	400	4%	1.0	6.7	9.9	4.1	7.1	3.1	7.8
EX-A	13.40	0.10	0.36	0.10	300	0.04	19.9	700	4%	1.0	11.7	31.5	2.4	3.9	3.1	19.1
EX-B	1.96	0.10	0.36	0.10	300	0.07	16.5	0	7%	1.3	0.0	16.5	3.3	5.6	0.6	4.0
EX-C	23.20	0.10	0.36	0.10	300	0.04	19.9	1000	4%	1.0	16.7	36.5	2.2	3.6	5.0	30.2

DEVELOPED

		WEIGHTED		*OVERLAND*				*STREET / CHANNEL FLOW*				T_C	*INTENSITY*		*TOTAL FLOWS*	
BASIN	**AREA TOTAL** *(Acres)*	C_5	C_{100}	C_5	**Length** *(ft)*	**Slope** *(ft/ft)*	T_t *(min)*	**Length** *(ft)*	**Slope** *(%)*	**Velocity** *(fps)*	T_t *(min)*	**TOTAL** *(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
		** For Calcs See Runoff Summary*														
OS-X	7.12	0.10	0.36	0.10	300	0.08	15.8	300	8%	1.4	3.5	19.3	3.1	5.2	2.1	13.4
OS-Y	21.40	0.15	0.40	0.15	300	0.06	16.5	1000	6%	1.2	13.6	30.1	2.5	4.0	7.7	34.5
OS-Z	1.84	0.41	0.60	0.41	30	0.10	3.2	400	4%	1.0	6.7	9.9	4.1	7.1	3.1	7.8
EX-B	1.96	0.10	0.36	0.10	300	0.07	16.5	0	7%	1.3	0.0	16.5	3.3	5.6	0.6	4.0
PR-1	9.92	0.41	0.59	0.41	300	0.04	13.7	600	4.0%	1.0	10.0	23.7	2.8	4.6	11.4	27.3
PR-2	9.30	0.41	0.59	0.41	300	0.04	13.7	600	4.0%	1.0	10.0	23.7	2.8	4.6	10.6	25.6
PR-3	8.78	0.86	0.93	0.86	300	0.04	4.8	800	4.0%	4.0	3.3	8.1	4.4	7.7	32.9	62.8
PR-4	3.27	0.10	0.36	0.10	300	0.10	14.7	0	10.0%	1.6	0.0	14.7	3.5	6.0	1.1	7.1
PR-5	1.78	0.16	0.41	0.16	300	0.10	13.7	0	10.0%	1.6	0.0	13.7	3.6	6.2	1.0	4.5
PR-6	0.42	0.10	0.36	0.10	20	0.05	4.7	400	5.0%	1.1	6.0	10.7	4.0	6.9	0.2	1.1
PR-7	3.03	0.16	0.41	0.16	200	0.08	12.1	0	8.0%	1.4	0.0	12.1	3.8	6.5	1.9	8.1

Note: Basin PR-3 is shown for the future commercial conditions.

Calculated by: DLF

Date: 2/20/2023

Checked by: _____

ABTR STORAGE
SURFACE ROUTING SUMMARY

Design Point(s)	*Contributing Basins*	*Area (ac)*	*Flow (cfs)*	
			Q_5	Q_{100}
A	EX-A, OS-X	20.52	5.2	32.4
B	EX-B	1.96	0.6	4.0
C	EX-C, OS-Y	44.60	12.7	64.7
1	PR-1	9.92	11.4	27.3
2	PR-2	9.30	10.6	25.6
3	PR-3	8.78	32.9	62.8
4	PR-4, PR-3, PR-2	21.35	44.7	95.5
5	PR-5, NW EDB Outfall	1.78	4.6	34.4
6	PR-6	0.42	0.2	1.1
7	PR-7	3.03	1.9	8.1
51	PR-5, NW EDB Outfall, OS-Y, OS-Z	25.02	15.4	76.7
52	PR-6, OS-X	7.54	2.3	14.4

Calculated by: DLF

Date: 2/20/2023

Checked by: _____

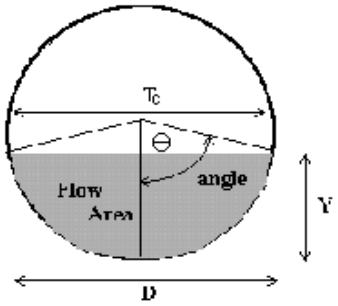
HYDRAULIC CALCULATIONS

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: ABTR Storage

Pipe ID: Existing Road Culvert



Design Information (Input)			
Pipe Invert Slope	So =	0.0270	ft/ft
Pipe Manning's n-value	n =	0.0220	*
Pipe Diameter	D =	54.00	inches
Design discharge	Q =	68.90	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	15.90	sq ft
Full-flow wetted perimeter	Pf =	14.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	191.45	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.40	radians
Flow area	An =	6.23	sq ft
Top width	Tn =	4.43	ft
Wetted perimeter	Pn =	6.30	ft
Flow depth	Yn =	1.87	ft
Flow velocity	Vn =	11.05	fps
Discharge	Qn =	68.90	cfs
Percent of Full Flow	Flow =	36.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.64	supercritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.65	radians
Critical flow area	Ac =	8.71	sq ft
Critical top width	Tc =	4.49	ft
Critical flow depth	Yc =	2.42	ft
Critical flow velocity	Vc =	7.91	fps
Critical Depth Froude Number	Fr_c =	1.00	

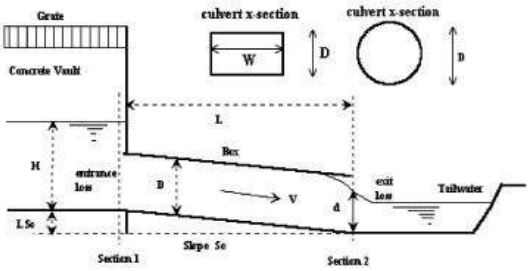
*** Unexpected value for Manning's n**

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

MHFD-Culvert, Version 4.00 (May 2020)

Project: ABTR Storage

ID: Existing Road Culvert



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	54	inches
	Inlet Edge Type (Choose from pull-down list)		Grooved Edge Projecting	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	H (Rise) =		ft
	Barrel Width (Span) in Feet	W (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	# Barrels =	1	
	Inlet Elevation at Culvert Invert	Elev IN =	6218	ft
	Outlet Elevation **OR** Slope	Elev OUT =	6216	ft
	Culvert Length	L =	75	ft
	Manning's Roughness	n =	0.022	**For concrete, typically <= 0.016**
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.90
Sum of All Loss Coefficients	K_s =	2.10
Minimum Energy Condition Coefficient	KE_{low} =	-0.0693
Orifice Inlet Condition Coefficient	C_d =	0.67

Calculations of Culvert Capacity (output):

Backwater calculations required to obtain Outlet Control Flowrate when HWo < 0.75 * Culvert Ris

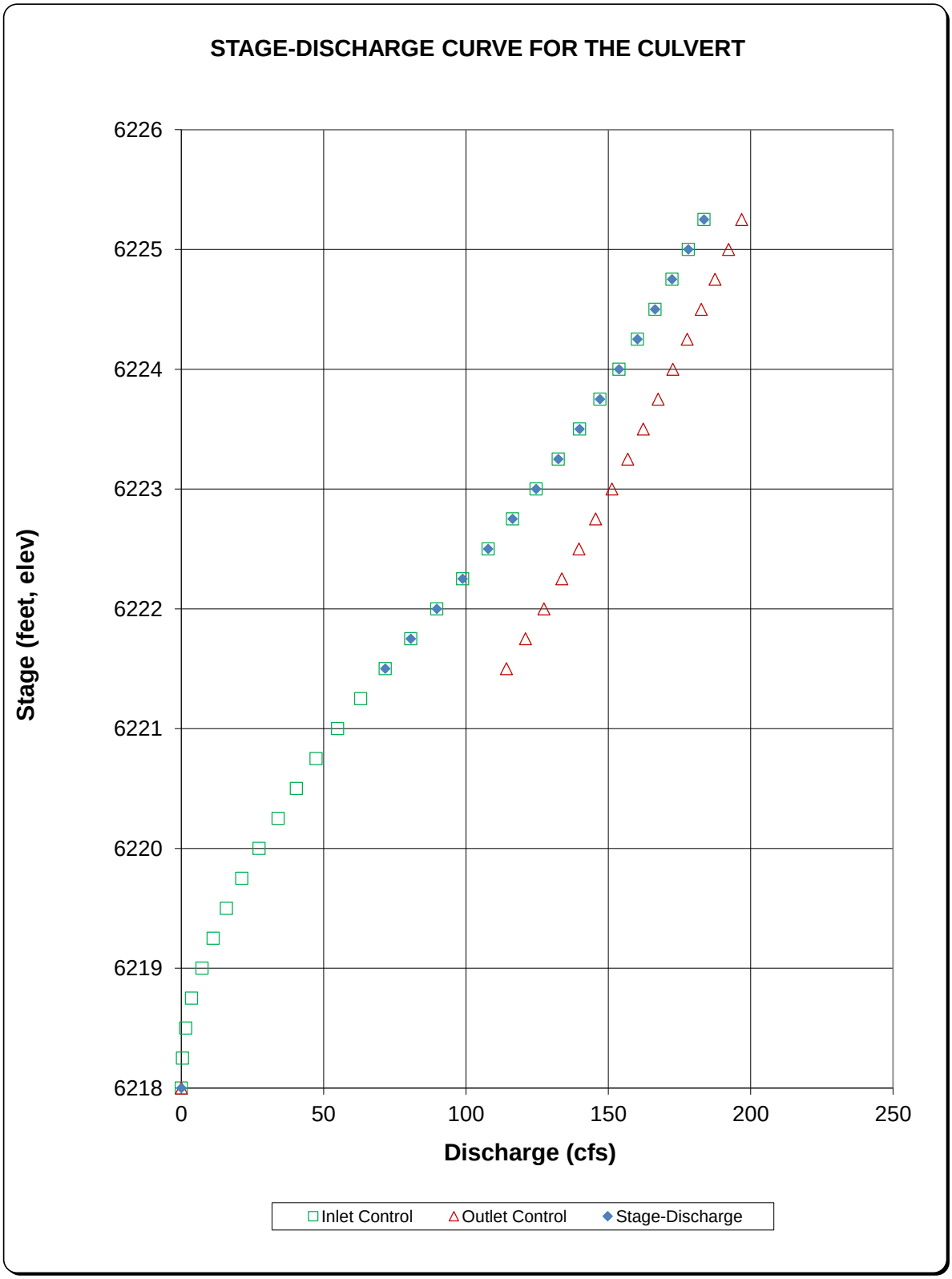
Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
6218.00		No Flow (WS < inlet)	0.00	0.00	**0.00**	N/A
6218.25		Min. Energy. Eqn.	0.41	#N/A	#N/A	#N/A
6218.50		Min. Energy. Eqn.	1.52	#N/A	#N/A	#N/A
6218.75		Min. Energy. Eqn.	3.55	#N/A	#N/A	#N/A
6219.00		Min. Energy. Eqn.	7.24	#N/A	#N/A	#N/A
6219.25		Min. Energy. Eqn.	11.16	#N/A	#N/A	#N/A
6219.50		Min. Energy. Eqn.	15.84	#N/A	#N/A	#N/A
6219.75		Min. Energy. Eqn.	21.23	#N/A	#N/A	#N/A
6220.00		Min. Energy. Eqn.	27.31	#N/A	#N/A	#N/A
6220.25		Min. Energy. Eqn.	34.02	#N/A	#N/A	#N/A
6220.50		Regression Eqn.	40.41	#N/A	#N/A	#N/A
6220.75		Regression Eqn.	47.34	#N/A	#N/A	#N/A
6221.00		Regression Eqn.	54.87	#N/A	#N/A	#N/A
6221.25		Regression Eqn.	62.98	#N/A	#N/A	#N/A
6221.50		Regression Eqn.	71.61	114.16	**71.61**	INLET
6221.75		Regression Eqn.	80.56	120.86	**80.56**	INLET
6222.00		Regression Eqn.	89.71	127.33	**89.71**	INLET
6222.25		Regression Eqn.	98.82	133.62	**98.82**	INLET
6222.50		Regression Eqn.	107.74	139.65	**107.74**	INLET
6222.75		Regression Eqn.	116.35	145.52	**116.35**	INLET
6223.00		Regression Eqn.	124.61	151.24	**124.61**	INLET
6223.25		Regression Eqn.	132.42	156.80	**132.42**	INLET
6223.50		Regression Eqn.	139.91	162.22	**139.91**	INLET
6223.75		Regression Eqn.	147.01	167.47	**147.01**	INLET
6224.00		Regression Eqn.	153.74	172.63	**153.74**	INLET
6224.25		Regression Eqn.	160.21	177.69	**160.21**	INLET
6224.50		Regression Eqn.	166.41	182.59	**166.41**	INLET
6224.75		Regression Eqn.	172.33	187.45	**172.33**	INLET
6225.00		Regression Eqn.	178.05	192.20	**178.05**	INLET
6225.25		Regression Eqn.	183.57	196.82	**183.57**	INLET
				Processing Time:	**00.30 Seconds**	

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

MHFD-Culvert, Version 4.00 (May 2020)

Project: **ABTR Storage**

ID: **Existing Road Culvert**

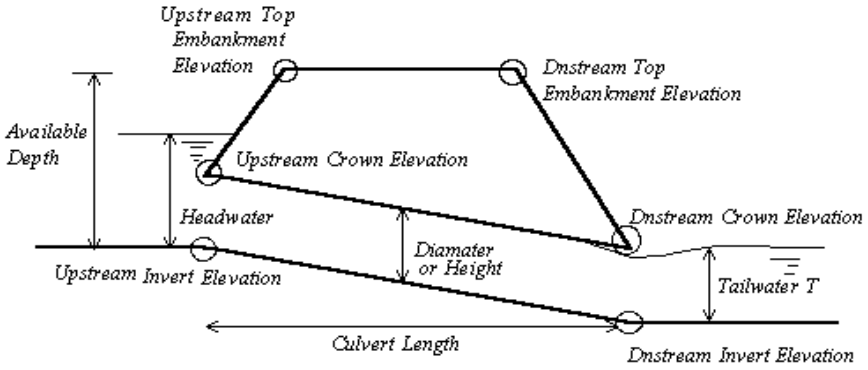


VERTICAL PROFILE FOR THE CULVERT

MHFD-Culvert, Version 4.00 (May 2020)

Project = ABTR Storage

ID = Existing Road Culvert



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	54.00	inches
Barrel Length	L =	75.00	ft
Barrel Invert Slope	So =	0.0270	ft/ft
Downstream Invert Elevation	EDI =	6216.00	ft
Downstream Top Embankment Elevation	EDT =	6225.00	ft
Upstream Top Embankment Elevation	EUT =	6225.00	ft
Design Headwater Depth (not elev.)	Hw =	4.00	ft
Tailwater Depth (not elev.)	Yt =	1.40	ft

Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	6.98	ft
Design Hw/D ratio	Hw/D =	0.89	

Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	6218.03	ft
Upstream Crown Elevation	EUC =	6222.53	ft
Upstream Soil Cover Depth	Upsoil =	2.48	ft
Downstream Crown Elevation	EDC =	6220.50	ft
Downstream Soil Cover Depth	Dnsoil =	4.50	ft

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **ABTR Storage** Location: SE Diversion Swale - E PL (need Q=13.4 cfs)

By: Dane Frank Date: 2/20/2023

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

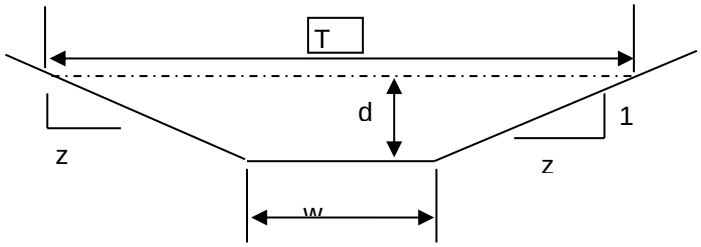
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	2
d (depth, ft)=	0.88
S (slope, ft/ft)	0.01
n_{low} =	0.035
n_{high} =	0.035

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.88	4.86	9.26	0.52	2.76218569	13.4176	2.762186	13.4176	T =	9.04
								Dm =	0.537
				Sc low =	0.0226	Sc high =	0.0226		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0158	0.0294	0.0158	0.0294		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **ABTR Storage** Location: SE Conveyance Swale - S PL (need Q=13.4 cfs)

