EPC STORMWATER REVIEW COMMENTS
IN ORANGE BOXES WITH BLACK TEXT

Final Drainage Report

UDON South
El Paso County, Colorado

PCD File No.: XXXX PPR2422

Prepared for:
UDON Holdings, LLC
12265 Highway 94
Colorado Springs, Colorado 80929

Prepared by:
Kimley-Horn and Associates, Inc.
2 North Nevada Ave
Suite 900
Colorado Springs, CO 80903
(719) 435-0182
Contact: Kevin Kofford, P.E.

Project #: 196020003

Prepared: June 26, 2024

Kimley»Horn

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CERTIFICATION

ENGINEERS 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 El Paso County, Colorado for drainage reports and said report is in conformity with the 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.

SIGNATURE (Affix Seal): _____

Kevin R. Kofford Date
Colorado P.E. No. 57234

DEVELOPER'S STATEMENT

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

_____
Business Name

_____
By:

_____
Title:

_____
Address:

EL PASO COUNTY STATEMENT

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.

_____ _____
Joshua Palmer, P.E. Date
County Engineer/ECM Administrator

Conditions:

GENERAL LOCATION AND DESCRIPTION

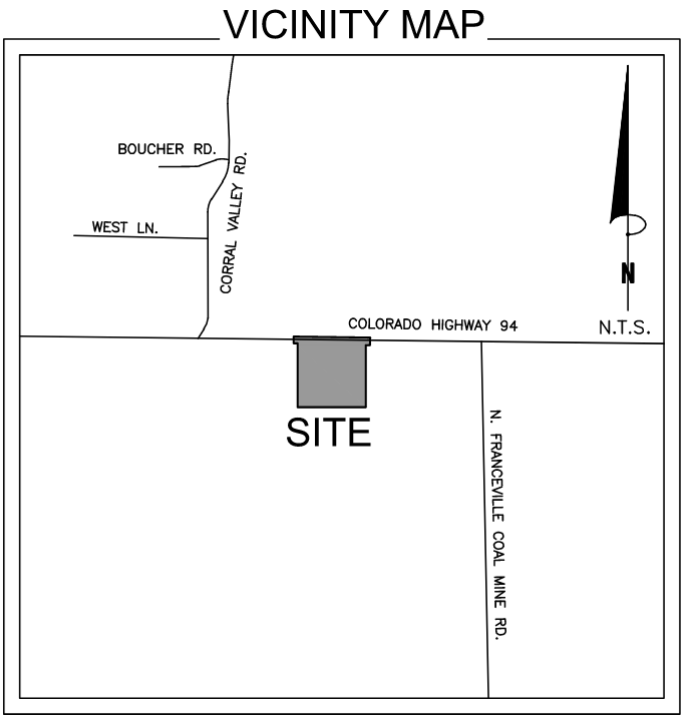
PURPOSE AND SCOPE OF STUDY

The purpose of this Final Drainage Report (FDR) is to provide the hydrologic and hydraulic calculations in addition to documenting and finalizing the drainage design methodology in support of the proposed UDON South development ("the Project") for UDON Holdings, LLC. The Project is located within the jurisdictional limits of El Paso County ("the County"). Thus, the guidelines for the hydrologic and hydraulic design components were based on the criteria outlined by the County.

LOCATION

The Project is located at 12265 Highway 94 approximately west southwest of the intersection of N. Franceville Coal Mine Rd. and Colorado Highway 94 in El Paso County, Colorado. More specifically, the Project is within the northeast quarter of the northwest quarter of Section 18, Township 14 South, Range 64 West of the 6th Principal Meridian in El Paso County, Colorado. A vicinity map has been provided below.

VICINITY MAP



DESCRIPTION OF PROPERTY

The Project is located on approximately ±34.71 ac (Parcel # 4400000237). The entire property consists of partially developed raw land with several existing building structures and associated utilities. The property has private, gravel driveways and most of the property is undeveloped meadow land consisting of natural grasses, shrubs, and other vegetation. The proposed Project consists of RV storage and parking areas with associated driveways, internal roads, sidewalk, stormwater quality and full spectrum extended detention basin, and associated drainage culverts. Currently, the site does not provide stormwater quality or detention. The site generally drains from the north to the south with slopes ranging from 2% to 12%, with the steeper slopes

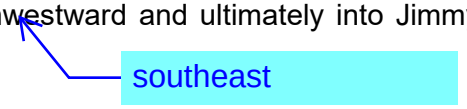
running through the middle of the site within an existing natural drainage channel. Runoff generally flows throughout the Site as sheet flow and is essentially channelized into a naturally vegetated existing drainage swale within the Project site. The Project is ultimately tributary to Jimmy Camp Creek approximately 1.5 miles to the west. The Project it is not located in any floodplain buffers or floodplains. See the ***Appendix*** for the floodplain maps.

SOILS DATA

NRCS soil data for the Site is provided in the ***Appendix*** and most of the onsite soils are generally USCS Hydrologic Soil Group D. Group D soils have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential.

PROJECT CHARACTERISTICS

The Project limits of disturbance are approximately ±18.06 ac with a total drainage study area of approximately ±50.73 ac. The proposed commercial development consists of RV storage and parking areas with associated driveways, internal roads, sidewalk, stormwater quality and full spectrum extended detention basin, and associated drainage culverts. Water quality and detention for the site will be provided by a proposed stormwater full spectrum extended detention basin located at the south property line that will accept flows from the majority of the site. Developed flows within the site will be collected by means of sheet flow and culverts before being captured into the proposed water quality facility. Flows are planned to outfall to the south into the exsiting drainage swale that runs generally southwestward and ultimately into Jimmy Camp Creek.



DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

The proposed stormwater facilities follow the El Paso County Drainage Criteria Manual (the "CRITERIA"), El Paso Engineering Criteria Manual (the "ECM"), and the Mile High Flood District Urban Storm Drainage Criteria Manual (the "MANUAL"). Further detail regarding proposed onsite drainage patterns is provided in the Proposed Drainage Conditions Section.

HYDROLOGIC CRITERIA

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the proposed drainage system per chapter 6 of the CRITERIA. Table 6-2 of the CRITERIA is the source for rainfall data for the 5-year and 100-year design storm events. Design runoff was calculated using the Rational Method for developed conditions as established in the CRITERIA and MANUAL. Runoff coefficients for the proposed development were determined using Table 6-6 of the CRITERIA by calculating weighted impervious values for each specific site basin. The full spectrum detention sizing was calculated using methods as specified in the CRITERIA and MANUAL. The full spectrum detention orifice structure was designed to release the Water Quality Capture Volume (WQCV) in 40 hours. Based upon this approach, the drainage design provided for the Site is in keeping with the historic drainage patterns for the Site.

HYDRAULIC CRITERIA

The proposed drainage facilities are designed in accordance with the CRITERIA and MANUAL. Floodplain identification was determined using FIRM panels by FEMA and information provided in the CRITERIA. Hydraulic calculations were computed using Flow master, and Storm CAD using the Standard Method. Results of the hydraulic calculations are summarized in the ***Appendix***.

VARIANCES FROM CRITERIA

There are no proposed variances from the El Paso County Drainage Criteria.

DRAINAGE BASINS AND SUB-BASINS

MAJOR BASIN DESCRIPTIONS

The Property is located in the Jimmy Camp Creek drainage basin and is tributary to Jimmy Camp Creek. The Drainage Basin Planning Study for the Jimmy Camp Creek drainage basin was prepared March 9th, 2015, by Kiowa Engineering Corporation. See Drainage Basin Planning Study in the ***Appendix***. There are no proposed creek improvements with the Project limits. Due to the proposed stormwater water quality full spectrum extended detention basin and distance from Jimmy Camp Creek, the project is not anticipated to adversely affect downstream conditions. There are no identified nearby irrigation facilities or other obstructions which could influence the local drainage.

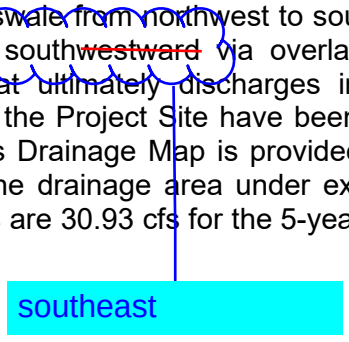
Currently, there is not an approved drainage report for the Property. All drainage design will comply with the existing Drainage Basin Planning Study for the Jimmy Camp Creek drainage basin.

FLOODPLAIN STATEMENT

The Project Site is located outside the 100-year floodplain and within Zone X (an area of minimal flood hazard) as noted on the FEMA FIRM Map No. 08041C0780G revised on December 7, 2018 (See ***Appendix***).

EXISTING DRAINAGE CONDITIONS

The existing Site has been divided into (5) five on-site (E1-E3) and off-site (OE1-OE2) sub-basins. A description of each sub-basin is listed below. In existing conditions, the total studied drainage area of the site is ±50.73 ac. Flows from stormwater runoff generally travel overland to channelized into an existing depressional swale from northwest to southeast at slopes of 2% to 12%. Runoff flows then travel generally southwestward via overland flow and the existing depressional natural vegetated swale that ultimately discharges into Jimmy Camp Creek. Calculations of the existing sub-basins on the Project Site have been completed using current stormwater criteria. An Existing Conditions Drainage Map is provided in the ***Appendix*** of this report. The weighted imperviousness of the drainage area under existing conditions is 4.2%. Total flows generated in existing conditions are 30.93 cfs for the 5-year event and 152.96 cfs for the 100-year event.



Eastward (see addtl redlines on this page)

Sub-Basin E1

Sub-basin E1 is 24.05 acres and consists of the generally central portion of the Site. This sub-basin consists of existing native grasses and vegetation, a few dirt roads with parking, and small building structures. The runoff developed within this basin sheet flows overland and generally channelized via an existing natural swale from northwest to southeast at slopes that range approximately 5% to 8%. From design point E1, flows then continue to travel southwestward via the existing depressional swale. The weighted imperviousness of sub-basin E1 is 2.0%. The developed direct runoff f ent and 66.21 cfs for the 100-year event.

Please also provide a design point with the total flow leaving the site at DP E1 including basins OE1 and OE2 that drain to basin E1

Sub-Basin E2

Sub-basin E2 is 2.45 a he Site. This sub-basin consists of existing native grasses and vegetation, and dirt road. The runoff developed within this basin sheet flows overland from southwest to northeast at slopes that range approximately 6% to 7%. From design point E2, flows then continue to travel westward towards an existing tributary of Jimmy Camp Creek along Colorado State Highway 94. The weighted imperviousness of sub-basin E2 is 6.8%. The developed direct runoff from sub-basin E1 is 1.82 cfs for the 5-year event and 8.31 cfs for the 100-year event.

Sub-Basin E3

Sub-basin E3 is 8.21 acres and consists of the southeast portion of the Site. This sub-basin consists of existing native grasses and vegetation, dirt road, and a building structure. The runoff developed within this basin sheet flows overland from northwest to southeast at slopes that range approximately 5% to 12%. From design point E3, flows then continue to travel southwestward towards Jimmy Camp Creek. The weighted imperviousness of sub-basin E3 is 3.0%. The developed direct runoff from sub-basin E1 is 5.01 cfs for the 5-year event and 25.45 cfs for the 100-year event.

Insert "an existing tributary of"

Sub-Basin OE1

Sub-basin OE1 is 5.60 acres and consists of the off-site portion northwest of the site. This sub-basin consists of existing native grasses and vegetation, gravel road, and asphalt road. The runoff developed within this basin sheet flows overland from northwest to southeast at slopes that range approximately 4% to 7%. The runoff flows all generally convene at the head of an existing 24" CMP culvert. From design point OE1, flows then continue to travel southwestward towards Jimmy Camp Creek. The weighted imperviousness of sub-basin OE1 is 7.9%. The developed direct runoff from sub-basin OE1 is 4.02 cfs for the 5-year event and 17.67 cfs for the 100-year event.

Slope range should be the same for OE1 and OP1. Please revise.

Elaborate on your description to be more consistent with the OP1 description.

Sub-Basin OE2

Sub-basin OE2 is 10.4 site portion w consists of existing native grasses and vegetation. The runoff developed within this basin sheet flows overland generally from west to east at slopes that range approximately 5% to 12%. From design point OE2, flows then continue to travel generally southeast onto the Site. The weighted imperviousness of sub-basin OE2 is 4.7%. The developed direct runoff from sub-basin OE2 is 7.43 cfs for the 5-year event and 35.33 cfs for the 100-year event.

Please make it clear that this basins flow is conveyed to basin E1 similar to what is described in the proposed conditions narrative.

