Final Drainage Report
Terra Ridge North
Colorado Springs, Colorado 80908

Prepared for:
El Paso County, CO

On Behalf of:
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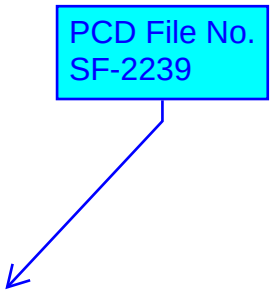


September 10, 2022
PCD File #XXXXX:

ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the 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: _____ Date: _____

Phillip Shay Miles, PE
Registered Professional Engineer State of Colorado No.40462

DEVELOPER'S STATEMENT:

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

Name of Owner/Developer: Phillip S. Miles

Authorized Signature: _____Date: _____

Title: Owner

Address: 15630 Fox Creek Lane, Colorado Springs, CO 80908

EL PASO COUNTY:

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

_____ _____

County Engineer / ECM Administrator Date

Conditions:

Table of Contents

Appendix A - Maps

- NRCS Soils Map and Hydrologic Group Data
- FEMA Flood Insurance Rate Map

Appendix B – Calculations

Hydrologic

- Composite Runoff Coefficients
- Percentage of Imperviousness
- Basin Runoff Summary (Rational Methodology)
- Surface Routing Summary

Hydraulic

- Ditches/Creek
- Culverts
- Outlet Erosion Protection

Detention Pond

- Forebay
- Stage-Storage
- Outlet Structure Design
- Spillway Riprap

Appendix C – Plan (located in plan pocket)

- Existing Drainage Plan
- Proposed Drainage Plan

Move Appendix A after report contents per table of contents.

Appendix A
Maps

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for El Paso County Area, Colorado

fox creek subdivision

October 13, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:5,510 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

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

MAP LEGEND

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

Soils
- Soil 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 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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
14	Brussett loam, 1 to 3 percent slopes	1.2	1.0%
68	Peyton-Pring complex, 3 to 8 percent slopes	123.2	94.7%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	5.7	4.4%
Totals for Area of Interest		**130.1**	**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

14—Brussett loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367j
Elevation: 7,200 to 7,500 feet
Frost-free period: 115 to 125 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Brussett and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brussett

Setting

Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits

Typical profile

A - 0 to 8 inches: loam
BA - 8 to 12 inches: loam
Bt - 12 to 26 inches: clay loam
Bk - 26 to 60 inches: silt loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
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 in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

68—Peyton-Pring complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369f
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
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
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b9
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Hills, alluvial fans
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

National Flood Hazard Layer FIRMette

FEMA

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 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 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 10/28/2019 at 7:40:48 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Move Appendix B after report contents per table of contents.

Appendix B
Calculations

1. Purpose

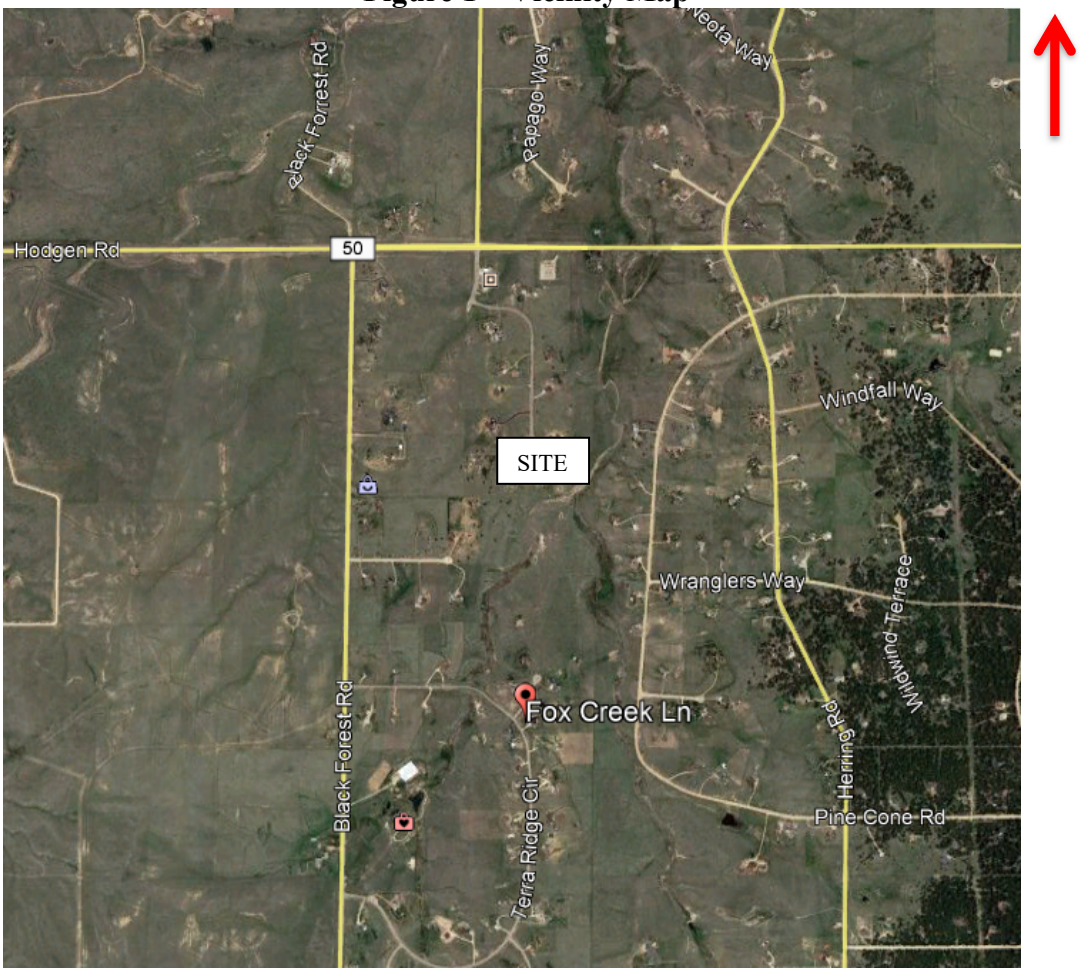
The purpose of this Final Drainage Report for Terra Ridge North is to quantify and evaluate the impacts of stormwater runoff generated by this Project and to provide adequate water quality/detention treatment.

2. General Description

The Terra Ridge North property (Project) is a 39.72-acre single-family development consisting of 11 lots and a public street (Fox Creek Lane) located within Black Forest, Colorado in El Paso County. The project will consist of a public street, detention pond, and new home construction and associated site elements typical of single-family residential development (e.g. – driveways, patios, landscaping, etc.). The property is bounded by Ridgeview Acres to the north, Whispering Hills Estates to the west Wildwood Village to the east, and Terra Ridge Estates to the south. All lots surrounding the subject property are all zoned RR-5. The entire 39.72-acre parcel lies within unincorporated El Paso County and is currently zoned RR-2.5.

This project is located in the Town of Black Forest, El Paso County, Colorado. Access to the site is from Fox Creek Lane. It is located in Section 29, Township 11 south, Range 65 west of the 6th principal meridian. A vicinity map is provided below in Figure 1.

Figure 1 – Vicinity Map



The existing site is covered with native grasses with a few randomly located ponderosa pines. The topography of the site is rolling hills with two drainage ways extending from south to north through the property. A 100-foot-wide electric easement extends north to south along the eastern portion of the site.

3. Soils Conditions

The proposed development is 39.72 acres. Ground cover primarily consists of existing vegetation primarily consisting of native grass and shrubs.

The general topography of the land slopes to the south at slopes in the range of 2% to 30%. According to the Natural Resources Conservation Service (NRCS), the soils in this area consist of Peyton-Pring Complex and Tomah-Crowfoot loamy sands, and can be classified as a Hydrologic Soil Group (HSG) Types B. A soil map and map unit (soils type) descriptions describing the HSG and other soils properties are provided in Appendix A. For the purposes of this report an HSG type B soil has been used to define rational method runoff coefficients.

Generally speaking, stormwater runoff from this project flows to the north and will initially enter an unnamed drainageway which ultimately discharges into East Cherry Creek.

4. Drainage Criteria

The hydrologic and hydraulic analysis performed in this report utilizes The City of Colorado Springs and El Paso County Drainage Criteria Manual (Vol 1, 1991) (Vol 2, 2002), The City of Colorado Springs (Chpt. 6, 2014, and the MHFD USDCM (Urban Storm Drainage Criteria Manual) Volumes 1 & 2. Stormwater runoff was determined using the Rational Method and was calculated for existing and proposed conditions for the 5-yr (minor) and 100-yr (major) recurrences. 1-hour rainfall depths were derived from NOAA Atlas 14, Volume 8, Version 2 specific to the Project location.

The following MHFD hydrologic and hydraulic software were used in this report:

- UD-Culvert v3.05 –Culvert and Erosion Protection Calculations
- MHFD-Detention v4.03 – Water Quality and Detention Calculations

5. Existing and Proposed Drainage Conditions

5.1 Drainage Patterns and Hydraulic Routing

Existing

Stormwater runoff from this Project generally flows to the north and will initially enter an unnamed tributary ultimately discharging to East Cherry Creek. The imperviousness value of undeveloped land is ~2% in accordance with DCM Table 6-6.

Design Point EX flows are generated from a naturally vegetated field in combination with the developed flows from the existing Terra Ridge subdivision. The Q_{100} flow is 433.2cfs.

Proposed

Proposed roadway construction and associated grading will create five (5) on-site basins and two (2) off-site basins. Refer to the drainage plan in Appendix C.

Design Point 1 flows are generated from basin B. Basin B consists of public roadway improvements to include pavement, and roadside ditches. Unconcentrated sheet flow across the pavement is collected in the adjacent ditch and is routed north to the proposed 18" storm culvert. At this location, runoff will be conveyed under the proposed roadway to the ditch on the east side. Runoff is then conveyed under the proposed maintenance access road via a 24" storm culvert with flow ultimately discharging into the proposed water quality/detention pond facility.

Design Point 2 flows are generated from basins A and B. Basin A consists of public roadway improvements to include pavement, and roadside ditches. Unconcentrated sheet flow across the pavement is collected in the adjacent ditch and combines with basin B runoff and is routed north to design point 2. At this location, runoff will be conveyed in a riprap rundown channel to the forebay of the proposed water quality/detention pond facility. Riprap will be provided with a d50 of 9" and a thickness of 18" to prevent erosion prior to entering the concrete forebay. The proposed forebay will be ~80cf in volume. Flows into a 1.5' wide concrete trickle channel will be conveyed to the outlet structure micropool. Refer to the forebay and detention pond calculations located in Appendix B. The emergency overflow route is over a 4' wide proposed spillway which has been designed to pass the peak flow from the 100yr flow event.

Design Point 3: The JR report shows flows entering the project site with a value of 366cfs (JR DP5). To route this flow to Fox Creek Design Point 3, this flow value (366cfs) and the time of concentration (Tc) for Design Point 5 from the JR report (0.765hrs = 45.9minutes) was held and a corresponding CA equivalent (rational method input) was calculated for routing to Design Point 4. The Tc for the JR flow (45.9) was added to the additional Tc (9.2 minutes) to route thru the site to Design Point 4, yielding a higher Tc (55.1) for Design Point 4 and was used to determine the peak flow (431.8). As a rough check, using the JR Design Point 5 report data and the 371 tributary acres with a resultant flow of 366cfs yields ~1.01cfs/acre. Our addition of off-site basin OS1 and onsite basin D (total 45acres) yielded a peak flow at Design Point 4 of 431.8cfs. Therefore, our project site had flows of ~0.96cfs/acre which is close to the 1.01cfs/acre value determined by JR.

Design Point 4 flows are generated from off-site basins OS1 and OS2, Design Point 3 as well as on-site basin D. Basin OS1 and OS2 consist of large lot single family subdivision development improvements with homes, driveways, sheds, and various outbuildings. Runoff flows down the side slope and directly into the adjacent drainageway. Basin D consists of a naturally vegetated field which will have some minor impervious area additions from the proposed home sites. Runoff from basin D is routed directly into the drainageway and then to the north to design point 4. To enable the flows at this location to pass under the proposed driveway, three 48" culverts are proposed. Energy dissipation will be provided at the outfall to minimize the potential for erosion/local scour.

Basin E flows are generated from a naturally vegetated field and a short segment of driveway pavement. This basin runoff is not being treated in the proposed water quality/detention pond because of the topographical constraints on site. Basin E flows are routed in the existing drainageway to the northeast combining with another drainageway to the east near the northeastern lot corner.

Basin F flows are generated from a naturally vegetated field which will have home site construction. Basin E flows are routed in an existing drainageway on the east side of the property which combines with the aforementioned drainageway within basin E near the northeastern lot corner.

Basic C is not used.

Basins D, E & F are excluded from permanent water quality per ECM Appendix I Section I.7.1.B.5 since these contain large lot single family sites (greater than 2.5 ac) and will expected soil and vegetation conditions which are suitable for infiltration/filtration.

Design Point 5 is the ultimate outflow outfall located at the northeast corner of the subdivision and is a combination of flows from DP4, basin E, and the pond outfall. The Q_{100} flow is 445.6cfs.

The developed 100-year flow at design point 5 is 12.4cfs higher than the historic 100-year flow at the same location (445.6 and 433.2 respectively). This yields only a 2.9% increase in flows from the proposed subdivision which is negligible and will not negatively impact downstream properties.

5.2 Site Improvements

Utilities that exist within the project area are overhead electric lines running north to south across the east half of the project. There are no other known public utilities in the area. The existing electric lines are contained within an e

provide a summary and recommendation based on the calculations. Sections of the ditch exceed the permissible velocity for native grass(4 fps) and will require a different treatment.

5.3 Hydraulic Calculations

Culverts

The calculations for the 18" culvert and 24" culvert which routes ditch flows from basin B to basin A under the proposed driveway and under the proposed maintenance access road were performed using 2022 Civil3D design software and are contained in Appendix B. The double 48" storm culverts routing the drainageway under the proposed driveway are also contained in Appendix B.

Ditch Capacities

The hydraulic analysis for the Fox Creek Lane roadway ditches was performed using 2022 Civil3D design software and are contained in Appendix B.

5.4 On-site Detention Requirements

A full spectrum water quality/detention pond is proposed for this site to provide water quality for developed flows as a result of this development. In addition to water quality, detention is

The drainage map states three culverts are proposed to be under driveway. Revise report to remove inconsistencies.

provided in the pond design. Refer to section 7 in this report for additional information regarding water quality capture volume (WQCV) and detention (peak flow attenuation) flow requirements for this project.

The Terra Ridge North HOA will own and maintain the water quality/detention pond.

5.5 Compliance with Other Studies

The only studies related to this project are the Terra Ridge Filing No 1 and 2 reports (see references). The basins that are common to this project (Terra Ridge – basin 12 and 17) have only been modified slightly to account for the proposed roadway construction. Flows as determined in the Terra Ridge reports for the natural drainageway have been used and supplemented with the additional flows from the Terra Ridge North watershed to determine the on-site flow at the proposed driveway crossing.

5.6 Four Step Process

Step 1 – Runoff Reduction Practices

This development address Low Impact Development strategies primarily through the utilization of roadway ditches. Runoff from the pavement sheet flows across the grass lined ditch side slopes which provides some level of water quality treatment.

Step 2 – Stabilize Drainageways

Portions of the existing conditions runoff currently enter the on-site natural drainageway via overland flow across the vacant lots and via the proposed full-spectrum detention pond. Due to the minor anticipated extent of land disturbance and improvements on these large lots coupled with on-site detention; the amount of runoff entering the drainageways remains basically the same. Predevelopment levels of release of the Excess Urban Runoff Volume (EURV) help the drainageway maintain its current morphology by mimicking the natural historic runoff rates over a longer period by peak flow attenuation.

Step 3 –Implement BMPs that Provide a Water Quality Capture Volume with Slow Release

On-site flow is directed to the on-site private proposed full-spectrum detention/water quality facility. The extended detention basin provides Water Quality Capture Volume (WQCV) required for this site and attenuates the peak flows releasing them at approximate historic runoff rates over a longer period by releasing Excess Urban Runoff Volume (EURV).

Step 4 – Consider Need for Industrial and Commercial BMPs

No industrial and commercial development exist onsite.

6. Water Quality

Stormwater that is generated from this Project is either discharged offsite in the form of unconcentrated sheet flow or is collected in roadside ditches and routed thru the proposed water quality/detention facility outfalling via an 18” storm sewer pipe.

The proposed on-site imperviousness of the area contributing to the pond is 25.9%. Basin C is not used in this report.

The proposed full spectrum extended detention basin (EDB) has been analyzed in this study based on the proposed site conditions as shown on the Drainage Plan. The pond facility provides 0.060 acre-ft of water quality capture volume, 0.137acre-ft of excess urban runoff volume and 0.235 acre-ft of detention storage. The proposed EDB will release a peak flow 5.6cfs during the 100-year storm event. Outflows from the proposed EDB are released via a proposed 18" storm sewer pipe with a restrictor plate located within the outlet structure box. The outlet structure will have an orifice plate designed to drain the EURV over a period of 72 hours. The orifice plate will have 3 rows of holes. The lowest will be 15/16" in diameter, and the second and third rows will be 7/16" in diameter. The EDB will have a rip rap emergency overflow spillway that will drain the 100yr peak flows (7.8cfs) in the event the outlet structure becomes entirely clogged or the pond is already full. The spillway will be constructed of rip rap with a d50 = 9", 18" thick, a crest length of 4.0' with 3:1 side slopes. Flow depth over the crest of the spillway during the 100yr event storm will be 0.60' with 1.0' of freeboard. The outfall pipe will need to have a 3'x5' riprap pad (see appendix B calculations) downstream which necessitates the extension of spillway a distance of 5' to the north. A 10ft maintenance road has been provided extending from the private driveway to the bottom of the pond. The pond will be maintained using a skid loader. Refer to the design calculations in Appendix B for additional information.

7. Erosion Control Plan

Pre-development grading is requested with the preliminary plan application and a pre-development GEC and SWMP has been submitted separately as a stand-alone construction drawing. Refer to plans titled Terra Ridge North – Grading, Erosion and Stormwater Quality Control Plans, prepared by Lodestar Engineering, dated September 2022.

8. Floodplain Statement

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) numbers 08041C0305G and 08041C0315G dated December 7, 2018 this project is not located within a FEMA designated 100yr floodplain. Therefore, no map revisions will be necessary as a result of this project. A copy of the FIRM maps is provided in Appendix A.

9. Drainage and Bridge Fees

The drainage basin is located within the East Cherry Creek Drainage Basin.

The project is not located within a fee (drainage) basin and bridge fees are not required. Therefore, no drainage or bridge fees are required for this development.

10. Construction Cost Opinion

Item	Unit	Quantity	Unit Price	Extended Cost
18" Storm Pipe	LF	40	$65	$2,600
24" Storm Pipe	LF	20	$75	$1,500
48" Storm Pipe	LF	150	$120	$18,000
Outlet Structure	EA	1	$10,000	$10,000

Staff recommends removing the predevelopment request since you are no longer processing the preliminary plan application. An Early Grading Permit application is required to do any type of predevelopment grading if the plat is not approved. Revise report to remove information if application is not submitted.

Forebay	EA	1	$5,000	$5,000
Trickle Channel	LS	1	$2,500	$2,500
			Sub-total	$39,600
			Contingency 10%	$3,960
			TOTAL	$43,560

All storm system elements for this project are private and therefore there will be no reimbursement from El Paso County.

11. Summary

The Final Drainage Report for Terra Ridge North was prepared using the El Paso County Engineering Criteria Manual, City of Colorado Springs Drainage Criteria Manuals, and Mile High Flood Control District Manuals. Stormwater quality and detention is provided by a proposed facility located on-site. No adverse downstream impacts are anticipated as a result of the proposed site improvements.

12. References

1. Engineering Criteria Manual, El Paso County, December 2016
2. Drainage Criteria Manual, Volumes I and II, El Paso County and City of Colorado Springs, Vol 1, 1991 and Vol 2, 2002
3. Drainage Criteria Manual, Chapter 6, Volume 1 Update, October 2018
4. Urban Storm Drainage Criteria Manual (USDCM), Volumes I-III, Mile High Flood Control District (MHFD).
5. Preliminary drainage report for Terra Ridge Filing No. 1, JR Engineering, April 1997.
6. Preliminary drainage report for Terra Ridge Filing No. 2, JR Engineering, June 1999.
7. FEMA Flood Insurance Rate Map Numbers 08041C0305G and 08041C0305G, El Paso County, Colorado, December 7, 2018
8. Natural Resources Conservation Service, Web Soil Survey, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
9. United States Geological Survey (USGS) Topographic Quadrangle Map

Appendix B
Calculations

Remove duplicated calculations in this appendix.

