



Phase III Drainage Study: Avilla Founders Village

Legal:

Tracts B and C,
Bella Mesa Filing No. 1

Prepared:

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Revised:

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Prepared for:

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I. CERTIFICATIONS

Engineer's Statement

I affirm that this report and plan for the Phase III drainage design of Avilla Founders Village 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.

Rachel Patton
Registered Professional Engineer
State Of Colorado No.

Date

Developer's Statement

NexMetro Communities hereby certifies that the drainage facilities for Avilla Founders Village 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 NexMetro Communities, guarantee that final drainage design review will absolve NexMetro Communities and/or their successors and/or assigns of future liability for improper design.

NexMetro Communities

Authorized Signature

II. GENERAL LOCATION AND DESCRIPTION

A. Site Location

The Avilla Founders Village development ("Site") is located within the Town of Castle Rock, within Douglas County. The Site is bounded on the north by the future Rock Canyon Trail and future school, Mitchell Street to the east, Mikelson Boulevard to the south and Mitchell Gulch ("Gulch") to the west.

The Site is more particularly situated in Southeast $\frac{1}{4}$ of Section 8, Township 8 South, Range 66 West of the 6th Principal Meridian, City of Castle Rock, County of Douglas, State of Colorado.

A Vicinity Map can be found in Appendix A.

B. Description of Property and Land Use

The 9.03-acre development is anticipated to consist of approximately 105 dwelling units in 88 residential structures, in addition to a clubhouse and amenities such as a pool. The Site also includes improvements such as paved streets, surface and garage parking, curb and gutter, hardscaping and landscaping.

Currently, the Site consists of undeveloped land with vegetation consisting of native grasses and weeds. The proposed improvements will disturb the entire Site with excavation, grading, utility installation and other construction activities.

The Site currently resides adjacent to a drainage ditch, with existing grades generally sloping from east to west at varying grades. Rock outcroppings have been observed on the Site.

There are two soil types on the Site as identified by the Natural Resource Conservation Service (NRCS) Web Soil Survey: Coni Rocky Loam, and Fondis Clay Loam, classified as Hydrologic Soil Group C and D. A copy of the soil survey is included in Appendix B. Soil groups D and C tend to have lower infiltration rates which will result in higher peak runoff rates for developed sites in comparison with soils classified within hydrologic soil groups A & B.

There is no known contamination on the Site. The contractor will be responsible for monitoring for contamination throughout the construction and any required remediation will occur immediately.

There are no known significant geologic features, irrigation canals or ditches, or floodplains as delineated by Town of Castle Rock or FEMA on the subject Site. Refer to the FEMA Firm map in Appendix B.

III. DRAINAGE BASIN AND SUB-BASINS

A. Major Drainage Basins

The Site is a part of Major Basin EX-5 within the Phase III Drainage Report for Founders Village Filing 24, Phase 2, September 2019 (CD19-0022), ("Filing 24 Study"). Basin EX-5 follows historic drainage patterns and is routed to Mitchell Gulch. The 'Detention Pond A' ("Regional Pond") of the Filing 24 Study has been sized to include the assumed future flow for the future multifamily residential.

Additionally, the Site is further studied within the Phase III Drainage Report for Founders Village Filing 24, 1st Amendment, May 2021 (CD21-0011), ("1st Amendment Study"), as Basins A1 and B1. Basin A1 and B1 follows historic drainage patterns, and is routed to Mitchell Gulch, delineated by the existing ridge that splits the Site. Basin A1 flows north and west to the Gulch and Basin B1 flows south and west to the Gulch. This 1st Amendment Study also proposes a storm sewer system that connects the existing storm sewer near Mitchell Drive at the northeast of the Site and routes these flows to the west and then north

before discharging into the existing regional pond. The storm sewer is sized to accommodate future flows for the Site.

The existing drainage pattern divides runoff into two directions, the majority of which is conveyed north to the regional detention pond, the rest is conveyed untreated and un-detained to the west; both of which eventually outfall into Mitchell Gulch.

The ultimate receiving waters is Cherry Creek.

The Site is shown to be in a Zone X (unshaded) Flood Area according to Firmette 08035C0306G effective March 16, 2016. Zone X (unshaded) is described by FEMA as areas determined to be outside the 500-year floodplain. See the Firmette in Appendix D.

According to the 1st Amendment Study, a portion of the Site was included as Basin A1. Basin A1 (5.08 acres) was assumed for the future development, with an overall imperviousness of 70% and the runoff will flow northwest where it will enter the proposed storm sewer and conveyed north to the Regional Pond. Basin A1 is anticipated to produce approximately 13.0 cfs in the 5-year event and 29.9 cfs in the 100-year event in the fully developed condition.