PROPOSED DRAINAGE CONDITIONS

The proposed Site has been divided into (4) four on-site sub-basins, P1-P4, and (3) three off-site sub-basins, OP1-OP3. A description of each sub-basin is listed below.. The project involves the construction of RV storage and parking areas with associated driveways, internal roads, sidewalk, landscaping, stormwater quality and full spectrum extended detention basin, and associated drainage culverts. The total disturbed area of the site is approximately ±18.06 acres. Generally, stormwater runoff flows generated from most the drainage area's proposed conditions are to be conveyed via overland sheet flow towards an existing naturally vegetated drainage swale. These flows will then continue to the proposed full spectrum extended detention basin. Flows are released from this proposed full spectrum extended detention basin feature via outlet pipe with orifice plate into the existing shallow natural drainage channel that runs generally southwest over natural meadowlands that ultimately discharges into Jimmy Camp Creek. Flows generated from the proposed conditions will generally follow historic patterns. Under proposed conditions the studied drainage area associated with this project is ±50.73 acres with a 24.2% weighted imperviousness and 5 and 100-yr flows of 53.66 cfs and 175.91 cfs respectively. A proposed conditions drainage map can be found in the ***Appendix*.**

Eastward (see addtl redlines on this page)

Sub-Basin P1

Sub-basin P1 is 11.25 acres and consists of the northwestern portion of the Site. This sub-basin consists of proposed gravel parking area, sidewalk, ADA parking stalls, existing building structures, and native grasses. The runoff developed within this basin sheet flows overland from west to east and east to west converging into the existing drainage swale at approximately 5% to 8% slopes. Flows then enter 2 proposed 36" RCP culverts at design point P1 and then travel into sub-basin P2. The weighted imperviousness of sub-basin P1 is 48.3%. The developed direct runoff from sub-basin P1 is 17.66 cfs for the 5-year event and 43.44 cfs for the 100-year event. Flows from sub-basin P1 will generally follow historic drainage patterns.

please also provide the total flow inclusive of the basins OP1 and OP2 conveyed to basin P1

Sub-Basi

Sub-basin P2 is 12.66 acres and consists of the southwestern portion of the Site. This sub-basin consists of proposed gravel parking area, road, and the stormwater full spectrum extended detention basin, and native grasses. The runoff developed within this basin sheet flows overland from west to east and east to west converging into the existing drainage swale at approximately 5% to 8% slopes. Flows then flow down into the proposed stormwater full spectrum extended detention basin via a proposed rip rap lined rock chute. Flows will then continue through the pond via a proposed 4 feet concrete trickle channel and exist through the proposed pond control structure and outfall pipe with orifice plate or emergency spillway. Flows then travel into the existing drainage swale and ultimately discharge into Jimmy Camp Creek. The weighted imperviousness of sub-basin P2 is 42.2%. The developed direct runoff from sub-basin P2 is 17.28 cfs for the 5-year event and 45.10 cfs for the 1 will generally follow historic drainage patterns.

please also provide a design point with the total flow leaving the site inclusive of all basins (OP1, OP2, P1 & P2)

Sub-Basin P3

Sub-basin P3 is 2.58 acres and consists of the northeastern portion of the Site. This sub-basin consists of proposed gravel roads, and native grasses. The runoff developed within this basin sheet flows overland from west to east at approximately 5% to 8% slopes. Flows then exit the Site at design point P3. Flows will then continue to travel westward adjacent to Colorado State Highway 94 into the existing tributary that ultimately converges with Jimmy Camp Creek. The weighted imperviousness of sub-basin P3 is 13.3%. The developed direct runoff from sub-basin

P3 is 2.24 cfs for the 5-year event and 8.84 cfs for the 100-year event. Flows from sub-basin P3 will generally follow historic drainage patterns.

Sub-Basin P4

Sub-basin P4 is 8.21 acres and consists of the southeastern portion of the Site. This sub-basin consists of existing building structures, existing dirt and gravel roads and native grasses. The runoff developed within this basin sheet flows overland from northwest to southeast at approximately 5% to 12% slopes. Flows then exit the Site at design point P4. Flows will then continue to travel southeastward and eventually southwest into Jimmy Camp Creek. The weighted imperviousness of sub-basin P4 is 3.0%. The developed direct runoff from sub-basin P4 is 5.01 cfs for the 5-year event and 25.45 cfs for the 100-year event. Flows from sub-basin P4 will generally follow historic drainage patterns.

Sub-Basin OP1

Sub-basin OP1 is 5.60 acres and consists of the off-site portion northwest of the site. This sub-basin consists of an existing gravel road, asphalt, and native grasses. The runoff developed within this basin sheet flows overland from northwest to southeast at approximately 5% to 8% slopes. Flows then convene at design point OP1 where they travel through an existing 24" CMP culvert under Colorado State Highway 94 and enter proposed sub-basin P1. The weighted imperviousness of sub-basin P4 is 7.9%. The developed direct runoff from sub-basin OP1 is 4.02 cfs for the 5-year event and 17.67 cfs for the 100-year event. Flows from off-site sub-basin OP1 will follow historic drainage patterns.

Slope range should be the same for OE1 and OP1.

Sub-Basin OP2

Sub-basin OP2 is 5.78 acres and consists of the off-site portion west of the site. This sub-basin consists of existing native grasses, and vegetation. The runoff developed within this basin sheet flows overland from northwest to southeast at approximately 5% to 12% slopes. Flows then travel on-site into proposed sub-basin P1 at design point OP2. The weighted imperviousness of sub-basin OP2 is 8.5%. The developed direct runoff from sub-basin OP2 is 4.84 cfs for the 5-year event and 20.88 cfs for the 100-year event. Flows from off-site sub-basin OP2 will follow historic drainage patterns.

Sub-Basin OP3

Sub-basin OP3 is 4.65 acres and consists of the off-site portion southwest of the site. This sub-basin consists of existing native grasses, and vegetation. The runoff developed within this basin sheet flows overland from west to east at approximately 5% to 8% slopes. Flows then travel on-site into proposed sub-basin P2 at design point OP3. The weighted imperviousness of sub-basin OP3 is 0%. The developed direct runoff from sub-basin OP3 is 2.60 cfs for the 5-year event and 14.54 cfs for the 100-year event. Flows from off-site sub-basin OP3 will follow historic drainage patterns.

DRAINAGE FACILITY DESIGN

please indicate who will maintain the pond.

DETENTION AND WATER QUALITY

The WQCV is required for this Project. This is accomplished through the proposed private above ground full spectrum extended detention basin located along the southern property line of the Site. The full spectrum detention basin will also provide attenuation for the 100 Year Storm event.

Provide name for the proposed EDB, see GEC Plan comments.

Please explain if the pond sizing included the eastern area with a planned 65% imperviousness development. The pond calculations do not reflect this on pg71 Either correct calculations or revise statement below.

The proposed full spectrum detention basin was also sized for future development of the eastern half of the Site, Subbasins P3 and P4. It was assumed that a 65% impervious value would be used for future development of this Site, based on the assumption of a future land use similar to the current Project. This impervious assumption was included in the weighted imperviousness that is used in the calculations for detention volumes per the MHFD UD-Detention Spreadsheet.

4.2% under existing drainage conditions.

Overall, site imperviousness moderately increases from 3.6% to 24.2% with flows increasing from 152.96 cfs to 175.91 cfs in the 100-year storm event. The slight increase in flows generated for the Site are controlled with the proposed stormwater full spectrum extended detention basin which reduces the 152.96 cfs in the existing condition to a release of 78.4 cfs, from the proposed detention pond. The proposed pond intends to mitigate the potential for flooding and negative water quality impacts to downstream waterways. The downstream grassy meadow appears stable and healthy with gradual longitudinal and side slopes of approximately 1-2%. In addition, as Jimmy Camp Creek is approximately 1.5 miles to the west from the proposed site.

Please clarify that flow from basins P3 and P4 will be conveyed to the pond in the future as they currently flow to the adjacent property. Identify that the appropriate changes to the proposed pond will be provided at that time (i.e. additional forebay, trickle channel, outlet orifice plate etc.)

Please revise this paragraph as design points E2 & E3 (existing conditions) as well as P3 & p4 are not conveyed to design point P2 (E1 in existing conditions) where the pond outfall is. Please compare the total existing flows at southern boundary with the total proposed flows at the southern boundary.
Also please discuss the increase in flows at design point P3. is the downstream adequate? in need of improvements? is the increase neglible? please address.

ne MANUAL pr
tion Control Mea

Reduction Pra
mostly vacant
site will increa
However, imple
ed stormwater
filtration.

Does this 24% include the assumptions for Subbasins P3 and P4? Clarify if it does or if the assumptions were only used to size the EDB.

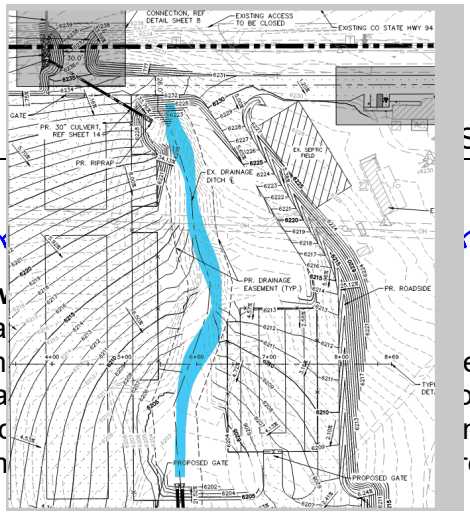
Step 2: Provide Water Quality Capture Volume (WQCV) name

The water quality capture volume will be detained using a full spectrum extended detention basin on the south end of the Site. The outfall from the water quality outlet structure will control the release of the WQCV stormwater to less than historic rates. Due to grading constraints, a portion of the disturbed area cannot be captured and treated in the proposed full spectrum extended detention basin. Per ECM Appendix I Section 1.7.C.1.a., 20% of the development site or less than 1 acre can be excluded from providing water quality. Water quality treatment is being provided for 18.07 acres which is 98.3% of the total non-exempt disturbed area.

The following table outlines the non-exempt areas receiving water quality treatment, and the disturbed areas flowing offsite that do not receive water quality treatment.

Condition	Total Area (AC)	Percentage of Total Non-Exempt Disturbed Area (%)	Sub-Basins
Areas Captured and Treated with Proposed Private Full Spectrum Extended Basin	18.07	98.3%	P1, P2, OP1, OP2, OP3
Disturbed Areas That Flow Offsite (No Treatment)	0.31	1.7%	P3

Explain how the existing drainageways will be stabilized that convey flow to the pond



Step 3: Stabilize Drainagew

There are no current draina Site. The proposed Site is approximately 1.5 miles from ed conditions the majority of all flows from Site will rea operty within the proposed stormwater facility. No adjac mpacted with the proposed improvements. No improven e proposed as part of this Project at this time.

Step 4: Consider need for Industrial and Commercial BMPs

Erosion control features for the final stages of the Project will be designed to reduce contamination. Source control BMPs will include the use of silt fences, concrete washout areas, stockpile management, and stabilized staging areas. The Grading and Erosion Control Plans will be submitted as a separate construction document set.

Water Quality Design

The proposed private full spectrum extended basin is designed with an outlet structure that is fitted with a restrictor plate to release the WQCV in a 40-hour time period per the MANUAL. Calculations included in the ***Appendix*** provide details regarding the private water quality design. Overall, based on 40-hour drain time 0.719 ac-ft of WQCV is required. The total area contributing to the full spectrum extended basin is 50.73 acres (24.2% imperviousness).

Outlet Requirements

The water quality standards established by the CRITERIA are met by the proposed full spectrum extended basin. The water quality outlet structure was designed per the specifications in the CRITERIA. The orifice plate will allow the WQCV to be drained in 40hours.

MHFD UD-Detention v4.06 was utilized for demonstrating volume provided and to determine WQCV WSE for the design of the outlet structure. Please refer to full spectrum extended basin construction details and UD-BMP spreadsheet provided in ***Appendix*** for full spectrum extended basin outlet structure design and details.

Emergency Spillway Path

The emergency overflow from the full spectrum extended basin is designed to spill over the top of the full spectrum extended basin and flow south into the existing natural shallow channel located in the meadow south of the site. The emergency overflow spillway path can be found on the Proposed Drainage Map.

Discuss the suitability of the outlet and emergency spillway. Will the quantities and velocities have any negetive downstream impacts?

DRAINAGE AND BRIDGE FEES

The Site is located in the Jimmy Camp Creek Drainage Basin. The site is not currently planned to be platted and as such there are no required drainage and bridge fees.

provide engineer estimate for complete pond design and update the FAE.

GRADING AND EROSION CONTROL

The GEC will be submitted in conjunction with this report to El Paso County Planning and Community Development Department for review and approval prior to construction. The GEC plans are consistent with this drainage report.

MAINTENANCE AND OPERATIONS

Twice per year inspections (spring and fall) of the water quality structure is recommended. The owner/operator will be responsible for maintenance. A copy of this report will be provided to the owner/operator. This satisfies the Operation and Maintenance (O&M) Manual.

OTHER GOVERNMENT AGENCY REQUIREMENTS

Approval from other agencies such as the FEMA, the Army Corps of Engineers, Colorado State Engineer, Colorado Water Conservation Board, and others are not required with this Project.

SUMMARY

Overall, site imperviousness moderately increases from 3.6% to 24.2% with flows increasing from 152.96 cfs to 175.91 cfs in the 100-year storm event. In the proposed conditions there is a slight increase to total runoff flows generated from the proposed development. The slight increase in flows generated for the Site are controlled with the proposed stormwater full spectrum extended detention basin that release at less than historic rates. The proposed pond intends to mitigate the potential for flooding and negative water quality impacts to downstream waterways. Furthermore, flows exiting the full spectrum extended detention basin will be entering a naturally vegetated grassy meadow swale. These areas appear stable and healthy so the minimal increase in flows will have negligible impacts, and as such the proposed project poses no risk to downstream waterways or infrastructure.

Compliance With Standards

The drainage design presented within this report for UDON South conforms to the El Paso County Drainage Criteria Manual and the Mile High Flood District Urban Storm Drainage Criteria Manual. Additionally, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments.