By: Dane Frank Date: 2/20/2023

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

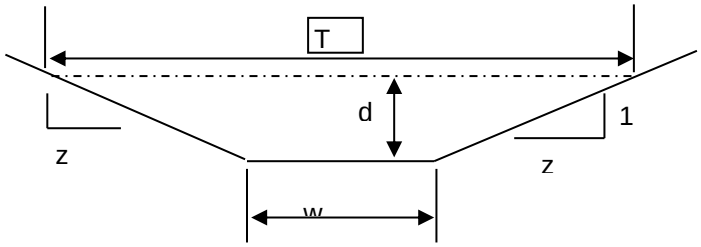
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	2
d (depth, ft)=	0.64
S (slope, ft/ft)	0.04
n_{low} =	0.035
n_{high} =	0.035

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.64	2.92	7.28	0.40	4.61749332	13.4757	4.617493	13.4757	T =	7.12
								Dm =	0.410
				Sc low =	0.0247	Sc high =	0.0247		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0173	0.0321	0.0173	0.0321		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **ABTR Storage** Location: NE Diversion Swale - E PL (need Q=34.5 cfs)

By: Dane Frank Date: 2/20/2023

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

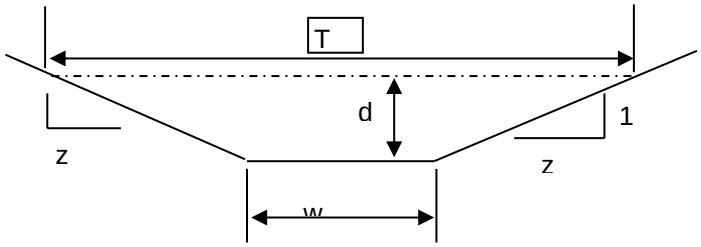
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	2
d (depth, ft)=	0.9
S (slope, ft/ft)	0.06
n_{low} =	0.035
n_{high} =	0.035

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.9	5.04	9.42	0.53	6.85311816	34.5397	6.853118	34.5397	T =	9.2
								Dm =	0.548
				Sc low =	0.0225	Sc high =	0.0225		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0158	0.0293	0.0158	0.0293		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **ABTR Storage** Location: Highway 94 Swale (need Q=7.8 cfs)

By: Dane Frank Date: 2/20/2023

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

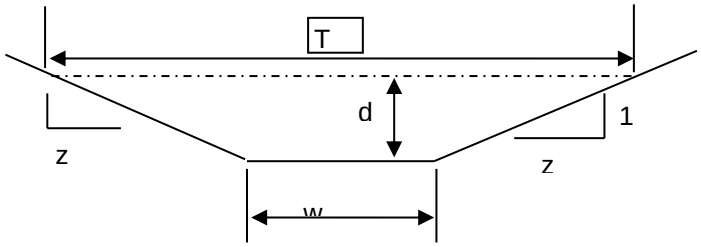
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	5
z (sideslope)=	5
b (btm width, ft)=	2
d (depth, ft)=	0.47
S (slope, ft/ft)	0.04
n_{low} =	0.035
n_{high} =	0.035

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.47	2.04	6.79	0.30	3.81338253	7.79646	3.813383	7.79646	T =	6.7
								Dm =	0.305
				Sc low =	0.0270	Sc high =	0.0270		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0189	0.0351	0.0189	0.0351		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

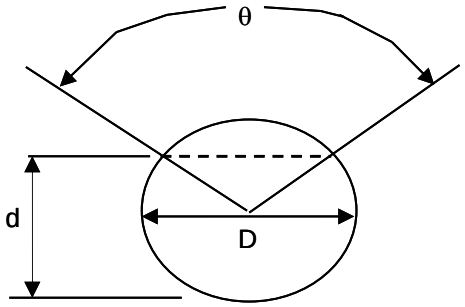
Created by: Mike O'Shea

MANNING'S EQUATION FOR PIPE FLOW

Project:	ABTR Storage	Location:	NE Div Swale Drain Pipe (need Q=34.5 cfs)
By:	dane Frank	Date:	
Chk. By:		Date:	

mdo version 12.8.00

Clear Data Entry Cells



INPUT

D=	24	inches
d=	24	inches
n=	0.012	mannings coeff
θ=	0.0	degrees
S=	0.03	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

Q=V x A

Solution to Mannings Equation				
Area,ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	flow, cfs
3.14	6.28	0.50	13.51	42.45

Manning's n-values	
PVC	0.01
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Created by: Mike O'Shea

DETENTION CALCULATIONS

Design Procedure Form: Runoff Reduction

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

Designer:	**Dane Frank**
Company:	**Terra Nova Engineering**
Date:	**February 20, 2023**
Project:	**ABTR Storage**
Location:	**Southwest corner driveway and corner of parking area below SW EDB**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches

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

Area Type	UIA:RPA											
Area ID	PR-7											
Downstream Design Point ID	7											
Downstream BMP Type	None											
DCIA (ft^2)	--											
UIA (ft^2)	910											
RPA (ft^2)	2,800											
SPA (ft^2)	--											
HSG A (%)	0%											
HSG B (%)	100%											
HSG C/D (%)	0%											
Average Slope of RPA (ft/ft)	0.030											
UIA:RPA Interface Width (ft)	1200.00											

CALCULATED RUNOFF RESULTS

Area ID	PR-7											
UIA:RPA Area (ft^2)	3,710											
L / W Ratio	0.06											
UIA / Area	0.2453											
Runoff (in)	0.00											
Runoff (ft^3)	0											
Runoff Reduction (ft^3)	38											

CALCULATED WQCV RESULTS

Area ID	PR-7											
WQCV (ft^3)	38											
WQCV Reduction (ft^3)	38											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

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

Downstream Design Point ID	7											
DCIA (ft^2)	0											
UIA (ft^2)	910											
RPA (ft^2)	2,800											
SPA (ft^2)	0											
Total Area (ft^2)	3,710											
Total Impervious Area (ft^2)	910											
WQCV (ft^3)	38											
WQCV Reduction (ft^3)	38											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

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

Total Area (ft^2)	3,710
Total Impervious Area (ft^2)	910
WQCV (ft^3)	38
WQCV Reduction (ft^3)	38
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

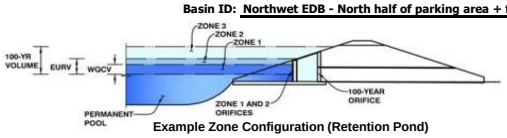
Notes about Runoff Reduction:
- The runoff reduction RPA is considered a WQ Facility and requires a signed Maintenance Agreement
- All RPA/SPA areas will need to be within a no build/drainage easement (or tract) and discussed in the maintenance agreement and O&M manual.
- RPA/SPA limits must be shown on GEC Plans (not just FDR) so our SW inspectors and the QSM know that these areas are to remain pervious. Our SW inspectors do not look at drainage reports.
- Provide a figure showing all proposed UIA, RPA and SPA areas to be utilized for runoff reduction.
- Provide a detail for the UIA:RPA interface that shows the recommended vertical drop of 4".

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: ABTR Storage

Basin ID: Northwet EDB - North half of parking area + future commercial development along HWY 94



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	21.40	acres
Watershed Length =	1,400	ft
Watershed Length to Centroid =	700	ft
Watershed Slope =	0.037	ft/ft
Watershed Imperviousness =	60.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.421	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.393	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.262	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.743	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.156	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.680	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.122	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.666	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3 in.) =	4.535	acre-feet	3.00	inches
Approximate 2-yr Detention Volume =	1.071	acre-feet		
Approximate 5-yr Detention Volume =	1.446	acre-feet		
Approximate 10-yr Detention Volume =	1.863	acre-feet		
Approximate 25-yr Detention Volume =	2.015	acre-feet		
Approximate 50-yr Detention Volume =	2.101	acre-feet		
Approximate 100-yr Detention Volume =	2.293	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.421	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.972	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.901	acre-feet
Total Detention Basin Volume =	2.293	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment

Stage - Storage Description								Volume (ft^3)	Volume (ac-ft)
Top of Micropoc									
								25	0.001
6222								50	0.001
								310	0.007
								1,040	0.024
								2,241	0.051
6223								4,526	0.104
								7,709	0.177
								10,988	0.252
								14,363	0.330
6224								17,873	0.410
								21,523	0.494
	--	3.00	--	--	--	15,222	0.349	25,276	0.580
	--	3.25	--	--	--	15,638	0.359	29,134	0.669
6225	--	3.50	--	--	--	16,360	0.376	33,133	0.761
	--	3.75	--	--	--	16,808	0.386	37,279	0.856
	--	4.00	--	--	--	17,256	0.396	41,537	0.954
	--	4.25	--	--	--	17,704	0.406	45,907	1.054
6226	--	4.50	--	--	--	18,455	0.424	50,427	1.158
	--	4.75	--	--	--	18,935	0.435	55,101	1.265
	--	5.00	--	--	--	19,415	0.446	59,895	1.375
	--	5.25	--	--	--	19,895	0.457	64,809	1.488
6227	--	5.50	--	--	--	20,672	0.475	69,879	1.604
	--	5.75	--	--	--	21,184	0.486	75,111	1.724
	--	6.00	--	--	--	21,696	0.498	80,471	1.847
	--	6.25	--	--	--	22,208	0.510	85,959	1.973
6228	--	6.50	--	--	--	23,013	0.528	91,612	2.103
	--	6.75	--	--	--	23,525	0.540	97,429	2.237
	--	7.00	--	--	--	24,037	0.552	103,375	2.373
	--	7.25	--	--	--	24,549	0.564	109,448	2.513
6229	--	7.50	--	--	--	25,475	0.585	115,701	2.656
	--	7.75	--	--	--	25,987	0.597	122,134	2.804
	--	8.00	--	--	--	26,499	0.608	128,694	2.954
	--	8.25	--	--	--	27,011	0.620	135,383	3.108
6230	--	8.50	--	--	--	28,062	0.644	142,267	3.266

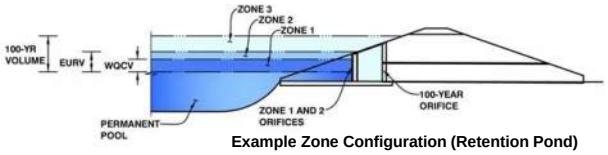
Provide calculation on a separate sheet for how imperviousness percentage was calculated. It appears that the only basins that drain to pond are PR-2 and PR-4. The imperviousness should be higher.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **ABTR Storage**

Basin ID: **Northwet EDB - North half of parking area + future commercial development along HWY 94**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.54	0.421	Orifice Plate
Zone 2 (EURV)	5.04	0.972	Orifice Plate
Zone 3 (100-year)	6.86	0.901	Weir&Pipe (Restrict)
Total (all zones)		2.293	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.208E-02	ft^2
Depth at top of Zone using Orifice Plate =	5.04	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.74	sq. inches (diameter = 1-1/2 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.00	2.00	3.00	3.50			
Orifice Area (sq. inches)	1.74	1.74	1.74	1.74	1.74			

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.04	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.04	N/A	feet
Overflow Weir Front Edge Length =	5.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	6.26	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	15.82	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	7.91	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	2.53	N/A	ft^2
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	0.83	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.09	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.98	feet
Spillway Crest Length =	20.00	feet	Stage at Top of Freeboard =	8.48	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.64	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	3.25	acre-ft

Calculated Parameters for Spillway

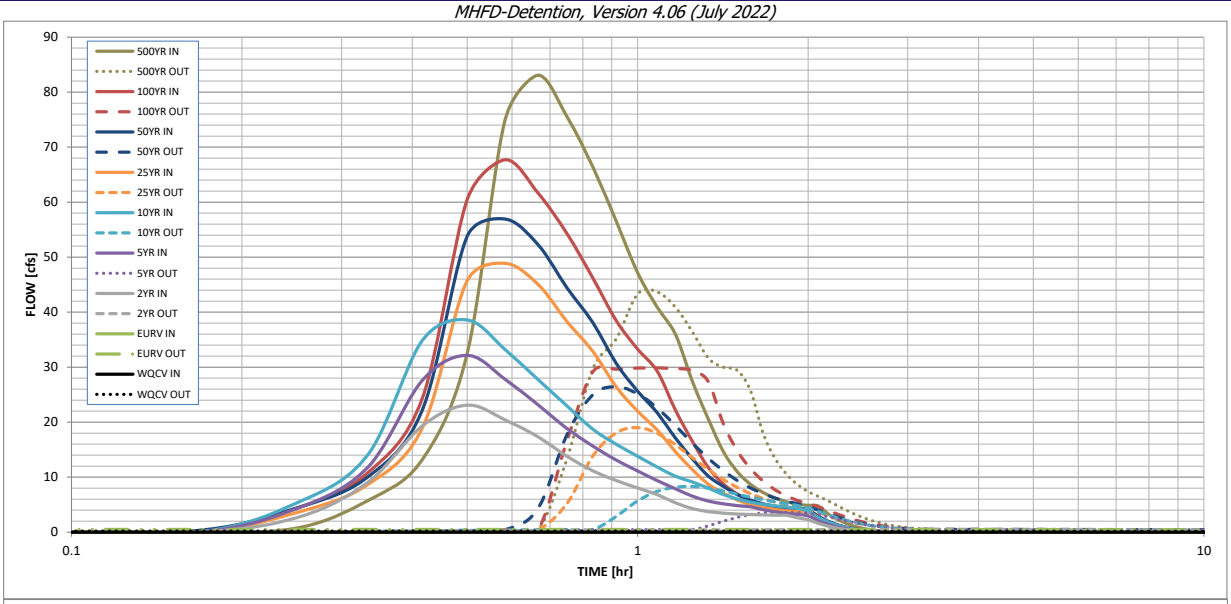
Routed Hydrograph Results

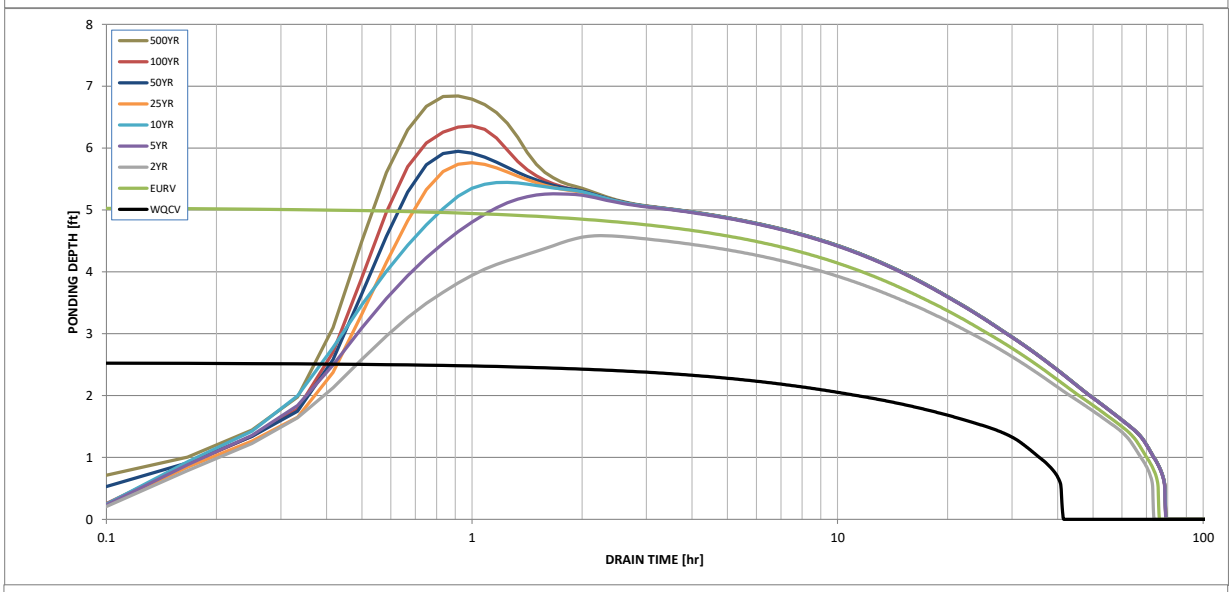
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