The hydrologic calculations in Appendix C show the 100-year peak discharge of the entire Site at 28.2 cfs, less than was anticipated in the 1st Amendment Study and therefore should present no adverse effects to the Regional Pond. Proceeding through the design process, the Site will maintain lesser values than calculated in the 1st Amendment Study for both the peak discharge and imperviousness in order not to present adverse impacts to the Regional Pond.

There are no known irrigation facilities that will be influenced by the Site.

No flows from surrounding properties are expected to have an impact on the Site.

B. Minor Drainage Basins

The Site is comprised of 17 drainage basins. The proposed basins and design points are shown on the Final Drainage Plan, included in Appendix F.

The following basins are conveyed and collected on-Site by the proposed drainage infrastructure. On-Site flows will be conveyed by the system to the storm sewer infrastructure constructed under ToCR approved plans CD21-0011. Runoff is then conveyed via this storm infrastructure to the regional water quality and detention pond, located to the north of the Site.

Basin A is 0.66 acres consisting of roofs, drives, sidewalks and landscaping. The peak flow rate is 1.7 cfs during the minor storm and 4.1 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type 16 Valley double inlet at design point 1. In the event of clogging, runoff will overtop the curb & gutter to the north and surface flow to the Mikelson Boulevard right-of-way.

Basin B is 0.57 acres consisting of roofs, sidewalks and landscaping. The peak flow rate is 0.9 cfs during the minor storm and 2.7 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type C inlet at Design point 2. In the event of clogging, all runoff will overtop and flow to the sump-condition Type 16 Valley double inlet at design point 1.

Basin C is 0.44 acres consisting of roofs, sidewalks and landscaping. The peak flow rate is 0.8 cfs during the minor storm and 2.2 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type C inlet at design

point 3. In the event of clogging, all runoff will overtop the curb & gutter and flow to a sump-condition Type 16 Valley double inlet at design point .

Basin D is 0.54 acres consisting of roofs, drives, sidewalks and landscaping. The peak flow rate is 1.8 cfs during the minor storm and 3.9 cfs during the major storm event. The majority of runoff will surface flow within the private drive and to a sump-condition Type 16 Valley double inlet at design point 4. In the event of clogging, all runoff will overtop the curb & gutter and flow to a Type C inlet located design point 3 for emergency overflow.

Basin E is 0.59 acres consisting of roofs, sidewalks, amenity space and landscaping. The peak flow rate is 1.2 cfs during the minor storm and 3.4 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type C inlet at design point 7. In the event of clogging, all runoff will overtop the curb & gutter and flow to a Type R inlet at design point 6.

Basin F is 0.77 acres consisting of roofs, sidewalks and landscaping. The peak flow rate is 1.5 cfs during the minor storm and 4.0 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type R inlet at design point 5. In the event of clogging, all runoff will overtop the curb & gutter and flow to a Type R inlet at design point 6.

Basin F1 is 0.22 acres and is a part of Basin F. This basin was analyzed to determine if the swale graded between western most buildings and the adjacent retaining wall can adequately contain the runoff captured by it. Although there are similar swales along the westside of basins A, C, J, K, and L, Basin F1 was analyzed as it will contain the largest amount of runoff. Thus, if the swale in Basin F1 is adequate, the swales in the other basins will be as well. The minimum depth of for all the mentioned swales is 0.5'. Runoff will sheet flow to and through the swale and be captured in landscape drains. The proposed landscape drains will direct runoff towards and connect to the proposed storm sewer. Analysis of this swale has been provided in Appendix D, for reference.

Basin G is 0.28 acres consisting of roofs, drives, sidewalks and landscaping. The peak flow rate is 0.9 cfs during the minor storm and 2.0 cfs during the major storm event. The majority of runoff will surface flow within the private drive and to a sump inlet. All runoff is conveyed to a sump-condition Type R inlet at design point 6. In the event of clogging, all runoff will flow to a Type R inlet at design point 9.

Basin I is 0.55 acres consisting of roofs, sidewalks and landscaping. The peak flow rate is 0.8 cfs during the minor storm and 2.5 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type C inlet at design point 8. In the event of clogging, all runoff will flow to a Type R inlet at design point 9.

Basin J is 1.25 acres consisting of roofs, drives, sidewalks and landscaping. The peak flow rate is 3.3 cfs during the minor storm and 8.0 cfs during the major storm event. The majority of runoff will surface flow within the private drive to a sump-condition Type R inlet at design point 9. In the event of clogging, all runoff will overtop the curb & gutter and be conveyed to the sump-condition Type R inlet at design point 10.

Basin K is 0.58 acres consisting of roofs, drives, sidewalks and landscaping. The peak flow rate is 1.3 cfs during the minor storm and 3.4 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type R inlet at design point 10. In the event of clogging, all runoff will overtop the curb & gutter and flow through the landscaped area between the buildings to Mitchell Gulch.

Basin L is 0.76 acres consisting of roofs, drives, sidewalks and landscaping. The peak flow rate is 1.3 cfs during the minor storm and 3.7 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type R inlet at design point 13. In the event of clogging, all runoff will flow to a Type R inlet at design point 15.