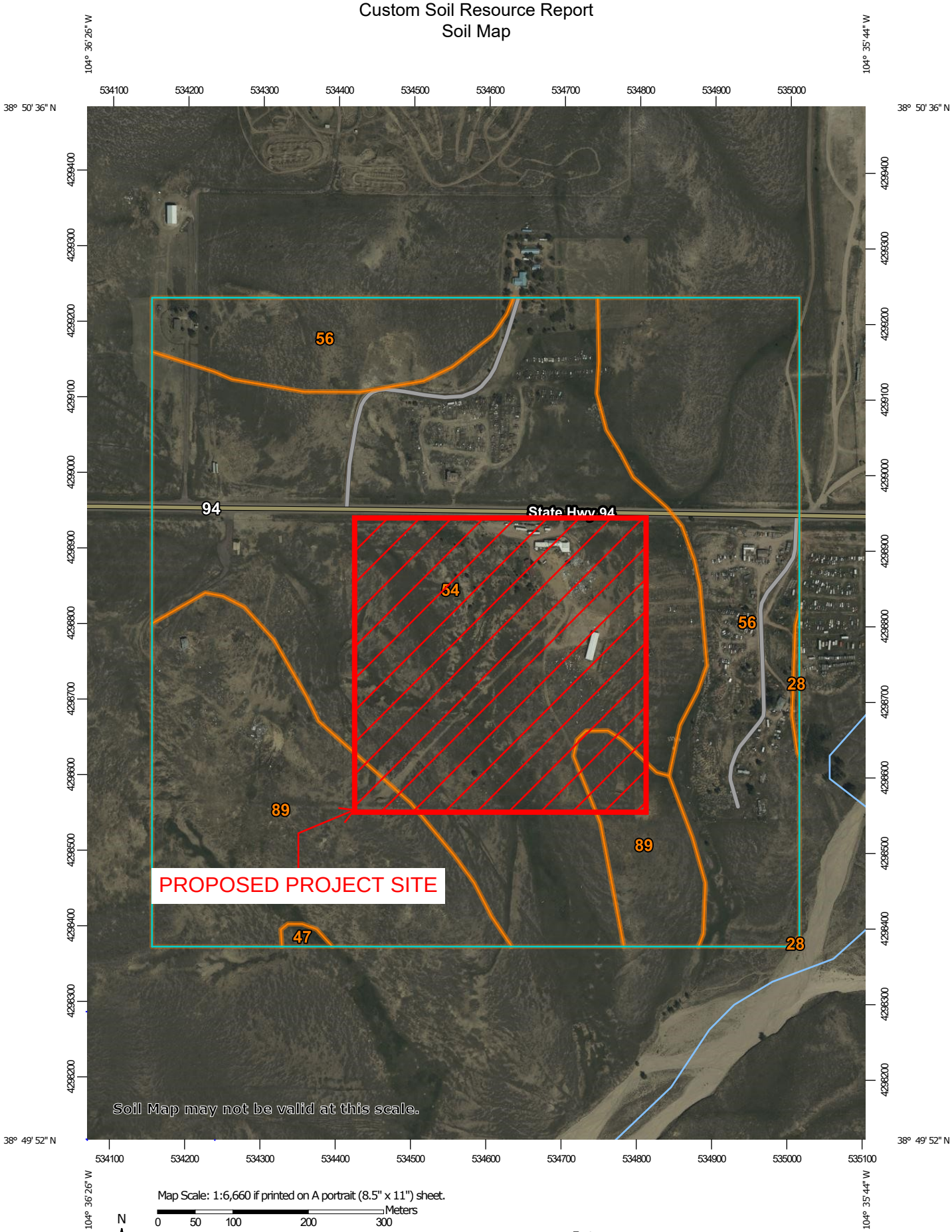
REFERENCES

1. El Paso County Drainage Criteria Manual, Vol. 1 and 2, October 1994.
2. City of Colorado Springs Drainage Criteria Manual, May 2014, Revised 2021.
3. El Paso County Engineering Criteria Manual, December 2004, Revised 2016
4. Mile High Flood District Drainage Criteria Manual (MHFDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.
5. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0780G Effective Date December 7, 2018, prepared by the Federal Emergency Management Agency (FEMA).

APPENDIX

SOILS MAP AND FEMA FIRM PANEL

Custom Soil Resource Report
Soil Map



Map Scale: 1:6,660 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 300 600 1200 1800

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 21, Aug 24, 2023

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

Date(s) aerial images were photographed: 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
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	0.3	0.2%
47	Limon clay, 0 to 3 percent slopes	0.4	0.2%
54	Midway clay loam, 3 to 25 percent slopes	91.9	50.2%
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	49.3	26.9%
89	Tassel fine sandy loam, 3 to 18 percent slopes	41.3	22.5%
Totals for Area of Interest		**183.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

28—Ellicott loamy coarse sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 3680
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Ellicott and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ellicott

Setting

Landform: Flood plains, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium

Typical profile

A - 0 to 4 inches: loamy coarse sand
C - 4 to 60 inches: stratified coarse sand to sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: R069XY031CO - Sandy Bottomland
Other vegetative classification: SANDY BOTTOMLAND (069AY031CO)
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquoll

Percent of map unit: 1 percent
Landform: Swales
Hydric soil rating: Yes

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

47—Limon clay, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 368p
Elevation: 5,200 to 6,200 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

Limon, occasionally flooded, and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Limon, Occasionally Flooded

Setting

Landform: Flood plains, alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from shale

Typical profile

A - 0 to 4 inches: clay
AC - 4 to 12 inches: silty clay
C - 12 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)

Sodium adsorption ratio, maximum: 10.0
Available water supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R069XY033CO - Salt Flat
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

54—Midway clay loam, 3 to 25 percent slopes

Map Unit Setting
National map unit symbol: 368y
Elevation: 5,200 to 6,200 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
Midway and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Midway

Setting
Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from shale

Typical profile
A - 0 to 4 inches: clay loam
C - 4 to 13 inches: clay
Cr - 13 to 17 inches: weathered bedrock

Properties and qualities
Slope: 3 to 25 percent

Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 15 percent
Maximum salinity: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 15.0
Available water supply, 0 to 60 inches: Very low (about 2.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: R069XY046CO - Shaly Plains
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

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

89—Tassel fine sandy loam, 3 to 18 percent slopes

Map Unit Setting

National map unit symbol: 36b5
Elevation: 5,600 to 6,400 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 51 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Tassel and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tassel

Setting

Landform: Hills
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Calcareous slope alluvium over residuum weathered from sandstone

Typical profile

A - 0 to 4 inches: fine sandy loam
C - 4 to 10 inches: 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: R067BY024CO - Sandy Plains
Other vegetative classification: SANDY PLAINS (069AY026CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 5 percent
Hydric soil rating: No

National Flood Hazard Layer FIRMette

FEMA

104°36'23"W 38°50'27"N

104°35'45"W 38°49'59"N

Feet

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/10/2022 at 9:13 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

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/.

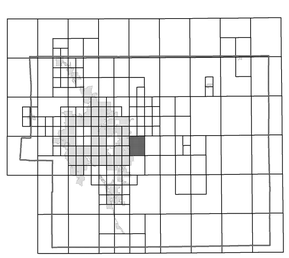
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

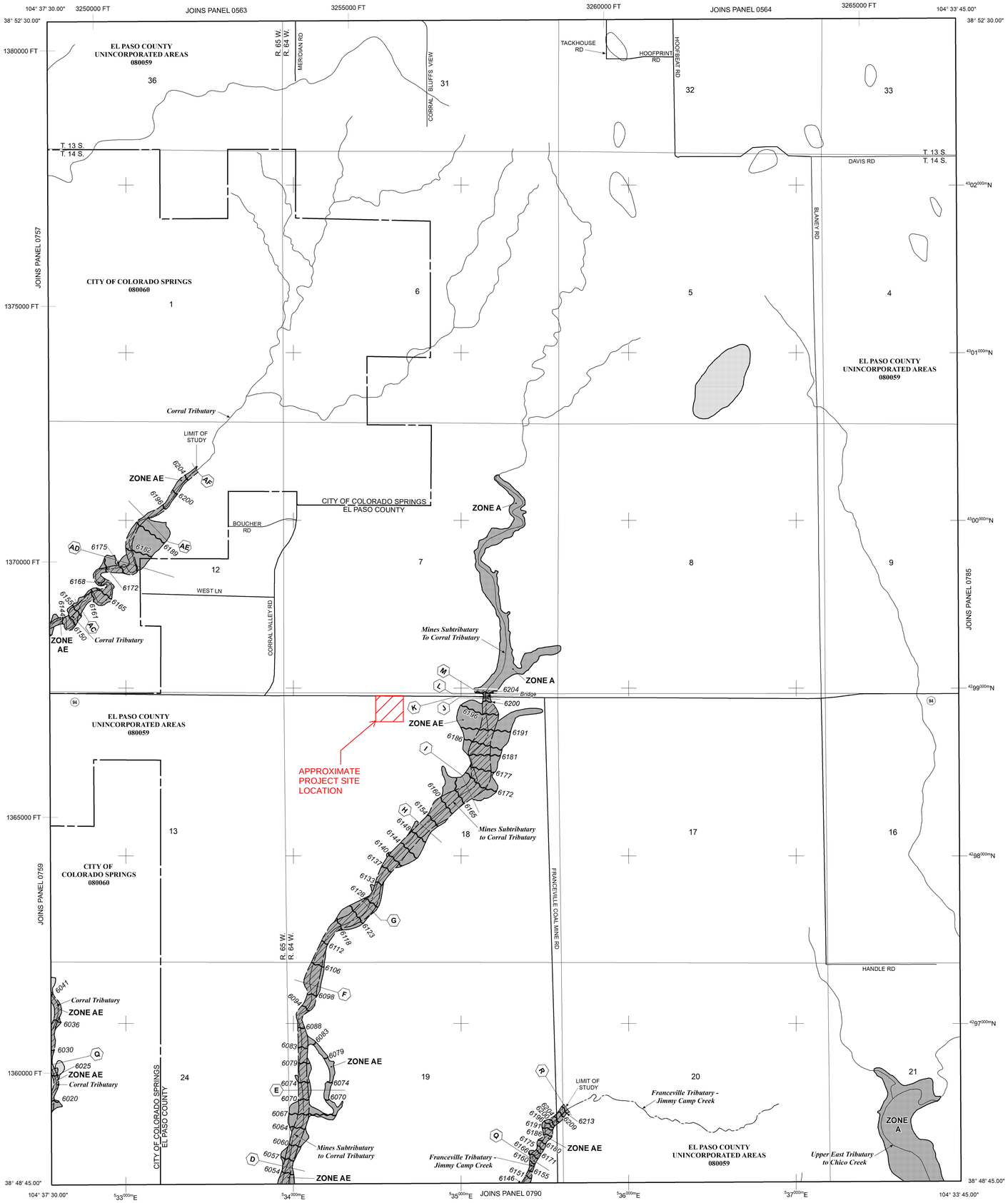
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

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)
4275000mN — 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

PANEL 0780G

MAP NUMBER 08041C0780G

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 reissued 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

Weighted Imperviousness Calculations: Existing

SUB-BASIN	AREA (SF)	AREA (Acres)	GRAVEL ROAD AREA	GRAVEL ROAD IMPERVIOUSNESS	GRAVEL ROAD C2	GRAVEL ROAD C5	GRAVEL ROAD C10	GRAVEL ROAD C100	PAVED ROAD AREA	PAVED ROAD IMPERVIOUSNESS	PAVED ROAD C2	PAVED ROAD C5	PAVED ROAD C10	PAVED ROAD C100	LANDSCAPE AREA	LANDSCAPE IMPERVIOUSNESS	LANDSCAPE C2	LANDSCAPE C5	LANDSCAPE C10	LANDSCAPE C100	ROOF AREA	ROOF IMPERVIOUSNESS	ROOF C2	ROOF C5	ROOF C10	ROOF C100	WEIGHTED IMPERVIOUSNESS	WEIGHTED COEFFICIENTS C2	WEIGHTED COEFFICIENTS C5	WEIGHTED COEFFICIENTS C10	WEIGHTED COEFFICIENTS C100
E1	1,047,604	24.05	20,055	80%	0.60	0.63	0.66	0.74	0	100%	0.89	0.9	0.92	0.96	1,021,990	0%	0.04	0.15	0.25	0.5	5,559	90%	0.73	0.75	0.77	0.83	2.0%	0.05	0.16	0.26	0.51
E2	106,580	2.45	7,850	80%	0.60	0.63	0.66	0.74	937	100%	0.89	0.9	0.92	0.96	98,730	0%	0.04	0.15	0.25	0.5	0	90%	0.73	0.75	0.77	0.83	6.8%	0.09	0.19	0.29	0.53
E3	357,659	8.21	9,215	80%	0.60	0.63	0.66	0.74	0	100%	0.89	0.9	0.92	0.96	344,853	0%	0.04	0.15	0.25	0.5	3,591	90%	0.73	0.75	0.77	0.83	3.0%	0.06	0.17	0.27	0.51
OE1	243,957	5.60	7,055	80%	0.60	0.63	0.66	0.74	13,674	100%	0.89	0.9	0.92	0.96	236,902	0%	0.04	0.15	0.25	0.5	0	90%	0.73	0.75	0.77	0.83	7.9%	0.11	0.21	0.31	0.56
OE2	454,182	10.43	0	80%	0.60	0.63	0.66	0.74	21,405	100%	0.89	0.9	0.92	0.96	454,182	0%	0.04	0.15	0.25	0.5	0	90%	0.73	0.75	0.77	0.83	4.7%	0.08	0.19	0.29	0.55
TOTAL	2,209,982	50.73	44,175	80%	0.60	0.63	0.66	0.74	36,016	100%	0.89	0.9	0.92	0.96	2,156,657	0%	0.04	0.15	0.25	0.5	9,150	90%	0.73	0.75	0.77	0.83	3.6%	0.07	0.18	0.28	0.52

UDON South

Time of Concentration: Existing Calculations

Watercourse Coefficient

Forest & Meadow	2.50	Short Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

	SUB-BASIN DATA				INITIAL / OVERLAND* TIME			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T©*
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
E1	E1	1,047,604	24.05	0.16	300	6.4%	16.0	1157	2.5%	2.50	0.4	49.1	65.1	1457	18.1	18.1
E2	E2	106,580	2.45	0.19	300	5.5%	16.3	78	9.4%	2.50	0.8	1.7	18.0	378	12.1	12.1
E3	E3	357,659	8.21	0.17	300	7.5%	15.1	422	7.2%	2.50	0.7	10.5	25.6	722	14.0	14.0
OE1	OE1	243,957	5.60	0.21	300	3.2%	19.1	927	6.9%	2.50	0.7	23.5	42.6	1227	16.8	16.8
OE2	OE2	454,182	10.43	0.19	300	4.0%	18.1	297	8.0%	2.50	0.7	7.0	25.1	597	13.3	13.3
TOTAL	TOTAL	2,209,982	50.73	0.18												

*Note: El Paso County Drainage Manual Chapter 6 indicates that the maximum overland flow length is 100ft for urbanized areas and 300ft for rural areas. The minimum time of concentration is 5 min for developed conditions, 10 min for undeveloped conditions.