Change titles to match rest of submittal documents.

FINAL DRAINAGE REPORT

JeniShay Farms

(Composite Runoff Coefficient - 5 Year)

ON-SITE							
Basin	**Area (acres)**						**C5**
	Paved/Drive/Walk	**Res 2.5ac**	**Gravel**	**Lawn/Meadow**	**Undev - Hist**	**TOTAL**	
A	0.43	2.69	0.12	0.96	0.00	4.20	0.18
B	0.40	0.00	0.06	0.49	0.00	0.94	0.46
C	Not Used						
D	0.19	14.38	0.02	0.00	0.00	14.59	0.09
E	0.17	6.18	0.02	0.00	0.00	6.36	0.10
F	0.00	14.15	0.00	0.00	0.00	14.15	0.08

OFF-SITE							
Basin	**Area (acres)**						**C5**
	Paved/Drive/Walks	**Res 5ac**	**Gravel**	**Lawn/Meadow**	**Undev - Hist**	**TOTAL**	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	0.05
OS2	0.00	6.36	0.00	0.00	0.00	6.36	0.05

EXISTING							
Basin	**Area (acres)**						**C5**
	Paved/Drive/Walks	**Res 5ac**	**Gravel**	**Lawn/Meadow**	**Undev - Hist**	**TOTAL**	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	0.09
EX2	0.00	0.00	0.00	0.00	14.10	14.10	0.09

Per DCM Table 6-6 Vol 1 Update

Surface	**Runoff Coefficent**
Paved/Drive/Walk	0.90
Res 2.5ac	0.08
Res 5ac	0.05
Gravel	0.59
Lawn/Meadow	0.08
Undev - Hist	0.09

Revise to include a quantity for paved areas since it would include Black Forest Road.

Note: Res 2.5ac and Res 5ac C5 based on 11% Imp and 5% Imp (Table 3-1) and Interpolation of MHFD table 6-5

Change titles to match rest of submittal documents.

FINAL DRAINAGE REPORT

JeniShay Farms

(Composite Runoff Coefficient - 100 Year)

ON-SITE							
Basin	**Area (acres)**						**C100**
	Paved/Drive/Walk	**Res 2.5ac**	**Gravel**	**Lawn/Meadow**	**Undev - Hist**	**TOTAL**	
A	0.43	2.69	0.12	0.96	0.00	4.20	0.51
B	0.40	0.00	0.06	0.49	0.00	0.94	0.63
C	Not Used						
D	0.19	14.38	0.02	0.00	0.00	14.59	0.49
E	0.17	6.18	0.02	0.00	0.00	6.36	0.49
F	0.00	14.15	0.00	0.00	0.00	14.15	0.48

OFF-SITE							
Basin	**Area (acres)**						**C100**
	Paved/Drive/Walks	**Res 5ac**	**Gravel**	**Lawn/Meadow**	**Undev - Hist**	**TOTAL**	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	0.46
OS2	0.00	6.36	0.00	0.00	0.00	6.36	0.46

EXISTING							
Basin	**Area (acres)**						**C100**
	Paved/Drive/Walks	**Res 5ac**	**Gravel**	**Lawn/Meadow**	**Undev - Hist**	**TOTAL**	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	0.36
EX2	0.00	0.00	0.00	0.00	14.10	14.10	0.36

Per DCM Table 6-6 Vol 1 Update

Surface	**Runoff Coefficent**
Paved/Drive/Walk	0.96
Res 2.5ac	0.48
Res 5ac	0.46
Gravel	0.70
Lawn/Meadow	0.35
Undev - Hist	0.36

Revise to include a quantity for paved areas since it would include Black Forest Road.

Note: Res 2.5ac and Res 5ac C5 based on 11% Imp and 5% Imp (Table 3-1) and Interpolation of MHFD table 6-5

Change titles to match rest of submittal documents.

FINAL DRAINAGE REPORT

JeniShay Farms

(Percentage of Imperviousness)

ON-SITE: PROPOSED							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walk	***Res 2.5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
A	0.43	2.69	0.12	0.96	0.00	4.20	19.68
B	0.48	0.00	0.06	0.49	0.00	1.02	51.42
C	NOT USED						
D	0.00	14.38	0.02	0.00	0.00	14.40	11.10
E	0.17	6.18	0.02	0.00	0.00	6.36	13.49
F	0.00	14.15	0.00	0.00	0.00	14.15	11.00
Totals	**1.08**	**37.39**	**0.22**	**1.44**	**0.00**	**40.12**	**13.37**

OFF-SITE: PROPOSED							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	7.00
OS2	0.00	6.36	0.00	0.00	0.00	6.36	7.00
Totals	**0.00**	**36.36**	**0.00**	**0.00**	**0.00**	**36.36**	**7.00**

TO POND: PROPOSED							
A,B	**0.91**	**2.69**	**0.18**	**1.44**	**0.00**	**5.22**	**25.90**

EXISTING							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	2.00
EX2	0.00	0.00	0.00	0.00	14.10	14.10	2.00
Totals	**0.00**	**0.00**	**0.00**	**0.00**	**38.94**	**38.94**	**2.00**

Per DCM Table 6-6

Surface	**% Impervious**
Paved/Drive/Walk	100
Res 2.5ac	11
Res 5ac	7
Gravel	80
Lawn/Meadow	0
Undeveloped - Historic	2

Note: Res 2.5+ac % Imp. Per ECM Appendix L, Table 3-1

Change titles to match rest of submittal documents.

Final Drainage Report

JeniShay Farms

(Basin Summary)

From Area Runoff Coefficient Summary				*OVERLAND FLOW TIME*				*TRAVEL TIME*					TOTAL	*INTENSITY **		*TOTAL FLOWS*	
BASIN	AREA TOTAL *(Acres)*	C_5	C_{100}	C_5	Length *(ft)*	Height *(ft)*	T_C *(min)*	Conveyance Coeff.	Slope *(%)*	Length *(ft)*	Velocity *(fps)*	T_t *(min)*	*(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
		From DCM Table 6-6															
A	4.20	0.18	0.51	0.18	150	10	11.3	15	4.0%	320	3.0	1.8	13.0	3.7	6.3	***2.8***	***13.4***
B	1.02	0.46	0.63	0.46	10	3.3	1.2	15	5.6%	1285	3.5	6.0	7.2	4.6	7.8	***2.2***	***5.0***
C	Basin C no longer used. Combined into Basin E																
D	14.40	0.09	0.49	0.09	300	24	16.5	10	5.0%	240	2.2	1.8	18.3	3.2	5.4	***4.2***	***38.2***
E	6.36	0.10	0.49	0.10	300	20	17.3	15	4.9%	70	3.3	0.4	17.7	3.3	5.5	***2.1***	***17.1***
F	14.15	0.08	0.48	0.08	300	28	15.8	15	3.2%	1180	2.7	7.3	23.1	2.9	4.8	***3.2***	***32.7***
OS1	30.00	0.05	0.46	0.05	300	12	21.5	15	3.0%	815	2.6	5.2	26.8	2.7	4.5	***4.0***	***61.4***
OS2	6.36	0.05	0.46	0.05	300	10	22.9	15	3.0%	580	2.6	3.7	26.6	2.7	4.5	***0.8***	***13.1***
EX1	24.84	0.09	0.36	0.09	300	24	16.5	15	5.0%	990	3.4	4.9	21.4	3.0	5.0	***6.7***	***44.9***
EX2	14.10	0.09	0.36	0.09	300	28	15.7	15	3.2%	1180	2.7	7.3	23.0	2.9	4.8	***3.7***	***24.5***

* Intensity equations assume a minimum travel time of 5 minutes.

Calculated by: PSM

Date: 8/20/2022

Checked by: PSM

Change titles to match rest of submittal documents.

FINAL DRAINAGE REPORT

JeniShay Farms

(Surface Routing Summary)

					Intensity		Flow		
Design Point(s)	***Contributing Basins/Design Points***	***Equivalent CA_5***	***Equivalent CA_{100}***	***Maximum T_C***	***I_5***	***I_{100}***	***Q_5***	***Q_{100}***	***Comments***
1	B	0.43	0.59	7.5	4.6	7.6	***2.0***	***4.5***	***To proposed 18" culvert***
2	DP1, A	1.19	2.73	11.6	3.9	6.6	***4.6***	***18.0***	***To proposed pond (inflow)***
3	JR ENG DP-005	47.97	118.08	45.9	1.8	3.1	***86.3***	***366.0***	***Creek flow at entrance to property***
4	DP3, OS1, OS2, D	3.13	23.87	55.1	1.6	2.6	***91.9***	***431.8***	***To proposed Triple 48" culverts***
5	DP4, E, POND OUT	DP4, Basin E Routed, Pond Out Direct Addition					***92.9***	***445.6***	***Proposed Site Outfall - Compare to DP EX***
EX	JR ENG DP-005, OS1, OS2, EX1	4.05	25.67	58.1	1.5	2.5	***93.1***	***433.2***	***Existing Site Outfall - Compare to DP 5***

EX to include JR Eng Basin 17

Basin F and JR Eng Basin 17 should be included to the ultimate outfall.

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Basin A ditch 100yr Sta 6+50

Triangular

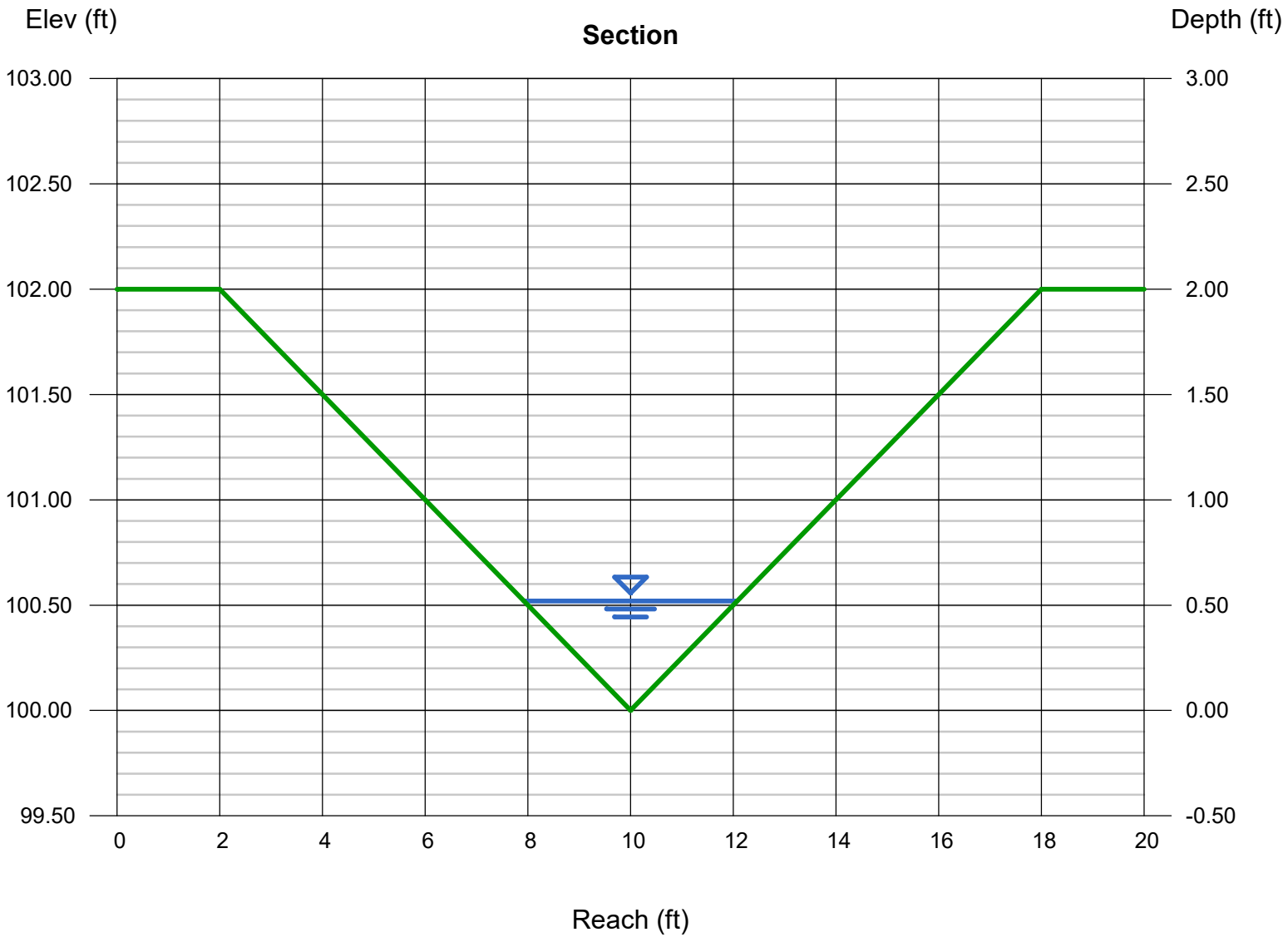
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 4.70

Highlighted

Depth (ft)	= 0.52
Q (cfs)	= 4.700
Area (sqft)	= 1.08
Velocity (ft/s)	= 4.35
Wetted Perim (ft)	= 4.29
Crit Depth, Yc (ft)	= 0.62
Top Width (ft)	= 4.16
EGL (ft)	= 0.81



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Basin A ditch 100yr Sta 10+00

Triangular

Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.00
N-Value	= 0.030

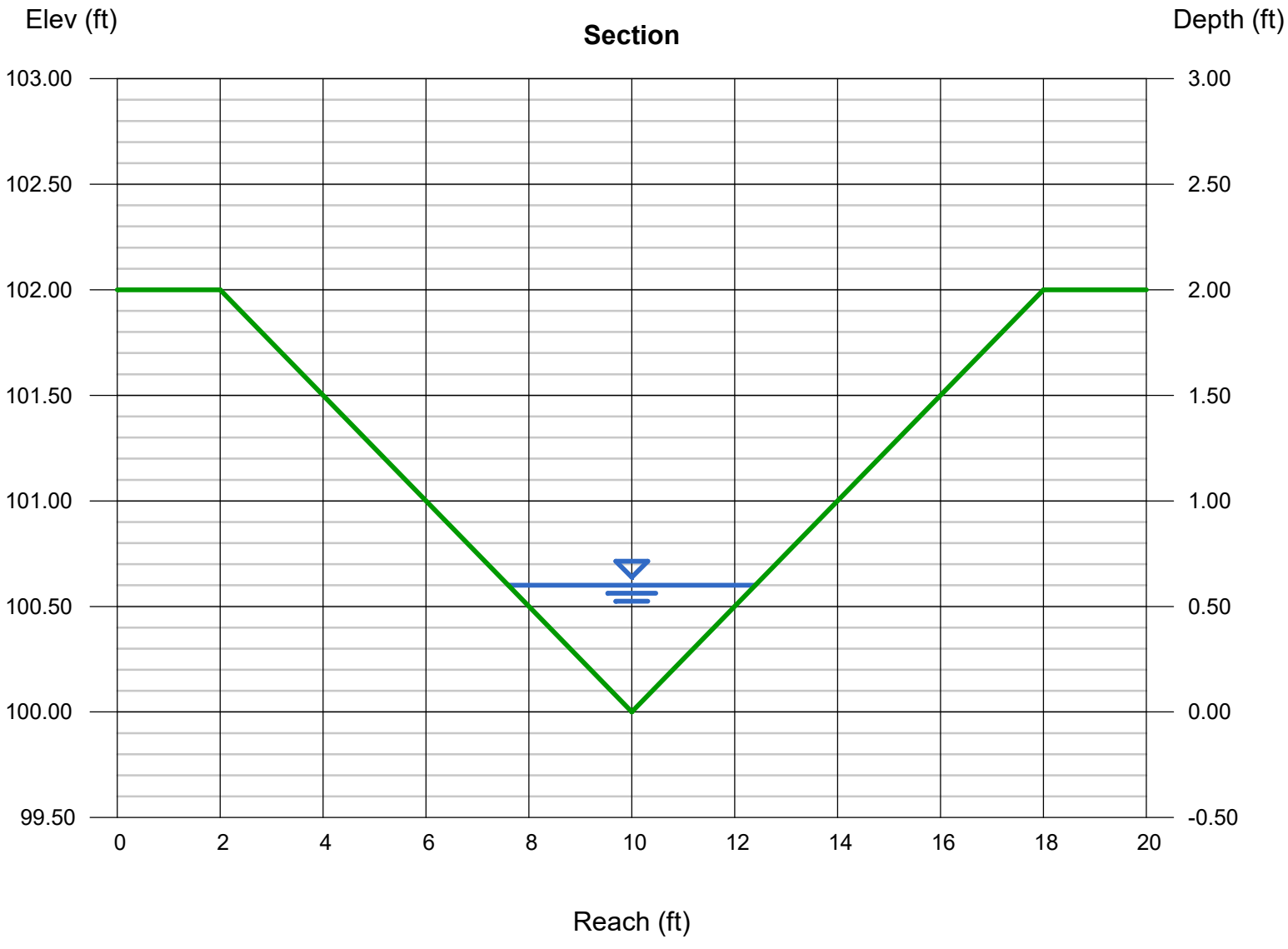
Calculations

Compute by:	Known Q
Known Q (cfs)	= 7

Highlighted

Depth (ft)	= 0.60
Q (cfs)	= 7.000
Area (sqft)	= 1.44
Velocity (ft/s)	= 4.86
Wetted Perim (ft)	= 4.95
Crit Depth, Yc (ft)	= 0.72
Top Width (ft)	= 4.80
EGL (ft)	= 0.97

velocities exceeds the permissible velocity for native grass and will require a different treatment



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Basin A ditch 100yr Sta 12+00

Triangular

Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.00
N-Value	= 0.030

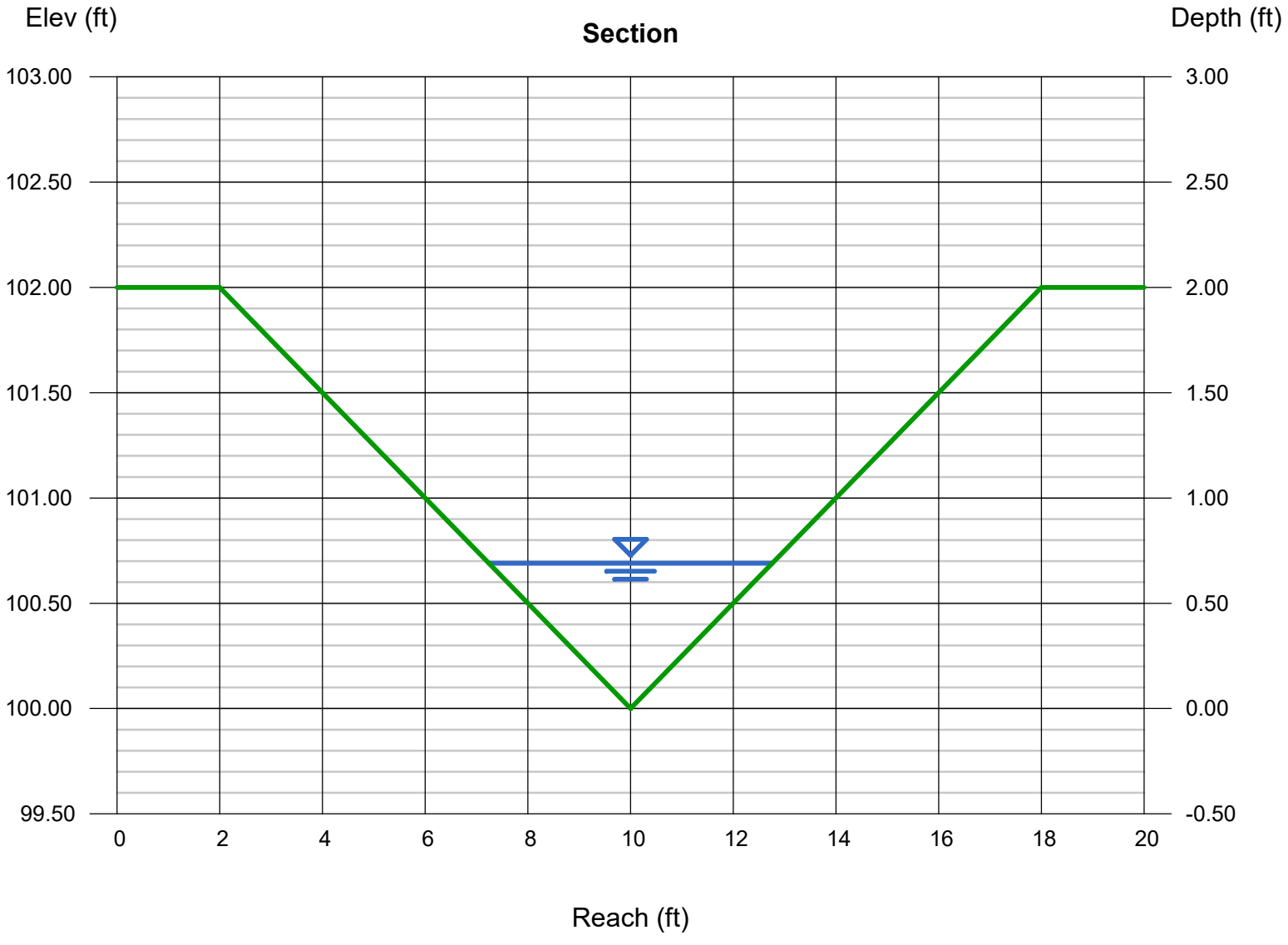
Calculations

Compute by:	Known Q
Known Q (cfs)	= 9.80

Highlighted

Depth (ft)	= 0.69
Q (cfs)	= 9.800
Area (sqft)	= 1.90
Velocity (ft/s)	= 5.15
Wetted Perim (ft)	= 5.69
Crit Depth, Yc (ft)	= 0.83
Top Width (ft)	= 5.52
EGL (ft)	= 1.10

velocities exceeds the permissible velocity for native grass. Additional armoring such as erosion control blanket is required.



