

PHASE II DRAINAGE STUDY
FOR
CRYSTAL VALLEY RANCH
FILING NO. 14 – AMENDMENT 1

(SDP26-0005)

Castle Rock, Colorado

Friday, January 23, 2026

(Updated August 11, 2026)

PREPARED FOR

CVR PA3A LLC

8031 S. Homesteader Drive

Morrison, CO 80465

Attn: Gregory W. Brown

PREPARED BY

Legacy Consulting Engineers Inc.

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Centennial CO 80122

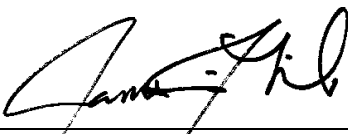
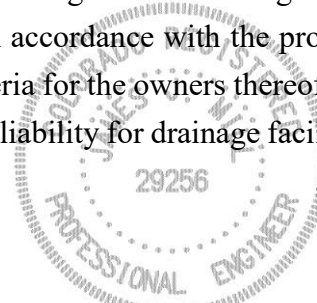
(720) 318-8862

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

ENGINEER'S STATEMENT:

I affirm that this report and plan for the PHASE II drainage design of CVR Filing 14 Amendment 1 was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Castle Rock Drainage Design and Technical Criteria for the owners thereof. I understand that the Town of Castle Rock does not and will not assume liability for drainage facilities designed by others.


_____

2026-08-11

Legacy Consulting Engineers, Inc.

James J. Mill, P.E. (Colorado PE #29256)

OWNER/DEVELOPER'S STATEMENT

CVR PA3A LLC hereby certifies that the drainage facilities for CVR Filing 14 Amendment 1 shall be constructed according to the design presented in this report. I understand that the Town of Castle Rock does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the Town of Castle Rock reviews drainage plans pursuant to the Municipal Code; but cannot, on behalf of CVR Filing 14 Amendment 1, guarantee that final drainage design review will absolve CVR PA3A LLC and/or their successors and/or assigns of future liability for improper design.



CVR PA3A LLC

2026-08-11

Date

Gregory W. Brown

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

TOWN OF CASTLE ROCK APPROVALS:

Engineering Division

Date

Development Services Director

Date

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

Table of Contents

II. GENERAL LOCATION AND DESCRIPTION	6
A. SITE LOCATION	6
B. DESCRIPTION OF PROPERTY	6
III. DRAINAGE BASINS AND SUB-BASINS	7
A. MAJOR DRAINAGE BASINS	7
B. MINOR DRAINAGE BASINS	7
IV. DRAINAGE DESIGN CRITERIA	10
A. REGULATIONS.....	10
B. DRAINAGE STUDIES, MASTER PLANS, SITE CONSTRAINTS.....	10
C. HYDROLOGY.....	10
D. HYDRAULICS.....	10
E. STORAGE AND WATER QUALITY ENHANCEMENT.....	11
V. STORMWATER MANAGEMENT FACILITY DESIGN.....	11
A. STORMWATER CONVEYANCE FACILITIES.....	11
B. STORMWATER STORAGE FACILITIES	12
C. WATER QUALITY ENHANCEMENT CONTROL MEASURES	12
D. FLOODPLAIN MODIFICATION	12
E. GEOTECH INVESTIGATION & SUB-SURFACE COLLECTION SYSTEM DESIGN.	12
F. OPERATION AND MAINTENANCE.....	12
G. ADDITIONAL PERMITTING REQUIREMENTS.....	12

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

H. GENERAL	12
VI. CONCLUSIONS	13
A. COMPLIANCE WITH STANDARDS	13
B. VARIANCES	13
C. DRAINAGE CONCEPT	13
VII. REFERENCES	14

<u>Figure</u>	<u>Description</u>
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APPENDIX A - PROJECT INFORMATION

1	Vicinity Map
2	SCS Soils Map and Soil Properties.

APPENDIX B - HYDROLOGY

3	Design Point Rainfall Values
4	Time-Intensity-Frequency Zones
5	Runoff Summary
6	Composite “I” and “C” Calculations
7	Average Flow Velocities
7	Time of Concentration, Rational Method Calculation Sheet, 5&10 Year

APPENDIX C - HYDRAULICS

8	Road Capacity and Inlet Capacity Calculations
9	Preliminary Storm Capacity Calculations

APPENDIX D – DETENTION – STORM & WATER QUALITY

10	Pond Calculations
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APPENDIX E – FIRM Map

APPENDIX F – Drainage Plan

APPENDIX G – Reference Materials

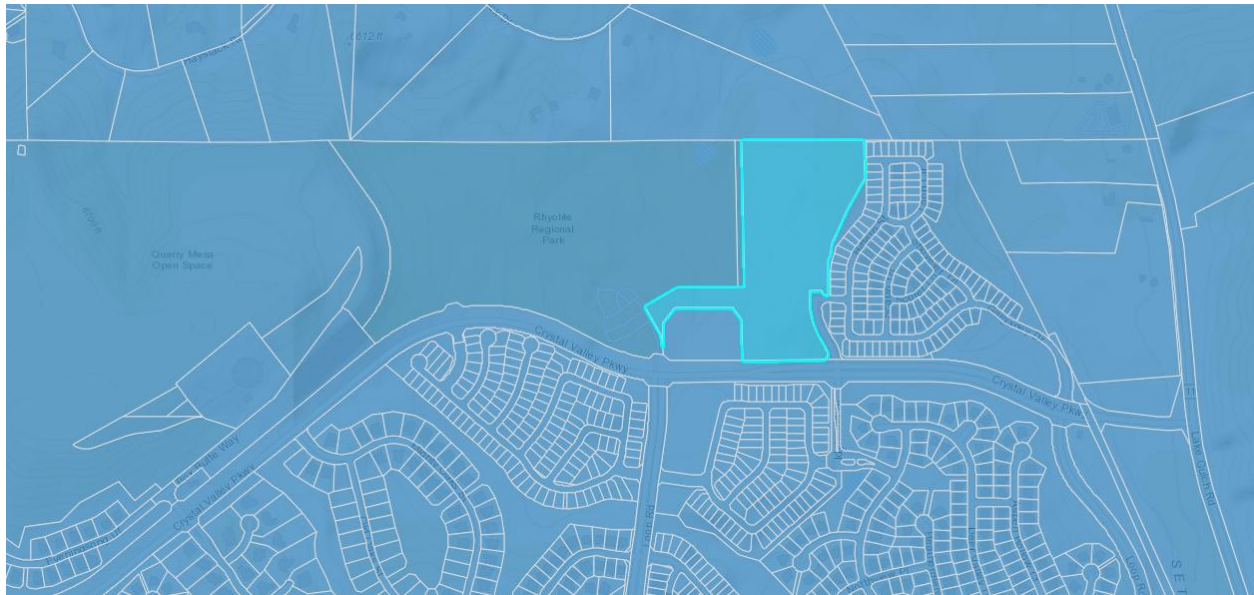
PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

II. GENERAL LOCATION AND DESCRIPTION

This PHASE II Drainage Study for CVR FILING NO. 14 AMENDMENT 1 (CVR14.A1) has been prepared to address onsite and offsite drainage concepts in accordance with requirements of Castle Rock, Colorado. The Appendix to this report includes minimum criteria, design computations and reference information to be used in subsequent phases of analysis and design. The attached PHASE II Drainage Plan summarizes the drainage concepts and conclusions of this study.

A. SITE LOCATION



CVR FILING NO. 14 AMENDMENT 1, containing a total of 21.1 acres, is located in Castle Rock as depicted on Figure 1 in the Appendix. The site is located in the northeast quarter of Section 24, Township 8 South, Range 67 West of the Sixth Principal Meridian, Castle Rock, Colorado. The site resides in the northeast portion of Crystal Valley Ranch PD. The site is bounded by Rhyolite Park on the west, Crystal Valley Ranch northern boundary and rural estate lots on the north, CVR Filing 14 on the east, and Crystal Valley Parkway on the south.

B. DESCRIPTION OF PROPERTY

The site is to consist of 21.1 acres to be subdivided as 112 single family home sites. Existing vegetation covers the site, which is not irrigated, consisting mainly of native grasses and deciduous brush with topography ranging from 1% to 25%. The site drains mostly to the southwest towards the existing regional pond 512, where runoff will be intercepted and routed through Pond 512 as indicated by Master Drainage Report for Crystal Valley Ranch, Updated

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

August 2015, Prepared by JR Engineering, Ltd (Reference 5).

There are no active irrigation facilities on the site.

The development will be overlotted graded for residential development. CVR Filing No. 14 Amendment 1 is zoned for a maximum of 127 units but is being platted for 112 units.

III. DRAINAGE BASINS AND SUB-BASINS

A. MAJOR DRAINAGE BASINS

Historically, this site has been an existing ranch that drains in all directions. In 2005 Crystal Valley Parkway was completed along with initial construction of Regional Detention Pond 511, in 2015 Regional Detention Pond 512 was completed.

At Pond 512 Stormwater is detained and released at rates determined by a separate approved Phase III Drainage Study for this regional pond (*Phase III D.S. for Regional Pond 512 (CD15-0015) Revised June 02, 2015*), conforming to EURV release patterns as established by the Town of Castle Rock. From Pond 512 this release continues in the historic drainage pattern to the north through an arroyo on Park Property (adjacent to the west of the site) which in turns confluences with Sellars Gulch to the northeast about 2000' downstream.

No off-site drainage enters the property. The existing drainage patterns will be reworked to direct runoff toward four detention facilities – Regional Pond 512, a NW Pond, a NE Pond, and Regional Pond 511.

The predominant soil types for the site include Kutch Sandy Loams (KtE) and Stony rough land (Su) (see Fig. 2 and Ref. 4). Kutch (KtE) soils have medium to rapid runoff with moderate to severe erosion potential and are in the “D” hydrologic soils group classification and represents 75% of the project. Stony rough land (Su) is a well drained soil group rapid runoff with slight to moderate erosion potential and is classified as soil group “D” and represents 23% of the project.

B. MINOR DRAINAGE BASINS

Sub-basins for this site have been divided as follows: A through K. Storm sewer systems are named according to their corresponding sub-basin

Sub-basins for this site are named according to their respective drainage patterns.

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

Basin “A” drains to the southwest toward existing pond 512. The total area of Basin A is 8.5 acres. The total runoff from Basin A in the minor and major event is 13.0 cfs & 30.8 cfs. Flows from basin A will be captured in storm lines A1 and A2 and routed directly to Pond 512 which was designed to handle all storm water detention from this site (see Pond 512 calculations and discussion in Appendix D).

Basin “B.3” drains to the northeast corner of the site. The total area of Basin B.3 is 1.7 acres. The total runoff from Basin B.3 in the minor and major event is 3.0 cfs & 7.8 cfs. Flows from Basin B.3 combine with Basins G (*eastern slope basin*) & F.1 (*rear lot flows along northern border – see further discussion below*) in a full spectrum detention pond (NE Pond) and are released to the historic route north at rates well below historic rates (see basin H-F). Emergency overflow for this NE Pond is routed to existing Loon Lane directly to the east of the pond.

Basin “C” is in the northwest corner of the site that doesn’t drain directly to existing regional detention pond 512. The total area of Basin C is 2.8 acres. The total runoff from Basin C in the minor and major event is 5.4 cfs & 13.1 cfs and are routed through a full spectrum detention pond at the NW corner of the site (NW Pond) and are released to the historic route west at rates well below historic (see basin H-E). Emergency overflow for this NW Pond is routed to the west to the Pond 512 arroyo to the west of the site directly downstream of the discharge point for the pond at DP 1. This unnamed arroyo confluent with Sellars Gulch about 2000’ downstream to the northeast offsite.

Basin “D” consists of roadway drainage only (Fabled Oak Dr) just north of Pond 512. The total area of Basin D is 1.1 acres. The total runoff from Basin D in the minor and major event is 3.5 cfs & 7.3 cfs. Basin D also drains directly to Pond 512 and will be handled in the same manner as runoff from Basin A.

Basin “E” consists of rear yard sheet flow drainage into and the arroyo downstream of pond 512 along the west side of the site. The total area of Basin E is 1.0 acres. The total runoff from Basin E in the minor and major event is 2.0 cfs & 5.4 cfs. Basin H-E is the historic basin to the same location. Basin H-E consists of 6.0 acres of area. The total runoff from Basin H-E in the minor and major event is 3.1 cfs & 15.9 cfs. Flows to DP 16 will be reduced to about 1/3 of the historic flows in the major event. This basin will not be treated and is presented as an exclusion per 13.1.4 as treating this area is not practicable. There is a 6 foot gravity retaining proposed all along these 15 lots to prevent grading on Park property directly to the west that precludes the installation of storm sewer or a concrete swale to capture water from this basin.

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

Basins “F.1 & F.2” (a split of formerly basin F) consists of rear yard sheet flow drainage toward the northern boundary of the site. F.1 flows east to the NE Pond at DP 17 and F.2 flows west to the NW Pond at DP 23. The total area of Basin F is 1.2 acres. F.1 & F.2 split evenly at 0.6 ac each.. The total runoff from each in the minor and major event is 2.1 cfs & 3.3 cfs. Basin H-F is the historic basin to the same location. Basin H-F consists of 7.5 acres of area. The total runoff from Basin H-F in the minor and major event is 5.5 cfs & 21.2 cfs. All flows will receive full spectrum detention treatment at either the NE Pond (F.1) or the NW Pond (F.2).

Basin “G” consists of cut slope drainage flowing toward the northern property line of the site and CVR along the east side of the site toward the northeast corner of the site. The total area of Basin G is 1.7 acres. The total runoff from Basin G in the minor and major event is 1.2 cfs & 6.4 cfs. Runoff from G will flow in virtually the same manner as it does today and is 0.2 acres less than the existing H-G of 1.9 acres but increases because of the decreased Tc, a consequence of the addition of a proposed concrete interception channel along the eastern border. All flows will receive full spectrum detention treatment at the NE Pond and discharge at significantly reduced rates at the same discharge location as H-G (Basin OS2 in the Phase III for CVR14).

Basin “J” consists of rear yard drainage flowing toward the southeast property line of the site and CV Pkwy. The total area of Basin J is 0.8 acres. The total runoff from Basin J in the minor and major event is 1.2 cfs & 3.7 cfs. Basin H-J is the historic basin to the same location. Basin H-J consists of 2.1 acres of area. Total runoff from Basin H-J in the minor and major event is 2.2 cfs & 8.5 cfs. Flows to DP 20 will be reduced to about one half of the historic flows in the major event.

Basin “H” consists of roadway drainage only (Snow Goose Rd) just north of existing Snow Goose Rd. The total area of Basin H is 0.5 acres. The total runoff from Basin H in the minor and major event is 1.1 cfs & 2.7 cfs. Basin H-H is the historic basin to the same location at DP 19. Basin H-H consists of 0.5 acres of area. The total runoff from Basin H-H in the minor and major event is 0.5 cfs & 1.8 cfs. Flows to DP 19 will increase slightly at DP 19 but when combined with Basin J nets out at a composite reduction of flows toward Snow Goose Rd and CV Pkwy. Both H & J are comparable to Basin OS1 in the CVR14 Drainage Study and are treated in Regional Detention Pond 511 to east. Basin OS1 is 2.5 acres with a Q peak of 7.8 cfs in the 100 yr, greater than H&J combined which is $3.7+2.7=6.4$ cfs.

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

Basin “K” consists of open space sheet flow drainage intercepted by pond 512 along the southwestern property line. The total area of Basin K is 0.4 acres. The total runoff from Basin K in the minor and major events is 0.5 and 1.8 cfs which is a reduction of flows in the historic condition at H-K of 1.6 & 6.3 cfs. All flow from Basin K will be routed through existing regional detention pond 512.

IV. DRAINAGE DESIGN CRITERIA

A. REGULATIONS

Storm drainage analysis and design criteria are to be taken from the "Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, Feb 2025", Reference 1, and the "Urban Storm Drainage Criteria Manual" (USDCM), Reference 2.

B. DRAINAGE STUDIES, MASTER PLANS, SITE CONSTRAINTS

Development criteria shall be in accordance with Castle Rock Water Department. The *Master Drainage Report for Crystal Valley Ranch – Updated August 2015, by JR Engineering, Ltd* (Reference 5), and the *Phase III D.S. for Regional Pond 512 (CD15-0015) Revised June 02, 2015* (Reference 6), and the *Phase III D.S. for Crystal Valley Ranch Regional Ponds 510 & 511* (Reference 7), and the *Phase III Drainage Study For Crystal Valley Ranch Filing No. 14 (CD14-0025)*, (Reference 8) were utilized to assist in developing the drainage plan and facilities for CVR14.A1.

C. HYDROLOGY

CVR FILING NO. 14 AMENDMENT 1 is within Douglas County rainfall zone 1. Figure 3 contains the appropriate rainfall data for Zone 1 and CVR Filing No. 14 Amendment 1. The Rational Method was utilized to analyze and quantify runoff from the developed basins. Design points were used to determine total flows at key points of interest. The 5-year storm event was used for the minor storm analysis within residential areas, and the 100-year storm frequency was analyzed for the major storm. Roadway capacities can be found in the inlet calculations in Appendix C.

D. HYDRAULICS

Sizing calculations for storm sewer were completed using Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. and Bently/Haestad Methods StormCAD v 5.5 for Storm HGL's (See Appendix C).

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

E. STORAGE AND WATER QUALITY ENHANCEMENT

A significant portion of the site currently drains to Regional Pond 512 and the outfall from Pond 512. Another significant portion of the site drains north towards the northern boundary of CVR and into the rural lots to the north.

At Pond 512 Stormwater is detained and released at rates determined by a separate approved Phase III Drainage Study for this regional pond (*Phase III D.S. for Regional Pond 512 (CD15-0015) Revised June 02, 2015*), conforming to EURV release patterns as established by the Town of Castle Rock. From Pond 512 this release continues in the historic drainage pattern to the north through an arroyo on Park Property (adjacent to the west of the site) which in turns confluences with Sellars Gulch to the northeast about 2000' downstream. An emergency overflow inlet and discharge pipe will be added to this pond as letting the overflow over the road would result in greater than 12" of ponding at FL. A single inlet is proposed that will connect the existing 36" RCP outlet with a new 18" RCP outlet, which when combined will pass the fully developed Major storm of 280 cfs with a headwater elevation equal to 12" of ponding at the flowline (6449.49).

The northern portion of the site drains to two proposed ponds – a NW Pond and a NE Pond. A small portion of the site at the southeast corner drains to Pond 511 as it has done since this pond's construction in 2015

Site soils are typical of the area and will require careful erosion and sediment control methods. Construction sedimentation will be controlled primarily using the existing detention pond 512, as well as other methods to meet Town of Castle Rock Performance Standards. Specifics of this erosion control plan will be demonstrated in the Temporary, Erosion, and Sedimentation Control Plan that will be included in the construction plan set at time of Final Plat.

No unsuitability of the site soils with regard to construction of this development have been identified thus far.

V. STORMWATER MANAGEMENT FACILITY DESIGN

A. STORMWATER CONVEYANCE FACILITIES

The general concept is to convey storm water via natural drainage-ways, culverts, and roadways to detention and water quality facilities and ultimately to the unnamed Sellars Gulch arroyo at the boundary of Crystal Valley Ranch. Basins consist of developed lots, roadways, natural drainage-ways and open space.

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

B. STORMWATER STORAGE FACILITIES

Full spectrum treatment will be provided for the entire site (except for the north half of Basin E) at four locations: Existing Regional Ponds 511 & 512, and two onsite ponds at the NE & NW corners of the site.

C. WATER QUALITY ENHANCEMENT CONTROL MEASURES

Water quality enhancement will be achieved via full spectrum detention.

D. FLOODPLAIN MODIFICATION

No modification of any established floodplain is required for this project.

E. GEOTECH INVESTIGATION & SUB-SURFACE COLLECTION SYSTEM DESIGN

Groundwater does appear in the boring logs. Groundwater will be addressed by a combination of dewatering practices during infrastructure construction and subsurface collection systems at the foundation of each house.

Eleven lots will be impacted by lot-to-lot drainage from B type lots behind them. A subsurface collection system at the back of walk is proposed to collect excess groundwater and direct it to the storm sewer system.

F. OPERATION AND MAINTENANCE.

Operation and maintenance of roadways, regional detention ponds, and storm sewer systems will be by the Town of Castle Rock. The two onsite detention ponds at the NW & NE corners of the site will be maintained and operated by the Crystal Valley Ranch Master Association.

G. ADDITIONAL PERMITTING REQUIREMENTS

No additional permitting beyond that, which is typical for a single family subdivision will be required.

H. GENERAL

Figure 1 is a vicinity map showing approximately where the CVR Filing No. 14 Amendment 1 development is located. Figure 2 presents the soil classifications found within the site. Appendix E presents a “firmette” for Map Number 08035C0304F. Figure 3 is the design point rainfall for Castle Rock. Figure 4 contains the time-intensity-frequency curves for Castle Rock. Figure 5 shows calculations for a composite “I” value. Figure 6 presents average flow velocities for use with the rational method. Figure 7 contains time of concentration calculations and peak storm

PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

flows using rational method calculation sheets for the 5 and 100 year storm events, respectively for each basin. Figures in Appendix C contains roadway capacity, inlet capacity nomographs. Appendix C presents preliminary storm sewer sizing calculations. Appendix D contains the required preliminary detention and water quality volumes for Pond 512, & the NW & NE Ponds. An overall drainage map is provided at the end of this report.

Historic Basins: All existing basins and proposed basins shown are presented with similar naming conventions for easy comparison between proposed and historic runoff.

VI. CONCLUSIONS

A. COMPLIANCE WITH STANDARDS

This PHASE II Drainage Study for CVR Filing No. 14 Amendment 1 was prepared in compliance with the Town of Castle Rock "Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, Feb 2025" and the Urban Storm Drainage Criteria Manual. In addition, no amendment to the Flood Hazard Area Delineation for this area is required for this development. There are no impacts to any threatened or endangered species that we are aware of. All Federal and State environmental permitting requirements, should they be necessary, will be complied with – this includes a State of Colorado Storm Water Discharge Permit.

B. VARIANCES

The north half of Basin E will be excepted from the full spectrum detention treatment. This basin will not be treated and is presented as an exclusion per 13.1.4, as treating this area is not practicable. This area cannot be intercepted by the NW Pond as the rear lots at the north end cannot be raised due to a limit on the wall height of 6.5', and no further grading will be permitted on park land. This exclusion does not require a variance

In order to comply with the minimum WQCV 40 hour drain time both the NW and NE ponds will require zone 1 orifices smaller than 1.5 sq-in and an associated well screen system. This arrangement will require a variance as part of the CD's.

C. DRAINAGE CONCEPT

The drainage designs and facilities presented in this report adequately convey developed runoff through the site and into existing drainage ways without increasing the existing discharge.

The report provides sufficient information to accommodate the planning process. Information herein supports the viability of this proposed project.

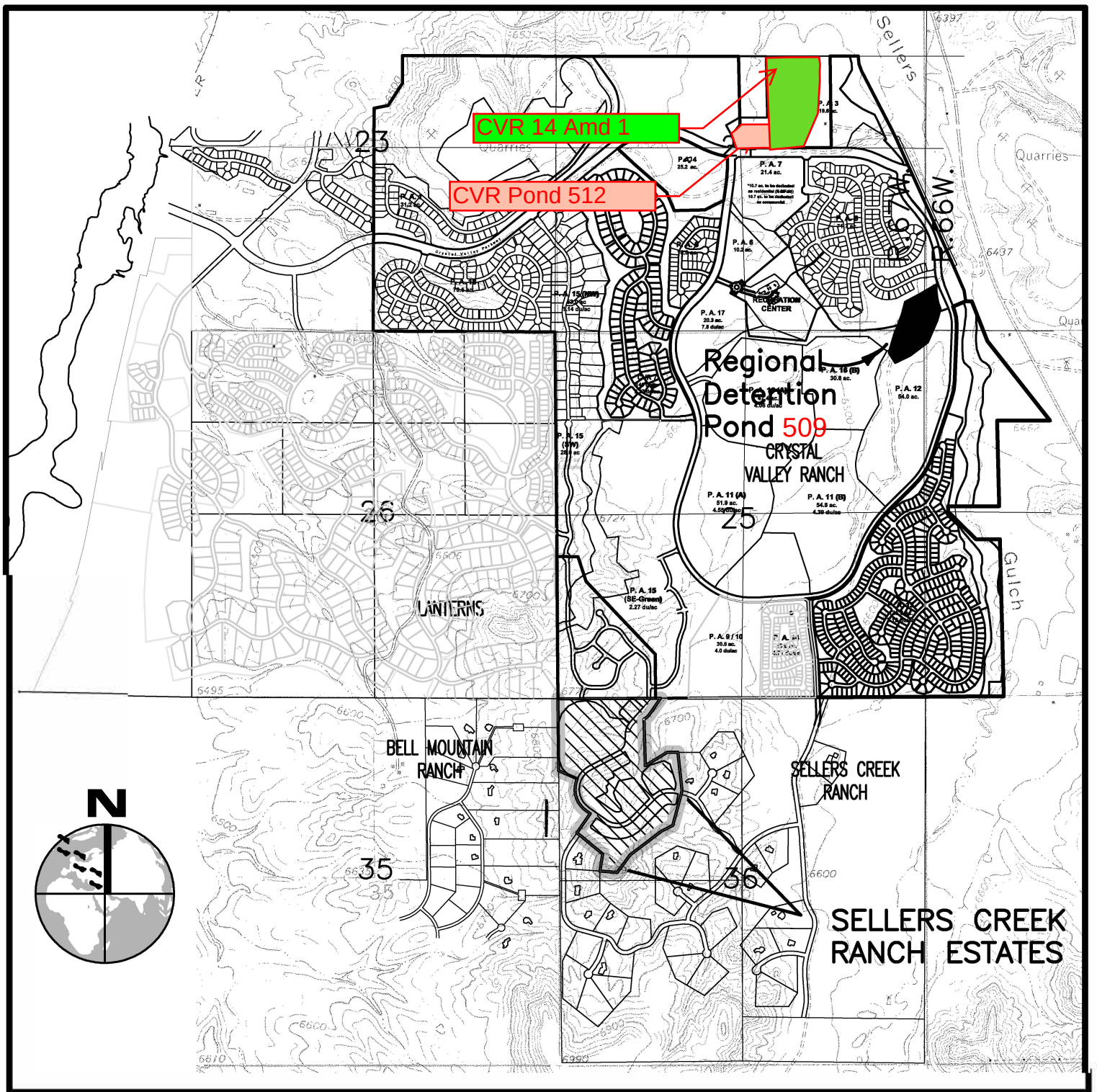
PHASE II DRAINAGE STUDY FOR CVR – Filing No. 14 Amendment 1

Castle Rock, Colorado - August 11, 2026

VII. REFERENCES

1. Town Of Castle Rock Storm Drainage Design And Technical Criteria Manual, February 18th, 2025
2. Criteria Manual Volume 1-3, Mile High Flood Control District, prepared by Wright-McLaughlin Engineers, March 1969, Revised Dec, 2011.
3. Flood Insurance Rate Map, Douglas County, Colorado, Map Number 08035CO304F September 30, 2005, prepared by FEMA.
4. Soil Survey of Castle Rock Area, Colorado, U.S. Department of Agriculture, Soil Conservation Service, issued November 1974.
5. Master Drainage Report for Crystal Valley Ranch, (Updated August 2015), Prepared by JR Engineering Ltd.
6. Phase III D.S. for Regional Pond 512 (CD15-0015) (Revised June 02, 2015)
7. Phase III D.S. for Crystal Valley Ranch Regional Ponds 510 & 511 (CD15-0001) (Revised February 19, 2015)
8. Phase III Drainage Study For Crystal Valley Ranch Filing No. 14 (CD14-0025) (Revised: Friday, December 12, 2014)
9. Software used - AutoDesk Civil 3D 2026; Microsoft Excel 2026; Microsoft Word 2026; UDFCD Excel Spreadsheets; Bently/Haestad Methods StormCAD v 5.5.

APPENDIX A - PROJECT INFORMATION



CVR 14 Amendment 1

VICINITY MAP

Scale: 1" = 2000'

Figure 1



United States
Department of
Agriculture

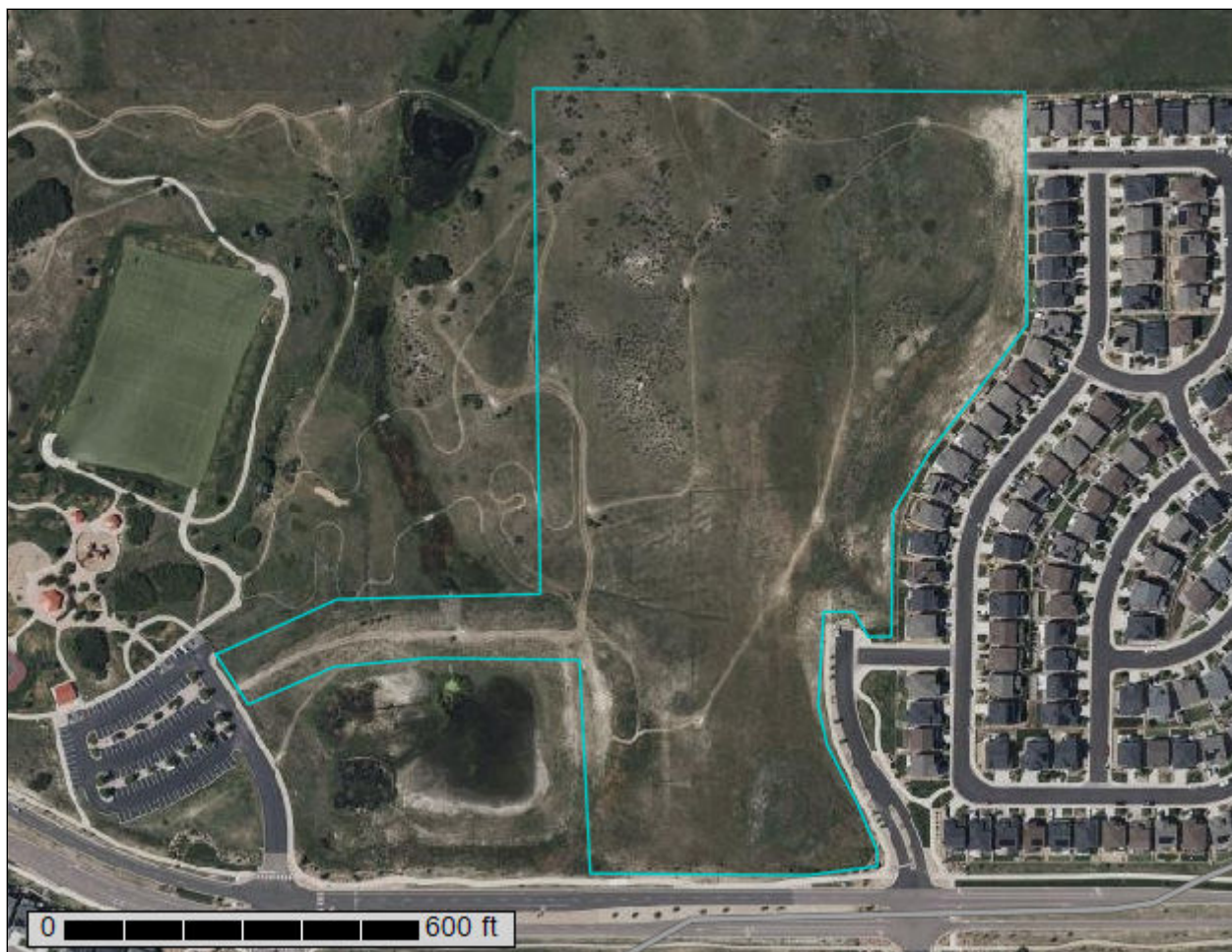
NRCS

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 **Castle Rock Area, Colorado**

USDA Soils Map



January 21, 2026

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.

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Contents

Preface	2
How Soil Surveys Are Made	5
Soil Map	8
Soil Map.....	9
Legend.....	10
Map Unit Legend.....	11
Map Unit Descriptions.....	11
Castle Rock Area, Colorado.....	13
Fu—Fondis-Kutch association.....	13
KtE—Kutch sandy loam, 5 to 20 percent slopes.....	15
Su—Stony rough land.....	16
References	18

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

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



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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 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Castle Rock Area, Colorado
Survey Area Data: Version 18, Aug 29, 2025

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

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

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Fu	Fondis-Kutch association	0.4	1.8%
KtE	Kutch sandy loam, 5 to 20 percent slopes	15.6	75.1%
Su	Stony rough land	4.8	23.1%
Totals for Area of Interest		20.8	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

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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.

Castle Rock Area, Colorado

Fu—Fondis-Kutch association

Map Unit Setting

National map unit symbol: jqyq
Elevation: 5,500 to 6,800 feet
Mean annual precipitation: 15 to 19 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 120 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Fondis and similar soils: 50 percent
Kutch and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fondis

Setting

Landform: Valley sides, draws
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits over coarse-silty outwash derived from arkose

Typical profile

H1 - 0 to 7 inches: loam
H2 - 7 to 24 inches: clay
H3 - 24 to 60 inches: sandy clay loam

Properties and qualities

Slope: 5 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R049XB208CO - Clayey Foothill
Hydric soil rating: No

Description of Kutch

Setting

Down-slope shape: Linear

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Across-slope shape: Linear

Parent material: Fine-textured residuum weathered from calcareous shale

Typical profile

H1 - 0 to 6 inches: sandy loam

H2 - 6 to 32 inches: clay

H3 - 32 to 36 inches: weathered bedrock

Properties and qualities

Slope: 5 to 40 percent

Depth to restrictive feature: 20 to 40 inches to paralithic bedrock

Drainage class: Well drained

Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Gypsum, maximum content: 2 percent

Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)

Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: D

Ecological site: R049XB208CO - Clayey Foothill

Hydric soil rating: No

Minor Components

Bresser

Percent of map unit: 5 percent

Hydric soil rating: No

Newlin

Percent of map unit: 5 percent

Hydric soil rating: No

Hilly gravelly land

Percent of map unit: 4 percent

Hydric soil rating: No

Aquic haplustolls

Percent of map unit: 1 percent

Landform: Swales

Hydric soil rating: Yes

KtE—Kutch sandy loam, 5 to 20 percent slopes

Map Unit Setting

National map unit symbol: jqz5
Elevation: 5,500 to 6,800 feet
Mean annual precipitation: 15 to 19 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 120 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Kutch and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kutch

Setting

Landform: Valley sides, alluvial fans, drainageways
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous fine-loamy clayey shale

Typical profile

H1 - 0 to 6 inches: sandy loam
H2 - 6 to 32 inches: clay
H3 - 32 to 36 inches: weathered bedrock

Properties and qualities

Slope: 5 to 20 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Bresser

Percent of map unit: 7 percent
Hydric soil rating: No

Newlin

Percent of map unit: 7 percent
Hydric soil rating: No

Aquic haplustolls

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

Su—Stony rough land

Map Unit Setting

National map unit symbol: jr0b
Elevation: 5,500 to 6,600 feet
Mean annual precipitation: 15 to 19 inches
Mean annual air temperature: 49 to 51 degrees F
Frost-free period: 120 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Stony rough land: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stony Rough Land

Setting

Landform: Hills, mesas, knobs
Landform position (three-dimensional): Side slope, base slope, crest
Down-slope shape: Linear
Across-slope shape: Linear

Typical profile

H1 - 0 to 6 inches: flaggy loam
H2 - 6 to 30 inches: flaggy clay loam
H3 - 30 to 34 inches: unweathered bedrock

Properties and qualities

Slope: 5 to 40 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Calcium carbonate, maximum content: 2 percent

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Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s

Hydrologic Soil Group: D

Ecological site: R048AY237CO - Stony Loam

Hydric soil rating: No

Minor Components

Fondis

Percent of map unit: 10 percent

Hydric soil rating: No

Crowfoot

Percent of map unit: 5 percent

Hydric soil rating: No

Peyton

Percent of map unit: 5 percent

Hydric soil rating: No

Pring

Percent of map unit: 5 percent

Hydric soil rating: No

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APPENDIX B - HYDROLOGY

TABLE 6-1
1-HOUR POINT RAINFALL VALUES FOR
THE TOWN OF CASTLE ROCK (INCHES)

2- YR	5-YR	10-YR	50-YR	100-YR
1.06	1.43	1.66	2.26	2.60

The one-hour rainfall depths are the basis of the Town's intensity-duration rainfall curves and are used to formulate design storm distributions.

6.1.2 Intensity-Duration Curves. Rainfall intensity based on storm duration for a variety of storm return periods can be found on Figure 6-1 at the end of this chapter. These curves were developed using distribution factors provided in the NOAA Atlas and also provided in Table RA-4 of the *UDFCD Manual*. These Intensity-Duration curves are based on Equation RA-3 in the Rainfall Section of the *UDFCD Manual*.

6.1.3 Six-hour Rainfall. In order to use the Colorado Urban Hydrograph Procedure (CUHP), 2-, 3- or 6-hour rainfall distributions are required, depending on watershed area. Table RA-1 in the *UDFCD Manual* summarizes storm durations, area adjustments, and incremental rainfall depths to be used in CUHP based on watershed area. The UD-Raincurve Spreadsheet included in the *UDFCD Manual* shall be used to generate the rainfall distribution curves necessary for a CUHP model. In order to generate these distribution curves, the 1-hour and 6-hour rainfall depths for the design return periods are necessary. Since the Town of Castle Rock is not located within UDFCD boundaries, the rainfall depth-duration-frequency curves provided in the *UDFCD Manual* do not provide rainfall values for the entire Town. Therefore these values are provided in these *Criteria*. The 1-hour point values can be found in Table 6-1 of this chapter. The 6-hour point values are as follows:

TABLE 6-2
6-HOUR POINT RAINFALL VALUES FOR
THE TOWN OF CASTLE ROCK (INCHES)

2- YR	5-YR	10-YR	50-YR	100-YR
1.5	2.0	2.2	3.0	3.4

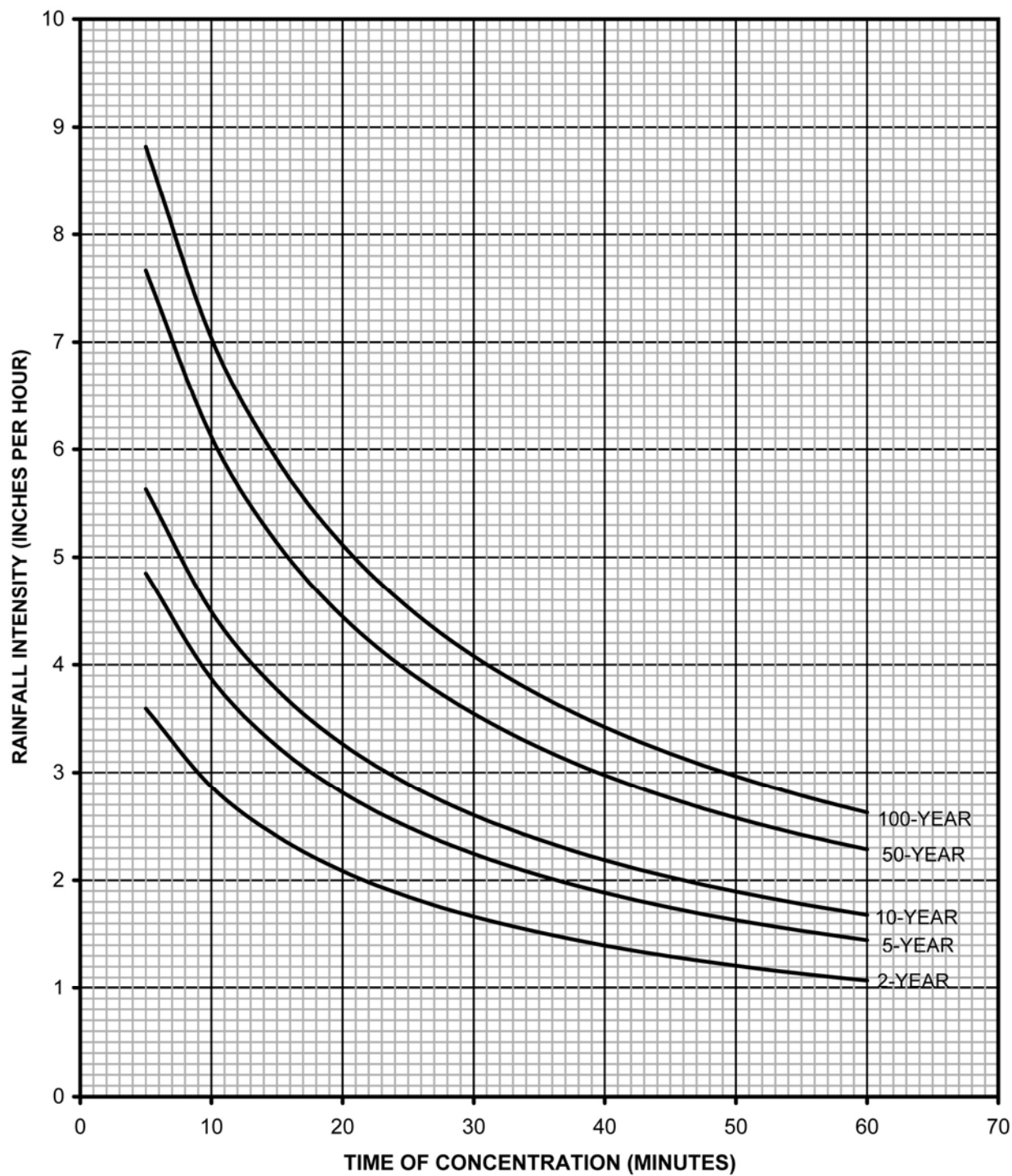
The UD-Raincurve spreadsheet shall be used for all portions of the Town. Once the rainfall distribution curves are generated using the UDFCD UD-Raincurve Spreadsheet, the CUHP model is to be set up following the procedures provided in the Runoff chapter in Volume 1 of the *UDFCD Manual*.

6.2 Selecting a Method to Estimate Runoff

Two primary methods for estimating storm runoff, peak flow rates and total volumes are used in the Town.