UDON South

Time of Concentration: Existing Calculations ***Design Storm*** ***5 Year Strom Event***

(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
E1	E1	24.05	0.16	18.1	3.91	3.24	12.65					0.00
E2	E2	2.45	0.19	12.1	0.47	3.84	1.82					0.00
E3	E3	8.21	0.17	14.0	1.38	3.62	5.01					
OE1	OE1	5.60	0.21	16.8	1.20	3.35	4.02					
OE2	OE2	10.43	0.19	13.3	2.01	3.70	7.43					
TOTAL	TOTAL	50.73					30.93					

UDON South

Time of Concentration: Existing Calculations ***Design Storm*** ***100 Year Storm Event***

(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
E1	E1	24.05	0.51	18.1	12.18	5.44	66.21					
E2	E2	2.45	0.53	12.1	1.29	6.45	8.31					
E3	E3	8.21	0.51	14.0	4.18	6.08	25.45					
OE1	OE1	5.60	0.56	16.8	3.14	5.63	17.67					
OE2	OE2	10.43	0.55	13.3	5.69	6.21	35.33					
TOTAL	TOTAL	50.73					152.96					

Weighted Imperviousness Calculations: Proposed

SUB-BASIN	AREA (SF)	AREA (Acres)	GRAVEL ROAD AREA	GRAVEL ROAD IMPERVIOUSNESS	GRAVEL ROAD C2	GRAVEL ROAD C5	GRAVEL ROAD C10	GRAVEL ROAD C100	PAVED ROAD AREA	PAVED ROAD IMPERVIOUSNESS	PAVED ROAD C2	PAVED ROAD C5	PAVED ROAD C10	PAVED ROAD C100	LANDSCAPE AREA	LANDSCAPE IMPERVIOUSNESS	LANDSCAPE C2	LANDSCAPE C5	LANDSCAPE C10	LANDSCAPE C100	ROOF AREA	ROOF IMPERVIOUSNESS	ROOF C2	ROOF C5	ROOF C10	ROOF C100	WEIGHTED IMPERVIOUSNESS	WEIGHTED COEFFICIENTS C2	WEIGHTED COEFFICIENTS C5	WEIGHTED COEFFICIENTS C10	WEIGHTED COEFFICIENTS C100
P1	490,176	11.25	289,787	80%	0.60	0.63	0.66	0.74	0	100%	0.89	0.9	0.92	0.96	194,830	0%	0.04	0.15	0.25	0.5	5,559	90%	0.73	0.75	0.77	0.83	48.3%	0.38	0.44	0.50	0.65
P2	551,435	12.66	290,752	80%	0.60	0.63	0.66	0.74	0	100%	0.89	0.9	0.92	0.96	260,683	0%	0.04	0.15	0.25	0.5	0	90%	0.73	0.75	0.77	0.83	42.2%	0.34	0.40	0.47	0.63
P3	112,569	2.58	17,933	80%	0.60	0.63	0.66	0.74	641	100%	0.89	0.9	0.92	0.96	94,636	0%	0.04	0.15	0.25	0.5	0	90%	0.73	0.75	0.77	0.83	13.3%	0.13	0.23	0.32	0.54
P4	357,660	8.21	9,215	80%	0.60	0.63	0.66	0.74	0	100%	0.89	0.9	0.92	0.96	344,854	0%	0.04	0.15	0.25	0.5	3,591	90%	0.73	0.75	0.77	0.83	3.0%	0.06	0.17	0.27	0.51
OP1	243,957	5.60	7,055	80%	0.60	0.63	0.66	0.74	13,674	100%	0.89	0.9	0.92	0.96	236,902	0%	0.04	0.15	0.25	0.5	0	90%	0.73	0.75	0.77	0.83	7.9%	0.11	0.21	0.31	0.56
OP2	251,638	5.78	0	80%	0.60	0.63	0.66	0.74	21,405	100%	0.89	0.9	0.92	0.96	251,638	0%	0.04	0.15	0.25	0.5	0	90%	0.73	0.75	0.77	0.83	8.5%	0.12	0.23	0.33	0.58
OP3	202,547	4.65	0	80%	0.60	0.63	0.66	0.74	0	100%	0.89	0.9	0.92	0.96	202,547	0%	0.04	0.15	0.25	0.5	0	90%	0.73	0.75	0.77	0.83	0.0%	0.04	0.15	0.25	0.50
TOTAL	2,209,982	50.73	614,742	80%	0.60	0.63	0.66	0.74	35,720	100%	0.89	0.9	0.92	0.96	1,586,090	0%	0.04	0.15	0.25	0.5	9,150	90%	0.73	0.75	0.77	0.83	24.2%	0.21	0.30	0.38	0.58

UDON South

Time of Concentration: Proposed Calculations

Watercourse Coefficient

Forest & Meadow	2.50	Short Grass Pasture & Lawns	7.00
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00
Grassed Waterway	15.00	Paved Area & Shallow Gutter	20.00

	SUB-BASIN DATA				INITIAL / OVERLAND* TIME			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T©*
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
P1	P1	490,176	11.25	0.44	300	3.6%	13.7	533	5.2%	20.00	4.6	1.9	15.6	833	14.6	14.6
P2	P2	551,435	12.66	0.40	300	4.9%	13.0	849	2.8%	20.00	3.3	4.2	17.3	1149	16.4	16.4
P3	P3	112,569	2.58	0.23	300	2.7%	19.8	223	6.8%	20.00	5.2	0.7	20.5	523	12.9	12.9
P4	P4	357,660	8.21	0.17	300	7.5%	15.1	422	7.4%	2.50	0.7	10.3	25.5	722	14.0	14.0
OP1	OP1	243,957	5.60	0.21	300	3.2%	19.1	927	6.9%	2.50	0.7	23.5	42.6	1227	16.8	16.8
OP2	OP2	251,638	5.78	0.23	300	4.0%	17.4	297	8.9%	2.50	0.7	6.6	24.1	597	13.3	13.3
OP3	OP3	202,547	4.65	0.15	300	7.3%	15.6	262	11.0%	2.50	0.8	5.3	20.8	562	13.1	13.1
TOTAL	TOTAL	2,209,982	50.73	0.30												

*Note: El Paso County Drainage Manual Chapter 6 indicates that the maximum overland flow length is 100ft for urbanized areas and 300ft for rural areas. The minimum time of concentration is 5 min for developed conditions, 10 min for undeveloped conditions.

UDON South

Time of Concentration: Proposed Calculations ***Design Storm*** ***5 Year Strom Event***

(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
P1	P1	11.25	0.44	14.6	4.96	3.56	17.66					0.00
P2	P2	12.66	0.40	16.4	5.10	3.39	17.28					0.00
P3	P3	2.58	0.23	12.9	0.60	3.75	2.24					
P4	P4	8.21	0.17	14.0	1.38	3.62	5.01					
OP1	OP1	5.60	0.21	16.8	1.20	3.35	4.02					
OP2	OP2	5.78	0.23	13.3	1.31	3.70	4.84					
OP3	OP3	4.65	0.15	13.1	0.70	3.72	2.60					
TOTAL	TOTAL	50.73					53.66					

UDON South

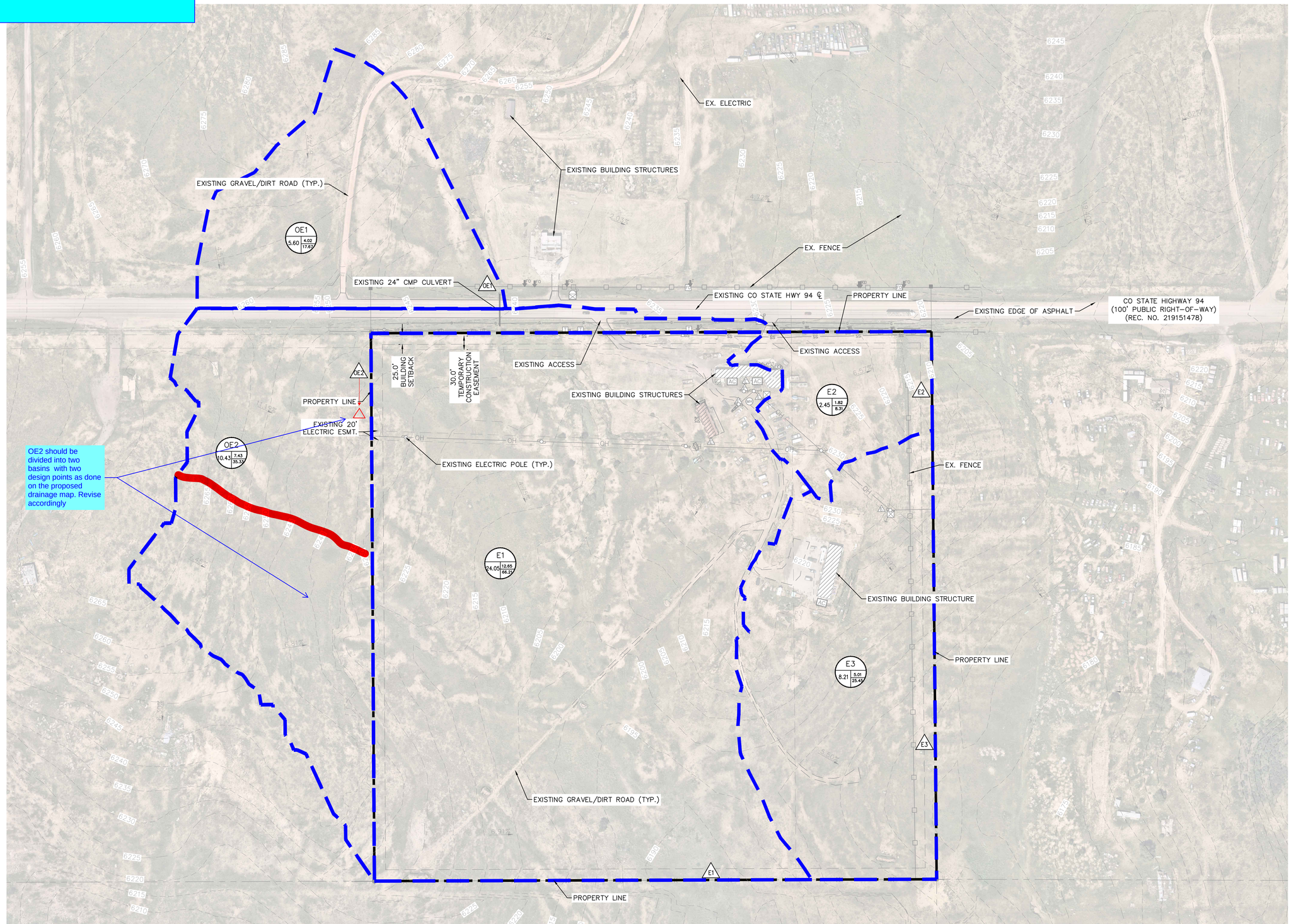
Time of Concentration: Proposed Calculations ***Design Storm*** ***100 Year Storm Event***

(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
P1	P1	11.25	0.65	14.6	7.27	5.98	43.44					
P2	P2	12.66	0.63	16.4	7.93	5.69	45.10					
P3	P3	2.58	0.54	12.9	1.41	6.29	8.84					
P4	P4	8.21	0.51	14.0	4.18	6.08	25.45					
OP1	OP1	5.60	0.56	16.8	3.14	5.63	17.67					
OP2	OP2	5.78	0.58	13.3	3.36	6.21	20.88					
OP3	OP3	4.65	0.50	13.1	2.32	6.25	14.54					
TOTAL	TOTAL	50.73					175.91					

EXISTING AND PROPOSED DRAINAGE MAP

Please move existing and proposed drainage maps to end of report



NORTH

GRAPHIC SCALE IN FEET
0 50 100 200

LEGEND

- PROPERTY LINE
- XXXX EX. MAJOR CONTOUR
- XXXX EX. MINOR CONTOUR
- EX. DRAINAGE BASIN BOUNDARY
- A = BASIN DESIGNATION
  B = AREA IN ACRES
  C = 5-YR RUNOFF
  D = 100-YR RUNOFF
- # = DESIGN POINT DESIGNATION
- X.XX% EXISTING SLOPE ARROW

SUMMARY - EXISTING RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
E1	E1	24.05	12.65	66.21
E2	E2	2.45	1.82	8.31
E3	E3	8.21	5.01	25.45
OE1	OE1	5.60	4.02	17.67
OE2	OE2	10.43	7.43	35.33
TOTAL		50.73	30.93	152.96

UDON SOUTH - EXISTING DRAINAGE EXHIBIT

Kimley»Horn
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2 N NEVADA AVE., SUITE 900, COLORADO SPRINGS, 80903
PHONE: 719-453-0180