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Basin A + B ditch 100ft West of Pond

Triangular

Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.50
N-Value	= 0.030

Calculations

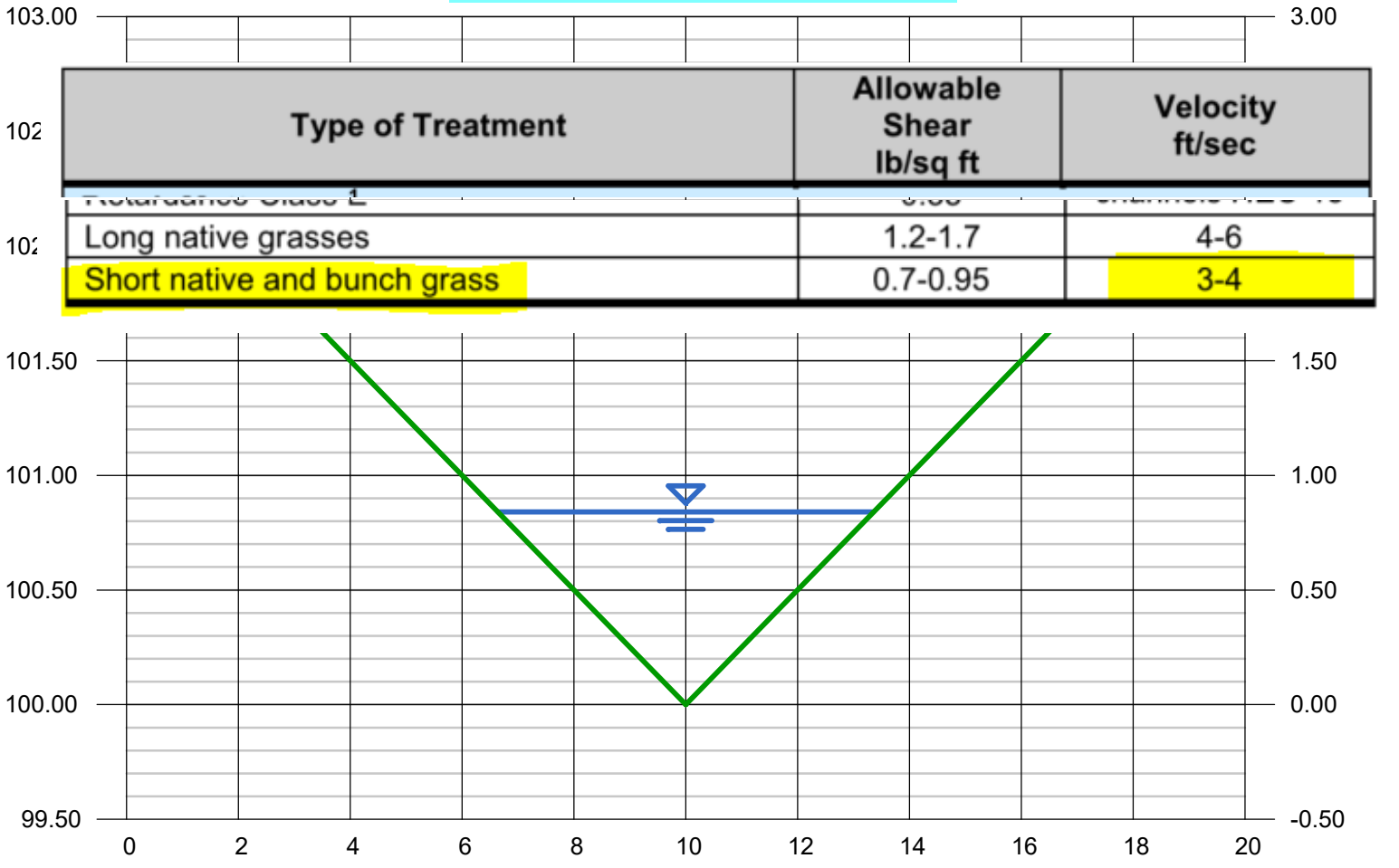
Compute by:	Known Q
Known Q (cfs)	= 17.80

Highlighted

Depth (ft)	= 0.84
Q (cfs)	= 17.80
Area (sqft)	= 2.82
Velocity (ft/s)	= 6.31
Wetted Perim (ft)	= 6.93
Crit Depth, Yc (ft)	= 1.05
Top Width (ft)	= 6.72
EGL (ft)	= 1.46

velocities exceeds the permissible velocity for native grass. Additional armoring such as erosion control blanket is required.
If you plan to use ECB then include the product specification in the drainage report that shows the permissible velocity for the given product proposed.

Type of Treatment	Allowable Shear lb/sq ft	Velocity ft/sec
Long native grasses	1.2-1.7	4-6
Short native and bunch grass	0.7-0.95	3-4



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Main Channel at DP EX Existing Condtions

User-defined

Invert Elev (ft)	= 35.00
Slope (%)	= 0.70
N-Value	= 0.035

Calculations

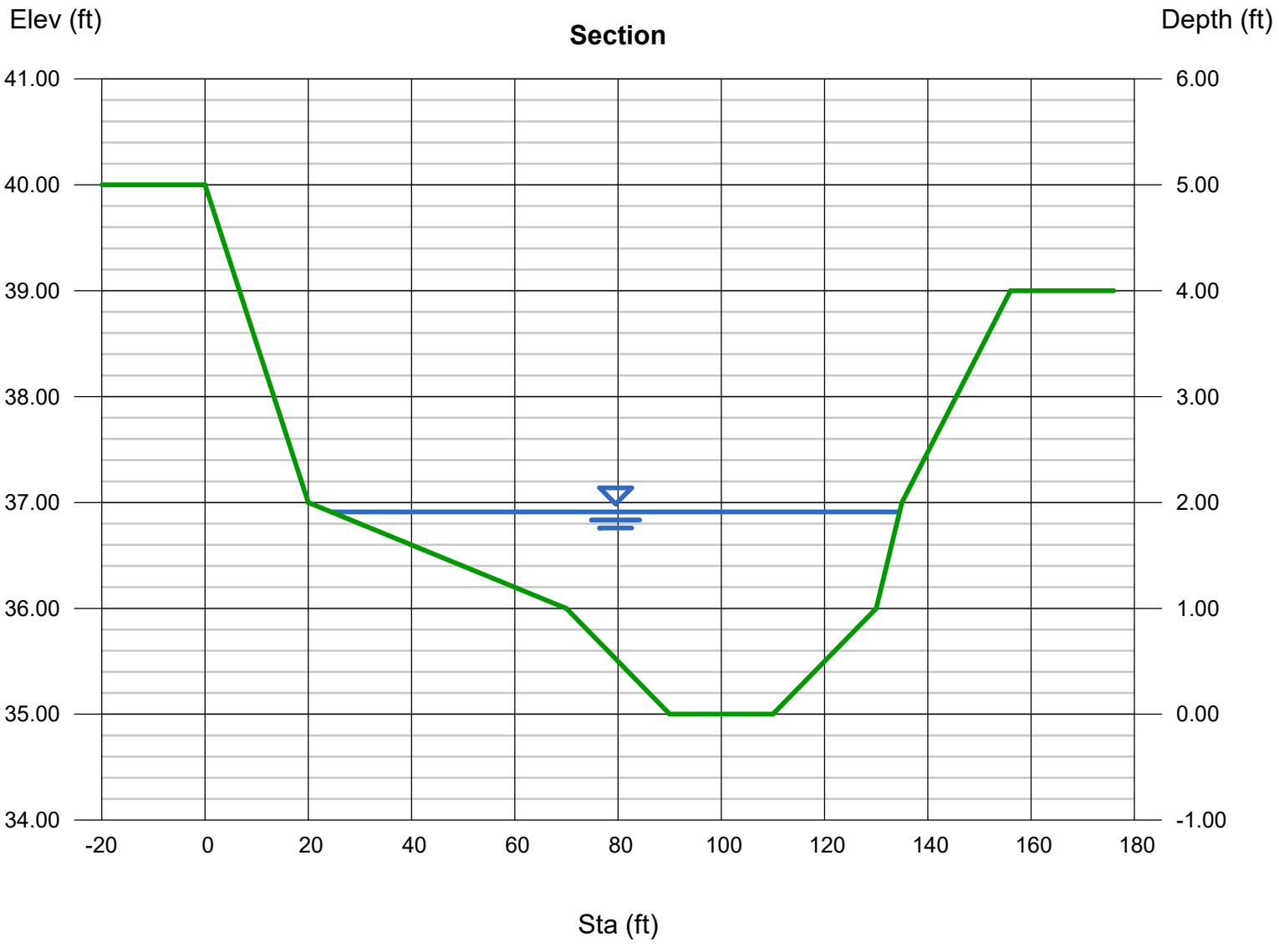
Compute by:	Known Q
Known Q (cfs)	= 433.20

Highlighted

Depth (ft)	= 1.91
Q (cfs)	= 433.20
Area (sqft)	= 117.37
Velocity (ft/s)	= 3.69
Wetted Perim (ft)	= 110.20
Crit Depth, Yc (ft)	= 1.55
Top Width (ft)	= 110.05
EGL (ft)	= 2.12

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

(0.00, 40.00)-(20.00, 37.00, 0.035)-(70.00, 36.00, 0.035)-(90.00, 35.00, 0.035)-(110.00, 35.00, 0.035)-(130.00, 36.00, 0.035)-(135.00, 37.00, 0.035)-(156.00, 39.00, 0.035)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Main Channel at DP 5 Proposed Condtions

User-defined

Invert Elev (ft)	= 35.00
Slope (%)	= 0.70
N-Value	= 0.035

Calculations

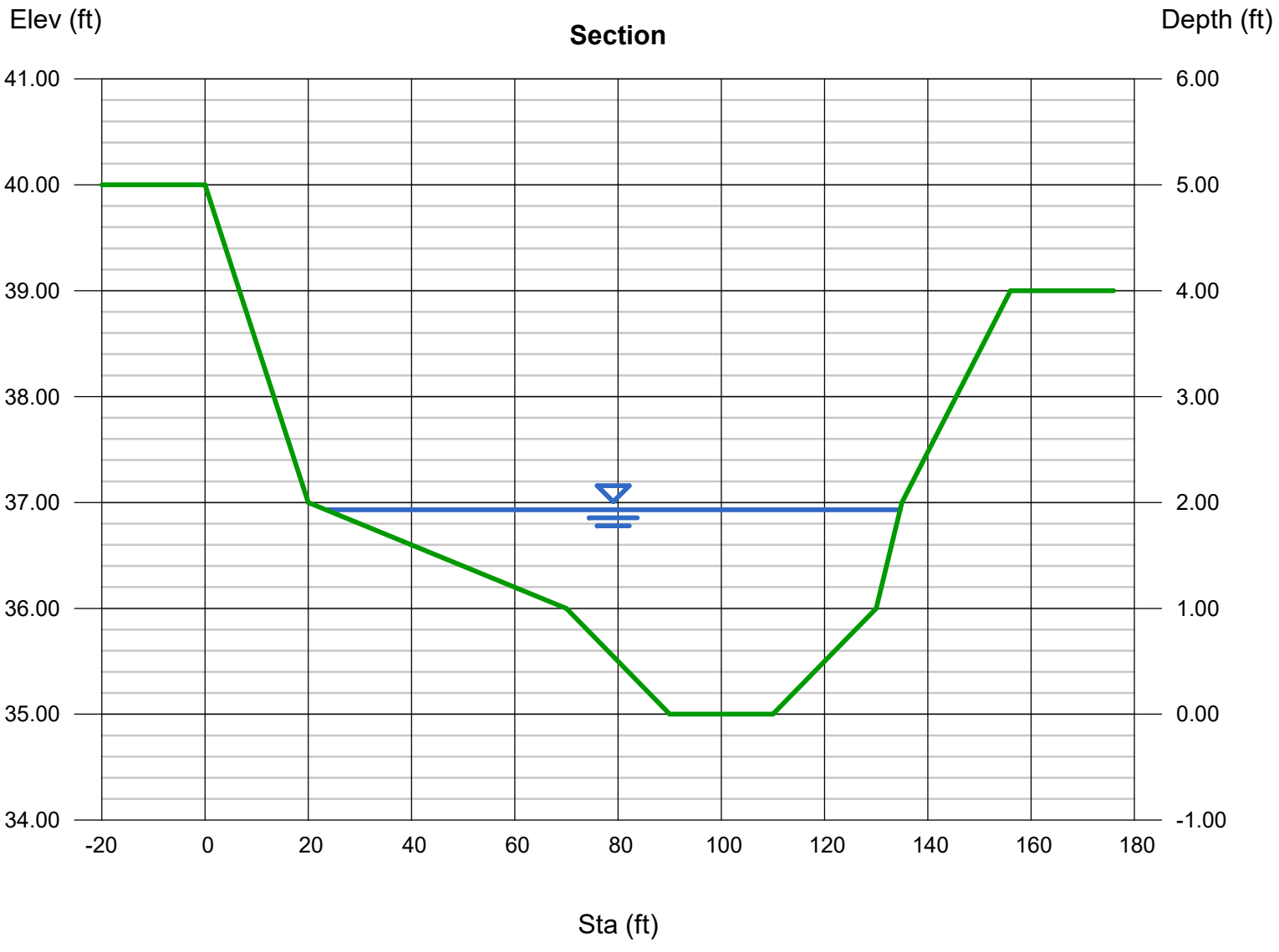
Compute by:	Known Q
Known Q (cfs)	= 445.60

Highlighted

Depth (ft)	= 1.93
Q (cfs)	= 445.60
Area (sqft)	= 119.58
Velocity (ft/s)	= 3.73
Wetted Perim (ft)	= 111.30
Crit Depth, Yc (ft)	= 1.57
Top Width (ft)	= 111.15
EGL (ft)	= 2.15

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

(0.00, 40.00)-(20.00, 37.00, 0.035)-(70.00, 36.00, 0.035)-(90.00, 35.00, 0.035)-(110.00, 35.00, 0.035)-(130.00, 36.00, 0.035)-(135.00, 37.00, 0.035)-(156.00, 39.00, 0.035)



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

18inch Culvert

Invert Elev Dn (ft)	=	100.00
Pipe Length (ft)	=	50.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	100.50
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

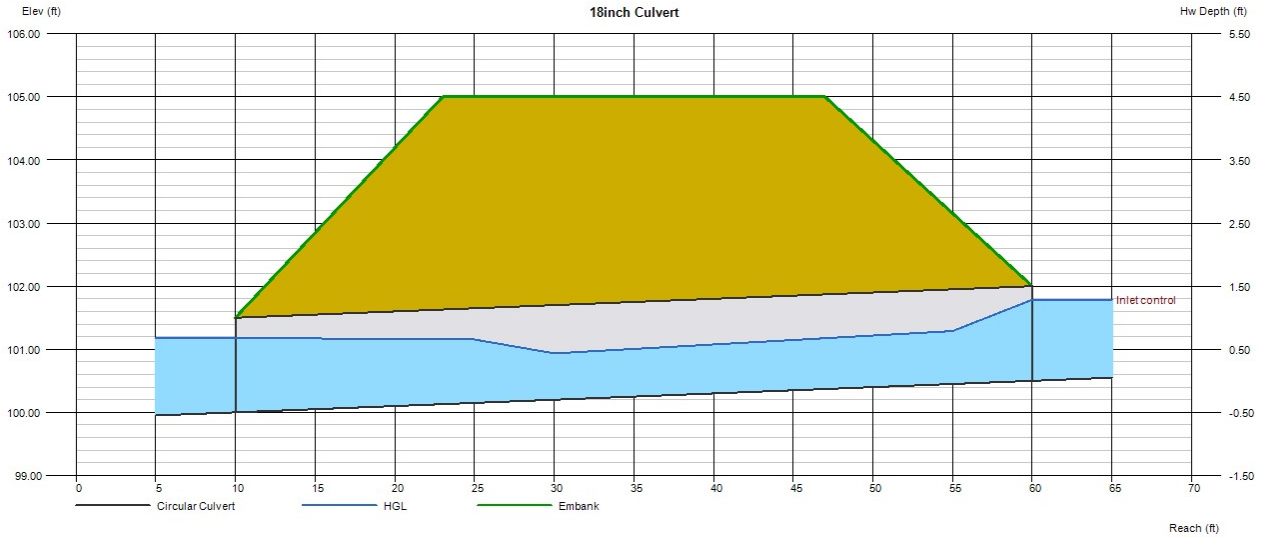
Top Elevation (ft)	=	105.00
Top Width (ft)	=	24.00
Crest Width (ft)	=	150.00

Calculations

Qmin (cfs)	=	5.00
Qmax (cfs)	=	5.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	5.00
Qpipe (cfs)	=	5.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.35
Veloc Up (ft/s)	=	4.77
HGL Dn (ft)	=	101.18
HGL Up (ft)	=	101.36
Hw Elev (ft)	=	101.78
Hw/D (ft)	=	0.86
Flow Regime	=	Inlet Control



Culvert Report

Circular Culvert

Invert Elev Dn (ft)	=	7445.00
Pipe Length (ft)	=	55.00
Slope (%)	=	0.02
Invert Elev Up (ft)	=	7445.01
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	2
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

Top Elevation (ft)	=	7450.00
Top Width (ft)	=	20.00
Crest Width (ft)	=	40.00

Calculations

Qmin (cfs)	=	431.00
Qmax (cfs)	=	431.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	431.00
Qpipe (cfs)	=	240.80
Qovertop (cfs)	=	190.20
Veloc Dn (ft/s)	=	10.01
Veloc Up (ft/s)	=	9.58
HGL Dn (ft)	=	7448.65
HGL Up (ft)	=	7449.09
Hw Elev (ft)	=	7451.34
Hw/D (ft)	=	1.58
Flow Regime	=	Inlet Control

There is conflicting information between this page and page number 45. Revise entire report contents to callout how many culverts are being proposed and delete conflicting information.