- Rational Method

FIGURE 6-1
RAINFALL INTENSITY-DURATION CURVE
TOWN OF CASTLE ROCK



CVR14 Amd 1 - Runoff Summary

4/17/2026 9:51

Basin ID	Design Point	Area	5 year Runoff	100 year Runoff	Remarks
A.1.1.1	6	2.3 ac	3.5 cfs	8.9 cfs	Road Capacity Check + Inlet A1.3
A.1.1.2	8	2.2 ac	3.7 cfs	9.1 cfs	Road Capacity Check
A.1.1.2.1	7	1.1 ac	2.0 cfs	5.0 cfs	Road Capacity Check + Inlet A1.2
A.1.1.2.2	8	1.1 ac	2.5 cfs	6.2 cfs	Road Capacity Check
A.1.1.1 + A.1.1.2.1	7	3.4 ac	5.9 cfs	13.0 cfs	Peak minus intercepted @ Inlet A1.2 (compare)
A.1.1	9	4.5 ac	6.1 cfs	15.4 cfs	Flow from south gutter @ inlet A1.1
A.1.2	9	0.1 ac	0.5 cfs	1.1 cfs	Flow from north gutter @ inlet A1.1
A.1	9	4.6 ac	6.4 cfs	16.0 cfs	Peak minus intercepted @ Inlet A1.1 (sump)
A.2.1	10	1.9 ac	3.7 cfs	8.0 cfs	Road Capacity Check + Inlet A2.2 & A2.1.A
A.2.2	10	2.0 ac	4.1 cfs	9.4 cfs	Road Capacity Check
A.2	10	3.9 ac	7.2 cfs	16.2 cfs	Peak minus intercepted @ Inlet A2.1 (sump)
A	11	8.5 ac	13.0 cfs	30.8 cfs	Sump inlet A2.1 + A1.1 - flow into Pond 512
B.3	22	1.7 ac	3.0 cfs	7.8 cfs	Sump Inlet B.3
B.3+G+F.1	22	4.0 ac	6.4 cfs	17.1 cfs	Total flow to NE Pond
C.1	5	2.0 ac	3.6 cfs	8.9 cfs	Sump Inlet C.1
C.2	4	0.9 ac	2.2 cfs	5.0 cfs	Sump Inlet C.2
C	3	2.9 ac	5.4 cfs	13.1 cfs	Total Flow in Storm Line C
D.1	12	0.7 ac	2.3 cfs	4.8 cfs	Sump Inlet D.1
D.2	13	0.3 ac	1.3 cfs	2.6 cfs	Sump Inlet D.2
D	14	1.1 ac	3.5 cfs	7.3 cfs	Total Flow in Storm Line D
E	16	1.0 ac	2.0 cfs	5.4 cfs	Proposed sheet flow to West
F.1 or F.2	17	0.6 ac	2.0 cfs	3.3 cfs	Rear Yard flow to either NW or NE Pond
G	18	1.7 ac	1.2 cfs	6.4 cfs	Proposed sheet flow to North in Swale
H	19	0.5 ac	1.1 cfs	2.7 cfs	Proposed flow to Snow Goose Rd
J	20	0.8 ac	1.2 cfs	3.7 cfs	Proposed flow to SE FES @ Snow Goose Rd
K	21	0.4 ac	0.5 cfs	1.8 cfs	Proposed sheet flow west to Pond 512
Historic Flows					
H-E	16	6.0 ac	3.1 cfs	15.9 cfs	Historic flow to West
H-F	17	7.5 ac	3.7 cfs	19.3 cfs	Historic flow to North
H-G	18	1.9 ac	0.9 cfs	4.6 cfs	Historic flow to North in Swale
H-H	19	0.5 ac	0.3 cfs	1.6 cfs	Historic flow to Snow Goose Rd (FKA OS-2 in CVR14)+++
H-J	20	2.1 ac	1.5 cfs	7.8 cfs	Hist flow to SE FES @ Snow Goose (FKA OS-2 in CVR14)+++
H-K	21	1.4 ac	1.1 cfs	5.8 cfs	Historic sheet flow west to Pond 512

+++ Compare to CVR14 Drainage Plan in Appendix G. Basins H&J can be compared to OS-2 in CVR14 study and is treated at Pond 511

CVR14 Amd 1			Imperviousness Calcs	
Basin A.1.1.1	COMPOSITE "I"		Total clustered lot area	20.0 acres
Area Description	Area	"I"	Imperv Area	Notes
footprints in Lots	0.8 acres	95%	0.7 acres	
Roadways	0.4 acres	95%	0.4 acres	
landscaped area	1.1 acres	20%	0.2 acres	
total	2.3 acres		1.4 acres	
CALCULATED BASIN "I" VALUE =			59.1%	
Basin A.1.1.2				
footprints in Lots	0.8 acres	95%	0.8 acres	
Roadways	0.4 acres	95%	0.4 acres	
landscaped area	1.0 acres	20%	0.2 acres	used for
total	2.2 acres		1.4 acres	A.1.1.2.1 & 2
CALCULATED BASIN "I" VALUE =			61.6%	
A.1.1				
footprints in Lots	1.6 acres	95%	1.5 acres	
Roadways	0.8 acres	95%	0.8 acres	
landscaped area	2.1 acres	20%	0.4 acres	
total	4.5 acres		2.7 acres	
CALCULATED BASIN "I" VALUE =			60%	
Basin A.1.2				
footprints in Lots	0.03 acres	95%	0.0 acres	
Roadways	0.10 acres	95%	0.1 acres	
landscaped area	0.02 acres	20%	0.0 acres	
total	0.15 acres		0.1 acres	
CALCULATED BASIN "I" VALUE =			87%	
Basin A.1	4.6 acres			
CALCULATED BASIN "I" VALUE =			61%	
Basin A.2.1				
footprints in Lots	0.8 acres	95%	0.7 acres	
Roadways	0.7 acres	95%	0.6 acres	
landscaped area	0.4 acres	20%	0.1 acres	
total	1.9 acres		1.5 acres	
CALCULATED BASIN "I" VALUE =			78%	
A.2.2				
footprints in Lots	1.0 acres	95%	0.9 acres	
Roadways	0.4 acres	95%	0.4 acres	
landscaped area	0.6 acres	20%	0.1 acres	
total	2.0 acres		1.4 acres	
CALCULATED BASIN "I" VALUE =			71.0%	
A				
A.1	4.6 acres	61%	2.8 acres	
A.2.1	1.9 acres	78%	1.5 acres	
A.2.2	2.0 acres	71%	1.4 acres	
total	8.54 acres		5.7 acres	
CALCULATED BASIN "I" VALUE =			67.2%	
Basin B.3				
footprints in Lots	0.6 acres	95%	0.6 acres	
Roadways	0.4 acres	95%	0.3 acres	
landscaped area	0.7 acres	20%	0.1 acres	
total	1.7 acres		1.06 acres	
CALCULATED BASIN "I" VALUE =			62%	
Basin C.1				
footprints in Lots	0.7 acres	95%	0.7 acres	
Roadways	0.4 acres	95%	0.4 acres	
landscaped area	0.9 acres	20%	0.2 acres	
total	2.0 acres		1.2 acres	
CALCULATED BASIN "I" VALUE =			61%	
Basin C.2				
footprints in Lots	0.3 acres	95%	0.3 acres	
Roadways	0.3 acres	95%	0.3 acres	
landscaped area	0.2 acres	20%	0.0 acres	
total	0.85 acres		0.6 acres	
CALCULATED BASIN "I" VALUE =			75%	
Basin C				
footprints in Lots	1.0 acres	95%	1.0 acres	
Roadways	0.7 acres	95%	0.7 acres	
landscaped area	1.1 acres	20%	0.2 acres	
total	2.9 acres		1.9 acres	
CALCULATED BASIN "I" VALUE =			65%	
Basin D.1				
footprints in Lots	0.1 acres	95%	0.1 acres	

Roadways	0.5 acres	95%	0.5 acres	
landscaped area	0.1 acres	20%	0.0 acres	
total	0.7 acres		0.6 acres	
CALCULATED BASIN "I" VALUE =			87%	
Basin D.2				
footprints in Lots	0.0 acres	95%	0.0 acres	
Roadways	0.33 acres	95%	0.3 acres	
landscaped area	0.01 acres	20%	0.0 acres	
total	0.35 acres		0.3 acres	
CALCULATED BASIN "I" VALUE =			92%	
Basin H-E to H-K				
footprints in Lots	0.0 acres	95%	0.0 acres	
Roadways	0.0 acres	95%	0.0 acres	
landscaped area	6.0 acres	5%	0.3 acres	
total	6.0 acres		0.3 acres	
CALCULATED BASIN "I" VALUE =			5%	
Basin E				
footprints in Lots	0.45 acres	95%	0.4 acres	
Roadways	0.00 acres	95%	0.0 acres	
landscaped area	0.55 acres	20%	0.1 acres	
total	1.00 acres		0.5 acres	
CALCULATED BASIN "I" VALUE =			53.7%	
Basin F				
footprints in Lots	0.60 acres	95%	0.6 acres	
Roadways	0.00 acres	95%	0.0 acres	
landscaped area	0.60 acres	20%	0.1 acres	
total	1.20 acres		0.69 acres	
CALCULATED BASIN "I" VALUE =			57.3%	
Basin G				
footprints in Lots	0.0 acres	95%	0.0 acres	
Roadways	0.0 acres	95%	0.0 acres	
native area	1.7 acres	5%	0.09 acres	
total	1.7 acres		0.09 acres	
CALCULATED BASIN "I" VALUE =			5%	
Basin H				
footprints in Lots	0.0 acres	95%	0.0 acres	
Roadways	0.3 acres	95%	0.3 acres	
landscaped area	0.2 acres	20%	0.0 acres	
total	0.47 acres		0.31 acres	
CALCULATED BASIN "I" VALUE =			66%	
Basin J				
footprints in Lots	0.2 acres	95%	0.2 acres	
Roadways	0.0 acres	95%	0.0 acres	
landscaped area	0.6 acres	20%	0.1 acres	
total	0.81 acres		0.30 acres	
CALCULATED BASIN "I" VALUE =			37%	
Basin K				
footprints in Lots	0.0 acres	95%	0.0 acres	
Roadways	0.0 acres	95%	0.0 acres	
landscaped area	0.4 acres	20%	0.1 acres	
total	0.4 acres		0.1 acres	
CALCULATED BASIN "I" VALUE =			20%	
Basin C+F.2				
footprints in Lots	1.3 acres	95%	1.3 acres	
Roadways	0.7 acres	95%	0.7 acres	
landscaped area	1.4 acres	20%	0.3 acres	
total	3.48 acres		2.2 acres	
CALCULATED BASIN "I" VALUE =			64%	
Basin B.3+G+F.1				
footprints in Lots	0.9 acres	95%	0.9 acres	
Roadways	0.4 acres	95%	0.3 acres	
landscaped area	1.0 acres	20%	0.2 acres	
native area	1.7 acres	5%	0.1 acres	
total	4.0 acres		1.5 acres	
CALCULATED BASIN "I" VALUE =			37%	
Basin H+J				
footprints in Lots	0.2 acres	95%	0.2 acres	
Roadways	0.3 acres	95%	0.3 acres	
landscaped area	0.8 acres	20%	0.2 acres	
total	1.28 acres		0.6 acres	
CALCULATED BASIN "I" VALUE =			47.38%	

Project		CVR14 Amd 1							
Job Description		Phase III Drainage Study						4/17/2026 9:51	
TABLE RO-5									
Runoff Coefficients, C									
Basin	Runoff Coefficients (by soil group)	Percentage Imperviousness		Storm Return Period					
		I	i	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
A.1.1.1	C _{CD}	59.1%	0.591	0.40	0.45	0.50	0.56	0.60	0.63
	C _B	59.1%	0.591	0.36	0.40	0.45	0.50	0.54	0.56
% B type?		0.00%			0.45				0.63
A.1.1.2	C _{CD}	61.6%	0.616	0.42	0.47	0.52	0.57	0.61	0.64
	C _B	61.6%	0.616	0.38	0.42	0.47	0.52	0.55	0.57
% B type?		0.00%			0.47				0.64
A.1.1	C _{CD}	60.3%	0.603	0.41	0.46	0.51	0.57	0.61	0.63
	C _B	60.3%	0.603	0.37	0.41	0.46	0.51	0.54	0.56
% B type?		0.00%			0.46				0.63
A.1.2	C _{CD}	86.9%	0.869	0.68	0.70	0.73	0.76	0.79	0.80
	C _B	86.9%	0.869	0.66	0.68	0.71	0.74	0.76	0.77
% B type?		0.00%			0.70				0.80
A.1	C _{CD}	61.2%	0.612	0.41	0.46	0.51	0.57	0.61	0.63
	C _B	61.2%	0.612	0.37	0.42	0.47	0.52	0.55	0.57
% B type?		0.00%			0.46				0.63
A.2.1	C _{CD}	78.1%	0.781	0.57	0.60	0.64	0.68	0.71	0.73
	C _B	78.1%	0.781	0.54	0.57	0.61	0.64	0.67	0.68
% B type?		0.00%			0.60				0.73
A.2.2	C _{CD}	71.0%	0.710	0.50	0.54	0.58	0.63	0.66	0.68
	C _B	71.0%	0.710	0.46	0.50	0.54	0.58	0.61	0.63
% B type?		0.00%			0.54				0.68
B.3	C _{CD}	62.3%	0.623	0.42	0.47	0.52	0.58	0.62	0.64
	C _B	62.3%	0.623	0.38	0.43	0.47	0.52	0.55	0.57
% B type?		0.00%			0.47				0.64
C.1	C _{CD}	61.5%	0.615	0.42	0.46	0.52	0.57	0.61	0.64
	C _B	61.5%	0.615	0.38	0.42	0.47	0.52	0.55	0.57
% B type?		0.00%			0.46				0.64
C.2	C _{CD}	74.9%	0.749	0.54	0.57	0.61	0.66	0.69	0.70
	C _B	74.9%	0.749	0.50	0.54	0.57	0.61	0.64	0.65
% B type?		0.00%			0.57				0.70
D.1	C _{CD}	87.1%	0.871	0.68	0.70	0.73	0.77	0.79	0.80
	C _A	87.1%	0.871	0.64	0.66	0.69	0.72	0.73	0.74
	C _B	87.1%	0.871	0.66	0.68	0.71	0.74	0.76	0.77
% B type?		0.00%			0.70				0.80
D.2	C _{CD}	92.3%	0.923	0.76	0.77	0.80	0.83	0.85	0.86
	C _B	92.3%	0.923	0.74	0.76	0.79	0.81	0.83	0.84
% B type?		0.00%			0.77				0.86
H's	C _{CD}	5.0%	0.050	0.08	0.18	0.28	0.39	0.46	0.52
	C _B	5.0%	0.050	0.04	0.10	0.19	0.28	0.33	0.38
% B type?		0.00%			0.18				0.52
E	C _{CD}	53.7%	0.537	0.36	0.42	0.47	0.54	0.58	0.61
	C _B	53.7%	0.537	0.32	0.37	0.42	0.48	0.51	0.54

% B type?	0.00%				0.42				0.61
F	C _{CD}	57.3%	0.573	0.38	0.44	0.49	0.55	0.60	0.62
	C _B	57.3%	0.573	0.34	0.39	0.44	0.49	0.53	0.55
% B type?	0.00%				0.44				0.62
G	C _{CD}	5.0%	0.050	0.08	0.18	0.28	0.39	0.46	0.52
	C _B	5.0%	0.050	0.04	0.10	0.19	0.28	0.33	0.38
% B type?	0.00%				0.18				0.52
H	C _{CD}	66.2%	0.662	0.45	0.50	0.54	0.60	0.64	0.66
	C _B	66.2%	0.662	0.42	0.46	0.50	0.55	0.57	0.60
	0.00%				0.50				0.66
J	C _{CD}	36.6%	0.366	0.26	0.33	0.40	0.49	0.54	0.58
	C _B	36.6%	0.366	0.21	0.28	0.34	0.41	0.45	0.49
% B type?	0.00%				0.33				0.58
K	C _{CD}	20.0%	0.200	0.17	0.26	0.34	0.44	0.50	0.55
	C _B	20.0%	0.200	0.11	0.20	0.27	0.35	0.40	0.44
% B type?	0.00%				0.26				0.55

Proposed Drainage Basins
Standard Form SF-2
Storm Drainage System Design
(Time of Concentration)

Project: CVR14 Amd 1

Calculated by: JJM

Reviewed by: JJM

Date: 4/17/2026

				<i>T_i</i>	<i>T_i</i>			<i>T_t</i>	<i>T_t</i>	<i>T_t</i>	<i>T_t</i>		<i>T_i+T_t</i>				
	AREA	C(5)	C(100)	LENGTH	SLOPE	<i>T_i</i>		LENGTH	SLOPE	SWALE	VEL	<i>T_t</i>	COMP	TOTAL	Urbanized?	Urbanized Check	FINAL
Basin	Ac			Ft	%	Min	<i>L-total</i>	Ft	%	CODE*	FPS	Min	T _c	LENGTH			T _c
A.1.1.1	2.3	0.45	0.63	100	1.4%	10.7	658.0	558	1.5%	20.0	2.4	3.8	14.5	658	y	13.7	13.7
A.1.1.2	2.2	0.47	0.64	50	2.5%	6.1	812.0	762	1.1%	20.0	2.1	6.1	12.1	812	y	14.5	12.1
A.1.1.2.1	1.1	0.47	0.64	50	2.5%	6.1	472.0	422	1.1%	20.0	2.1	3.4	9.4	472	y	12.6	9.4
A.1.1.2.2	1.1	0.47	0.64	0	2.5%	0.0	340.0	340	1.1%	20.0	2.1	2.7	2.7	340	y	11.9	5.0
A.1.1	4.5	0.46	0.63	100	1.4%	10.5	1420.0	1320	1.1%	20.0	2.1	10.5	21.0	1420	y	17.9	17.9
A.1.2	0.15	0.60	0.73	20	2.5%	3.0	212.0	192	1.1%	20.0	2.1	1.5	4.5	212	y	11.2	5.0
A.2.1	1.9	0.60	0.73	90	2.5%	6.4	1162.0	1072	1.1%	20.0	2.1	8.5	14.9	1162	y	16.5	14.9
A.2.2	2.0	0.54	0.68	90	2.5%	7.2	676.0	586	1.9%	20.0	2.8	3.5	10.8	676	y	13.8	10.8
B.3	1.7	0.44	0.62	100	5.1%	7.1	500.0	400	4.5%	20.0	4.2	1.6	8.6	500	y	12.8	8.6
C.1	2.0	0.46	0.64	90	2.5%	8.1	487.0	397	2.2%	20.0	3.0	2.2	10.4	487	y	12.7	10.4
C.2	0.9	0.57	0.70	30	2.5%	3.9	446.0	416	2.2%	20.0	3.0	2.3	6.2	446	y	12.5	6.2
D.1	0.7	0.70	0.80	30	2.5%	2.9	693.0	663	2.5%	20.0	3.2	3.5	6.4	693	y	13.9	6.4
D.2	0.35	0.77	0.86	20	2.0%	2.1	335.0	315	4.0%	20.0	4.0	1.3	3.4	335	y	11.9	5.0
H-E	6.0	0.18	0.52	150	2.0%	16.4	466.0	316	9.1%	5.0	1.5	3.5	19.9	466	n	12.6	19.9
E	1.0	0.42	0.61	20	20.0%	2.1	60.0	40	10.0%	7.0	2.2	0.3	2.4	60	y	10.3	5.0
H-F	7.5	0.18	0.52	150	3.3%	13.9	794.0	644	8.5%	5.0	1.5	7.4	21.2	794	n	14.4	21.2
F	1.2	0.44	0.62	20	20.0%	2.0	60.0	260	5.0%	20.0	4.5	1.0	3.0	280	y	11.6	5.0
H-G	1.9	0.18	0.52	150	16.7%	8.1	954.0	804	2.9%	5.0	0.8	15.9	23.9	954	n	15.3	23.9
G	1.7	0.18	0.52	50	15.0%	4.8	955.0	905	2.9%	20.0	3.4	4.5	9.3	955	n	15.3	9.3
H-H	0.5	0.18	0.52	50	2.0%	9.4	160.0	110	20.0%	5.0	2.2	0.8	10.3	160	n	10.9	10.3
H	0.5	0.50	0.66	26	2.0%	4.5	160.0	134	2.2%	20.0	3.0	0.8	5.2	160	y	10.9	5.2
H-J	2.1	0.18	0.52	45	9.2%	5.4	405.0	360	8.1%	5.0	1.4	4.2	9.6	405	n	12.3	9.6
J	0.8	0.33	0.58	45	24.0%	3.3	370.0	325	3.9%	7.0	1.4	3.9	7.2	370	y	12.1	7.2
H-K	1.4	0.18	0.52	45	9.3%	5.4	257.0	212	12.2%	5.0	1.7	2.0	7.4	257	n	11.4	7.4
K	0.4	0.26	0.55	10	6.7%	2.6	50.0	40	6.7%	7.0	1.8	0.4	3.0	50	y	10.3	5.0

*SWALE CODES ARE:

MEADOW AND FORREST	2.50
TILLAGE	5.00
LAWN	7.00
BARE GROUND	10.00
GRASSED WATERWAY	15.00
PAVED WATERWAY	20.00

Regional Time of Concentration

$$T_i = 0.395 \left[\frac{(1.1 - C_s) \sqrt{L}}{\sqrt[3]{S}} \right]$$

Urbanized Time of Concentration

$$T_c = \frac{L}{180} + 10$$

Figure 7.0

Proposed Drainage Basins
Standard Form SF-3
Storm Drainage System Design
(Rational Method Procedure)

Project: CVR14 Amd 1
Calc'd by: JJM
Reviewed by: JJM

Date: 04/17/26

Design Storm: 5 Year
 P_1 : 1.43 inches

(Mannings value = 0.013)

Basin ID	Design Point	Direct Runoff						Total Runoff				Inlet		Storm Sewer			Travel Time			Remarks
		Area (ac)	Tc (Min)	Runoff Coefficient C	Intensity (in/hr)	C*A (acres)	Direct Runoff (cfs)	Tc (Min)	Intensity (in/hr)	C*A (acres)	Total Runoff (cfs)	Intercepted (cfs)	Bypass (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Travel Time (Min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
A.1.1.1	6	2.3	13.7	0.45	3.4	1.0	3.5					2.9	0.6						6.1	Road Capacity Check + Inlet A1.3
A.1.1.2	8	2.2	12.1	0.47	3.6	1.0	3.7				4.3									Road Capacity Check
A.1.1.2.1	7	1.1	9.4	0.47	4.0	0.5	2.0					2.2	2.6							Road Capacity Check + Inlet A1.2
A.1.1.2.2	8	1.1	5.0	0.47	4.9	0.5	2.5													Road Capacity Check
A.1.1.1 + A.1.1.2.1	7	3.4	13.7	0.51	3.4	1.7	5.9				3.0	1.8	1.3							Peak minus intercepted @ Inlet A1.2 (compare)
A.1.1	9	4.5	17.9	0.46	3.0	2.1	6.1													Flow from south gutter @ inlet A1.1
A.1.2	9	0.1	5.0	0.70	4.9	0.1	0.5													Flow from north gutter @ inlet A1.1
A.1	9	4.6						17.9	3.0	2.2	6.4	1.3	0.0							Peak minus intercepted @ Inlet A1.1 (sump)
A.2.1	10	1.9	14.9	0.60	3.3	1.13	3.7					3.7	0.0							Road Capacity Check + Inlet A2.2 & A2.1.A
A.2.2	10	2.0	10.8	0.54	3.8	1.08	4.1													Road Capacity Check
A.2	10	3.9						14.9	3.3	2.2	7.2	3.5	0.0							Peak minus intercepted @ Inlet A2.1 (sump)
A	11	8.5						17.9	3.0	4.4	13.0			12.4	0.5	24		5.6		Sump inlet A2.1 + A1.1 - flow into Pond 512
B.3	8	1.7	8.6	0.44	4.1	0.7	3.0													Sump Inlet B.3
B.3+G+F.1	22	4.0	9.3	0.40	4.0	1.6	6.4													Total flow to NE Pond
C.1	5	2.0	10.4	0.46	3.8	0.9	3.6													Sump Inlet C.1
C.2	4	0.9	6.2	0.57	4.6	0.5	2.2													Sump Inlet C.2
C	3	2.9						10.4	3.8	1.4	5.4			5.1	0.5	18		4.5		Total Flow in Storm Line C
D.1	12	0.7	6.4	0.70	4.5	0.5	2.3													Sump Inlet D.1
D.2	13	0.35	5.0	0.77	4.9	0.3	1.3													Rear lot drainage into Pond 511
D	14	1.1						6.4	4.5	0.8	3.5			3.8	0.5	18		4.2		Total Flow in Storm Line D
H-E	16	6.0	19.9	0.18	2.8	1.1	3.1													Historic flow to West
E	16	1.0	5.0	0.42	4.9	0.4	2.0													Proposed sheet flow to West
H-F	17	7.5	21.2	0.18	2.7	1.4	3.7													Historic flow to North
F.1 or F.2	17	1.2	10.3	0.44	3.8	0.5	2.0													FES Inlet at daylight LP
H-G	18	1.9	23.9	0.18	2.6	0.4	0.9													Historic flow to North in Swale
G	18	1.7	9.3	0.18	4.0	0.3	1.2													Proposed sheet flow to North in Swale
H-H	19	0.5	10.3	0.18	3.8	0.1	0.3													Historic flow to Snow Goose Rd (FKA OS-2 in CVR14)+++
H	19	0.5	5.2	0.50	4.8	0.2	1.1													Proposed flow to Snow Goose Rd
H-J	20	2.1	9.6	0.18	3.9	0.4	1.5													Hist flow to SE FES @ Snow Goose (FKA OS-2 in CVR14)+++
J	20	0.8	7.2	0.33	4.4	0.3	1.2													Proposed flow to SE FES @ Snow Goose Rd
H-K	21	1.4	7.4	0.18	4.3	0.3	1.1													Historic sheet flow west to Pond 512
K	21	0.4	5.0	0.26	4.9	0.1	0.5													Proposed sheet flow west to Pond 512

Note: Basin annotation in this report is hierarchical. For instance, Basin A contains all sub-basins, and sub-sub-basins differentiated by a period. E.g. - A.1+A.2=A, & A.1.1+A.1.2=A.1, and so forth.

+++ Compare to CVR14 Drainage Plan in Appendix G. Basins H&J can be compared to OS-2 in CVR14 study and is treated at Pond 511

Figure 7.1a

Proposed Drainage Basins
Standard Form SF-3
Storm Drainage System Design
(Rational Method Procedure)

Project: CVR14 Amd 1
Calc'd by: JJM
Reviewed by: JJM

Date: 04/17/26

Design Storm: 100 Year

P_1 : 2.60 inches

(Mannings value = 0.013)

Basin ID	Design Point	Direct Runoff						Total Runoff				Inlet		Storm Sewer			Travel Time			Remarks
		Area (ac)	Tc (Min)	Runoff Coefficient C	Intensity (in/hr)	C*A (acres)	Direct Runoff (cfs)	Tc (Min)	Intensity (in/hr)	C*A (acres)	Total Runoff (cfs)	Intercepted (cfs)	Bypass (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Travel Time (Min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
A.1.1.1	6	2.3	13.7	0.63	6.2	1.4	8.9					5.6	3.3						6.1	Road Capacity Check + Inlet A1.3
A.1.1.2	8	2.2	12.1	0.64	6.5	1.4	9.1													Road Capacity Check
A.1.1.2.1	7	1.1	9.4	0.64	7.2	0.7	5.0				8.3	3.3	8.1						3.4	Road Capacity Check + Inlet A1.2
A.1.1.2.2	8	1.1	5.0	0.64	8.8	0.7	6.2													Road Capacity Check
A.1.1.1 + A.1.1.2.1	7	3.4	13.7	0.62	6.2	2.1	13.0				7.4	2.8	4.7							Peak minus intercepted @ Inlet A1.2 (compare)
A.1.1	9	4.5	17.9	0.63	5.4	2.8	15.4													Flow from south gutter @ inlet A1.1
A.1.2	9	0.15	5.0	0.80	8.8	0.1	1.1													Flow from north gutter @ inlet A1.1
A.1	9	4.6						17.9	5.4	3.0	16.0	7.1	0.0							Peak minus intercepted @ Inlet A1.1 (sump)
A.2.1	10	1.9	14.9	0.73	5.9	1.4	8.0					7.0	1.0							Road Capacity Check + Inlet A2.2 & A2.1.A
A.2.2	10	2.0	10.8	0.68	6.8	1.4	9.4													Road Capacity Check
A.2	10	3.9						14.9	5.9	2.7	16.2	9.2	0.0							Peak minus intercepted @ Inlet A2.1 (sump)
A	11	8.5						17.9	5.4	5.7	30.8			30.0	2.0	24		9.6		Sump inlet A2.1 + A1.1 - flow into Pond 512
B.3	22	1.7	8.6	0.62	7.4	1.1	7.8							7.8	3.0	18				Sump Inlet B.3
B.3+G+F.1	22	4.0	9.3	0.59	7.2	2.4	17.1													Total flow to NE Pond
C.1	5	2.0	10.4	0.64	6.9	1.29	8.9													Sump Inlet C.1
C.2	4	0.9	6.2	0.70	8.3	0.60	5.0													Sump Inlet C.2
C	3	2.9						10.4	6.9	1.9	13.1			12.5	2.0	18		7.1		Total Flow in Storm Line C
D.1	12	0.7	6.4	0.80	8.2	0.6	4.8													Sump Inlet D.1
D.2	13	0.35	5.0	0.86	8.8	0.3	2.6													Sump Inlet D.2
D	14	1.1						6.4	8.2	0.9	7.3			7.7	2.0	18		4.4		Total Flow in Storm Line D
H-E	16	6.0	19.9	0.52	5.1	3.1	15.9													Historic flow to West
E	16	1.0	5.0	0.61	8.8	0.6	5.4													Proposed sheet flow to West
H-F	17	7.5	21.2	0.52	5.0	3.9	19.3													Historic flow to North
F.1 or F.2	17	0.6	5.0	0.62	8.8	0.4	3.3													Rear Yard flow to either NW or NE Pond
H-G	18	1.9	23.9	0.52	4.6	1.0	4.6													Historic flow to North in Swale
G	18	1.7	9.3	0.52	7.2	0.9	6.4													Proposed sheet flow to North in Swale
G+B.3	22	3.4	9.3	0.57	7.2	1.9	14.0													Check if flows combined @ NE Corner ~ site
H-H	19	0.5	10.3	0.52	7.0	0.2	1.6													Historic flow to Snow Goose Rd (FKA OS-2 in CVR14)+++
H	19	0.5	5.2	0.66	8.7	0.3	2.7													Proposed flow to Snow Goose Rd
H-J	20	2.1	9.6	0.52	7.1	1.1	7.8													Hist flow to SE FES @ Snow Goose (FKA OS-2 in CVR14)+++
J	20	0.8	7.2	0.58	7.9	0.5	3.7													Proposed flow to SE FES @ Snow Goose Rd
H-K	21	1.4	7.4	0.52	7.8	0.7	5.8													Historic sheet flow west to Pond 512
K	21	0.4	5.0	0.55	8.8	0.2	1.8													Proposed sheet flow west to Pond 512

Note: Basin annotation in this report is hierarchical. For instance, Basin A contains all sub-basins, and sub-sub-basins differentiated by a period. E.g. - A.1+A.2=A, & A.1.1+A.1.2=A.1, and so forth.

+++ Compare to CVR14 Drainage Plan in Appendix G. Basins H&J can be compared to OS-2 in CVR14 study and is treated at Pond 511

Figure 7.1b

APPENDIX C - HYDRAULICS

USER-DEFINED INPUT

User-Defined Design Flows

Bypass (Carry-Over) Flow from Upstream

Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.

Watershed Characteristics

Watershed Profile

Minor Storm Rainfall Input

Major Storm Rainfall Input

[illegible]

CALCULATED OUTPUT

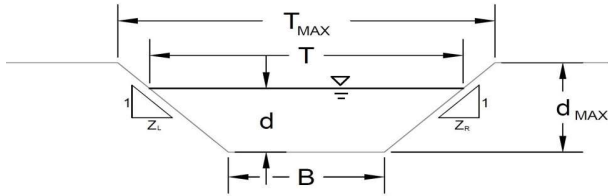
Minor Storm (Calculated) Analysis of Flow Time

Major Storm (Calculated) Analysis of Flow Time

[illegible]

AREA INLET IN A SWALE

CVR PA3a
F.1 F.2 or E.1



This worksheet uses the NRCS
vegetal retardance method to
determine Manning's n for grass-lined
channels.

An override Manning's n can be
entered for other channel materials.

Analysis of Trapezoidal Channel (Grass-Lined uses SCS Method)

NRCS Vegetal Retardance (A, B, C, D, or E)
Manning's n (Leave cell D16 blank to manually enter an n value)
Channel Invert Slope
Bottom Width
Left Side Slope
Right Side Slope

Check one of the following soil types:

Soil Type:	Max. Velocity (V _{MAX})	Max Froude No. (F _{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

A, B, C, D, or E =

n = 0.013

S₀ = 0.0100 ft/ft

B = 2.00 ft

Z1 = 10.00 ft/ft

Z2 = 10.00 ft/ft

Choose One:

☒ Non-Cohesive

☐ Cohesive

☐ Paved

Maximum Allowable Top Width of Channel for Minor & Major Storm
Maximum Allowable Water Depth in Channel for Minor & Major Storm

	Minor Storm	Major Storm	
T _{MAX} =	10.00	10.00	ft
d _{MAX} =	1.00	1.00	ft

Maximum Channel Capacity Based On Allowable Top Width

Maximum Allowable Top Width
Water Depth
Flow Area
Wetted Perimeter
Hydraulic Radius
Manning's n
Flow Velocity
Velocity-Depth Product
Hydraulic Depth
Froude Number
Maximum Flow Based on Allowable Water Depth

	Minor Storm	Major Storm	
T _{MAX} =	10.00	10.00	ft
d =	0.40	0.40	ft
A =	2.40	2.40	sq ft
P =	10.04	10.04	ft
R =	0.24	0.24	ft
n =	0.013	0.013	
V =	4.41	4.41	fps
VR =	1.06	1.06	ft ² /s
D =	0.24	0.24	ft
Fr =	1.59	1.59	
Q _T =	10.6	10.6	cfs

Maximum Channel Capacity Based On Allowable Water Depth

Maximum Allowable Water Depth
Top Width
Flow Area
Wetted Perimeter
Hydraulic Radius
Manning's n
Flow Velocity
Velocity-Depth Product
Hydraulic Depth
Froude Number
Maximum Flow Based On Allowable Water Depth

	Minor Storm	Major Storm	
d _{MAX} =	1.00	1.00	ft
T =	22.00	22.00	ft
A =	12.00	12.00	sq ft
P =	22.10	22.10	ft
R =	0.54	0.54	ft
n =	0.013	0.013	
V =	7.63	7.63	fps
VR =	4.14	4.14	ft ² /s
D =	0.55	0.55	ft
Fr =	1.82	1.82	
Q _d =	91.5	91.5	cfs

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Top Width Criterion
MAJOR STORM Allowable Capacity is based on Top Width Criterion

	Minor Storm	Major Storm	
Q _{allow} =	10.6	10.6	cfs
d _{allow} =	0.40	0.40	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow
Water Depth
Top Width
Flow Area
Wetted Perimeter
Hydraulic Radius
Manning's n
Flow Velocity
Velocity-Depth Product
Hydraulic Depth
Froude Number

	2.0	3.3	
Q _o =	2.0	3.3	cfs
d =	0.18	0.23	ft
T =	5.67	6.67	ft
A =	0.70	1.01	sq ft
P =	5.69	6.70	ft
R =	0.12	0.15	ft
n =	0.013	0.013	
V =	2.84	3.26	fps
VR =	0.35	0.49	ft ² /s
D =	0.12	0.15	ft
Fr =	1.42	1.47	

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

CVR PA3a
F.1 F.2 or E.1

Inlet Design Information (Input)

Type of Inlet

CDOT Type C (Depressed)

Inlet Type =

CDOT Type C (Depressed)

Angle of Inclined Grate (must be <= 30 degrees)

Width of Grate

Length of Grate

Open Area Ratio

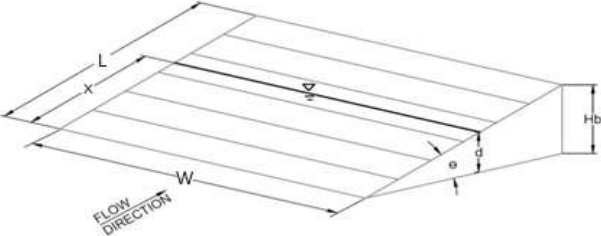
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



θ =

0.00

degrees

W =

3.00

ft

L =

3.00

ft

A_{RATIO} =

0.70

H_B =

0.00

ft

C_f =

0.50

C_d =

0.84

C_o =

0.56

C_w =

1.81

Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)

d =

MINOR	MAJOR
1.18	1.23

Grate Capacity as a Weir

Submerged Side Weir Length

Inclined Side Weir Flow

Base Weir Flow

Interception Without Clogging

Interception With Clogging

X =

3.00

3.00

ft

Q_{ws} =

12.2

13.0

cfs

Q_{wb} =

17.4

18.6

cfs

Q_{wi} =

41.9

44.6

cfs

Q_{wa} =

20.9

22.3

cfs

Grate Capacity as an Orifice

Interception Without Clogging

Interception With Clogging

Q_{oi} =

30.9

31.6

cfs

Q_{oa} =

15.5

15.8

cfs

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

Capture Percentage = Qa/Qo

Q_a =

15.5

15.8

cfs

Q_b =

0.0

0.0

cfs

C% =

100

100

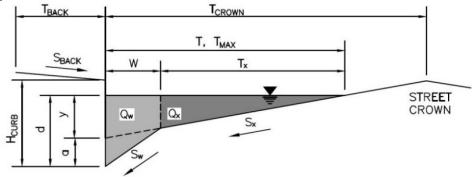
%

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: A1.3



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.015 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_w * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	9.6	9.6	cfs
Q _w	5.7	5.7	cfs
Q _{BACK}	0.8	0.8	cfs
Q _T	16.1	16.1	cfs
V	7.8	7.8	fps
V*d	3.5	3.5	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.4	20.8	ft
T _{x TH}	8.4	18.8	ft
E _o	0.560	0.285	
Q _{x TH}	2.4	21.0	cfs
Q _x	2.4	20.5	cfs
Q _w	3.1	8.4	cfs
Q _{BACK}	0.0	3.9	cfs
Q	5.5	32.7	cfs
V	6.2	9.1	fps
V*d	2.1	4.9	
R	1.00	1.00	
Q _d	5.5	32.7	cfs
d	4.00	6.50	inches
d _{CROWN}	0.00	1.15	inches

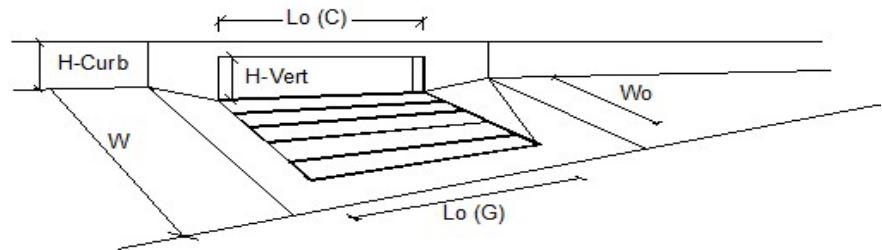
MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
Q _{allow}	5.5	16.1	cfs

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.50 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.90 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



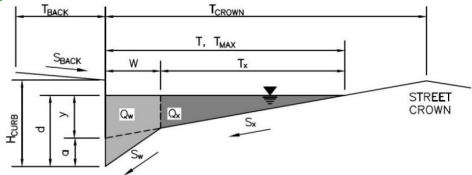
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	Denver No. 16 Combination	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_f (G)$ =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_f (C)$ =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{Allowable Street Capacity}$					
Design Discharge for Half of Street (from <i>Inlet Management</i>)		Q_o =	3.5	8.9	cfs
Water Spread Width		T =	8.4	12.7	ft
Water Depth at Flowline (outside of local depression)		d =	3.5	4.6	inches
Water Depth at Street Crown (or at T_{MAX})		d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow		E_o =	0.666	0.465	
Discharge outside the Gutter Section W, carried in Section T_x		Q_x =	1.2	4.7	cfs
Discharge within the Gutter Section W		Q_w =	2.3	4.1	cfs
Discharge Behind the Curb Face		Q_{BACK} =	0.0	0.1	cfs
Flow Area within the Gutter Section W		A_w =	0.42	0.60	sq ft
Velocity within the Gutter Section W		V_w =	5.5	6.9	fps
Water Depth for Design Condition		d_{LOCAL} =	5.5	6.6	inches
Grate Analysis (Calculated)					
Total Length of Inlet Grate Opening		L =	9.00	9.00	ft
Ratio of Grate Flow to Design Flow		$E_{O-GRATE}$ =	0.620	0.426	
Under No-Clogging Condition					
Minimum Velocity Where Grate Splash-Over Begins		V_o =	3.53	3.53	fps
Interception Rate of Frontal Flow		R_f =	0.94	0.86	
Interception Rate of Side Flow		R_x =	0.61	0.53	
Interception Capacity		Q_i =	2.8	5.9	cfs
Under Clogging Condition					
Clogging Coefficient for Multiple-unit Grate Inlet		GrateCoeff =	1.75	1.75	
Clogging Factor for Multiple-unit Grate Inlet		GrateClog =	0.29	0.29	
Effective (unclogged) Length of Multiple-unit Grate Inlet		L_e =	6.38	6.38	ft
Minimum Velocity Where Grate Splash-Over Begins		V_o =	2.97	2.97	fps
Interception Rate of Frontal Flow		R_f =	0.88	0.81	
Interception Rate of Side Flow		R_x =	0.41	0.33	
Actual Interception Capacity		Q_a =	2.5	4.7	cfs
Carry-Over Flow = $Q_o - Q_a$ (to be applied to curb opening or next d/s inlet)		Q_b =	1.0	4.1	cfs
Curb Opening or Slotted Inlet Analysis (Calculated)					
Equivalent Slope S_e		S_e =	0.117	0.088	ft/ft
Required Length L_T to Have 100% Interception		L_T =	6.20	14.28	ft
Under No-Clogging Condition					
Effective Length of Curb Opening or Slotted Inlet (minimum of L , L_T)		L =	6.20	9.00	ft
Interception Capacity		Q_i =	0.5	1.1	cfs
Under Clogging Condition					
Clogging Coefficient		CurbCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet		CurbClog =	0.06	0.06	
Effective (Unclogged) Length		L_e =	6.20	8.50	ft
Actual Interception Capacity		Q_a =	0.4	0.9	cfs
Carry-Over Flow = $Q_o - Q_a$		Q_b =	0.6	3.2	cfs
Summary					
Total Inlet Interception Capacity		Q =	2.9	5.6	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q_b =	0.6	3.3	cfs
Capture Percentage = Q_a/Q_o		C% =	83	63	%

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: A1.2



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.0 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.011 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_w * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	8.2	8.2	cfs
Q _w	4.9	4.9	cfs
Q _{BACK}	0.7	0.7	cfs
Q _T	13.7	13.7	cfs
V	6.7	6.7	fps
V*d	3.0	3.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.5	20.8	ft
T _{x TH}	8.5	18.8	ft
E _o	0.552	0.285	
Q _{x TH}	2.2	18.0	cfs
Q _x	2.2	17.5	cfs
Q _w	2.7	7.2	cfs
Q _{BACK}	0.0	3.2	cfs
Q	4.9	27.9	cfs
V	5.3	7.8	fps
V*d	1.8	4.2	
R	1.00	1.00	
Q _d	4.9	27.9	cfs
d	4.04	6.50	inches
d _{CROWN}	0.00	1.15	inches

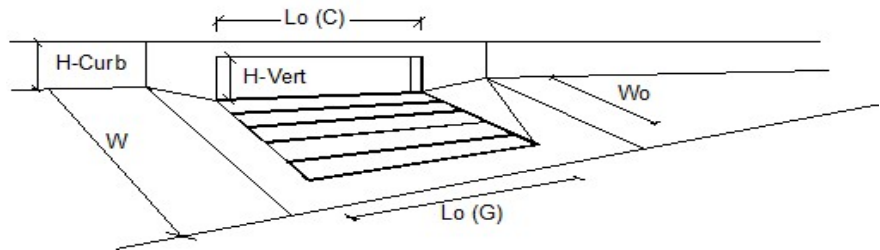
MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
Q _{allow}	4.9	13.7	cfs

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.80 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 11.40 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



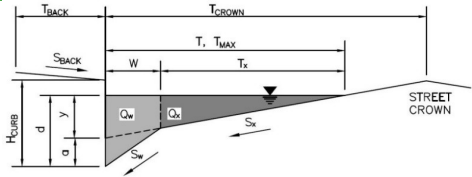
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	Denver No. 16 Combination	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a _{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L _o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W _o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C _f (G) =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C _f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR		MAJOR	
Design Discharge for Half of Street (from <i>Inlet Management</i>)		Q _o =	4.8	11.4	cfs
Water Spread Width		T =	10.4	14.9	ft
Water Depth at Flowline (outside of local depression)		d =	4.0	5.1	inches
Water Depth at Street Crown (or at T _{MAX})		d _{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow		E _o =	0.556	0.398	
Discharge outside the Gutter Section W, carried in Section T _x		Q _x =	2.1	6.6	cfs
Discharge within the Gutter Section W		Q _w =	2.7	4.4	cfs
Discharge Behind the Curb Face		Q _{BACK} =	0.0	0.4	cfs
Flow Area within the Gutter Section W		A _w =	0.50	0.68	sq ft
Velocity within the Gutter Section W		V _w =	5.3	6.4	fps
Water Depth for Design Condition		d _{LOCAL} =	6.0	7.1	inches
Grate Analysis (Calculated)		MINOR		MAJOR	
Total Length of Inlet Grate Opening		L =	3.00	3.00	ft
Ratio of Grate Flow to Design Flow		E _{O-GRATE} =	0.513	0.362	
Under No-Clogging Condition		MINOR		MAJOR	
Minimum Velocity Where Grate Splash-Over Begins		V _o =	1.86	1.86	fps
Interception Rate of Frontal Flow		R _f =	0.81	0.73	
Interception Rate of Side Flow		R _x =	0.12	0.09	
Interception Capacity		Q _i =	2.3	3.5	cfs
Under Clogging Condition		MINOR		MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet		GrateCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Grate Inlet		GrateClog =	0.50	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet		L _e =	1.50	1.50	ft
Minimum Velocity Where Grate Splash-Over Begins		V _o =	1.07	1.07	fps
Interception Rate of Frontal Flow		R _f =	0.74	0.66	
Interception Rate of Side Flow		R _x =	0.03	0.02	
Actual Interception Capacity		Q _a =	1.9	2.8	cfs
Carry-Over Flow = Q _o -Q _a (to be applied to curb opening or next d/s inlet)		Q _b =	2.9	8.3	cfs
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR		MAJOR	
Equivalent Slope S _e		S _e =	0.101	0.078	ft/ft
Required Length L _r to Have 100% Interception		L _r =	11.06	21.21	ft
Under No-Clogging Condition		MINOR		MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L _r , L _T)		L =	3.00	3.00	ft
Interception Capacity		Q _i =	0.4	0.6	cfs
Under Clogging Condition		MINOR		MAJOR	
Clogging Coefficient		CurbCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet		CurbClog =	0.17	0.17	
Effective (Unclogged) Length		L _e =	2.50	2.50	ft
Actual Interception Capacity		Q _a =	0.3	0.5	cfs
Carry-Over Flow = Q _b (GRATE)-Q _a		Q _b =	2.6	7.8	cfs
Summary		MINOR		MAJOR	
Total Inlet Interception Capacity		Q =	2.2	3.3	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q _b =	2.6	8.1	cfs
Capture Percentage = Q _a /Q _o		C% =	46	29	%

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: A1.1



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.000 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_y * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.4	20.8	ft
T _{x TH}	8.4	18.8	ft
E _o	0.560	0.285	
Q _{x TH}	0.0	0.0	cfs
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	
R	SUMP	SUMP	
Q _d	SUMP	SUMP	cfs
d			inches
d _{CROWN}			inches

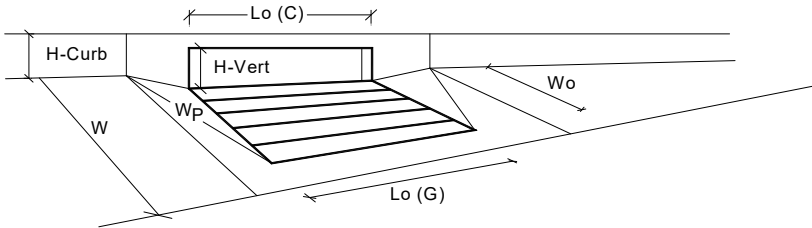
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q _{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



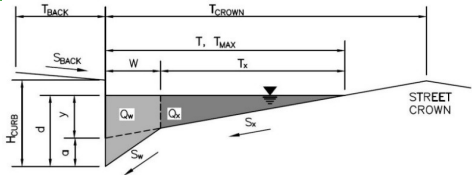
Design Information (Input)		Denver No. 16 Combination	
Type of Inlet	Type =		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =		
Number of Unit Inlets (Grate or Curb Opening)	No =		
Water Depth at Flowline (outside of local depression)	Ponding Depth =		
Grate Information		☒ Override Depths	
Length of a Unit Grate	$L_o(G)$ =		
Width of a Unit Grate	W_o =		
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =		
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	$C_f(G)$ =		
Grate Weir Coefficient (typical value 2.15 - 3.60)	$C_w(G)$ =		
Grate Orifice Coefficient (typical value 0.60 - 0.80)	$C_o(G)$ =		
Curb Opening Information			
Length of a Unit Curb Opening	$L_o(C)$ =		
Height of Vertical Curb Opening in Inches	H_{vert} =		
Height of Curb Orifice Throat in Inches	H_{throat} =		
Angle of Throat	Theta =		
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =		
Clogging Factor for a Single Curb Opening (typical value 0.10)	$C_f(C)$ =		
Curb Opening Weir Coefficient (typical value 2.3-3.7)	$C_w(C)$ =		
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	$C_o(C)$ =		
Grate Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =		
Clogging Factor for Multiple Units	Clog =		
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =		
Interception with Clogging	Q_{wa} =		
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =		
Interception with Clogging	Q_{oa} =		
Grate Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =		
Interception with Clogging	Q_{ma} =		
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =		
Curb Opening Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =		
Clogging Factor for Multiple Units	Clog =		
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =		
Interception with Clogging	Q_{wa} =		
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =		
Interception with Clogging	Q_{oa} =		
Curb Opening Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =		
Interception with Clogging	Q_{ma} =		
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =		
Resultant Street Conditions			
Total Inlet Length	L =		
Resultant Street Flow Spread (based on street geometry from above)	T =		
Resultant Flow Depth at Street Crown	d_{CROWN} =		
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth	d_{Grate} =		
Depth for Curb Opening Weir Equation	d_{Curb} =		
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =		
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =		
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =		
Total Inlet Interception Capacity (assumes clogged condition)		Q_a =	
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)		$Q_{PEAK\ REQUIRED}$ =	

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: A2.2



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.011 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☒	☒	

MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

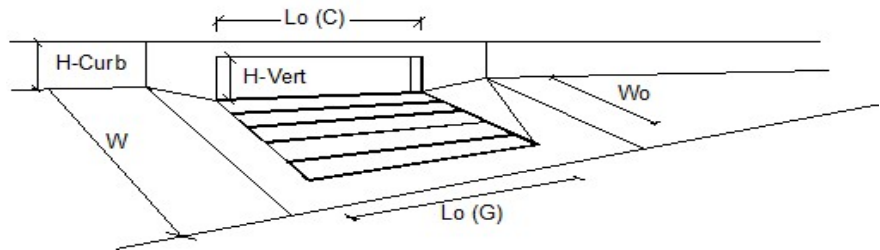
Q_{allow} =

Minor Storm	Major Storm	
4.7	28.0	cfs

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 3.70 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.00 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



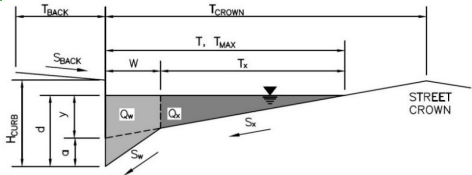
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	Denver No. 16 Combination	Denver No. 16 Combination			
Local Depression (additional to continuous gutter depression 'a')		Type =			
Total Number of Units in the Inlet (Grate or Curb Opening)		a_{LOCAL} =	2.0	2.0	inches
Length of a Single Unit Inlet (Grate or Curb Opening)		No =	1	1	
Width of a Unit Grate (cannot be greater than W, Gutter Width)		L_o =	3.00	3.00	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_f (G)$ =	0.50	0.50	
		$C_f (C)$ =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{Allowable Street Capacity}$		MINOR		MAJOR	
Design Discharge for Half of Street (from <i>Inlet Management</i>)		Q_o =	3.7	8.0	cfs
Water Spread Width		T =	9.3	13.0	ft
Water Depth at Flowline (outside of local depression)		d =	3.7	4.6	inches
Water Depth at Street Crown (or at T_{MAX})		d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow		E_o =	0.615	0.455	
Discharge outside the Gutter Section W, carried in Section T_x		Q_x =	1.4	4.3	cfs
Discharge within the Gutter Section W		Q_w =	2.3	3.6	cfs
Discharge Behind the Curb Face		Q_{BACK} =	0.0	0.1	cfs
Flow Area within the Gutter Section W		A_w =	0.46	0.61	sq ft
Velocity within the Gutter Section W		V_w =	5.0	5.9	fps
Water Depth for Design Condition		d_{LOCAL} =	5.7	6.6	inches
Grate Analysis (Calculated)		MINOR		MAJOR	
Total Length of Inlet Grate Opening		L =	3.00	3.00	ft
Ratio of Grate Flow to Design Flow		$E_{O-GRATE}$ =	0.570	0.417	
Under No-Clogging Condition		MINOR		MAJOR	
Minimum Velocity Where Grate Splash-Over Begins		V_o =	1.86	1.86	fps
Interception Rate of Frontal Flow		R_f =	0.83	0.77	
Interception Rate of Side Flow		R_x =	0.13	0.10	
Interception Capacity		Q_i =	2.0	3.0	cfs
Under Clogging Condition		MINOR		MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet		GrateCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Grate Inlet		GrateClog =	0.50	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet		L_e =	1.50	1.50	ft
Minimum Velocity Where Grate Splash-Over Begins		V_o =	1.07	1.07	fps
Interception Rate of Frontal Flow		R_f =	0.76	0.70	
Interception Rate of Side Flow		R_x =	0.03	0.02	
Actual Interception Capacity		Q_a =	1.6	2.4	cfs
Carry-Over Flow = $Q_o - Q_a$ (to be applied to curb opening or next d/s inlet)		Q_b =	2.1	5.5	cfs
Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR		MAJOR	
Equivalent Slope S_e		S_e =	0.110	0.087	ft/ft
Required Length L_T to Have 100% Interception		L_T =	8.92	16.44	ft
Under No-Clogging Condition		MINOR		MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L , L_T)		L =	3.00	3.00	ft
Interception Capacity		Q_i =	0.4	0.5	cfs
Under Clogging Condition		MINOR		MAJOR	
Clogging Coefficient		CurbCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet		CurbClog =	0.17	0.17	
Effective (Unclogged) Length		L_e =	2.50	2.50	ft
Actual Interception Capacity		Q_a =	0.3	0.4	cfs
Carry-Over Flow = $Q_o - Q_a$		Q_b =	1.8	5.1	cfs
Summary		MINOR		MAJOR	
Total Inlet Interception Capacity		Q =	1.9	2.8	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q_b =	1.8	5.2	cfs
Capture Percentage = Q_a/Q_o		C% =	52	35	%

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: A2.1.A



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.010 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☒	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_w * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	7.8	7.8	cfs
Q _w	4.6	4.6	cfs
Q _{BACK}	0.7	0.7	cfs
Q _T	13.2	13.2	cfs
V	6.4	6.4	fps
V*d	2.9	2.9	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.4	20.8	ft
T _{x TH}	8.4	18.8	ft
E _o	0.560	0.285	
Q _{x TH}	2.0	17.1	cfs
Q _x	2.0	16.7	cfs
Q _w	2.5	6.8	cfs
Q _{BACK}	0.0	3.2	cfs
Q	4.5	26.7	cfs
V	5.0	7.4	fps
V*d	1.7	4.0	
R	1.00	1.00	
Q _d	4.5	26.7	cfs
d	4.00	6.50	inches
d _{CROWN}	0.00	1.15	inches

MINOR STORM Allowable Capacity is based on Depth Criterion

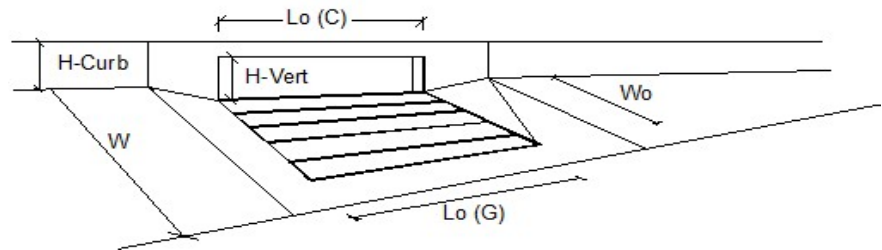
MAJOR STORM Allowable Capacity is based on Depth Criterion

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.80 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 5.20 cfs on sheet 'Inlet Management'

Q_{allow} = 4.5 26.7 cfs

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



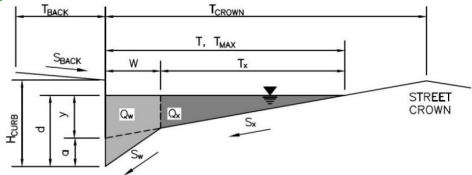
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	Denver No. 16 Combination	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		$C_f (G)$ =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		$C_f (C)$ =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{Allowable Street Capacity}$					
Design Discharge for Half of Street (from <i>Inlet Management</i>)		Q_o =	2.8	5.2	cfs
Water Spread Width		T =	8.3	11.0	ft
Water Depth at Flowline (outside of local depression)		d =	3.5	4.2	inches
Water Depth at Street Crown (or at T_{MAX})		d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow		E_o =	0.670	0.529	
Discharge outside the Gutter Section W, carried in Section T_x		Q_x =	0.9	2.4	cfs
Discharge within the Gutter Section W		Q_w =	1.9	2.8	cfs
Discharge Behind the Curb Face		Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W		A_w =	0.42	0.53	sq ft
Velocity within the Gutter Section W		V_w =	4.5	5.2	fps
Water Depth for Design Condition		d_{LOCAL} =	5.5	6.2	inches
Grate Analysis (Calculated)					
Total Length of Inlet Grate Opening		L =	9.00	9.00	ft
Ratio of Grate Flow to Design Flow		$E_{O-GRATE}$ =	0.624	0.488	
Under No-Clogging Condition					
Minimum Velocity Where Grate Splash-Over Begins		V_o =	3.53	3.53	fps
Interception Rate of Frontal Flow		R_f =	1.00	0.97	
Interception Rate of Side Flow		R_x =	0.69	0.65	
Interception Capacity		Q_i =	2.5	4.2	cfs
Under Clogging Condition					
Clogging Coefficient for Multiple-unit Grate Inlet		GrateCoeff =	1.75	1.75	
Clogging Factor for Multiple-unit Grate Inlet		GrateClog =	0.29	0.29	
Effective (unclogged) Length of Multiple-unit Grate Inlet		L_e =	6.38	6.38	ft
Minimum Velocity Where Grate Splash-Over Begins		V_o =	2.97	2.97	fps
Interception Rate of Frontal Flow		R_f =	0.96	0.92	
Interception Rate of Side Flow		R_x =	0.50	0.45	
Actual Interception Capacity		Q_a =	2.2	3.5	cfs
Carry-Over Flow = $Q_o - Q_a$ (to be applied to curb opening or next d/s inlet)		Q_b =	0.6	1.7	cfs
Curb Opening or Slotted Inlet Analysis (Calculated)					
Equivalent Slope S_e		S_e =	0.118	0.097	ft/ft
Required Length L_T to Have 100% Interception		L_T =	4.58	8.41	ft
Under No-Clogging Condition					
Effective Length of Curb Opening or Slotted Inlet (minimum of L , L_T)		L =	4.58	8.41	ft
Interception Capacity		Q_i =	0.4	0.8	cfs
Under Clogging Condition					
Clogging Coefficient		CurbCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet		CurbClog =	0.06	0.06	
Effective (Unclogged) Length		L_e =	4.58	8.41	ft
Actual Interception Capacity		Q_a =	0.4	0.6	cfs
Carry-Over Flow = $Q_o - Q_a$		Q_b =	0.2	1.0	cfs
Summary					
Total Inlet Interception Capacity		Q =	2.6	4.2	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q_b =	0.2	1.0	cfs
Capture Percentage = Q_a/Q_o		C% =	93	80	%

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: A2.1



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.000 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_y * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.4	20.8	ft
T _{x TH}	8.4	18.8	ft
E _o	0.560	0.285	
Q _{x TH}	0.0	0.0	cfs
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	
R	SUMP	SUMP	
Q _d	SUMP	SUMP	cfs
d			inches
d _{CROWN}			inches

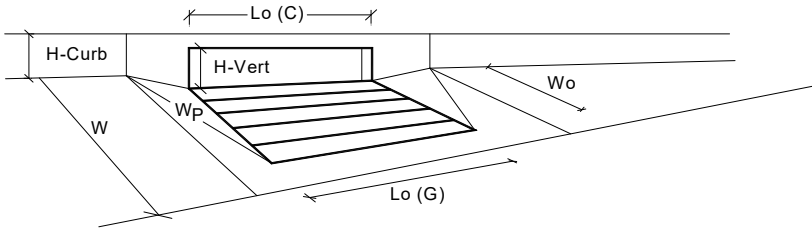
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q _{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



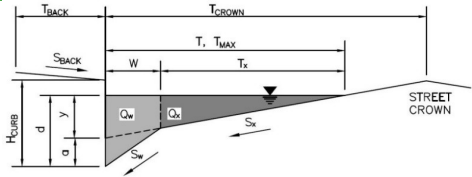
Design Information (Input)		Denver No. 16 Combination	
Type of Inlet	Type = Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00 inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3	3
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4	6.1 inches
Grate Information	☒ Override Depths		
Length of a Unit Grate	L_o (G) =	3.00	3.00 feet
Width of a Unit Grate	W_o =	1.73	1.73 feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60
Curb Opening Information			
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00 feet
Height of Vertical Curb Opening in Inches	H_{vert} =	4.50	4.50 inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25 inches
Angle of Throat	Theta =	0.00	0.00 degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00 feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66
Grate Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.75	1.75
Clogging Factor for Multiple Units	Clog =	0.29	0.29
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	3.3	7.3 cfs
Interception with Clogging	Q_{wa} =	2.3	5.2 cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	14.5	17.0 cfs
Interception with Clogging	Q_{oa} =	10.2	12.0 cfs
Grate Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	6.2	10.0 cfs
Interception with Clogging	Q_{ma} =	4.4	7.1 cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	2.3	5.2 cfs
Curb Opening Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00
Clogging Factor for Multiple Units	Clog =	0.06	0.06
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	1.7	5.4 cfs
Interception with Clogging	Q_{wa} =	1.6	5.1 cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	15.2	17.1 cfs
Interception with Clogging	Q_{oa} =	14.4	16.2 cfs
Curb Opening Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	4.4	8.3 cfs
Interception with Clogging	Q_{ma} =	4.1	7.8 cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	1.6	5.1 cfs
Resultant Street Conditions			
Total Inlet Length	L =	9.00	9.00 feet
Resultant Street Flow Spread (based on street geometry from above)	T =	11.9	19.2 ft. >T-Crown
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.8 inches
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth	d_{Grate} =	0.39	0.53 ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.20	0.34 ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.41	0.58
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.41	0.58
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	3.5	9.2 cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	3.5	9.2 cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: B.3



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.000 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_y * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.4	20.8	ft
T _{x TH}	8.4	18.8	ft
E _o	0.560	0.285	
Q _{x TH}	0.0	0.0	cfs
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	
R	SUMP	SUMP	
Q _d	SUMP	SUMP	cfs
d			inches
d _{CROWN}			inches

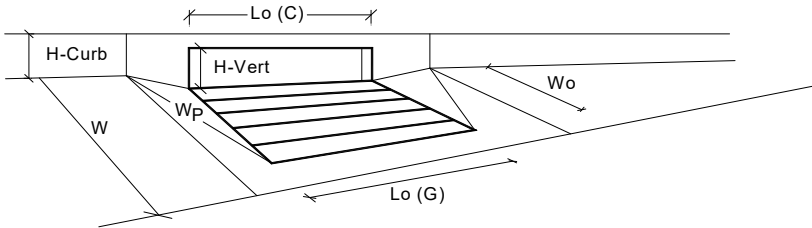
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q _{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



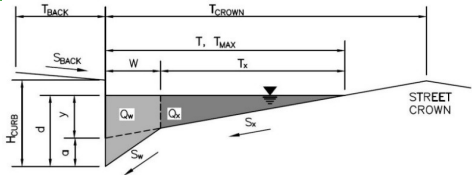
Design Information (Input)		Denver No. 16 Combination	
Type of Inlet	Type = Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00 inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3	3
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4	5.8 inches
Grate Information	☒ Override Depths		
Length of a Unit Grate	L_o (G) =	3.00	3.00 feet
Width of a Unit Grate	W_o =	1.73	1.73 feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60
Curb Opening Information			
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00 feet
Height of Vertical Curb Opening in Inches	H_{vert} =	4.50	4.50 inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25 inches
Angle of Throat	Theta =	0.00	0.00 degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00 feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66
Grate Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.75	1.75
Clogging Factor for Multiple Units	Clog =	0.29	0.29
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	2.9	6.5 cfs
Interception with Clogging	Q_{wa} =	2.0	4.6 cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	14.1	16.5 cfs
Interception with Clogging	Q_{oa} =	10.0	11.7 cfs
Grate Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	5.7	9.3 cfs
Interception with Clogging	Q_{ma} =	4.1	6.6 cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	2.0	4.6 cfs
Curb Opening Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00
Clogging Factor for Multiple Units	Clog =	0.06	0.06
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	1.4	4.6 cfs
Interception with Clogging	Q_{wa} =	1.3	4.3 cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	14.9	16.8 cfs
Interception with Clogging	Q_{oa} =	14.1	15.9 cfs
Curb Opening Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	3.9	7.5 cfs
Interception with Clogging	Q_{ma} =	3.7	7.1 cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	1.3	4.3 cfs
Resultant Street Conditions			
Total Inlet Length	L =	9.00	9.00 feet
Resultant Street Flow Spread (based on street geometry from above)	T =	11.0	17.9 ft. >T-Crown
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.4 inches
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth	d_{Grate} =	0.37	0.51 ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.18	0.32 ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.39	0.55
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.39	0.55
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	3.0	7.9 cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	3.0	7.8 cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: C.1



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.023 ft/ft
S_w = 0.083 ft/ft
S_o = 0.000 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_y * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	4.42	4.42	inches
d _c	2.0	2.0	inches
a	1.44	1.44	inches
d	5.86	5.86	inches
T _x	14.0	14.0	ft
E _o	0.360	0.360	
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	9.3	18.3	ft
T _{x TH}	7.3	16.3	ft
E _o	0.594	0.314	
Q _{x TH}	0.0	0.0	cfs
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	
R	SUMP	SUMP	
Q _d	SUMP	SUMP	cfs
d			inches
d _{CROWN}			inches

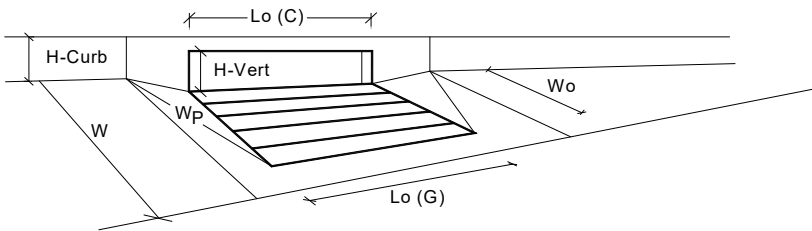
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q _{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



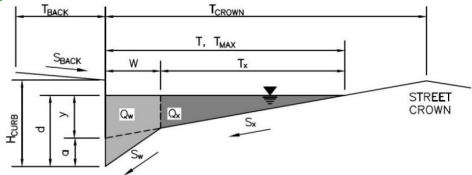
Design Information (Input)		Denver No. 16 Combination	
Type of Inlet	Type = Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00 inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3	3
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4	6.0 inches
Grate Information	☒ Override Depths		
Length of a Unit Grate	L_o (G) =	3.00	3.00 feet
Width of a Unit Grate	W_o =	1.73	1.73 feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60
Curb Opening Information			
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00 feet
Height of Vertical Curb Opening in Inches	H_{vert} =	4.50	4.50 inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25 inches
Angle of Throat	Theta =	0.00	0.00 degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00 feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66
Grate Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.75	1.75
Clogging Factor for Multiple Units	Clog =	0.29	0.29
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	3.3	7.1 cfs
Interception with Clogging	Q_{wa} =	2.4	5.0 cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	14.5	16.9 cfs
Interception with Clogging	Q_{oa} =	10.3	11.9 cfs
Grate Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	6.3	9.9 cfs
Interception with Clogging	Q_{ma} =	4.4	7.0 cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	2.4	5.0 cfs
Curb Opening Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00
Clogging Factor for Multiple Units	Clog =	0.06	0.06
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	1.8	5.2 cfs
Interception with Clogging	Q_{wa} =	1.7	4.9 cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	15.3	17.1 cfs
Interception with Clogging	Q_{oa} =	14.4	16.1 cfs
Curb Opening Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	4.5	8.1 cfs
Interception with Clogging	Q_{ma} =	4.2	7.7 cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	1.7	4.9 cfs
Resultant Street Conditions			
Total Inlet Length	L =	9.00	9.00 feet
Resultant Street Flow Spread (based on street geometry from above)	T =	10.8	16.7 ft. >T-Crown
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.2 inches
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth	d_{Grate} =	0.39	0.53 ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.20	0.34 ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.42	0.57
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.42	0.57
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	3.6	8.9 cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	3.6	8.9 cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: C.2



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.000 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_y * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.4	20.8	ft
T _{x TH}	8.4	18.8	ft
E _o	0.560	0.285	
Q _{x TH}	0.0	0.0	cfs
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	
R	SUMP	SUMP	
Q _d	SUMP	SUMP	cfs
d			inches
d _{CROWN}			inches

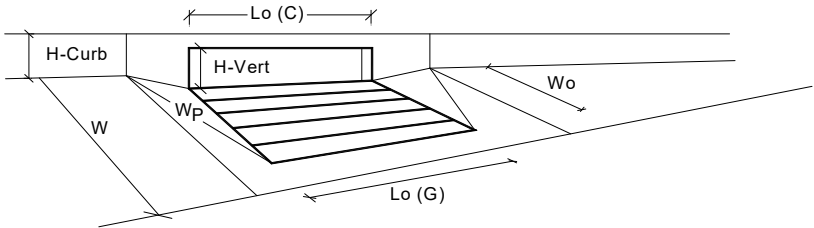
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q _{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



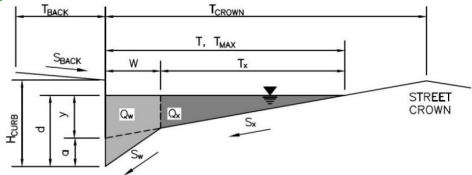
Design Information (Input)		Denver No. 16 Combination	
Type of Inlet	Type = Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00 inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.0	5.4 inches
Grate Information	☐ Override Depths		
Length of a Unit Grate	$L_o(G)$ =	3.00	3.00 feet
Width of a Unit Grate	W_o =	1.73	1.73 feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	$C_f(G)$ =	0.50	0.50
Grate Weir Coefficient (typical value 2.15 - 3.60)	$C_w(G)$ =	3.60	3.60
Grate Orifice Coefficient (typical value 0.60 - 0.80)	$C_o(G)$ =	0.60	0.60
Curb Opening Information			
Length of a Unit Curb Opening	$L_o(C)$ =	3.00	3.00 feet
Height of Vertical Curb Opening in Inches	H_{vert} =	4.50	4.50 inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25 inches
Angle of Throat	Theta =	0.00	0.00 degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00 feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	$C_f(C)$ =	0.10	0.10
Curb Opening Weir Coefficient (typical value 2.3-3.7)	$C_w(C)$ =	3.70	3.70
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	$C_o(C)$ =	0.66	0.66
Grate Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.50	1.50
Clogging Factor for Multiple Units	Clog =	0.38	0.38
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	2.5	5.0 cfs
Interception with Clogging	Q_{wa} =	1.6	3.1 cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	9.2	10.6 cfs
Interception with Clogging	Q_{oa} =	5.8	6.6 cfs
Grate Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	4.3	6.6 cfs
Interception with Clogging	Q_{ma} =	2.7	4.1 cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	1.6	3.1 cfs
Curb Opening Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00
Clogging Factor for Multiple Units	Clog =	0.08	0.08
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	1.1	3.3 cfs
Interception with Clogging	Q_{wa} =	1.0	3.0 cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	9.8	10.9 cfs
Interception with Clogging	Q_{oa} =	9.0	10.0 cfs
Curb Opening Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	2.9	5.2 cfs
Interception with Clogging	Q_{ma} =	2.6	4.7 cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	1.0	3.0 cfs
Resultant Street Conditions			
Total Inlet Length	L =	6.00	6.00 feet
Resultant Street Flow Spread (based on street geometry from above)	T =	10.4	16.0 ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0 inches
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth	d_{Grate} =	0.36	0.47 ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.17	0.28 ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.47	0.63
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.47	0.63
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	2.3	5.5 cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	2.2	5.0 cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: D.1



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.000 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_y * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.4	20.8	ft
T _{x TH}	8.4	18.8	ft
E _o	0.560	0.285	
Q _{x TH}	0.0	0.0	cfs
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	
R	SUMP	SUMP	
Q _d	SUMP	SUMP	cfs
d			inches
d _{CROWN}			inches

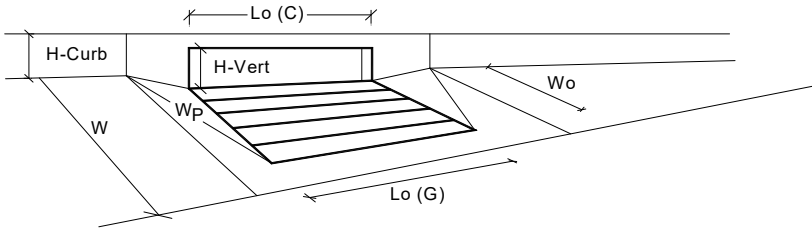
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q _{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



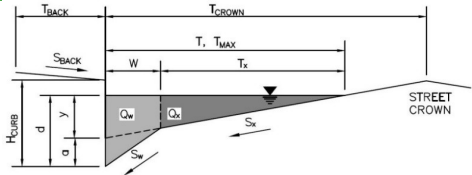
Design Information (Input)		Denver No. 16 Combination	
Type of Inlet	Type = Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00 inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3	3
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.0	5.4 inches
Grate Information	☐ Override Depths		
Length of a Unit Grate	L_o (G) =	3.00	3.00 feet
Width of a Unit Grate	W_o =	1.73	1.73 feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60
Curb Opening Information			
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00 feet
Height of Vertical Curb Opening in Inches	H_{vert} =	4.50	4.50 inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25 inches
Angle of Throat	Theta =	0.00	0.00 degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00 feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66
Grate Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.75	1.75
Clogging Factor for Multiple Units	Clog =	0.29	0.29
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	2.6	5.3 cfs
Interception with Clogging	Q_{wa} =	1.9	3.8 cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	13.9	15.9 cfs
Interception with Clogging	Q_{oa} =	9.8	11.3 cfs
Grate Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	5.4	8.3 cfs
Interception with Clogging	Q_{ma} =	3.8	5.9 cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	1.9	3.8 cfs
Curb Opening Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00
Clogging Factor for Multiple Units	Clog =	0.06	0.06
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} =	1.2	3.5 cfs
Interception with Clogging	Q_{wa} =	1.1	3.3 cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} =	14.7	16.3 cfs
Interception with Clogging	Q_{oa} =	13.9	15.4 cfs
Curb Opening Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} =	3.6	6.5 cfs
Interception with Clogging	Q_{ma} =	3.4	6.1 cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	1.1	3.3 cfs
Resultant Street Conditions			
Total Inlet Length	L =	9.00	9.00 feet
Resultant Street Flow Spread (based on street geometry from above)	T =	10.4	16.0 ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0 inches
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth	d_{Grate} =	0.36	0.47 ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.17	0.28 ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.38	0.50
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.38	0.50
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	2.7	6.3 cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	2.3	4.8 cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR PA3a

Inlet ID: D.2



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK} = 6.0 ft
S_{BACK} = 0.020 ft/ft
n_{BACK} = 0.012

H_{CURB} = 4.00 inches
T_{CROWN} = 16.0 ft
W = 2.00 ft
S_x = 0.020 ft/ft
S_w = 0.083 ft/ft
S_o = 0.000 ft/ft
n_{STREET} = 0.012

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T _{MAX}	16.0	16.0	ft
d _{MAX}	4.0	6.5	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (T * S_y * 12)
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline (y + a)
Allowable Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Discharge outside the Gutter Section, carried in Section T_x
Discharge within the Gutter Section (Q_T - Q_x - Q_{BACK})
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	3.84	3.84	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.35	5.35	inches
T _x	14.0	14.0	ft
E _o	0.372	0.372	
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)
Theoretical Discharge outside the Gutter Section, carried in Section T_{x TH}
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})
Discharge within the Gutter Section (Q_d - Q_x)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"
Max Flow based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	10.4	20.8	ft
T _{x TH}	8.4	18.8	ft
E _o	0.560	0.285	
Q _{x TH}	0.0	0.0	cfs
Q _x	0.0	0.0	cfs
Q _w	0.0	0.0	cfs
Q _{BACK}	0.0	0.0	cfs
Q	SUMP	SUMP	cfs
V	0.0	0.0	fps
V*d	0.0	0.0	
R	SUMP	SUMP	
Q _d	SUMP	SUMP	cfs
d			inches
d _{CROWN}			inches

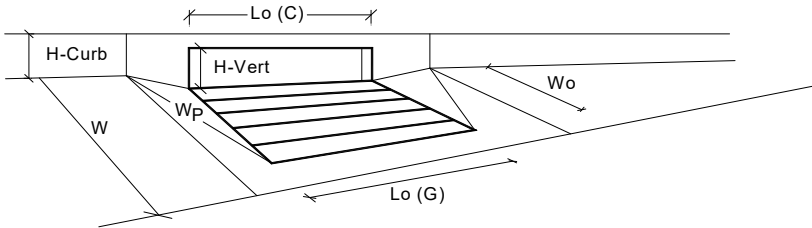
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q _{allow}	SUMP	SUMP	cfs

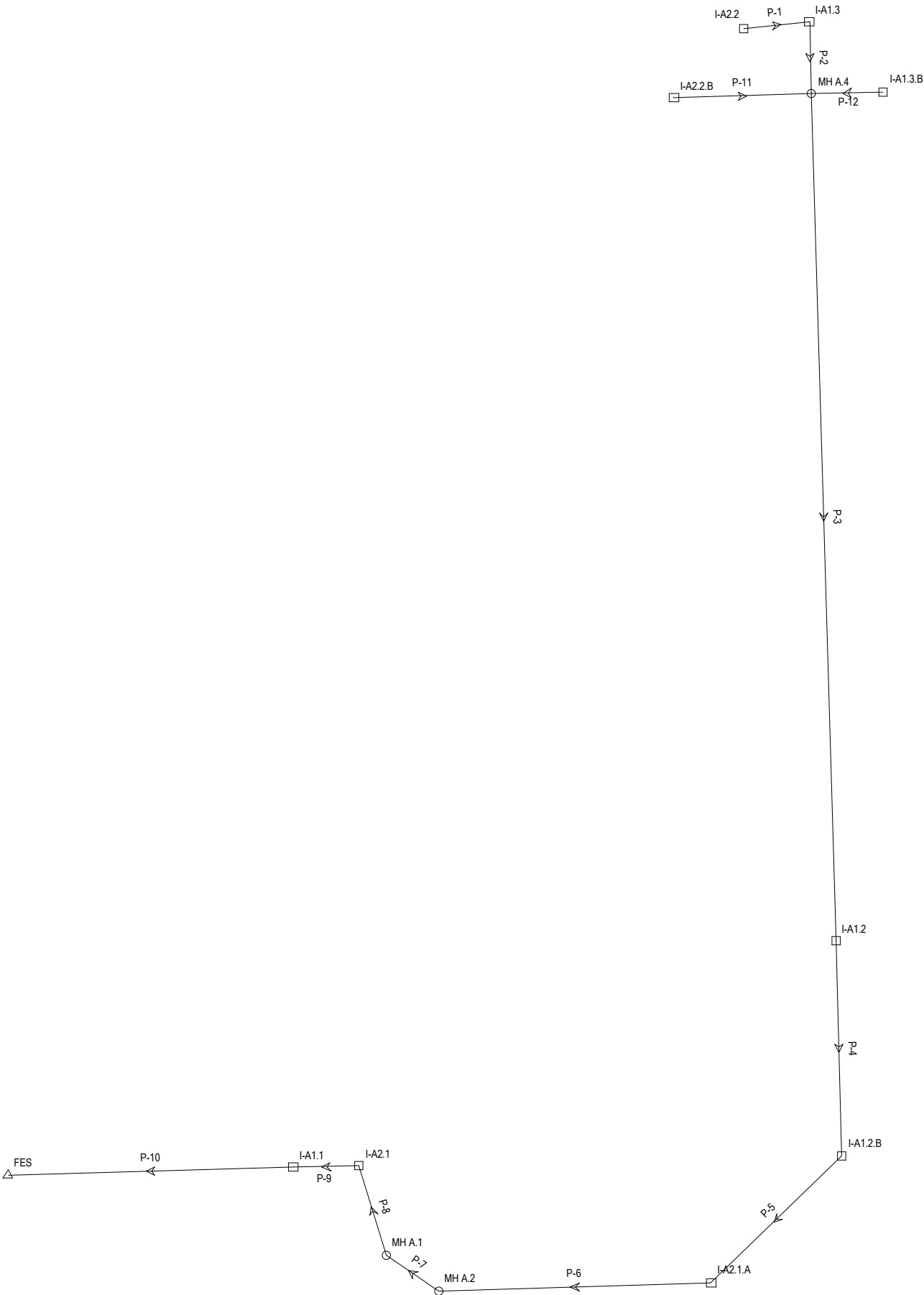
INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)		Denver No. 16 Combination	
Type of Inlet	Type =		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} = 2.00 inches		
Number of Unit Inlets (Grate or Curb Opening)	No = 1		
Water Depth at Flowline (outside of local depression)	Ponding Depth = 3.6 inches		
Grate Information		☒ Override Depths	
Length of a Unit Grate	$L_o(G)$ = 3.00 feet		
Width of a Unit Grate	W_o = 1.73 feet		
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} = 0.31		
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	$C_f(G)$ = 0.50		
Grate Weir Coefficient (typical value 2.15 - 3.60)	$C_w(G)$ = 3.60		
Grate Orifice Coefficient (typical value 0.60 - 0.80)	$C_o(G)$ = 0.60		
Curb Opening Information			
Length of a Unit Curb Opening	$L_o(C)$ = 3.00 feet		
Height of Vertical Curb Opening in Inches	H_{vert} = 4.50 inches		
Height of Curb Orifice Throat in Inches	H_{throat} = 5.25 inches		
Angle of Throat	Theta = 0.00 degrees		
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p = 2.00 feet		
Clogging Factor for a Single Curb Opening (typical value 0.10)	$C_f(C)$ = 0.10		
Curb Opening Weir Coefficient (typical value 2.3-3.7)	$C_w(C)$ = 3.70		
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	$C_o(C)$ = 0.66		
Grate Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef = 1.00		
Clogging Factor for Multiple Units	Clog = 0.50		
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} = 1.8 cfs		
Interception with Clogging	Q_{wa} = 0.9 cfs		
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} = 4.4 cfs		
Interception with Clogging	Q_{oa} = 2.2 cfs		
Grate Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} = 2.5 cfs		
Interception with Clogging	Q_{ma} = 1.3 cfs		
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} = 0.9 cfs		
Curb Opening Flow Analysis (Calculated)			
Clogging Coefficient for Multiple Units	Coef = 1.00		
Clogging Factor for Multiple Units	Clog = 0.17		
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{wi} = 0.7 cfs		
Interception with Clogging	Q_{wa} = 0.6 cfs		
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)			
Interception without Clogging	Q_{oi} = 4.8 cfs		
Interception with Clogging	Q_{oa} = 4.0 cfs		
Curb Opening Capacity as Mixed Flow			
Interception without Clogging	Q_{mi} = 1.5 cfs		
Interception with Clogging	Q_{ma} = 1.3 cfs		
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} = 0.6 cfs		
Resultant Street Conditions			
Total Inlet Length	L = 3.00 feet		
Resultant Street Flow Spread (based on street geometry from above)	T = 8.7 ft		
Resultant Flow Depth at Street Crown	d_{CROWN} = 0.0 inches		
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth	d_{Grate} = 0.32 ft		
Depth for Curb Opening Weir Equation	d_{Curb} = 0.13 ft		
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} = 0.56		
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} = N/A		
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ = 0.56		
Total Inlet Interception Capacity (assumes clogged condition)		Q_a = 1.3 cfs	
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)		$Q_{PEAK\ REQUIRED}$ = 1.3 cfs	

Scenario: 5yr



Scenario: 5yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	I-A2.2	I-A1.3	30.50	18 inch	1.48	1.90	6.03	15.46	6,460.75	6,460.30	6,461.27	6,461.05
P-2	I-A1.3	MH A.4	33.50	18 inch	1.37	4.80	7.54	14.87	6,460.04	6,459.58	6,460.88	6,460.21
P-3	MH A.4	I-A1.2	394.80	18 inch	1.01	4.90	6.70	12.60	6,459.00	6,455.01	6,459.85	6,455.98
P-4	I-A1.2	I-A1.2.B	100.20	18 inch	0.51	7.10	5.46	8.70	6,454.71	6,454.20	6,455.74	6,455.23
P-5	I-A1.2.B	I-A2.1.A	84.80	18 inch	1.56	7.14	8.77	15.91	6,453.90	6,452.58	6,454.93	6,453.30
P-6	I-A2.1.A	MH A.2	127.30	18 inch	0.77	9.34	6.88	10.88	6,452.28	6,451.30	6,453.46	6,452.38
P-7	MH A.2	MH A.1	29.40	18 inch	0.48	9.34	5.29	8.39	6,451.00	6,450.86	6,452.31	6,452.04
P-8	MH A.1	I-A2.1	43.30	18 inch	0.74	9.34	6.75	10.64	6,450.56	6,450.24	6,451.74	6,451.65
P-9	I-A2.1	I-A1.1	30.50	18 inch	4.00	12.84	14.88	26.49	6,449.94	6,448.72	6,451.29	6,449.62
P-10	I-A1.1	FES	107.60	24 inch	2.32	14.14	12.13	42.10	6,445.90	6,443.40	6,447.25	6,444.23
P-11	I-A2.2.B	MH A.4	64.00	18 inch	1.47	0.05	2.11	15.42	6,460.24	6,459.30	6,460.32	6,459.92
P-12	I-A1.3.B	MH A.4	33.70	18 inch	1.48	0.05	2.11	15.51	6,459.80	6,459.30	6,459.92	6,459.92

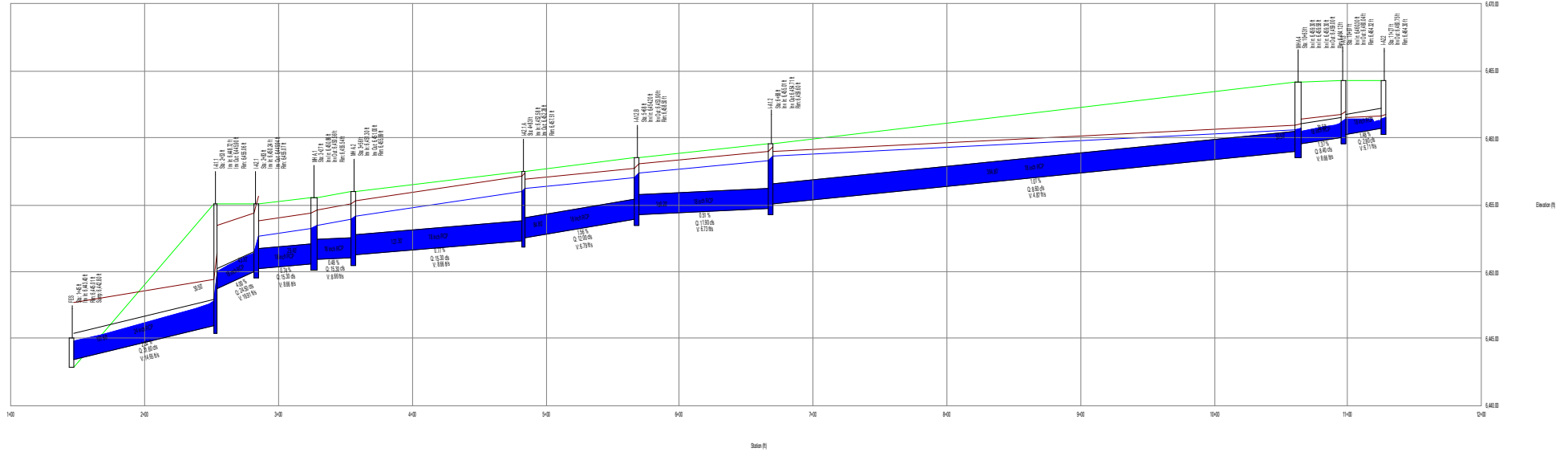
Scenario: 100yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	I-A2.2	I-A1.3	30.50	18 inch	1.48	2.80	6.71	15.46	6,460.75	6,460.30	6,461.39	6,461.44
P-2	I-A1.3	MH A.4	33.50	18 inch	1.37	8.40	8.66	14.87	6,460.04	6,459.58	6,461.16	6,460.46
P-3	MH A.4	I-A1.2	394.80	18 inch	1.01	8.60	4.87	12.60	6,459.00	6,455.01	6,460.59	6,458.62
P-4	I-A1.2	I-A1.2.B	100.20	18 inch	0.51	11.90	6.73	8.70	6,454.71	6,454.20	6,458.27	6,457.36
P-5	I-A1.2.B	I-A2.1.A	84.80	18 inch	1.56	12.00	6.79	15.91	6,453.90	6,452.58	6,457.00	6,456.22
P-6	I-A2.1.A	MH A.2	127.30	18 inch	0.77	15.30	8.66	10.88	6,452.28	6,451.30	6,455.98	6,454.14
P-7	MH A.2	MH A.1	29.40	18 inch	0.48	15.30	8.66	8.39	6,451.00	6,450.86	6,453.91	6,453.48
P-8	MH A.1	I-A2.1	43.30	18 inch	0.74	15.30	8.66	10.64	6,450.56	6,450.24	6,453.25	6,452.62
P-9	I-A2.1	I-A1.1	30.50	18 inch	4.00	24.50	16.91	26.49	6,449.94	6,448.72	6,451.43	6,450.04
P-10	I-A1.1	FES	107.60	24 inch	2.32	31.60	14.65	42.10	6,445.90	6,443.40	6,447.78	6,444.79
P-11	I-A2.2.B	MH A.4	64.00	18 inch	1.47	0.10	2.58	15.42	6,460.24	6,459.30	6,460.66	6,460.66
P-12	I-A1.3.B	MH A.4	33.70	18 inch	1.48	0.10	2.59	15.51	6,459.80	6,459.30	6,460.66	6,460.66