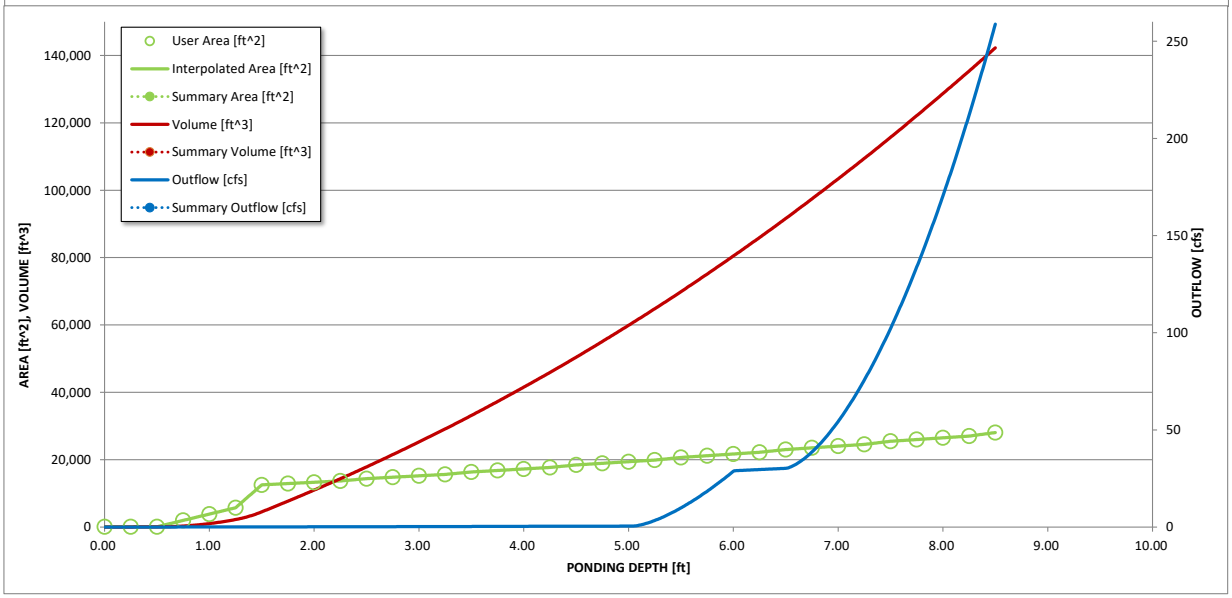
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
CUHP Runoff Volume (acre-ft) =	0.421	1.393	1.262	1.743	2.156	2.680	3.122	3.666	4.535
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.262	1.743	2.156	2.680	3.122	3.666	4.535
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.6	7.2	10.9	19.2	24.2	30.2	39.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.34	0.51	0.90	1.13	1.41	1.84
Peak Inflow Q (cfs) =	N/A	N/A	23.1	32.2	38.6	48.9	56.9	67.7	83.1
Peak Outflow Q (cfs) =	0.2	0.5	0.5	3.6	8.3	19.0	26.4	29.9	43.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.8	1.0	1.1	1.0	1.1
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.00	N/A	0.2	0.5	1.2	1.6	1.9	1.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	65	69	68	66	64	63	60
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	70	75	74	73	72	71	70
Maximum Ponding Depth (ft) =	2.54	5.05	4.58	5.26	5.45	5.76	5.95	6.36	6.84
Area at Maximum Ponding Depth (acres) =	0.33	0.45	0.43	0.46	0.47	0.49	0.50	0.52	0.54
Maximum Volume Stored (acre-ft) =	0.424	1.397	1.192	1.492	1.576	1.729	1.818	2.025	2.285

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







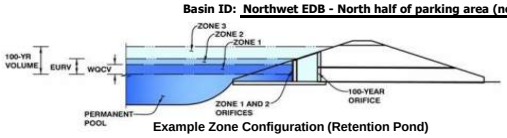
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **ABTR Storage**

Basin ID: **Northwest EDB - North half of parking area (no future commercial)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	21.40	acres
Watershed Length =	1,400	ft
Watershed Length to Centroid =	700	ft
Watershed Slope =	0.037	ft/ft
Watershed Imperviousness =	20.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	

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

Water Quality Capture Volume (WQCV) =	0.206	acre-feet
Excess Urban Runoff Volume (EURV) =	0.425	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.467	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.851	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	1.216	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	1.811	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	2.237	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	2.828	acre-feet
500-yr Runoff Volume (P1 = 3 in.) =	3.681	acre-feet
Approximate 2-yr Detention Volume =	0.292	acre-feet
Approximate 5-yr Detention Volume =	0.432	acre-feet
Approximate 10-yr Detention Volume =	0.698	acre-feet
Approximate 25-yr Detention Volume =	0.864	acre-feet
Approximate 50-yr Detention Volume =	0.913	acre-feet
Approximate 100-yr Detention Volume =	1.122	acre-feet

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.206	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.219	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.697	acre-feet
Total Detention Basin Volume =	1.122	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Watershed imperviousness should be higher based on land coverage draining to pond. Revise and provide calculation for how impervious value was determined.

	3.00	inches

Depth Increment = 0.25 ft

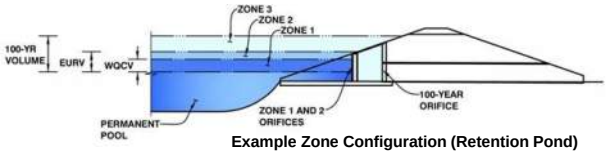
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	100	0.002		
	--	0.25	--	--	--	100	0.002	25	0.001
6222	--	0.50	--	--	--	100	0.002	50	0.001
	--	0.75	--	--	--	1,981	0.045	310	0.007
	--	1.00	--	--	--	3,862	0.089	1,040	0.024
	--	1.25	--	--	--	5,742	0.132	2,241	0.051
	--	1.50	--	--	--	12,540	0.288	4,526	0.104
	--	1.75	--	--	--	12,924	0.297	7,709	0.177
	--	2.00	--	--	--	13,308	0.306	10,988	0.252
	--	2.25	--	--	--	13,692	0.314	14,363	0.330
	--	2.50	--	--	--	14,390	0.330	17,873	0.410
	--	2.75	--	--	--	14,806	0.340	21,523	0.494
	--	3.00	--	--	--	15,222	0.349	25,276	0.580
	--	3.25	--	--	--	15,638	0.359	29,134	0.669
	--	3.50	--	--	--	16,360	0.376	33,133	0.761
	--	3.75	--	--	--	16,808	0.386	37,279	0.856
	--	4.00	--	--	--	17,256	0.396	41,537	0.954
	--	4.25	--	--	--	17,704	0.406	45,907	1.054
	--	4.50	--	--	--	18,455	0.424	50,427	1.158
	--	4.75	--	--	--	18,935	0.435	55,101	1.265
	--	5.00	--	--	--	19,415	0.446	59,895	1.375
	--	5.25	--	--	--	19,895	0.457	64,809	1.488
	--	5.50	--	--	--	20,672	0.475	69,879	1.604
	--	5.75	--	--	--	21,184	0.486	75,111	1.724
	--	6.00	--	--	--	21,696	0.498	80,471	1.847
	--	6.25	--	--	--	22,208	0.510	85,959	1.973
6228	--	6.50	--	--	--	23,013	0.528	91,612	2.103
	--	6.75	--	--	--	23,525	0.540	97,429	2.237
	--	7.00	--	--	--	24,037	0.552	103,375	2.373
	--	7.25	--	--	--	24,549	0.564	109,448	2.513
6229	--	7.50	--	--	--	25,475	0.585	115,701	2.656
	--	7.75	--	--	--	25,987	0.597	122,134	2.804
	--	8.00	--	--	--	26,499	0.608	128,694	2.954
	--	8.25	--	--	--	27,011	0.620	135,383	3.108
6230	--	8.50	--	--	--	28,062	0.644	142,267	3.266

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **ABTR Storage**

Basin ID: **Northwet EDB - North half of parking area (no future commercial)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.85	0.206	Orifice Plate
Zone 2 (EURV)	2.55	0.219	Orifice Plate
Zone 3 (100-year)	4.42	0.697	Weir&Pipe (Restrict)
Total (all zones)		1.122	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	4.931E-03	ft²
Depth at top of Zone using Orifice Plate =	2.55	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.71	sq. inches (diameter = 15/16 inch)	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

15/16in diameter is actually A=0.69 sq in. Revise calcs and plans accordingly.

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00					
Orifice Area (sq. inches)	0.71	0.71	0.71					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft²
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.55	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.55	N/A	feet
Overflow Weir Front Edge Length =	5.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	5.04	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	15.82	N/A	ft²
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	7.91	N/A	ft²
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	3.14	N/A	ft²
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	1.00	N/A	feet
Restrictor Plate Height Above Pipe Invert =	24.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.98	feet
Spillway Crest Length =	20.00	feet	Stage at Top of Freeboard =	8.48	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.64	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	3.25	acre-ft

Calculated Parameters for Spillway

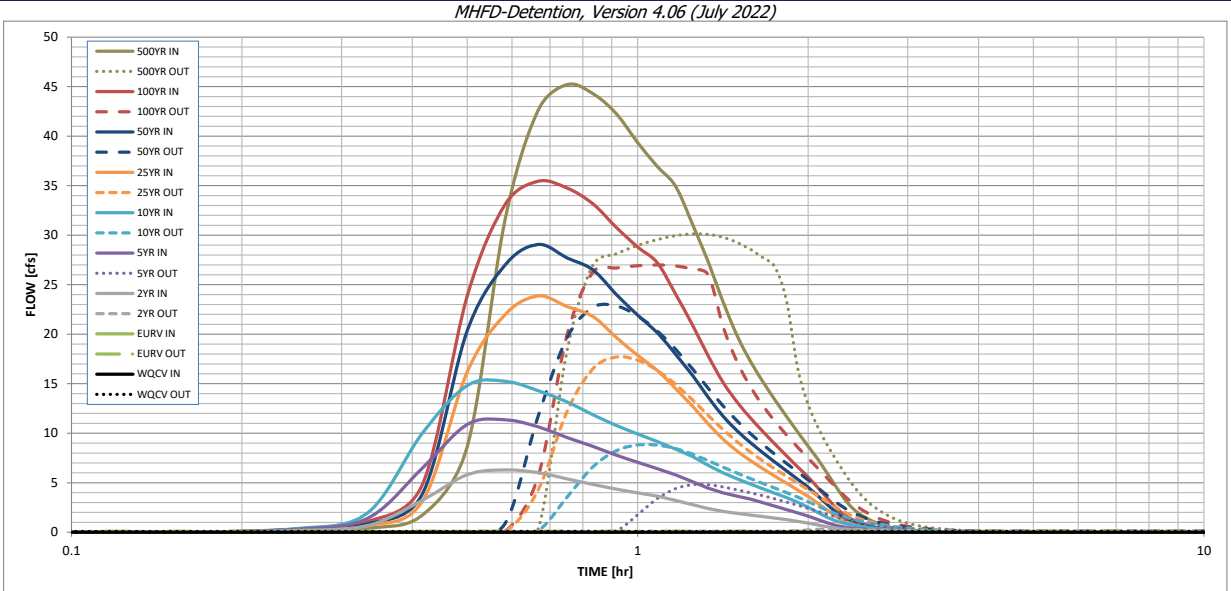
Routed Hydrograph Results

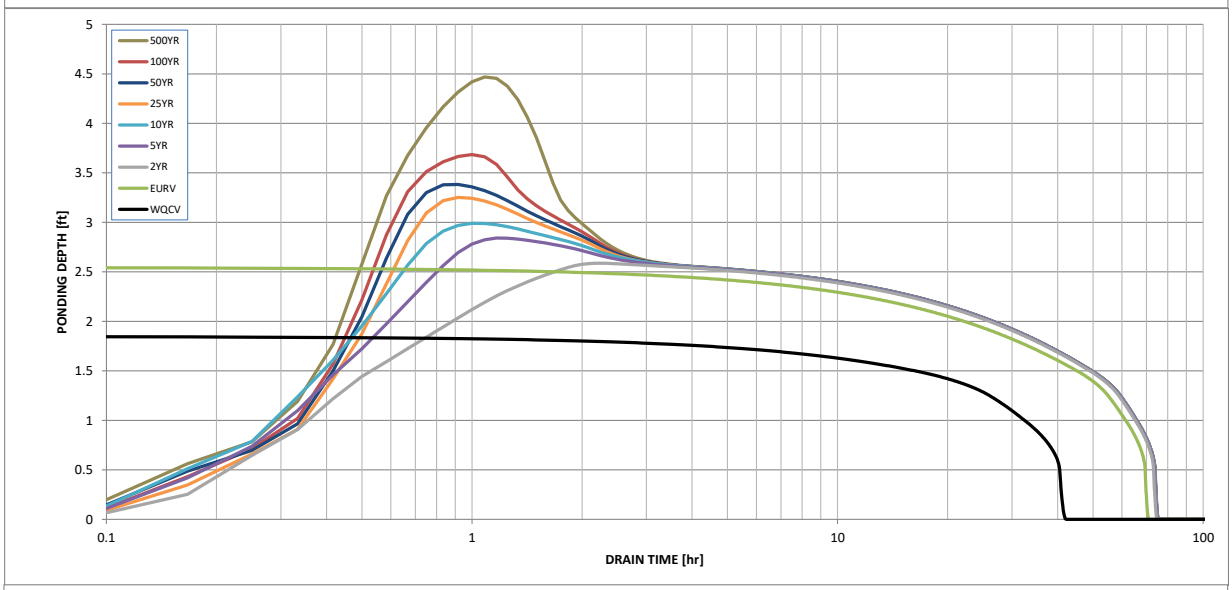
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

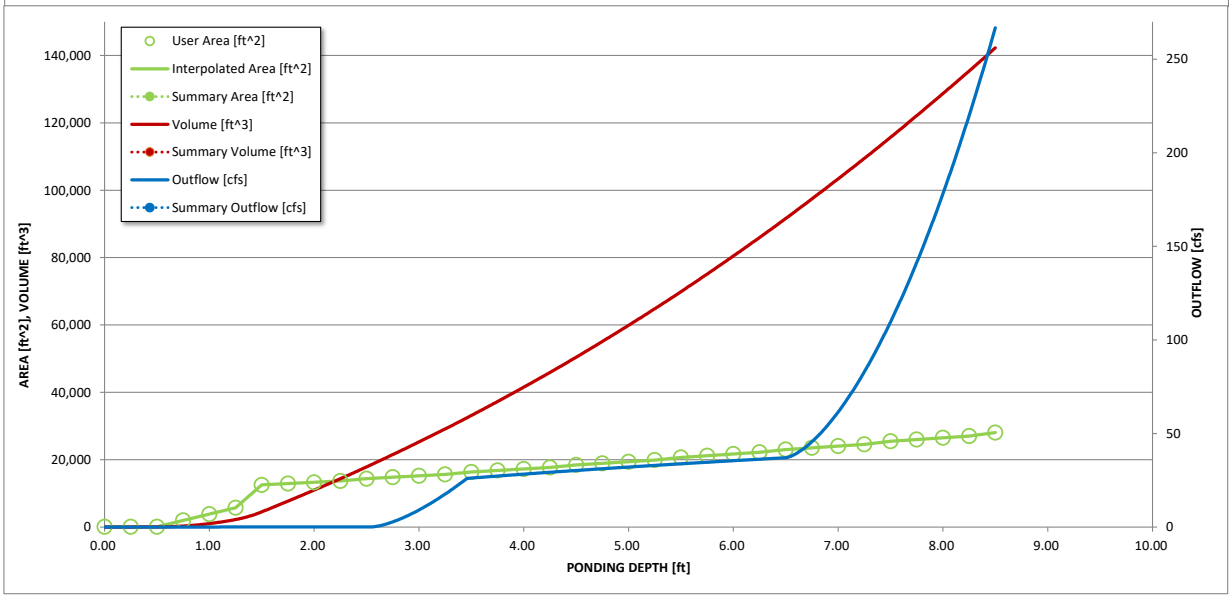
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
CUHP Runoff Volume (acre-ft) =	0.206	0.425	0.467	0.851	1.216	1.811	2.237	2.828	3.681
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.467	0.851	1.216	1.811	2.237	2.828	3.681
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.6	7.2	10.9	19.2	24.2	30.2	39.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.34	0.51	0.90	1.13	1.41	1.84
Peak Inflow Q (cfs) =	N/A	N/A	6.3	11.4	15.3	23.9	29.1	35.4	45.2
Peak Outflow Q (cfs) =	0.1	0.1	0.3	4.8	8.8	17.7	22.9	27.0	30.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.8	0.9	0.9	0.9	0.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.02	0.3	0.6	1.1	1.4	1.7	1.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	65	68	65	63	59	56	53	49
Time to Drain 99% of Inflow Volume (hours) =	**40**	68	72	71	69	68	66	65	63
Maximum Ponding Depth (ft) =	1.85	2.55	2.59	2.84	2.99	3.25	3.38	3.69	4.47
Area at Maximum Ponding Depth (acres) =	0.30	0.33	0.33	0.34	0.35	0.36	0.37	0.38	0.42
Maximum Volume Stored (acre-ft) =	0.207	0.427	0.437	0.525	0.573	0.669	0.716	0.829	1.141

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







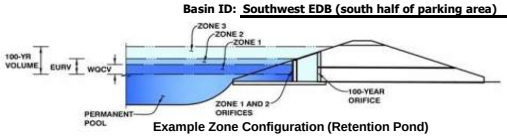
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: ABTR Storage