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

24inch Culvert

Invert Elev Dn (ft)	=	100.00
Pipe Length (ft)	=	25.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	100.25
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

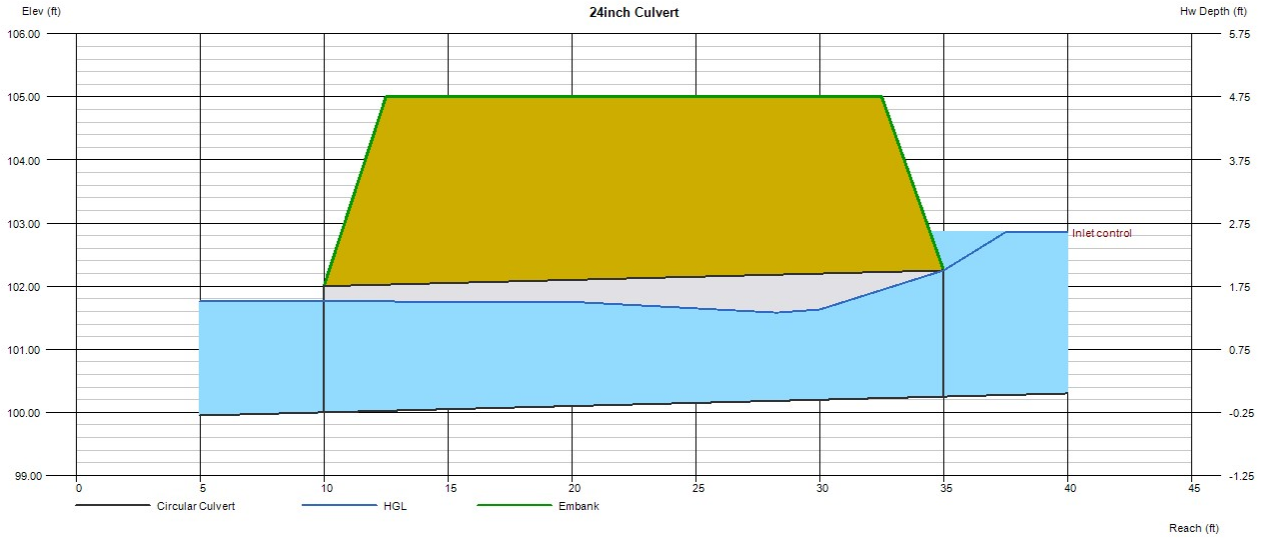
Top Elevation (ft)	=	105.00
Top Width (ft)	=	20.00
Crest Width (ft)	=	150.00

Calculations

Qmin (cfs)	=	17.80
Qmax (cfs)	=	17.80
Tailwater Elev (ft)	=	(dc+D)/2

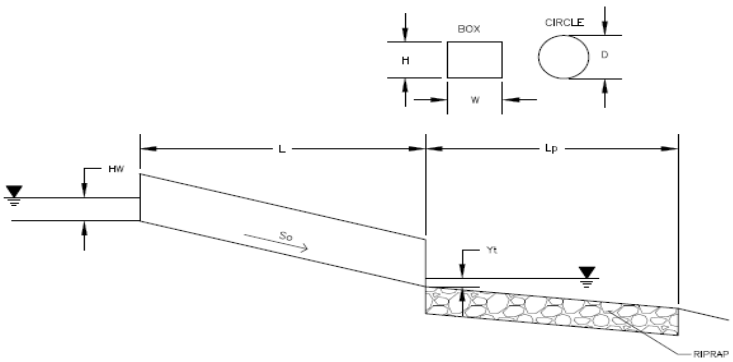
Highlighted

Qtotal (cfs)	=	17.80
Qpipe (cfs)	=	17.80
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.08
Veloc Up (ft/s)	=	6.93
HGL Dn (ft)	=	101.76
HGL Up (ft)	=	101.77
Hw Elev (ft)	=	102.86
Hw/D (ft)	=	1.30
Flow Regime	=	Inlet Control



Determination of Culvert Headwater and Outlet Protection

Project: JeniShay Farms
Basin ID: Triple 48" Culvert Outfall



There is conflicting information between this page and page number 43. Revise entire report contents to callout how many culverts are being proposed and delete conflicting information.

Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

	Design Discharge	Q =	432	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	48	inches
	Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	3	
	Inlet Elevation	Elev IN =	100.6	ft
	Outlet Elevation **OR** Slope	Elev OUT =	100	ft
	Culvert Length	L =	60	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =	103.75	ft
	Max Allowable Channel Velocity	V =	5	ft/s

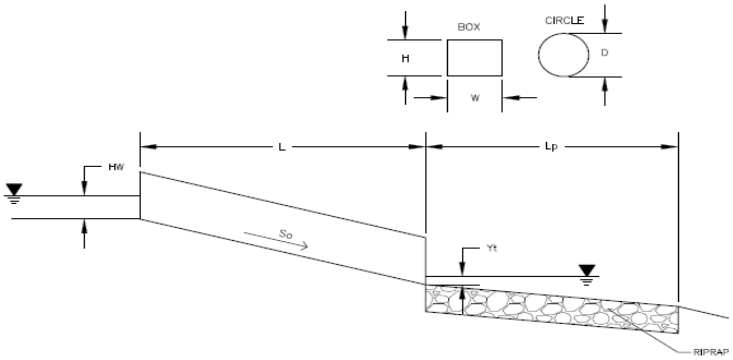
Required Protection (Output):

Tailwater Surface Height	Y_t =	3.75	ft
Flow Area at Max Channel Velocity	A_t =	28.80	ft^2
Culvert Cross Sectional Area Available	A =	12.57	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.25	
Sum of All Losses Coefficients	k_s =	1.45	ft
Culvert Normal Depth	Y_n =	3.03	ft
Culvert Critical Depth	Y_c =	3.55	ft
Tailwater Depth for Design	d =	3.77	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	3.52	ft
Expansion Factor	1/(2*tan(Θ)) =	5.93	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	4.50	$ft^{0.5}/s$
Froude Number	Fr =	1.44	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	1.07	
Inlet Control Headwater	HW_I =	6.89	ft
Outlet Control Headwater	HW_O =	6.13	
Design Headwater Elevation	**HW =**	**107.49**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.72**	**HW/D > 1.5!**
Minimum Theoretical Riprap Size	d_{50} =	6	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**22**	**ft**
Width of Protection	**T =**	**8**	**ft**

Per DCM HW/D should not exceed 1.5. Revise to meet criteria.

Determination of Culvert Headwater and Outlet Protection

Project: JeniShay Farms
Basin ID: Pond Outfall Pipe 18"



Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

	Design Discharge	Q =	5.6	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	100.45	ft
	Outlet Elevation **OR** Slope	Elev OUT =	100	ft
	Culvert Length	L =	45	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.60	ft
Flow Area at Max Channel Velocity	A_t =	1.12	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.69	
Sum of All Losses Coefficients	k_s =	1.89	ft
Culvert Normal Depth	Y_n =	0.74	ft
Culvert Critical Depth	Y_c =	0.91	ft
Tailwater Depth for Design	d =	1.21	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.12	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.03	$ft^{0.5}/s$
Froude Number	Fr =	1.49	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.54	
Inlet Control Headwater	HW_I =	1.32	ft
Outlet Control Headwater	HW_O =	1.05	
Design Headwater Elevation	**HW =**	**101.77**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.88**	
Minimum Theoretical Riprap Size	d_{50} =	3	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**5**	**ft**
Width of Protection	**T =**	**3**	**ft**

Change titles to match rest of submittal documents.

Final Drainage Report

JENISHAY FARMS

(Forebay Calculations)

WQCV Equation

WQCV = a(0.91*(I)^3 - 1.19*I^2 + 0.78*I)

(per UDFCD eq 3-1)

Solve		WQCV = water quality capture volume (watershed inches)
1		a = 40-hr drain time coefficient (per UDFCD Vol 3 Table 3-2)
0.259		I = imperviousness (%/100) (per imperviousness calculations)
Solution =	**0.14**	

Water Quality Capture Volume Required

V = (WQCV/12)*A

(per UDFCD eq 3-3)

Solve		V = required storage volume (acre-ft)
0.14		WQCV = water quality capture volume (watershed inches)
5.13		A = tributary watershed area (acre)
Solution =	**0.059**	acre-ft
Solution =	**2570**	ft^3

Water Quality Capture Volume Required (per UDFCD: Basins 5 to 20 acres = 3%)

V = (WQCV*.03)

Solve		V = required storage volume (ft^3), minimum
2570		WQCV Required (ft^3)
Solution =	**77.1**	ft^3 - *Minimum*
Solution =	**80.0**	ft^3 - *Per geometric design*

Peak Release Rate

Q = V/T

Solve		Q = peak release rate (ft^3/s)
80.0		V = required storage volume (ft^3)
300		T = 5 minute drain time (s)
Solution =	**0.267**	ft^3/s

Area of Orifice

Ao = Q/(Cd*2*g*h)

(orifice equation)

Solve		Ao = area of orifice (ft^2)
0.267		Q = peak release rate (ft^3/s)
0.6		Cd = coefficient of discharge
32.17		g = gravitational constant (ft/s)^2
1.5		h = head (ft) - *per forebay design depth*
Solution =	**0.00461**	(ft^2)
Solution =	**0.6631**	(in^2)

Release Pipe Size

D = (4*A)/pi)^2

Solve		D = diameter of pipe (in)
0.6631		Ao = area of orifice (in^2)
3.1416		pi
Solution =	**0.71**	(in)

Release Pipe Size (4" Minimum)

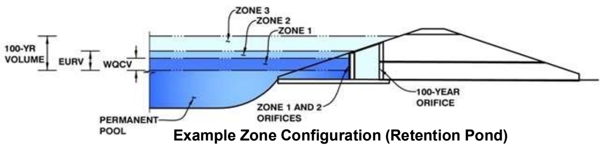
Solution =	**4.00**	(in)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: **JeniShay Farms**

Basin ID:



Example Zone Configuration (Retention Pond)

Depth Increment = ___ ft

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	5.22	acres
Watershed Length =	950	ft
Watershed Length to Centroid =	450	ft
Watershed Slope =	0.047	ft/ft
Watershed Imperviousness =	25.90%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	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) =	0.060	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.137	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.92 in.) =	0.080	acre-feet	0.92	inches
5-yr Runoff Volume (P1 = 1.19 in.) =	0.133	acre-feet	1.19	inches
10-yr Runoff Volume (P1 = 1.44 in.) =	0.210	acre-feet	1.44	inches
25-yr Runoff Volume (P1 = 1.82 in.) =	0.395	acre-feet	1.82	inches
50-yr Runoff Volume (P1 = 2.13 in.) =	0.523	acre-feet	2.13	inches
100-yr Runoff Volume (P1 = 2.47 in.) =	0.693	acre-feet	2.47	inches
500-yr Runoff Volume (P1 = 3.36 in.) =	1.082	acre-feet	3.36	inches
Approximate 2-yr Detention Volume =	0.075	acre-feet		
Approximate 5-yr Detention Volume =	0.111	acre-feet		
Approximate 10-yr Detention Volume =	0.174	acre-feet		
Approximate 25-yr Detention Volume =	0.228	acre-feet		
Approximate 50-yr Detention Volume =	0.250	acre-feet		
Approximate 100-yr Detention Volume =	0.311	acre-feet		

Revise to match City DCM Vol. 1 table 6-2 rainfall depths.

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.060	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.077	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.174	acre-feet
Total Detention Basin Volume =	0.311	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	1,530	0.035		
	--	0.50	--	--	--	2,106	0.048	909	0.021
7444	--	1.00	--	--	--	2,757	0.063	2,125	0.049
	--	1.50	--	--	--	3,492	0.080	3,687	0.085
7445	--	2.00	--	--	--	4,170	0.096	5,602	0.129
	--	2.50	--	--	--	5,024	0.115	7,901	0.181
7446	--	3.00	--	--	--	5,778	0.133	10,601	0.243
	--	3.50	--	--	--	6,653	0.153	13,709	0.315
7447	--	4.00	--	--	--	7,462	0.171	17,238	0.396
	--	4.50	--	--	--	8,414	0.193	21,207	0.487
7448	--	5.00	--	--	--	9,325	0.214	25,642	0.589
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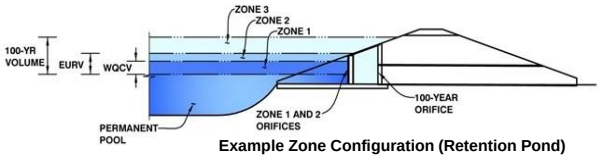
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **JeniShay Farms**

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.18	0.060	Orifice Plate
Zone 2 (EURV)	2.09	0.077	Orifice Plate
Zone 3 (100-year)	3.48	0.174	Weir&Pipe (Restrict)
Total (all zones)		0.311	

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.09	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.75	1.50					
Orifice Area (sq. inches)	0.70	0.14	0.14					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.09	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.72	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	2.58	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	10.35	N/A	
Horiz. Length of Weir Sides =	2.50	N/A	feet	Overflow Grate Open Area w/o Debris =	7.22	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	3.61	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.70	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.36	N/A	feet
Restrictor Plate Height Above Pipe Invert =	7.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.40	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

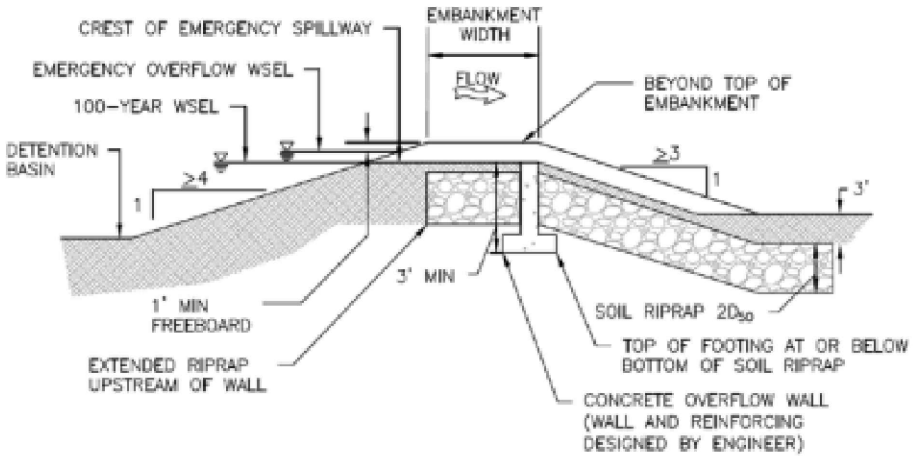
Spillway Invert Stage=	3.10	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.60 feet
Spillway Crest Length =	4.00	feet	Stage at Top of Freeboard =	4.70 feet
Spillway End Slopes =	3.00	H:V	Basin Area at Top of Freeboard =	0.20 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.53 acre-ft

Calculated Parameters for Spillway

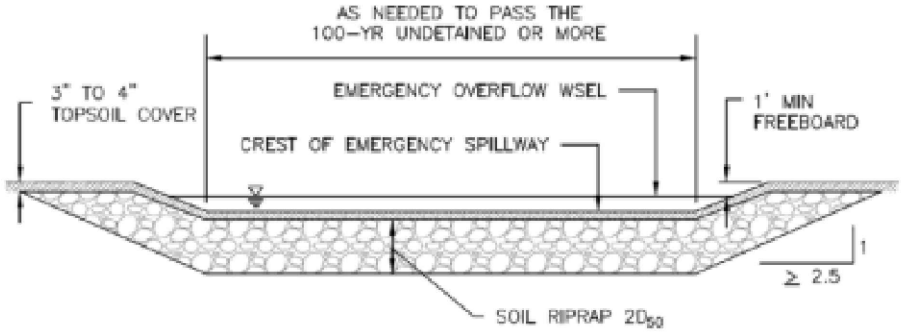
Routed Hydrograph Results

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	0.92	1.19	1.44	1.82	2.13	2.47	3.36
CUHP Runoff Volume (acre-ft) =	0.060	0.137	0.080	0.133	0.210	0.395	0.523	0.693	1.082
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.080	0.133	0.210	0.395	0.523	0.693	1.082
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.4	1.1	3.3	4.5	6.2	9.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.07	0.22	0.63	0.87	1.20	1.90
Peak Inflow Q (cfs) =	N/A	N/A	0.9	1.4	2.3	4.6	6.1	7.8	11.8
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.7	3.0	4.5	5.6	9.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.6	0.9	1.0	0.9	1.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.4	0.6	0.8	0.8
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) =	42	64	49	64	65	59	56	52	44
Time to Drain 99% of Inflow Volume (hours) =	**45**	69	53	69	72	68	67	65	60
Maximum Ponding Depth (ft) =	1.17	2.09	1.36	1.96	2.29	2.56	2.68	2.94	3.49
Area at Maximum Ponding Depth (acres) =	0.07	0.10	0.08	0.09	0.11	0.12	0.12	0.13	0.15
Maximum Volume Stored (acre-ft) =	0.060	0.137	0.073	0.125	0.157	0.187	0.203	0.235	0.312



EMERGENCY SPILLWAY PROFILE



EMERGENCY SPILLWAY SECTION AND SPILLWAY CHANNEL

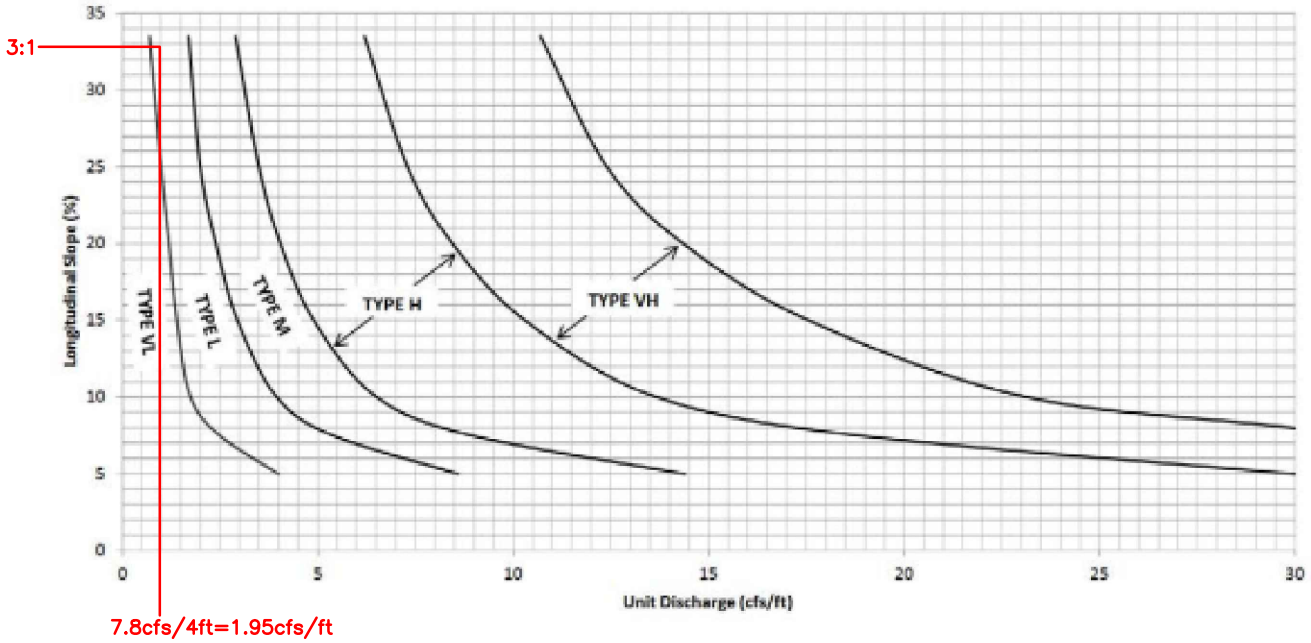


Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

USE TYPE L

Remove any duplicate sheets from report.