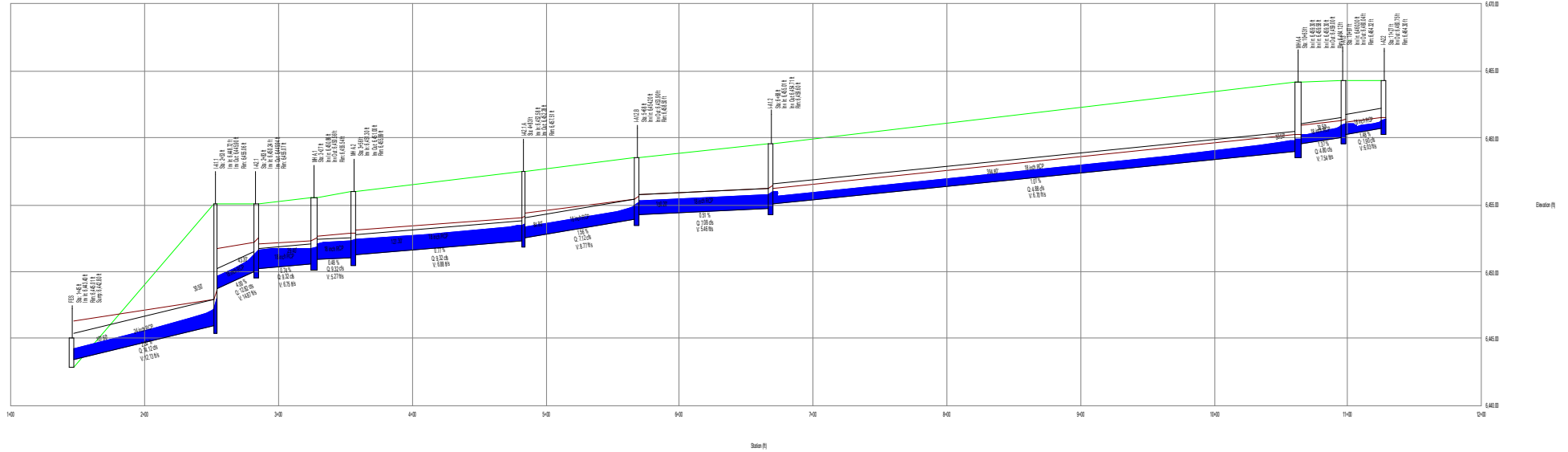
Profile Scenario: 100yr

Profile: I-A2.2 to FES
Scenario: 100yr



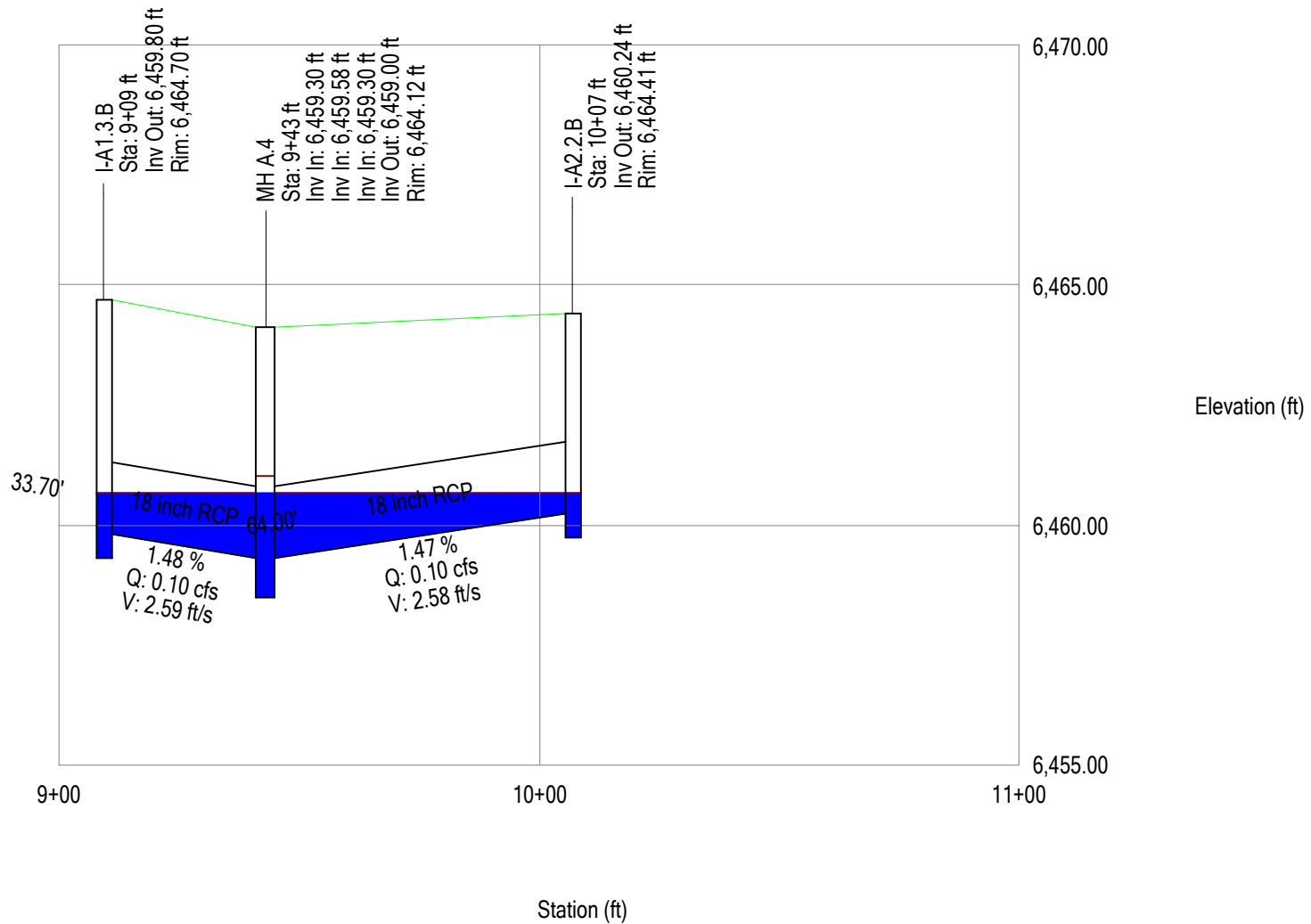
Profile Scenario: 5yr

Profile: I-A2.2 to FES
Scenario: 5yr



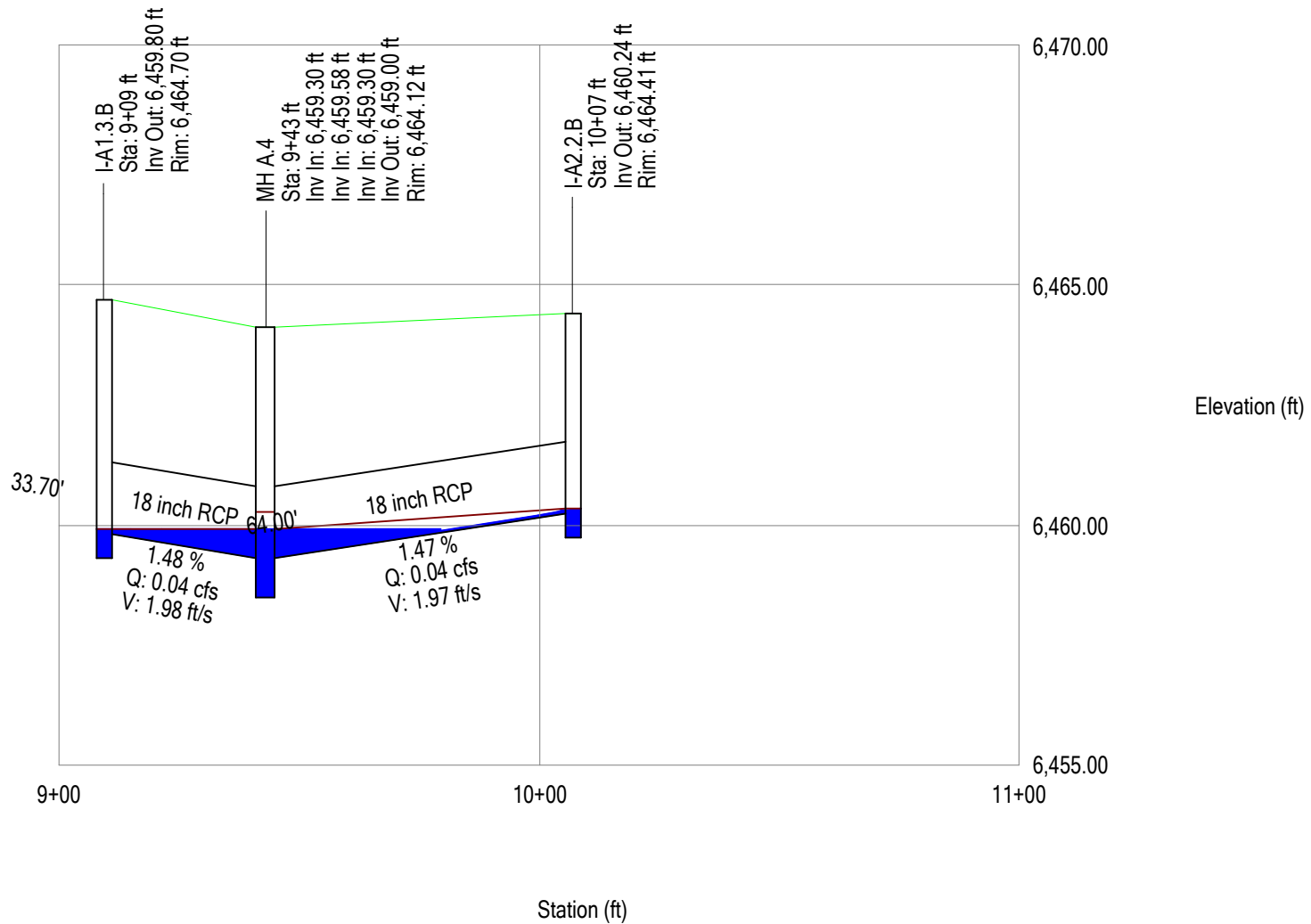
Profile
Scenario: 100yr

Profile: I-A2.2.B to I-A1.3.B
Scenario: 100yr

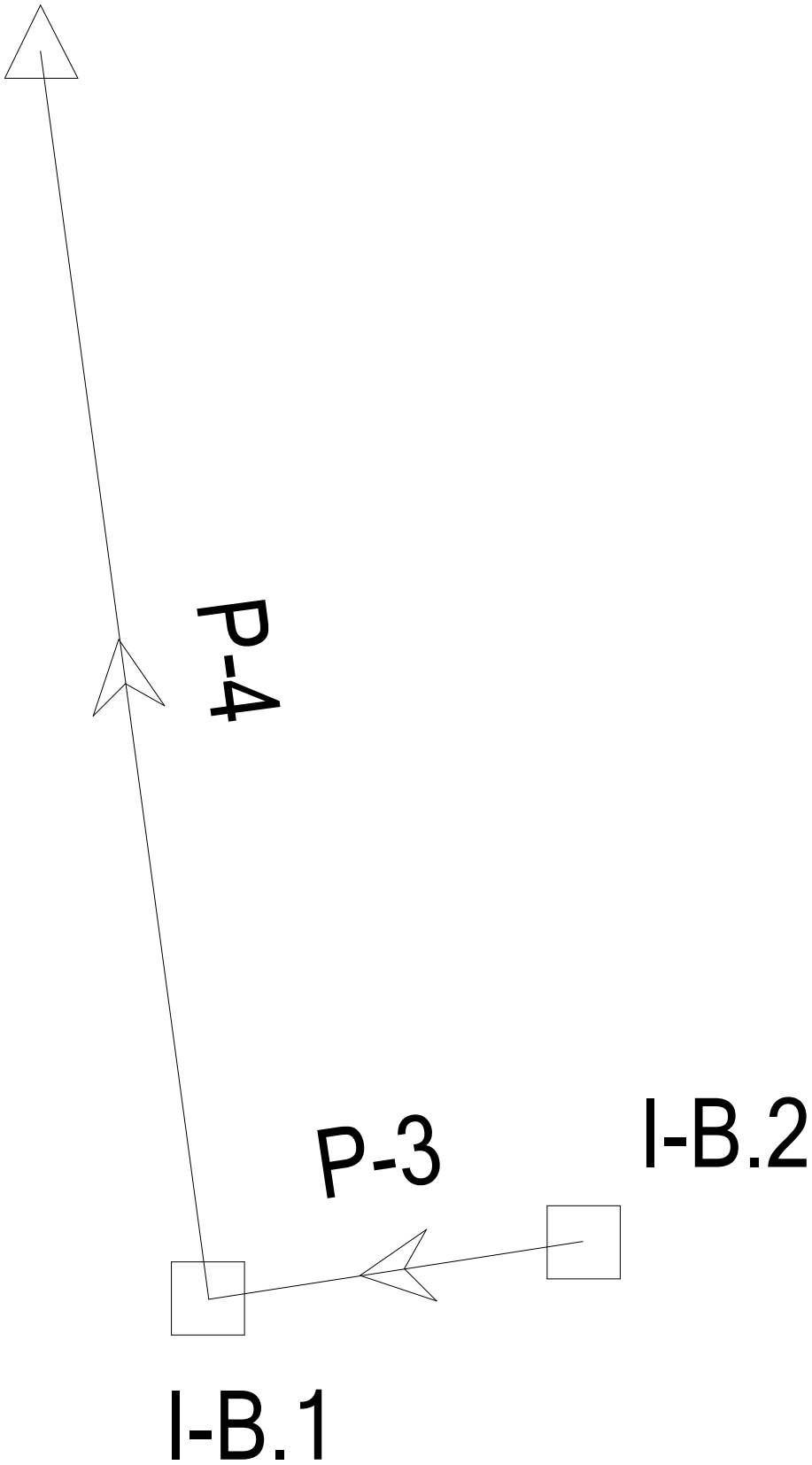


Profile
Scenario: 5yr

Profile: I-A2.2.B to I-A1.3.B
Scenario: 5yr

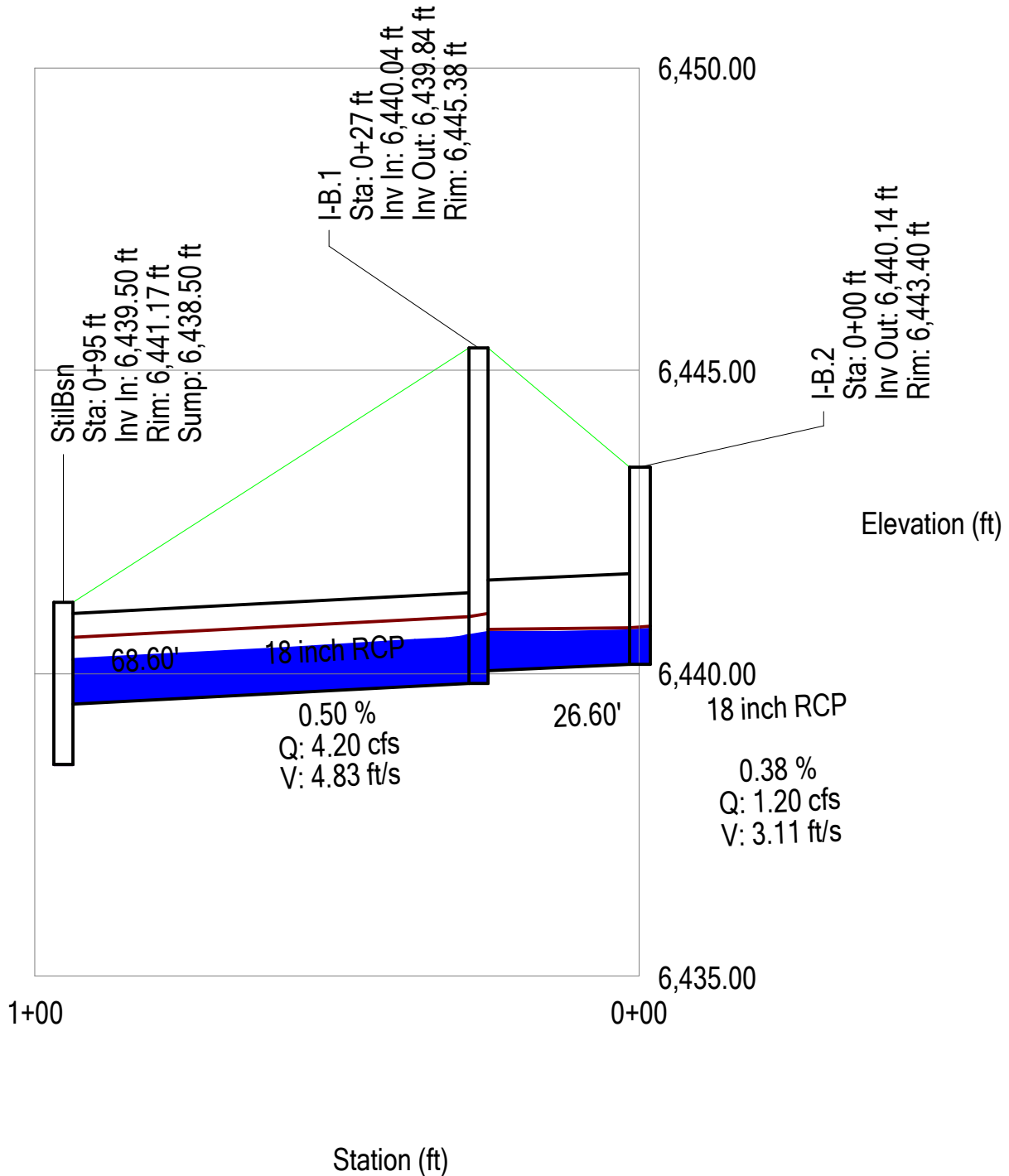


StilBsn



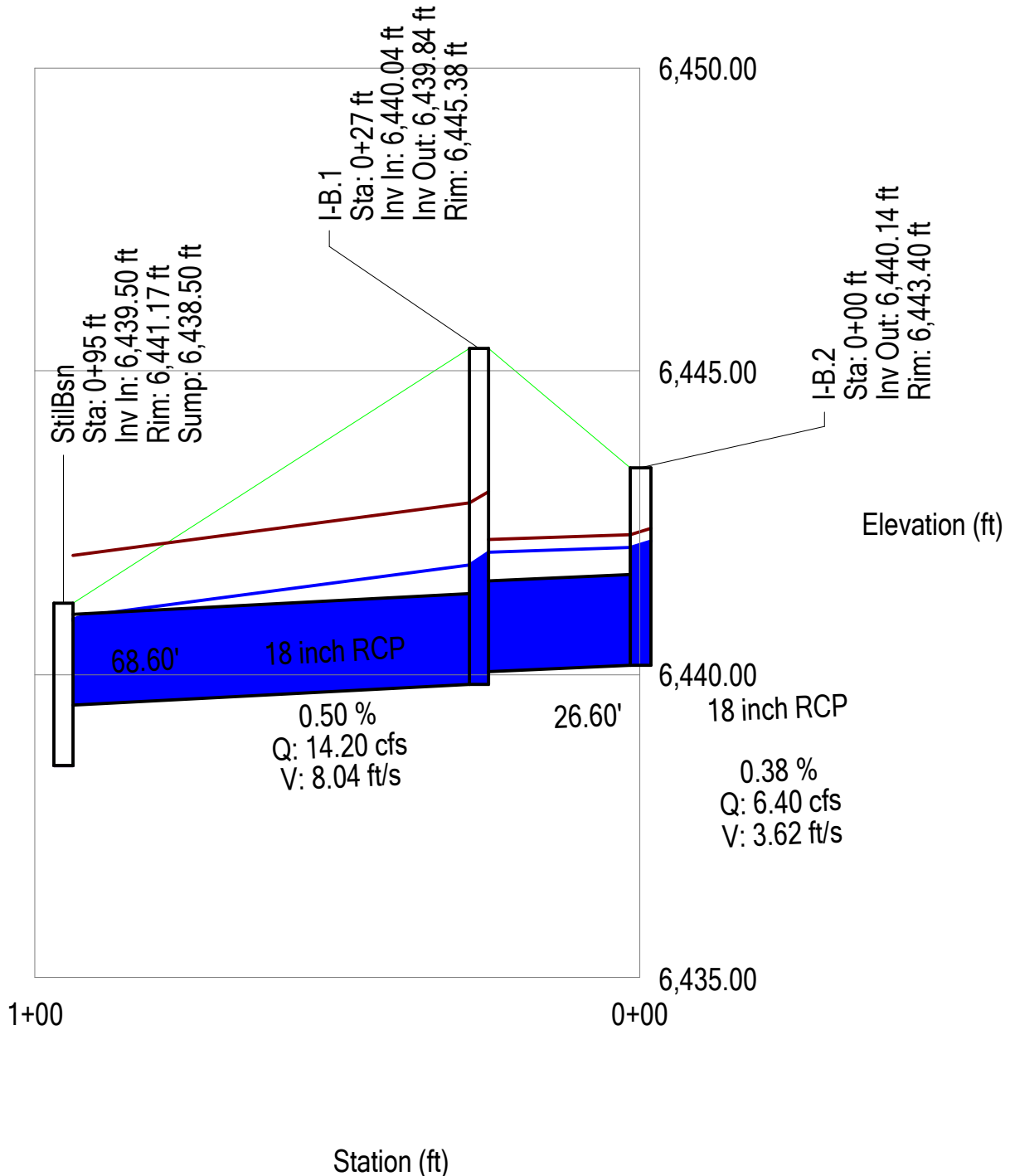
Profile: I-B.2 to StilBsn

Scenario: 5yr



Profile: I-B.2 to StilBsn

Scenario: 100yr



Scenario: 5yr

LCE Pipe n Node

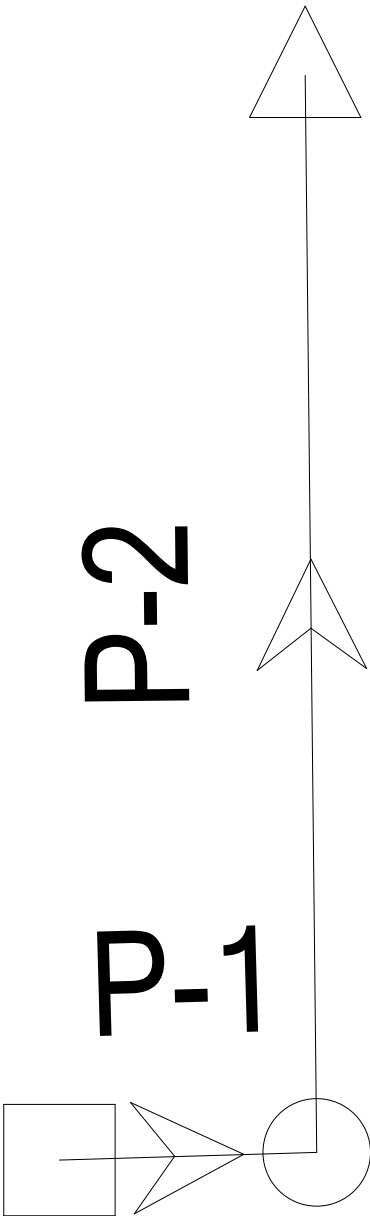
Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-3	I-B.2	I-B.1	26.60	18 inch	0.38	1.20	3.11	7.39	6,440.14	6,440.04	6,440.69	6,440.69
P-4	I-B.1	StilBsn	68.60	18 inch	0.50	4.20	4.83	8.58	6,439.84	6,439.50	6,440.63	6,440.24

Scenario: 100yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-3	I-B.2	I-B.1	26.60	18 inch	0.38	6.40	3.62	7.39	6,440.14	6,440.04	6,442.10	6,442.02
P-4	I-B.1	StilBsn	68.60	18 inch	0.50	14.20	8.04	8.58	6,439.84	6,439.50	6,441.82	6,440.89

Headwall-



Outlet-Strc

Scenario: 5yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	Outlet-Str	MH1	7.30	18 inch	1.51	0.10	2.61	15.64	6,435.35	6,435.24	6,435.47	6,435.32
P-2	MH1	Headwall-O	38.60	18 inch	0.49	0.10	1.70	8.55	6,434.94	6,434.75	6,435.06	6,434.86

Scenario: 100yr

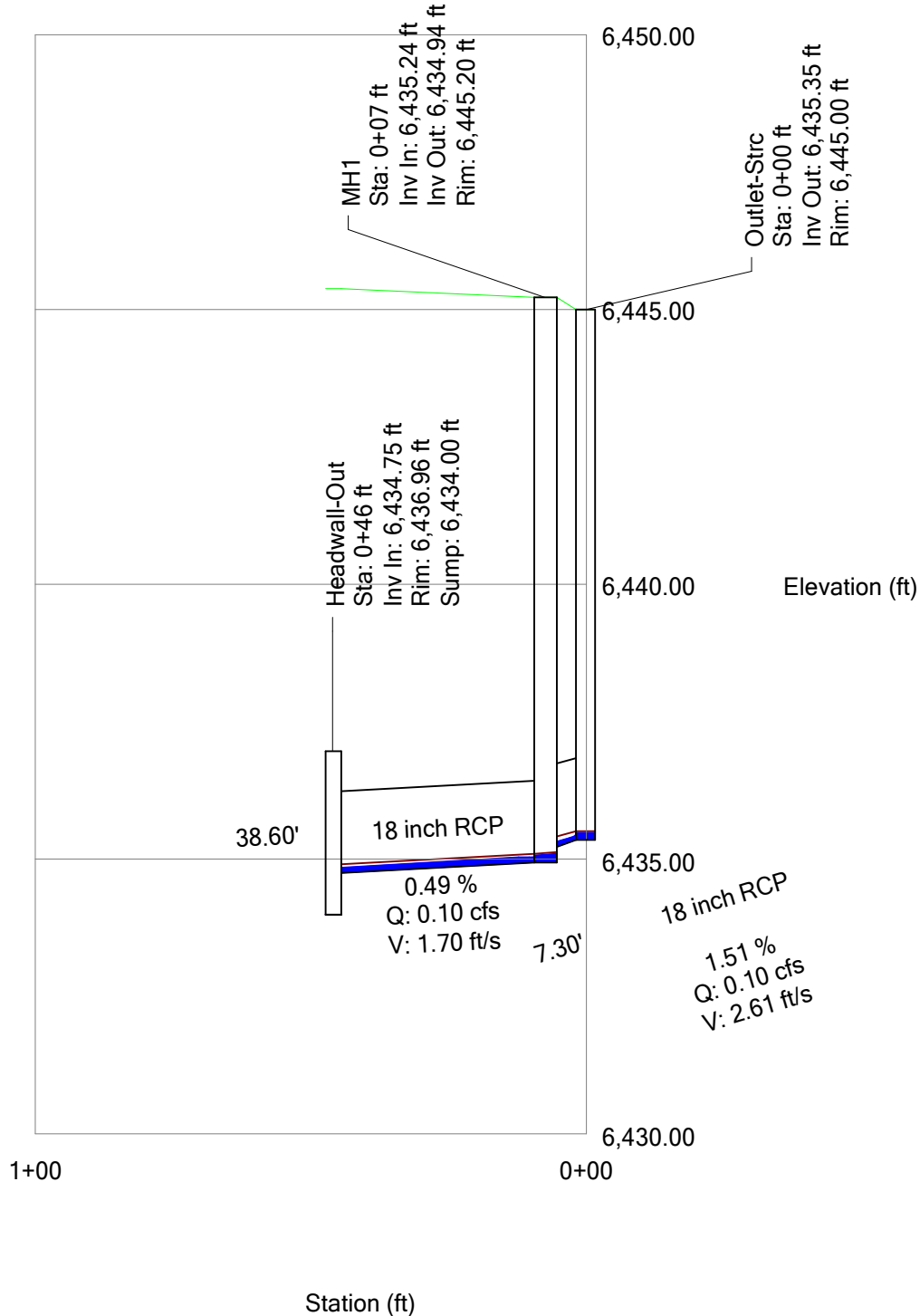
LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	Outlet-Str	MH1	7.30	18 inch	1.51	7.50	8.76	15.64	6,435.35	6,435.24	6,436.41	6,436.49
P-2	MH1	Headwall-O	38.60	18 inch	0.49	7.50	5.42	8.55	6,434.94	6,434.75	6,436.04	6,435.81

Profile
Scenario: 5yr

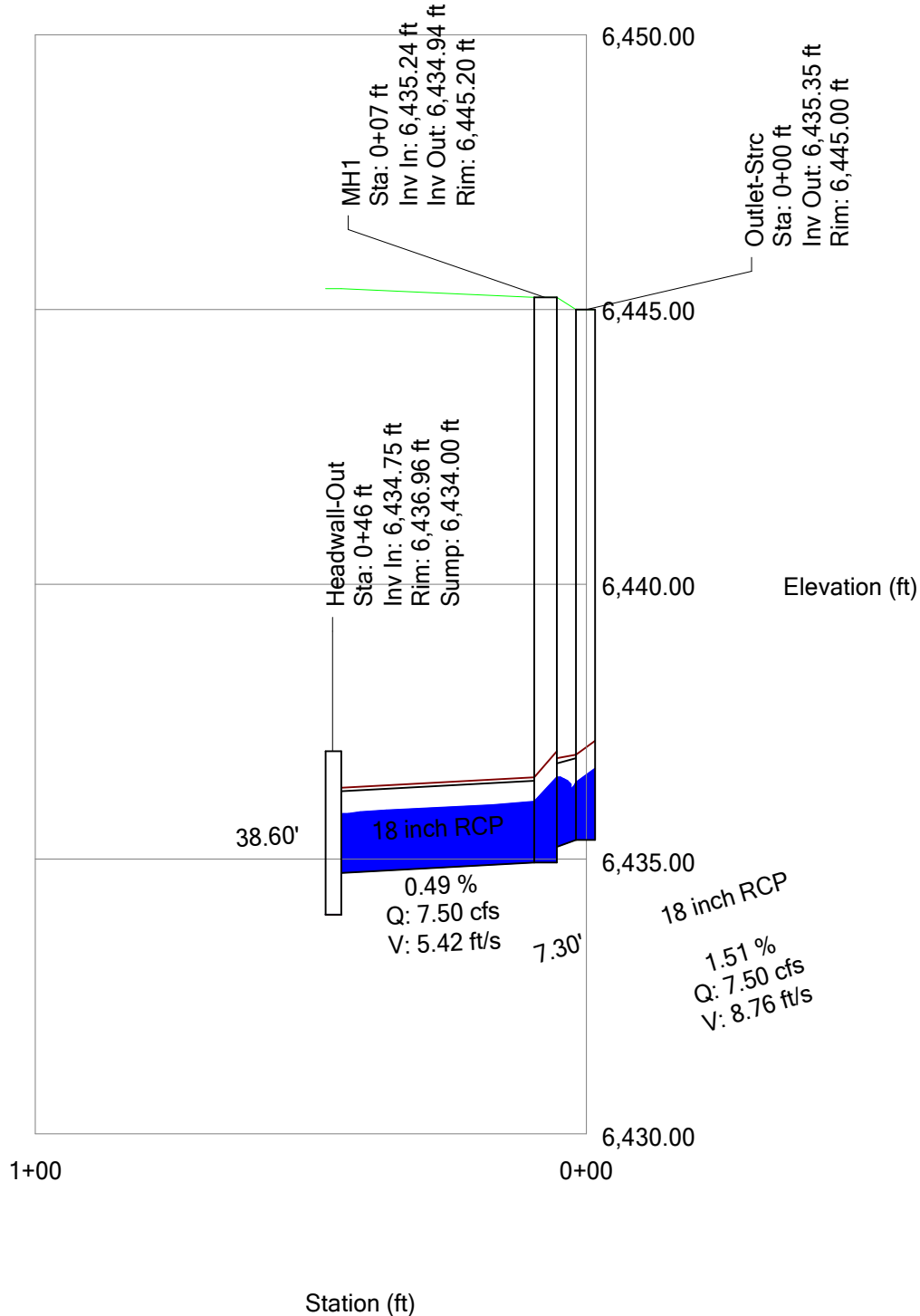
Profile: Outlet to Headwall

Scenario: 5yr

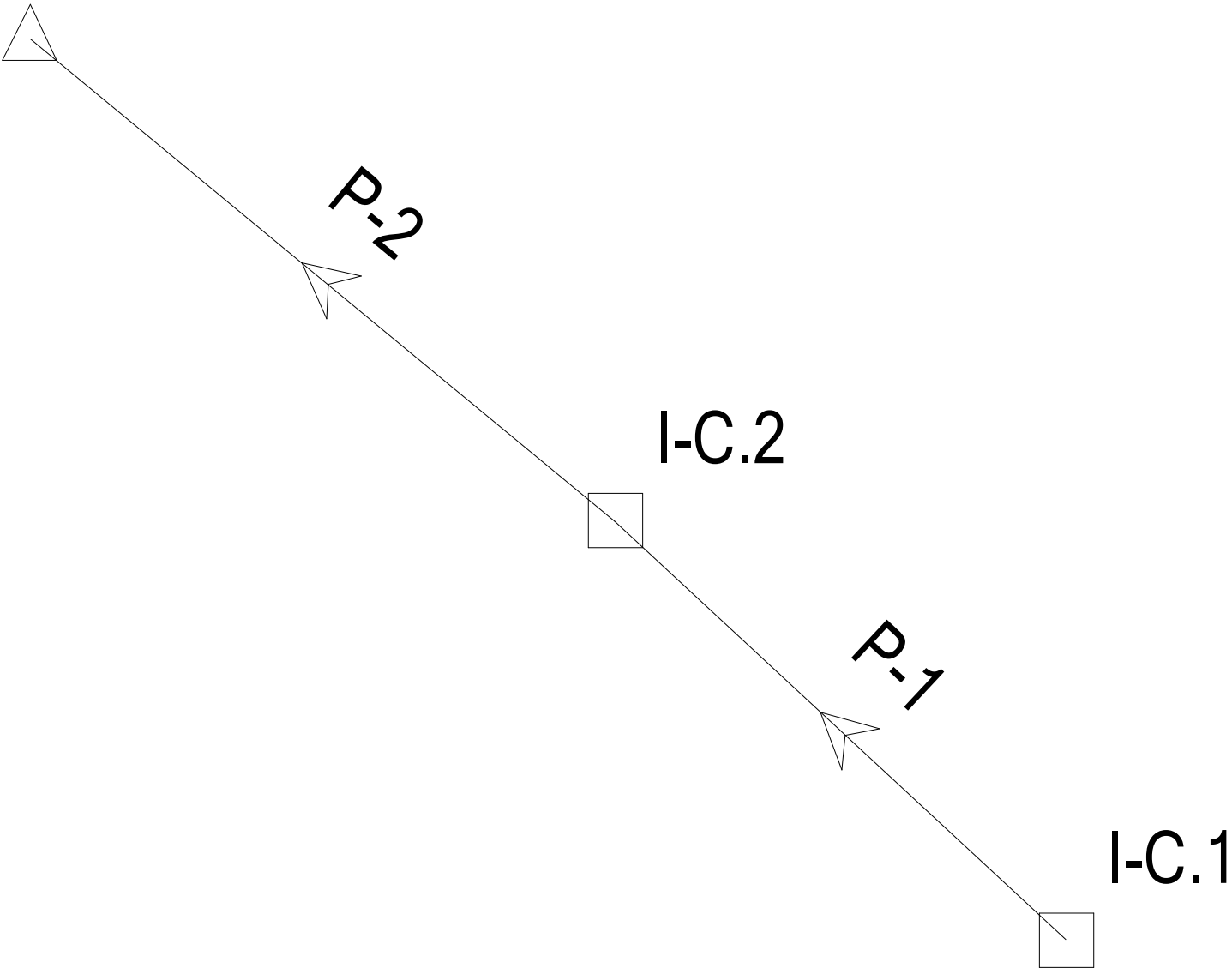


Profile
Scenario: 100yr

Profile: Outlet to Headwall
Scenario: 100yr

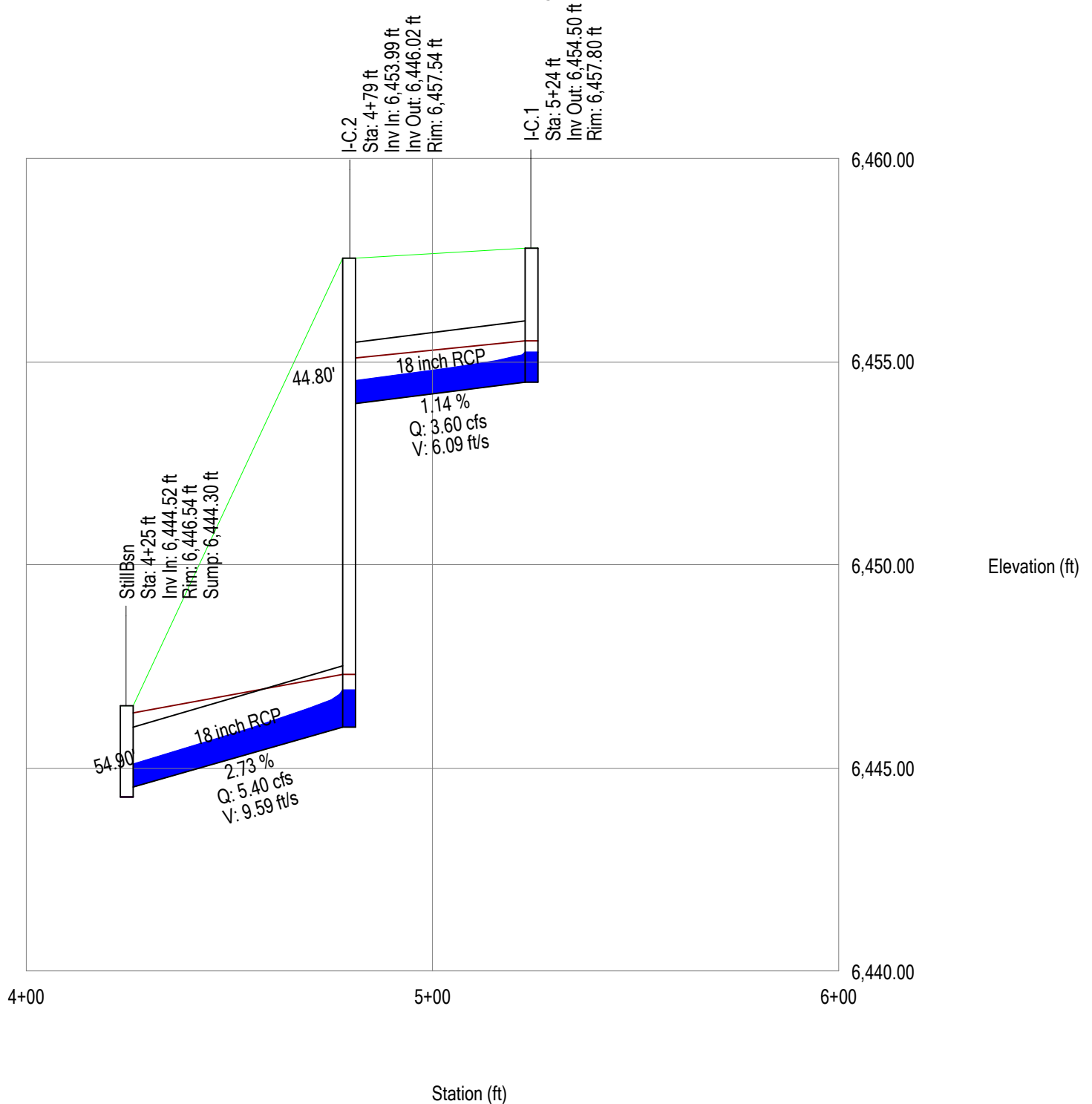


StillBsn



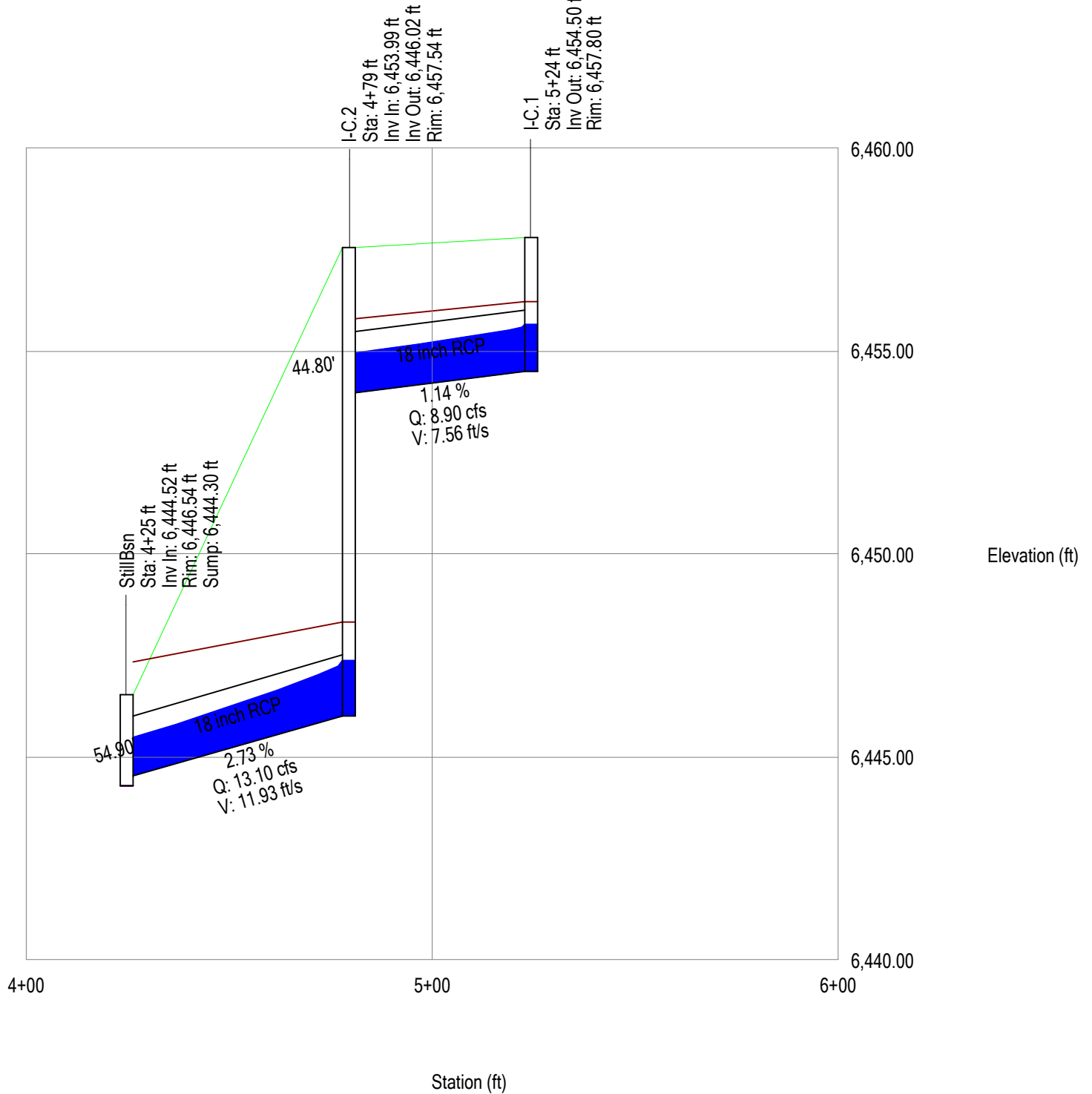
Profile
Scenario: 5yr

Profile: I-C.1 to FES
Scenario: 5yr



Profile
Scenario: 100yr

Profile: I-C.1 to FES
Scenario: 100yr



Scenario: 100yr

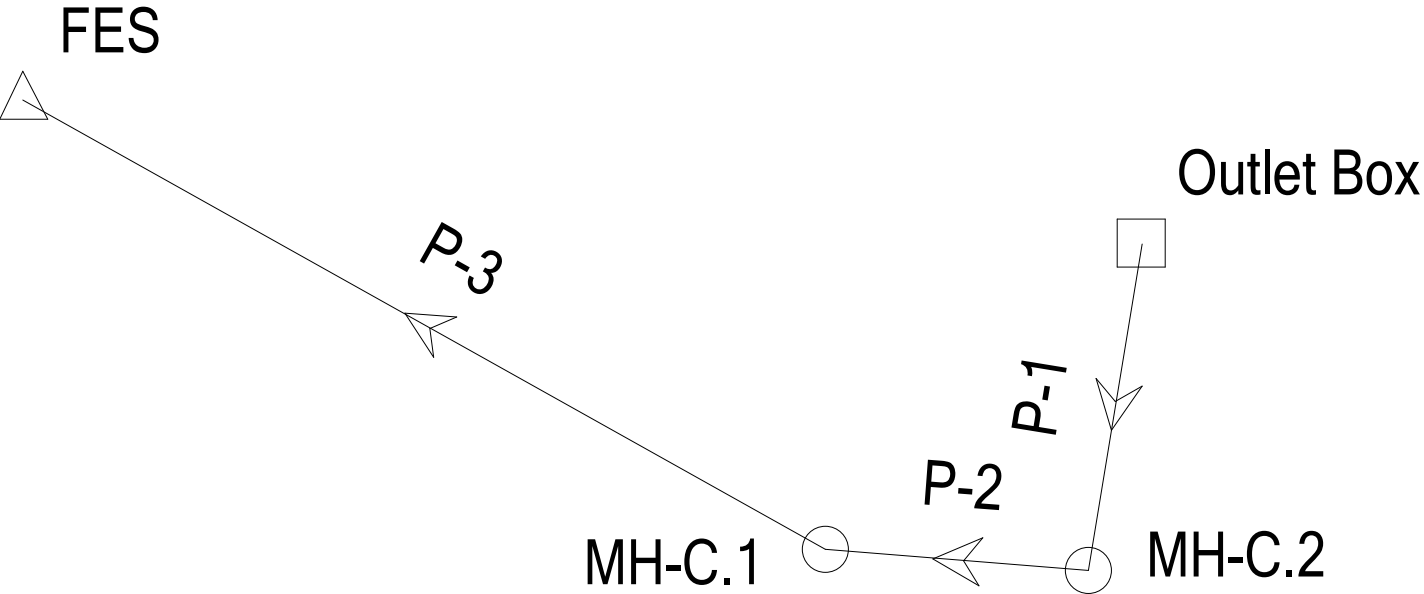
LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	I-C.1	I-C.2	44.80	18 inch	1.14	8.90	7.56	12.32	6,454.50	6,453.99	6,455.65	6,454.96
P-2	I-C.2	StillBsn	54.90	18 inch	2.73	13.10	11.93	19.77	6,446.02	6,444.52	6,447.37	6,445.49

Scenario: 5yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	I-C.1	I-C.2	44.80	18 inch	1.14	3.60	6.09	12.32	6,454.50	6,453.99	6,455.22	6,454.55
P-2	I-C.2	StillBsn	54.90	18 inch	2.73	5.40	9.59	19.77	6,446.02	6,444.52	6,446.92	6,445.08



Scenario: 100yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	Outlet Bo	MH-C.2	27.60	18 inch	2.21	5.70	8.94	17.63	6,440.36	6,439.75	6,441.28	6,440.40
P-2	MH-C.2	MH-C.1	22.00	18 inch	10.95	5.70	16.80	41.84	6,426.00	6,423.59	6,426.92	6,424.04
P-3	MH-C.1	FES	76.70	18 inch	0.93	5.70	6.29	11.02	6,417.02	6,416.31	6,417.94	6,417.08

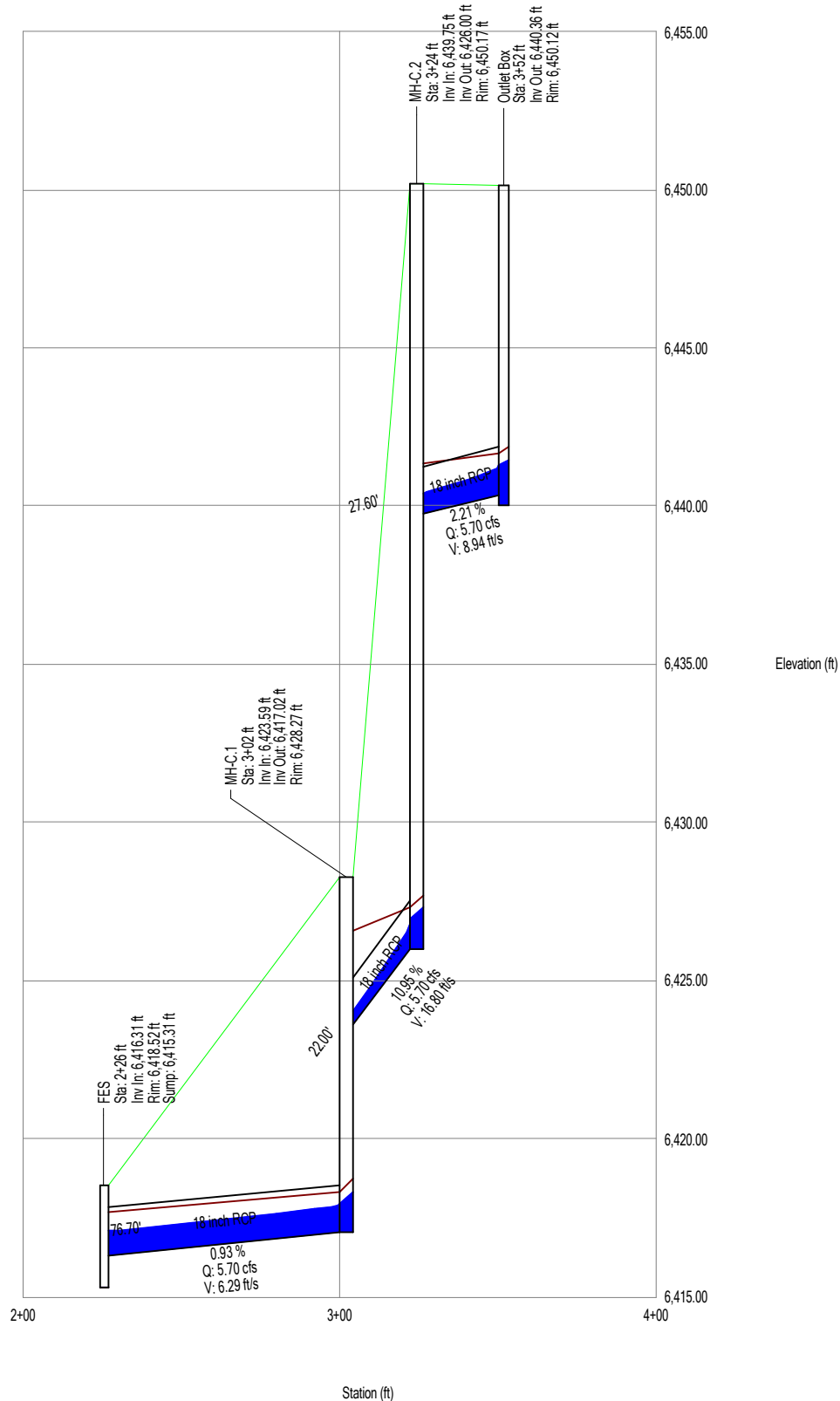
Scenario: 5yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	Outlet Bo	MH-C.2	27.60	18 inch	2.21	0.20	3.47	17.63	6,440.36	6,439.75	6,440.52	6,439.86
P-2	MH-C.2	MH-C.1	22.00	18 inch	10.95	0.20	6.40	41.84	6,426.00	6,423.59	6,426.16	6,423.66
P-3	MH-C.1	FES	76.70	18 inch	0.93	0.20	2.49	11.02	6,417.02	6,416.31	6,417.18	6,416.45