Basin ID: Southwest EDB (south half of parking area)



Example Zone Configuration (Retention Pond)

Correct value to 97%
Recalculate

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	9.92	acres
Watershed Length =	1,000	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.046	ft/ft
Watershed Imperviousness =	40.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.149	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.417	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.400	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.598	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.775	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.031	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.229	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.489	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3 in.) =	1.886	acre-feet	3.00	inches
Approximate 2-yr Detention Volume =	0.307	acre-feet		
Approximate 5-yr Detention Volume =	0.429	acre-feet		
Approximate 10-yr Detention Volume =	0.590	acre-feet		
Approximate 25-yr Detention Volume =	0.660	acre-feet		
Approximate 50-yr Detention Volume =	0.693	acre-feet		
Approximate 100-yr Detention Volume =	0.794	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.149	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.268	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.377	acre-feet
Total Detention Basin Volume =	0.794	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.25 ft

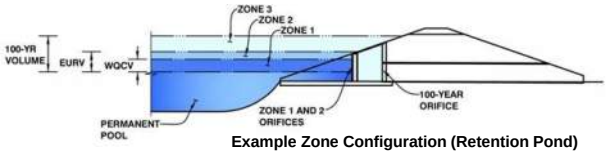
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	100	0.002		
	--	0.25	--	--	--	100	0.002	25	0.001
	--	0.50	--	--	--	100	0.002	50	0.001
	--	0.75	--	--	--	1,981	0.045	310	0.007
	--	1.00	--	--	--	3,862	0.089	1,040	0.024
	--	1.25	--	--	--	5,742	0.132	2,241	0.051
	--	1.50	--	--	--	7,623	0.175	3,911	0.090
	--	1.75	--	--	--	8,007	0.184	5,865	0.135
	--	2.00	--	--	--	8,391	0.193	7,915	0.182
	--	2.25	--	--	--	8,775	0.201	10,061	0.231
6238	--	2.50	--	--	--	9,159	0.210	12,302	0.282
	--	2.75	--	--	--	9,575	0.220	14,644	0.336
	--	3.00	--	--	--	9,991	0.229	17,090	0.392
	--	3.25	--	--	--	10,407	0.239	19,640	0.451
6239	--	3.50	--	--	--	10,823	0.248	22,293	0.512
	--	3.75	--	--	--	11,271	0.259	25,055	0.575
	--	4.00	--	--	--	11,719	0.269	27,929	0.641
	--	4.25	--	--	--	12,167	0.279	30,915	0.710
6240	--	4.50	--	--	--	12,615	0.290	34,012	0.781
	--	4.75	--	--	--	13,095	0.301	37,226	0.855
	--	5.00	--	--	--	13,575	0.312	40,560	0.931
	--	5.25	--	--	--	14,055	0.323	44,014	1.010
6241	--	5.50	--	--	--	14,535	0.334	47,587	1.092
	--	5.75	--	--	--	15,047	0.345	51,285	1.177
	--	6.00	--	--	--	15,559	0.357	55,111	1.265
	--	6.25	--	--	--	16,071	0.369	59,065	1.356
6242	--	6.50	--	--	--	16,583	0.381	63,146	1.450

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **ABTR Storage**

Basin ID: **Southwest EDB (south half of parking area)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.83	0.149	Orifice Plate
Zone 2 (EURV)	3.11	0.268	Orifice Plate
Zone 3 (100-year)	4.55	0.377	Weir&Pipe (Restrict)
Total (all zones)		0.794	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.903E-03	ft²
Depth at top of Zone using Orifice Plate =	3.11	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.85	sq. inches (diameter = 1 inch)	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

1in diameter is actually A=0.785 sq in. Revise calcs and plans accordingly.

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.00	2.00	2.50				
Orifice Area (sq. inches)	0.85	0.85	0.85	0.85				

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft²
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.25	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.25	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.58	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	12.66	N/A	ft²
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	6.33	N/A	ft²
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.47	N/A	ft²
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.64	N/A	feet
Restrictor Plate Height Above Pipe Invert =	14.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.16	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.75	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.65	feet
Spillway Crest Length =	15.00	feet	Stage at Top of Freeboard =	6.40	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.38	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.41	acre-ft

Calculated Parameters for Spillway

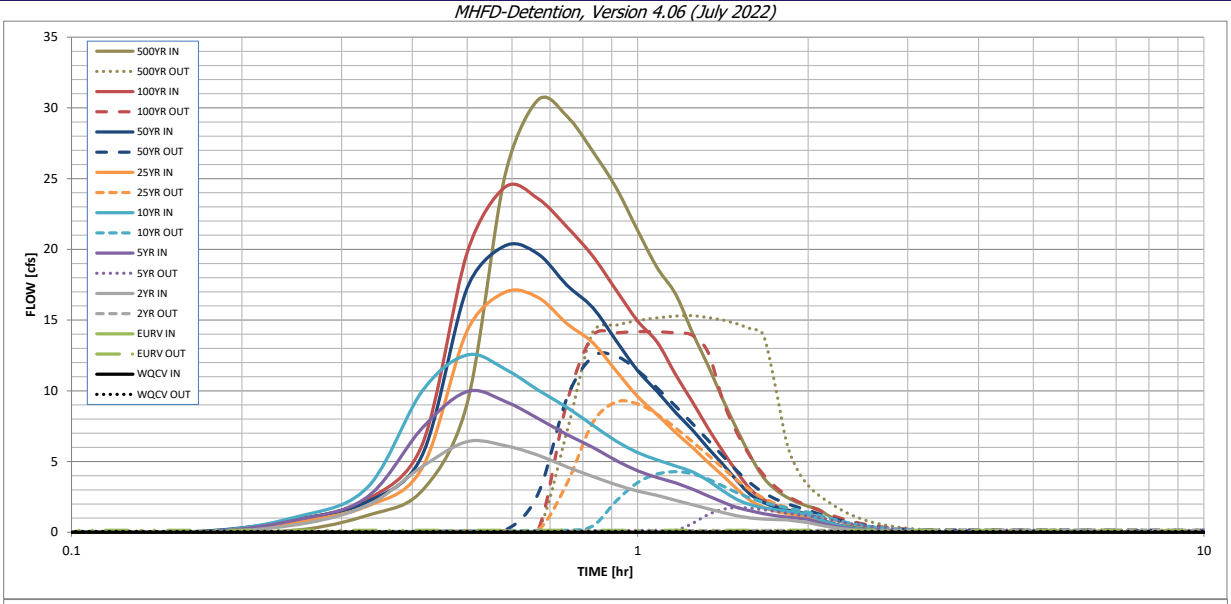
Routed Hydrograph Results

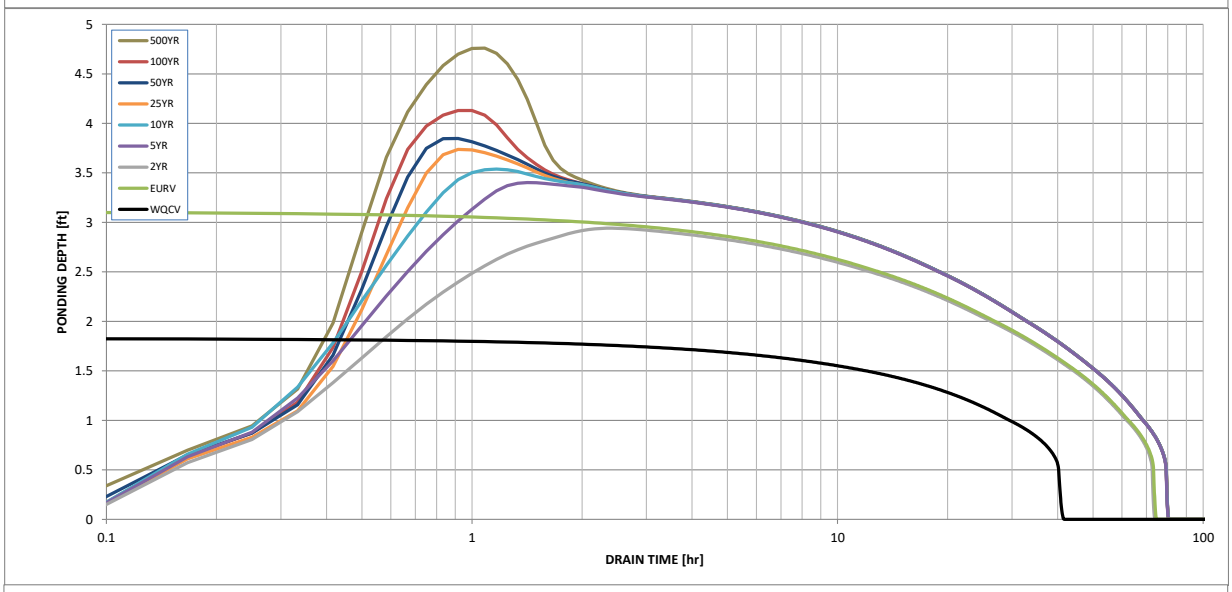
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

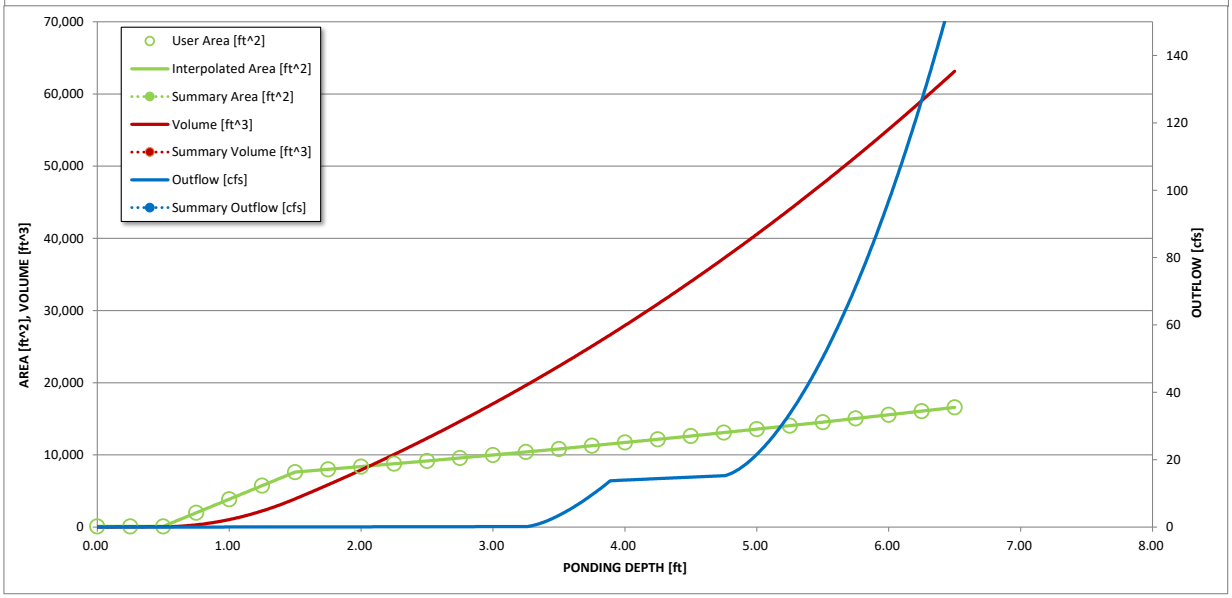
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
CUHP Runoff Volume (acre-ft) =	0.149	0.417	0.400	0.598	0.775	1.031	1.229	1.489	1.886
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.400	0.598	0.775	1.031	1.229	1.489	1.886
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.2	3.4	5.1	9.1	11.4	14.3	18.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.34	0.52	0.92	1.15	1.44	1.87
Peak Inflow Q (cfs) =	N/A	N/A	6.4	10.0	12.5	17.0	20.3	24.4	30.6
Peak Outflow Q (cfs) =	0.1	0.1	0.1	1.7	4.3	9.2	12.5	14.2	15.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.8	1.0	1.1	1.0	0.8
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.3	0.7	1.0	1.1	1.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	68	67	71	69	66	64	62	59
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	71	77	76	75	74	73	71
Maximum Ponding Depth (ft) =	1.83	3.11	2.94	3.40	3.54	3.74	3.85	4.13	4.76
Area at Maximum Ponding Depth (acres) =	0.19	0.23	0.23	0.24	0.25	0.26	0.26	0.27	0.30
Maximum Volume Stored (acre-ft) =	0.149	0.418	0.379	0.487	0.519	0.570	0.599	0.674	0.858

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

No matching calc page provided for the NE Forebay. Make this page for both or have a separate page for each.

3% is for forebays with 5-20ac of impervious area tributary to them. Clarify that this is why 3% was used here. And clarify why half was used (because flows split between two forebays). But make sure that flows are split 50/50.

FORBAY VOLUMES

NW POND - SE FOREBAY - FORBAY VOLUME

Required Forbay Volume = Half of 3% of WQCV

WQCV = 0.421 ac-ft

WQCV = 18,339 cu-ft

Half of 3% of WQCV = 275 cu-ft

ELEV	*AREA*	*AREA AVG.*	*DELTA ELEV.*	*VOLUME*	*VOLUME TOTAL*
6223.00	200				
		200	1.50	300	
6224.50	200				300

Design Volume: 300 cu-ft

0.007 ac-ft

Include calcs that show sizing of Forebay notch. See EDB tab of UD-BMP spreadsheet.

FORBAY VOLUMES

2% is for forebays with 2-5ac of impervious area tributary to them. Clarify that this is why 2% was used here.

SW POND - FORBAY VOLUME

Required Forbay Volume = 2% of WQCV

WQCV =	0.149	ac-ft
WQCV =	6,490	cu-ft
2% of WQCV =	97	cu-ft

ELEV	*AREA*	*AREA AVG.*	*DELTA ELEV.*	*VOLUME*	*VOLUME TOTAL*
6237.00	157				
		157	1.50	236	
6238.50	157				236

Design Volume: 236 cu-ft
0.005 ac-ft

Include calcs that show sizing of Forebay notch. See EDB tab of UD-BMP spreadsheet.

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **ABTR Storage** Location: NW EDB - Forebay Notch - Q=35.4 cfs * 2% = 0.71 cfs

By: Dane Frank Date: 2/22/2023

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

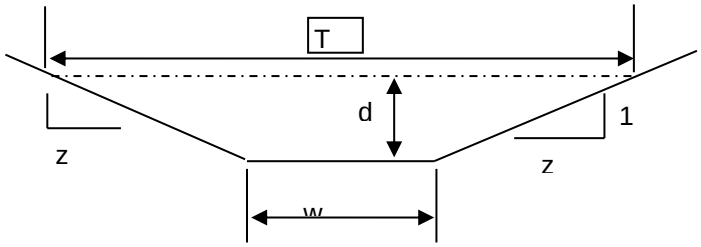
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	0
z (sideslope)=	0
b (btm width, ft)=	0.25
d (depth, ft)=	1.5
S (slope, ft/ft)	0.005
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.5	0.38	3.25	0.12	1.91555431	0.71833	1.915554	0.71833	T =	0.25
								Dm =	1.500
				Sc low =	0.0657	Sc high =	0.0657		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0460	0.0854	0.0460	0.0854		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **ABTR Storage** Location: SW EDB Trickle Channels (need Q= 0.71 cfs)

By: Dane Frank Date: 2/22/2023

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

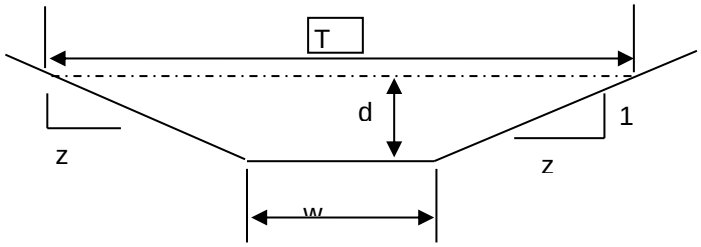
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	0
z (sideslope)=	0
b (btm width, ft)=	0.6
d (depth, ft)=	0.5
S (slope, ft/ft)	0.005
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.5	0.30	1.60	0.19	2.64770995	0.79431	2.64771	0.79431	T =	0.6
								Dm =	0.500
				Sc low =	0.0115	Sc high =	0.0115		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0080	0.0149	0.0080	0.0149		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**ABTR Storage**	Location:	SW EDB - Forebay Notch - Q=22.4 cfs * 2% = 0.45 cfs	
By:	Dane Frank	Date:	2/22/2023	
Chk By:		Date:		version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