Basin M is 0.49 acres consisting of roofs, sidewalks and landscaping. The peak flow rate is 0.8 cfs during the minor storm and 2.4 cfs during the major storm event. All runoff is conveyed to a sump-condition Type C inlet at design point 12. In the event of clogging, all runoff will flow to a Type R inlet at design point 13.

Basin N is 0.61 acres consisting of roofs, sidewalks and landscaping. The peak flow rate is 0.9 cfs during the minor storm and 3.0 cfs during the major storm event. Runoff will surface flow through landscaping and be captured by landscape drains. All runoff is conveyed to a sump-condition Type C inlet at design point 16. In the event of clogging, all runoff will flow to a Type R inlet at design point 15.

Basin O is 0.37 acres consisting of roofs, sidewalks and landscaping. The peak flow rate is 1.3 cfs during the minor storm and 2.7 cfs during the major storm event. The majority of runoff will surface flow within the private drive to a sump Type R inlet at the Site entrance and Rock Canyon Trail at design point 15. In the event of clogging, all runoff will overtop the crown of Rock Canyon Trail and flow to a Type R inlet at design point 14.

Basin P is 0.11 acres consisting of the north half of Rock Canyon Trail. The peak flow rate is 0.5 cfs during the minor storm and 0.9 cfs during the major storm event. Runoff will sheet flow to the gutter and conveyed to a sump-condition Type R inlet at design point 14. In the event of clogging, all runoff will overtop the curb and gutter and surface flow to the regional pond to the north.

Basin Q is 0.15 acres consisting of roofs, drives, and landscaping. The peak flow rate is 0.6 cfs during the minor storm and 1.2 cfs during the major storm event. The majority of runoff will surface flow within the private drive and to a sump-condition Type R inlet. All runoff is conveyed to a sump-condition Type R inlet at design point 11. In the event of clogging, all runoff will flow to a Type R inlet at design point 13.

Basin OS-1 is 0.27 acres and consists of landscaping and a retaining wall. The peak flow rate is 0.1 cfs during the minor storm and 1.6 fs during the major storm event. Capturing runoff from this subbasin was considered impractical from a grading perspective. This runoff will follow historic drainage patterns and flow to Mitchell Gulch.

Runoff from all basins will ultimately be conveyed to the existing Regional Pond located to the north of the Site. Each sub-basin is designed to convey runoff originating within the basin to its respective downstream storm sewer inlet. Proposed storm sewer infrastructure will convey a peak flow rate of 29.4 cfs from the major storm to the proposed storm sewer infrastructure in Rock Canyon Trail.

No flows from surrounding properties are expected to have an impact on the Site as a result of the development of the Site.

IV. DRAINAGE DESIGN CRITERIA

A. Regulations

The principal design criteria used for this study was the Town of Castle Rock's Storm Drainage Design and Technical Criterial Manual (SDDTCM).

In addition, Urban Storm Drainage Criteria Manuals, Volumes 1, 2 and 3 for Mile High Flood District (MHFD) was also consulted.

B. Drainage Studies, Master Plans, Site Constraints

The Site is included in the Phase III Drainage Report for Founders Village Filing 24 – 1st Amendment by Redland. The proposed Site is in compliance with the drainage requirements set forth in the 1st Amendment Study.

C. Hydrology

The Town of Castle Rock SSDTC Manual was followed without variation or deviation. For the 5-year storm, P1=1.43 inches, and for the 100-year storm, P1=2.60 inches. As previously mentioned, Hydrologic Soil Group C and D were used.

The Rational Method was used to analyze the minor 5-year storm and the major 100-year storm for design of storm sewer and inlets. The Rational Method Calculation for the Site can be found in Appendix C.

Composite runoff coefficients were calculated for each of the major basins. The minimum time of concentration used for urbanized basins was 5 minutes.

D. Hydraulics

Inlet capacity was based on utilizing the MHFD spreadsheet “MHFD-Inlet V.5.01”, released April 2021.

Proposed storm sewer pipes have been sized to convey the 100-year event as a part of this Phase III Drainage report.

The Town of Castle Rock SSDTC Manual was followed without variation or deviation. The following design charts and supplemental models will be used to assist with the analysis as a part of the Phase III Drainage report:

- StormCAD computer model for hydraulic grade line analysis
- FlowMaster computer model for hydraulic analysis.

Flows were based on the Rational Calculation flow routing as shown on Standard Form 3 (SF-3). The calculations are shown in Appendix C.

StormCAD analysis and Inlet capacity calculations can be found in Appendix E, for reference.

E. Water Quality Enhancement

The water quality capture volume corresponding to the developed Site is being provided regionally within the Regional Pond.