Date: June 24, 2024 – 8:14am / User: DrewMcClain
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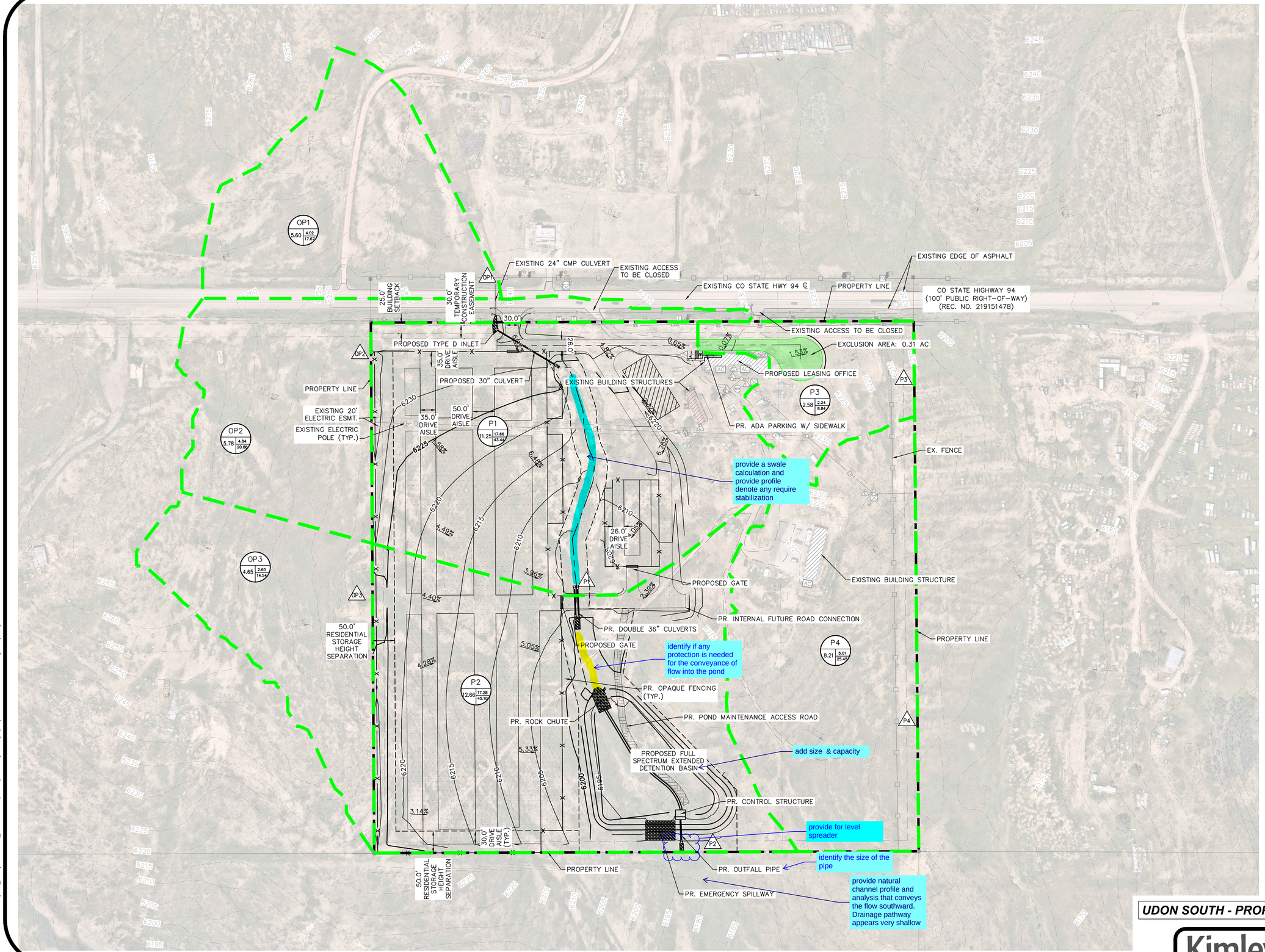

NORTH

GRAPHIC SCALE IN FEET
0 50 100 200

LEGEND

- PROPERTY LINE
- EX. MAJOR CONTOUR
- EX. MINOR CONTOUR
- PR. MAJOR CONTOUR
- PR. MINOR CONTOUR
- PR. DRAINAGE BASIN BOUNDARY
- A = BASIN DESIGNATION
  B = AREA IN ACRES
  C = 5-YR RUNOFF
  D = 100-YR RUNOFF
- # = DESIGN POINT DESIGNATION
- X.XX% EXISTING SLOPE ARROW
- X.XX% PROPOSED SLOPE ARROW
- DRAINAGE EXCLUSION AREA

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
P1	P1	11.25	17.66	43.44
P2	P2	12.66	17.28	45.10
P3	P3	2.58	2.24	8.84
P4	P4	8.21	5.01	25.45
OP1	OP1	5.60	4.02	17.67
OP2	OP2	5.78	4.84	20.88
OP3	OP3	4.65	2.60	14.54
TOTAL		50.73	53.66	175.91

UDON SOUTH - PROPOSED DRAINAGE EXHIBIT

Kimley»Horn
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PHONE: 719-453-0180

Date: June 24, 2024 - 8:14am / User: Drew McGinn
Path: K:\COS_DAV\196020003_UDON South\CAD\Exhibits\Drainage\Proposed Conditions Drainage Map.dwg

StormCAD

UDON South
Active Scenario: 5-yr (30" North Inlet)
FlexTable: Catch Basin Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Local In) (cfs)	Flow (Total Out) (cfs)	Headloss Coefficient (Standard)
PR. TYPE D INLET	6,230.20	6,225.13	7.00	7.00	0.050

UDON South
Active Scenario: 5-yr (30" North Inlet)

FlexTable: Conduit Table

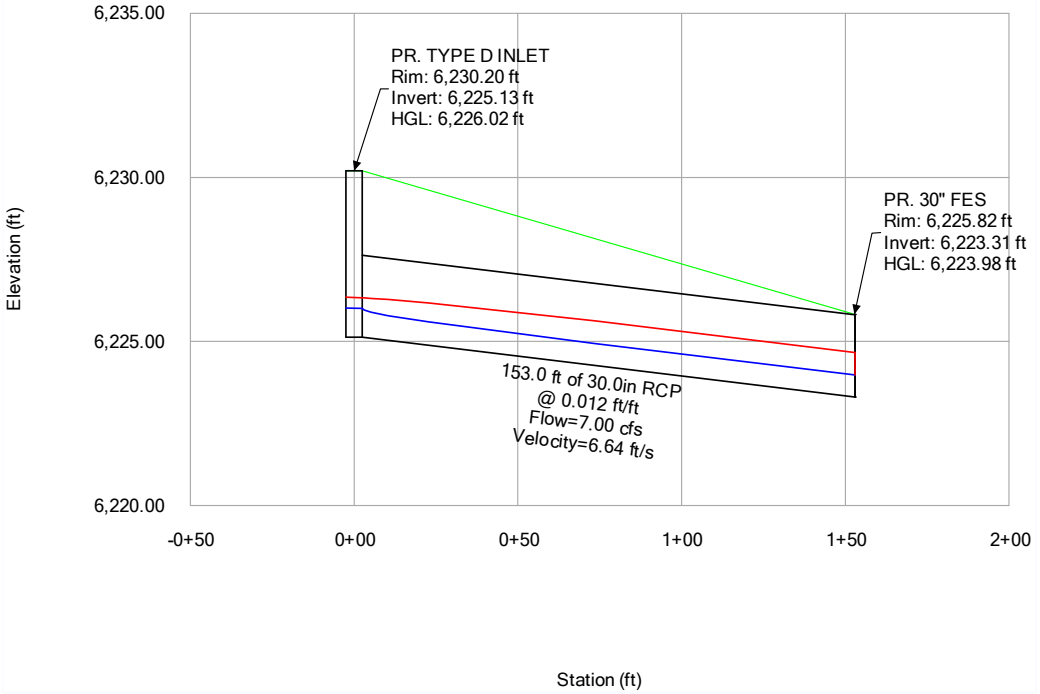
Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
PR. 30" RCP	PR. TYPE D INLET	PR. 30" FES	6,225.13	6,223.31	153.0	0.012	30.0	7.00	6.64	6,226.01	6,223.98

UDON South
Active Scenario: 5-yr (30" North Inlet)
FlexTable: Outfall Table

Label	Elevation (Invert) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
PR. 30" FES	6,223.31	6,223.98	7.00

Add tailwater values to results table.

UDON South
Active Scenario: 5-yr (30" North Inlet)
Profile Report
Engineering Profile - North Culvert - 5YR (UDON South North Culvert - StormCAD.stsw)



UDON South
Active Scenario: 100-yr (30" North Inlet)
FlexTable: Catch Basin Table

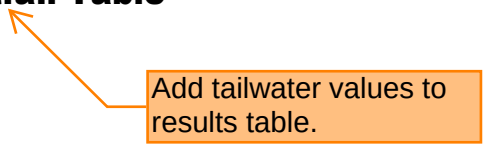
Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Local In) (cfs)	Flow (Total Out) (cfs)	Headloss Coefficient (Standard)
PR. TYPE D INLET	6,230.20	6,225.13	30.00	30.00	0.050

UDON South
Active Scenario: 100-yr (30" North Inlet)
FlexTable: Conduit Table

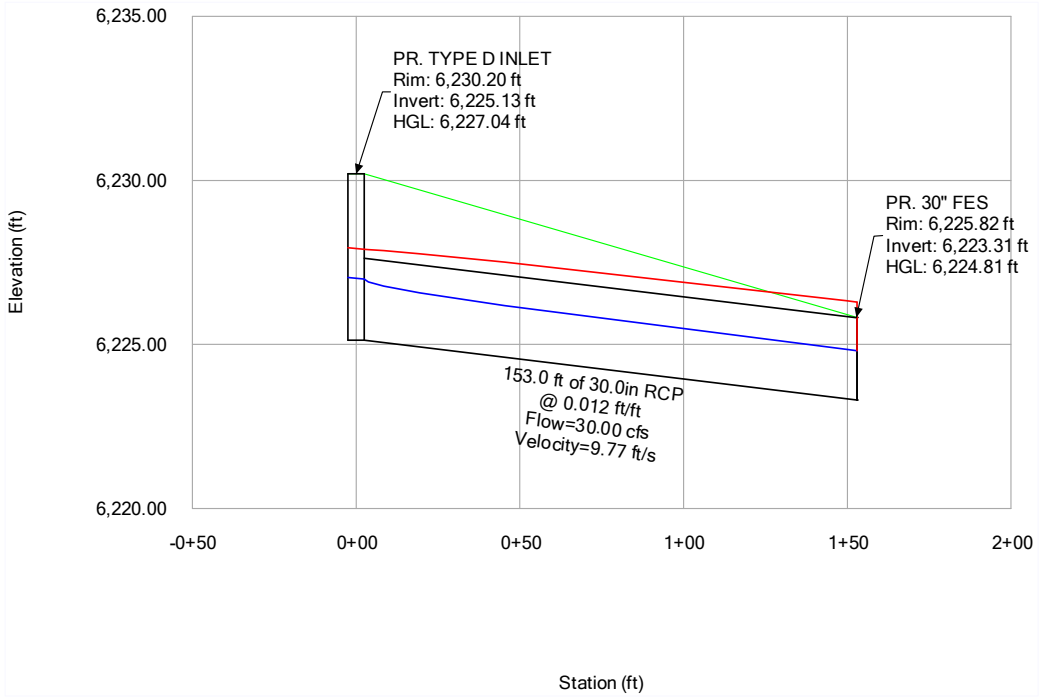
Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
PR. 30" RCP	PR. TYPE D INLET	PR. 30" FES	6,225.13	6,223.31	153.0	0.012	30.0	30.00	9.77	6,227.00	6,224.81

UDON South
Active Scenario: 100-yr (30" North Inlet)
FlexTable: Outfall Table

Label	Elevation (Invert) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
PR. 30" FES	6,223.31	6,224.81	30.00



UDON South
Active Scenario: 100-yr (30" North Inlet)
Profile Report
Engineering Profile - North Culvert - 100YR (UDON South North Culvert - StormCAD.stsw)



UDON South

Active Scenario: 5-yr (42" Outfall)

FlexTable: Catch Basin Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Local In) (cfs)	Flow (Total Out) (cfs)	Headloss Coefficient (Standard)
PR. MOD. CONTROL STRUCTURE TYPE C	6,195.65	6,188.98	15.60	15.60	0.050

UDON South

Active Scenario: 5-yr (42" Outfall)

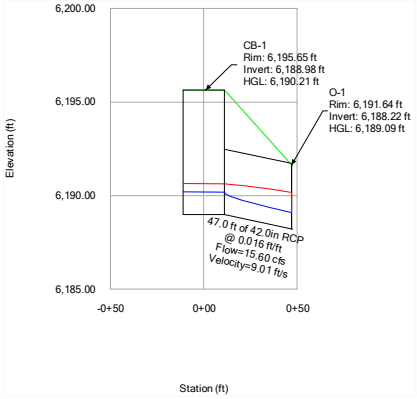
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
PR. 42" RCP	PR. MOD. CONTROL STRUCTURE TYPE C	PR. 42" FES	6,188.98	6,188.22	47.0	0.016	42.0	15.60	9.01	6,190.18	6,189.09

UDON South
Active Scenario: 5-yr (42" Outfall)
FlexTable: Outfall Table

Label	Elevation (Invert) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
PR. 42" FES	6,188.22	6,189.09	15.60

UDON South
Active Scenario: 5-yr (42" Outfall)
Profile Report
Engineering Profile - Outfall Pipe - 5YR (UDON South - StormCAD.stsw)



UDON South

Active Scenario: 100-yr (42" Outfall)

FlexTable: Catch Basin Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Local In) (cfs)	Flow (Total Out) (cfs)	Headloss Coefficient (Standard)
PR. MOD. CONTROL STRUCTURE TYPE C	6,195.65	6,188.98	78.40	78.40	0.050

UDON South

Active Scenario: 100-yr (42" Outfall)

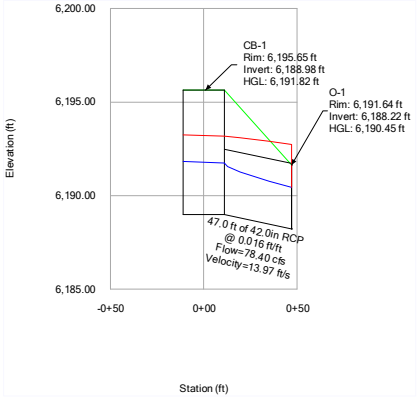
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
PR. 42" RCP	PR. MOD. CONTROL STRUCTURE TYPE C	PR. 42" FES	6,188.98	6,188.22	47.0	0.016	42.0	78.40	13.97	6,191.75	6,190.45

UDON South
Active Scenario: 100-yr (42" Outfall)
FlexTable: Outfall Table

Label	Elevation (Invert) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
PR. 42" FES	6,188.22	6,190.45	78.40

UDON South
Active Scenario: 100-yr (42" Outfall)
Profile Report
Engineering Profile - Outfall Pipe - 100YR (UDON South - StormCAD.stsw)