FINAL DRAINAGE REPORT

JeniShay Farms

(Composite Runoff Coefficient - 5 Year)

ON-SITE							
Basin	***Area (acres)***						***C5***
	Paved/Drive/Walk	***Res 2.5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
A	0.43	2.69	0.12	0.96	0.00	4.20	0.18
B	0.40	0.00	0.06	0.49	0.00	0.94	0.46
C	Not Used						
D	0.19	14.38	0.02	0.00	0.00	14.59	0.09
E	0.17	6.18	0.02	0.00	0.00	6.36	0.10
F	0.00	14.15	0.00	0.00	0.00	14.15	0.08

OFF-SITE							
Basin	***Area (acres)***						***C5***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	0.05
OS2	0.00	6.36	0.00	0.00	0.00	6.36	0.05

EXISTING							
Basin	***Area (acres)***						***C5***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	0.09
EX2	0.00	0.00	0.00	0.00	14.10	14.10	0.09

Per DCM Table 6-6 Vol 1 Update

Surface	**Runoff Coefficent**
Paved/Drive/Walk	0.90
Res 2.5ac	0.08
Res 5ac	0.05
Gravel	0.59
Lawn/Meadow	0.08
Undev - Hist	0.09

Note: Res 2.5ac and Res 5ac C5 based on 11% Imp and 5% Imp (Table 3-1) and Interpolation of MHFD table 6-5

FINAL DRAINAGE REPORT

JeniShay Farms

(Composite Runoff Coefficient - 100 Year)

ON-SITE							
Basin	***Area (acres)***						***C100***
	Paved/Drive/Walk	***Res 2.5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
A	0.43	2.69	0.12	0.96	0.00	4.20	0.51
B	0.40	0.00	0.06	0.49	0.00	0.94	0.63
C	Not Used						
D	0.19	14.38	0.02	0.00	0.00	14.59	0.49
E	0.17	6.18	0.02	0.00	0.00	6.36	0.49
F	0.00	14.15	0.00	0.00	0.00	14.15	0.48

OFF-SITE							
Basin	***Area (acres)***						***C100***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	0.46
OS2	0.00	6.36	0.00	0.00	0.00	6.36	0.46

EXISTING							
Basin	***Area (acres)***						***C100***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	0.36
EX2	0.00	0.00	0.00	0.00	14.10	14.10	0.36

Per DCM Table 6-6 Vol 1 Update

Surface	**Runoff Coefficent**
Paved/Drive/Walk	0.96
Res 2.5ac	0.48
Res 5ac	0.46
Gravel	0.70
Lawn/Meadow	0.35
Undev - Hist	0.36

Note: Res 2.5ac and Res 5ac C5 based on 11% Imp and 5% Imp (Table 3-1) and Interpolation of MHFD table 6-5

JeniShay Farms

(Percentage of Imperviousness)

ON-SITE: PROPOSED							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walk	***Res 2.5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
A	0.43	2.69	0.12	0.96	0.00	4.20	19.68
B	0.48	0.00	0.06	0.49	0.00	1.02	51.42
C	NOT USED						
D	0.00	14.38	0.02	0.00	0.00	14.40	11.10
E	0.17	6.18	0.02	0.00	0.00	6.36	13.49
F	0.00	14.15	0.00	0.00	0.00	14.15	11.00
Totals	**1.08**	**37.39**	**0.22**	**1.44**	**0.00**	**40.12**	**13.37**

OFF-SITE: PROPOSED							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	7.00
OS2	0.00	6.36	0.00	0.00	0.00	6.36	7.00
Totals	**0.00**	**36.36**	**0.00**	**0.00**	**0.00**	**36.36**	**7.00**

TO POND: PROPOSED							
A,B	**0.91**	**2.69**	**0.18**	**1.44**	**0.00**	**5.22**	**25.90**

EXISTING							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	2.00
EX2	0.00	0.00	0.00	0.00	14.10	14.10	2.00
Totals	**0.00**	**0.00**	**0.00**	**0.00**	**38.94**	**38.94**	**2.00**

Per DCM Table 6-6

Surface	**% Impervious**
Paved/Drive/Walk	100
Res 2.5ac	11
Res 5ac	7
Gravel	80
Lawn/Meadow	0
Undeveloped - Historic	2

Note: Res 2.5+ac % Imp. Per ECM Appendix L, Table 3-1

Final Drainage Report

JeniShay Farms

(Basin Summary)

From Area Runoff Coefficient Summary				*OVERLAND FLOW TIME*				*TRAVEL TIME*					TOTAL	*INTENSITY **		*TOTAL FLOWS*	
BASIN	**AREA TOTAL** *(Acres)*	C_5	C_{100}	C_5	**Length** *(ft)*	**Height** *(ft)*	T_C *(min)*	**Conveyance Coeff.**	**Slope** *(%)*	**Length** *(ft)*	**Velocity** *(fps)*	T_t *(min)*	*(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
		From DCM Table 6-6															
A	4.20	0.18	0.51	0.18	150	10	11.3	15	4.0%	320	3.0	1.8	13.0	3.7	6.3	***2.8***	***13.4***
B	1.02	0.46	0.63	0.46	10	3.3	1.2	15	5.6%	1285	3.5	6.0	7.2	4.6	7.8	***2.2***	***5.0***
C	Basin C no longer used. Combined into Basin E																
D	14.40	0.09	0.49	0.09	300 .	24	16.5	10	5.0%	240	2.2	1.8	18.3	3.2	5.4	***4.2***	***38.2***
E	6.36	0.10	0.49	0.10	300	20	17.3	15	4.9%	70	3.3	0.4	17.7	3.3	5.5	***2.1***	***17.1***
F	14.15	0.08	0.48	0.08	300	28	15.8	15	3.2%	1180	2.7	7.3	23.1	2.9	4.8	***3.2***	***32.7***
OS1	30.00	0.05	0.46	0.05	300	12	21.5	15	3.0%	815	2.6	5.2	26.8	2.7	4.5	***4.0***	***61.4***
OS2	6.36	0.05	0.46	0.05	300	10	22.9	15	3.0%	580	2.6	3.7	26.6	2.7	4.5	***0.8***	***13.1***
EX1	24.84	0.09	0.36	0.09	300	24	16.5	15	5.0%	990	3.4	4.9	21.4	3.0	5.0	***6.7***	***44.9***
EX2	14.10	0.09	0.36	0.09	300	28	15.7	15	3.2%	1180	2.7	7.3	23.0	2.9	4.8	***3.7***	***24.5***

* Intensity equations assume a minimum travel time of 5 minutes.

Calculated by: PSM

Date: 8/20/2022

Checked by: PSM

FINAL DRAINAGE REPORT

JeniShay Farms

(Surface Routing Summary)

					Intensity		Flow		
Design Point(s)	***Contributing Basins/Design Points***	***Equivalent CA_5***	***Equivalent CA_{100}***	***Maximum T_C***	***I_5***	***I_{100}***	***Q_5***	***Q_{100}***	***Comments***
1	B	0.43	0.59	7.5	4.6	7.6	***2.0***	***4.5***	***To proposed 18" culvert***
2	DP1, A	1.19	2.73	11.6	3.9	6.6	***4.6***	***18.0***	***To proposed pond (inflow)***
3	JR ENG DP-005	47.97	118.08	45.9	1.8	3.1	***86.3***	***366.0***	***Creek flow at entrance to property***
4	DP3, OS1, OS2, D	3.13	23.87	55.1	1.6	2.6	***91.9***	***431.8***	***To proposed Triple 48" culverts***
5	DP4, E, POND OUT	DP4, Basin E Routed, Pond Out Direct Addition					***92.9***	***445.6***	***Proposed Site Outfall - Compare to DP EX***
EX	JR ENG DP-005, OS1, OS2, EX1	4.05	25.67	58.1	1.5	2.5	***93.1***	***433.2***	***Existing Site Outfall - Compare to DP 5***

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Basin A ditch 100yr Sta 6+50

Triangular

Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.00
N-Value	= 0.030

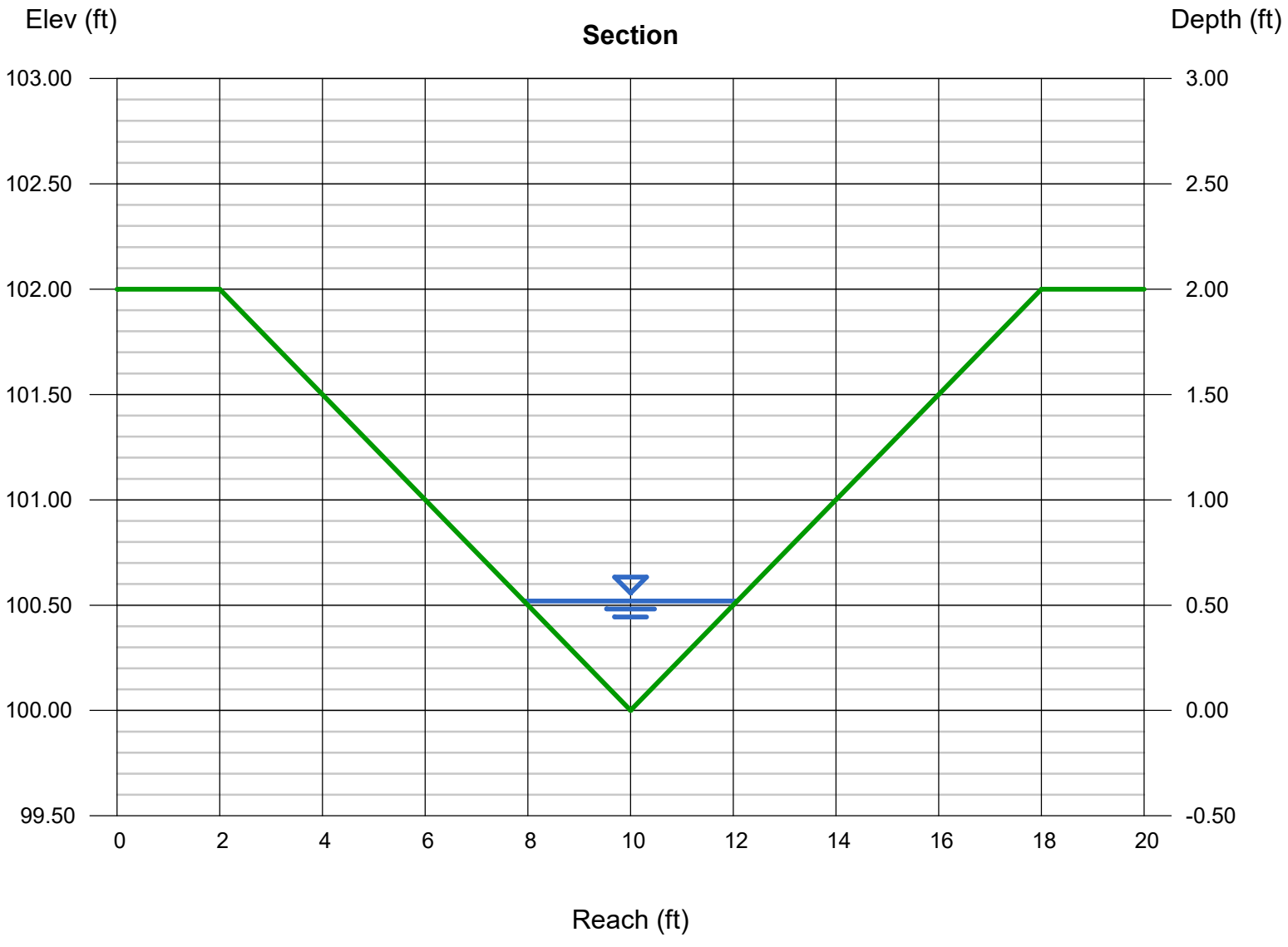
Calculations

Compute by:	Known Q
Known Q (cfs)	= 4.70

Highlighted

Depth (ft)	= 0.52
Q (cfs)	= 4.700
Area (sqft)	= 1.08
Velocity (ft/s)	= 4.35
Wetted Perim (ft)	= 4.29
Crit Depth, Yc (ft)	= 0.62
Top Width (ft)	= 4.16
EGL (ft)	= 0.81

velocities exceeds the permissible velocity for native grass and will require a different treatment.



Channel Report

This seems to be a duplicate of page 37.

Check the entire drainage report and remove any duplicate documents.

Basin A ditch 100yr Sta 10+00

Triangular

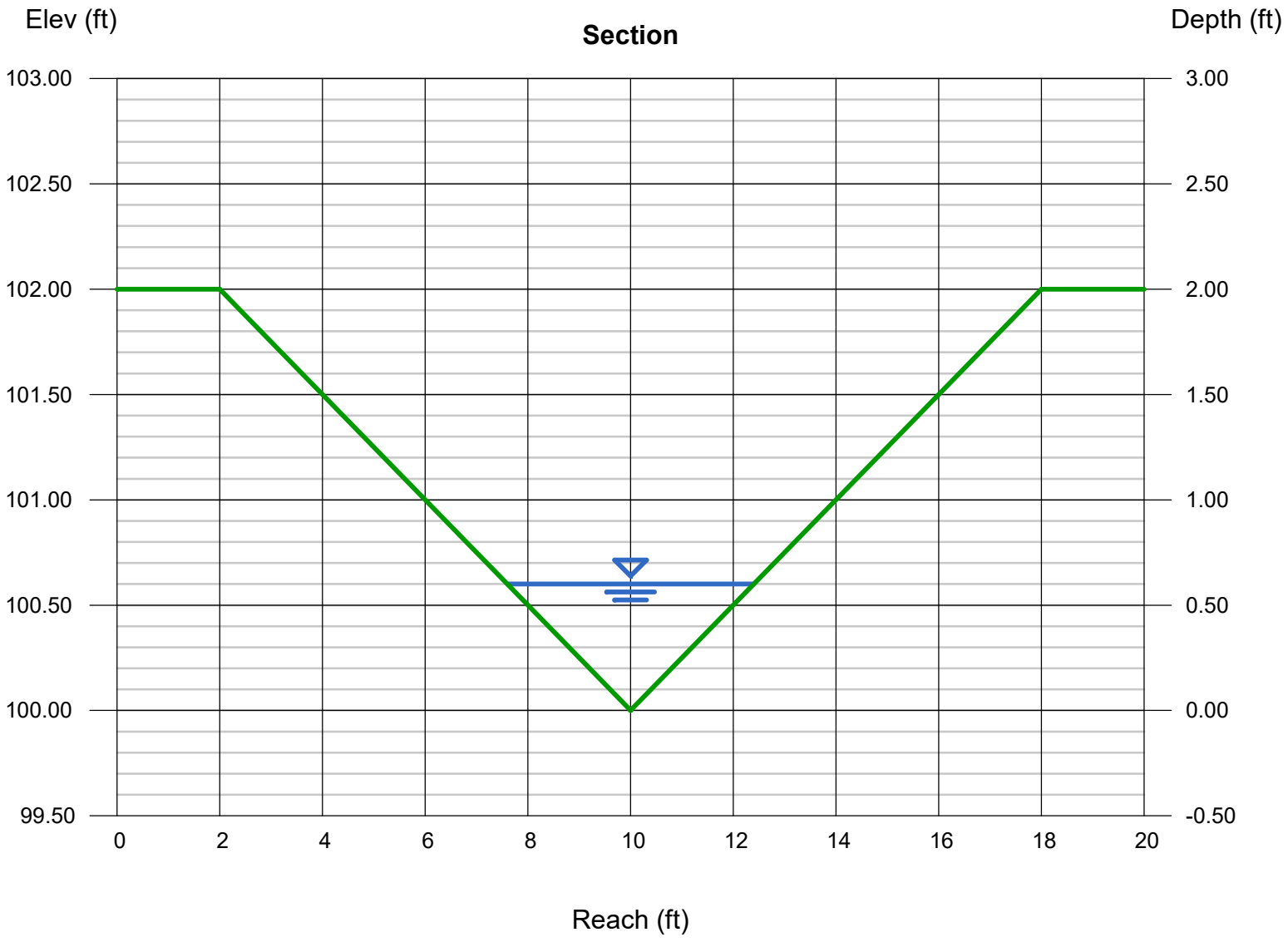
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 7.00

Highlighted

Depth (ft)	= 0.60
Q (cfs)	= 7.000
Area (sqft)	= 1.44
Velocity (ft/s)	= 4.86
Wetted Perim (ft)	= 4.95
Crit Depth, Yc (ft)	= 0.72
Top Width (ft)	= 4.80
EGL (ft)	= 0.97



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Basin A ditch 100yr Sta 12+00

Triangular

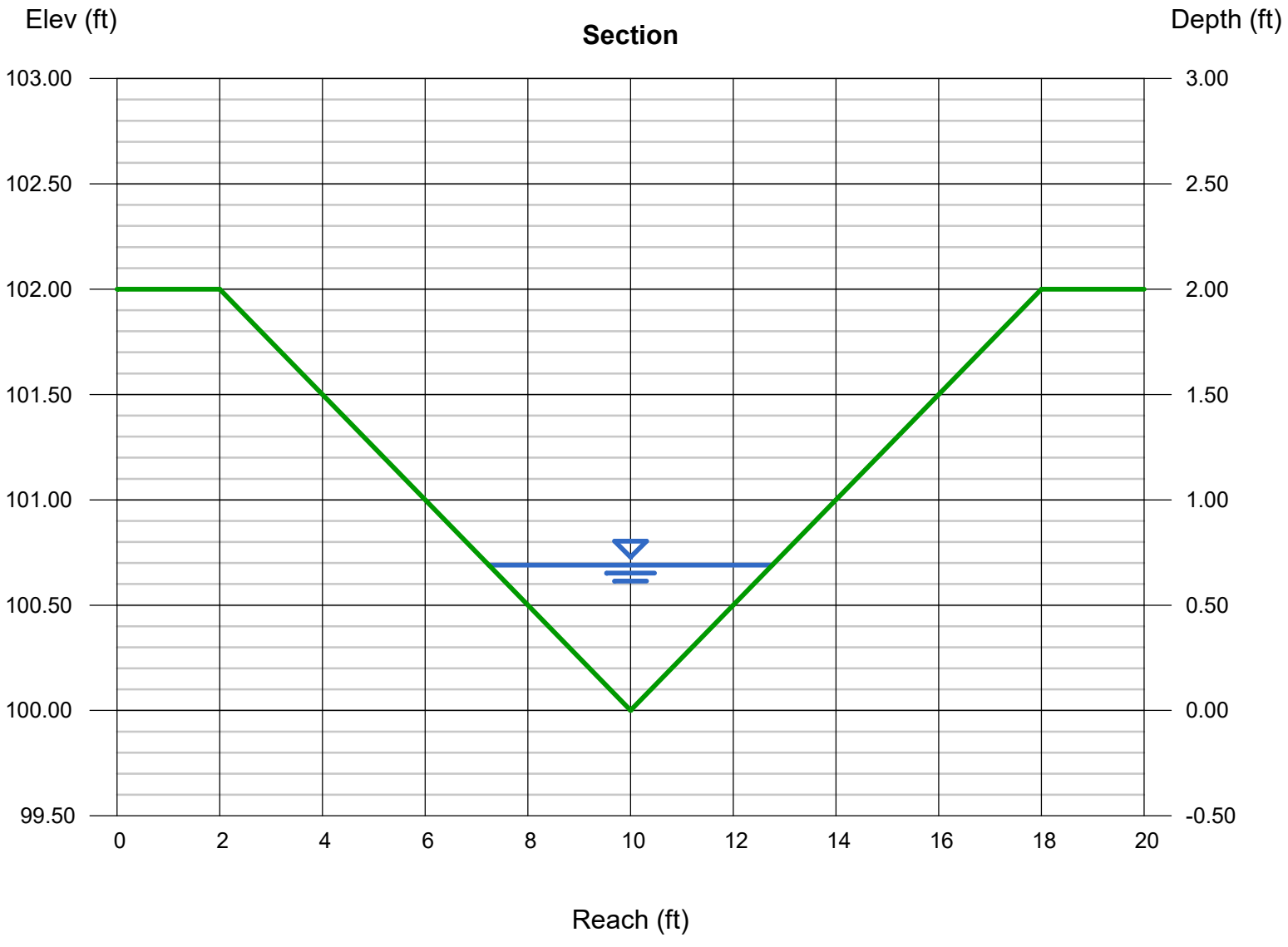
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 9.80

Highlighted

Depth (ft)	= 0.69
Q (cfs)	= 9.800
Area (sqft)	= 1.90
Velocity (ft/s)	= 5.15
Wetted Perim (ft)	= 5.69
Crit Depth, Yc (ft)	= 0.83
Top Width (ft)	= 5.52
EGL (ft)	= 1.10



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Basin A + B ditch 100ft West of Pond

Triangular

Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.50
N-Value	= 0.030

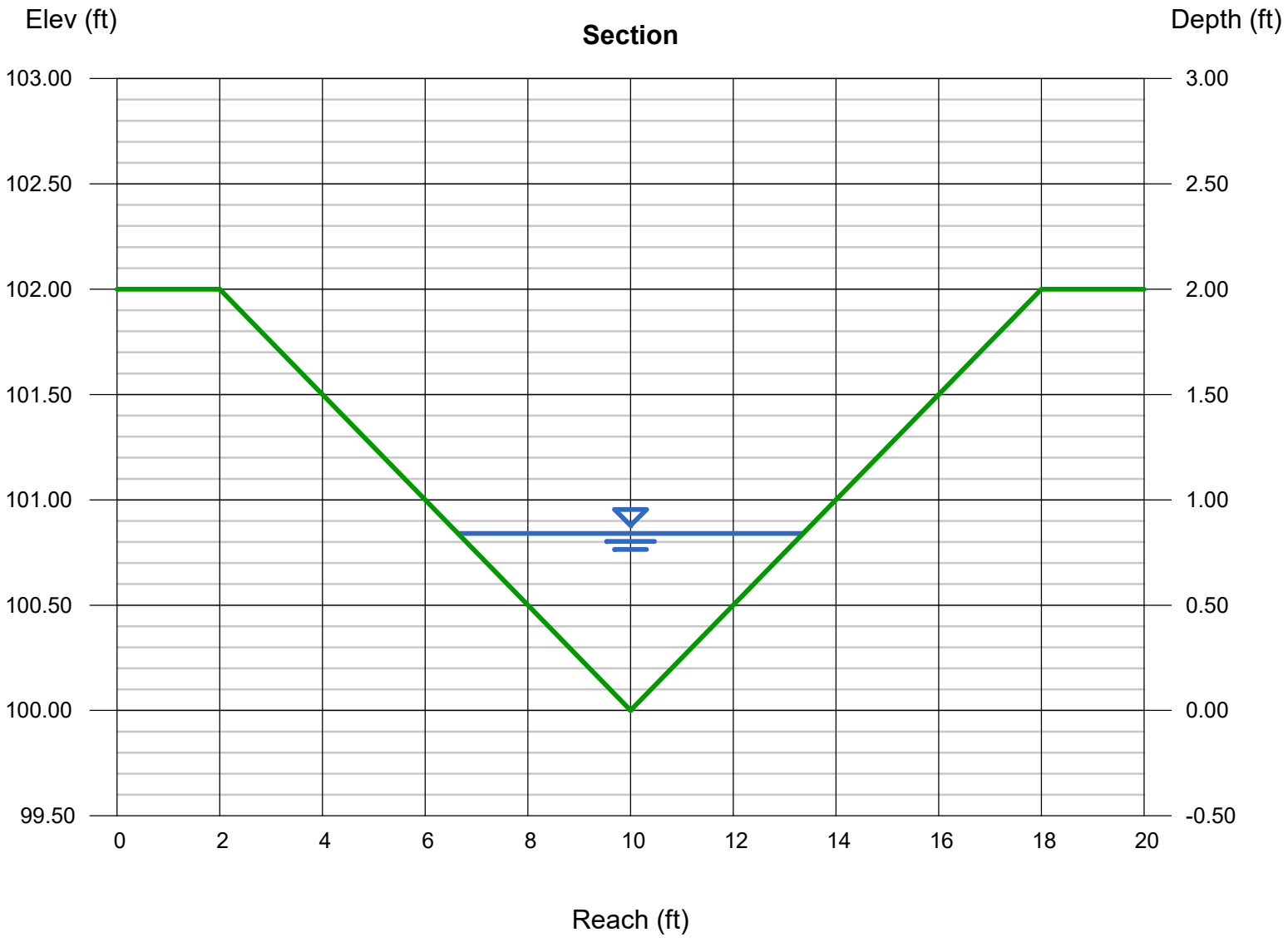
Calculations

Compute by:	Known Q
Known Q (cfs)	= 17.80

Highlighted

Depth (ft)	= 0.84
Q (cfs)	= 17.80
Area (sqft)	= 2.82
Velocity (ft/s)	= 6.31
Wetted Perim (ft)	= 6.93
Crit Depth, Yc (ft)	= 1.05
Top Width (ft)	= 6.72
EGL (ft)	= 1.46

velocities exceeds the permissible velocity for native grass and will require a different treatment.