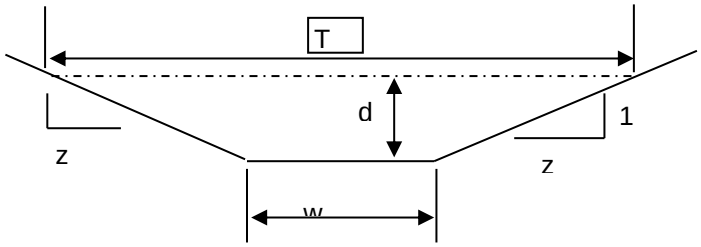
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	0
z (sideslope)=	0
b (btm width, ft)=	0.19
d (depth, ft)=	1.5
S (slope, ft/ft)	0.005
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.5	0.29	3.19	0.09	1.61520734	0.46033	1.615207	0.46033	T =	0.19
								Dm =	1.500
				Sc low =	0.0924	Sc high =	0.0924		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0647	0.1201	0.0647	0.1201		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **ABTR Storage** Location: SW EDB Trickle Channels (need Q= 0.45 cfs)

By: Dane Frank Date: 2/22/2023

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

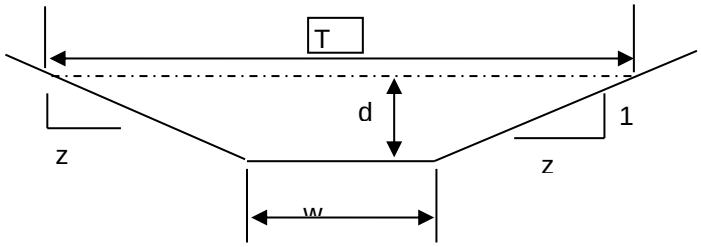
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	0
z (sideslope)=	0
b (btm width, ft)=	0.4
d (depth, ft)=	0.5
S (slope, ft/ft)	0.005
n_{low} =	0.013
n_{high} =	0.013

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.5	0.20	1.40	0.14	2.20868406	0.44174	2.208684	0.44174	T =	0.4
								Dm =	0.500
				Sc low =	0.0165	Sc high =	0.0165		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0115	0.0214	0.0115	0.0214		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

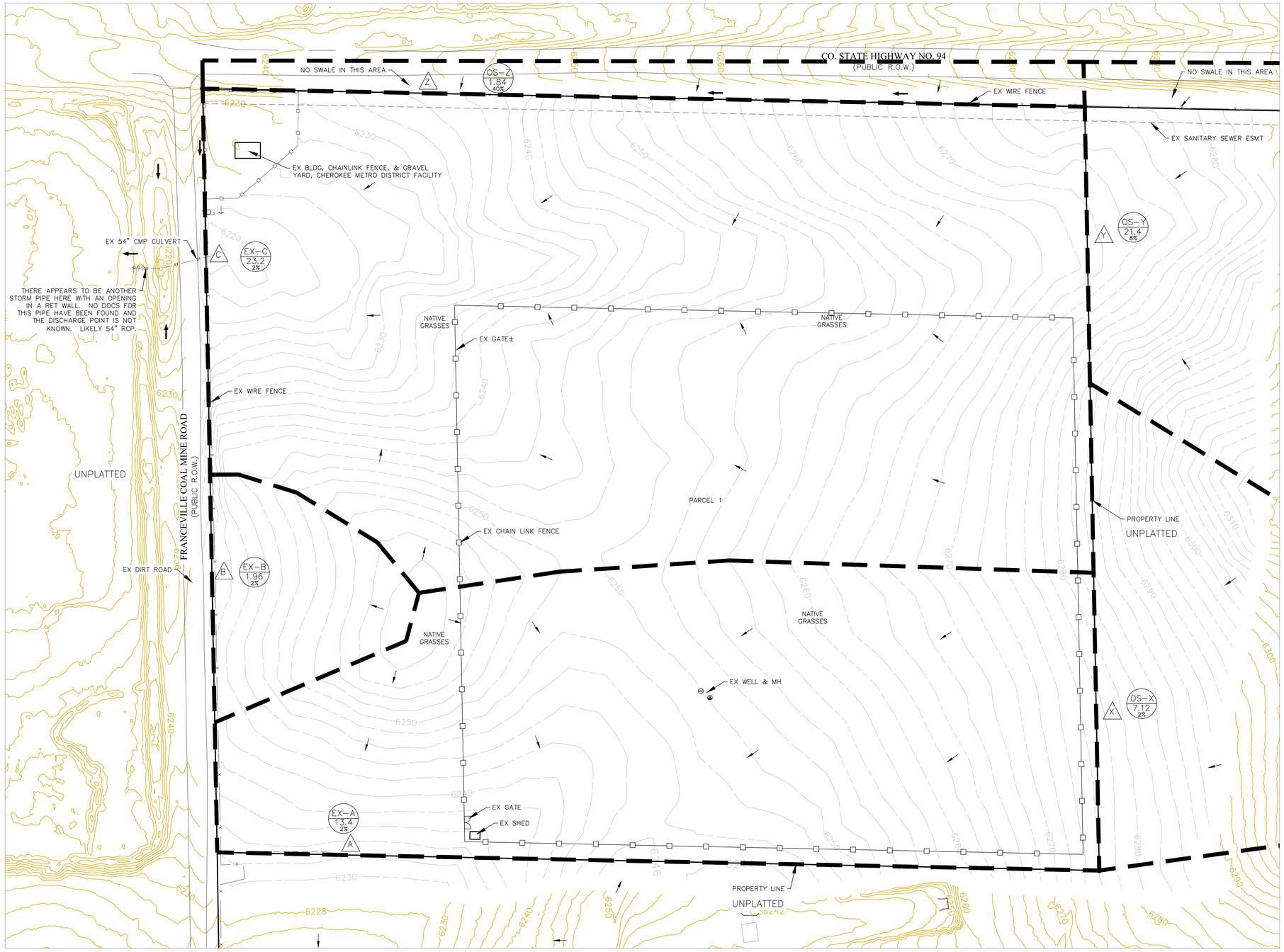
DRAINAGE MAPS

ABTR STORAGE

SITE DEVELOPMENT PLAN

EXISTING DRAINAGE MAP

MARCH 2023



LEGEND

- P-7 / 12.22 / 40 %IMP — BASIN DESIGNATION, AREA IN BASIN (AC), PERCENT IMPERVIOUS
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 2' CONTOUR
- GROUND SURFACE FLOW DIRECTION
- ROAD AND DITCH FLOW DIRECTION
- FENCE
- EX — EXISTING
- PR — PROPOSED

NOTES

1. ALL FEATURE SHOWN ARE EXISTING.
2. NO GRADING CHANGES ARE INCLUDED IN THIS PLAN.
3. BROWN GROUND SURFACE CONTOURS ARE LIDAR DATA DOWNLOADED FROM THE COLORADO HAZARD MAPPING & RISK MAP PORTAL, DATA SET: 2018 3DEP EAST CO EL PASO. THIS DATA IS APPROXIMATE. LIDAR DATA IS FROM 2018.

BASIN SUMMARY

BASIN	AREA TO TOTAL (Acres)	TOTAL FLOWS Q_5 (c.f.s.)	TOTAL FLOWS Q_{100} (c.f.s.)
OS-X	7.12	2.1	13.4
OS-Y	21.40	7.7	34.5
OS-Z	1.84	3.1	7.8
EX-A	13.40	3.1	19.1
EX-B	1.96	0.6	4.0
EX-C	23.20	5.0	30.2

Provide a summary table for the design points shown on the drainage map.

N

80' 0 80' 160'

SCALE: 1"=80'

REVISIONS NO.	DESCRIPTION	DATE

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR:
FLYING HORSE REALTY
ATTN: MIKE JACOBSON
2748 NORTH GATE BLVD
COLORADO SPRINGS, CO 80921
719.235.8195

Terra Nova Engineering, Inc.
Creative Civil Engineering Solutions
721 S. 23RD STREET
COLORADO SPRINGS, CO 80904
OFFICE: 719-635-6422
FAX: 719-635-6426
www.tnesinc.com

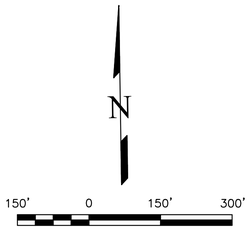
ABTR STORAGE

EXISTING DRAINAGE MAP

DESIGNED BY DLF
DRAWN BY DLF
CHECKED BY LD
H-SCALE AS SHOWN
V-SCALE N/A
JOB NO. 2309.00
DATE ISSUED 03/07/23
SHEET NO. 1 OF 6

N:\jobs\2309.00\Drawings\230900 SDP.dwg, 3/8/2023 11:41:54 AM

ABTR STORAGE
SITE DEVELOPMENT PLAN
EXISTING OFFSITE BASINS
MARCH 2023



SCALE: 1"=150'

BASIN SUMMARY

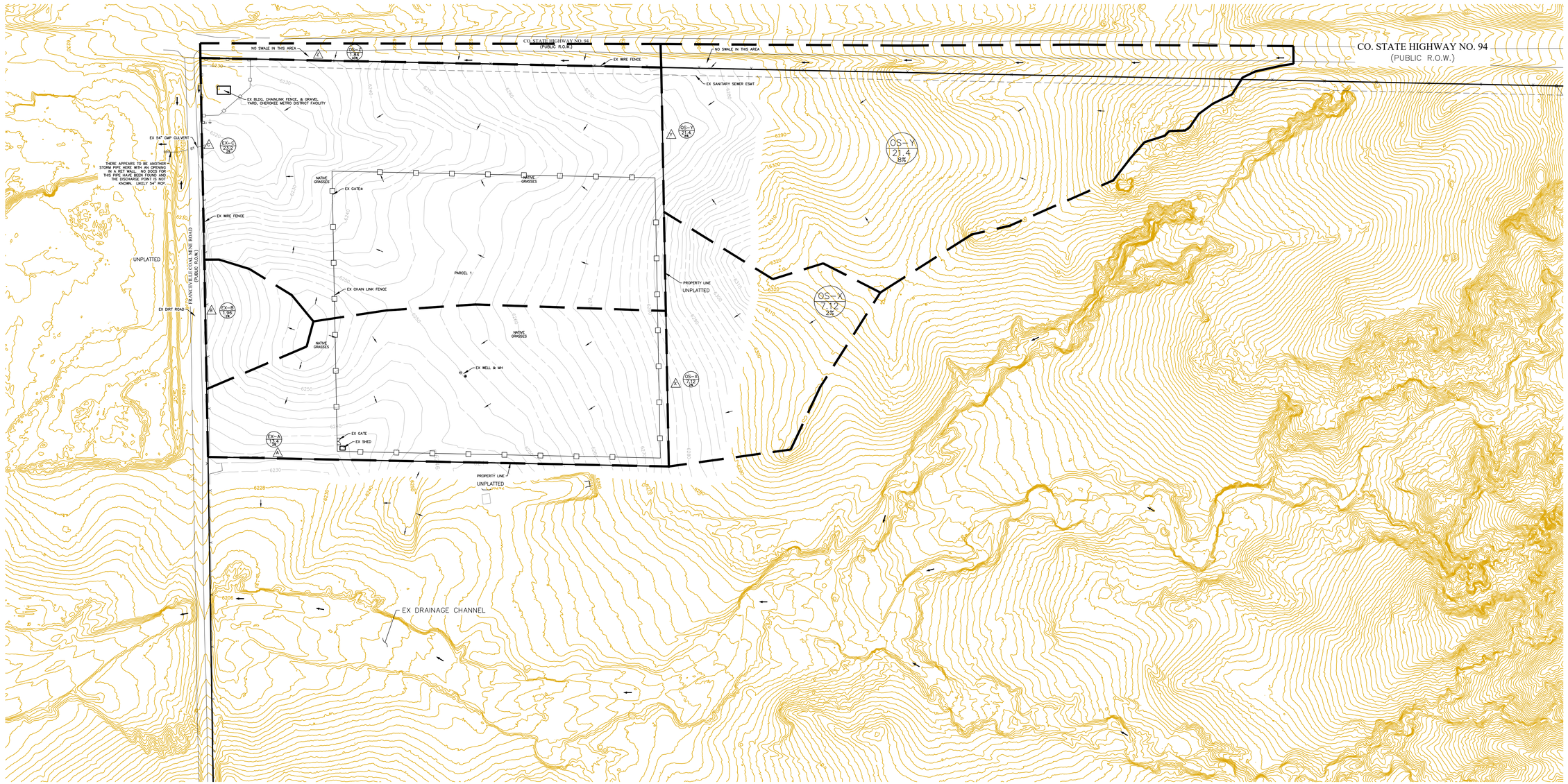
BASIN	AREA TOTAL (Acres)	TOTAL FLOWS Q_5 (c.f.s.)	TOTAL FLOWS Q_{100} (c.f.s.)
OS-X	7.12	2.1	13.4
OS-Y	21.40	7.7	34.5
OS-Z	1.84	3.1	7.8
EX-A	13.40	3.1	19.1
EX-B	1.96	0.6	4.0
EX-C	23.20	5.0	30.2

NOTES

1. ALL FEATURE SHOWN ARE EXISTING.
2. NO GRADING CHANGES ARE INCLUDED IN THIS PLAN.
3. BROWN GROUND SURFACE CONTOURS ARE LIDAR DATA DOWNLOADED FROM THE COLORADO HAZARD MAPPING & RISK MAP PORTAL, DATA SET: 2018 3DEP EAST CO EL PASO. THIS DATA IS APPROXIMATE. LIDAR DATA IS FROM 2018 AND AT 2' INTERVALS.

LEGEND

- P-7 / 12.22 / 2% IMP. — BASIN DESIGNATION, AREA IN BASIN (AC), PERCENT IMPERVIOUS
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 2' CONTOUR
- GROUND SURFACE FLOW DIRECTION
- ROAD AND DITCH FLOW DIRECTION
- FENCE
- EX — EXISTING
- PR — PROPOSED



CO. STATE HIGHWAY NO. 94
(PUBLIC R.O.W.)

REVISIONS

NO.	DESCRIPTION	DATE

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR:
FLYING HORSE REALTY
ATTN: MIKE JACOBSON
2748 NORTH GATE BLVD
COLORADO SPRINGS, CO 80921
719.235.8195

Terra Nova Engineering, Inc.
Creative Civil Engineering Solutions
721 S. 23RD STREET
COLORADO SPRINGS, CO 80904
OFFICE: 719-635-6422
FAX: 719-635-6428
www.tnesinc.com