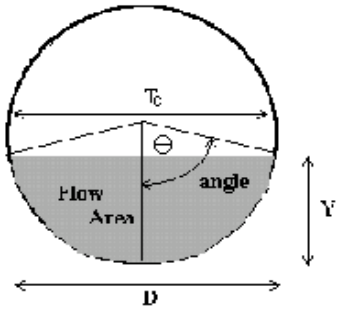
Culverts

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: UDON South

Pipe ID: Ex. Off-Site North Culvert (24" CMP)



Design Information (Input)			
Pipe Invert Slope	So =	0.0195	ft/ft
Pipe Manning's n-value	n =	0.0220	*
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	18.00	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	18.72	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.18	radians
Flow area	An =	2.65	sq ft
Top width	Tn =	1.64	ft
Wetted perimeter	Pn =	4.37	ft
Flow depth	Yn =	1.57	ft
Flow velocity	Vn =	6.79	fps
Discharge	Qn =	18.00	cfs
Percent of Full Flow	Flow =	96.2%	of full flow
Normal Depth Froude Number	Fr_n =	0.94	subcritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.13	radians
Critical flow area	Ac =	2.58	sq ft
Critical top width	Tc =	1.70	ft
Critical flow depth	Yc =	1.53	ft
Critical flow velocity	Vc =	6.99	fps
Critical Depth Froude Number	Fr_c =	1.00	

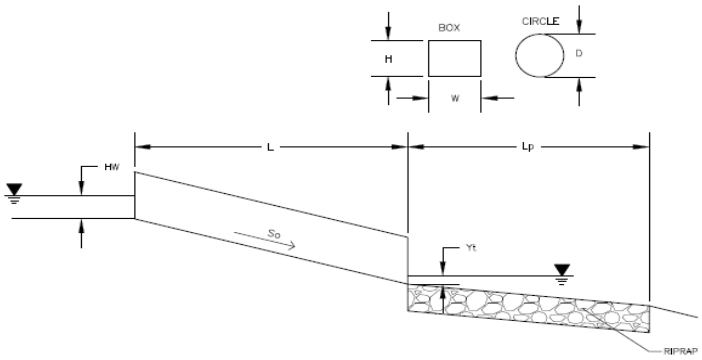
*** Unexpected value for Manning's n**

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **UDON South**

ID: **Ex. Off-Site North Culvert (24" CMP)**



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

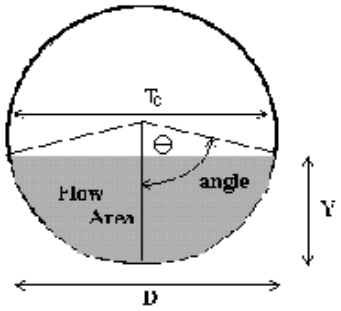
Design Information:				
	Design Discharge	Q =	18	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (Choose from pull-down list)		Beveled Edge (1:1)	
OR:				
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	H (Rise) =		ft
	Barrel Width (Span) in Feet	W (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	# Barrels =	1	
	Inlet Elevation	Elev IN =	6233.92	ft
	Outlet Elevation **OR** Slope	So =	0.0195	ft/ft
	Culvert Length	L =	71	ft
	Manning's Roughness	n =	0.022	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
	Max Allowable Channel Velocity	V =	7	ft/s
Calculated Results:				
	Culvert Cross Sectional Area Available	A =	3.14	ft^2
	Culvert Normal Depth	Y_n =	1.57	ft
	Culvert Critical Depth	Y_c =	1.53	ft
	Froude Number	Fr =	0.94	
	Entrance Loss Coefficient	k_e =	0.20	
	Friction Loss Coefficient	k_f =	2.51	
	Sum of All Loss Coefficients	k_s =	3.71	ft
Headwater:				
	Inlet Control Headwater	HW_I =	2.49	ft
	Outlet Control Headwater	HW_O =	2.27	ft
	Design Headwater Elevation	**HW =**	**6236.41**	**ft**
	Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.24**	
Outlet Protection:				
	Flow/(Diameter^2.5)	Q/D^2.5 =	3.18	$ft^{0.5}/s$
	Tailwater Surface Height	Y_t =	0.80	ft
	Tailwater/Diameter	Yt/D =	0.40	
	Expansion Factor	1/(2*tan(Θ)) =	4.22	
	Flow Area at Max Channel Velocity	A_t =	2.57	ft^2
	Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
	Length of Riprap Protection	**L_p =**	**6**	**ft**
	Width of Riprap Protection at Downstream End	**T =**	**4**	**ft**
	Adjusted Diameter for Supercritical Flow	Da =	-	ft
	Minimum Theoretical Riprap Size	d_{50} min=	5	in
	Nominal Riprap Size	d_{50} nominal=	6	in
	MHFD Riprap Type	**Type =**	**VL**	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: UDON South

Pipe ID: Pr. South Double Culverts (36")



Design Information (Input)			
Pipe Invert Slope	So =	0.0243	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	36.00	inches
Design discharge	Q =	100.00	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	7.07	sq ft
Full-flow wetted perimeter	Pf =	9.42	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	104.25	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.18	radians
Flow area	An =	5.95	sq ft
Top width	Tn =	2.46	ft
Wetted perimeter	Pn =	6.53	ft
Flow depth	Yn =	2.36	ft
Flow velocity	Vn =	16.79	fps
Discharge	Qn =	100.00	cfs
Percent of Full Flow	Flow =	95.9%	of full flow
Normal Depth Froude Number	Fr_n =	1.90	supercritical

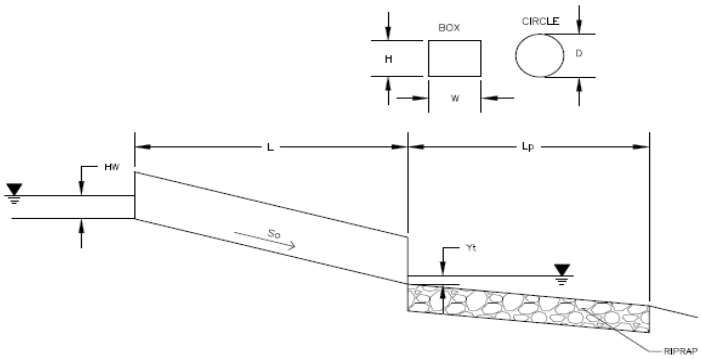
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.77	radians
Critical flow area	Ac =	6.99	sq ft
Critical top width	Tc =	1.10	ft
Critical flow depth	Yc =	2.90	ft
Critical flow velocity	Vc =	14.30	fps
Critical Depth Froude Number	Fr_c =	1.00	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **UDON South**

ID: **Pr. South Double Culverts (36")**



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	100	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	36	inches
Inlet Edge Type (Choose from pull-down list)		Beveled Edge (1:1)	
OR:			
Box Culvert:		**OR**	
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 =	2	
Inlet Elevation	Elev IN =	6200.77	ft
Outlet Elevation **OR** Slope	So =	0.0243	ft/ft
Culvert Length	L =	60	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	7	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	7.07	ft^2
Culvert Normal Depth	Y_n =	1.46	ft
Culvert Critical Depth	Y_c =	2.30	ft
Froude Number	Fr =	2.41	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.43	
Sum of All Loss Coefficients	k_s =	1.63	ft
Headwater:			
Inlet Control Headwater	HW_I =	3.75	ft
Outlet Control Headwater	HW_O =	2.46	ft
Design Headwater Elevation	**HW =**	**6204.52**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.25**	
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	3.21	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	1.20	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	4.20	
Flow Area at Max Channel Velocity	A_t =	14.29	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	6.00	ft
Length of Riprap Protection	**L_p =**	**25**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**12**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	2.23	ft
Minimum Theoretical Riprap Size	d_{50} min=	9	in
Nominal Riprap Size	d_{50} nominal=	9	in
MHFD Riprap Type	**Type =**	**L**	

Rock Chute

Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Pond Rock Chute **County:** El Paso County
Designer: KRK **Checked by:**
Date: May 22, 2024 **Date:**

Input Geometry:

Upstream Channel	Chute		Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.		Bw = 6.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 (F_s)	1.2 Min	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) →	2.0:1 max.	Velocity n-value = 0.035
Bed slope = 0.0050 ft./ft.	Bed slope (4:1) = 0.250 ft./ft →	3.0:1 max.	Bed slope = 0.0086 ft./ft.
Note: n value = a) velocity n from waterway program	Freeboard = 0.5 ft. →		
or b) computed mannings n for channel	Outlet apron depth, d = 1.5 ft.		Base flow = 0.0 cfs

Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

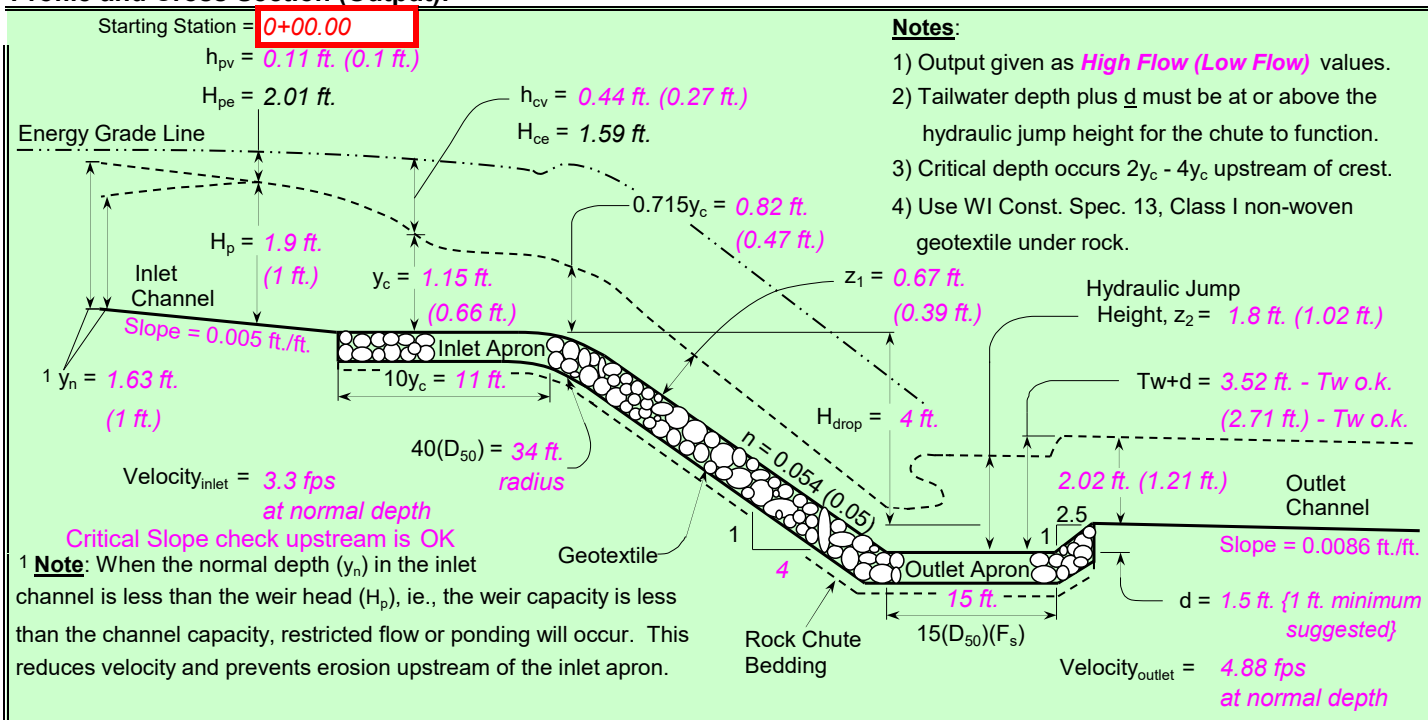
Apron elev. --- Inlet = 198.0 ft. ------- Outlet 192.5 ft. --- (H_{drop} = 4 ft.)

Q_{high} = Runoff from design storm capacity from Table 2, FOTG Standard 410
Q_5 = Runofff from a 5-year,24-hour storm.

Q_{high} = 89.0 cfs High flow storm through chute → Tw (ft.) = Program
Q_5 = 35.0 cfs Low flow storm through chute → Tw (ft.) = Program

***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*
***Input tailwater (Tw)**:* 0.25 1.20

Profile and Cross Section (Output):

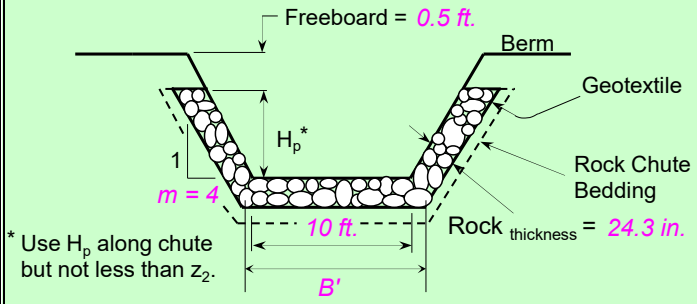


Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.
4) Use WI Const. Spec. 13, Class I non-woven geotextile under rock.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than z_2.