Following the four-step process of Stormwater Quality Design Process per the SDDTCM:

Step 1: Reduce Runoff Volume to the Maximum Extent Practicable

- Reducing runoff volume is accomplished by reducing directly connected impervious areas. All roof downspouts discharge into landscaping and are directed to the storm infrastructure via landscape swales, allowing runoff to sheet flow over pervious landscaped areas which encourages infiltration, which decreases runoff from the Site.
- Additionally, sidewalks and drives are proposed to the minimum dimensions allowed per zoning requirements, public safety and fire access. Minimal width sidewalks and drives limit earth disturbances to the Site and allow the design of the Site to contain the maximum amount of pervious landscaped areas, resulting in a decrease of runoff from the Site.

Step 2: Provide Water Quality Capture Volume and Flood Control Detention via Full-Spectrum Detention

- Water Quality Capture Volume and Full-Spectrum Detention is provided for the Site in the Regional Pond, which as previously discussed, was sized for the future development of the Site.

Step 3: Utilize Stream Channel Stabilization Techniques

- No channels exist on or adjacent to the Site or are proposed to be constructed as a part of the development. Additionally, no off-site drainageways receive runoff from the Site.

Step 4: Undertake Source Control

- Proposed structural source control measures include:
 - o Proper sanitary sewer connections (as shown on the plans)
 - o Provision of proper waste receptacles.
- Non-Structural Controls
 - o General good housekeeping practices (proper material storage, clean and orderly work areas)
 - o Preventative maintenance
 - o Spill prevention and response
 - o Employee “awareness” education and training
- Additional information and a discussion of the uses and activities proposed for the Site that may have the potential for illicit discharges will be included in the Phase III Report.

V. STORMWATER MANAGEMENT FACILITY DESIGN

A. Stormwater Conveyance Facilities

The general concept for the drainage design is to follow the drainage design as outlined in the 1st Amendment Study and to match or decrease the allotted flows. Runoff from the Site will flow to the north to the existing water quality and detention pond.

B. Existing Stormwater Storage Facilities

As previously mentioned, the Regional Pond is located to the north of the Site. Per the 1st Amendment Study, Basin A1 “is anticipated that the future development will have an overall imperviousness of 70% and the runoff will flow northwest to Design Point 1 where it will be collected and enter the proposed storm sewer.” Basin B1 is assumed that “the future development will provide water quality for this runoff and will over-detain in the existing detention pond so the site as a whole remains at historical release rates.”

It is understood per the 1st Amendment Study that the existing detention pond does not have volume reserved for Basin B1 and it was not anticipated to be routed to the pond. However, the entire developed Site is less than the allowable for Basin A1, which the detention pond was designed to accommodate. Therefore, no additional water quality or detention is required in support of the development of the Site.

Existing Basin	Area (Acres)	Planned Impervious	C ₂	C ₅	C ₁₀₀	Q ₂ (CFS)	Q ₅ (CFS)	Q ₁₀₀ (CFS)
A1 **	5.08	70%	-	0.61	0.77	-	13.0	29.9
B1	3.76	70%	0.61	-	0.77	8.1	-	18.6
Proposed Basin								
Site **	8.99	59%	-	0.51	0.72	-	11.0	28.2

**Basin A1 and Site are routed to the existing regional detention pond.

References to the 1st Amendment Study can be found in Appendix D.

C. Water Quality Enhancement Best Management Practices

The water quality capture volume corresponding to the developed Site is being provided regionally within the regional detention pond.

D. Floodplain Modifications

A Preliminary Floodplain Modification Study was prepared by Harris Kocher Smith, dated December 3, 2021 to develop the floodplain boundaries and base flood elevations.

All finished floors are a minimum of two-feet above the adjacent floodplain base flood elevation.

The Preliminary Floodplain Modification Study letter can be found in Appendix D.

E. Additional Permitting Requirements

The Colorado Water Quality Control Division administers a program under the Colorado Quality Act that regulates discharges of stormwater to State waters. The proposed Site will likely require a Colorado State Stormwater Discharge permit for the Discharge into Pond A.

The Town of Castle Rock will require a Grading, Erosion and Sediment Control permit.

F. Operation and Maintenance

All on-site storm sewer is private. Inspection and maintenance of the on-site proposed storm infrastructure will be the responsibility of the property owner. Proper maintenance is important to the function of the storm sewer maintenance. Without proper maintenance there is an increased risk of on-Site flooding and clogging of the storm sewer pipes throughout the Site.

Routine maintenance performed on a scheduled basis can help avoid more costly rehabilitative maintenance that results when facilities are not adequately maintained. Routine work, including trash/debris pickup that may be clogging any inlet, should be performed multiple times per year. Periodic work, such as sediment removal or minor repair of inlets or structures, should be complete on an as-needed basis. All stormwater management facilities shall be inspected by a qualified individual at a minimum of one time per year.

If the property owner fails to maintain a facility, the Town as the right to complete maintenance and charge the owner at 1.25 times the cost of maintenance.