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Main Channel at DP EX Existing Condtions

User-defined

Invert Elev (ft)	= 35.00
Slope (%)	= 0.70
N-Value	= 0.035

Calculations

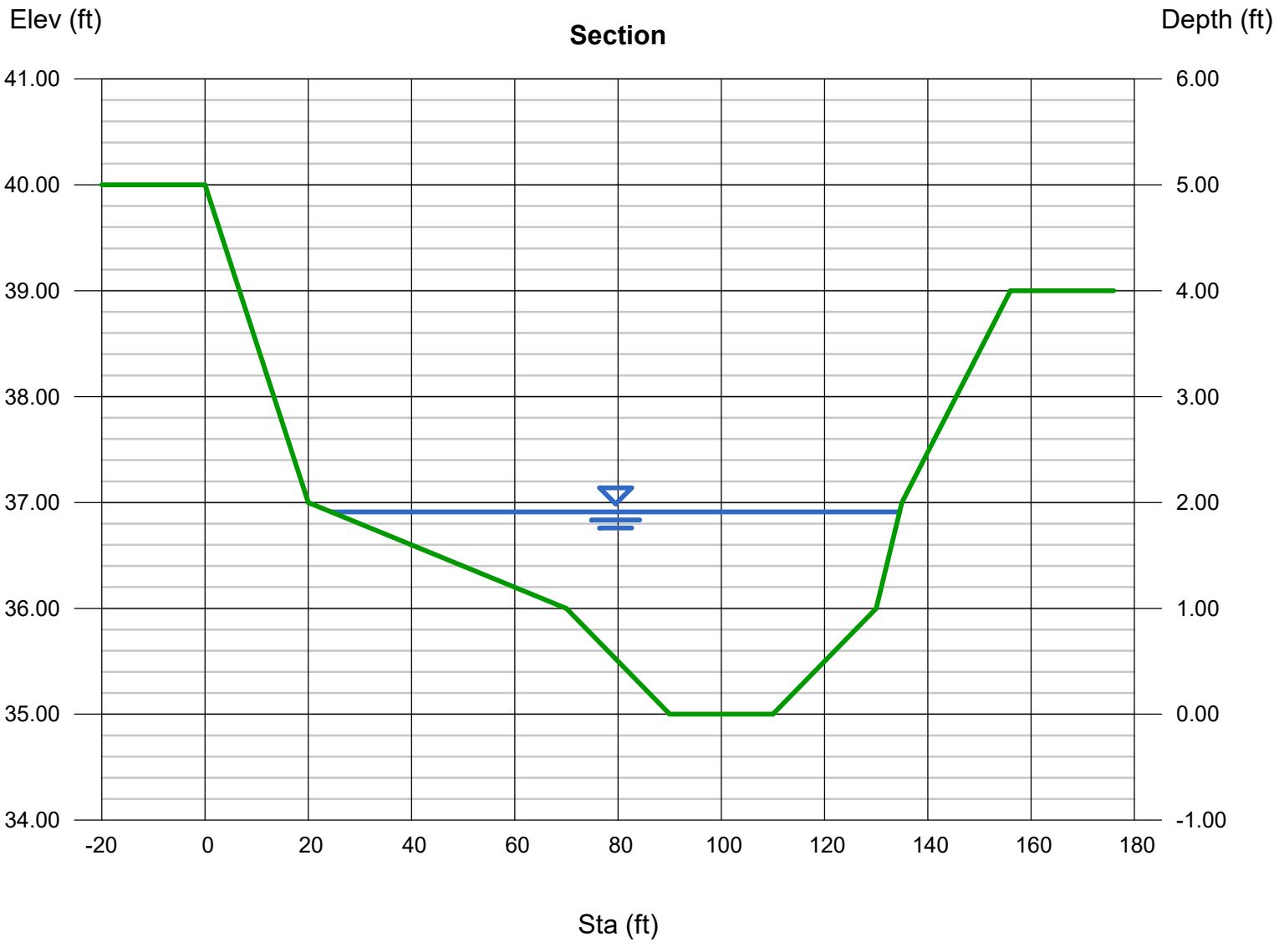
Compute by:	Known Q
Known Q (cfs)	= 433.20

Highlighted

Depth (ft)	= 1.91
Q (cfs)	= 433.20
Area (sqft)	= 117.37
Velocity (ft/s)	= 3.69
Wetted Perim (ft)	= 110.20
Crit Depth, Yc (ft)	= 1.55
Top Width (ft)	= 110.05
EGL (ft)	= 2.12

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

(0.00, 40.00)-(20.00, 37.00, 0.035)-(70.00, 36.00, 0.035)-(90.00, 35.00, 0.035)-(110.00, 35.00, 0.035)-(130.00, 36.00, 0.035)-(135.00, 37.00, 0.035)-(156.00, 39.00, 0.035)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

Main Channel at DP 5 Proposed Condtions

User-defined

Invert Elev (ft)	= 35.00
Slope (%)	= 0.70
N-Value	= 0.035

Calculations

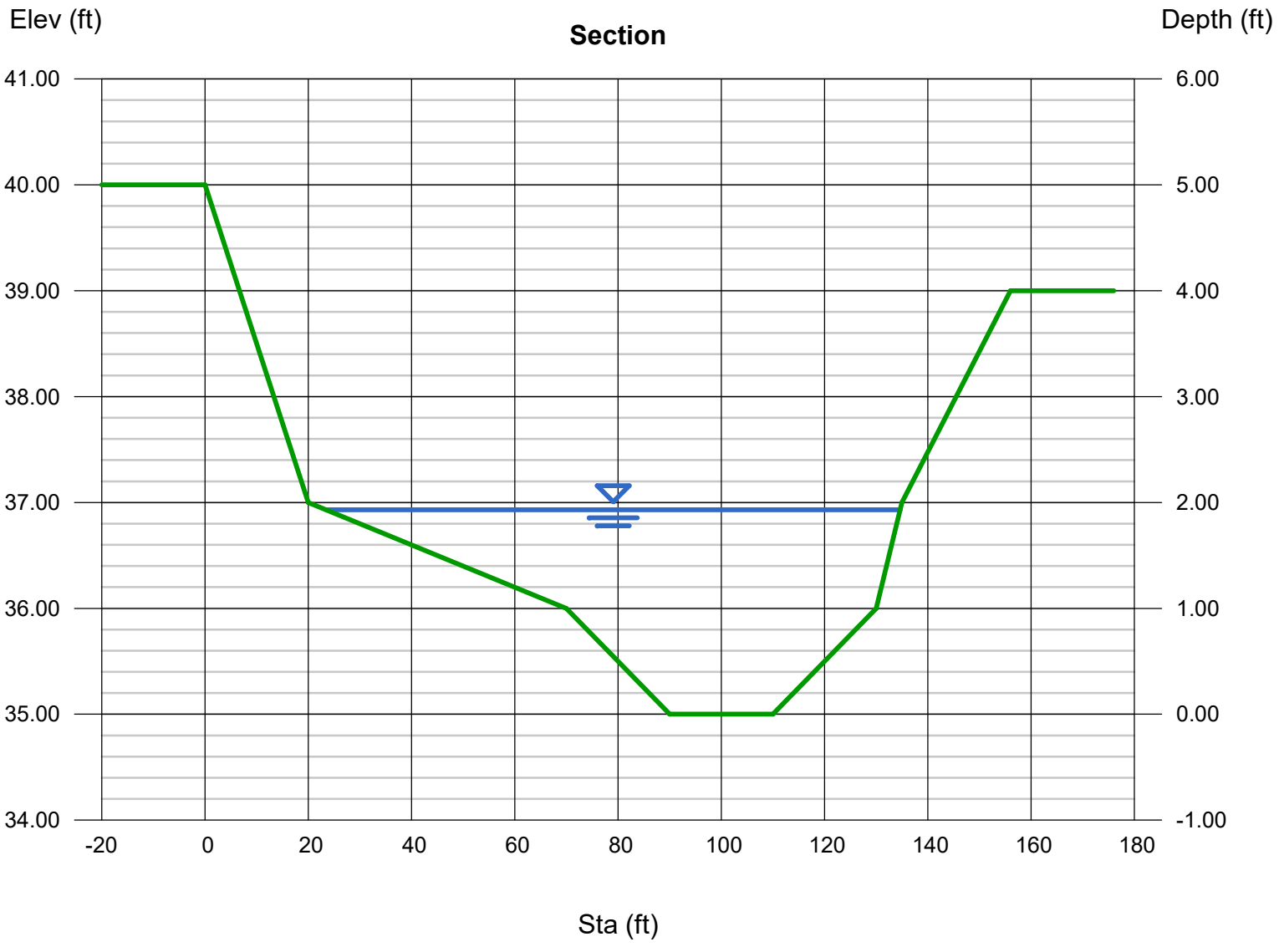
Compute by:	Known Q
Known Q (cfs)	= 445.60

Highlighted

Depth (ft)	= 1.93
Q (cfs)	= 445.60
Area (sqft)	= 119.58
Velocity (ft/s)	= 3.73
Wetted Perim (ft)	= 111.30
Crit Depth, Yc (ft)	= 1.57
Top Width (ft)	= 111.15
EGL (ft)	= 2.15

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

(0.00, 40.00)-(20.00, 37.00, 0.035)-(70.00, 36.00, 0.035)-(90.00, 35.00, 0.035)-(110.00, 35.00, 0.035)-(130.00, 36.00, 0.035)-(135.00, 37.00, 0.035)-(156.00, 39.00, 0.035)



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

18inch Culvert

Invert Elev Dn (ft)	=	100.00
Pipe Length (ft)	=	50.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	100.50
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

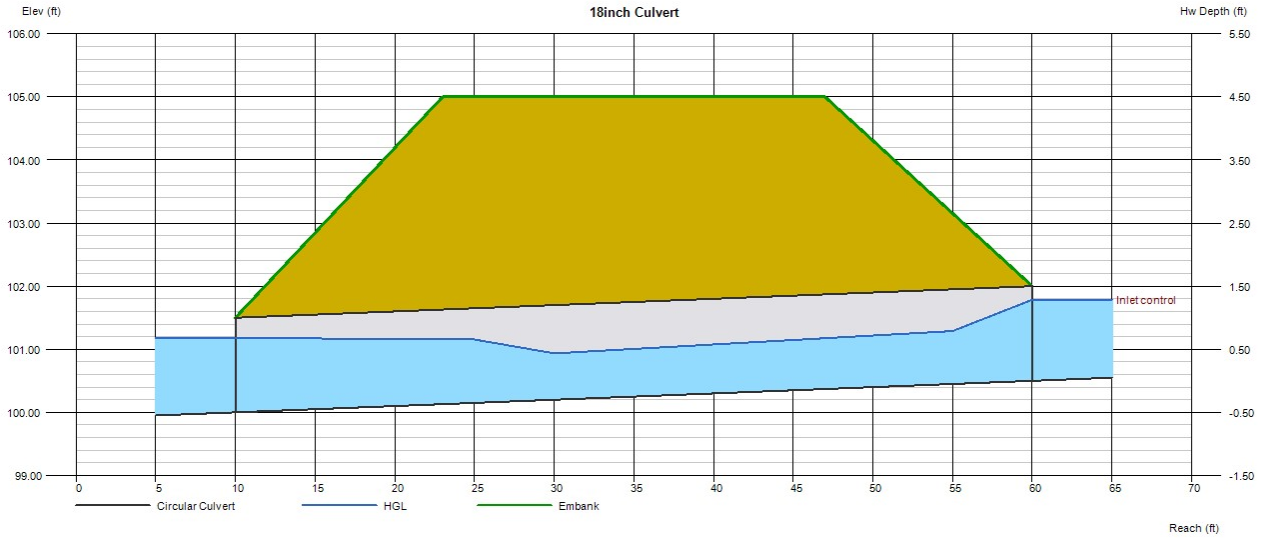
Top Elevation (ft)	=	105.00
Top Width (ft)	=	24.00
Crest Width (ft)	=	150.00

Calculations

Qmin (cfs)	=	5.00
Qmax (cfs)	=	5.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	5.00
Qpipe (cfs)	=	5.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.35
Veloc Up (ft/s)	=	4.77
HGL Dn (ft)	=	101.18
HGL Up (ft)	=	101.36
Hw Elev (ft)	=	101.78
Hw/D (ft)	=	0.86
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

24inch Culvert

Invert Elev Dn (ft)	=	100.00
Pipe Length (ft)	=	25.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	100.25
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

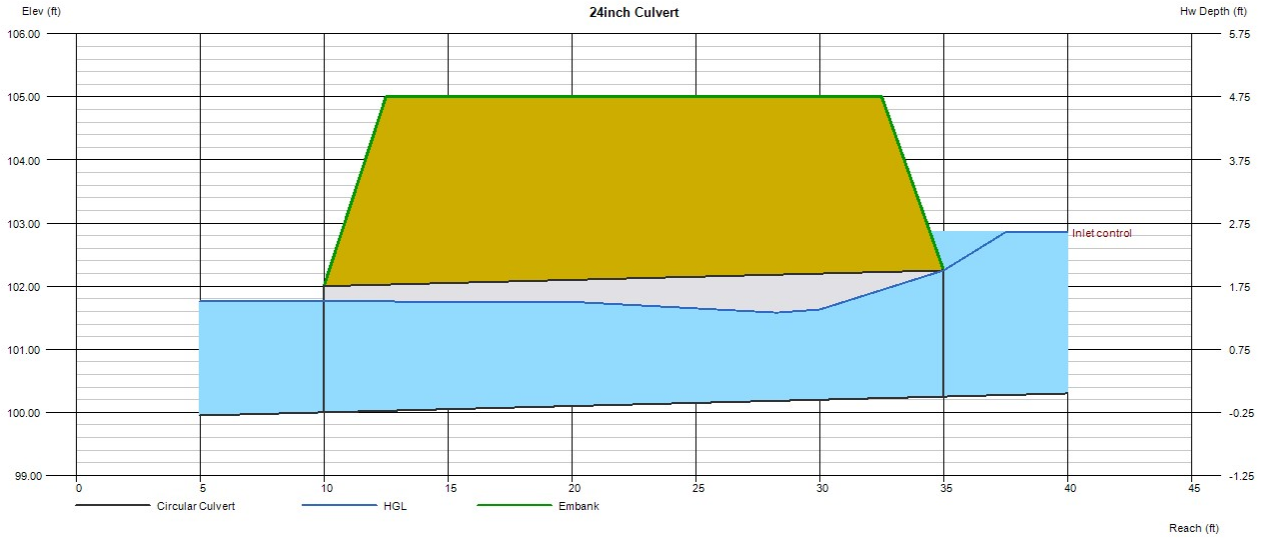
Top Elevation (ft)	=	105.00
Top Width (ft)	=	20.00
Crest Width (ft)	=	150.00

Calculations

Qmin (cfs)	=	17.80
Qmax (cfs)	=	17.80
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	17.80
Qpipe (cfs)	=	17.80
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.08
Veloc Up (ft/s)	=	6.93
HGL Dn (ft)	=	101.76
HGL Up (ft)	=	101.77
Hw Elev (ft)	=	102.86
Hw/D (ft)	=	1.30
Flow Regime	=	Inlet Control



Culvert Report

Circular Culvert

Invert Elev Dn (ft)	=	7445.00
Pipe Length (ft)	=	55.00
Slope (%)	=	0.02
Invert Elev Up (ft)	=	7445.01
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	2
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

Top Elevation (ft)	=	7450.00
Top Width (ft)	=	20.00
Crest Width (ft)	=	40.00

Calculations

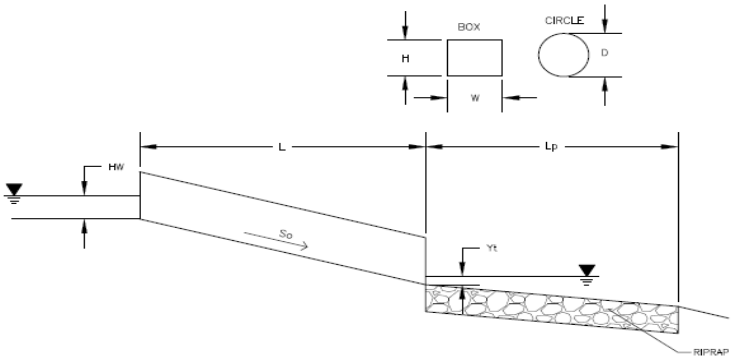
Qmin (cfs)	=	431.00
Qmax (cfs)	=	431.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	431.00
Qpipe (cfs)	=	240.80
Qovertop (cfs)	=	190.20
Veloc Dn (ft/s)	=	10.01
Veloc Up (ft/s)	=	9.58
HGL Dn (ft)	=	7448.65
HGL Up (ft)	=	7449.09
Hw Elev (ft)	=	7451.34
Hw/D (ft)	=	1.58
Flow Regime	=	Inlet Control