ABTR STORAGE

EXISTING OFFSITE BASINS

DESIGNED BY DLF
DRAWN BY DLF
CHECKED BY LD

H-SCALE AS SHOWN
V-SCALE N/A

JOB NO. 2309.00
DATE ISSUED 03/07/23
SHEET NO. 2 OF 6

N:\jobs\2309.00\Drawings\230900 SDP.dwg, 3/8/2023 11:41:55 AM

ABTR STORAGE

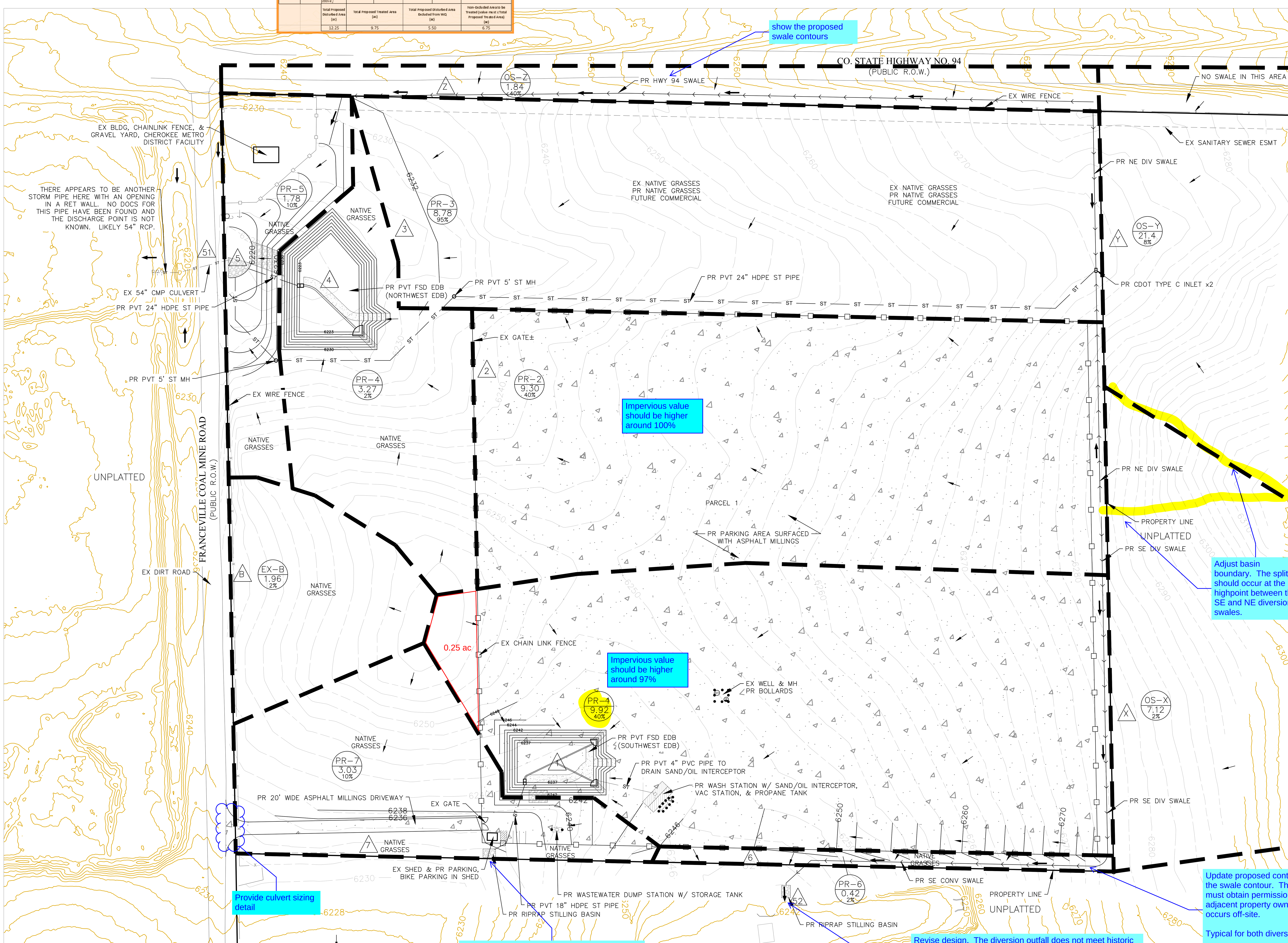
SITE DEVELOPMENT PLAN

PROPOSED DRAINAGE MAP

MARCH 2023

We need to know how much disturbed area is untreated and if there are any exclusions that apply to those areas. So please create a basic overview map (or modify an existing drainage map) with color shading/hatching that shows areas tributary to each PBMP (pond, runoff reduction, etc.) and those disturbed areas that are not treated by a PBMP, with the applicable exclusion labeled (ex: 20% up to 1ac of development can be excluded per ECM App I.7.1.C.1 and exclusions listed in ECM App I.7.1.B.#). An accompanying summary table on this map (or in the report text above) would also be very helpful (example provided):

Basin ID	Total Area (ac)	Total Proposed Disturbed Area (ac)	Area Trib to Pond A (ac)	Disturbed Area Treated via Runoff Reduction (ac)	Disturbed Area Excluded from WQ per ECM App I.7.1.C.1 (ac)	Disturbed Area Excluded from WQ per ECM App I.7.1.B.# (ac)	Applicable WQ Exclusions (App I.7.1.B.#)
A	4.50	4.50	4.50	-	-	-	
B	1.25	1.25	-	1.25	-	-	
C	6.00	4.00	-	-	-	4.00	ECM App I.7.1.B.5
D	2.50	2.50	1.00	-	0.50	1.00	ECM App I.7.1.B.7
E	3.00	-	3.00	-	-	-	
F	8.25	-	-	-	-	-	
Total	25.50	12.25	8.50	1.25	0.50	5.00	
Comments		[For each row, the sum of the values in Columns 4-7 must be greater than or equal to the value in Column 3 above.]	[Values in this column can be more than Column 3 if over-treating non-disturbed areas of the same land-use.]	[See RR calc spreadsheet.]	[Total must be <20% of site and <1ac.]		
		Total Proposed Disturbed Area (ac)	Total Proposed Treated Area (ac)		Total Proposed Disturbed Area Excluded from WQ (ac)		Non-Excluded Area to be Treated (value must ≤ Total Proposed Treated Area) (ac)
		12.25	9.75		5.50		6.75



show the proposed swale contours
CO. STATE HIGHWAY NO. 94
(PUBLIC R.O.W.)
PR HWY 94 SWALE
NO SWALE IN THIS AREA
EX WIRE FENCE
EX SANITARY SEWER ESMT
PR NE DIV SWALE
EX BLDG, CHAINLINK FENCE, & GRAVEL YARD, CHEROKEE METRO DISTRICT FACILITY
THERE APPEARS TO BE ANOTHER STORM PIPE HERE WITH AN OPENING IN A RET WALL. NO DOCS FOR THIS PIPE HAVE BEEN FOUND AND THE DISCHARGE POINT IS NOT KNOWN. LIKELY 54" RCP.
EX NATIVE GRASSES
PR NATIVE GRASSES
FUTURE COMMERCIAL
NATIVE GRASSES
EX 54" CMP CULVERT
PR PVT 24" HDPE ST PIPE
PR PVT FSD EDB (NORTHWEST EDB)
PR PVT 5' ST MH
PR PVT 24" HDPE ST PIPE
PR CDOT TYPE C INLET x2
EX GATE±
EX WIRE FENCE
Impervious value should be higher around 100%
UNPLATTED
FRANCEVILLE COAL MINE ROAD
(PUBLIC R.O.W.)
EX DIRT ROAD
PARCEL 1
PR PARKING AREA SURFACED WITH ASPHALT MILLINGS
PR NE DIV SWALE
PROPERTY LINE
UNPLATTED
PR SE DIV SWALE
Adjust basin boundary. The split should occur at the highpoint between the SE and NE diversion swales.
0.25 ac
EX CHAIN LINK FENCE
Impervious value should be higher around 97%
EX WELL & MH
PR BOLLARDS
PR FSD EDB (SOUTHWEST EDB)
PR PVT 4" PVC PIPE TO DRAIN SAND/OIL INTERCEPTOR
PR WASH STATION W/ SAND/OIL INTERCEPTOR, VAC STATION, & PROPANE TANK
PR 20' WIDE ASPHALT MILLINGS DRIVEWAY
EX GATE
PR SE DIV SWALE
EX SHED & PR PARKING, BIKE PARKING IN SHED
PR WASTEWATER DUMP STATION W/ STORAGE TANK
PR PVT 18" HDPE ST PIPE
PR RIPRAP STILLING BASIN
PR SE CONV SWALE
PROPERTY LINE
UNPLATTED
PR RIPRAP STILLING BASIN
Provide culvert sizing detail
Update proposed contour to show the swale contour. The applicant must obtain permission from the adjacent property owner if grading occurs off-site.
Typical for both diversion swales.
OS-Z 1.84 40%
PR-5 1.78 10%
PR-3 8.78 95%
OS-Y 21.4 8%
PR-4 3.27 2%
PR-2 9.30 40%
EX-B 1.96 2%
PR-1 9.92 40%
PR-7 3.03 10%
OS-X 7.12 2%
PR-6 0.42 2%

Analyze the flow path down to the next suitable outfall as defined in ECM Chapter 3 section 3.2.4. The flow path must be hydraulically adequate/non-erosive.

Revise design. The diversion outfall does not meet historic flow. The diversion flow has changed the manner and quantity of flow. Historically, runoff was sheet flow as it enters the adjacent property. The current design has changed this to a concentrated flow.

LEGEND

- P-7 / 12.22 / 4% — BASIN DESIGNATION, AREA IN BASIN (AC), PERCENT IMPERVIOUS
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 2' CONTOUR
- GROUND SURFACE FLOW DIRECTION
- ROAD AND DITCH FLOW DIRECTION
- FENCE
- EX — EXISTING
- PR — PROPOSED

NOTES

1. BROWN GROUND SURFACE CONTOURS ARE LIDAR DATA DOWNLOADED FROM THE COLORADO HAZARD MAPPING & RISK MAP PORTAL, DATA SET: 2018 3DEP EAST CO EL PASO. THIS DATA IS APPROXIMATE. LIDAR DATA IS FROM 2018 AND AT 2' INTERVALS.
2. BASIN PR-3 PERCENT IMPERVIOUS IS BASED ON THE FUTURE COMMERCIAL DEVELOPED CONDITION SO THE NORTHWEST EDB COULD BE SIZED TO ACCOMMODATE THAT RUNOFF.

BASIN SUMMARY

BASIN	AREA TOTAL (Acres)	TOTAL FLOWS Q_5 (c.f.s.)	TOTAL FLOWS Q_{100} (c.f.s.)
OS-X	7.12	2.1	13.4
OS-Y	21.40	7.7	34.5
OS-Z	1.84	3.1	7.8
EX-B	1.96	0.6	4.0
PR-1	9.92	11.4	27.3
PR-2	9.30	10.6	25.6
PR-3	8.78	32.9	62.8
PR-4	3.27	1.1	7.1
PR-5	1.78	1.0	4.5
PR-6	0.42	0.2	1.1
PR-7	3.03	1.9	8.1

DESIGN POINT SUMMARY

Design Point(s)	Contributing Basins	Area (ac)	Flow (cfs) Q_5	Flow (cfs) Q_{100}
A	EX-A, OS-X	20.52	5.2	32.4
B	EX-B	1.96	0.6	4[illegible]
C	EX-C, OS-Y	44.60	12.7	64[illegible]
1	PR-1	9.92	11.4	27[illegible]
2	PR-2	9.30	10.6	25.6
3	PR-3	8.78	32.9	62.8
4	PR-4, PR-3, PR-2	21.35	44.7	95.5
5	PR-5, NW EDB Outfall	1.78	4.6	34.4
6	PR-6	0.42	0.2	1.1
7	PR-7	3.03	1.9	8.1
51	PR-5, NW EDB Outfall, OS-Y, OS-Z	25.02	15.4	76.7
52	PR-6, OS-X	7.54	2.3	14.4

Revise pond release rate so flows at DP 5 is equal to or less than existing condition DP C

N

80' 0 80' 160'

SCALE: 1"=80'

REVISIONS — NO. — DESCRIPTION — DATE

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR: FLYING HORSE REALTY
ATTN: MAKE JACOBSON
2748 NORTH GATE BLVD
COLORADO SPRINGS, CO 80921
719.235.8195

Terra Nova Engineering, Inc. — Creative Civil Engineering Solutions

ABTR STORAGE — PROPOSED DRAINAGE MAP

DESIGNED BY DLF
DRAWN BY DLF
CHECKED BY LD
H-SCALE AS SHOWN
V-SCALE N/A
JOB NO. 2309.00
DATE ISSUED 03/07/23
SHEET NO. 3 OF 6

ABTR STORAGE

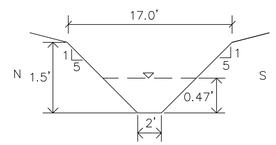
SITE DEVELOPMENT PLAN

PROPOSED DRAINAGE MAP

MARCH 2023

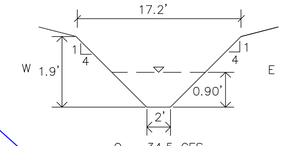
LEGEND

P-7 / 12.22 / 45 %IMP	BASIN DESIGNATION / AREA IN BASIN (AC) / PERCENT IMPERVIOUS
D	DESIGN POINT
	BASIN BOUNDARY
	EXISTING 2' CONTOUR
	GROUND SURFACE FLOW DIRECTION
	ROAD AND DITCH FLOW DIRECTION
	FENCE
EX	EXISTING
PR	PROPOSED



Q = 7.8 CFS
SLOPE = 4.0%
n VALUE = 0.035
DEPTH = 0.47'
VELOCITY = 3.81 FT/S

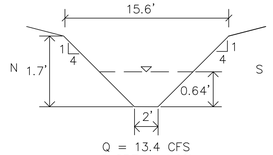
SWALE CROSS SECTION – HWY 94



Provide recommendation for armoring on ditch since velocities are erosive per critera.

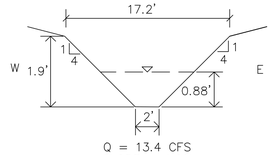
Q = 34.5 CFS
SLOPE = 6.0%
n VALUE = 0.035
DEPTH = 0.90'
VELOCITY = 6.85 FT/S

SWALE CROSS SECTION – NE DIV



Q = 13.4 CFS
SLOPE = 4.0%
n VALUE = 0.035
DEPTH = 0.64'
VELOCITY = 4.62 FT/S

SWALE CROSS SECTION – SE CONV



Q = 13.4 CFS
SLOPE = 1.0%
n VALUE = 0.035
DEPTH = 0.88'
VELOCITY = 2.76 FT/S

SWALE CROSS SECTION – SE DIV

REVISIONS		
NO.	DESCRIPTION	DATE

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR:
FLYING HORSE REALTY
ATTN: MAKE JACOBSON
2748 NORTH GATE BLVD
COLORADO SPRINGS, CO 80921
719.235.8195

Terra Nova Engineering, Inc. Creative Civil Engineering Solutions
721 S. 23RD STREET
COLORADO SPRINGS, CO 80904
OFFICE: 719-635-6422
FAX: 719-635-6426
www.tnesinc.com

ABTR STORAGE

PROPOSED DRAINAGE MAP

DESIGNED BY	DLF
DRAWN BY	DLF
CHECKED BY	LD
H-SCALE	AS SHOWN
V-SCALE	N/A
JOB NO.	2309.00
DATE ISSUED	03/07/23
SHEET NO.	4 OF 6

N:\jobs\2309.00\Drawings\230900 SDP.dwg, 3/8/2023 11:41:59 AM

ABTR STORAGE
SITE DEVELOPMENT PLAN
NORTHWEST DETENTION POND
MARCH 2023

LEGEND

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 1' CONTOUR
- EXISTING 10' CONTOUR
- GROUND SURFACE FLOW DIRECTION
- ROAD AND DITCH FLOW DIRECTION
- FENCE

POND WATER LEVEL ELEVS

WQCV: 6223.35
EURV: 6224.05
100-YR: 6225.19

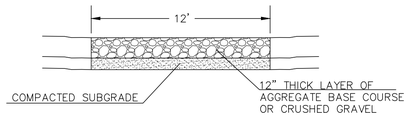
N

30' 0 30' 60'

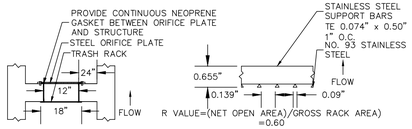
SCALE: 1"=30'

NOTES

1. ALL HDPE STORM PIPE IS TO BE SMOOTH INTERIOR PIPE.
2. LARGE BLOCKS OF TEXT QUOTING STANDARD DRAWINGS OR DETAILS ARE INCLUDED AS A REQUIREMENT OF THE COUNTY.