	6.99 cfs/ft.	Equivalent unit discharge
F_S =	1.20	Factor of safety (multiplier)
z_1 =	0.67 ft.	Normal depth in chute
n-value =	0.054	Manning's roughness coefficient
$D_{50}(F_s)$ =	12.2 in.	Minimum Design D50*
$2(D_{50})(F_s)$ =	24.3 in.	Rock chute thickness
Tw + d =	3.52 ft.	Tailwater above outlet apron
z_2 =	1.8 ft.	Hydraulic jump height
*** ***The outlet***	***will***	***function adequately***

High Flow Storm Information

Kimley»Horn

Rock Chute Forebay

Contributing Sub-Basins:

Date	6/5/2024	
Prepared By	DPM	
Checked By	KRK	

	Required	Forebay A Flow: Q_{100} = (cfs)	Forebay A Release Rate
Forebay Release and Configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	185.00	3.70

			Required (CF)	Provided (CF)
Minimum Forebay Volume Required	2% of the WQCV	40hr drain time, a = 1 I = 0.364 A = 52.69 AC	626.62	675.00

	Required	Provided
Maximum Forebay Depth	18" Max	18"

Forebay Notch Calculations			
$Q = C_o A_o (2gH_o)^{0.5}$			
Q_a	3.70	cfs	2% of Peak 100 YR Discharge for contributing Sub-Basins
C_o	0.6		
H_o	1.5	ft	
g	32.2	ft/s^2	
A_a	0.63	ft^2	
L_a	0.42	ft	
	5.02	**in**	3" Minimum per Criteria

$$WQCV = a(0.91I^3 - 1.19I^2 + 0.78I)$$ Equation 3-1

Where:

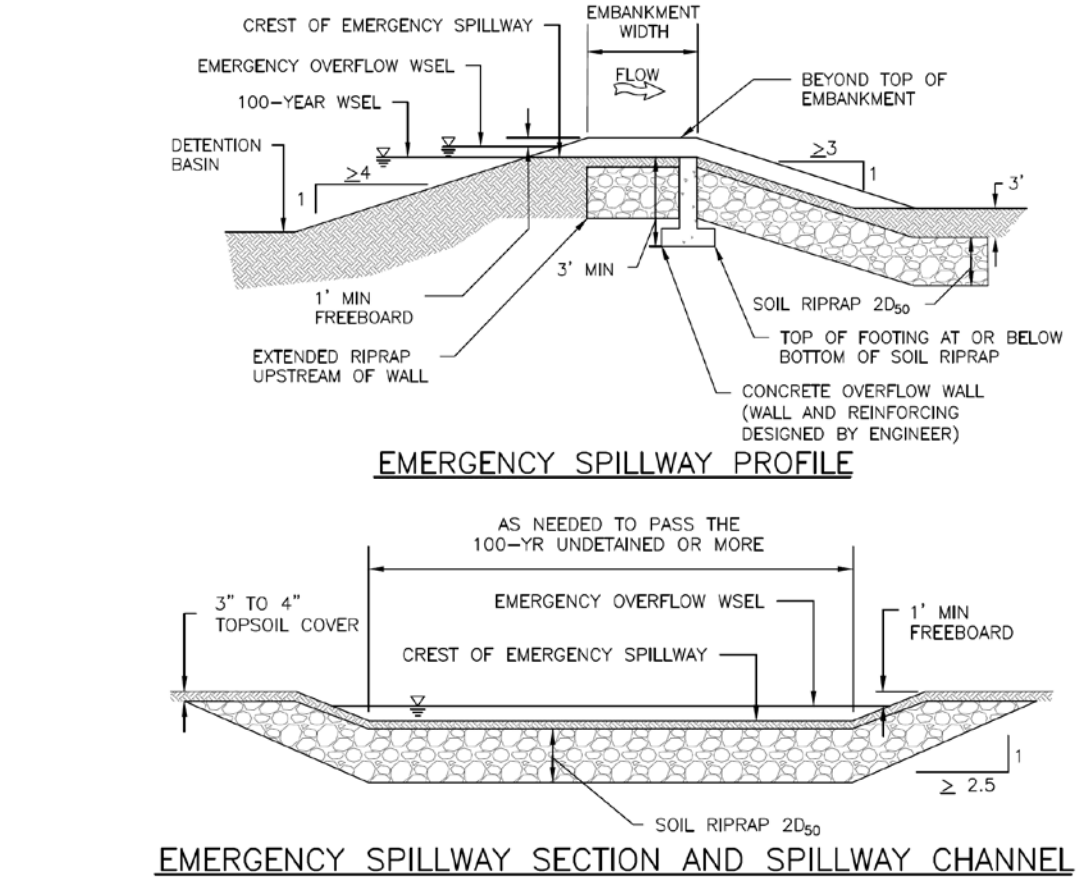
WQCV = Water Quality Capture Volume (watershed inches)

a = Coefficient corresponding to WQCV drain time (Table 3-2)

I = Imperviousness (%/100) (see Figures 3-3 through 3-5 [single family land use] and /or the *Runoff* chapter of Volume 1[other typical land uses])

Table 3-2. Drain Time Coefficients for WQCV Calculations

Drain Time (hrs)	Coefficient, a
12 hours	0.8
24 hours	0.9
40 hours	1.0



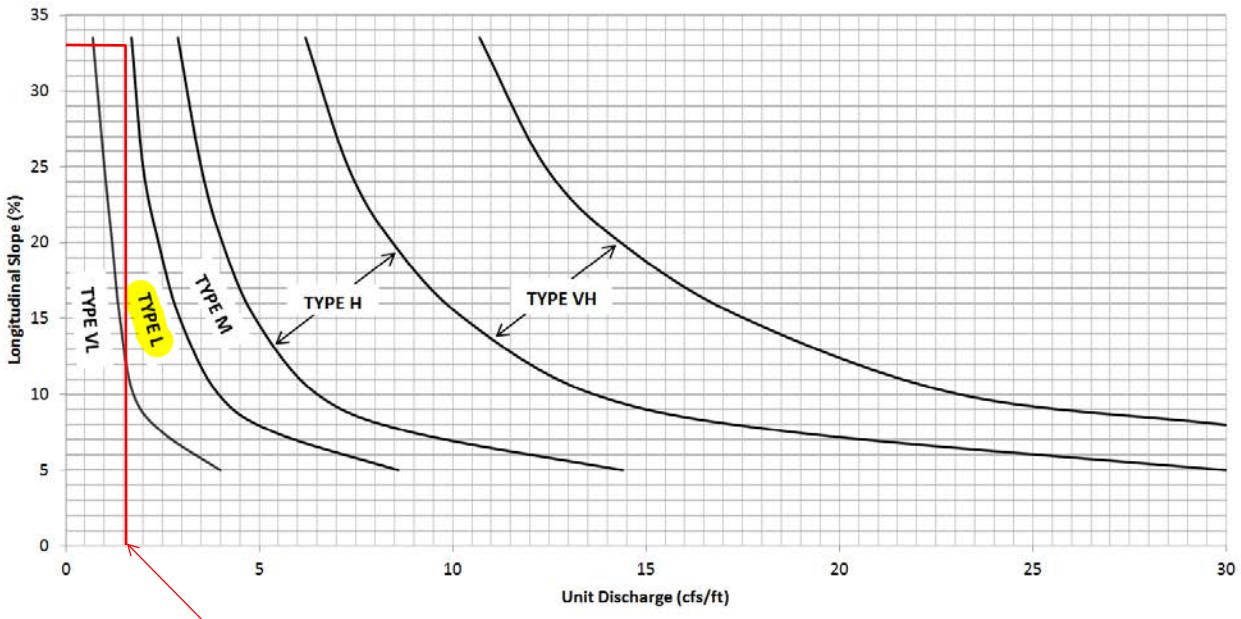


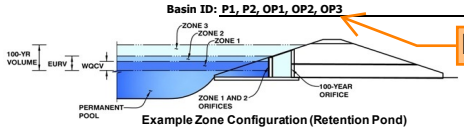
Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: UDON South

Basin ID: P1, P2, OP1, OP2, OP3



Example Zone Configuration (Retention Pond)

Provide pond name.

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	50.73	acres
Watershed Length =	2,008	ft
Watershed Length to Centroid =	1,091	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	36.40%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.719 acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.703 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	2.173 acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	3.343 acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	4.369 acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	5.618 acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	6.701 acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	8.072 acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	10.803 acre-feet		inches
Approximate 2-yr Detention Volume =	1.478 acre-feet		
Approximate 5-yr Detention Volume =	2.359 acre-feet		
Approximate 10-yr Detention Volume =	2.708 acre-feet		
Approximate 25-yr Detention Volume =	2.998 acre-feet		
Approximate 50-yr Detention Volume =	3.126 acre-feet		
Approximate 100-yr Detention Volume =	3.727 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.719	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.984	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.024	acre-feet
Total Detention Basin Volume =	3.727	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio (R_{LW}) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

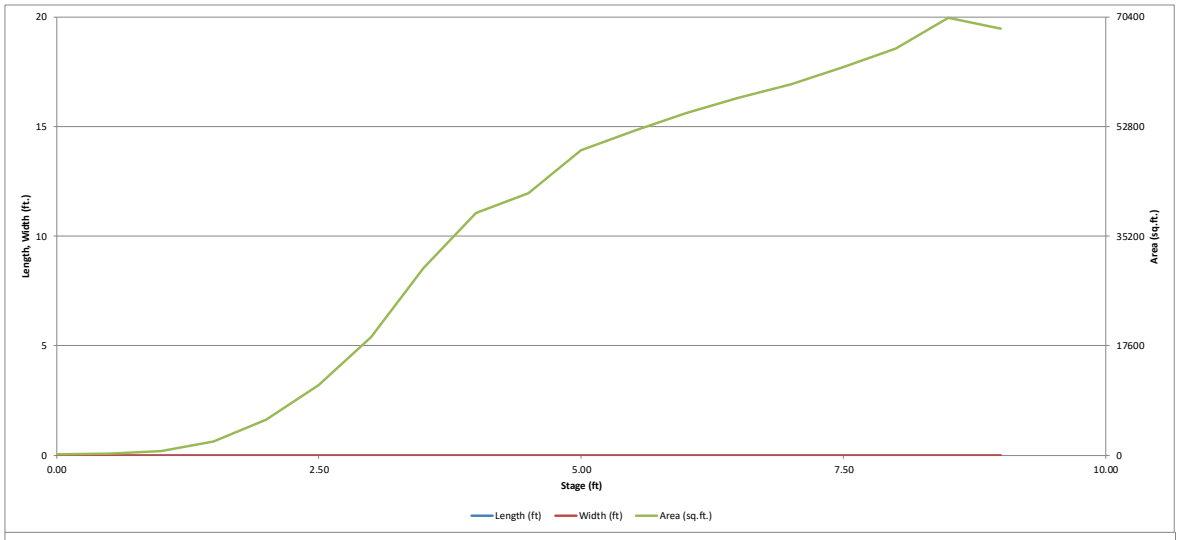
Depth Increment = 0.50 ft

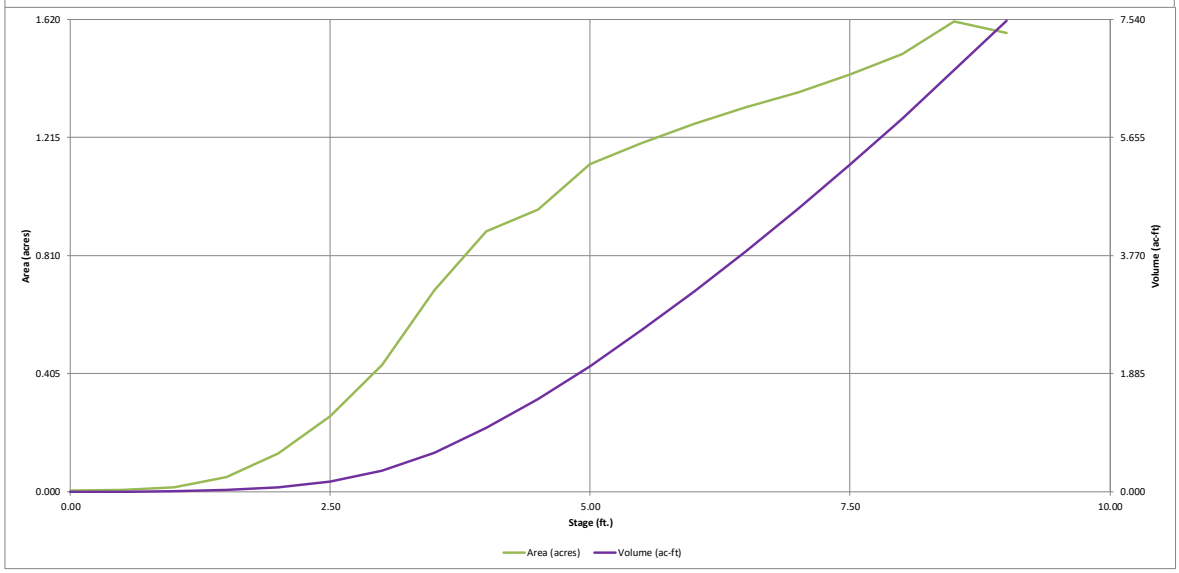
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
6189.5 **Top of Micropool**	--	0.00	--	--	--	202	0.005		
6190	--	0.50	--	--	--	232	0.005	108	0.002
6190.5	--	1.00	--	--	--	689	0.016	339	0.008
6191	--	1.50	--	--	--	2,186	0.050	1,057	0.024
6191.5	--	2.00	--	--	--	5,684	0.130	3,025	0.069
6192	--	2.50	--	--	--	11,248	0.258	7,258	0.167
6192.5	--	3.00	--	--	--	18,948	0.435	14,807	0.340
6193	--	3.50	--	--	--	30,068	0.690	27,061	0.621
6193.5	--	4.00	--	--	--	38,938	0.894	44,312	1.017
6194	--	4.50	--	--	--	42,123	0.967	64,578	1.482
6194.5	--	5.00	--	--	--	48,947	1.124	87,345	2.005
6195	--	5.50	--	--	--	52,100	1.196	112,607	2.585
6195.5	--	6.00	--	--	--	54,945	1.261	139,368	3.199
6196	--	6.50	--	--	--	57,443	1.319	167,465	3.844
6196.5	--	7.00	--	--	--	59,599	1.368	196,726	4.516
6197	--	7.50	--	--	--	62,366	1.432	227,217	5.216
6197.5	--	8.00	--	--	--	65,389	1.501	259,156	5.949
6198	--	8.50	--	--	--	70,316	1.614	293,082	6.728
6198.5	--	9.00	--	--	--	68,543	1.574	327,797	7.525

Please also provide design for 65% impervious as discussed pg #10

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)