G. General

All tables, figures and charts are in compliance with the Town of Castle Rock's SDDTCM.

VI. CONCLUSIONS

A. Compliance with Standards

The drainage design is prepared in compliance with the Town of Castle Rock's SDDTCM and drainage studies.

B. Variances

No variances are requested.

C. Drainage Concept

The proposed development of this Site will have no adverse impact to the downstream system.

VII. REFERENCES

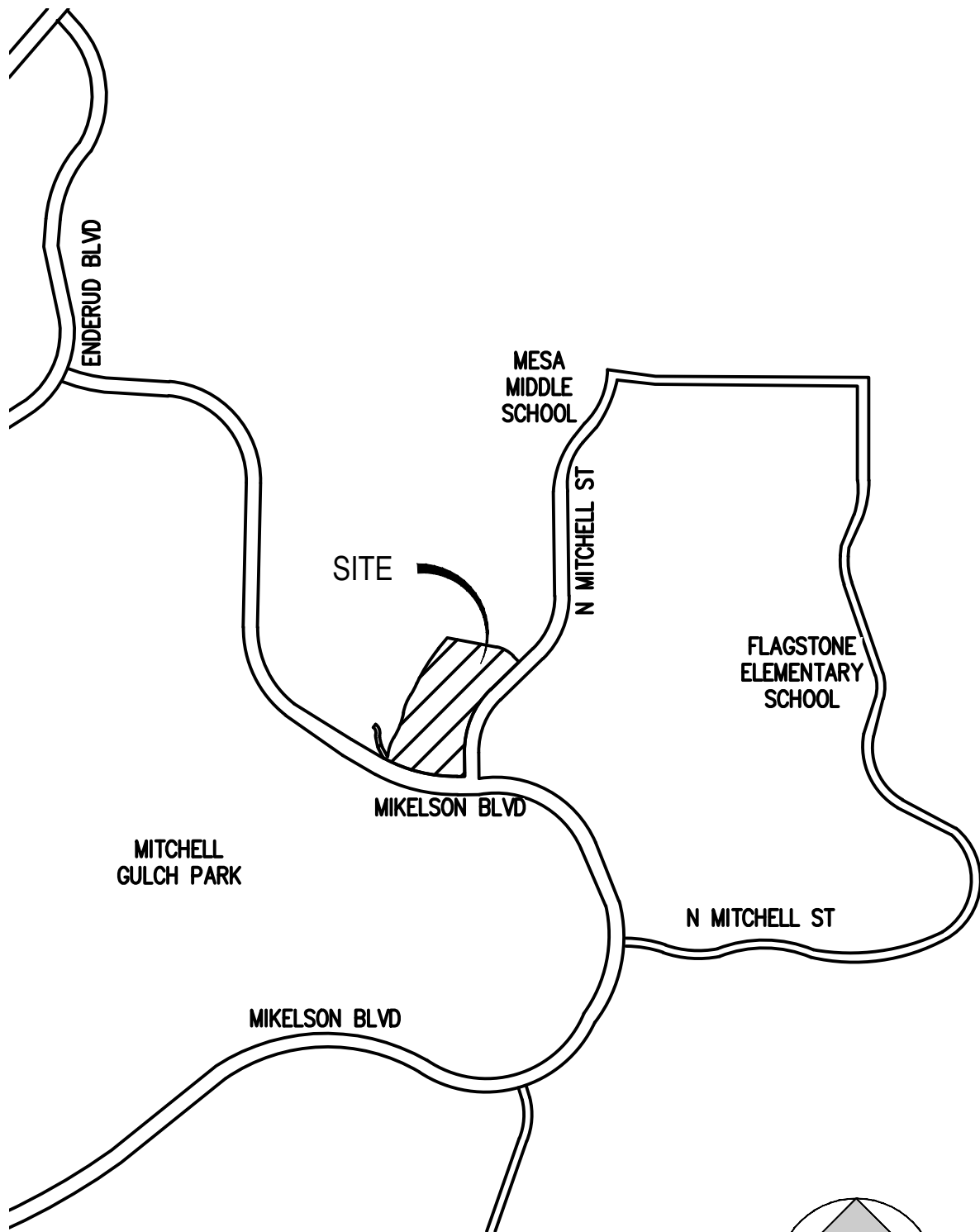
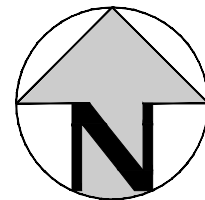
References

1. *Town of Castle Rock Storm Drainage Design and Technical Criteria Manual*, Utilities Department, Town of Castle Rock, Douglas County, Revised 2019.
2. Urban Storm Drainage Criteria Manual, Vol. 1 and 2, Mile High Flood District, Revised January 2016
3. *Urban Storm Drainage Criteria Manual, Vol. 3*, Mile High Flood District, Revised November 2015
4. *Custom Soil Resource Report*, Natural Resources Conservation Service, United States Department of Agriculture.
5. Phase III Drainage Report for Founders Village Filing 24, CORE Consultants, April 17, 2018.