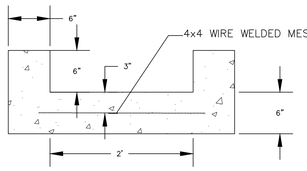


12' MAINTENANCE ACCESS ROAD SECTION
NOT TO SCALE

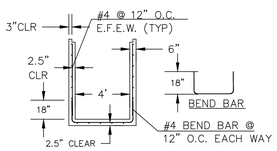


SECTION B–B
NOT TO SCALE

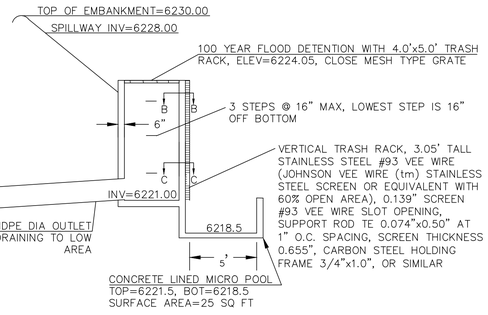
SECTION C–C
NOT TO SCALE



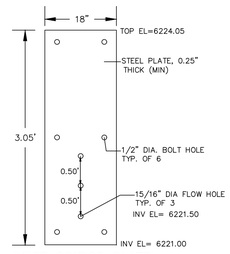
2' CONCRETE TRICKLE CHANNEL
NOT TO SCALE



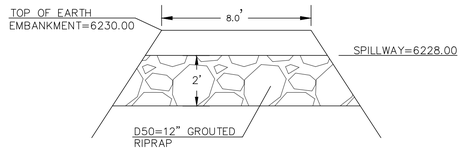
4'x5' OUTLET BOX STRUCTURAL DETAIL
NOT TO SCALE

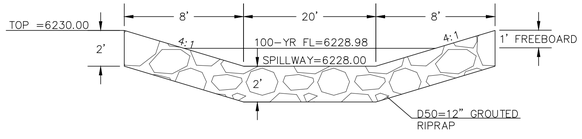


OUTLET STRUCTURE
NOT TO SCALE



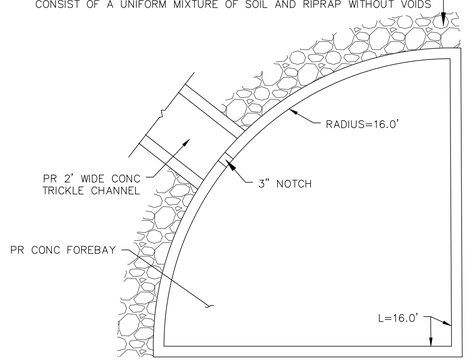
INLET ORIFICE PLATE PERFORATED HOLE PATTERN
NOT TO SCALE



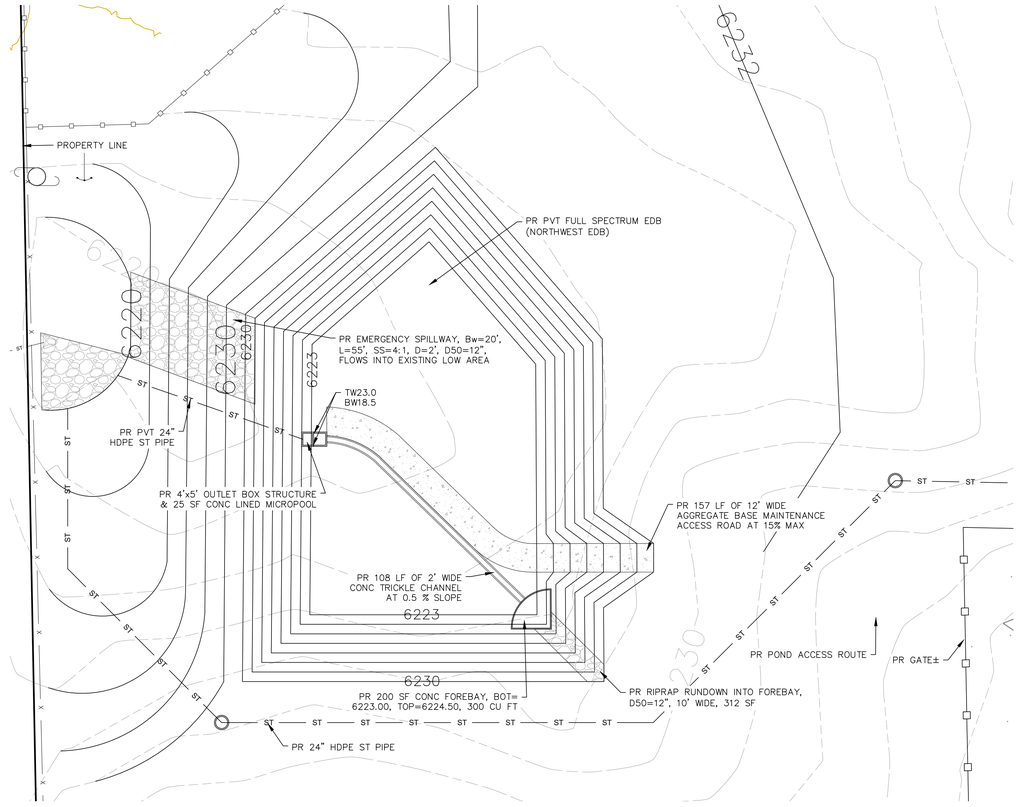


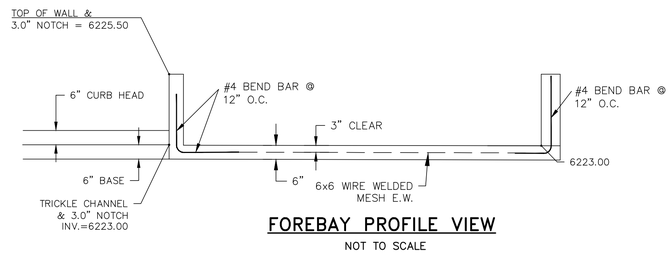
EDB EMERGENCY SPILLWAY
NOT TO SCALE

PR D50=12" TYPE M SOIL RIPRAP AROUND WALL, 2' WIDE, 1' DEEP, INSTALL PER URBAN DRAINAGE SPEC SECTION 31-37-00, ROCK REQUIREMENTS ARE TO COMPLY WITH RIPRAP AS SPECIFIED IN ARTICLE MATERIALS, THE SOIL MATERIAL SHALL BE NATIVE OR TOPSOIL AND MIXED WITH SIXTY-FIVE PERCENT (65%) RIPRAP AND THIRTY FIVE PERCENT (35%) SOIL BY VOLUME, SOIL RIPRAP SHALL CONSIST OF A UNIFORM MIXTURE OF SOIL AND RIPRAP WITHOUT VOIDS



FOREBAY PLAN VIEW
NOT TO SCALE





FOREBAY PROFILE VIEW
NOT TO SCALE

FOR REFERENCE ONLY
NOT FOR CONSTRUCTION

REVISIONS

NO.	DESCRIPTION	DATE

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR:
FLYING HORSE REALTY
ATTN: MIKE JACOBSON
2748 NORTH GATE BLVD
COLORADO SPRINGS, CO 80921
719.235.8195

Terra Nova Engineering, Inc.
Creative Civil Engineering Solutions
721 S. 23RD STREET
COLORADO SPRINGS, CO 80904
OFFICE: 719-635-6422
FAX: 719-635-6426
www.tnsinc.com

ABTR STORAGE

NORTHWEST DETENTION POND

DESIGNED BY DLF
DRAWN BY DLF
CHECKED BY LD
H-SCALE AS SHOWN
V-SCALE N/A
JOB NO. 2309.00
DATE ISSUED 03/07/23
SHEET NO. 5 OF 6

N:\jobs\2309.00\Drawings\230900 SDP.dwg, 3/8/2023 11:42:00 AM

ABTR STORAGE
SITE DEVELOPMENT PLAN
SOUTHWEST DETENTION POND
MARCH 2023

LEGEND

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 1' CONTOUR
- EXISTING 10' CONTOUR
- GROUND SURFACE FLOW DIRECTION
- ROAD AND DITCH FLOW DIRECTION
- FENCE

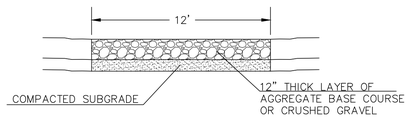
POND WATER LEVEL ELEVS

WQCV: 6237.33
EURV: 6238.61
100-YR: 6239.63

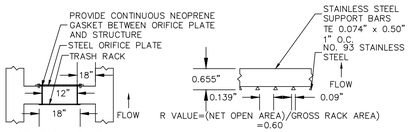
N

30' 0 30' 60'

SCALE: 1"=30'

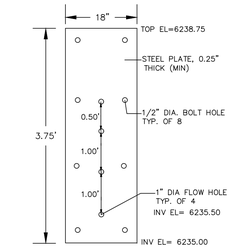


12' MAINTENANCE ACCESS ROAD SECTION
NOT TO SCALE

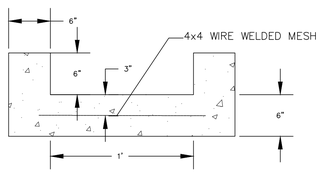


SECTION B-B
NOT TO SCALE

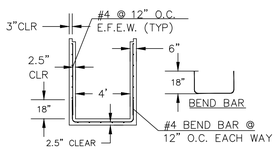
SECTION C-C
NOT TO SCALE



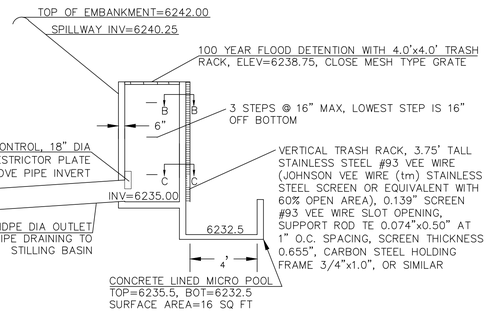
INLET ORIFICE PLATE PERFORATED HOLE PATTERN
NOT TO SCALE



1' CONCRETE TRICKLE CHANNEL
NOT TO SCALE

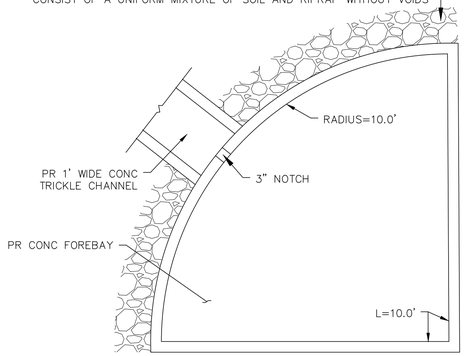


4'x4' OUTLET BOX STRUCTURAL DETAIL
NOT TO SCALE

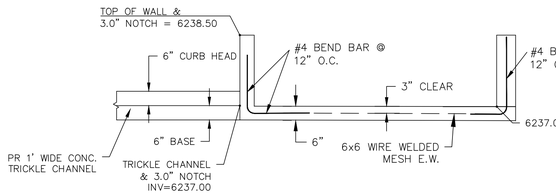


OUTLET STRUCTURE
NOT TO SCALE

PR D50=12" TYPE M SOIL RIPRAP AROUND WALL, 2' WIDE, 1' DEEP, INSTALL PER URBAN DRAINAGE SPEC SECTION 31-37-00, ROCK REQUIREMENTS ARE TO COMPLY WITH RIPRAP AS SPECIFIED IN ARTICLE MATERIALS, THE SOIL MATERIAL SHALL BE NATIVE OR TOPSOIL AND MIXED WITH SIXTY-FIVE PERCENT (65%) RIPRAP AND THIRTY FIVE PERCENT (35%) SOIL BY VOLUME, SOIL RIPRAP SHALL CONSIST OF A UNIFORM MIXTURE OF SOIL AND RIPRAP WITHOUT VOIDS

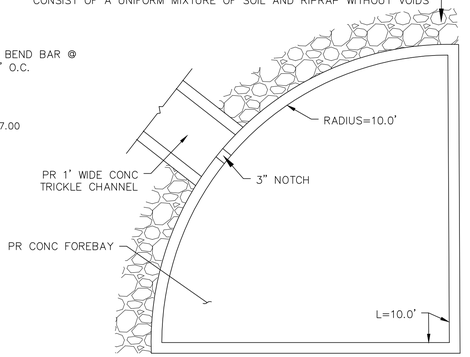


SOUTHEAST FOREBAY PLAN VIEW
NOT TO SCALE

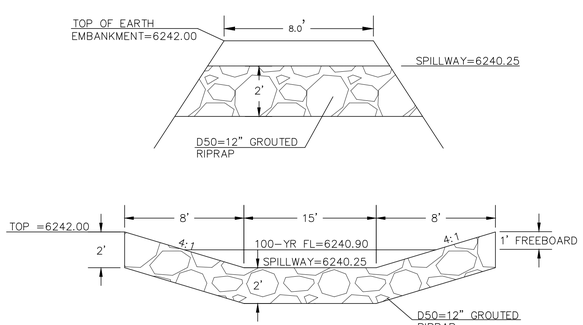


NORTHEAST FOREBAY PROFILE VIEW
NOT TO SCALE

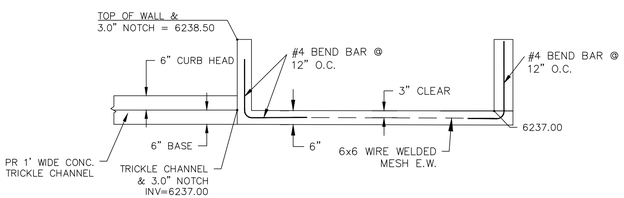
PR D50=12" TYPE M SOIL RIPRAP AROUND WALL, 2' WIDE, 1' DEEP, INSTALL PER URBAN DRAINAGE SPEC SECTION 31-37-00, ROCK REQUIREMENTS ARE TO COMPLY WITH RIPRAP AS SPECIFIED IN ARTICLE MATERIALS, THE SOIL MATERIAL SHALL BE NATIVE OR TOPSOIL AND MIXED WITH SIXTY-FIVE PERCENT (65%) RIPRAP AND THIRTY FIVE PERCENT (35%) SOIL BY VOLUME, SOIL RIPRAP SHALL CONSIST OF A UNIFORM MIXTURE OF SOIL AND RIPRAP WITHOUT VOIDS



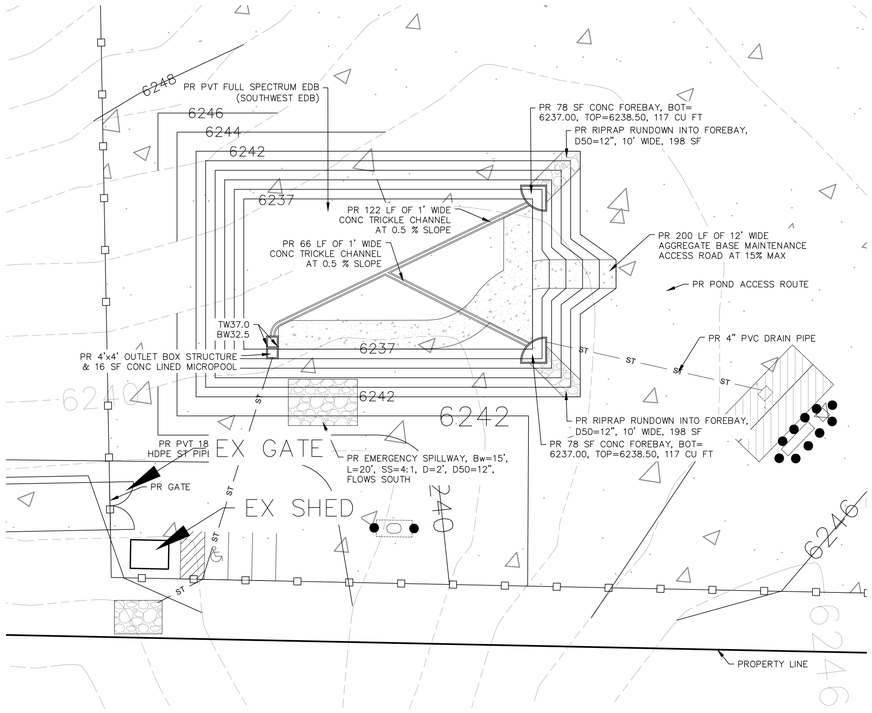
NORTHEAST FOREBAY PLAN VIEW
NOT TO SCALE



EDB EMERGENCY SPILLWAY
NOT TO SCALE



SOUTHEAST FOREBAY PROFILE VIEW
NOT TO SCALE



FOR REFERENCE ONLY
NOT FOR CONSTRUCTION

NOTES

1. ALL HDPE STORM PIPE IS TO BE SMOOTH INTERIOR PIPE.
2. LARGE BLOCKS OF TEXT QUOTING STANDARD DRAWINGS OR DETAILS ARE INCLUDED AS A REQUIREMENT OF THE COUNTY.

REVISIONS		
NO.	DESCRIPTION	DATE

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR:
FLYING HORSE REALTY
ATTN: MIKE JACOBSON
2748 NORTH GATE BLVD
COLORADO SPRINGS, CO 80921
719.235.8195

Terra Nova Engineering, Inc. Creative Civil Engineering Solutions
721 S. 23RD STREET
COLORADO SPRINGS, CO 80904
OFFICE: 719-635-6422
FAX: 719-635-6426
www.tnesinc.com

ABTR STORAGE

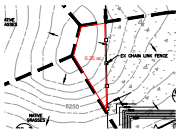
SOUTHWEST DETENTION POND

DESIGNED BY	DLF
DRAWN BY	DLF
CHECKED BY	LD
H-SCALE	AS SHOWN
V-SCALE	N/A
JOB NO.	2309.00
DATE ISSUED	03/07/23
SHEET NO.	6 OF 6

N:\jobs\2309.00\Drawings\230900 SDP.dwg, 3/8/2023 11:42:01 AM

v1_Drainage Report - Final_Comments.pdf Markup Summary

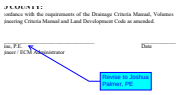
Area Measurement (1)



Subject: Area Measurement
Page Label: [1] 230900 SDP-PR DRAIN
Author: eschoenheit
Date: 6/14/2023 4:13:24 PM
Status:
Color:
Layer:
Space:

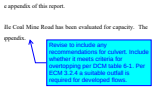
0.25 ac

Callout (18)



Subject: Callout
Page Label: 3
Author: lpackman
Date: 6/13/2023 9:08:08 AM
Status:
Color:
Layer:
Space:

Revise to Joshua Palmer, PE

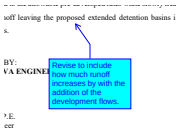


Subject: Callout
Page Label: 9
Author: lpackman
Date: 6/13/2023 1:25:24 PM
Status:
Color:
Layer:
Space:

Revise to include any recommendations for culvert. Include whether it meets criteria for overtopping per DCM table 6-1. Per ECM 3.2.4 a suitable outfall is required for developed flows.