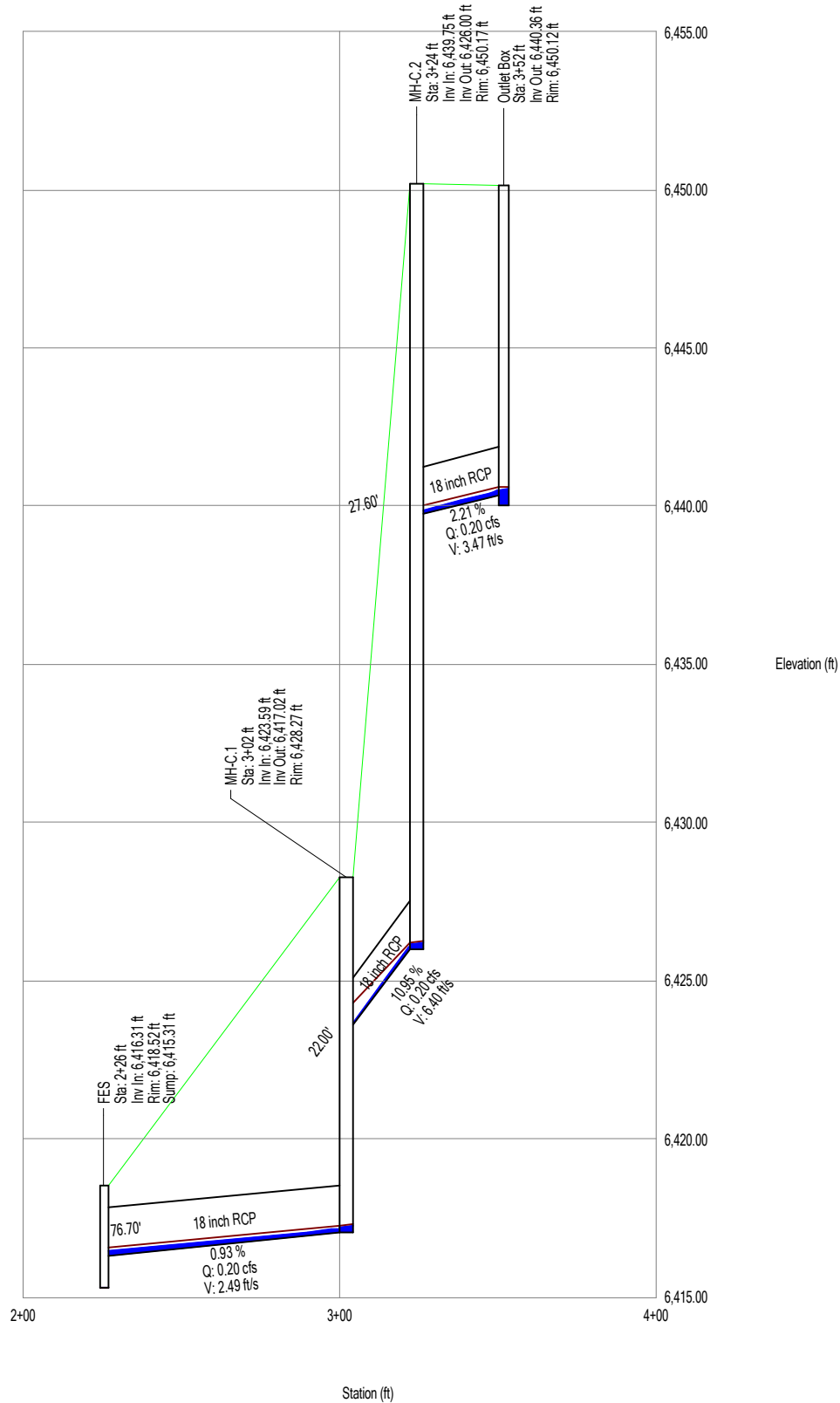
Profile Scenario: 100yr

Profile: Outlet to FES Scenario: 100yr

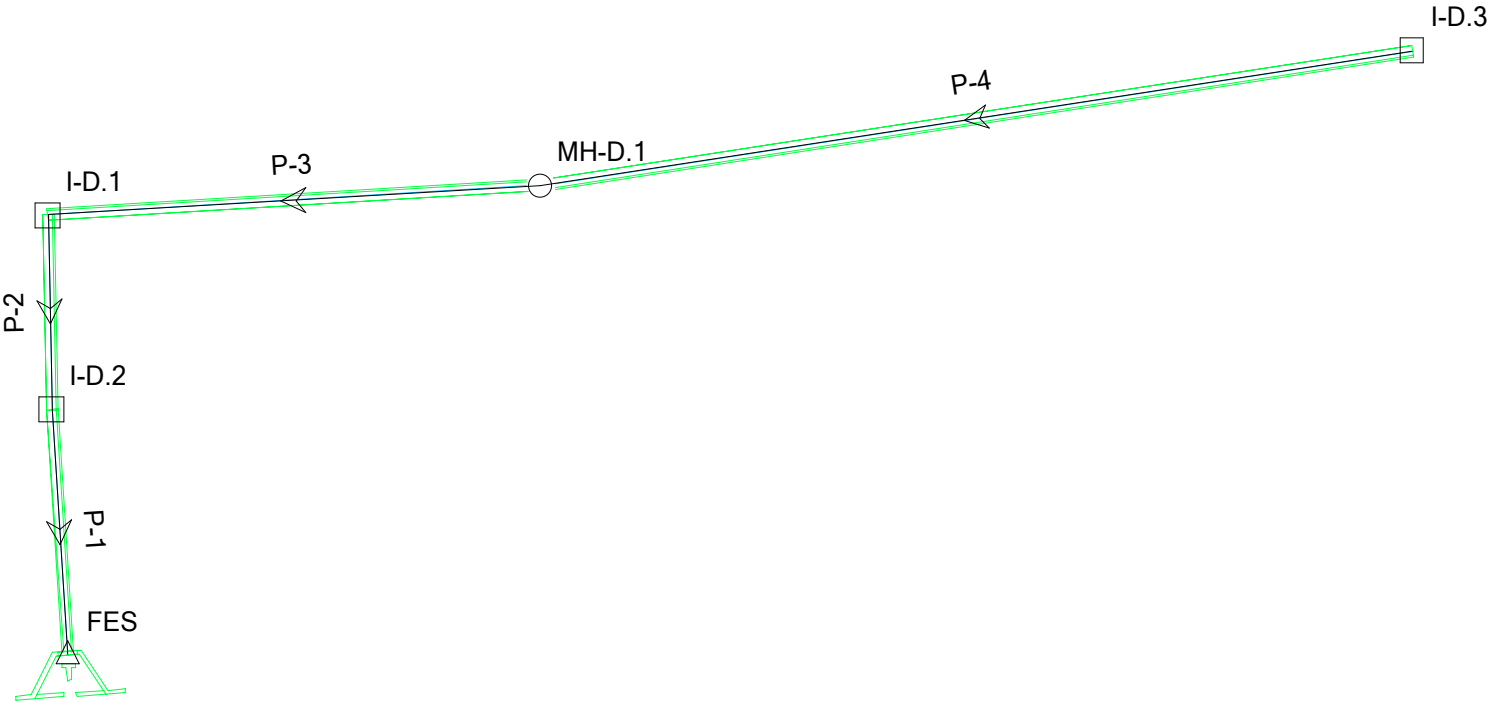


Profile Scenario: 5yr

Profile: Outlet to FES Scenario: 5yr

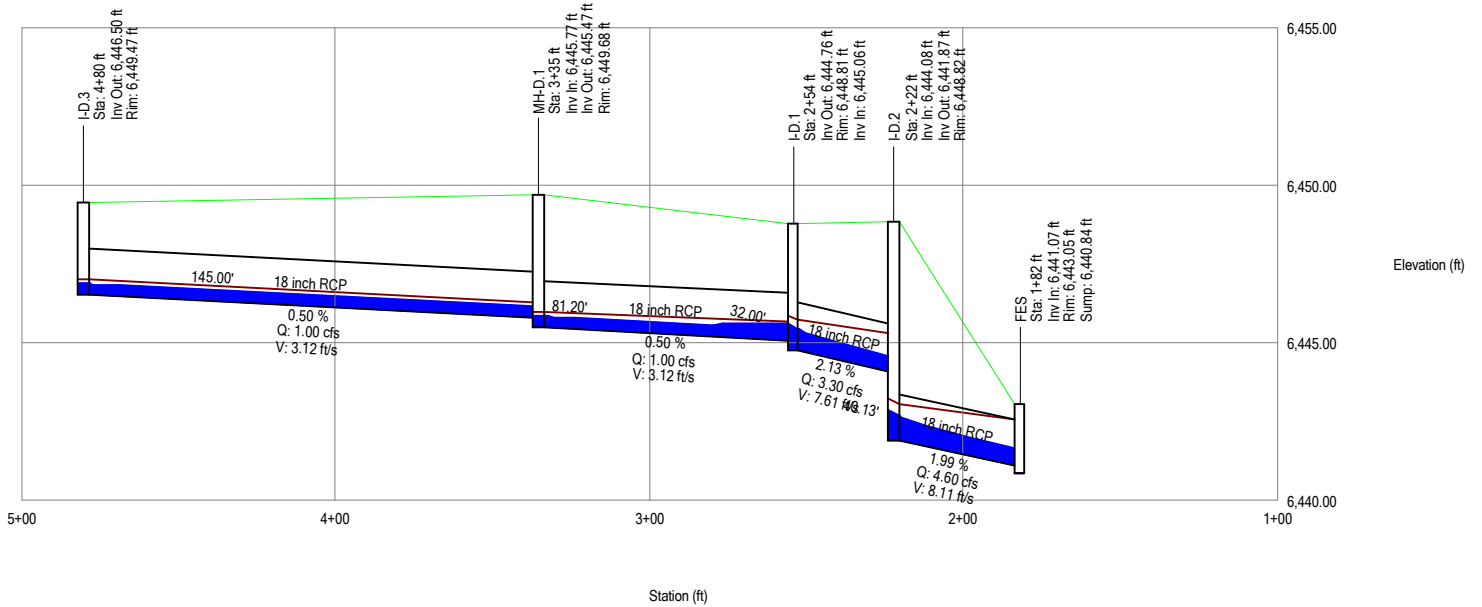


Scenario: 100yr



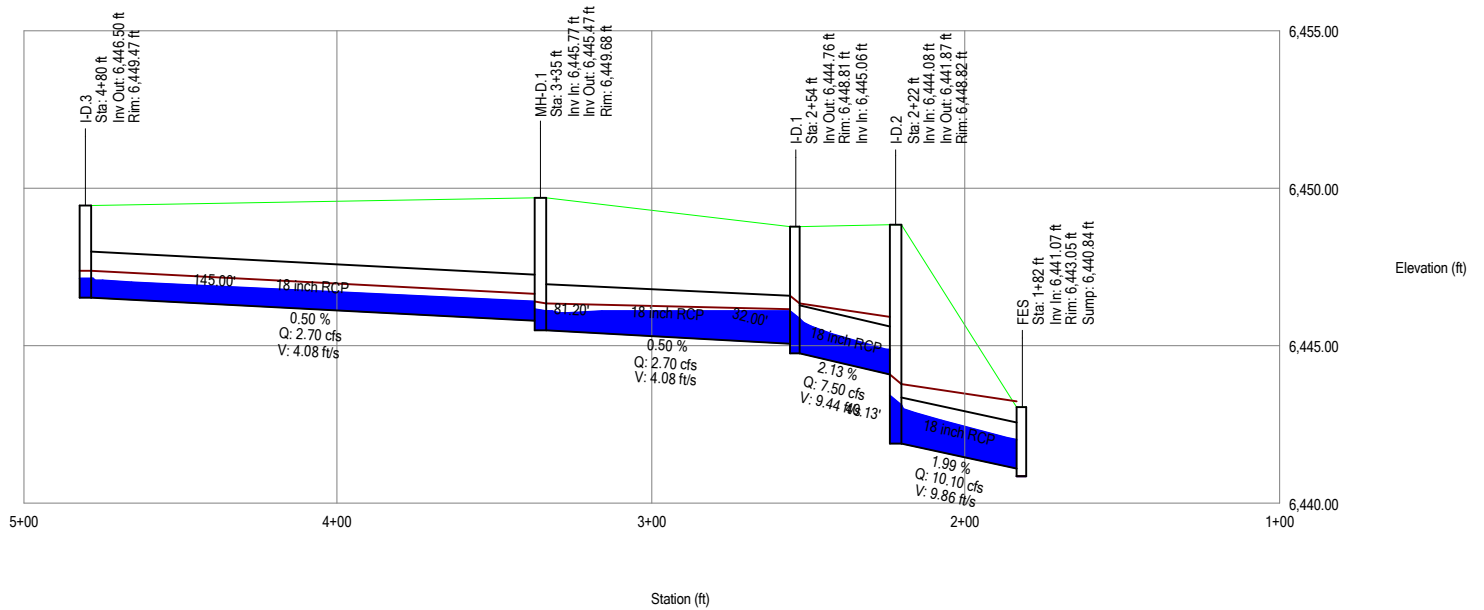
Profile Scenario: 5yr

Profile: I-D.3 to Stilling Basin Scenario: 5yr



Profile Scenario: 100yr

Profile: I-D.3 to Stilling Basin Scenario: 100yr



Scenario: 5yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-4	I-D.3	MH-D.1	145.00	18 inch	0.50	1.00	3.12	7.93	6,446.50	6,445.77	6,446.87	6,446.13
P-3	MH-D.1	I-D.1	81.20	18 inch	0.50	1.00	3.12	7.94	6,445.47	6,445.06	6,445.84	6,445.59
P-2	I-D.1	I-D.2	32.00	18 inch	2.13	3.30	7.61	17.26	6,444.76	6,444.08	6,445.45	6,444.55
P-1	I-D.2	FES	40.13	18 inch	1.99	4.60	8.11	16.67	6,441.87	6,441.07	6,442.69	6,441.64

Scenario: 100yr

LCE Pipe n Node

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	Constructed Slope (%)	Total Flow (cfs)	Average Velocity (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-4	I-D.3	MH-D.1	145.00	18 inch	0.50	2.70	4.08	7.93	6,446.50	6,445.77	6,447.12	6,446.37
P-3	MH-D.1	I-D.1	81.20	18 inch	0.50	2.70	4.08	7.94	6,445.47	6,445.06	6,446.09	6,446.07
P-2	I-D.1	I-D.2	32.00	18 inch	2.13	7.50	9.44	17.26	6,444.76	6,444.08	6,445.82	6,444.84
P-1	I-D.2	FES	40.13	18 inch	1.99	10.10	9.86	16.67	6,441.87	6,441.07	6,443.09	6,441.98

Channel Report

Concrete Swale at East PL - 100yr

Rectangular

Bottom Width (ft) = 2.00
Total Depth (ft) = 1.00

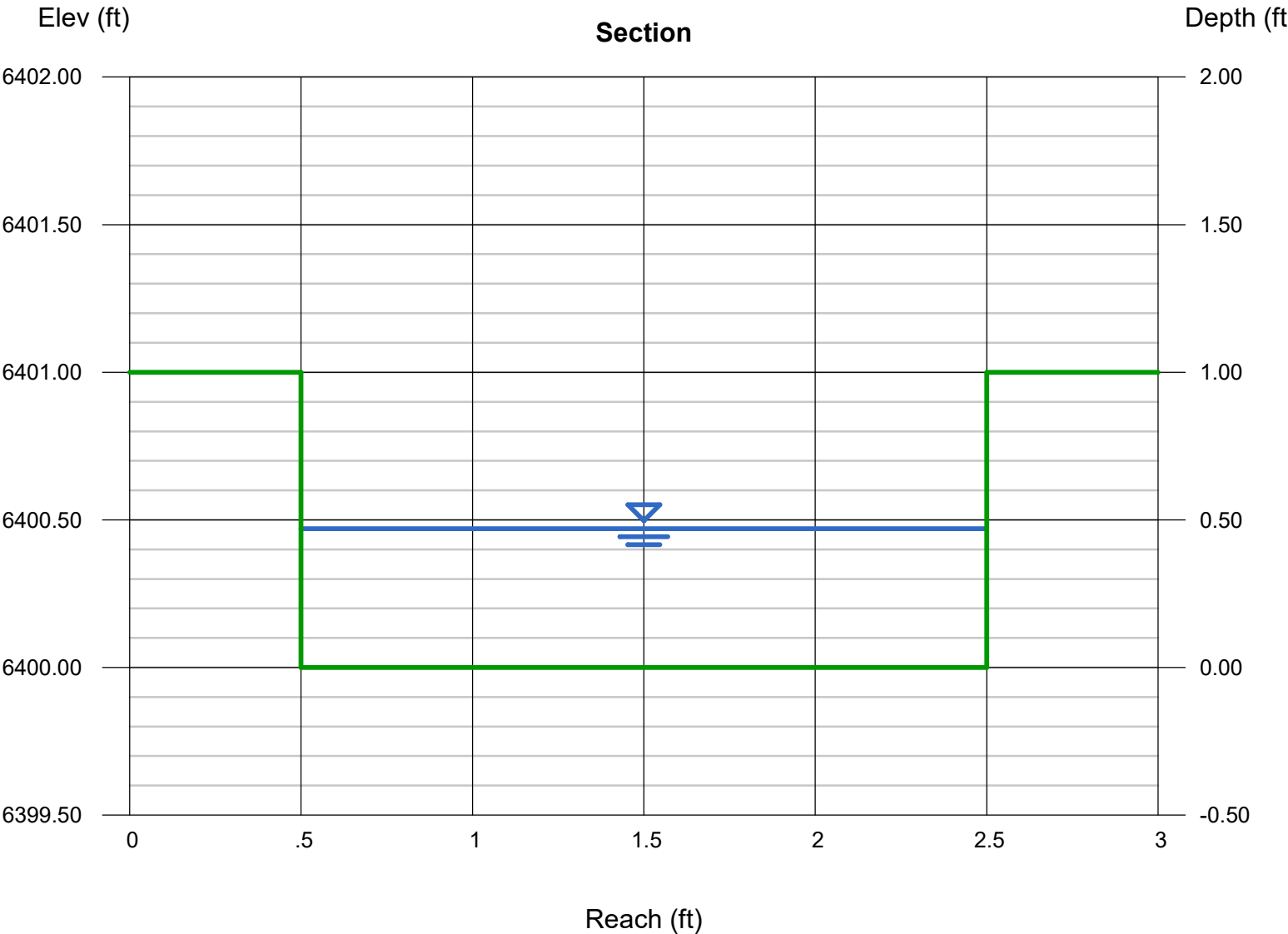
Invert Elev (ft) = 6400.00
Slope (%) = 1.70
N-Value = 0.013

Calculations

Compute by: Known Q
Known Q (cfs) = 6.40

Highlighted

Depth (ft) = 0.47
Q (cfs) = 6.400
Area (sqft) = 0.94
Velocity (ft/s) = 6.81
Wetted Perim (ft) = 2.94
Crit Depth, Yc (ft) = 0.69
Top Width (ft) = 2.00
EGL (ft) = 1.19



Weir Report

Emgc Overflow Weir for Basin A

Trapezoidal Weir

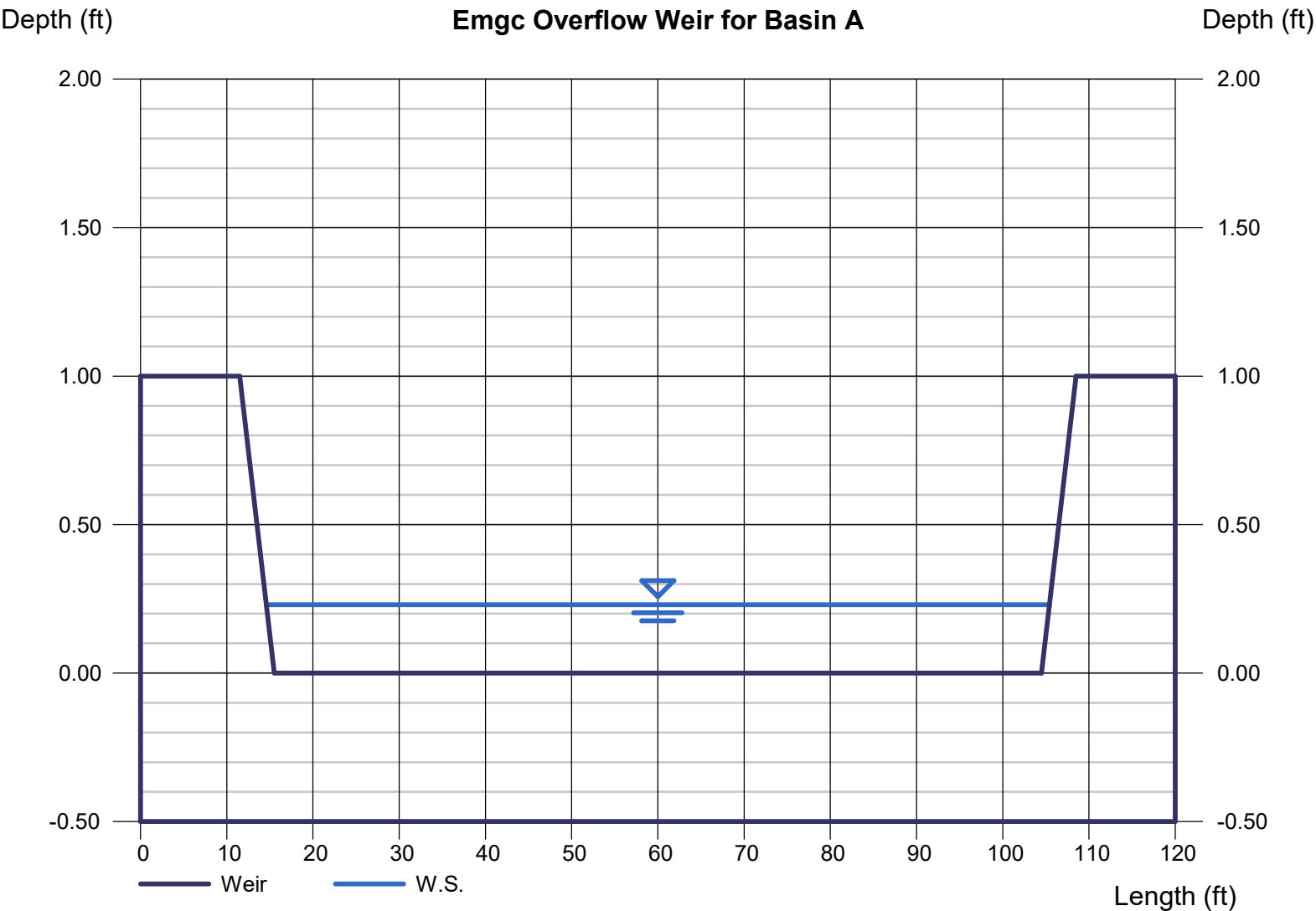
Crest = Sharp
Bottom Length (ft) = 89.00
Total Depth (ft) = 1.00
Side Slope (z:1) = 4.00

Highlighted

Depth (ft) = 0.23
Q (cfs) = 30.00
Area (sqft) = 20.68
Velocity (ft/s) = 1.45
Top Width (ft) = 90.84

Calculations

Weir Coeff. Cw = 3.10
Compute by: Known Q
Known Q (cfs) = 30.00



Weir Report

Emgc Overflow for Basin C into the NW Pond

Trapezoidal Weir

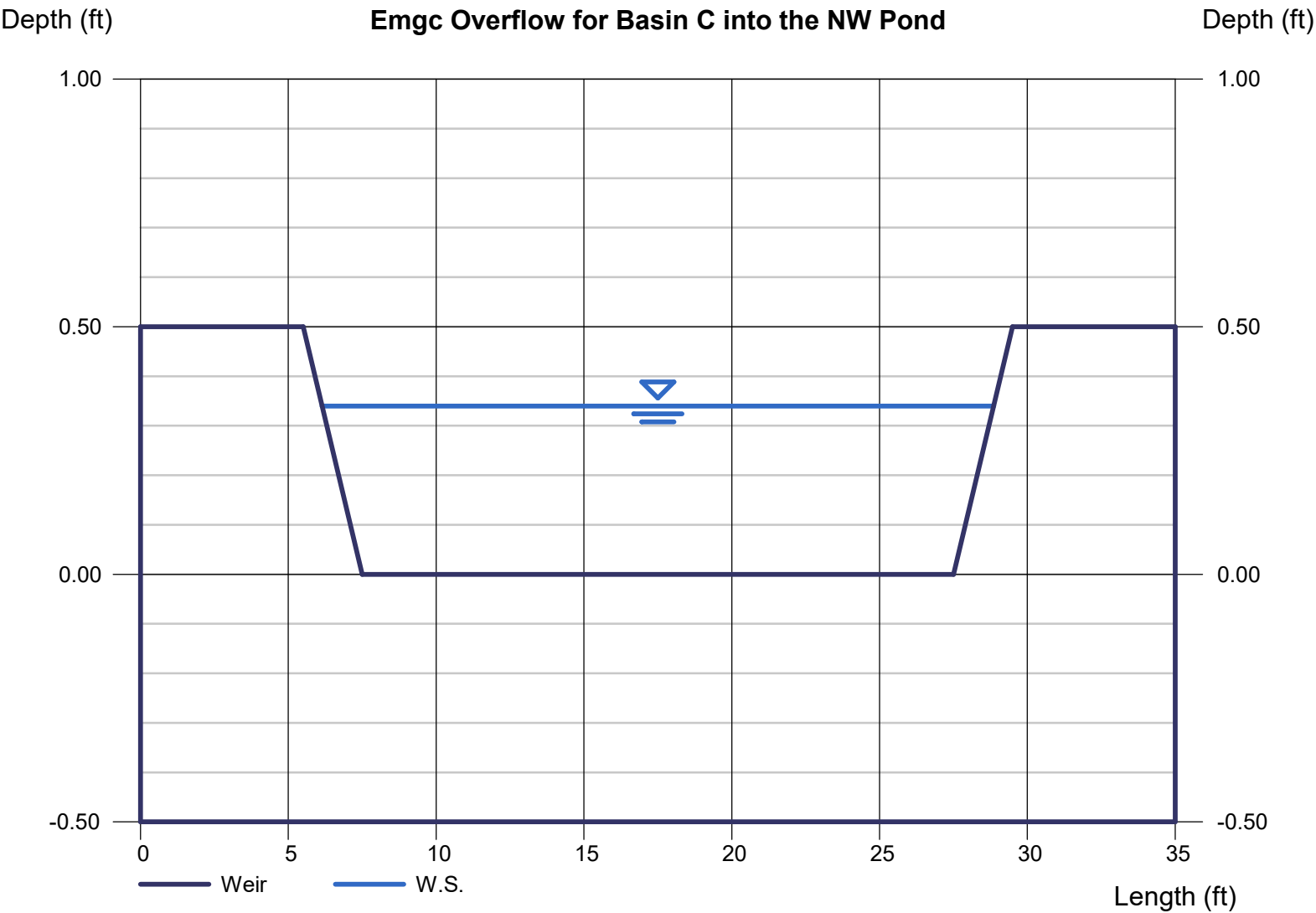
Crest = Sharp
Bottom Length (ft) = 20.00
Total Depth (ft) = 0.50
Side Slope (z:1) = 4.00

Highlighted

Depth (ft) = 0.34
Q (cfs) = 12.50
Area (sqft) = 7.26
Velocity (ft/s) = 1.72
Top Width (ft) = 22.72

Calculations

Weir Coeff. Cw = 3.10
Compute by: Known Q
Known Q (cfs) = 12.50



Weir Report

NW Pond Emergency Overflow Weir

Trapezoidal Weir

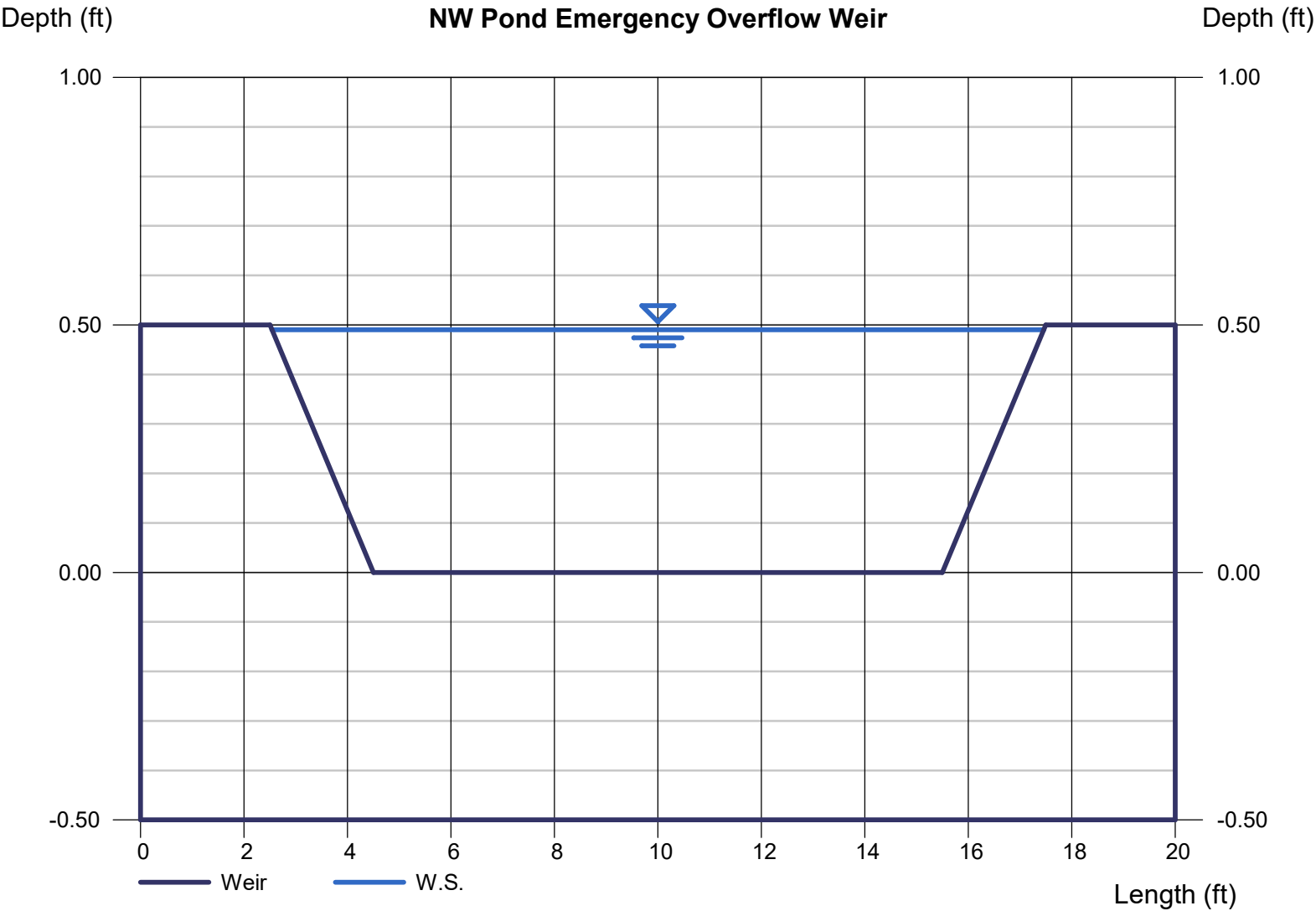
Crest = Sharp
Bottom Length (ft) = 11.00
Total Depth (ft) = 0.50
Side Slope (z:1) = 4.00

Highlighted

Depth (ft) = 0.49
Q (cfs) = 13.10
Area (sqft) = 6.35
Velocity (ft/s) = 2.06
Top Width (ft) = 14.92

Calculations

Weir Coeff. Cw = 3.10
Compute by: Known Q
Known Q (cfs) = 13.10



Weir Report

Emgc Overflow at Inlet B.3

Trapezoidal Weir

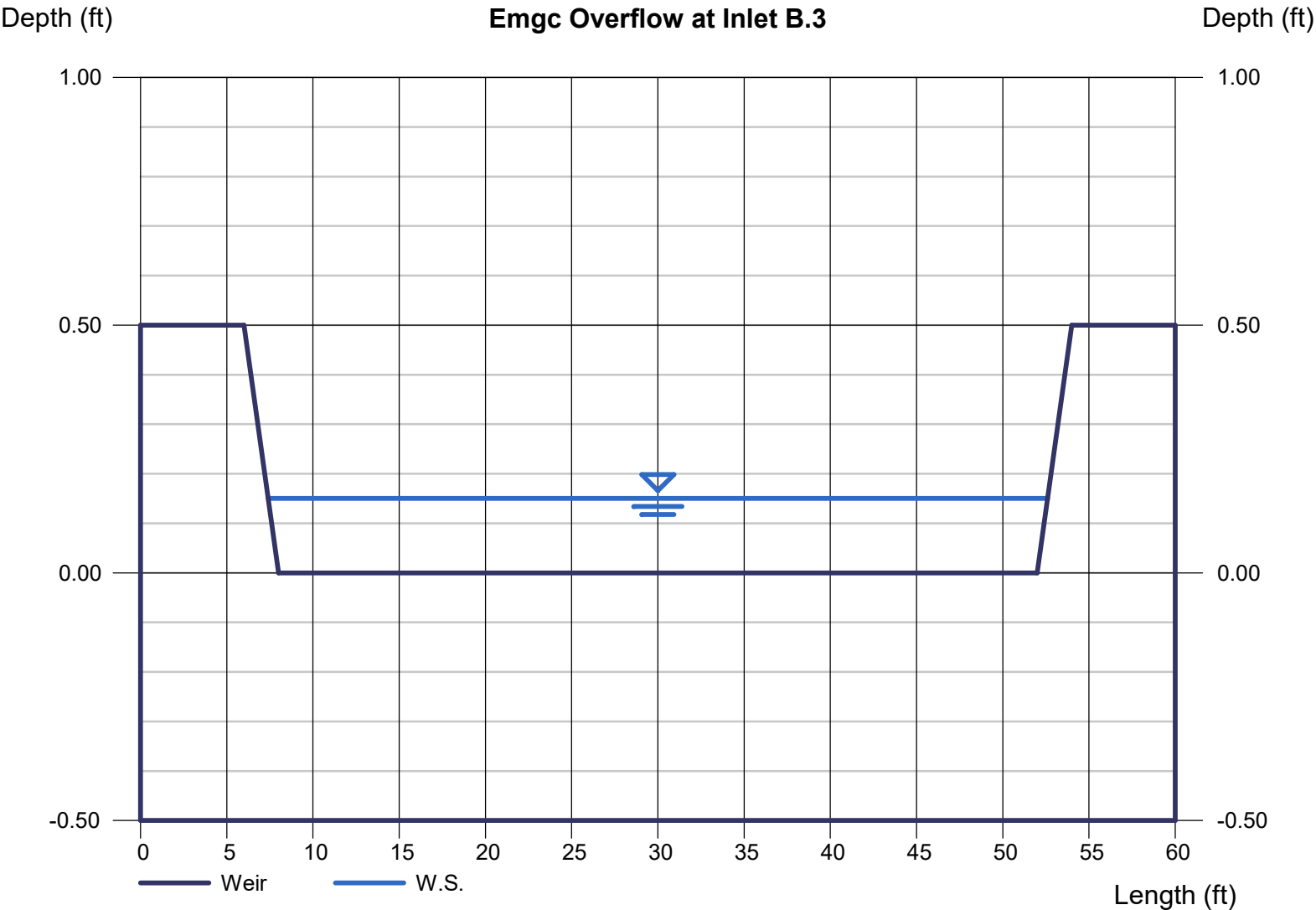
Crest	= Sharp
Bottom Length (ft)	= 44.00
Total Depth (ft)	= 0.50
Side Slope (z:1)	= 4.00

Highlighted

Depth (ft)	= 0.15
Q (cfs)	= 7.400
Area (sqft)	= 6.69
Velocity (ft/s)	= 1.11
Top Width (ft)	= 45.20

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 7.40



Channel Report

Stm F.1 or F.2 - 100yr Flow

Circular

Diameter (ft) = 1.00

Invert Elev (ft) = 46.04

Slope (%) = 0.80

N-Value = 0.012

Calculations

Compute by: Known Q

Known Q (cfs) = 3.30

Highlighted

Depth (ft) = 0.79

Q (cfs) = 3.300

Area (sqft) = 0.67

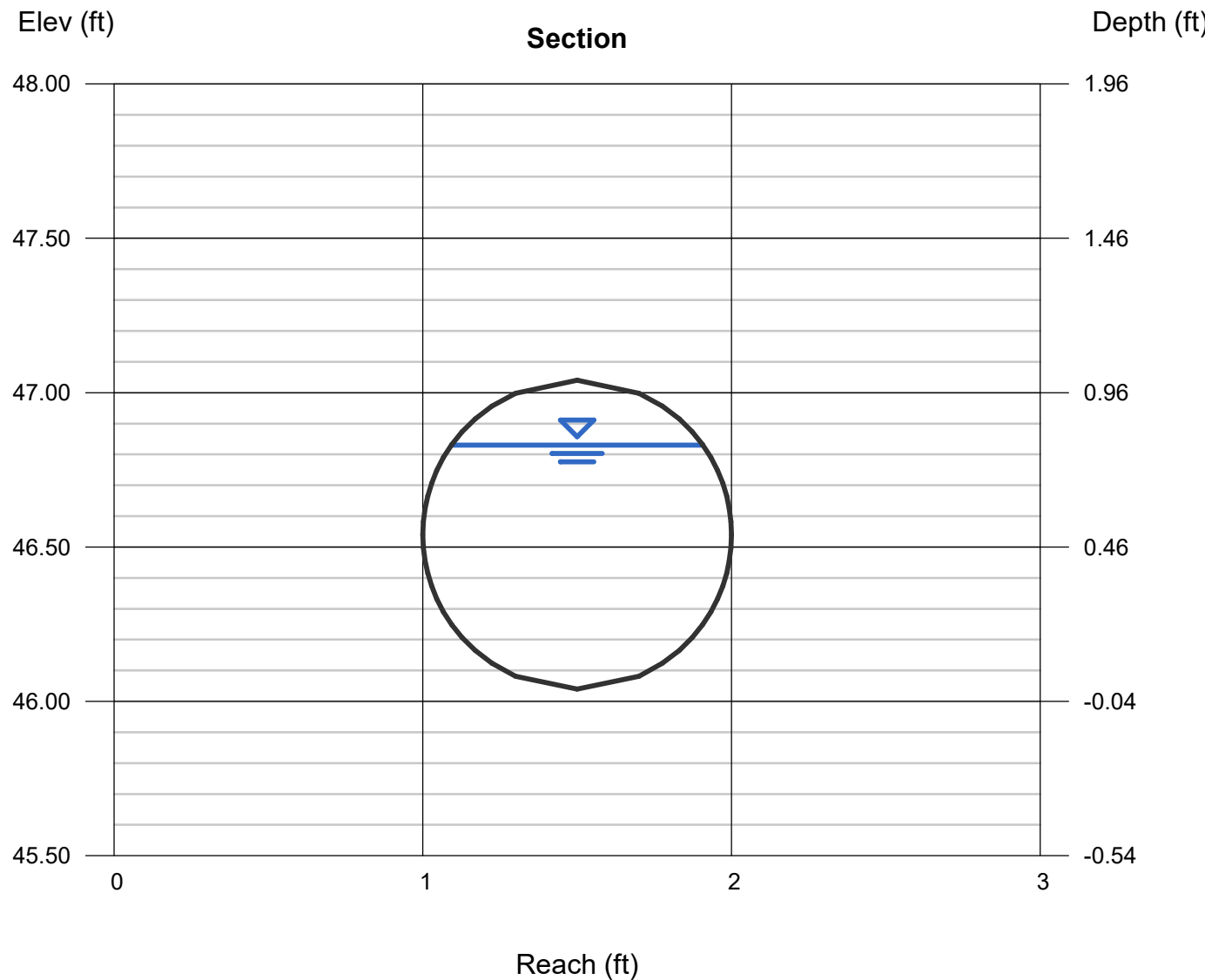
Velocity (ft/s) = 4.96

Wetted Perim (ft) = 2.19

Crit Depth, Yc (ft) = 0.78

Top Width (ft) = 0.81

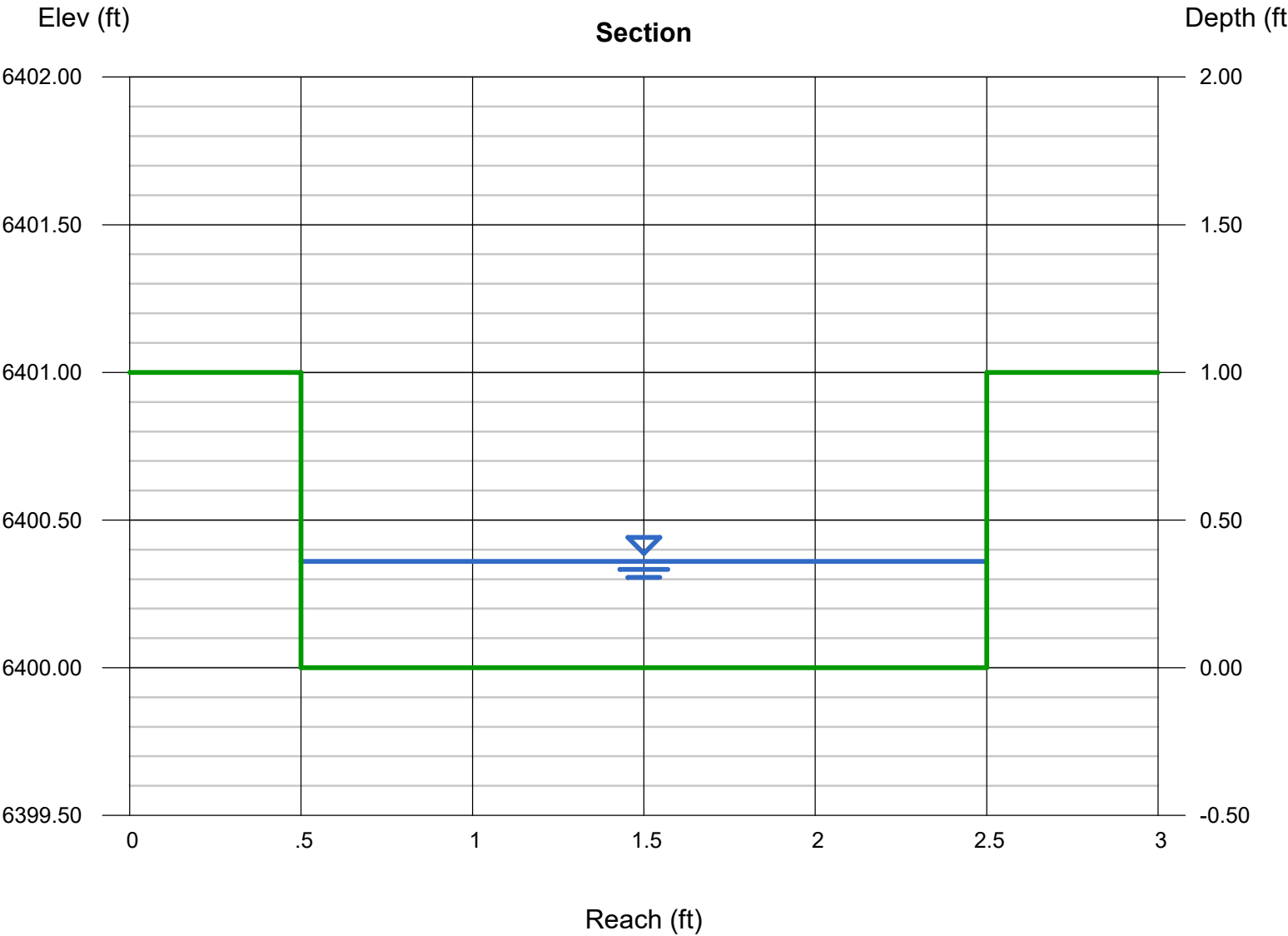
EGL (ft) = 1.17



Channel Report

F.1 or F.2 Rear Yard Swale above wall - 100yr

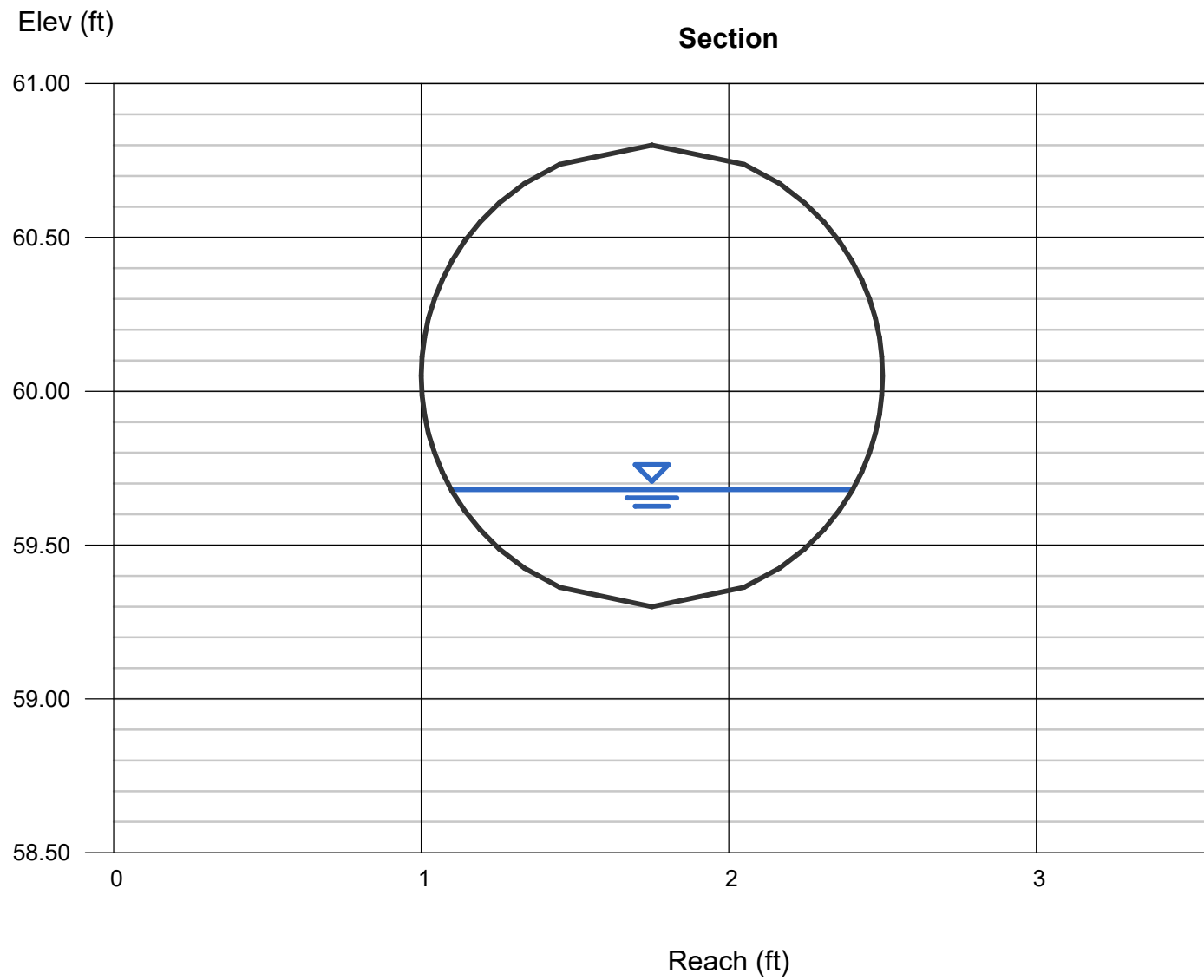
Rectangular		Highlighted	
Bottom Width (ft)	= 2.00	Depth (ft)	= 0.36
Total Depth (ft)	= 1.00	Q (cfs)	= 3.300
		Area (sqft)	= 0.72
Invert Elev (ft)	= 6400.00	Velocity (ft/s)	= 4.58
Slope (%)	= 1.00	Wetted Perim (ft)	= 2.72
N-Value	= 0.013	Crit Depth, Yc (ft)	= 0.44
		Top Width (ft)	= 2.00
		EGL (ft)	= 0.69
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 3.30		