APPENDIX A

Vicinity Map

Plotted: TUE 11/30/21 11:56:09A By: Rachel Patton Filepath: k:\210431\engineering\ref\vic map.dwg Layout: layout1



SCALE: 1" = 1000'

APPENDIX B

FEMA FIRM

NRCS Soil Study

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/NGS-12
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 provided by the Douglas County GIS Department and the Town of Castle Rock GIS Department. Additional input was provided by the City of Lone Tree and Town of Parker. These data are current as of 2010.

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

The **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.

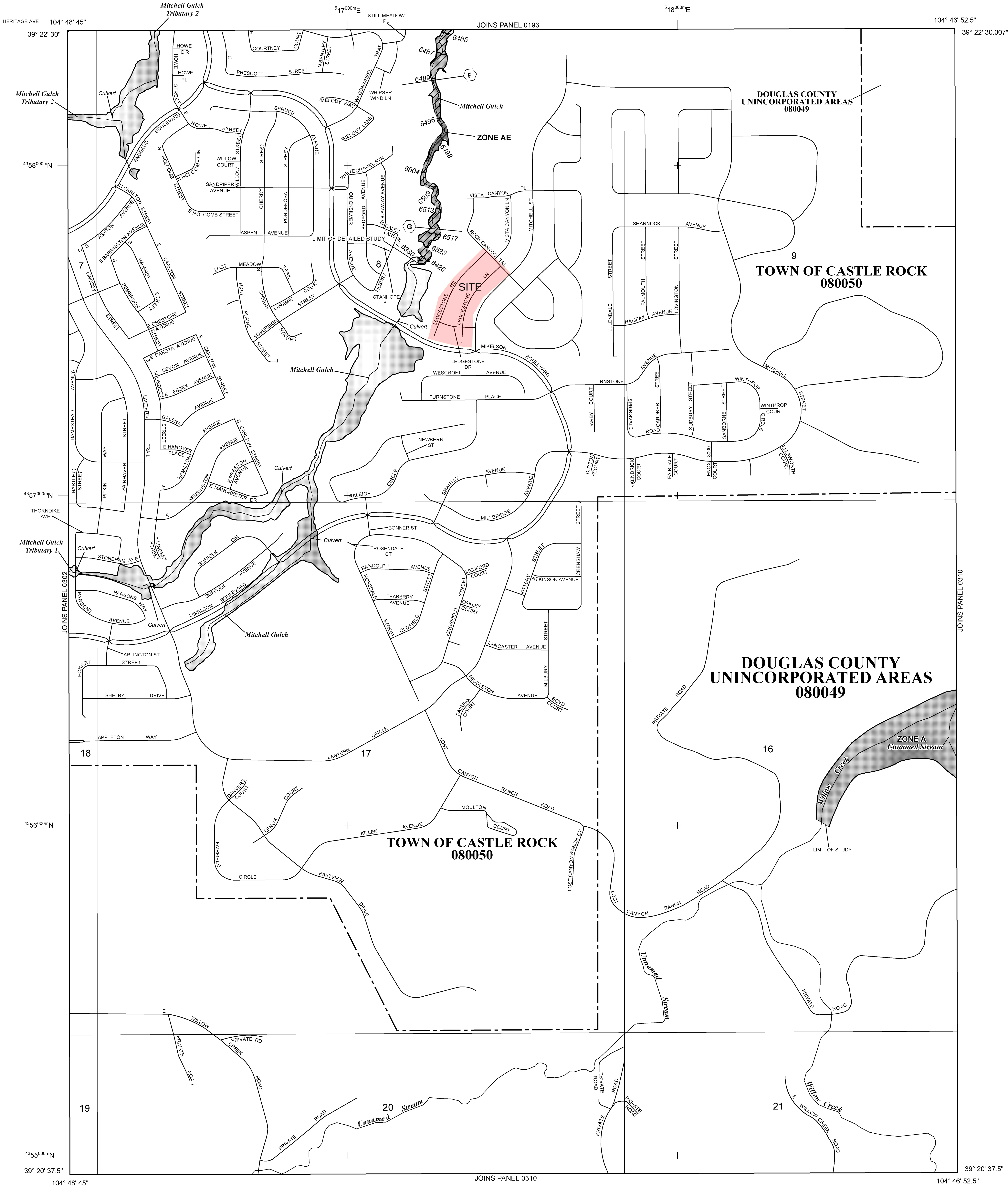
Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations** and **floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the 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.