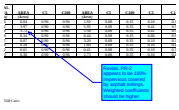
Subject: Callout
Page Label: 11
Author: lpackman
Date: 6/13/2023 2:50:41 PM
Status:
Color:
Layer:
Space:

Revise to include what information was included from other reports. Include those reports in the reference list.



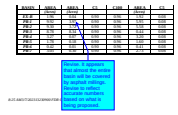
Subject: Callout
Page Label: 11
Author: lpackman
Date: 6/13/2023 1:10:23 PM
Status:
Color:
Layer:
Space:

Revise to include how much runoff increases by with the addition of the development flows.



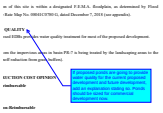
Subject: Callout
Page Label: 25
Author: lpackman
Date: 6/13/2023 3:39:11 PM
Status:
Color:
Layer:
Space:

Revise. PR-2 appears to be 100% impervious covered by asphalt millings. Weighted coefficients should be higher.



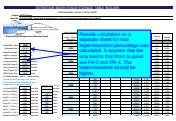
Subject: Callout
Page Label: 25
Author: lpackman
Date: 6/14/2023 4:58:20 PM
Status:
Color:
Layer:
Space:

Revise. It appears that almost the entire basin will be covered by asphalt millings. Revise to reflect accurate numbers based on what is being proposed.



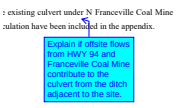
Subject: Callout
Page Label: 10
Author: lpackman
Date: 6/13/2023 3:54:12 PM
Status:
Color:
Layer:
Space:

If proposed ponds are going to provide water quality for the current proposed development and future development, add an explanation stating so. Ponds should be sized for commercial development now.



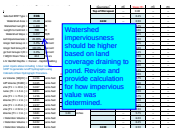
Subject: Callout
Page Label: 40
Author: lpackman
Date: 6/14/2023 5:03:44 PM
Status:
Color:
Layer:
Space:

Provide calculation on a separate sheet for how imperviousness percentage was calculated. It appears that the only basins that drain to pond are PR-2 and PR-4. The imperviousness should be higher.



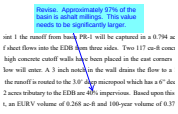
Subject: Callout
Page Label: 9
Author: lpackman
Date: 6/13/2023 4:00:13 PM
Status:
Color:
Layer:
Space:

Explain if offsite flows from HWY 94 and Franceville Coal Mine contribute to the culvert from the ditch adjacent to the site.



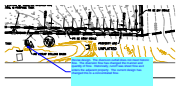
Subject: Callout
Page Label: 43
Author: lpackman
Date: 6/14/2023 5:04:24 PM
Status:
Color:
Layer:
Space:

Watershed imperviousness should be higher based on land coverage draining to pond. Revise and provide calculation for how impervious value was determined.



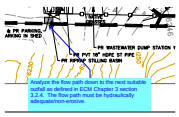
Subject: Callout
Page Label: 8
Author: dsdlaforce
Date: 6/14/2023 4:29:53 PM
Status:
Color:
Layer:
Space:

Revise. Approximately 97% of the basin is ashalt millings. This value needs to be significantly larger.



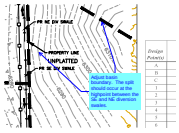
Subject: Callout
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:41:47 PM
Status:
Color:
Layer:
Space:

Revise design. The diversion outfall does not meet historic flow. The diversion flow has changed the manner and quantity of flow. Historically, runoff was sheet flow as it enters the adjacent property. The current design has changed this to a concentrated flow.



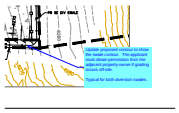
Subject: Callout
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:38:03 PM
Status:
Color:
Layer:
Space:

Analyze the flow path down to the next suitable outfall as defined in ECM Chapter 3 section 3.2.4. The flow path must be hydraulically adequate/non-erosive.



Subject: Callout
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:40:18 PM
Status:
Color:
Layer:
Space:

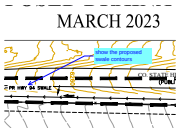
Adjust basin boundary. The split should occur at the highpoint between the SE and NE diversion swales.



Subject: Callout
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:44:31 PM
Status:
Color:
Layer:
Space:

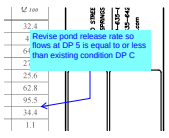
Update proposed contour to show the swale contour. The applicant must obtain permission from the adjacent property owner if grading occurs off-site.

Typical for both diversion swales.



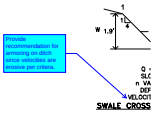
Subject: Callout
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:46:38 PM
Status:
Color:
Layer:
Space:

show the proposed swale contours



Subject: Callout
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:50:44 PM
Status:
Color:
Layer:
Space:

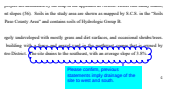
Revise pond release rate so flows at DP 5 is equal to or less than existing condition DP C



Subject: Callout
Page Label: [1] 230900 SDP-PR DRAIN DET
Author: lpackman
Date: 6/14/2023 5:09:03 PM
Status:
Color:
Layer:
Space:

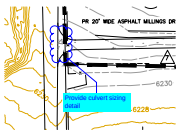
Provide recommendation for armoring on ditch since velocities are erosive per critera.

Cloud+ (3)



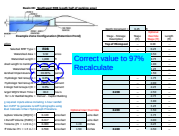
Subject: Cloud+
Page Label: 4
Author: eschoenheit
Date: 6/14/2023 2:15:22 PM
Status:
Color:
Layer:
Space:

Please confirm, previous statements imply drainage of the site to west and south.



Subject: Cloud+
Page Label: [1] 230900 SDP-PR DRAIN
Author: eschoenheit
Date: 6/14/2023 2:41:17 PM
Status:
Color:
Layer:
Space:

Provide culvert sizing detail



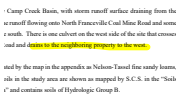
Subject: Cloud+
Page Label: 46
Author: eschoenheit
Date: 6/14/2023 4:18:43 PM
Status:
Color:
Layer:
Space:

Correct value to 97%
Recalculate

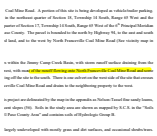
File Attachment (1)

Subject: File Attachment
Page Label: [1] 230900 SDP-PR DRAIN
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 8:18:33 AM
Status:
Color:
Layer:
Space:

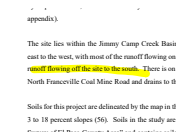
Highlight (11)



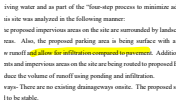
Subject: Highlight
Page Label: 4
Author: eschoenheit
Date: 6/14/2023 2:15:28 PM
Status:
Color:
Layer:
Space:



Subject: Highlight
Page Label: 4
Author: eschoenheit
Date: 6/14/2023 2:15:36 PM
Status:
Color:
Layer:
Space:

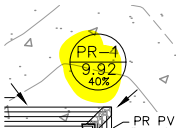


Subject: Highlight
Page Label: 4
Author: eschoenheit
Date: 6/14/2023 2:15:38 PM
Status:
Color:
Layer:
Space:

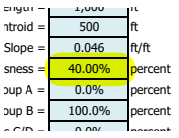


Subject: Highlight
Page Label: 9
Author: eschoenheit
Date: 6/14/2023 2:19:26 PM
Status:
Color:
Layer:
Space:

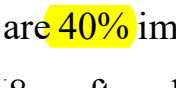
Subject: Highlight
Page Label: 4
Author: eschoenheit
Date: 6/14/2023 2:28:00 PM
Status:
Color:
Layer:
Space:



Subject: Highlight
Page Label: [1] 230900 SDP-PR DRAIN
Author: eschoenheit
Date: 6/14/2023 4:15:58 PM
Status:
Color:
Layer:
Space:

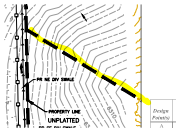


Subject: Highlight
Page Label: 46
Author: eschoenheit
Date: 6/14/2023 4:17:55 PM
Status:
Color:
Layer:
Space:

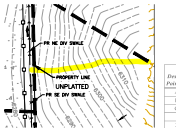


Subject: Highlight
Page Label: 8
Author: dsdlaforce
Date: 6/14/2023 4:28:35 PM
Status:
Color:
Layer:
Space:

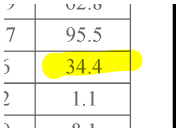
40%



Subject: Highlight
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:39:13 PM
Status:
Color:
Layer:
Space:

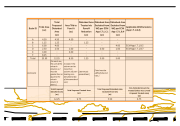


Subject: Highlight
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:40:14 PM
Status:
Color:
Layer:
Space:



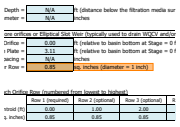
Subject: Highlight
Page Label: [1] 230900 SDP-PR DRAIN
Author: dsdlaforce
Date: 6/14/2023 4:47:57 PM
Status:
Color:
Layer:
Space:

Image (1)

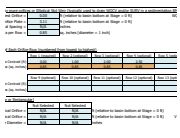


Subject: Image
Page Label: [1] 230900 SDP-PR DRAIN
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 8:14:50 AM
Status:
Color:
Layer:
Space:

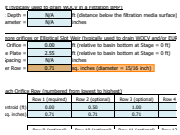
SW - Rectangle (4)



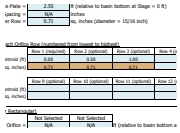
Subject: SW - Rectangle
Page Label: 47
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:33:41 PM
Status:
Color:
Layer:
Space:



Subject: SW - Rectangle
Page Label: 47
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:33:38 PM
Status:
Color:
Layer:
Space:

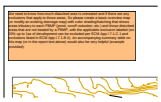


Subject: SW - Rectangle
Page Label: 44
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:36:41 PM
Status:
Color:
Layer:
Space:



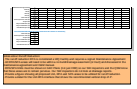
Subject: SW - Rectangle
Page Label: 44
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:36:47 PM
Status:
Color:
Layer:
Space:

SW - Textbox (7)



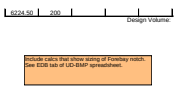
Subject: SW - Textbox
Page Label: [1] 230900 SDP-PR DRAIN
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 7:59:01 AM
Status:
Color:
Layer:
Space:

We need to know how much disturbed area is untreated and if there are any exclusions that apply to those areas. So please create a basic overview map (or modify an existing drainage map) with color shading/hatching that shows areas tributary to each PBMP (pond, runoff reduction, etc.) and those disturbed areas that are not treated by a PBMP, with the applicable exclusion labeled (ex: 20% up to 1ac of development can be excluded per ECM App I.7.1.C.1 and exclusions listed in ECM App I.7.1.B.#). An accompanying summary table on this map (or in the report text above) would also be very helpful (example provided):



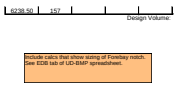
Subject: SW - Textbox
Page Label: 39
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 10:39:52 AM
Status:
Color:
Layer:
Space:

Notes about Runoff Reduction:
- The runoff reduction RPA is considered a WQ Facility and requires a signed Maintenance Agreement
- All RPA/SPA areas will need to be within a no build/drainage easement (or tract) and discussed in the maintenance agreement and O&M manual.
- RPA/SPA limits must be shown on GEC Plans (not just FDR) so our SW inspectors and the QSM know that these areas are to remain pervious. Our SW inspectors do not look at drainage reports.
- Provide a figure showing all proposed UIA, RPA and SPA areas to be utilized for runoff reduction.
- Provide a detail for the UIA:RPA interface that shows the recommended vertical drop of 4”.



Subject: SW - Textbox
Page Label: 49
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:02:25 PM
Status:
Color:
Layer:
Space:

Include calcs that show sizing of Forebay notch. See EDB tab of UD-BMP spreadsheet.



Subject: SW - Textbox
Page Label: 50
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:02:33 PM
Status:
Color:
Layer:
Space:

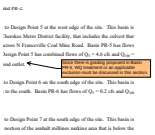
Include calcs that show sizing of Forebay notch. See EDB tab of UD-BMP spreadsheet.

Subject: SW - Textbox
Page Label: 10
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:28:42 PM
Status:
Color:
Layer:
Space:

Headwalls and Wingwalls: Given the erodible soils onsite, provide a headwall and/or wingwall for the inlet and outlet of culverts/piping as necessary given flowrate, slope, and length (per MHFD USDCM Vol 2, Chapter 9, Section 3.0). Or based on engineering judgement, state that based on the site conditions, they are not necessary.

Subject: SW - Textbox
Page Label: 11
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:28:57 PM
Status:
Color:
Layer:
Space:

Per DCMv2 – Chap 4.2, trickle channel should at a minimum provide capacity equal to twice the release capacity at the upstream forebay outlet. Provide these calcs in the drainage report and revise plans as needed.



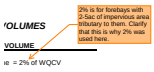
Subject: SW - Textbox
Page Label: 7
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 3:11:35 PM
Status:
Color:
Layer:
Space:

Since there is grading proposed in Basin PR-5, WQ treatment or an applicable exclusion must be discussed in this section.

SW - Textbox with Arrow (7)

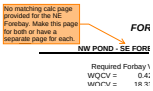
Subject: SW - Textbox with Arrow
Page Label: 1
Author: Glenn Reese - EPC Stormwater
Date: 6/8/2023 6:49:08 PM
Status:
Color:
Layer:
Space:

PPR2319



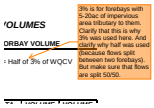
Subject: SW - Textbox with Arrow
Page Label: 50
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:01:02 PM
Status:
Color:
Layer:
Space:

2% is for forebays with 2-5ac of impervious area tributary to them. Clarify that this is why 2% was used here.



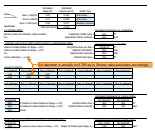
Subject: SW - Textbox with Arrow
Page Label: 49
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:06:50 PM
Status:
Color:
Layer:
Space:

No matching calc page provided for the NE Forebay. Make this page for both or have a separate page for each.



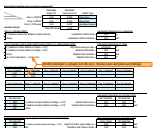
Subject: SW - Textbox with Arrow
Page Label: 49
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:07:52 PM
Status:
Color:
Layer:
Space:

3% is for forebays with 5-20ac of impervious area tributary to them. Clarify that this is why 3% was used here. And clarify why half was used (because flows split between two forebays). But make sure that flows are split 50/50.



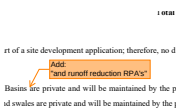
Subject: SW - Textbox with Arrow
Page Label: 47
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:34:57 PM
Status:
Color:
Layer:
Space:

1in diameter is actually A=0.785 sq in. Revise calcs and plans accordingly.



Subject: SW - Textbox with Arrow
Page Label: 44
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 12:36:49 PM
Status:
Color:
Layer:
Space:

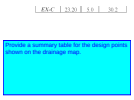
15/16in diameter is actually A=0.69 sq in. Revise calcs and plans accordingly.



Subject: SW - Textbox with Arrow
Page Label: 10
Author: Glenn Reese - EPC Stormwater
Date: 6/14/2023 3:13:09 PM
Status:
Color:
Layer:
Space:

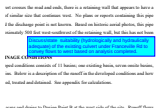
Add:
"and runoff reduction RPA's"

Text Box (5)



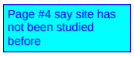
Subject: Text Box
Page Label: [1] 230900 SDP-EX DRAIN
Author: lpackman
Date: 6/13/2023 9:38:27 AM
Status:
Color:
Layer:
Space:

Provide a summary table for the design points shown on the drainage map.



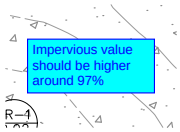
Subject: Text Box
Page Label: 6
Author: eschoenheit
Date: 6/14/2023 5:29:39 PM
Status:
Color:
Layer:
Space:

Discuss/state suitability (hydrologically and hydraulically adequate) of the existing culvert under Franceville Rd to convey flows to west based on analysis completed.



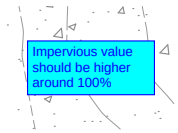
Subject: Text Box
Page Label: 11
Author: eschoenheit
Date: 6/14/2023 2:27:23 PM
Status:
Color:
Layer:
Space:

Page #4 say site has not been studied before



Subject: Text Box
Page Label: [1] 230900 SDP-PR DRAIN
Author: eschoenheit
Date: 6/14/2023 4:16:58 PM
Status:
Color:
Layer:
Space:

Impervious value should be higher around 97%



Subject: Text Box
Page Label: [1] 230900 SDP-PR DRAIN
Author: eschoenheit
Date: 6/14/2023 4:17:34 PM
Status:
Color:
Layer:
Space:

Impervious value should be higher around 100%