✓ = calcs match details in plans

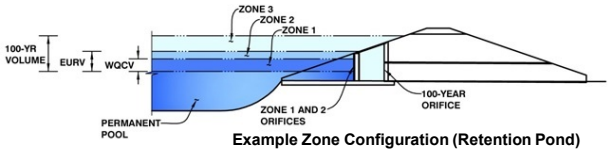
X = calcs do not match details in plans

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: UDON South

Basin ID: P1, P2, OP1, OP2, OP3



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.64	0.719	Orifice Plate
Zone 2 (EURV)	4.73	0.984	Orifice Plate
Zone 3 (100-year)	6.42	2.024	Weir&Pipe (Restrict)
Total (all zones)		3.727	

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 =	N/A	ft²
Depth at top of Zone using Orifice Plate =	4.79 X	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	11.80 ✓	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft²

4.9'

0.98', 1.96'

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	1.60 X	3.19 X					
Orifice Area (sq. inches)	2.39 ✓	2.39 ✓	2.80 ✓					

	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 =	4.85 ✓	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.45	N/A	feet
Overflow Weir Front Edge Length =	22.00 ✓	N/A	feet	Overflow Weir Slope Length =	6.03	N/A	feet
Overflow Weir Grate Slope =	10.00 ✓	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	13.55	N/A	
Horiz. Length of Weir Sides =	6.00 ✓	N/A	feet	Overflow Grate Open Area w/o Debris =	92.33	N/A	ft²
Overflow Grate Type =	Type C Grate ✓	N/A		Overflow Grate Open Area w/ Debris =	46.17	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 =	0.52 ✓	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	6.81	N/A	ft²
Outlet Pipe Diameter =	42.00 ✓	N/A	inches	Outlet Orifice Centroid =	1.31	N/A	feet
Restrictor Plate Height Above Pipe Invert =	28.00 ✓		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.75 ✓	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.91	feet
Spillway Crest Length =	50.00 ✓	feet	Stage at Top of Freeboard =	8.66	feet
Spillway End Slopes =	4.00 ✓	H:V	Basin Area at Top of Freeboard =	1.60	acres
Freeboard above Max Water Surface =	1.00 ✓	feet	Basin Volume at Top of Freeboard =	6.99	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

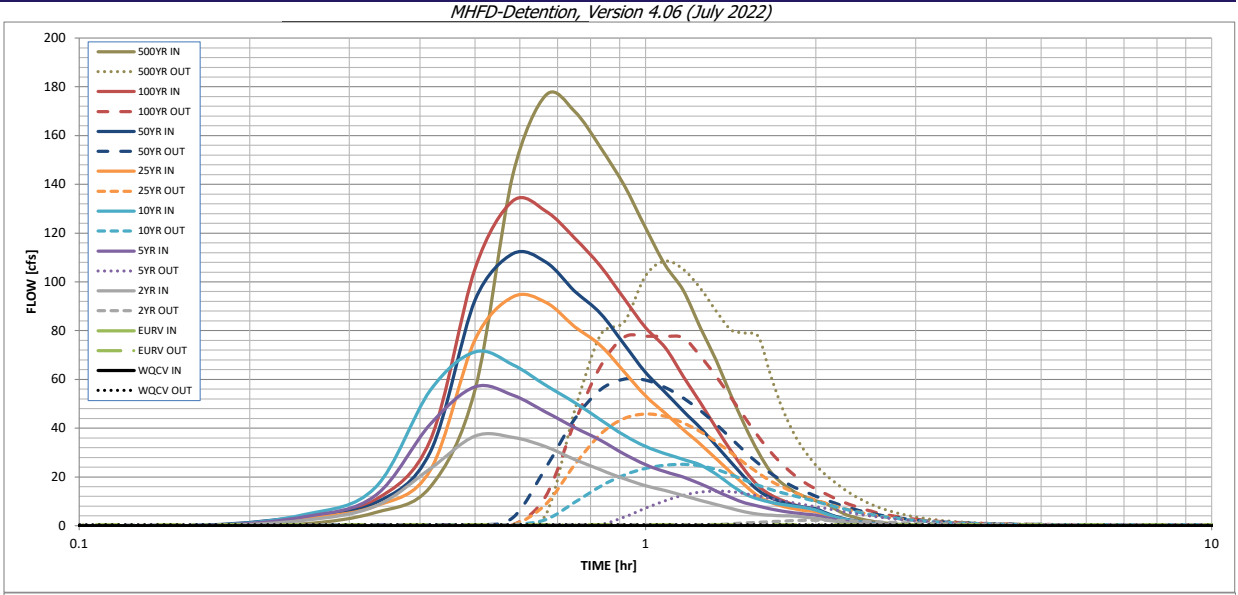
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

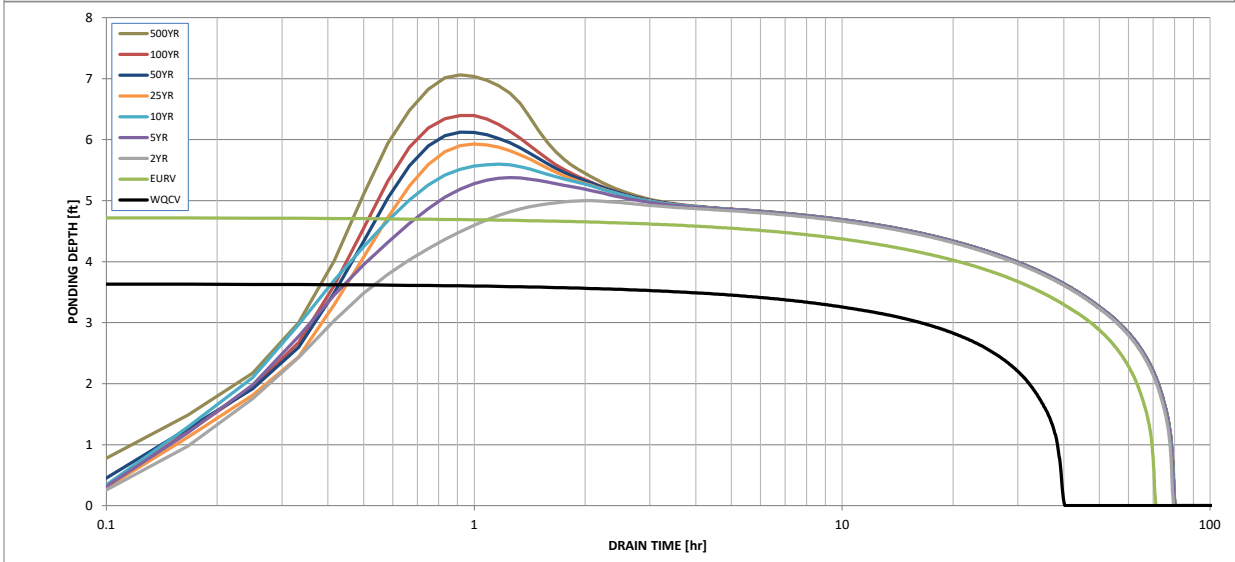
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.719	1.703	2.173	3.343	4.369	5.618	6.701	8.072	10.803
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.173	3.343	4.369	5.618	6.701	8.072	10.803
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	12.9	26.8	36.9	56.5	69.7	85.5	117.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.25	0.53	0.73	1.11	1.37	1.69	2.32
Peak Inflow Q (cfs) =	N/A	N/A	36.8	56.9	71.3	93.9	111.5	133.2	176.6
Peak Outflow Q (cfs) =	0.3	0.4	2.3	14.2	25.1	45.8	60.1	77.7	108.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.7	0.8	0.9	0.9	0.9
Structure Controlling Flow =	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.02	0.1	0.3	0.5	0.6	0.8	0.9
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) =	37	65	72	70	68	66	64	62	57
Time to Drain 99% of Inflow Volume (hours) =	39	68	76	75	74	73	73	72	70
Maximum Ponding Depth (ft) =	3.64	4.73	5.00	5.37	5.59	5.92	6.12	6.39	7.06
Area at Maximum Ponding Depth (acres) =	0.75	1.04	1.12	1.18	1.21	1.25	1.28	1.31	1.37
Maximum Volume Stored (acre-ft) =	0.722	1.713	1.994	2.431	2.693	3.099	3.352	3.700	4.585

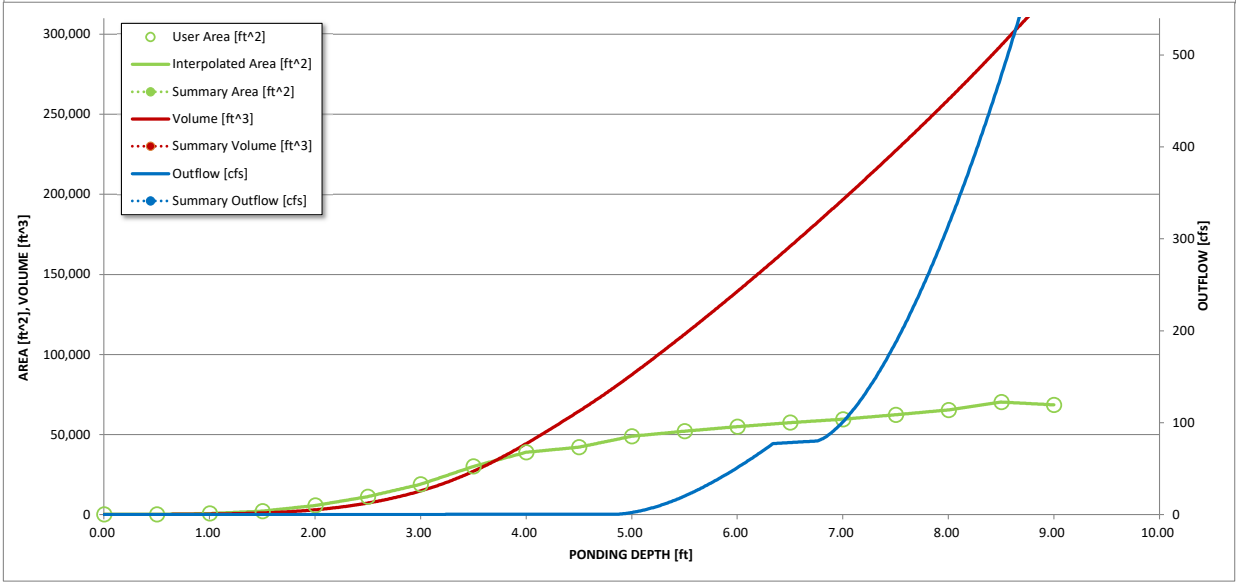
Adjust design to meet the 40-hr requirement, fixing the orifice numbers may help

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 OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.03	0.82
	0:15:00	0.00	0.00	2.22	3.65	4.53	3.05	3.83	3.73	5.42
	0:20:00	0.00	0.00	8.03	12.28	15.61	7.95	9.28	10.61	15.81
	0:25:00	0.00	0.00	23.35	41.64	55.46	22.70	30.12	34.99	55.75
	0:30:00	0.00	0.00	36.80	56.92	71.27	76.28	92.47	105.39	143.77
	0:35:00	0.00	0.00	36.24	53.54	66.01	93.86	111.53	133.18	176.57
	0:40:00	0.00	0.00	32.35	46.64	57.54	91.66	108.14	129.03	169.89
	0:45:00	0.00	0.00	27.20	40.23	50.50	81.65	96.23	117.95	155.06
	0:50:00	0.00	0.00	22.89	35.05	43.45	73.90	87.05	106.37	139.69
	0:55:00	0.00	0.00	19.30	29.42	37.07	63.17	74.44	93.15	122.24
	1:00:00	0.00	0.00	16.43	25.00	32.49	53.22	62.87	81.29	106.91
	1:05:00	0.00	0.00	14.46	22.11	29.57	46.15	54.76	73.03	96.41
	1:10:00	0.00	0.00	12.34	19.87	27.19	39.34	46.94	61.14	81.24
	1:15:00	0.00	0.00	10.42	17.14	24.90	33.51	40.20	50.55	67.65
	1:20:00	0.00	0.00	8.67	14.22	21.08	27.35	32.74	39.98	53.40
	1:25:00	0.00	0.00	7.06	11.56	16.68	21.83	26.00	30.68	40.80
	1:30:00	0.00	0.00	5.63	9.31	12.99	16.46	19.56	22.59	30.01
	1:35:00	0.00	0.00	4.69	8.06	10.89	12.02	14.40	16.25	21.89
	1:40:00	0.00	0.00	4.26	6.86	9.60	9.51	11.45	12.53	17.05
	1:45:00	0.00	0.00	4.05	5.92	8.67	7.92	9.56	10.17	13.91
	1:50:00	0.00	0.00	3.93	5.26	8.02	6.89	8.33	8.54	11.74
	1:55:00	0.00	0.00	3.46	4.76	7.36	6.17	7.46	7.38	10.19
	2:00:00	0.00	0.00	3.04	4.29	6.40	5.70	6.89	6.56	9.07
	2:05:00	0.00	0.00	2.35	3.30	4.87	4.35	5.24	4.84	6.70
	2:10:00	0.00	0.00	1.77	2.44	3.57	3.17	3.81	3.44	4.77
	2:15:00	0.00	0.00	1.33	1.81	2.61	2.33	2.79	2.54	3.49
	2:20:00	0.00	0.00	1.00	1.34	1.89	1.72	2.05	1.88	2.58
	2:25:00	0.00	0.00	0.74	0.96	1.37	1.25	1.49	1.38	1.89
	2:30:00	0.00	0.00	0.54	0.68	0.99	0.90	1.07	1.00	1.37
	2:35:00	0.00	0.00	0.38	0.47	0.71	0.65	0.78	0.72	0.99
	2:40:00	0.00	0.00	0.26	0.32	0.49	0.46	0.55	0.51	0.70
	2:45:00	0.00	0.00	0.16	0.21	0.31	0.30	0.36	0.34	0.45
	2:50:00	0.00	0.00	0.09	0.12	0.17	0.18	0.21	0.20	0.26
	2:55:00	0.00	0.00	0.04	0.06	0.08	0.09	0.10	0.09	0.12
	3:00:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.04
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).