Channel Report

Min Velocity Check of storm from A2.2.b & A1.3.b @ 25% Full

Circular		Highlighted	
Diameter (ft)	= 1.50	Depth (ft)	= 0.38
		Q (cfs)	= 1.791
		Area (sqft)	= 0.35
Invert Elev (ft)	= 59.30	Velocity (ft/s)	= 5.09
Slope (%)	= 1.47	Wetted Perim (ft)	= 1.58
N-Value	= 0.013	Crit Depth, Yc (ft)	= 0.51
		Top Width (ft)	= 1.30
		EGL (ft)	= 0.78
Calculations			
Compute by:	Known Depth		
Known Depth (ft)	= 0.38		



Channel Report

Concrete Swale at West PL - 100yr

Rectangular

Bottom Width (ft) = 1.00
Total Depth (ft) = 1.00

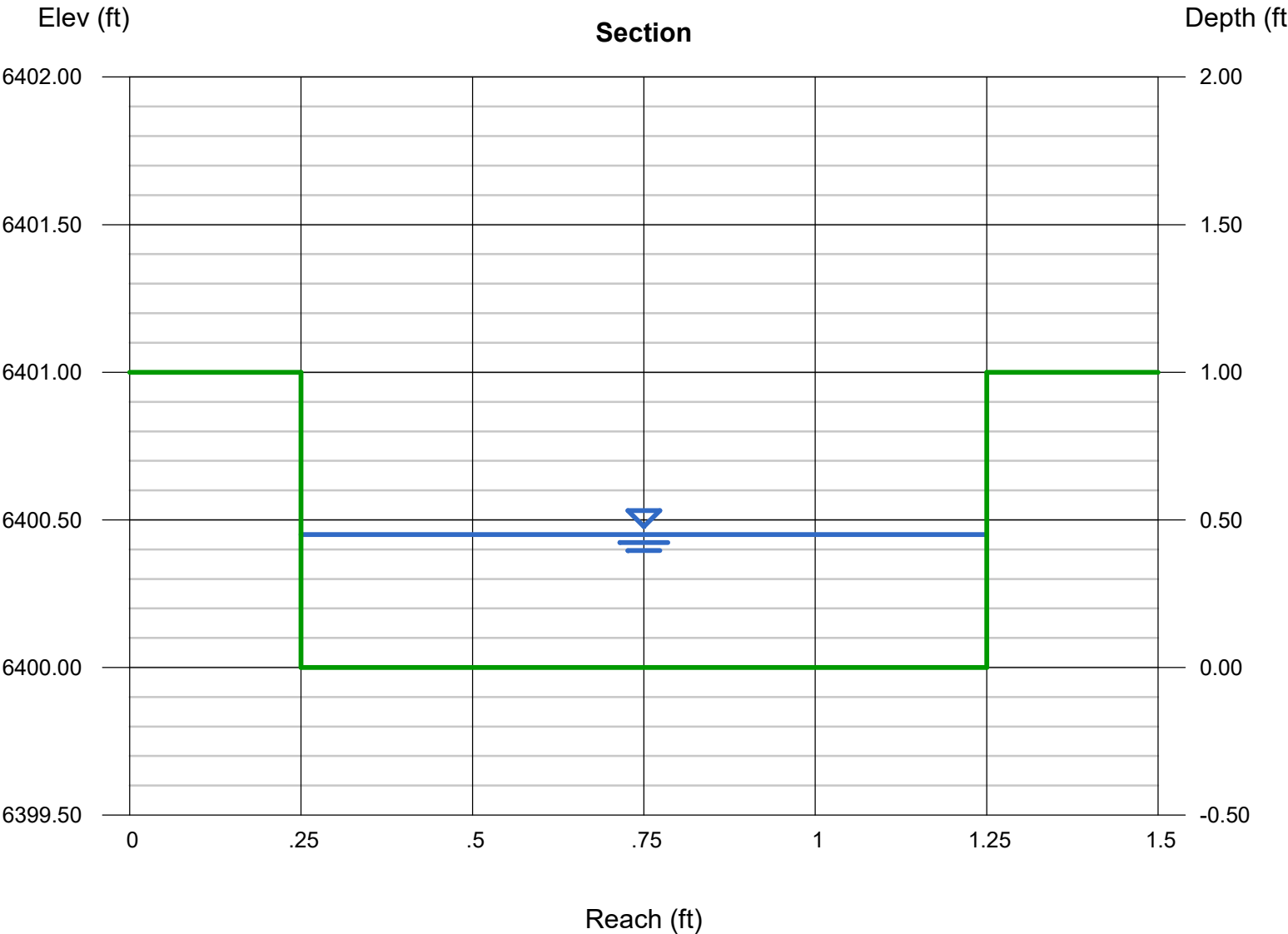
Invert Elev (ft) = 6400.00
Slope (%) = 2.00
N-Value = 0.013

Calculations

Compute by: Known Q
Known Q (cfs) = 2.70

Highlighted

Depth (ft) = 0.45
Q (cfs) = 2.700
Area (sqft) = 0.45
Velocity (ft/s) = 6.00
Wetted Perim (ft) = 1.90
Crit Depth, Yc (ft) = 0.61
Top Width (ft) = 1.00
EGL (ft) = 1.01



APPENDIX D – DETENTION – STORM & WATER QUALITY

Permanent Water Quality Determination Worksheet (Taken from 2019 SDDTCM Sections 13.1.4 and 13.1.5)

Project:

Project #:

Applicant:

1 Non-applicable Sites			
Section	Question	Response	Instructions
1.1	Will the project result in a temporary disturbance of greater than one acre?	No Yes	Proceed to section 1.2. Proceed to section 2.
1.2	Is the project part of a larger common plan of development or sale where multiple separate and distinct construction activities may be taking place at different times on different schedules, but remain related and are within 1/4 mile of each other? (A common plan of development will generally be documented on a site development plan, master plan, or equivalent, for the property/project)	No Yes	Proceed to section 1.3. Proceed to section 2.
1.3	Is the project within the Cherry Creek Watershed?	Yes No	Permanent water quality control measures may be required. Refer to Water Quality Control Regulation 72.7 for details and allowable exclusions. Permanent water quality control measures are not required.
2 Applicable Site Types and Exclusions by Variance			
Section	Question	Response	Instructions
2.1	Does the project have more than 35% impervious area on the existing site?	No Yes	Project is an applicable Development Site. Proceed to section 3. Proceed to 2.2.
2.2	Does the project have greater than 75% impervious area on the existing site?	No Yes	Project is an applicable Redevelopment Site. Proceed to section 3. Project is an applicable Constrained Redevelopment Site. Proceed to 2.3.
2.3	Will 100% of the runoff from the existing and proposed site be captured and treated using one or more of the allowable design standards for permanent water quality?	Yes No	No further action required. Proceed to 2.4.
2.4	Do any other water quality exclusions apply to the site?	No Yes	Portions of the project are excluded. Proceed with design in accordance with Constrained Redevelopment standards and apply for variance for <u>Constrained Redevelopment Sites</u> . Proceed to section 3. Following approval of other exclusions, design remaining site in accordance with Constrained Redevelopment standards and apply for variance for <u>Constrained Redevelopment Sites</u> .

3	Applicable Sites with Other Exclusions by Variance		
3.1	Category 1: Roadways, bridges and trails only		
3.1.1	Is the project a bike or pedestrian trail?	Yes No	Proceed to next line. Proceed to 3.1.2.
.	Is the trail for a roadway?	Yes No	Proceed to 3.1.2. Project is excluded. Submit variance for <u>Trails Excluded from Permanent Water Quality Requirements</u> .
3.1.2	Is the project primarily used for parking or access to parking?	Yes No	This exclusion does not apply. Permanent water quality is required. Proceed to 3.1.3.
3.1.3	Does the project add impervious area?	No Yes	Project is excluded. Submit variance for <u>Pavement Management Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.1.4.
3.1.4	Does the project add more than 8.25 feet of paved width at any location to the existing roadway?	No Yes	Project is excluded. Submit variance for <u>Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
.	Does the project add more than one acre of paved area per mile to an existing roadway?	No Yes	Project is excluded. Submit variance for <u>Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
.	Does the project increase the width by two times or more, on average, of the original roadway area?	No Yes	Existing areas of site are excluded only. Submit variance for <u>Existing Roadway Surfaces Only Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.
3.2	Category 2: Non-residential and non-commercial projects only		
3.2.1	Is the project associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities, including activities necessary to prepare a site for drilling and the movement and placement of drilling equipment?	Yes No	Project is excluded. Submit variance for <u>Oil and Gas Exploration Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.2.
3.2.2	Is the project for stream stabilization?	Yes No	Project is excluded. Submit variance for <u>Stream Stabilization Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.3.
3.2.3	Is the project for installation or maintenance of aboveground or underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the construction activity including activities to install, replace or maintain utilities under roadways or other paved areas that return the surface to the same condition?	Yes No	Project is excluded. Submit variance for <u>Aboveground and Underground Utilities Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.4.
3.2.4	Is the project on undeveloped land (land with no human-made structures such as buildings or pavement) that will remain undeveloped after the project?	Yes No	Project is excluded. Submit variance for <u>Sites with Land Disturbances to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.5.
3.2.5	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	No Yes	Project is excluded. Submit study along with variance for <u>Non-residential and Non-commercial Infiltration Conditions Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.

Section	Question	Response	Instructions
3.3	Category 3: Residential, Agricultural and Commercial projects		
3.3.1	Is the project a single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling unit?	Yes	Proceed to next line.
.		No	Proceed to 3.3.2.
.	Is the project site greater than 10% impervious?	No	Project is excluded. Submit variance for <u>Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements</u> .
.		Yes	Proceed to next line.
.	Is the project site greater than 20% impervious?	Yes	This exclusion does not apply. Permanent water quality is required.
.		No	Proceed to next line.
.	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	No	Project is excluded. Submit study along with variance for <u>Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements</u> .
.		Yes	This exclusion does not apply. Permanent water quality is required.
3.3.2	Will 100% of the runoff from the residential or commercial site be captured?	Yes	This exclusion does not apply. Permanent water quality is required.
.		No	Proceed to next line.
.	Is all or a portion of the site undeveloped or will it remain undeveloped after construction?	Yes	This portion of the project is excluded. Submit variance for <u>Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
.		No	Proceed to next line.
.	Is the remaining untreated impervious area greater than 20% of the site?	Yes	This exclusion does not apply. Permanent water quality is required.
.		No	Proceed to next line.
.	Is the remaining untreated impervious area greater than one acre?	Yes	This exclusion does not apply. Permanent water quality is required.
.		No	Proceed to next line.
.	Is it practicable to capture runoff from portions of the site that will not drain to a control measure?	No	Document justification demonstrating that it is not practicable to capture runoff from this portion of the site in the drainage report . No further action is needed.
.		Yes	TA36:D72his exclusion does not apply. Permanent water quality is required.

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: C+F/2

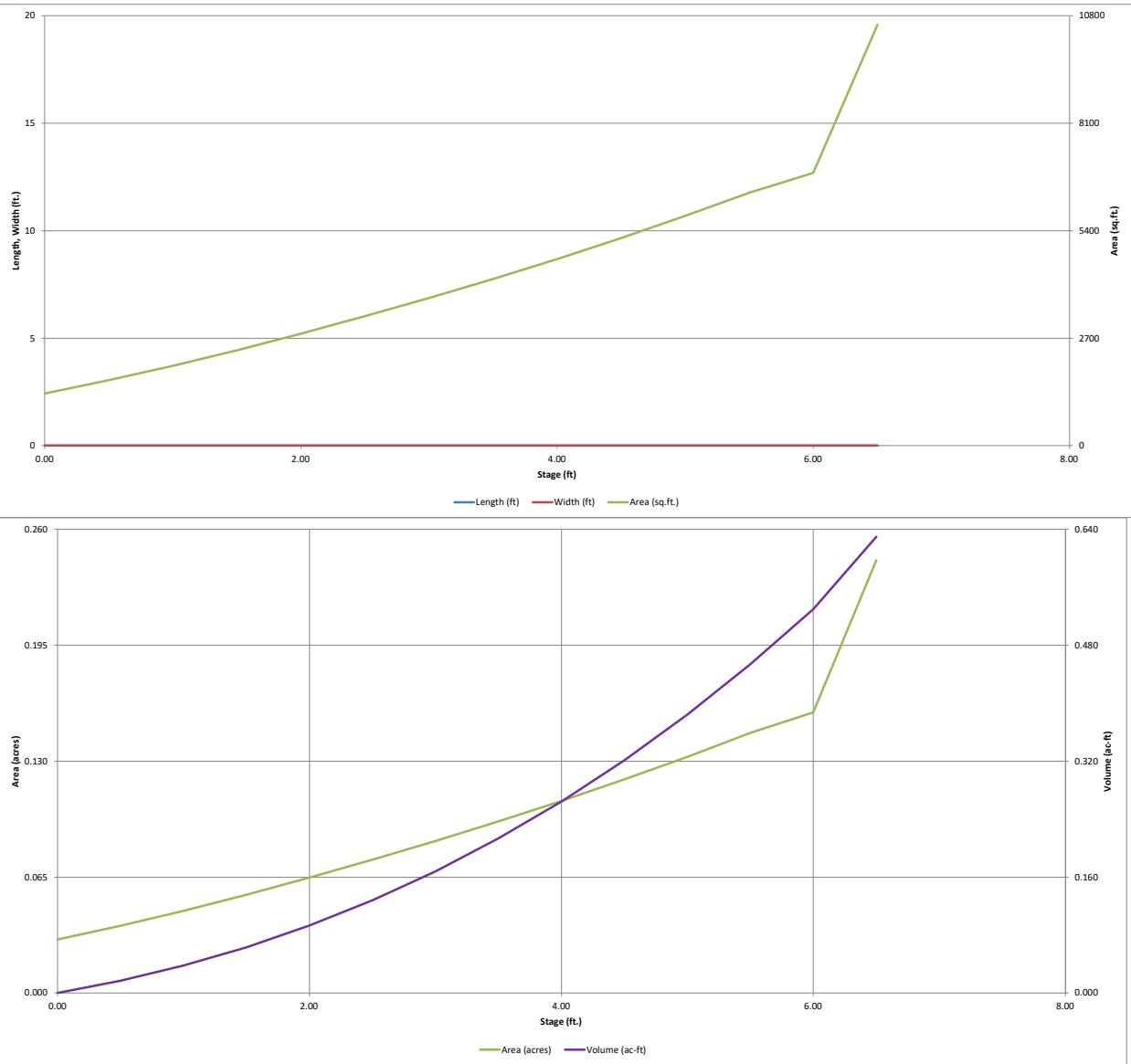


Selected BMP Type =	EDB
Watershed Area =	3.77 acres
Watershed Length =	480 ft
Length to Centroid =	240 ft
Watershed Slope =	0.022 ft/ft
Imperviousness =	64.00% percent
Hydrologic Soil Group A =	0.0% percent
Hydrologic Soil Group B =	0.0% percent
Hydrologic Soil Groups C/D =	100.0% percent
Detention WQCV Drain Time =	40.0 hours
1-hr Rainfall Depths =	Castle Pines - City Office

Optional User Overrides

Water Quality Capture Volume (WQCV) =	0.079	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.233	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	0.149	acre-feet	inches
5-yr Runoff Volume (P1 = 1.43 in.) =	0.308	acre-feet	1.43 inches
10-yr Runoff Volume (P1 = 1.36 in.) =	0.285	acre-feet	inches
25-yr Runoff Volume (P1 = 1.72 in.) =	0.403	acre-feet	inches
50-yr Runoff Volume (P1 = 2.01 in.) =	0.492	acre-feet	inches
100-yr Runoff Volume (P1 = 2.6 in.) =	0.684	acre-feet	2.60 inches
500-yr Runoff Volume (P1 = 3.07 in.) =	0.832	acre-feet	inches
Approximate 2-yr Detention Volume =	0.148	acre-feet	
Approximate 5-yr Detention Volume =	0.282	acre-feet	
Approximate 10-yr Detention Volume =	0.263	acre-feet	
Approximate 25-yr Detention Volume =	0.310	acre-feet	
Approximate 50-yr Detention Volume =	0.332	acre-feet	
Approximate 100-yr Detention Volume =	0.420	acre-feet	

Zone 1 Volume (WQV_C) =	0.079	acre-feet
Zone 2 Volume ($EURV - Zone\ 1$) =	0.154	acre-feet
Zone 3 ($100yr + 1/2\ WQV_C - Zones\ 1\ \&\ 2$) =	0.226	acre-feet
Total Detention Basin Volume =	0.459	acre-feet
Initial Surcharge Volume (ISV) =	user	ft ³
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{TODA}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (ST_C) =	user	ft/ft
Slopes of Main Basin Sides (S_{MAIN}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft ²
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft ²
Volume of Basin Floor (V_{FLOOR}) =	user	ft ³
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft ²
Volume of Main Basin (V_{MAIN}) =	user	ft ³
Calculated Total Basin Volume (V_{TOTAL}) =	user	acre-feet

[illegible]

NW 100 Pond - STAGE STORAGE TABLE

AVG END

AVG END

ELEV	TOTAL		Stage (ft)	AREA	DEPTH	INC. VOL.	
	VOL.						
	Volume						
	(ac-ft)	(cu. ft.)		(sq. ft.)	(ft)	(cu. ft.)	
6,444.00	0.000	0	0.00	1,306	N/A	N/A	
6,444.10	0.003	134	0.10	1,371	0.1	133.87	
6,444.20	0.006	274	0.20	1,438	0.1	140.46	
6,444.30	0.010	422	0.30	1,505	0.1	147.16	
6,444.40	0.013	575	0.40	1,574	0.1	153.97	
6,444.50	0.017	736	0.50	1,644	0.1	160.88	
6,444.60	0.021	904	0.60	1,714	0.1	167.9	
6,444.70	0.025	1079	0.70	1,786	0.1	175.01	
6,444.80	0.029	1262	0.80	1,859	0.1	182.24	
6,444.90	0.033	1451	0.90	1,933	0.1	189.57	
6,445.00	0.038	1648	1.00	2,008	0.1	197.01	
6,445.10	0.043	1853	1.10	2,084	0.1	204.56	
6,445.20	0.047	2065	1.20	2,161	0.1	212.21	
6,445.30	0.052	2285	1.30	2,239	0.1	219.98	
6,445.40	0.058	2513	1.40	2,318	0.1	227.87	
6,445.50	0.063	2749	1.50	2,399	0.1	235.88	
6,445.60	0.069	2993	1.60	2,481	0.1	243.99	
6,445.70	0.074	3245	1.70	2,564	0.1	252.23	
6,445.80	0.080	3505	1.80	2,648	0.1	260.59	WQCV @ 1.79
6,445.90	0.087	3774	1.90	2,733	0.1	269.05	
6,446.00	0.093	4052	2.00	2,818	0.1	277.58	
6,446.10	0.100	4338	2.10	2,904	0.1	286.14	
6,446.20	0.106	4633	2.20	2,992	0.1	294.79	
6,446.30	0.113	4937	2.30	3,080	0.1	303.59	
6,446.40	0.121	5249	2.40	3,170	0.1	312.52	
6,446.50	0.128	5571	2.50	3,259	0.1	321.47	
6,446.60	0.135	5901	2.60	3,348	0.1	330.38	
6,446.70	0.143	6240	2.70	3,438	0.1	339.32	
6,446.80	0.151	6589	2.80	3,529	0.1	348.35	
6,446.90	0.159	6946	2.90	3,620	0.1	357.46	
6,447.00	0.168	7313	3.00	3,713	0.1	366.64	
6,447.10	0.177	7689	3.10	3,805	0.1	375.9	
6,447.20	0.185	8074	3.20	3,900	0.1	385.25	
6,447.30	0.194	8469	3.30	3,995	0.1	394.73	
6,447.40	0.204	8873	3.40	4,091	0.1	404.3	
6,447.50	0.213	9287	3.50	4,189	0.1	413.99	
6,447.60	0.223	9711	3.60	4,287	0.1	423.81	
6,447.70	0.233	10144	3.70	4,387	0.1	433.71	WQCV+EURV Target (@ 3.70)
6,447.80	0.243	10588	3.80	4,487	0.1	443.67	
6,447.90	0.253	11042	3.90	4,588	0.1	453.72	
6,448.00	0.264	11506	4.00	4,690	0.1	463.88	
6,448.10	0.275	11980	4.10	4,793	0.1	474.14	
6,448.20	0.286	12464	4.20	4,897	0.1	484.52	
6,448.30	0.298	12959	4.30	5,003	0.1	495	
6,448.40	0.309	13465	4.40	5,109	0.1	505.58	
6,448.50	0.321	13981	4.50	5,217	0.1	516.28	
6,448.60	0.333	14508	4.60	5,325	0.1	527.09	

6,448.70	0.345	15046	4.70	5,435	0.1	538.01
6,448.80	0.358	15595	4.80	5,546	0.1	549.04
6,448.90	0.371	16155	4.90	5,658	0.1	560.18
6,449.00	0.384	16727	5.00	5,771	0.1	571.41 Top of plate & conc for 100yr weir
6,449.10	0.397	17310	5.10	5,884	0.1	582.73
6,449.20	0.411	17904	5.20	5,999	0.1	594.14
6,449.30	0.425	18509	5.30	6,115	0.1	605.66
6,449.40	0.439	19127	5.40	6,232	0.1	617.33
6,449.46	0.448	19503	5.46	6,305	0.06	376.11 100 yr @ 5.48
6,449.50	0.454	19756	5.50	6,351	0.04	253.12
6,449.60	0.468	20399	5.60	6,512	0.1	643.18 500yr @ 5.61
6,449.70	0.483	21054	5.70	6,594	0.1	655.31
6,449.80	0.499	21718	5.80	6,678	0.1	663.61
6,449.90	0.514	22390	5.90	6,765	0.1	672.18 Emg Spillway Stage @ 5.96 (6449.96)
6,450.00	0.530	23071	6.00	6,855	0.1	681.02 Back of outlet structure
6,450.10	0.546	23763	6.10	6,981	0.1	691.8 Inner edge of access road @ top of pond
6,450.20	0.562	24495	6.20	7,667	0.1	732.39
6,450.30	0.581	25300	6.30	8,428	0.1	804.73
6,450.40	0.601	26184	6.40	9,249	0.1	883.85
6,450.46	0.614	26763	6.46	10,035	0.06	578.53 Top of Bank, top of emg overflow
6,450.50	0.624	27175	6.50	10,571	0.04	412.12 Dummy elevation for MHFD Det sht

Channel Report

Trickle Channel in NW Pond

Rectangular

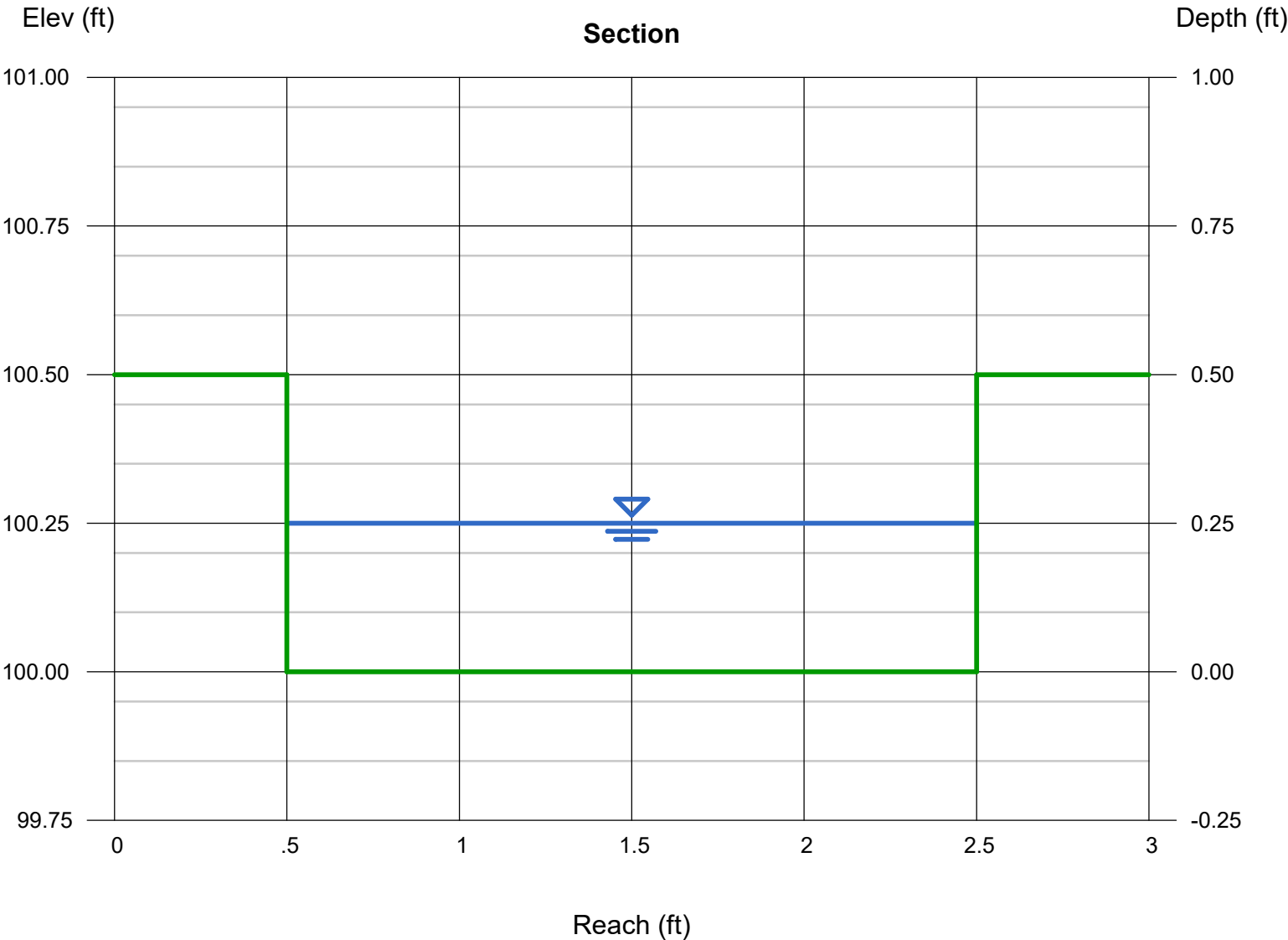
Bottom Width (ft)	= 2.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 0.50
N-Value	= 0.130

Calculations

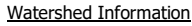
Compute by:	Known Q
Known Q (cfs)	= 0.13

Highlighted

Depth (ft)	= 0.25
Q (cfs)	= 0.130
Area (sqft)	= 0.50
Velocity (ft/s)	= 0.26
Wetted Perim (ft)	= 2.50
Crit Depth, Yc (ft)	= 0.06
Top Width (ft)	= 2.00
EGL (ft)	= 0.25



MHFD-Detention, Version 4.06 (July 2022)

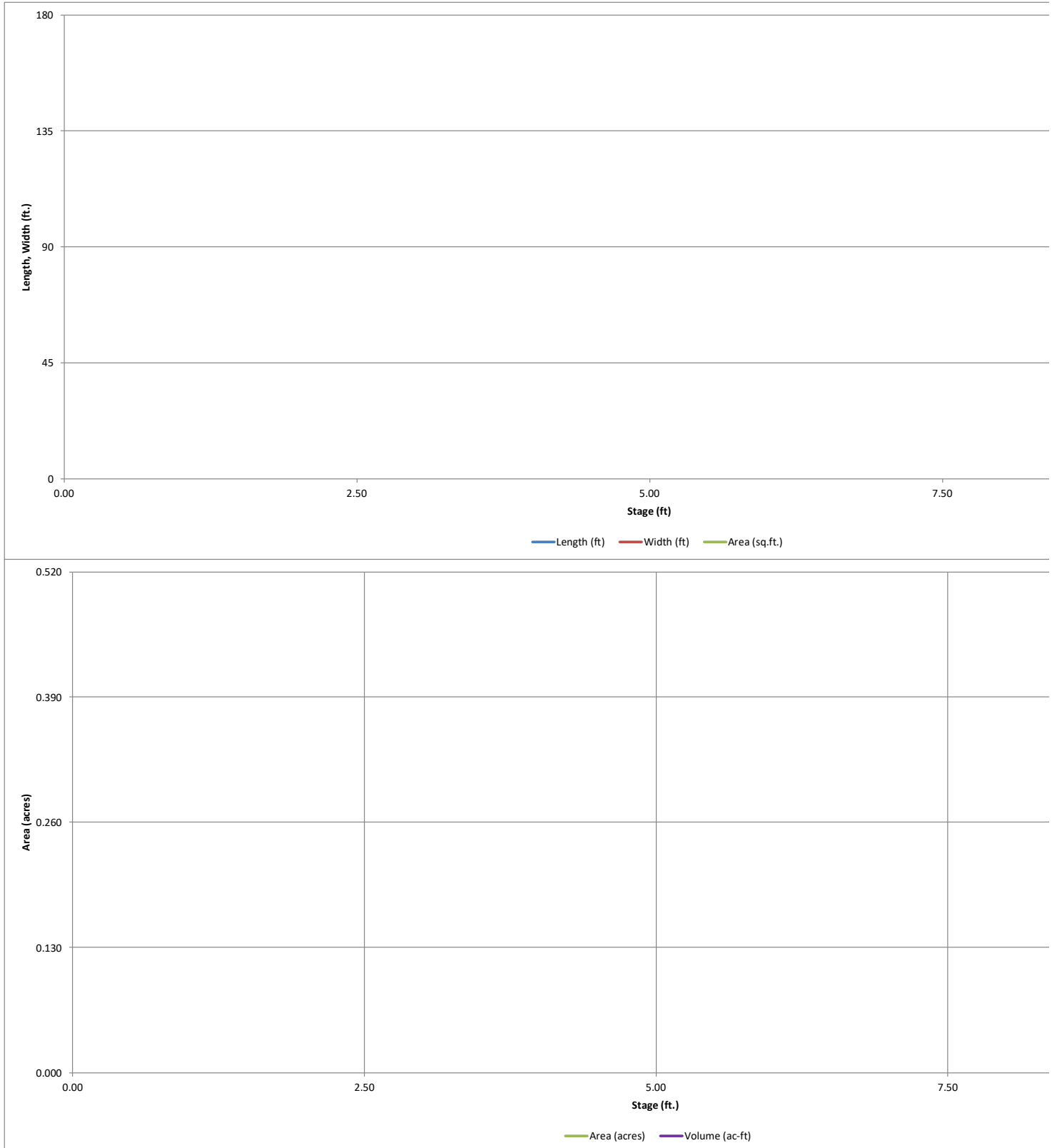
Basin ID: A

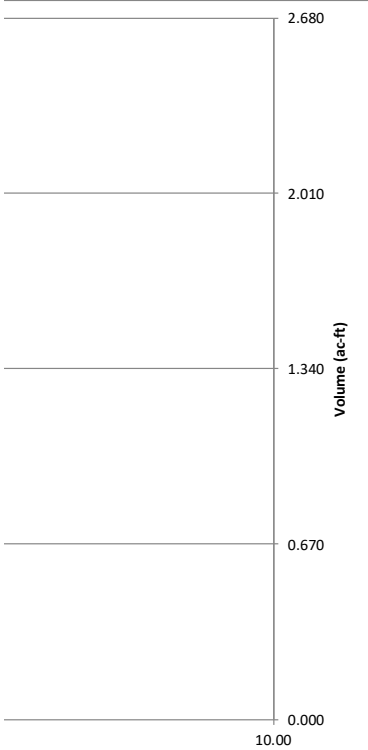
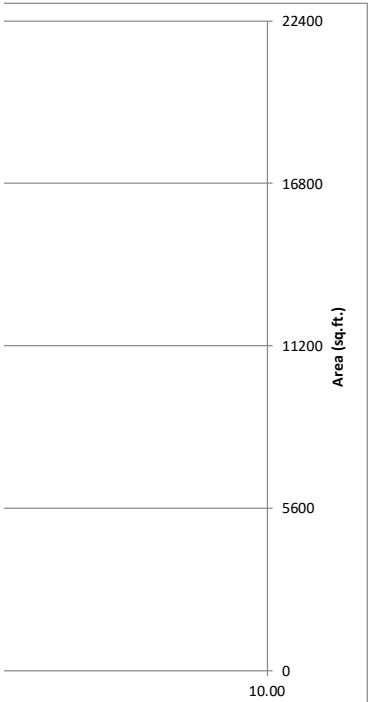
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DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)





Channel Report

Basin A Emgc Overflow into Pond 512

Trapezoidal

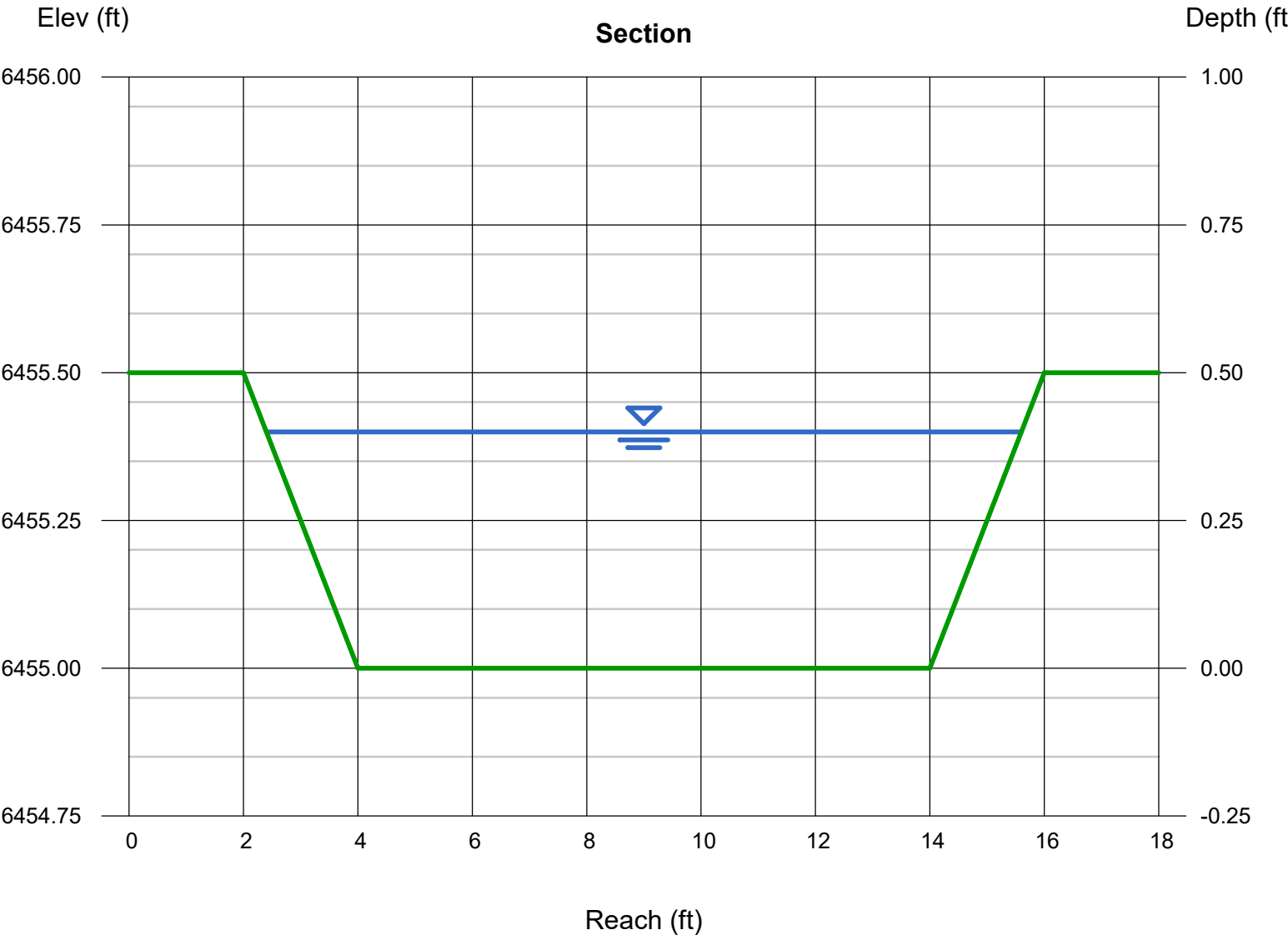
Bottom Width (ft) = 10.00
Side Slopes (z:1) = 4.00, 4.00
Total Depth (ft) = 0.50
Invert Elev (ft) = 6455.00
Slope (%) = 10.00
N-Value = 0.035

Calculations

Compute by: Known Q
Known Q (cfs) = 30.80

Highlighted

Depth (ft) = 0.40
Q (cfs) = 30.80
Area (sqft) = 4.64
Velocity (ft/s) = 6.64
Wetted Perim (ft) = 13.30
Crit Depth, Yc (ft) = 0.50
Top Width (ft) = 13.20
EGL (ft) = 1.09



Watershed Information

Selected BMP Type =	EDB
Watershed Area =	8.57 acres
Watershed Length =	1,497 ft
Watershed Length to Centroid =	750 ft
Watershed Slope =	0.012 ft/ft
Watershed Imperviousness =	67.20% percent
Percentage Hydrologic Soil Group A =	0.0% percent
Percentage Hydrologic Soil Group B =	0.0% percent
Percentage Hydrologic Soil Groups C/D =	100.0% percent
Target WQCV Drain Time =	40.0 hours
Location for 1-hr Rainfall Depths =	Castle Pines - City Office

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

Water Quality Capture Volume (WQCV) =	0.188	acre-feet
Excess Urban Runoff Volume (EURV) =	0.558	acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	0.380	acre-feet
5-yr Runoff Volume (P1 = 1.43 in.) =	0.772	acre-feet
10-yr Runoff Volume (P1 = 1.36 in.) =	0.715	acre-feet
25-yr Runoff Volume (P1 = 1.72 in.) =	1.001	acre-feet
50-yr Runoff Volume (P1 = 2.01 in.) =	1.217	acre-feet
100-yr Runoff Volume (P1 = 2.6 in.) =	1.681	acre-feet
500-yr Runoff Volume (P1 = 3.07 in.) =	2.041	acre-feet
Approximate 2-yr Detention Volume =	0.355	acre-feet
Approximate 5-yr Detention Volume =	0.671	acre-feet
Approximate 10-yr Detention Volume =	0.626	acre-feet
Approximate 25-yr Detention Volume =	0.738	acre-feet
Approximate 50-yr Detention Volume =	0.788	acre-feet
Approximate 100-yr Detention Volume =	0.989	acre-feet

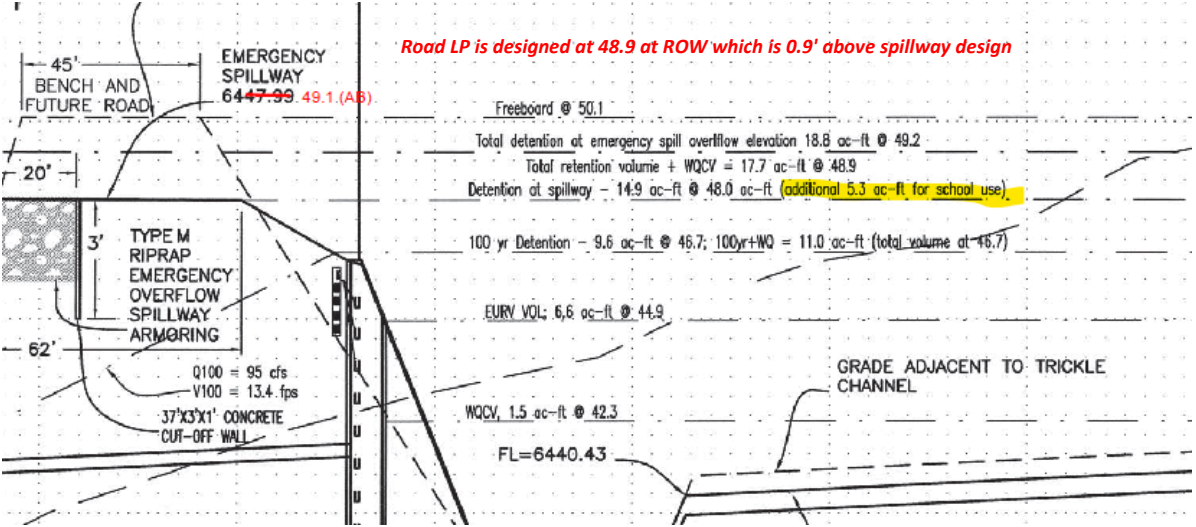
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.188	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.370	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	0.525	acre-feet
Total Detention Basin Volume =	1.083	acre-feet

Basin A
needed
volume per
MHFD Det

Optional User Overrides

	acre-feet
	acre-feet
	inches
1.43	inches
	inches
	inches
	inches
2.60	inches
	inches



JJM Notes 20260416

Existing Pond 512 was designed with room for an additional 5.3 ac-ft for this site's use.
There is plenty of room for 1.08 ac-ft (per MHFD Det) plus Basin D (1.1 ac) (rd on top of berm)
Another 0.16 ac-ft needed for Basin D
Note that the entire 100 yr runoff volume is 1.62ac-ft, Basin D is about 0.2ac-ft
11.0+1.8=12.8 ac-ft occurs at 6447.3 with a discharge of 97 cfs - 2 cfs more than design of 95 cfs
It can be concluded that entire storm can be detained in Pond 512
2cfs is less than the historic flow to Pond 512 from Basin H-E of 15.5 cfs
The historic flow at the release point of the pond is 112cfs, total proposed is 108.1cfs
Lots of volume to rework the stage storage discharge curves to reduce the peak outflow even further if necessary
Road LP will be at 6448.9 which will become the new emergency overflow
Volume at 48.9 is about 17.8 ac-ft & 47.9 is 14.6 ac-ft - plenty of room to work with
West Entry road reduces Pond 512 volume by about 0.2 ac-ft - negligible impact

Comparison of Major Storm Flows to pond 512 Outfall			
	Historic	Existing Today	Proposed
Historic	112.0 cfs	n/a	n/a
Pond 512 Release	0.0 cfs	95.0 cfs	97.0 cfs
Basin H-E	0.0 cfs	15.5 cfs	0.0 cfs
Basin E	0.0 cfs	0.0 cfs	5.4 cfs
Basin H-C	0.0 cfs	0.0 cfs	0.0 cfs
Basin C	0.0 cfs	0.0 cfs	5.7 cfs
	112.0 cfs	110.5 cfs	108.1 cfs
True Peak Flow	112.0 cfs	95.0 cfs	97.0 cfs

Stage Storage Curve

Project: Pond 512

		Contour	Incremental	Cumulative	Cumulative		
Elevation	Stage	Area	Volume	Volume	Volume	Discharge	
6438.43	0.00'	3,390 sf	0 cf	0 cf	0.0 ac-ft	0.0 cfs	Bottom of micro-pool
6439.00	0.57'	4,213 sf	2,167 cf	2,167 cf	0.0 ac-ft	0.3 cfs	
6440.00	1.57'	5,830 sf	5,021 cf	7,188 cf	0.2 ac-ft	0.4 cfs	
6440.76	2.33'	9,723 sf	5,910 cf	13,098 cf	0.3 ac-ft	0.6 cfs	Top of micro-pool
6441.00	2.57'	10,953 sf	8,391 cf	15,579 cf	0.4 ac-ft	0.7 cfs	
6442.00	3.57'	48,073 sf	29,513 cf	45,093 cf	1.0 ac-ft	1.0 cfs	
6442.34	3.91'	59,216 sf	18,505 cf	63,597 cf	1.5 ac-ft	1.1 cfs	WQCV
6443.00	4.57'	80,377 sf	64,225 cf	109,318 cf	2.5 ac-ft	1.3 cfs	
6443.67	5.24'	89,730 sf	56,856 cf	166,174 cf	3.8 ac-ft	1.6 cfs	EURV Volume
6444.00	5.57'	94,369 sf	87,373 cf	196,690 cf	4.5 ac-ft	1.7 cfs	
6444.93	6.50'	102,510 sf	91,549 cf	288,239 cf	6.6 ac-ft	1.9 cfs	EURV Depth
6445.00	6.57'	103,123 sf	98,746 cf	295,436 cf	6.8 ac-ft	6.8 cfs	
6446.00	7.57'	112,323 sf	107,723 cf	403,159 cf	9.3 ac-ft	87.0 cfs	
6446.66	8.23'	118,704 sf	76,436 cf	479,595 cf	11.0 ac-ft	95.0 cfs	100yr+WQCV
6447.00	8.57'	121,966 sf	117,145 cf	520,304 cf	11.9 ac-ft	96.0 cfs	
6448.00	9.57'	135,866 sf	128,916 cf	649,220 cf	14.9 ac-ft	99.0 cfs	Emg Overflow Invert
6448.86	10.43'	147,846 sf	251,185 cf	771,489 cf	17.7 ac-ft	100.0 cfs	Ret Vol+WQCV
6449.00	10.57'	147,501 sf	141,683 cf	790,903 cf	18.2 ac-ft	101.0 cfs	
6449.20	10.77'	149,552 sf	29,705 cf	820,609 cf	18.8 ac-ft	102.0 cfs	Vol at Overflow
6450.00	11.57'	157,755 sf	152,628 cf	943,532 cf	21.7 ac-ft	103.0 cfs	Top of embankment

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Wednesday, Jun 24 2026

Pond 512 Emg Overflow - one existing 36in pipe

Invert Elev Dn (ft) = 37.88
Pipe Length (ft) = 114.40
Slope (%) = 0.48
Invert Elev Up (ft) = 38.43
Rise (in) = 36.0
Shape = Circular
Span (in) = 36.0
No. Barrels = 1
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) = 48.92
Top Width (ft) = 45.00
Crest Width (ft) = 115.00

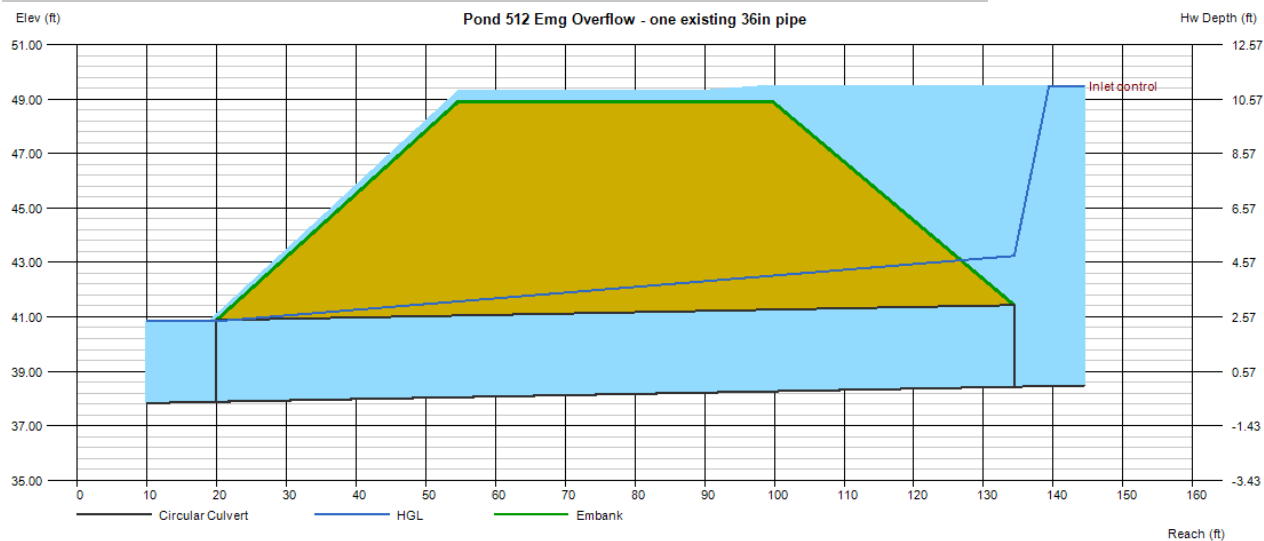
Calculations

Qmin (cfs) = 250.00
Qmax (cfs) = 250.00
Tailwater Elev (ft) = $(dc+D)/2$

Highlighted

Qtotal (cfs) = 250.00
Qpipe (cfs) = 106.63
Qovertop (cfs) = 143.37
Veloc Dn (ft/s) = 15.13
Veloc Up (ft/s) = 15.09
HGL Dn (ft) = 40.84
HGL Up (ft) = 43.24
Hw Elev (ft) = 49.49
Hw/D (ft) = 3.69
Flow Regime = Inlet Control

Flow in existing 36" RCP at a headwater depth equal to 12" ponding at flowline at the road LP. 27 cfs in a proposed 18" pipe, 107 cfs in the existing 36" RCP, and 146 cfs overtopping the road for a total of 280 cfs.