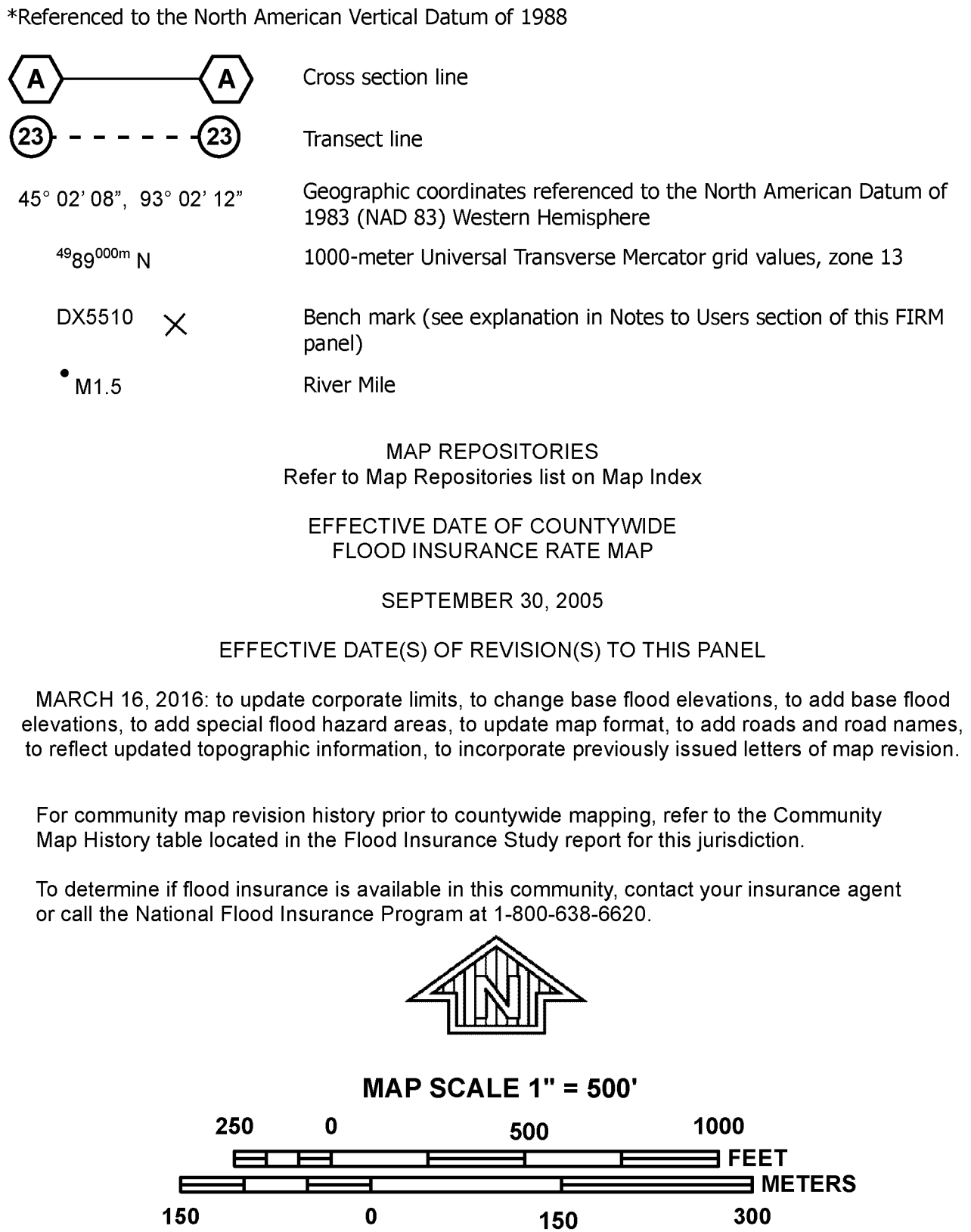
For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products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



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 decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.
- FLOODWAY AREAS IN ZONE AE**
- OTHER FLOOD AREAS**
ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
OTHER AREAS
ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.
- COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
OTHERWISE PROTECTED AREAS (OPAs)
- CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.
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*



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0306G

FIRM
FLOOD INSURANCE RATE MAP
DOUGLAS COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 306 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
CASTLE ROCK, TOWN OF 080050 0306 G
DOUGLAS COUNTY 080049 0306 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 08035C0306G
MAP REVISED MARCH 16, 2016
Federal Emergency Management Agency



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



November 30, 2021

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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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

Custom Soil Resource Report

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



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 14, Aug 31, 2021

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

Date(s) aerial images were photographed: Jul 24, 2018—Nov 19, 2018

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CoG	Coni rocky loam, 3 to 100 percent slopes	10.2	95.7%
FoD	Fondis clay loam, 3 to 9 percent slopes	0.5	4.3%
Totals for Area of Interest		10.7	100.0%

Map Unit Descriptions

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

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

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

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

onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

Castle Rock Area, Colorado

CoG—Coni rocky loam, 3 to 100 percent slopes

Map Unit Setting

National map unit symbol: jqyg
Elevation: 6,600 to 7,800 feet
Mean annual precipitation: 17 to 21 inches
Mean annual air temperature: 43 to 47 degrees F
Frost-free period: 115 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