Determination of Culvert Headwater and Outlet Protection

Project: JeniShay Farms
Basin ID: Triple 48" Culvert Outfall



Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

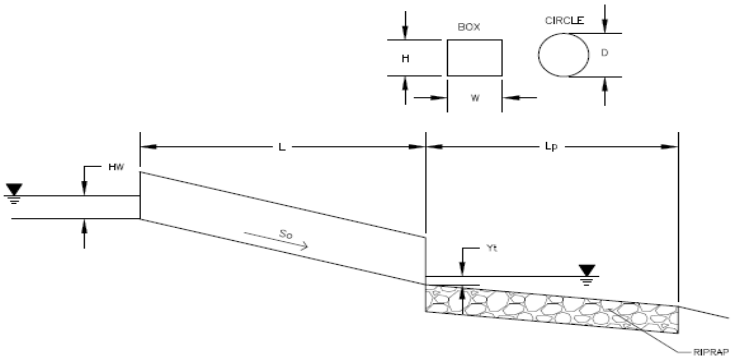
	Design Discharge	Q =	432	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	48	inches
	Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	3	
	Inlet Elevation	Elev IN =	100.6	ft
	Outlet Elevation **OR** Slope	Elev OUT =	100	ft
	Culvert Length	L =	60	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =	103.75	ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	3.75	ft
Flow Area at Max Channel Velocity	A_t =	28.80	ft^2
Culvert Cross Sectional Area Available	A =	12.57	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.25	
Sum of All Losses Coefficients	k_s =	1.45	ft
Culvert Normal Depth	Y_n =	3.03	ft
Culvert Critical Depth	Y_c =	3.55	ft
Tailwater Depth for Design	d =	3.77	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	3.52	ft
Expansion Factor	1/(2*tan(Θ)) =	5.93	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	4.50	$ft^{0.5}$/s
Froude Number	Fr =	1.44	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	1.07	
Inlet Control Headwater	HW_I =	6.89	ft
Outlet Control Headwater	HW_O =	6.13	
Design Headwater Elevation	**HW =**	**107.49**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.72**	**HW/D > 1.5!**
Minimum Theoretical Riprap Size	d_{50} =	6	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**22**	**ft**
Width of Protection	**T =**	**8**	**ft**

Determination of Culvert Headwater and Outlet Protection

Project: JeniShay Farms
Basin ID: Pond Outfall Pipe 18"



Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

	Design Discharge	Q =	5.6	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	100.45	ft
	Outlet Elevation **OR** Slope	Elev OUT =	100	ft
	Culvert Length	L =	45	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.60	ft
Flow Area at Max Channel Velocity	A_t =	1.12	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.69	
Sum of All Losses Coefficients	k_s =	1.89	ft
Culvert Normal Depth	Y_n =	0.74	ft
Culvert Critical Depth	Y_c =	0.91	ft
Tailwater Depth for Design	d =	1.21	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.12	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.03	$ft^{0.5}/s$
Froude Number	Fr =	1.49	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.54	
Inlet Control Headwater	HW_I =	1.32	ft
Outlet Control Headwater	HW_O =	1.05	
Design Headwater Elevation	**HW =**	**101.77**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.88**	
Minimum Theoretical Riprap Size	d_{50} =	3	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**5**	**ft**
Width of Protection	**T =**	**3**	**ft**

Final Drainage Report

JENISHAY FARMS

(Forebay Calculations)

WQCV Equation

WQCV = a(0.91*(I)^3 - 1.19*I^2 + 0.78*I)

(per UDFCD eq 3-1)

Solve		WQCV = water quality capture volume (watershed inches)
1		a = 40-hr drain time coefficient (per UDFCD Vol 3 Table 3-2)
0.259		I = imperviousness (%/100) (per imperviousness calculations)
Solution =	**0.14**	

Water Quality Capture Volume Required

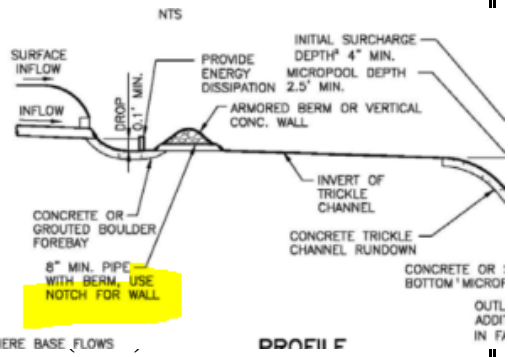
V = (WQCV/12)*A

(per UDFCD eq 3-3)

Solve		V = required storage volume (acre-ft)
0.14		WQCV = water quality capture volume (watershed inches)
5.13		A = tributary watershed area (acre)
Solution =	**0.059**	acre-ft
Solution =	**2570**	ft^3

Revise design to a rectangular notch.

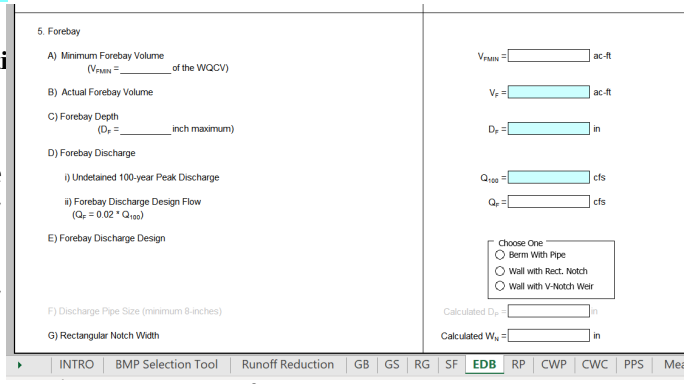
UD-BMP provides calculation the required width. This may simplify construction and future maintenance.
Per MHFD a notch should be used for walls.



V = required storage volume (ft^3)

300

Soluti



Area of Orifice

Ao = Q/(Cd*2*g*h)

(orifice equation)

Solve		
0.267		
0.6		
32.17		
1.5		
Solution =	**0.00461**	(ft^2)
Solution =	**0.6631**	(in^2)

Release Pipe Size

D = (4*A)/pi)^2

Solve		D = diameter of pipe (in)
0.6631		Ao = area of orifice (in^2)
3.1416		pi
Solution =	**0.71**	(in)

Release Pipe Size (4" Minimum)

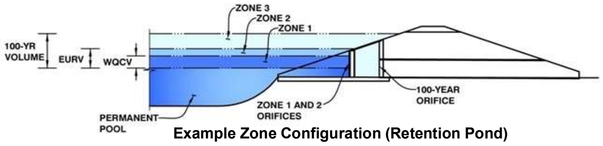
Solution =	**4.00**	(in)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: **JeniShay Farms**

Basin ID:



Example Zone Configuration (Retention Pond)

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	1,530	0.035		
	--	0.50	--	--	--	2,106	0.048	909	0.021
7444	--	1.00	--	--	--	2,757	0.063	2,125	0.049
	--	1.50	--	--	--	3,492	0.080	3,687	0.085
7445	--	2.00	--	--	--	4,170	0.096	5,602	0.129
	--	2.50	--	--	--	5,024	0.115	7,901	0.181
7446	--	3.00	--	--	--	5,778	0.133	10,601	0.243
	--	3.50	--	--	--	6,653	0.153	13,709	0.315
7447	--	4.00	--	--	--	7,462	0.171	17,238	0.396
	--	4.50	--	--	--	8,414	0.193	21,207	0.487
7448	--	5.00	--	--	--	9,325	0.214	25,642	0.589
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Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	5.22	acres
Watershed Length =	950	ft
Watershed Length to Centroid =	450	ft
Watershed Slope =	0.047	ft/ft
Watershed Imperviousness =	25.90%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	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) =	0.060	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.137	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.92 in.) =	0.080	acre-feet	0.92	inches
5-yr Runoff Volume (P1 = 1.19 in.) =	0.133	acre-feet	1.19	inches
10-yr Runoff Volume (P1 = 1.44 in.) =	0.210	acre-feet	1.44	inches
25-yr Runoff Volume (P1 = 1.82 in.) =	0.395	acre-feet	1.82	inches
50-yr Runoff Volume (P1 = 2.13 in.) =	0.523	acre-feet	2.13	inches
100-yr Runoff Volume (P1 = 2.47 in.) =	0.693	acre-feet	2.47	inches
500-yr Runoff Volume (P1 = 3.36 in.) =	1.082	acre-feet	3.36	inches
Approximate 2-yr Detention Volume =	0.075	acre-feet		
Approximate 5-yr Detention Volume =	0.111	acre-feet		
Approximate 10-yr Detention Volume =	0.174	acre-feet		
Approximate 25-yr Detention Volume =	0.228	acre-feet		
Approximate 50-yr Detention Volume =	0.250	acre-feet		
Approximate 100-yr Detention Volume =	0.311	acre-feet		

Define Zones and Basin Geometry

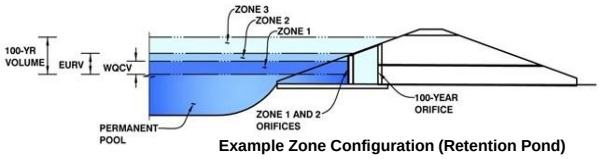
Zone 1 Volume (WQCV) =	0.060	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.077	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.174	acre-feet
Total Detention Basin Volume =	0.311	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **JeniShay Farms**

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.18	0.060	Orifice Plate
Zone 2 (EURV)	2.09	0.077	Orifice Plate
Zone 3 (100-year)	3.48	0.174	Weir&Pipe (Restrict)
Total (all zones)		0.311	

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.09	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.75	1.50					
Orifice Area (sq. inches)	0.70	0.14	0.14					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.09	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.72	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	2.58	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	10.35	N/A	
Horiz. Length of Weir Sides =	2.50	N/A	feet	Overflow Grate Open Area w/o Debris =	7.22	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	3.61	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.70	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.36	N/A	feet
Restrictor Plate Height Above Pipe Invert =	7.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.40	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

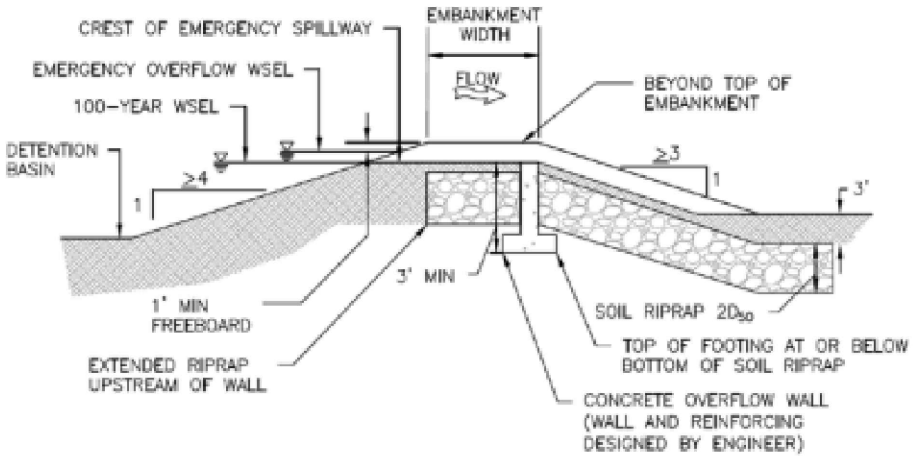
Spillway Invert Stage=	3.10	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.60 feet
Spillway Crest Length =	4.00	feet	Stage at Top of Freeboard =	4.70 feet
Spillway End Slopes =	3.00	H:V	Basin Area at Top of Freeboard =	0.20 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.53 acre-ft

Calculated Parameters for Spillway

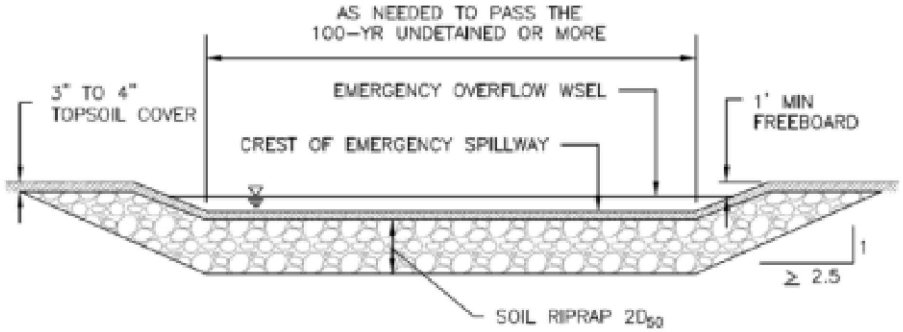
Routed Hydrograph Results

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	0.92	1.19	1.44	1.82	2.13	2.47	3.36
CUHP Runoff Volume (acre-ft) =	0.060	0.137	0.080	0.133	0.210	0.395	0.523	0.693	1.082
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.080	0.133	0.210	0.395	0.523	0.693	1.082
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.4	1.1	3.3	4.5	6.2	9.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.07	0.22	0.63	0.87	1.20	1.90
Peak Inflow Q (cfs) =	N/A	N/A	0.9	1.4	2.3	4.6	6.1	7.8	11.8
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.7	3.0	4.5	5.6	9.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.6	0.9	1.0	0.9	1.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.4	0.6	0.8	0.8
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) =	42	64	49	64	65	59	56	52	44
Time to Drain 99% of Inflow Volume (hours) =	**45**	69	53	69	72	68	67	65	60
Maximum Ponding Depth (ft) =	1.17	2.09	1.36	1.96	2.29	2.56	2.68	2.94	3.49
Area at Maximum Ponding Depth (acres) =	0.07	0.10	0.08	0.09	0.11	0.12	0.12	0.13	0.15
Maximum Volume Stored (acre-ft) =	0.060	0.137	0.073	0.125	0.157	0.187	0.203	0.235	0.312



EMERGENCY SPILLWAY PROFILE



EMERGENCY SPILLWAY SECTION AND SPILLWAY CHANNEL

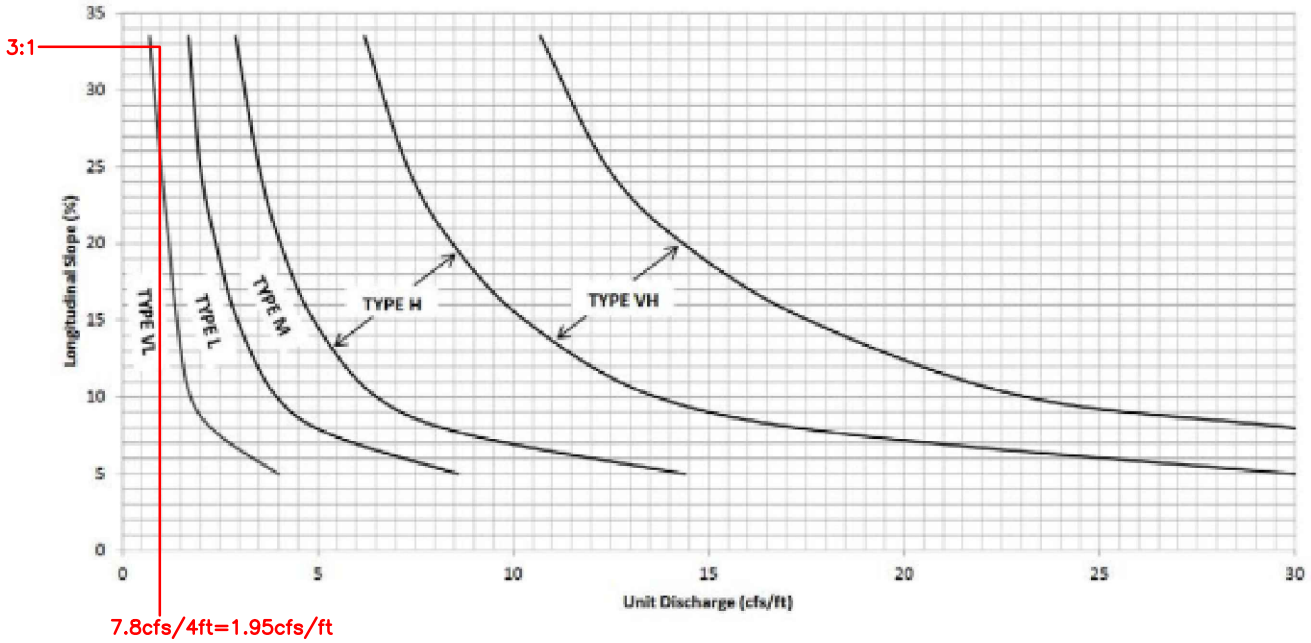
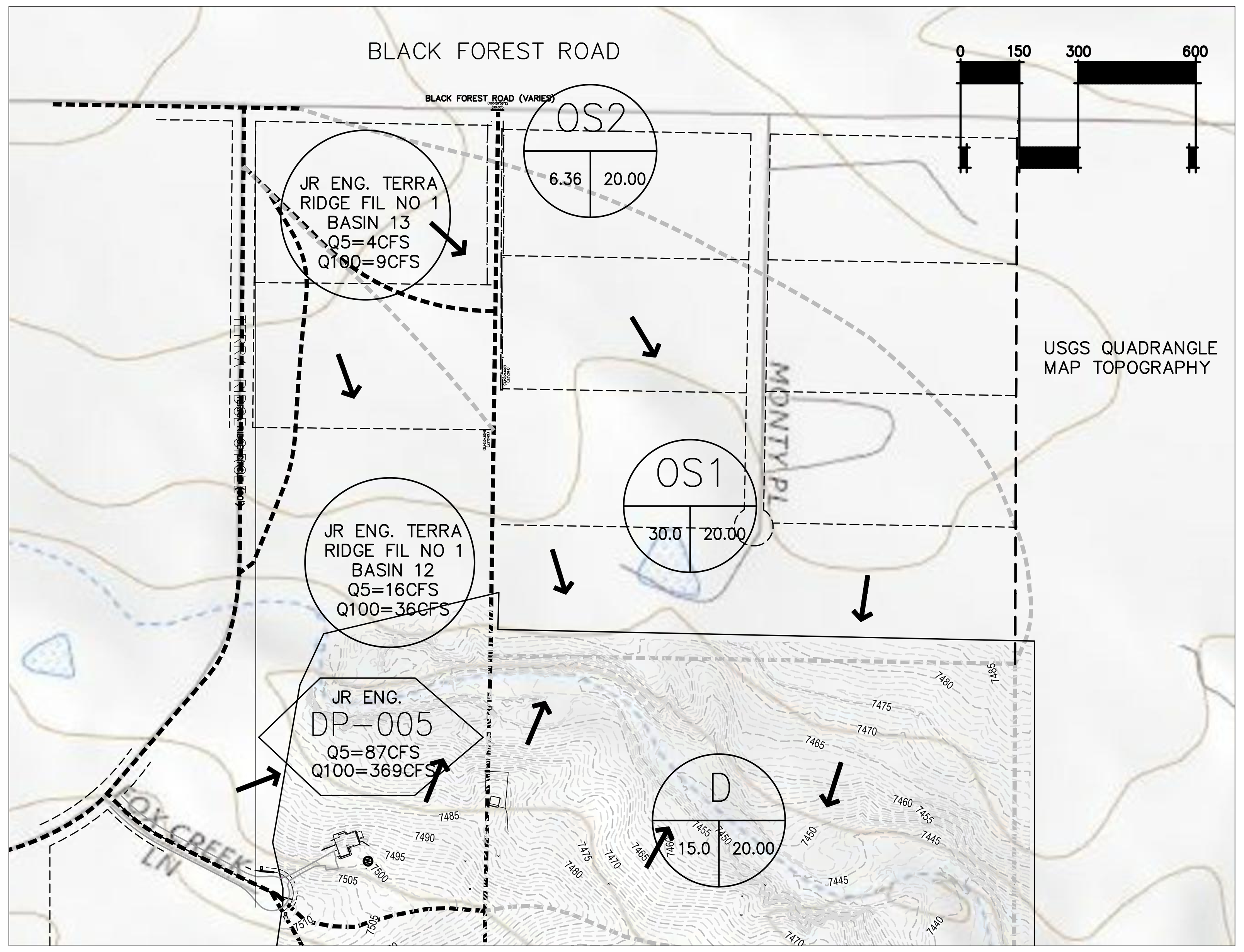