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Wednesday, Jun 24 2026

Pond 512 Emg Overflow - one extra 18in pipe

Invert Elev Dn (ft) = 37.88
Pipe Length (ft) = 114.40
Slope (%) = 0.48
Invert Elev Up (ft) = 38.43
Rise (in) = 18.0
Shape = Circular
Span (in) = 18.0
No. Barrels = 1
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) = 48.92
Top Width (ft) = 45.00
Crest Width (ft) = 115.00

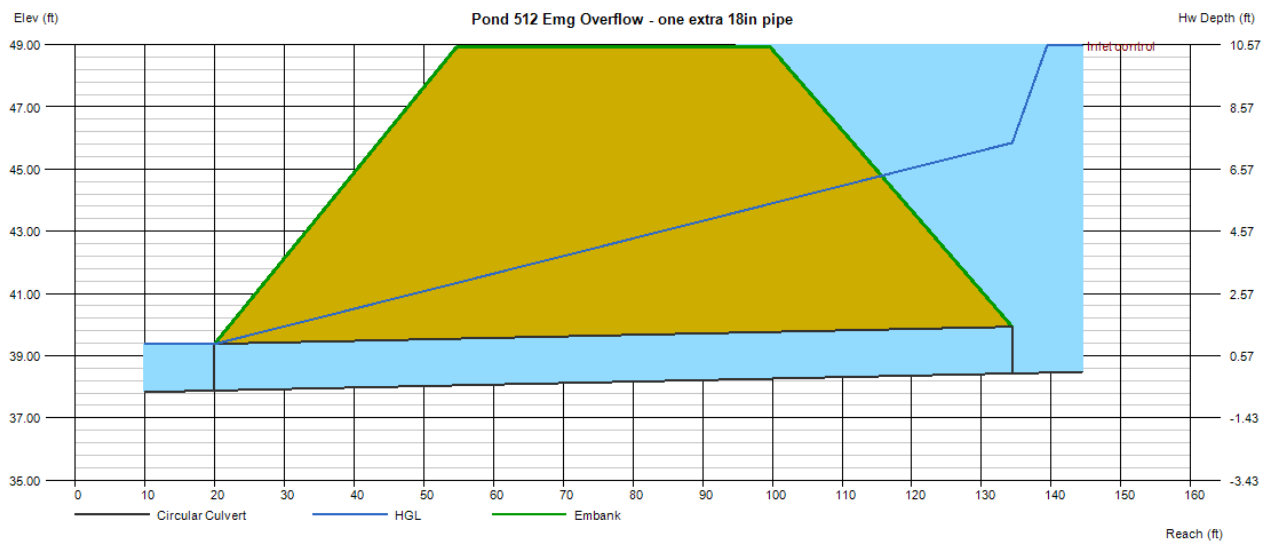
Calculations

Qmin (cfs) = 30.00
Qmax (cfs) = 30.00
Tailwater Elev (ft) = (dc+D)/2

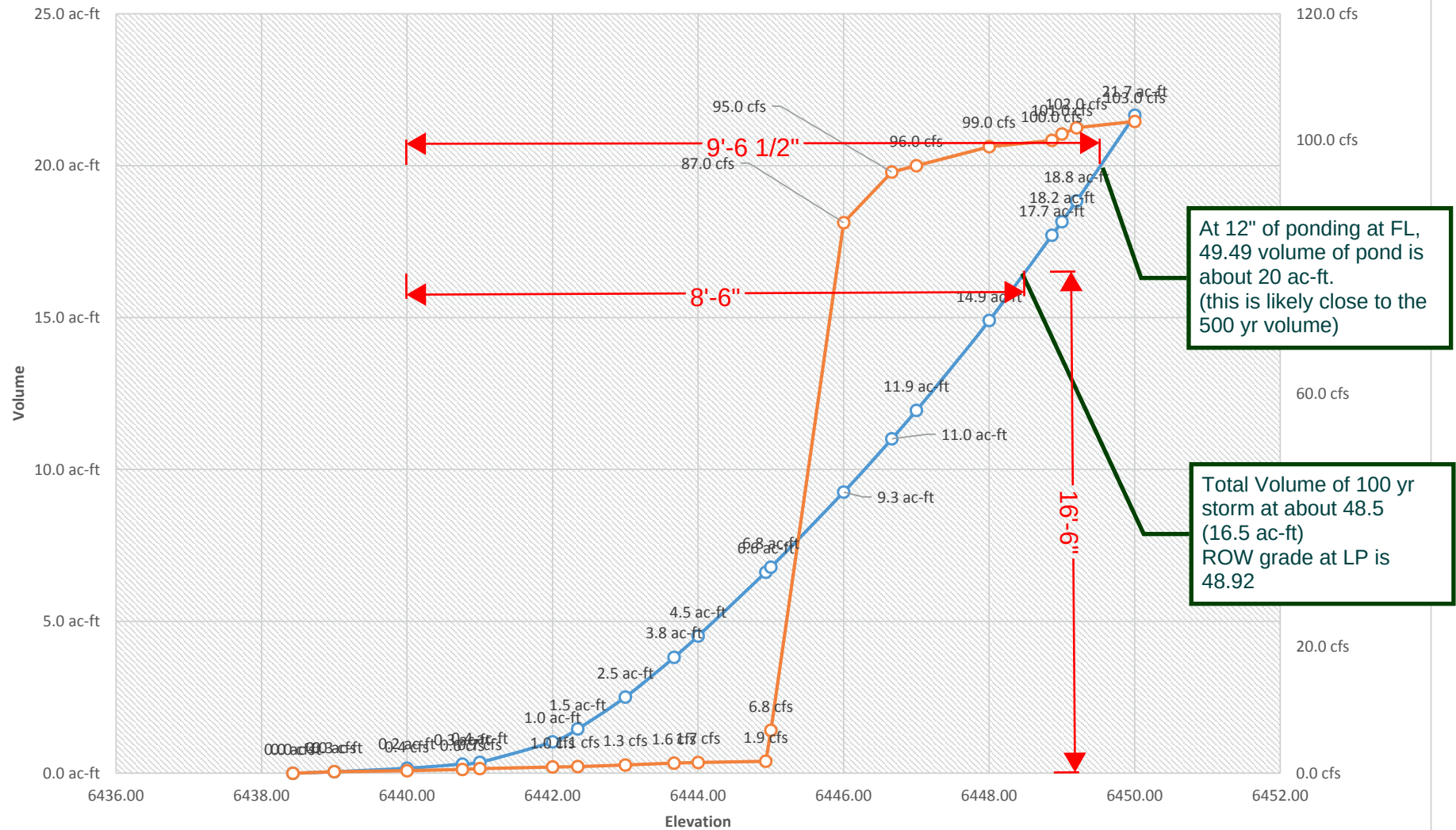
Highlighted

Qtotal (cfs) = 30.00
Qpipe (cfs) = 27.37
Qovertop (cfs) = 2.63
Veloc Dn (ft/s) = 15.49
Veloc Up (ft/s) = 15.49
HGL Dn (ft) = 39.38
HGL Up (ft) = 45.84
Hw Elev (ft) = 48.98
Hw/D (ft) = 7.03
Flow Regime = Inlet Control

This calculates the HW depth installing one extra 18" RCP. 27 cfs in this pipe, 107 cfs in the existing 36" RCP, and 146 cfs overtopping the road for a total of 280 cfs.



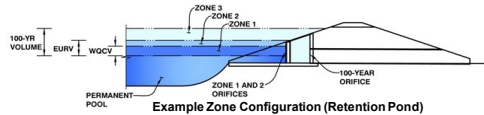
Pond 512 Stage Storage Discharge Curve



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: G+B.3+F.1



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	4.00	acres
Watershed Length =	500	ft
Watershed Length to Centroid =	250	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	37.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depth = Castle Pines - City Office		

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

Water Quality Curve Volume (WQCV) =	0.057	acre-feet
Excess Urban Runoff Volume (EURV) =	0.137	acre-feet
2-yr Runoff Volume ($P1 = 0.84$) =	0.086	acre-feet
5-yr Runoff Volume ($P1 = 1.43$) in =	0.232	acre-feet
10-yr Runoff Volume ($P1 = 1.36$) in =	0.206	acre-feet
25-yr Runoff Volume ($P1 = 1.72$) in =	0.335	acre-feet
50-yr Runoff Volume ($P1 = 2.01$) in =	0.427	acre-feet
100-yr Runoff Volume ($P1 = 2.6$) in =	0.634	acre-feet
500-yr Runoff Volume ($P1 = 3.07$) in =	0.790	acre-feet
Approximate 2-yr Detention Volume =	0.084	acre-feet
Approximate 5-yr Detention Volume =	0.180	acre-feet
Approximate 10-yr Detention Volume =	0.168	acre-feet
Approximate 25-yr Detention Volume =	0.206	acre-feet
Approximate 50-yr Detention Volume =	0.223	acre-feet
Approximate 100-yr Detention Volume =	0.306	acre-feet

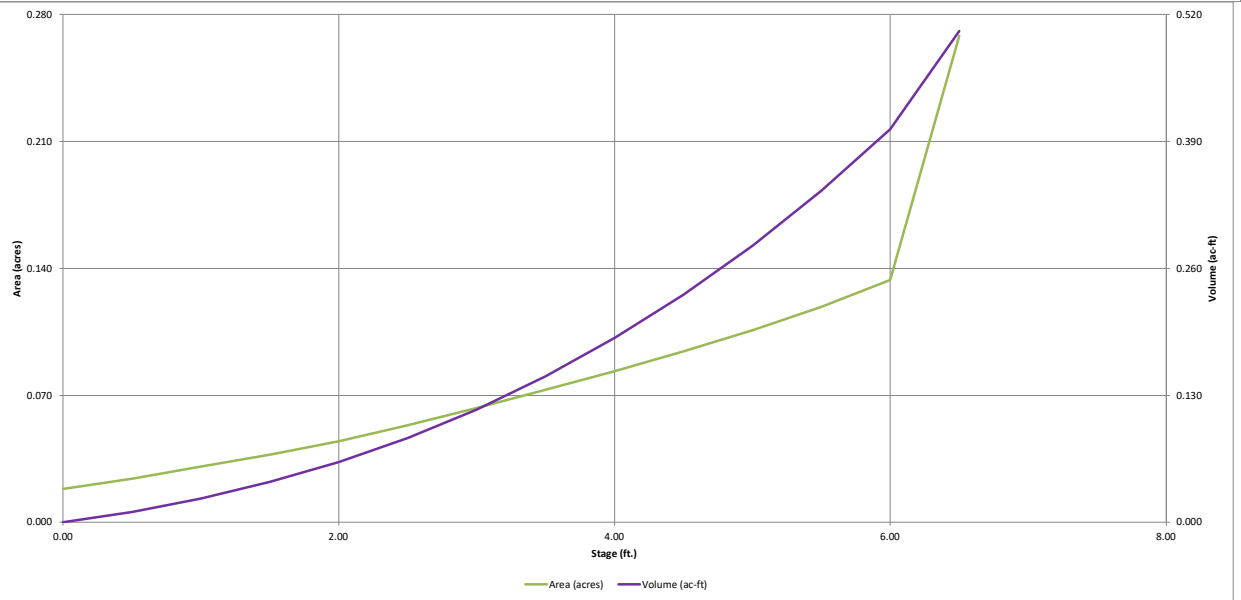
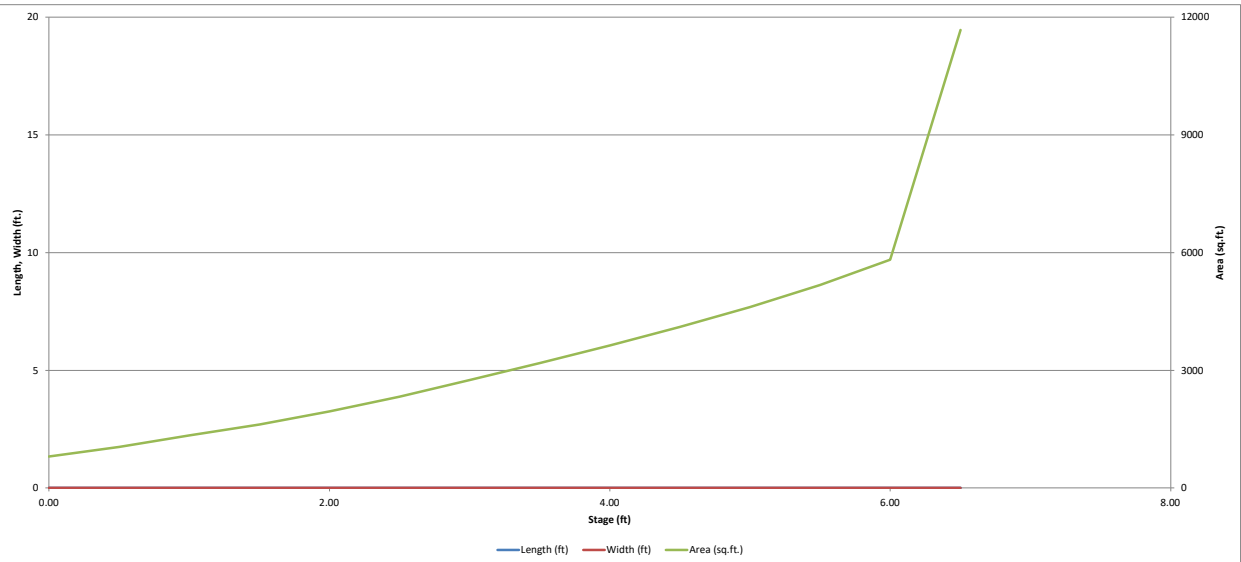
Define Zones and Basin Geometry

Zone 1 Volume (WQV_{Z1}) =	0.057	acre-feet
Zone 2 Volume ($EURV - Zone 1$) =	0.079	acre-feet
Zone 3 ($100yr + 1/2 WQV_{Z1} - Zones 1 \& 2$) =	0.198	acre-feet
Total Detention Basin Volume =	0.335	acre-feet
Initial Surge Volume (ISV) =	user	ft ³
Initial Surge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{TDA}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (STC) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Initial Surcharge Area (A_{SV})	=	user	ft ²
Surcharge Volume Length (L_{SV})	=	user	ft
Surcharge Volume Width (W_{SV})	=	user	ft
Depth of Basin Floor (H_{FLOOR})	=	user	ft
Length of Basin Floor (L_{FLOOR})	=	user	ft
Width of Basin Floor (W_{FLOOR})	=	user	ft
Area of Basin Floor (A_{FLOOR})	=	user	ft ²
Volume of Basin Floor (V_{FLOOR})	=	user	ft ³
Depth of Main Basin (H_{MAIN})	=	user	ft
Length of Main Basin (L_{MAIN})	=	user	ft
Width of Main Basin (W_{MAIN})	=	user	ft
Area of Main Basin (A_{MAIN})	=	user	ft ²
Volume of Main Basin (V_{MAIN})	=	user	ft ³
culated Total Basin Volume (V_{TOTAL})	=	user	acre-feet

Optional User Overrides

	acre-feet
	acre-feet
	inches
1.43	inches
	inches
	inches
	inches
2.60	inches
	inches

[illegible]

MHFD-Detention, Version 4.06 (July 2022)

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below
Underdrain Orifice Diameter =	N/A	inches

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used)		
Centroid of Lowest Orifice =	0.00	ft (relative to base)
Depth at top of Zone using Orifice Plate =	1.80	ft (relative to base)
Orifice Plate: Orifice Vertical Spacing =	10.80	inches
Orifice Plate: Orifice Area per Row =	0.40	sq. inches (diameter)

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	0.90						
Orifice Area (sq. inches)	0.40	0.40						

	Row 9 (optional)	Row 10 (optional)
Stage of Orifice Centroid (ft)		
Orifice Area (sq. inches)		

User Input: Vertical Orifice (Circular or Rectangular)		
	Zone 2 Rectangular	Not Selected
Invert of Vertical Orifice =	1.90	N/A
Depth at top of Zone using Vertical Orifice =	3.32	N/A
Vertical Orifice Height =	2.00	N/A
Vertical Orifice Width =	0.38	

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

	Zone 3 Weir	Nct Selected			Zone 3 Weir	Nct Selected
Overflow Weir Front Edge Height, H_o	4.80	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_u	N/A	N/A
Overflow Weir Bottom Length	4.00	N/A		ft	Overflow Weir Slope Length	N/A
Overflow Weir Side Slopes	4.00	N/A	H:V	Grate Open Area / 100-y/ Orifice Area	N/A	N/A
Horiz. Length of Weir Sides	N/A	N/A	ft	Overflow Grate Open Area w/o Debris	N/A	N/A
Overflow Grate Type	Type C Grate	N/A		Overflow Grate Open Area w/ Debris	N/A	N/A
Debris Clogging %	50%	N/A	%			

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

	Not Selected	Not Selected			Not Selected	Not Selected
Depth to Invert of Outlet Pipe =	N/A	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	N/A	N/A
Circular Orifice Diameter =	N/A	N/A	inches	Outlet Orifice Centroid =	N/A	N/A
						ft ²

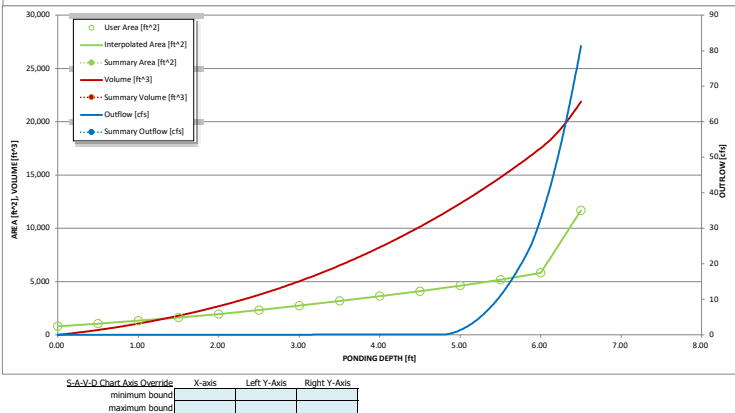
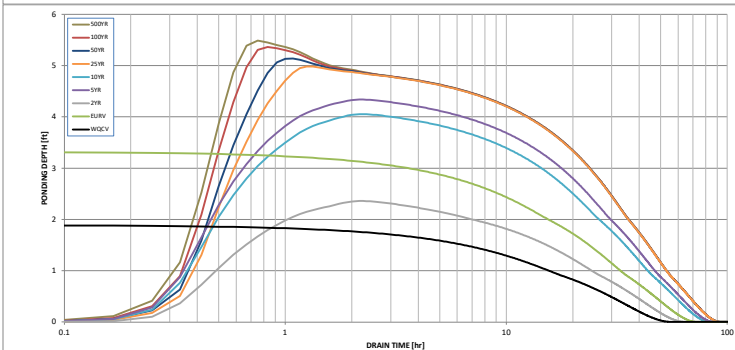
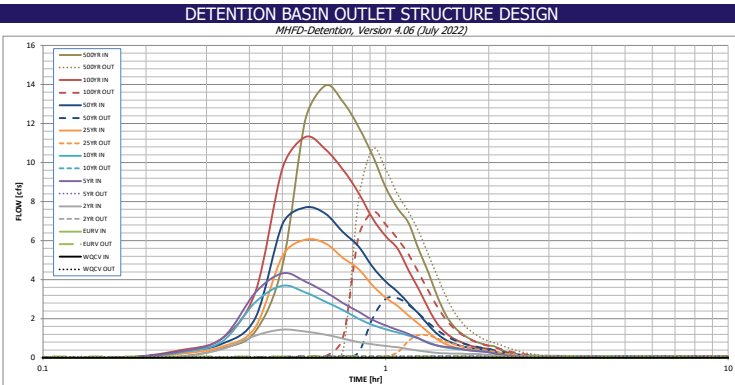
User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	5.86	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth =	0.46	feet
Spillway Crest Length =	10.00	feet	Stage at Top of Freeboard =	7.28	feet
Spillway End Slopes =	4:1	H:V	Basin Area at Top of Freeboard =	0.27	acres
Freeboard above Max Water Surface =	0.96	feet	Basin Volume at Top of Freeboard =	0.50	acre-ft
Spillway position relative to Overflow Weir =	Offset				

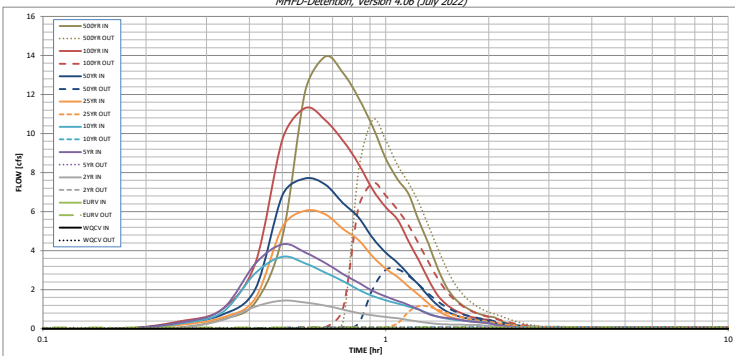
Routed Hydrograph Results

	Design Storm Duration One-Hour Rainfall Depth (in)	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
CUPH Runoff Volume (cfs)	N/A	N/A	0.84	1.43	1.36	1.72	2.01	2.60	3.07	
CUPH Runoff Volume (cfs)	0.057	0.137	0.086	0.22	0.206	0.335	0.427	0.534	0.790	
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.086	0.232	0.223	0.337	0.427	0.534	0.790	
CUPH Predevelopment Peak Q (cfs)	N/A	N/A	N/A	1.9	1.5	3.5	4.8	7.5	9.5	
OPTIONAL Overdevelopment Predevelopment Peak Q (cfs)	N/A	N/A	N/A	3.7				19.3		
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.01	0.03	0.37	0.88	1.19	4.83	2.37	
Peak Inflow Q (cfs)	N/A	N/A	1.5	4.3	6.1	7.7	11.3	14.0		
Peak Outflow Q (cfs)	0.0	0.1	0.1	0.1	0.1	1.2	3.1	7.5	10.7	
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.0	0.1	0.3	0.6	0.4	1.1	
Structure Controlling Flow	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	
Max Velocity through Gate 1 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Max Velocity through Gate 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)	45	57	52	66	64	68	64	58	54	
Time to Drain 99% of Inflow Volume (hours)	50	64	57	75	72	79	77	73	71	
Maximum Ponding Depth (ft)	0.09	3.33	2.36	4.34	4.05	4.98	5.14	5.36	5.49	
Area at Maximum Ponding Depth (acres)	0.04	0.01	0.05	0.09	0.08	0.11	0.12	0.12	0.12	
Maximum Volume Stored (acre-ft)	0.057	0.137	0.079	0.217	0.193	0.281	0.297	0.323	0.337	

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



MHFD-Detention, Version 4.06 (July 2022)



Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

Time Interval	SOURCE	CJHP	CJHP	CJHP	CJHP	CJHP	CJHP	CJHP	CJHP	CJHP
	TIME	WQCY [c/s]	EURR [c/s]	2 Year [c/s]	5 Year [c/s]	10 Year [c/s]	25 Year [c/s]	50 Year [c/s]	100 Year [c/s]	500 Year [c/s]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07
	0:15:00	0.00	0.06	0.32	0.26	0.21	0.27	0.21	0.29	0.49
	0:20:00	0.00	0.00	0.45	1.01	0.85	0.58	0.72	1.01	1.36
	0:25:00	0.00	0.00	1.15	3.36	2.87	1.59	2.05	3.38	4.78
	0:30:00	0.00	0.00	1.46	4.33	3.70	5.24	6.87	9.75	12.21
	0:35:00	0.00	0.00	1.34	3.91	3.35	6.06	7.71	11.33	13.96
	0:40:00	0.00	0.00	1.20	3.36	2.88	5.86	7.38	10.68	13.12
	0:45:00	0.00	0.00	0.99	2.82	2.46	5.13	6.45	9.65	11.83
	0:50:00	0.00	0.00	0.82	2.36	2.01	4.55	5.71	8.45	10.34
	0:55:00	0.00	0.69	0.94	1.94	1.68	3.69	4.64	7.13	8.73
	1:00:00	0.00	0.00	0.61	1.66	1.47	3.99	3.91	6.23	7.66
	1:05:00	0.00	0.00	0.54	1.44	1.30	2.66	3.39	5.60	6.90
	1:10:00	0.00	0.00	0.45	1.23	1.14	2.16	2.78	4.47	5.52
	1:15:00	0.00	0.37	0.59	0.99	0.79	1.73	2.25	3.51	4.36
	1:20:00	0.00	0.00	0.30	0.76	0.79	1.30	1.68	2.51	3.12
	1:25:00	0.00	0.00	0.26	0.63	0.63	0.94	1.22	1.74	2.18
	1:30:00	0.00	0.00	0.23	0.56	0.53	0.70	0.91	1.27	1.60
	1:35:00	0.00	0.32	0.22	0.52	0.47	0.55	0.77	1.24	1.24
	1:40:00	0.00	0.00	0.21	0.45	0.43	0.46	0.60	0.79	1.00
	1:45:00	0.00	0.00	0.21	0.39	0.40	0.39	0.52	0.65	0.83
	1:50:00	0.00	0.00	0.21	0.35	0.38	0.36	0.47	0.56	0.72
	1:55:00	0.00	0.00	0.18	0.32	0.35	0.33	0.43	0.50	0.64
	2:00:00	0.00	0.00	0.16	0.29	0.31	0.31	0.40	0.46	0.59
	2:05:00	0.00	0.00	0.12	0.21	0.22	0.23	0.29	0.33	0.43
	2:10:00	0.00	0.00	0.09	0.15	0.16	0.16	0.21	0.24	0.31
	2:15:00	0.00	0.11	0.06	0.11	0.11	0.11	0.15	0.17	0.22
	2:20:00	0.00	0.00	0.04	0.08	0.08	0.08	0.11	0.12	0.16
	2:25:00	0.00	0.00	0.03	0.05	0.05	0.06	0.06	0.07	0.08
	2:30:00	0.00	0.00	0.02	0.03	0.04	0.04	0.05	0.05	0.11
	2:35:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.04	0.05
	2:40:00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03
	2:45:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically. The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

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

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

NE Pond STAGE STORAGE TABLE

AVG END

AVG END

TOTAL

VOL.

AREA

DEPTH

INC. VOL.

ELEV	Vol (ac-ft)	(cu. ft.)	Stage (ft)	(sq. ft.)	(ft)	(cu. ft.)
6,439.00	0.000	0	0.00	801	N/A	N/A
6,439.10	0.002	82	0.10	841	0.1	82
6,439.20	0.004	168	0.20	886	0.1	86
6,439.30	0.006	260	0.30	935	0.1	91
6,439.40	0.008	356	0.40	991	0.1	96
6,439.50	0.011	458	0.50	1050	0.1	102
6,439.60	0.013	566	0.60	1109	0.1	108
6,439.70	0.016	680	0.70	1167	0.1	114
6,439.80	0.018	799	0.80	1226	0.1	120
6,439.90	0.021	925	0.90	1284	0.1	125
6,440.00	0.024	1056	1.00	1341	0.1	131
6,440.10	0.027	1193	1.10	1396	0.1	137
6,440.20	0.031	1335	1.20	1451	0.1	142
6,440.30	0.034	1483	1.30	1507	0.1	148
6,440.40	0.038	1637	1.40	1564	0.1	154
6,440.50	0.041	1796	1.50	1621	0.1	159
6,440.60	0.045	1961	1.60	1680	0.1	165
6,440.70	0.049	2132	1.70	1742	0.1	171
6,440.80	0.053	2310	1.80	1807	0.1	177
6,440.90	0.057	2494	1.90	1875	0.1	184 WQCV @ 1.89
6,441.00	0.062	2685	2.00	1950	0.1	191
6,441.10	0.066	2884	2.10	2027	0.1	199
6,441.20	0.071	3090	2.20	2103	0.1	207
6,441.30	0.076	3304	2.30	2179	0.1	214
6,441.40	0.081	3526	2.40	2254	0.1	222
6,441.50	0.086	3755	2.50	2332	0.1	229
6,441.60	0.092	3993	2.60	2415	0.1	237
6,441.70	0.097	4238	2.70	2500	0.1	246
6,441.80	0.103	4493	2.80	2582	0.1	254
6,441.90	0.109	4755	2.90	2665	0.1	262
6,442.00	0.115	5026	3.00	2749	0.1	271
6,442.10	0.122	5305	3.10	2833	0.1	279
6,442.20	0.128	5592	3.20	2919	0.1	288
6,442.30	0.135	5888	3.30	3005	0.1	296 EURV Volume at 3.33
6,442.40	0.142	6193	3.40	3093	0.1	305
6,442.50	0.149	6507	3.50	3182	0.1	314
6,442.60	0.157	6830	3.60	3271	0.1	323
6,442.70	0.164	7161	3.70	3360	0.1	332
6,442.80	0.172	7502	3.80	3450	0.1	341
6,442.90	0.180	7851	3.90	3540	0.1	349
6,443.00	0.188	8210	4.00	3631	0.1	359
6,443.10	0.197	8578	4.10	3723	0.1	368
6,443.20	0.206	8955	4.20	3815	0.1	377
6,443.30	0.214	9341	4.30	3910	0.1	386

6,443.40	0.224	9737	4.40	4006	0.1	396
6,443.50	0.233	10142	4.50	4104	0.1	406
6,443.60	0.242	10557	4.60	4203	0.1	415
6,443.70	0.252	10983	4.70	4304	0.1	425
6,443.80	0.262	11418	4.80	4406	0.1	435 Top of plate/conc bot of 100yr weir
6,443.90	0.272	11864	4.90	4510	0.1	446
6,444.00	0.283	12320	5.00	4616	0.1	456
6,444.10	0.294	12787	5.10	4723	0.1	467
6,444.20	0.305	13265	5.20	4833	0.1	478
6,444.30	0.316	13754	5.30	4946	0.1	489
6,444.36	0.323	14052	5.36	5000	0.06	298 Max Ponding Depth (100yr @5.36)
6,444.40	0.327	14254	5.40	5060	0.1	500
6,444.50	0.339	14766	5.50	5177	0.1	512 500yr @ 5.49
6,444.60	0.351	15290	5.60	5296	0.1	524
6,444.70	0.363	15826	5.70	5419	0.1	536
6,444.80	0.376	16374	5.80	5544	0.1	548 Top of box @ 5.80
6,444.90	0.389	16934	5.90	5670	0.1	561 Spillway Invert @ 5.86
6,445.00	0.402	17509	6.00	5821	0.1	575
6,445.10	0.416	18142	6.10	6849	0.1	633
6,445.20	0.433	18882	6.20	7947	0.1	740
6,445.30	0.453	19735	6.30	9115	0.1	853
6,445.36	0.466	20305	6.36	9883	0.06	570 Top of Berm
6,445.50			6.50	11677		Extrapolation for UD Detention

Weir Report

NE Pond Emergency Overflow

Trapezoidal Weir

Crest	= Sharp
Bottom Length (ft)	= 18.00
Total Depth (ft)	= 0.50
Side Slope (z:1)	= 4.00

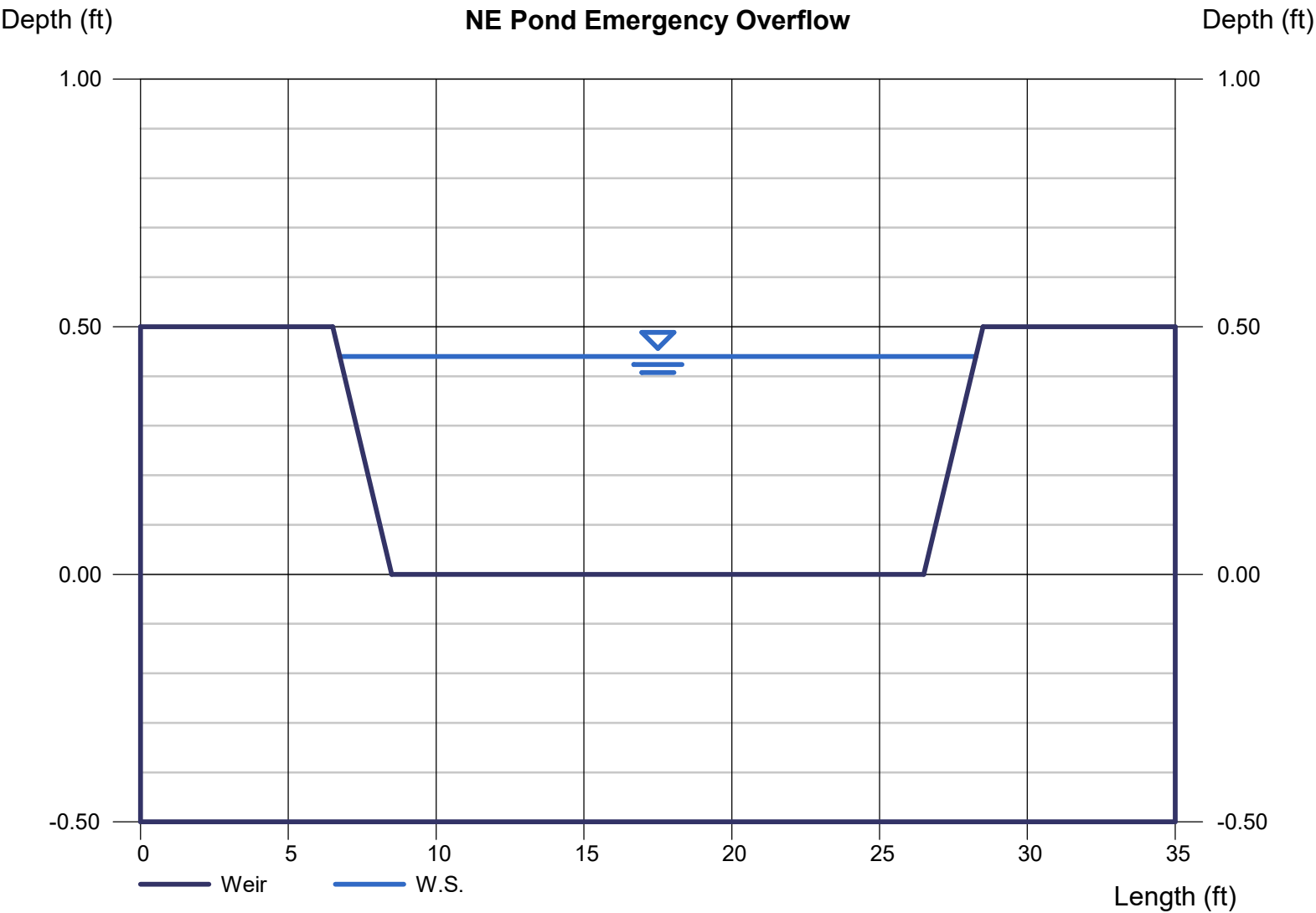
Highlighted

Depth (ft)	= 0.44
Q (cfs)	= 17.10
Area (sqft)	= 8.69
Velocity (ft/s)	= 1.97
Top Width (ft)	= 21.52

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 17.10

Note: This calculation is for the emergency overflow at the SE corner of Pond NW.

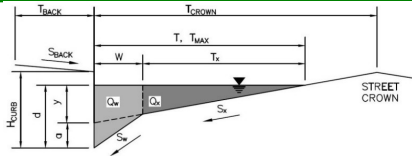


ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: CVR 14 Amendment 1

Inlet ID: NE Pnd Emgc in Loon Ln

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK} =$	6.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.012	

$H_{CURB} =$	4.00	inches
$T_{CROWN} =$	16.0	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.037	ft/ft
$n_{STREET} =$	0.012	

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	16.0	16.0	ft
$d_{MAX} =$	4.0	4.9	inches
	☐	☐	

Maximum Capacity for 1/2 Street based On Allowable SpreadWater Depth without Gutter Depression ($T * S_x * 12$)Vertical Depth between Gutter Lip and Gutter Flowline ($W * S_w * 12$)Gutter Depression ($d_c - (W * S_x * 12)$)Water Depth at Gutter Flowline ($y + a$)Allowable Spread for Discharge outside the Gutter Section ($T - W$)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)

Discharge outside the Gutter Section, carried in Section T_x Discharge within the Gutter Section ($Q_T - Q_x - Q_{BACK}$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

 $V*d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
$y =$	3.84	3.84	inches
$d_c =$	2.0	2.0	inches
$a =$	1.51	1.51	inches
$d =$	5.35	5.35	inches
$T_x =$	14.0	14.0	ft
$E_o =$	0.372	0.372	
$Q_x =$	15.1	15.1	cfs
$Q_w =$	9.0	9.0	cfs
$Q_{BACK} =$	1.3	1.3	cfs
$Q_T =$	25.5	25.5	cfs
$V =$	12.4	12.4	fps
$V*d =$	5.5	5.5	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section ($T - W$)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)

Theoretical Discharge outside the Gutter Section, carried in Section T_{XTH} Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})Discharge within the Gutter Section ($Q_d - Q_x$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

 $V*d$ Product: Flow Velocity Times Gutter Flowline DepthSlope-Based Safety Factor for Minor/Major Storm depth reduction, $d \geq 6"$

Max Flow based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
$T_{TH} =$	10.4	14.1	ft
$T_{XTH} =$	8.4	12.1	ft
$E_o =$	0.560	0.421	
$Q_{XTH} =$	3.8	10.3	cfs
$Q_x =$	3.8	10.3	cfs
$Q_w =$	4.9	7.5	cfs
$Q_{BACK} =$	0.0	0.5	cfs
$Q =$	8.7	18.2	cfs
$V =$	9.8	11.5	fps
$V*d =$	3.3	4.7	
$R =$	1.00	1.00	
$Q_d =$	8.7	18.2	cfs
$d =$	4.00	4.90	inches
$d_{CROWN} =$	0.00	0.00	inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	8.7	18.2	cfs

Major storm max. allowable capacity GOOD - greater than the design peak flow of 17.10 cfs on sheet 'Inlet Management'

Weir Report

NE Pond Emergency Overflow in CVR15 at East End of Loon Cir

Trapezoidal Weir

Crest = Sharp
Bottom Length (ft) = 20.00
Total Depth (ft) = 1.00
Side Slope (z:1) = 4.00

Highlighted

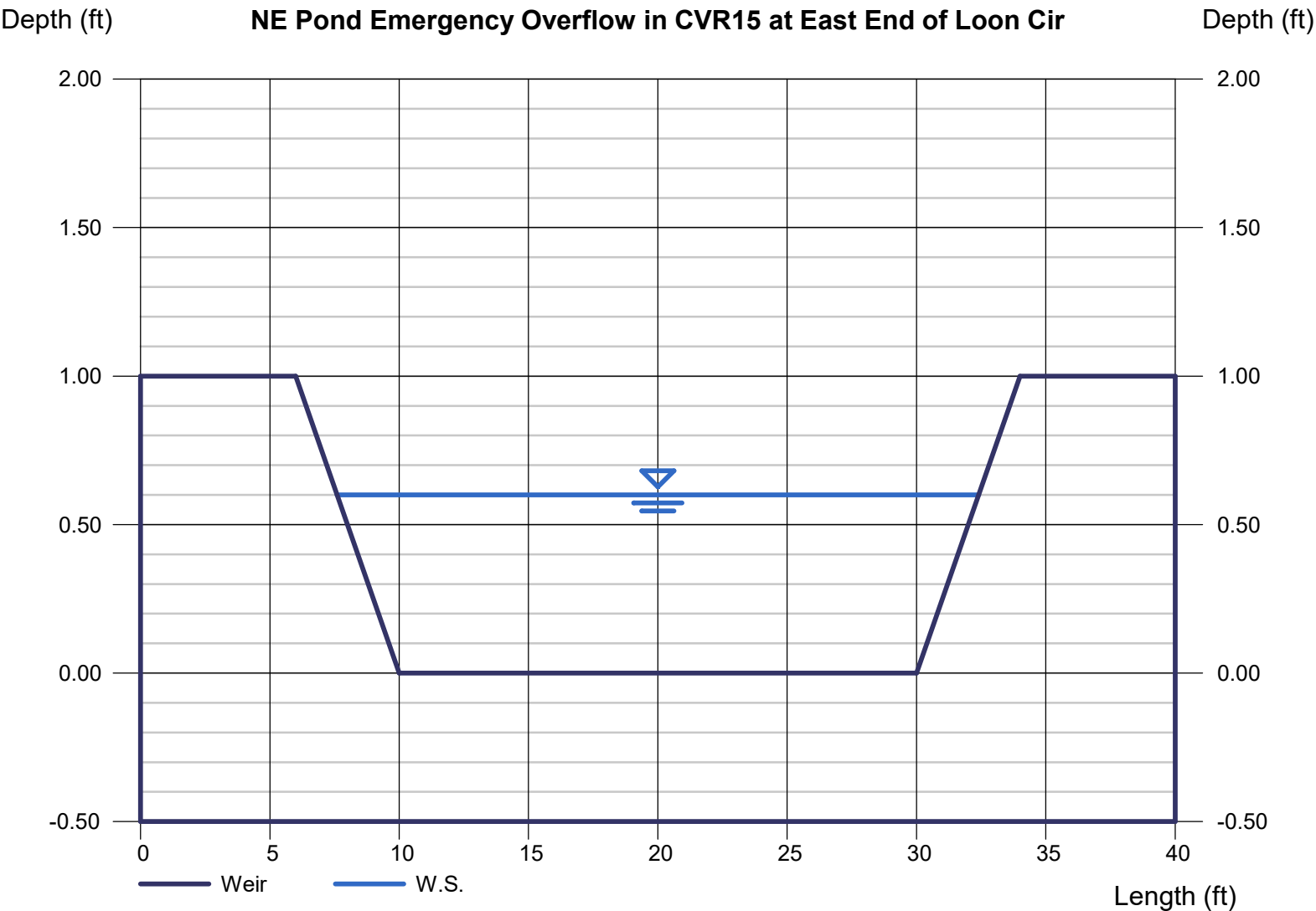
Depth (ft) = 0.60
Q (cfs) = 31.30
Area (sqft) = 13.44
Velocity (ft/s) = 2.33
Top Width (ft) = 24.80

Calculations

Weir Coeff. Cw = 3.10
Compute by: Known Q
Known Q (cfs) = 31.30

Tract throat opening is 25.6'

17.1cfs from NE
Pond, 14.2cfs from
Basin B in CVR14.



APPENDIX E –

March 2016 FIRM

NOTES TO USERS

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

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

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

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1998 or later.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Based on updated topographic information, this map reflects more detailed and up-to-date stream channel configurations and floodplain delineations than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

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

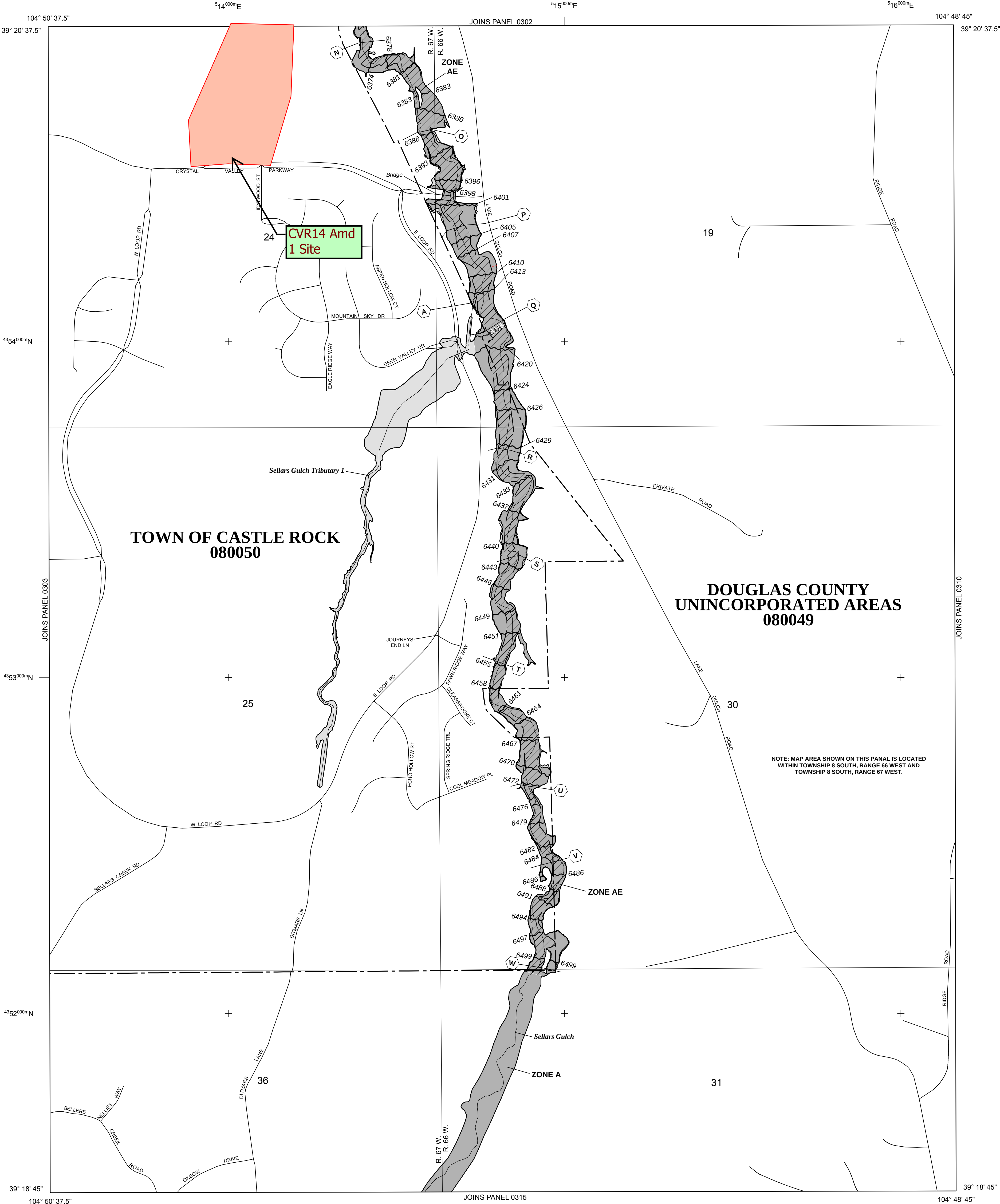
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which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

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/business/nfp>.

NOTICE TO MAP USERS

FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period or at the final Consultation Coordination Officer's meeting. Approved requests for changes will be shown on the final printed FIRM.



LEGEND

- SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**
- The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.
- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently described. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.
- FLOODWAY AREAS IN ZONE AE**

- The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.
- OTHER FLOOD AREAS**
- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- OTHER AREAS**
- ZONE D** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.
- COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
- OTHERWISE PROTECTED AREAS (OPAs)**

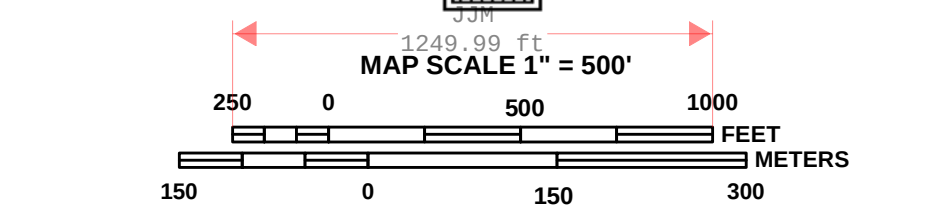
- CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.
- 1% Annual Chance Floodplain Boundary
- 0.2% Annual Chance Floodplain Boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

- *Referenced to the North American Vertical Datum of 1988
- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 1000-meter Universal Transverse Mercator grid values, zone 13
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- River Mile

- MAP REPOSITORIES
- Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0304G

FIRM

FLOOD INSURANCE RATE MAP

DOUGLAS COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 304 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUEFIX
CASTLE ROCK, TOWN OF	080050	0304	G
DOUGLAS COUNTY	080049	0304	G

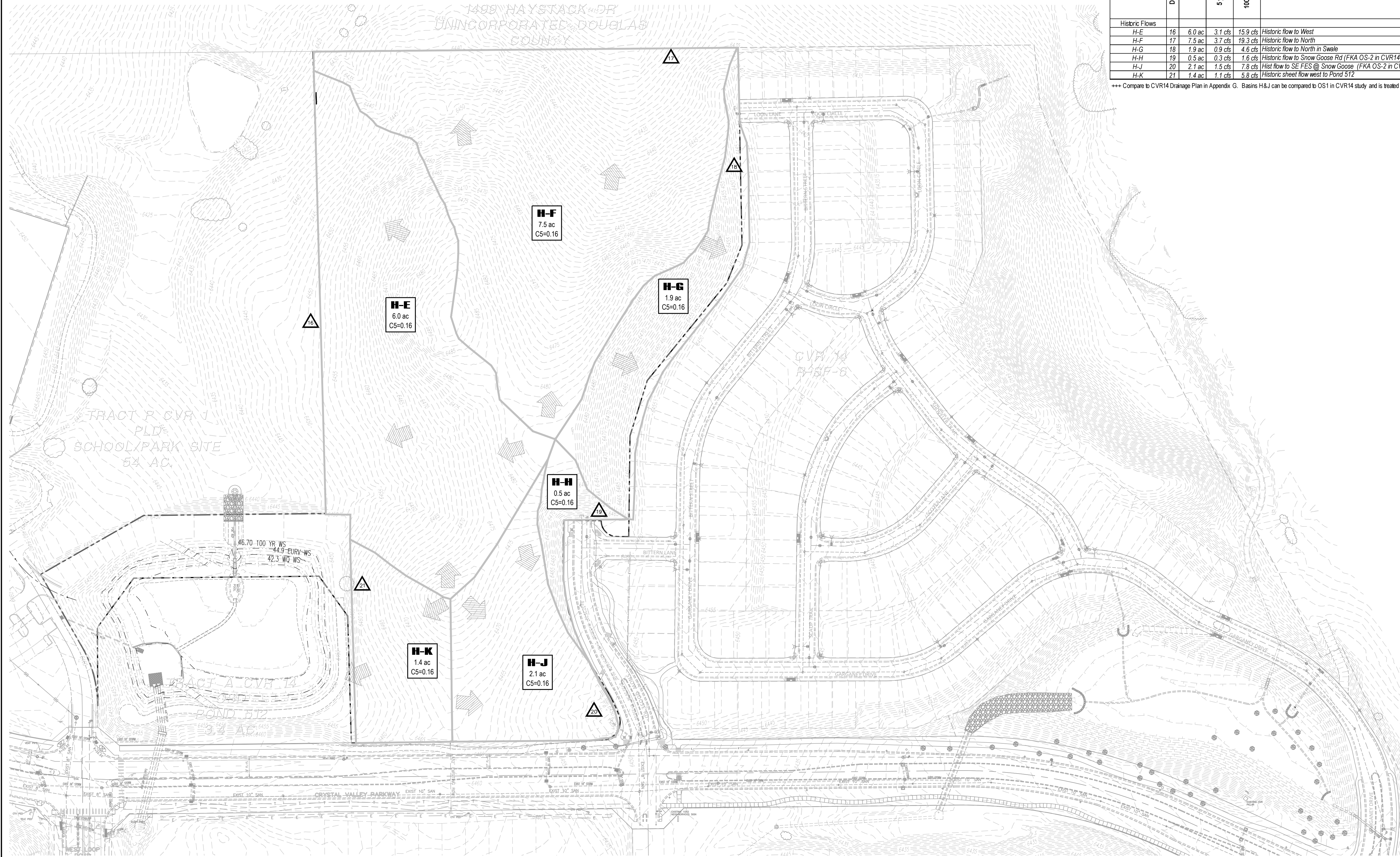
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08035C0304G

MAP REVISED
March 16, 2016

Federal Emergency Management Agency

C:\Users\lun\OneDrive\Documents\Legacy\CV\CV14\CV14.dwg, E:\Plan 100d, 6/20/2026 11:13:28 AM, 1:1



CVR14 Amd 1 - Runoff Summary

6/23/2026 13:10

Basin ID	Design Point	Area	5 year Runoff	100 year Runoff	Remarks
Historic Flows					
H-E	16	6.0 ac	3.1 cfs	15.9 cfs	Historic flow to West
H-F	17	7.5 ac	3.7 cfs	19.3 cfs	Historic flow to North
H-G	18	1.9 ac	0.9 cfs	4.6 cfs	Historic flow to North in Swale
H-H	19	0.5 ac	0.3 cfs	1.6 cfs	Historic flow to Snow Goose Rd (FKA OS-2 in CVR14)+++
H-I	20	2.1 ac	1.5 cfs	7.8 cfs	Hist flow to SE FES @ Snow Goose (FKA OS-2 in CVR14)+++
H-J	21	1.4 ac	1.1 cfs	5.8 cfs	Historic sheet flow west to Pond 512

+++ Compare to CVR14 Drainage Plan in Appendix G. Basins H&J can be compared to OS1 in CVR14 study and is treated at Pond 512

- LEGEND**
- DESIGN POINT
 - SUB BASIN DESIGNATION
AREA IN ACRES
RUNOFF COEFFICIENT
 - PROPOSED STORM SEWER
 - EXISTING STORM SEWER
 - HP HIGH POINT
 - BASIN FLOW ORIGIN
 - FLOW DIRECTION
 - BASIN BOUNDARY LINE

CVR FILING 14 Amd 1

**Phase II
Drainage Plan
(HISTORIC)**



JOB NO. <JOB NUMBER>

SCALE
HORIZONTAL
1" = 100'

VERTICAL
N/A

REVISIONS		DATE	BY
NO	DESCRIPTION		

DESIGNED BY:
JIM

DRAWN BY:
JIM

CHECKED BY:
JIM

APPROVED BY:
JIM

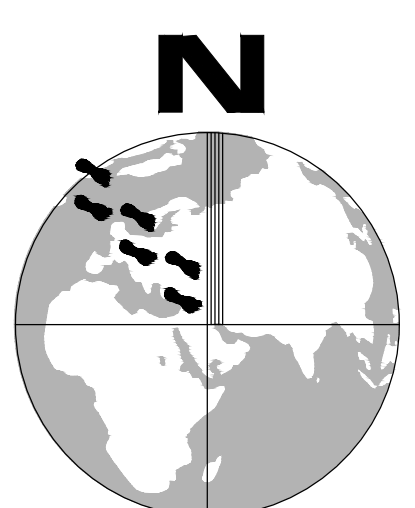


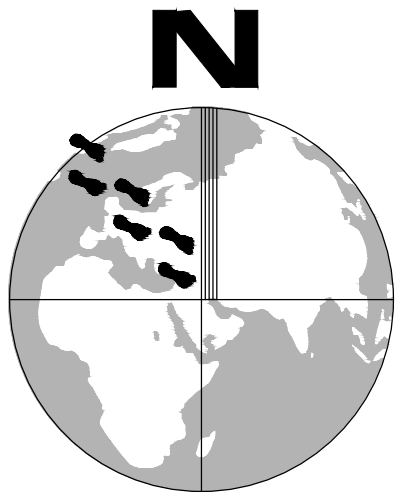
REUSE OF DOCUMENT

THE IDEAS AND DESIGN INFORMATION HEREON ARE THE PROPERTY OF LEGACY CONSULTING ENGINEERS, INC. AND ARE NOT TO BE USED FOR ANY OTHER PROJECT WITHOUT WRITTEN AUTHORIZATION OF LEGACY CONSULTING ENGINEERS, INC.

SCALE VERIFICATION
BAR IS 1" ON ORIGINAL
0 1"
IF NOT ONE INCH ON THIS SHEET,
ADJUST SCALES ACCORDINGLY

FOR BURIED UTILITY INFORMATION
48 HOURS BEFORE YOU DIG
CALL 1-800-922-1987
FOR LOCATING AND MARKING GAS,
ELECTRIC, TELEPHONE, CABLE TV, ETC.



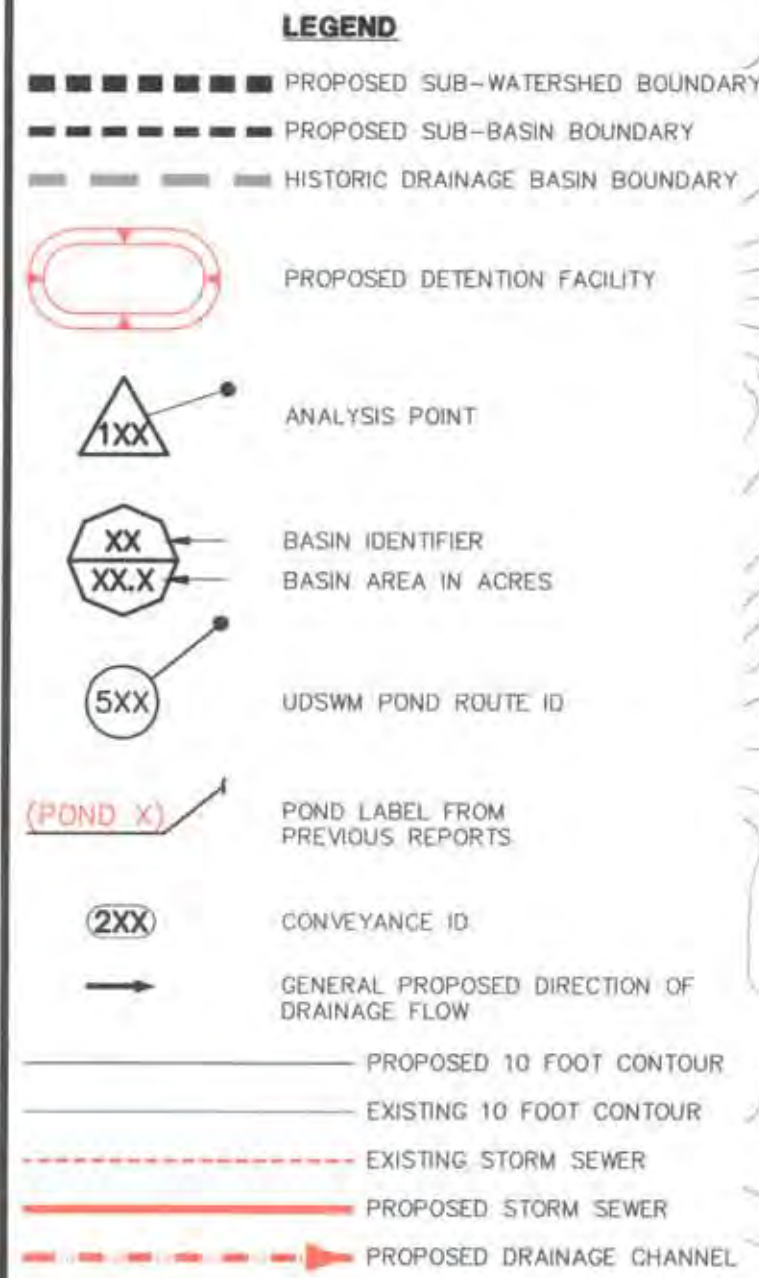


Basin ID	Design Point	Area	5 year Runoff	100 year Runoff	Remarks
A.1.1.1	6	2.3 ac	3.5 cfs	8.9 cfs	Road Capacity Check + Inlet A1.3
A.1.1.2	8	2.2 ac	3.7 cfs	9.1 cfs	Road Capacity Check
A.1.1.2.1	7	1.1 ac	2.0 cfs	5.0 cfs	Road Capacity Check + Inlet A1.2
A.1.1.2.2	8	1.1 ac	2.5 cfs	6.2 cfs	Road Capacity Check
A.1.1.1 + A.1.1.2.1	7	3.4 ac	5.9 cfs	13.0 cfs	Peak minus interpolated @ Inlet A1.2 (compare)
A.1.1	9	4.5 ac	6.1 cfs	15.4 cfs	Flow from south gutter @ inlet A1.1
A.1.2	9	0.1 ac	0.5 cfs	1.1 cfs	Flow from north gutter @ inlet A1.1
A.1	9	4.6 ac	6.4 cfs	16.0 cfs	Peak minus interpolated @ Inlet A1.1 (sump)
A.2.1	10	1.9 ac	3.7 cfs	8.0 cfs	Road Capacity Check + Inlet A2.2 & A2.1 A
A.2.2	10	2.0 ac	4.1 cfs	9.4 cfs	Road Capacity Check
A.2	10	3.9 ac	7.2 cfs	19.2 cfs	Peak minus interpolated @ Inlet A2.1 (sump)
A	11	8.5 ac	13.0 cfs	30.8 cfs	Sump Inlet A2.1 + A1.1 - flow into Pond 512
B.3	22	17.2 ac	3.0 cfs	7.8 cfs	Sump Inlet B.3
B.3+G.F.1	22	40.4 ac	6.4 cfs	17.1 cfs	Total flow to NE Pond
C.1	5	2.0 ac	3.6 cfs	8.9 cfs	Sump Inlet C.1
C.2	4	0.9 ac	2.2 cfs	5.0 cfs	Sump Inlet C.2
C	3	2.9 ac	5.4 cfs	13.1 cfs	Total Flow in Storm Line C
D.1	12	0.7 ac	2.3 cfs	4.8 cfs	Sump Inlet D.1
D.2	13	0.3 ac	1.3 cfs	2.6 cfs	Sump Inlet D.2
D	14	1.1 ac	3.5 cfs	7.3 cfs	Total Flow in Storm Line D
E	18	1.0 ac	2.0 cfs	5.4 cfs	Proposed sheet flow to West
F 1 or F 2	17	0.6 ac	2.0 cfs	3.3 cfs	Rear Yard flow to either NW or NE Pond
G	18	1.7 ac	1.2 cfs	6.4 cfs	Proposed sheet flow to North in Swale
H	19	0.5 ac	1.1 cfs	2.7 cfs	Proposed flow to Snow Goose Rd
J	20	0.8 ac	1.2 cfs	3.7 cfs	Proposed flow to SE FES @ Snow Goose Rd
K	21	0.4 ac	0.5 cfs	1.8 cfs	Proposed sheet flow west to Pond 512

BASIN BOUNDARY LINE



APPENDIX G – Reference Materials



GENERAL NOTES

1. FUTURE STORM SEWERS SHOWN ON THIS PLAN ARE ONLY INTENDED TO INDICATE GENERAL LOCATIONS AND APPROXIMATE SIZES OF FUTURE FACILITIES. ACTUAL STORM SEWER SIZES AND LOCATIONS SHALL BE DETERMINED WITH MORE DETAILED ANALYSIS AT THE TIME OF DETAILED DESIGN OF FACILITIES. IT IS LIKELY THAT ADDITIONAL FACILITIES NOT SHOWN ON THIS PLAN WILL BE REQUIRED.

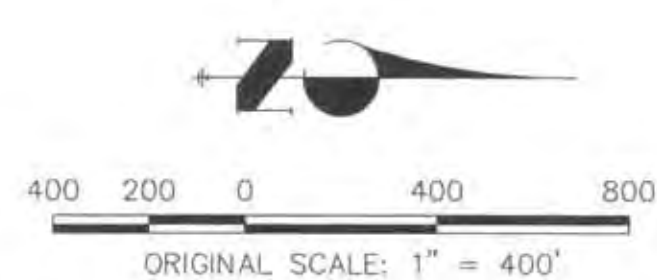
2. PROPOSED DETENTION PONDS SHOWN ON THIS PLAN ARE ONLY INTENDED TO INDICATE GENERAL LOCATIONS AND LAND AREA REQUIRED FOR THESE FACILITIES. ACTUAL LOCATION AND LAND AREA REQUIRED SHALL BE DETERMINED AT THE TIME OF DETAILED DESIGN OF THE FACILITIES.

3. EXCEPT AS OTHERWISE NOTED, THIS PLAN SHALL NOT MODIFY THE REQUIREMENTS OF PREVIOUSLY APPROVED MASTER DEVELOPMENT DRAINAGE PLANS AND FINAL DRAINAGE REPORTS.

SUB-BASIN DATA COMPARISON SUMMARY									
Updated Master Drainage Report									
Basin I.D.	Area (acres)	T _c (minutes)	Impervious Area (%)	C ₁₀₀	Q _s	Q ₁₀₀	Peak Runoff (cfs)	Q ₁₀₀	Q ₁₀₀
1	2,326.0	NA	2	0.43	334	558	2,068		
2	2,235.0	NA	2	0.46	305	497	1,743		
3	421.0	NA	2	0.46	88	137	461		
4	416.0	NA	2	0.47	126	190	616		
5	221.0	NA	2	0.49	71	106	328		
6	214.0	NA	2	0.50	53	79	249		
7	264.0	NA	2	0.48	59	90	298		
21	93.9	35.6	18	0.50	50	66	169		
31	107.8	28.2	26	0.56	88	112	255		
41	81.8	23.5	24	0.48	52	69	183		
42									
43	95.5	22.0	24	0.53	84	109	251		
44	21.6	17.8	6	0.42	12	17	50		
45	31.7	20.9	45	0.53	32	40	100		
46	11.0	13.4	36	0.54	14	17	37		
47	33.1	16.7	38	0.49	33	41	92		
48	25.4	18.2	32	0.53	25	32	72		
49	11.7	16.1	35	0.52	12	16	35		
50	38.0	21.8	25	0.46	25	33	85		
51	42.3	17.5	42	0.58	53	65	133		
52	28.7	17.1	53	0.57	38	46	91		
53	42.0	17.1	26	0.55	45	58	129		
54	25.6	16.5	28	0.51	25	32	74		
55	11.8	18.3	40	0.58	15	18	37		
56	20.3	14.2	38	0.56	27	33	69		
57	15.1	11.5	70	0.68	32	38	68		
58	13.9	13.3	19	0.55	16	21	46		
59	53.2	17.6	41	0.58	68	83	171		
60	23.3	16.0	18	0.55	24	32	74		
61	22.9	14.8	41	0.58	35	43	82		
62	44.2	18.0	30	0.56	49	62	136		
63	49.4	14.4	29	0.57	61	78	169		
64	24.2	12.9	30	0.54	29	38	83		
70	16.3	14.7	23	0.53	17	23	52		
71	15.3	16.3	47	0.58	20	25	50		
72	21.5	13.2	49	0.60	35	42	82		
73	26.5	12.0	73	0.69	57	67	119		
74	32.5	17.2	42	0.59	43	53	107		
75	22.4	17.5	43	0.59	54	36	73		
76	32.3	16.9	65	0.65	29	64	118		
77	24.0	18.5	13	0.53	20	28	68		
81	62.0	18.5	33	0.54	64	81	177		
82	42.2	13.8	48	0.60	64	78	153		
83	119.2	30.6	3	0.51	45	62	174		
90	441.0	NA	2	0.51	140	198	571		

ANALYSIS POINT DATA COMPARISON SUMMARY									
Updated Master Drainage Report									
Analysis Point	Watershed (acres)	Q _s	Q ₁₀₀	Peak Runoff (cfs)	Q _s	Q ₁₀₀	Peak Runoff (cfs)	Q _s	Q ₁₀₀
101	2,326	334	558	2,068					
102	4,561	339	694	3,210					
103	4,655	356	709	3,271					
104	5,076	370	749	3,490					
105	5,184	385	766	3,539					
106	5,600	409	806	3,756					
107	6,371	463	892	4,213					
108	6,592	471	909	4,320					
109	6,783	507	958	4,433					
110	6,997	523	985	4,566					
111	7,116	552	1,027	4,722					
112	7,380	559	1,046	4,830					
113	7,821	596	1,107	5,102					
121	177	96	124	288					
130	53	41	50	130					
131	188	89	106	179					
132	242	123	146	269					
133	33	47	55	92					
134	70	66	82	166					
135	70	76	98	202					
136	312	186	230	450					
140	354	207	259	532					
141	71	90	112	224					
142	425	292	361	745					
143	469	300	377	826					
144	492	325	407	891					
150	68	70	90	203					
151	71	90	112	224					
152	35	53	71	138					
153	115	141	180	378					
154	129	15	200	425					
155	182	218	279	589					
156	205	243	306	657					
157	747	579	731	1,623					
158	771	56	89	507					
170	16	17	23	52					
171	32	36	46	102					
172	53	70	88	183					
173	112	109	131	230					
174	167	191	231	421					
175	191	39	51	135					
180	104	127	159	332					

REGIONAL DETENTION POND DATA COMPARISON SUMMARY											
Updated Master Drainage Report											
Detention Pond ID	Watershed Area (acres)	Q _s	Q ₁₀₀	Q ₁₀₀	Q ₁₀₀	Q ₁₀₀	Q ₁₀₀	Q ₁₀₀	Q ₁₀₀	Q ₁₀₀	Q ₁₀₀
505	82	52	69	183	27	37	70	1.0	1.5	5.9	NA
506	177	96	124	288	77	94	166	0.8	1.3	7.0	NA
507	22	12	17	50	10	12	20	0.1	0.2	1.4	NA
509 (B9)	747	579	731	1,623	52	87	500	31.6	41.9	75.5	12.4
510 (11a)	53	70	88	183	27	33	80	1.6	2.0	5.0	NA
511 (11b)	167	191	231	421	36	49	110	7.5	9.3	18.4	3.5
512	104	127	159	332	19	29	102	4.3	5.5	11.6	2.1



PHASE III DRAINAGE STUDY
FOR
CRYSTAL VALLEY RANCH

FILING NO. 14

(CD14-0025)

Castle Rock, Colorado

Friday, November 07, 2014

(Revised: Friday, December 12, 2014)

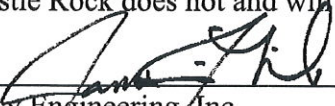
PREPARED FOR
CRYSTAL VALLEY RANCH
1175 Crystal Valley Parkway
Castle Rock Co 80104-9624
(303) 814-6862
Attn: Gregory W. Brown

PREPARED BY
Legacy Engineering, Inc.
1626 Thatch Circle
Castle Rock, Colorado 80109
(720) 200-4577

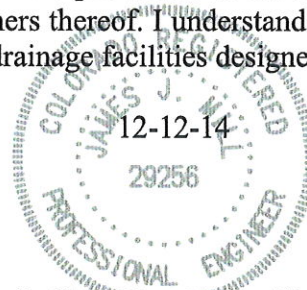
PHASE III DRAINAGE STUDY FOR CVR – Filing No. 14
Castle Rock, Colorado - December 15, 2014

ENGINEER'S STATEMENT:

I affirm that this report and plan for the Phase III drainage design of CVR Filing 14 was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Castle Rock Drainage Design and Technical Criteria for the owners thereof. I understand that the Town of Castle Rock does not and will not assume liability for drainage facilities designed by others.

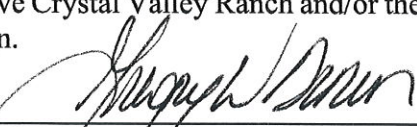


Legacy Engineering, Inc.
James J. Mill, P.E. (Colorado PE #29256)



OWNER/DEVELOPER'S STATEMENT

Crystal Valley Ranch hereby certifies that the drainage facilities for CVR Filing 14 shall be constructed according to the design presented in this report. I understand that the Town of Castle Rock does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the Town of Castle Rock reviews drainage plans pursuant to the Municipal Code; but cannot, on behalf of CVR Filing 14, guarantee that final drainage design review will absolve Crystal Valley Ranch and/or their successors and/or assigns of future liability for improper design.



Crystal Valley Ranch
Gregory W. Brown

12-15-14
Date

TOWN OF CASTLE ROCK APPROVALS:



Engineering Division

Approved
Development Services

1/13/15
Date



Development Services Director

JAN 13 2015

1/13/15
Date

Town of Castle Rock

PHASE III DRAINAGE STUDY FOR CVR – Filing No. 14
Castle Rock, Colorado - December 12, 2014

TABLE OF CONTENTS

		<u>Page</u>
I.	GENERAL LOCATION AND DESCRIPTION	
A.	Location.....	4
B.	Description of Property.....	4
C.	Irrigation Facilities.....	4
D.	Land Use.....	4
II.	DRAINAGE BASINS AND SUB-BASINS	
A.	Historic Drainage Patterns.....	5
B.	Major Basin Description.....	5
C.	Sub-Basin Description.....	6
III.	DRAINAGE DESIGN CRITERIA	
A.	Regulations.....	7
B.	Development Criteria Reference and Constraints.....	7
C.	Hydrological Criteria.....	7
D.	Hydraulic Criteria.....	7
E.	Sediment & Erosion Control.....	8
IV.	DRAINAGE FACILITY DESIGN	
A.	General Concept.....	8
V.	STORMWATER MANAGEMENT PLAN.....	9
VI.	CONCLUSIONS	
A.	Compliance with Standards.....	12
B.	Drainage Concept.....	12
C.	Summary.....	12
VII.	REFERENCES.....	13

<u>Figure</u>	<u>Description</u>
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APPENDIX A - PROJECT INFORMATION

1	Vicinity Map
2	SCS Soils Map and Soil Properties.
2a	Firmette Map

APPENDIX B - HYDROLOGY

3	Design Point Rainfall Values
4	Time-Intensity-Frequency Zones
5	Composite “I” and “C” Calculations
6	Average Flow Velocities
7	Time of Concentration, Rational Method Calculation Sheet, 5&10 Year

APPENDIX C - HYDRAULICS

8	ToCR Road Capacity and Inlet Capacity Nomographs
9	Preliminary Storm Capacity Calculations

APPENDIX D – DETENTION – STORM & WATER QUALITY

10	WQ Pond Calculations
----	----------------------

Drainage Plan

CVR Filing No. 14

12/23/2014

CALC. BY: JJM

MINIMUM DETENTION VOLUMES

CHKED BY: JJM

Using Simplified Formula Method (V=kA)

Basin	Description	AREA	SOIL TYPE	100YR REL.	10 yr REL.	Weighted Basin Imperviousness	K	K	Volume	Volume	Q-REL.	Q-REL.	WQCV Inches	WQCV Volume	Total Min Volume
				FAC.	FAC.		100 YEAR	10 YEAR	100 YEAR	10 YEAR	100 YEAR	10 YEAR		(x1.0)	100 YEAR + WQCV
B	North End of PA3 trib NE	3.4 acres	C	1.00 cfs/ac	0.30 cfs/ac	57	0.0914	0.0523	0.31 ac-ft	0.18 ac-ft	3.4 cfs	1.0 cfs	0.23 inch	0.065 ac-ft	0.38 ac-ft

3.4 acres

Map Symbol	Soil Series		Soil Type	Site Impact
KtE	Kutch sandy loam		C	85%
Su	Stony rough land		D	15%

$$K_{10} = \frac{(0.95I - 1.90)}{1,000}$$

$$K_{100} = \frac{(1.78I - 0.002I^2 - 3.56)}{900}$$

$$WQCV \text{ Inches} = x = a(0.91I^3 - 1.19I^2 + 0.78I)$$

a= 1.0 (40 hr drain time)

2839 cf WQCV only

Note: This calculation is for the WQCV of the NorthEast water quality detention pond. Storm detention is handled by Regional Detention Pond 511 on site.

Figure 10.1

North East water quality pond, WQCV calculation and Outlet Structure Design

Based on the UDFCD stormwater criteria Volume III, the WQCV volume and orifice plate opening for the North-East water quality pond can be calculated, and presented as follows:

Given: Tributary area of sub-basin B=3.5 acres, impervious rate=57%, and allow drains time is set to be 40 hrs.

The WQCV is calculated as a function of imperviousness and BMP drain time using Equation 3-1, and as shown in Figure 3-2:

$$WQCV = a(0.91I^3 - 1.19I^2 + 0.78I) \quad \text{Equation 3-1}$$

Where:

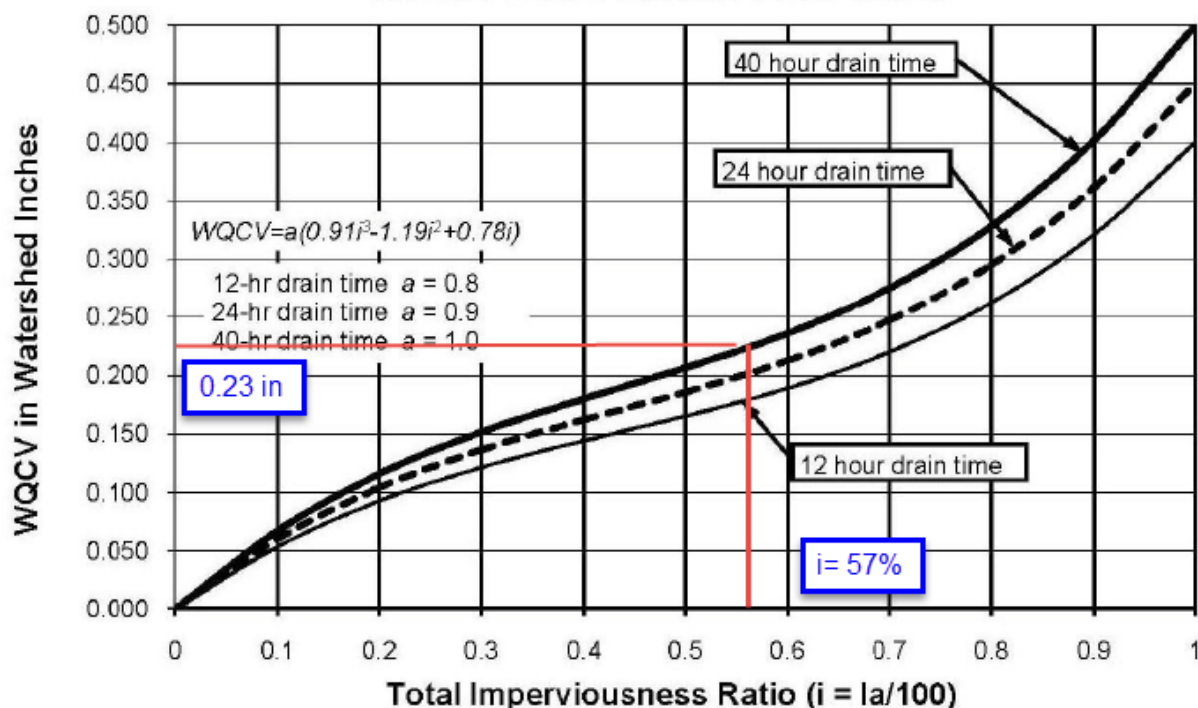
WQCV = Water Quality Capture Volume (watershed inches)

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

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

Table 3-2. Drain Time Coefficients for WQCV Calculations

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



For a 40 hr. drain time and a WQCV depth of 0.23 inch, the total volume can be calculated as:

$$V = \left(\frac{\text{WQCV}}{12} \right) A$$

The tributary area is 3.4 acres, therefore the total volume = $0.23/12 * 3.4 * 43560 = 2839 \text{ cu-ft}$.

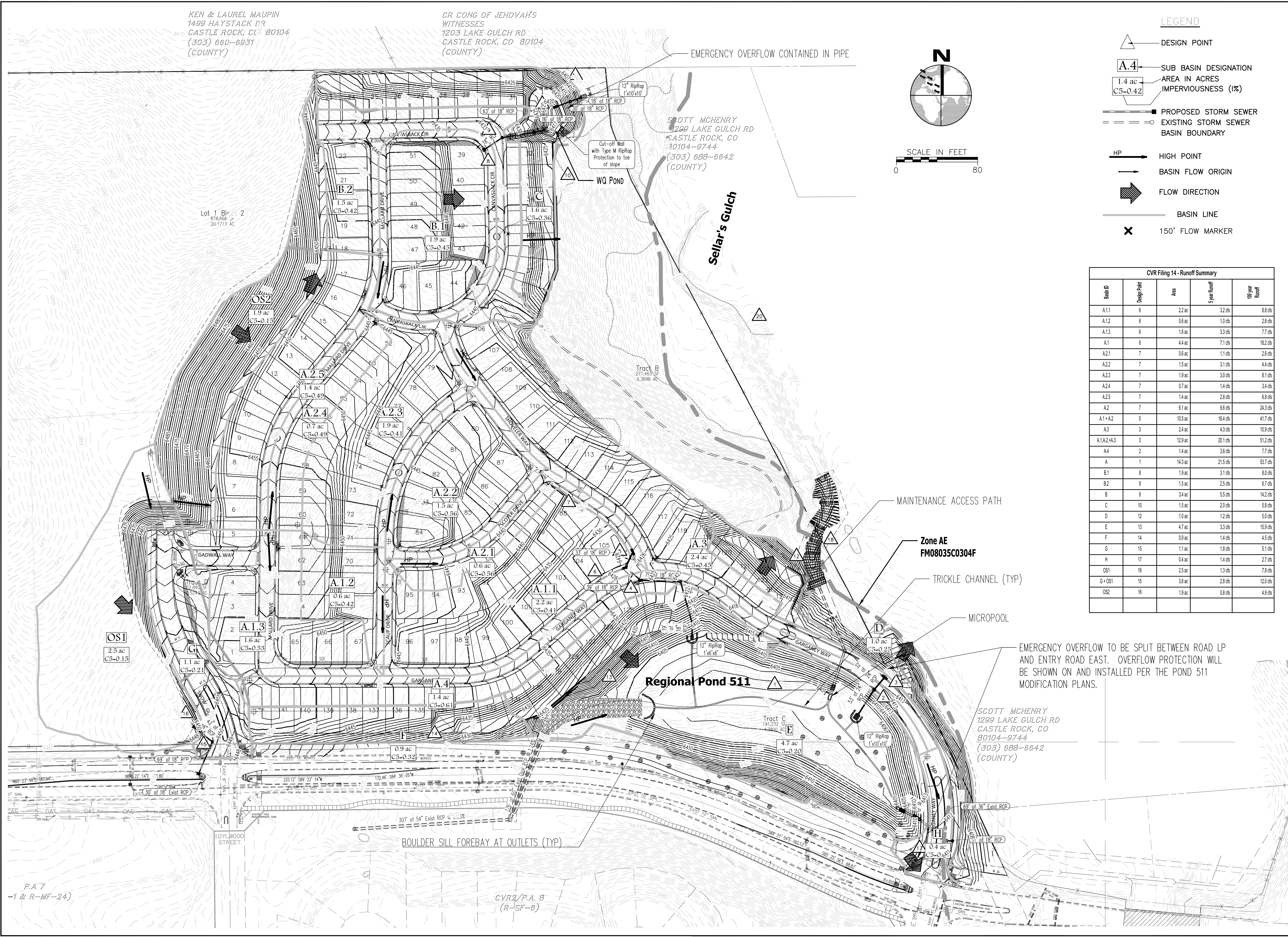
With a 40 hour drain time, the control flow rate is approximately 0.0197cfs. The orifice opening area can be determined by orifice equation.

$$Q = C_d A \sqrt{2g \Delta h}$$

In which A=orifice opening area, h=ponding depth, and C_d is the orifice coefficient which set to be 0.65 in the general case condition.

With the average orifice depth is approximately 1.5 ft. (the total depth is approximately 3 ft.), the orifice opening area should be 0.44 sq.-inch. The suggested opening should be single orifice diameter of 0.75inch, located at bottom of the orifice plate.

Of



**PHASE III DRAINAGE STUDY
FOR
CRYSTAL VALLEY RANCH
REGIONAL POND 512**

(CD15-0015)

Castle Rock, Colorado

Monday, October 29th, 2007

(Revised: Friday, April 03, 2015)

(Revised: Tuesday, June 02, 2015)

**PREPARED FOR
CRYSTAL VALLEY RANCH DEVELOPMENT CO., LLC**

1175 Crystal Valley Parkway

Castle Rock Co 80104-9624

Attn: Gregory W. Brown

&

CRYSTAL VALLEY RECOVERY ACQUISITION LLC

1251 Avenue of the Americas, 50th Floor

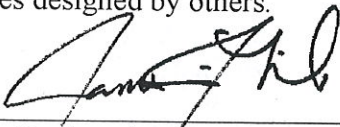
New York, NY 10020

Attn: Jon Shumaker

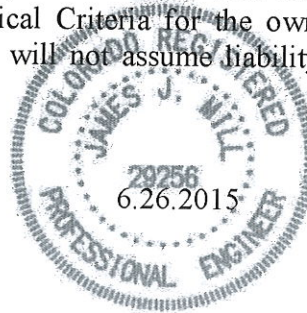
**PREPARED BY
Legacy Engineering, Inc.
1626 Thatch Circle
Castle Rock, Colorado 80109
(720) 200-4577**

ENGINEER'S STATEMENT:

I affirm that this report and plan for the Phase III drainage design of Crystal Valley Ranch Pond 512 was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Castle Rock Drainage Design and Technical Criteria for the owners thereof. I understand that the Town of Castle Rock does not and will not assume liability for drainage facilities designed by others.

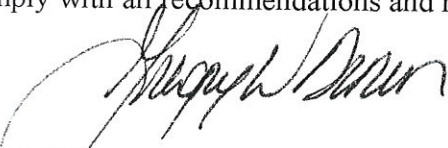


Legacy Engineering, Inc.
James J. Mill, P.E. (Colorado PE #29256)



OWNER/DEVELOPER'S STATEMENT

As Owner/Developer of land(s) identified within this report; I agree to proceed, implement and comply with all recommendations and requirements outlined herein.

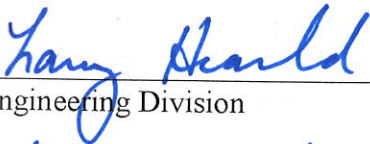


Crystal Valley Metro District.
Gregory R. Brown

6.26.2015

Date

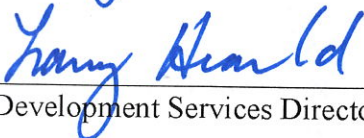
TOWN OF CASTLE ROCK APPROVALS:



Engineering Division

8/20/15

Date



Development Services Director

8/20/15

Date

Approved
Development Services

AUG 20 2015

Town of Castle Rock



Phase II Drainage Report Checklist

The Phase II Drainage Report must be in conformance with the latest Town of Castle Rock Storm Drainage Design and Technical Criteria Manual available on the Town's website.

The Phase II Drainage Report must be signed and sealed by a Professional Engineer licensed in the State of Colorado. The purpose of the Phase II Drainage Report is to identify and refine conceptual storm-water management solutions to the challenges that may be present or occur on-site and off-site.

The preparer should contact and work with the Town Stormwater Engineering Staff regarding any design, master planning and existing system questions (720-733-6000). The following outline sets forth the **required minimum** content to be provided in the Phase II Drainage Report that shall be submitted with the Planned Development Plan or Straight Zoning documents. A copy of this checklist must be submitted with the Phase II Drainage Report.

Please see Chapter 4 of the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual for additional details and information. Please check off the following items to assure your report is complete. Appropriate notations shall be provided with the checklist. For example, if a specific item is not addressed or not applicable, an explanation needs to be provided.

Included	N/A	
		I. COVER SHEET
☒		A. Name of Project, including legal name of development
☒		B. Address
☒		C. Owner
☒		D. Developer
☒		E. Engineer
☒		F. Submittal date and revision dates as applicable
		II. GENERAL LOCATION AND DESCRIPTION
☒		A. Site Location
☒		B. Description of Property and Land Use
		III. DRAINAGE BASIN AND SUB-BASINS
☒		A. Major Drainage Basins
☒		B. Minor Drainage Basins
		IV. DRAINAGE DESIGN CRITERIA
☒		A. Regulations
☒		B. Drainage Studies, Master Plans, Site Constraints
☒		C. Hydrology
☒		D. Hydraulics
☒		E. Water Quality Enhancement

Phase II Drainage Report Checklist

Included	N/A	
		V. STORMWATER MANAGEMENT FACILITY DESIGN
☒		A. Stormwater Conveyance Facilities
☒		B. Stormwater Storage Facilities
☒		C. Water Quality Enhancement Best Management Practices
☒		D. Floodplain Modification
☒		E. Additional Permitting Requirements
☒		F. General
		VI. CONCLUSIONS
☒		A. Compliance with Standards
☒		B. Variances
☒		C. Drainage Concept
		VII. REFERENCES
		VIII. APPENDICES
☒		A. Hydrologic Computations
☒		B. Hydraulic Computations (If known at this time—not required)
☒		C. Water Quality Enhancement Best Management Practices
☒		D. Referenced Information
☒		OVERALL DRAINAGE PLAN (IN POCKET)
	☒	DETAILED DRAINAGE PLANS (IN POCKET)

Notes/Comments:



Summary of Water Quality Conformance to MS4 Permit

The purpose of this worksheet is to document conformance with the Town of Castle Rock's MS4 permit with regard to permanent water quality on land disturbance projects.

Project Name CVR 14 Amendment 1

Project Owner CVR PA3A LLC

Project Location Crystal Valley Ranch

ToCR Project Number SDP26-0005

Total Site Area 21.1 acres

Total Size of Common Plan of Development 21.1 acres

Check all that apply:

☒ **Project within Plum Creek Basin**

☐ **Project within Cherry Creek Basin**

Estimated construction completion date 2030

1. The water quality control measure(s) for applicable development sites shall meet one of the following base design standards as per the SDDTCM Section 14.4. Please select all design standards that were applied to meet conformance with the MS4 on this site.

☒ WQCV standard

☐ Pollutant removal standard

☐ Runoff reduction standard

☒ Applicable site draining to regional WQVC control measure (accepts drainage prior to discharging to WOTS)

☐ Applicable site draining to regional WQVC control facility (with receiving pervious area control measure upstream of WOTS)

☐ Constrained redevelopment sites standard

• Imperviousness of existing site _____/_____ (Imp. Ac/Site Ac) = ____%

• Variance required TCV No. _____

☒ Existing control measure with WQCV per previous criteria standards

• Reference Construction Permit No. CD15-0015

☐ Cherry Creek Basin only, choose one: ☐ Tier 1 ☐ Tier 2 ☐ Tier 3

☐ No control measures provided (See Permanent WQ Worksheet for applicability)

Summary of Water Quality Conformance to MS4 Permit

2. Was an exclusion to water quality applied as per SDDTCM Section 13.1.5? ☐ Yes ☒ No

i. If yes, please select all that apply, provide total excluded impervious area(s) and submit variance, as applicable: TCV No. _____

- ☐ Pavement management site
Excluded impervious area: _____ acres
- ☐ Excluded roadway redevelopment
Excluded impervious area: _____ acres
- ☐ Excluded existing roadway areas
Excluded impervious area: _____ acres
- ☐ Above ground and below ground utilities
- ☐ Large lot single family home
- ☐ Non-residential and non-commercial infiltration
Excluded impervious area: _____ acres
- ☐ Land disturbance for land to remain undeveloped
Excluded impervious area: _____ acres
- ☐ Stream Stabilization Sites
Excluded impervious area: _____ acres
- ☐ Trails
Excluded impervious area: _____ acres
- ☐ Oil and Gas Exploration

3. For Development and Redevelopment sites, following any exclusions claimed above, was any portion of the site excluded up to 20% of the site and not to exceed one acre? ☒ Yes ☐ No

If yes, complete the following:

Excluded area: 1 _____ acres
Total Site area: 21.1 _____ acres, 4.7 _____ % site excluded

4. For Constrained sites, was any portion of the site excluded up to 50% of the site and not to exceed 50% of the impervious area? ☐ Yes ☒ No

If yes, complete the following:

Excluded area: _____ acres
Excluded impervious area: _____ acres
Total Site area: _____ acres, _____ % site excluded
Total Impervious area: _____ acres, _____ % impervious excluded