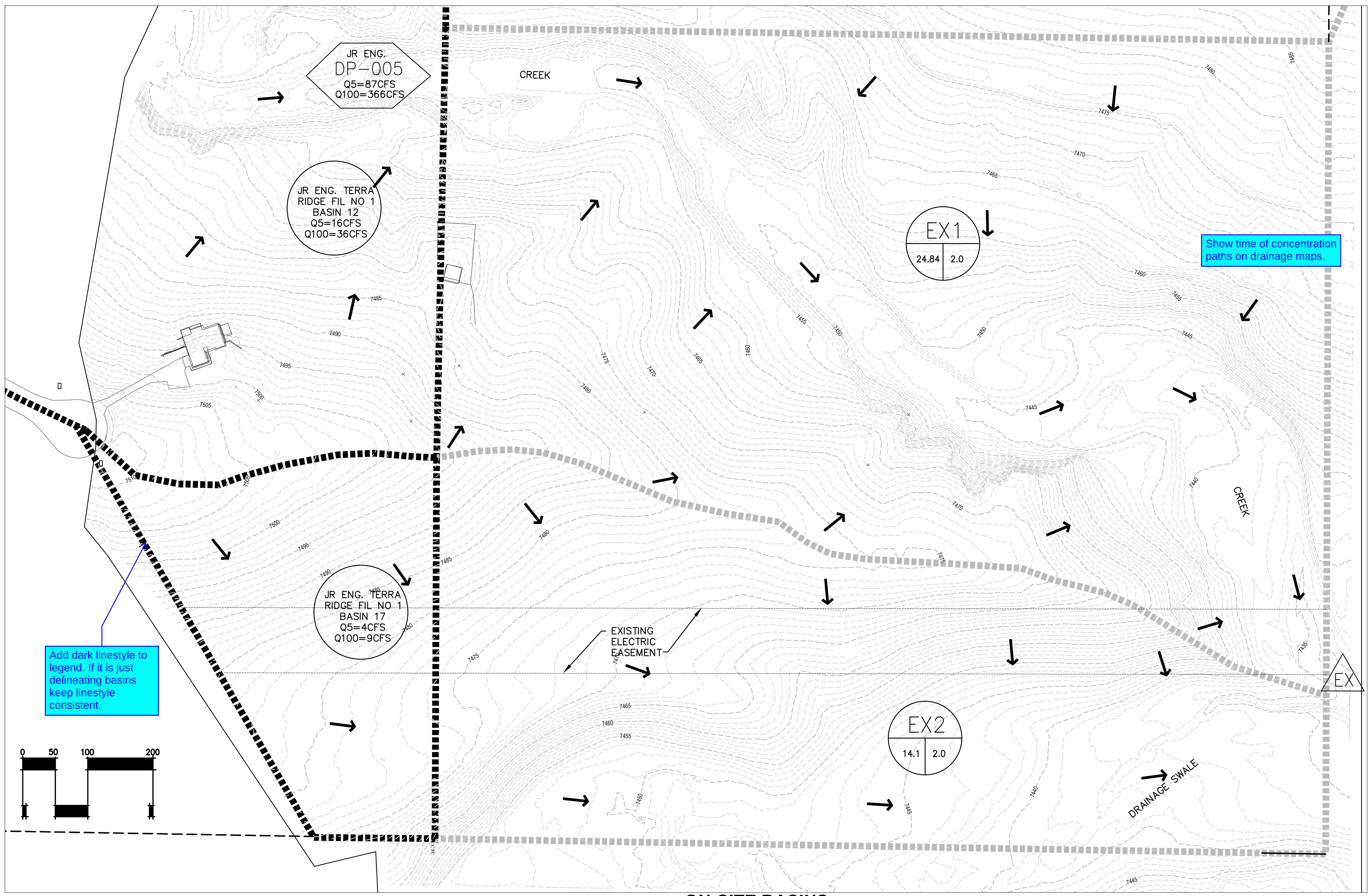
Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

USE TYPE L

Appendix C
Plan



OFF-SITE BASINS



ON-SITE BASINS

LEGEND

- A / 1.25 | 3.0 — BASIN ID; % IMPERVIOUS; AREA (ACRES)
- 1 — DESIGN POINT
- DRAINAGE BASIN BOUNDARY
- EXISTING CONTOUR (2')
- PROPOSED CONTOUR (2')
- SURFACE FLOW DIRECTION
- DRAINAGE EASEMENT

RUNOFF COEFFICIENT SUMMARY

BASIN	AREA (ACRES)	C5	C100
EX1	24.84	0.09	0.36
EX2	6.36	0.09	0.36

RUNOFF SUMMARY

DESIGN POINT	Q5	Q100
EX	93.1	433.2

NORTH

LODESTAR ENGINEERING, LLC

ISSUED 10/28/19

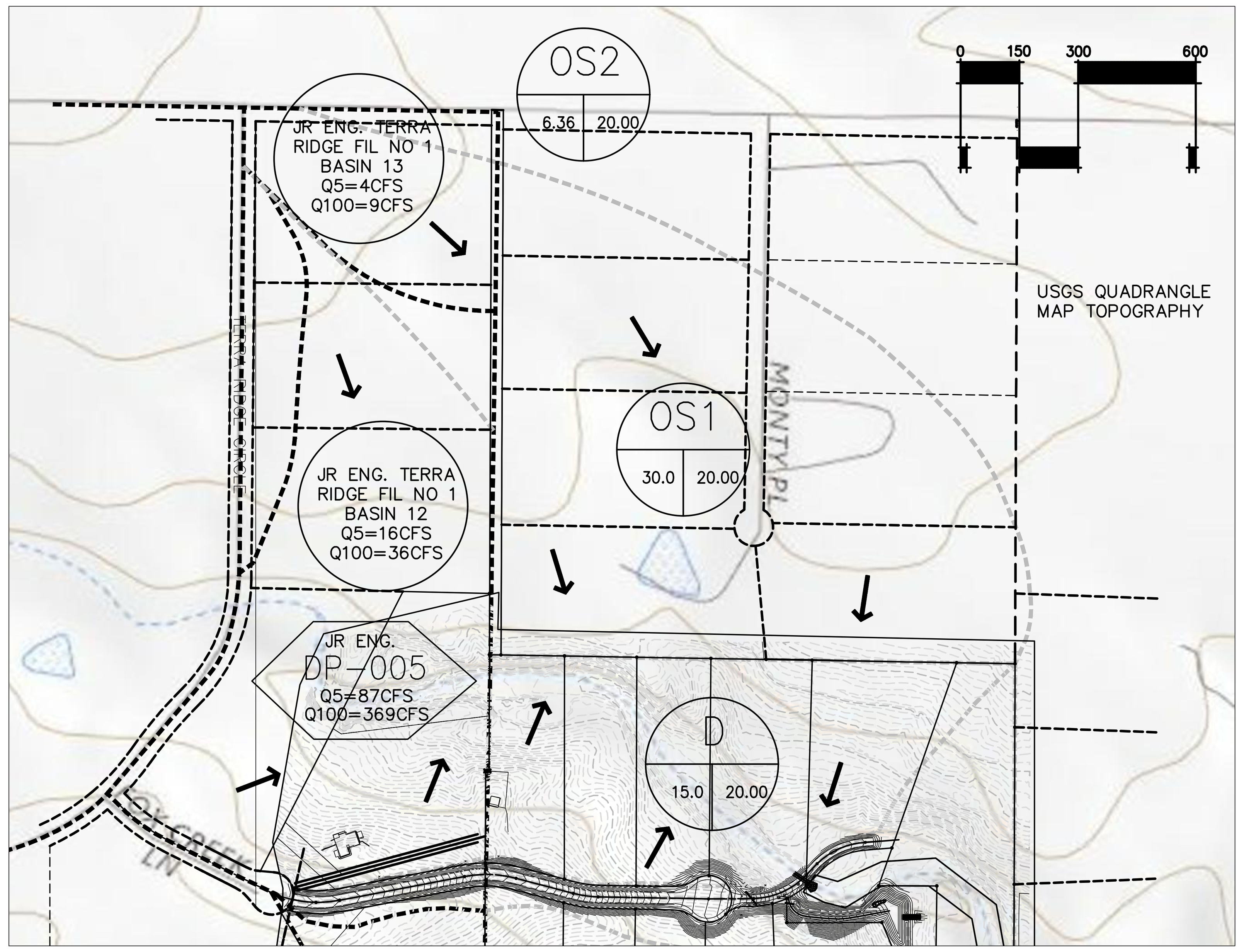
REVISIONS

TERRA RIDGE NORTH

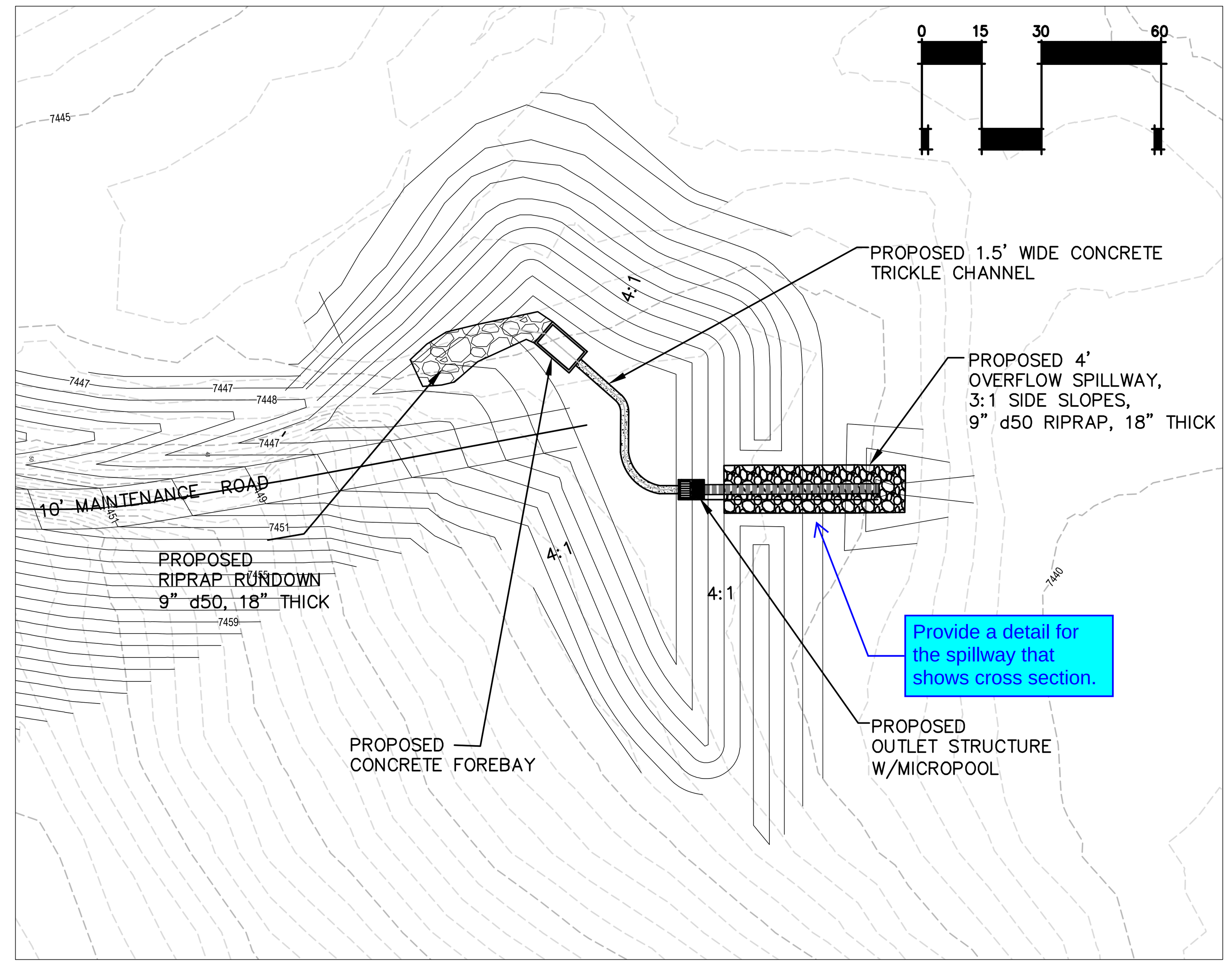
TOWN OF BLACK FOREST
EL PASO COUNTY, COLORADO

EXISTING DRAINAGE PLAN

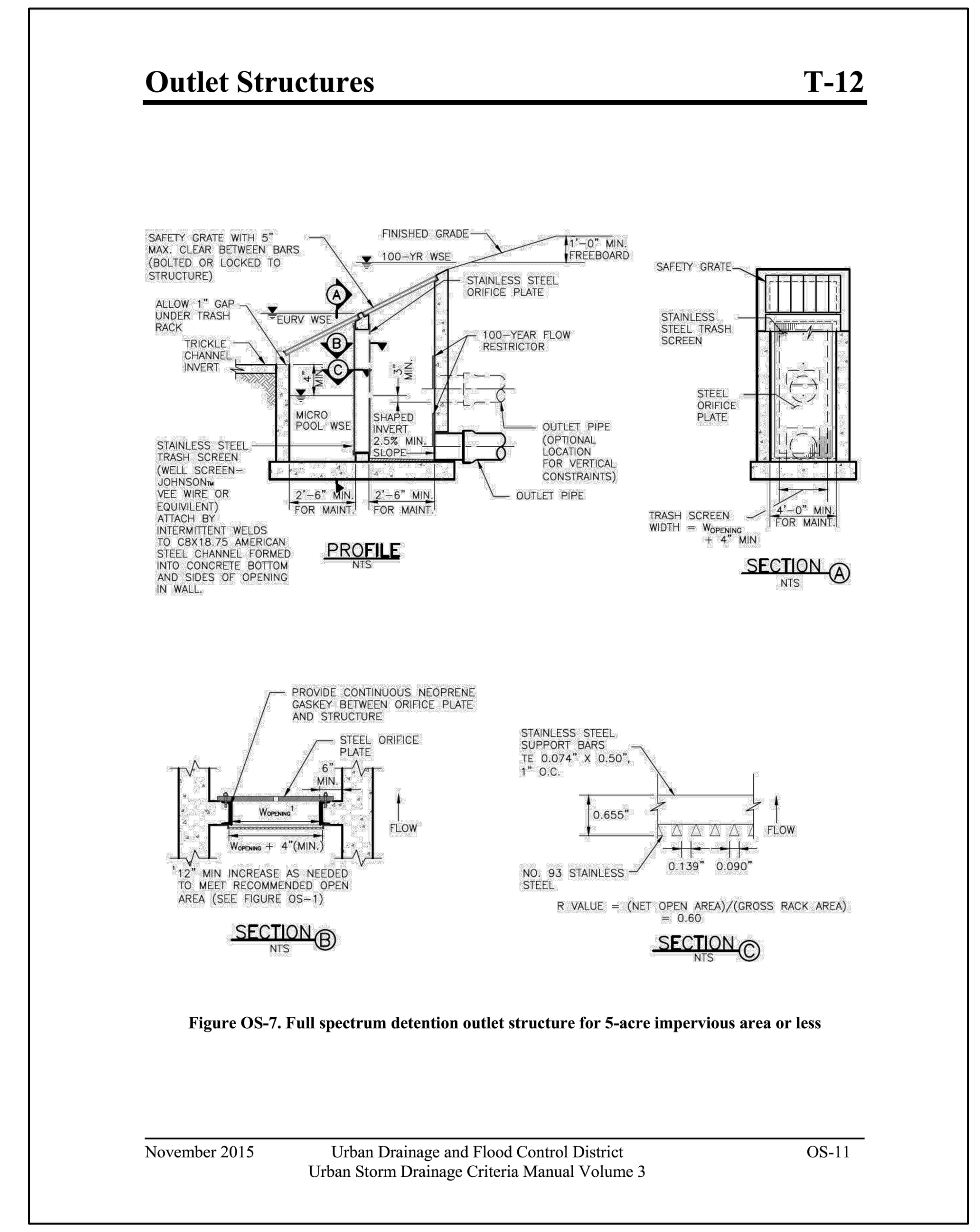
D1
SHEET NO.

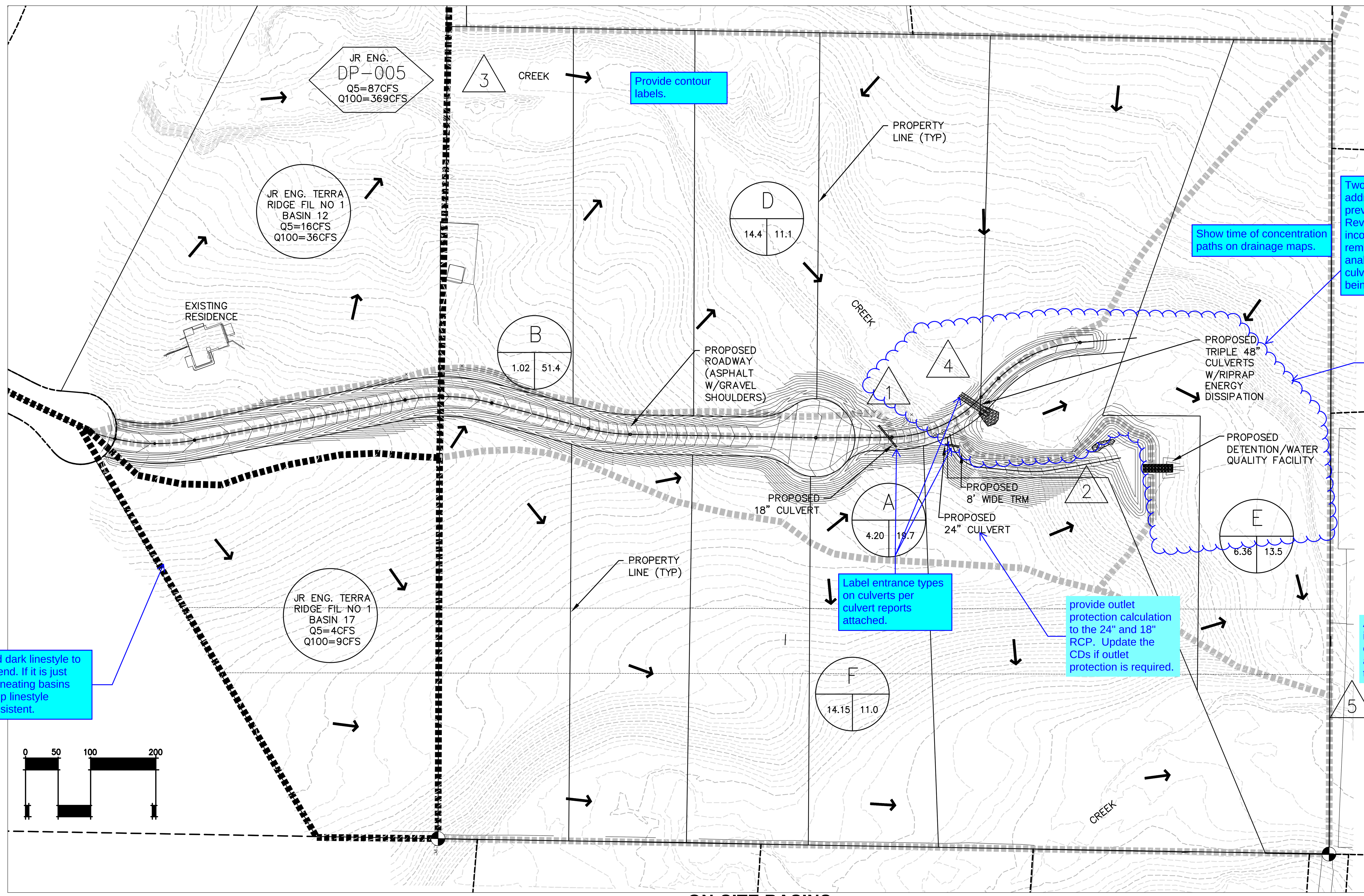


OFF-SITE BASINS
1"=300'



DETENTION/WATER QUALITY FACILITY
1"=30'





ON-SITE BASINS
1"=100'

NORTH

LEGEND

- A / 1.25 2.0 — BASIN ID; % IMPERVIOUS; AREA (ACRES)
- 1 (triangle) — DESIGN POINT
- DRAINAGE BASIN BOUNDARY
- EXISTING CONTOUR (2')
- PROPOSED CONTOUR (2')
- SURFACE FLOW DIRECTION
- DRAINAGE EASEMENT

RUNOFF COEFFICIENT SUMMARY

BASIN	AREA (ACRES)	C5	C100
A	4.20	0.18	0.51
B	0.94	0.46	0.63
C	N/A	N/A	N/A
D	14.59	0.09	0.49
E	6.36	0.10	0.49
F	14.15	0.08	0.48
OS1	30.00	0.05	0.46
OS2	6.36	0.05	0.46
EX1	24.84	0.09	0.36
EX2	14.10	0.09	0.36

RUNOFF SUMMARY

DESIGN POINT	Q5	Q100
1	2.0	4.5
2	5.4	18.0
3	86.3	366.0
4	88.6	431.8
5	89.1	445.6
EX	88.5	433.2

WATER QUALITY/DETENTION SUMMARY

FACILITY TYPE	EXTENDED DET. BASIN
WQCV	0.060 ACRE-FT
EURV	0.137 ACRE-FT
100-YR STORAGE PROVIDED	0.235 ACRE-FT
100-YR PEAK OUTFLOW Q	5.6 CFS

LODESTAR ENGINEERING, LLC

ISSUED 8/29/21

REVISIONS

TERRA RIDGE NORTH
TOWN OF BLACK FOREST
EL PASO COUNTY, COLORADO

DEVELOPED DRAINAGE PLAN

D2
SHEET NO.