Coni and similar soils: 70 percent
Stony rough land: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Coni

Setting

Landform: Buttes, mesas
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic, sedimentary rock over unweathered conglomerate

Typical profile

H1 - 0 to 7 inches: loam
H2 - 7 to 17 inches: clay loam
H3 - 17 to 21 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 10 to 20 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)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: R048AY222CO - Loamy Park
Hydric soil rating: No

Description of Stony Rough Land

Setting

Down-slope shape: Linear
Across-slope shape: Linear

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Properties and qualities

Slope: 3 to 99 percent

Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8s

Hydrologic Soil Group: D

Hydric soil rating: No

Minor Components

Brussett

Percent of map unit: 5 percent

Hydric soil rating: No

Falcon

Percent of map unit: 5 percent

Hydric soil rating: No

Kettle

Percent of map unit: 4 percent

Hydric soil rating: No

Aquic haplustolls

Percent of map unit: 1 percent

Landform: Swales

Hydric soil rating: Yes

FoD—Fondis clay loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: jqyp

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: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fondis

Setting

Landform: Mesas, buttes, ridges

Down-slope shape: Linear

Across-slope shape: Linear

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Parent material: Eolian deposits over coarse-silty outwash derived from arkose

Typical profile

H1 - 0 to 7 inches: clay loam

H2 - 7 to 24 inches: clay

H3 - 24 to 60 inches: sandy clay loam

Properties and qualities

Slope: 3 to 9 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 9.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: C

Ecological site: R049XB208CO - Clayey Foothill

Hydric soil rating: No

Minor Components

Kutch

Percent of map unit: 5 percent

Hydric soil rating: No

Englewood

Percent of map unit: 5 percent

Hydric soil rating: No

Denver

Percent of map unit: 4 percent

Hydric soil rating: No

Aquic haplustolls

Percent of map unit: 1 percent

Landform: Swales

Hydric soil rating: Yes

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Custom Soil Resource Report

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

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Map—Hydrologic Soil Group



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MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

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 14, Aug 31, 2021

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

Date(s) aerial images were photographed: Jul 24, 2018—Nov 19, 2018

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CoG	Coni rocky loam, 3 to 100 percent slopes	D	10.2	95.7%
FoD	Fondis clay loam, 3 to 9 percent slopes	C	0.5	4.3%
Totals for Area of Interest			10.7	100.0%

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelpdb1043084>

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United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX C

Hydrologic Calculations

Project Name:

Avilla Founders Village

Composite C-Value Computations

Post-Development

Project No:

210431

Date:

07/29/22

Revised:

10/12/22

Design by:

RCP

Checked by:

RCP

NRCS Soil Group

C/D

BASIN	TOTAL AREA (ACRES)	ROOFS (90%)	CONCRETE DRIVES & WALKS (90%)	STREETS (100%)	LANDSCAPE AREA (2%)	PERCENT IMPERVIOUS	C ₅ =	C ₁₀₀ =
A	0.66	0.22	0.03	0.20	0.22	64%	0.56	0.75
B	0.57	0.27	0.03	0.00	0.28	48%	0.43	0.68
C	0.44	0.21	0.02	0.00	0.21	48%	0.43	0.68
D	0.54	0.07	0.06	0.32	0.08	82%	0.71	0.82
E	0.59	0.12	0.19	0.00	0.29	47%	0.42	0.68
F	0.77	0.30	0.03	0.09	0.34	52%	0.46	0.70
G	0.28	0.02	0.02	0.19	0.06	79%	0.68	0.81
I	0.55	0.24	0.02	0.00	0.28	44%	0.40	0.67
J	1.25	0.40	0.04	0.42	0.40	66%	0.57	0.75
K	0.58	0.26	0.04	0.07	0.21	59%	0.52	0.72
L	0.76	0.30	0.03	0.08	0.35	50%	0.45	0.69
M	0.49	0.25	0.02	0.00	0.22	50%	0.44	0.69
N	0.61	0.24	0.02	0.00	0.34	41%	0.37	0.65
O	0.37	0.02	0.00	0.30	0.05	87%	0.75	0.84
P	0.11	0.00	0.00	0.11	0.00	97%	0.83	0.88
Q	0.15	0.02	0.00	0.12	0.00	96%	0.82	0.88
Total Treated	8.72	2.93	0.57	1.89	3.33	59%	0.51	0.72
Off Site Basins								
OS-1	0.27	0.00	0.00	0.00	0.27	2%	0.05	0.49
Total Untreated	0.27	0.00	0.00	0.00	0.27	2%	0.05	0.49
Swale Analysis Basin								
F1	0.22	0.10	0.00	0.00	0.11	44%	0.40	0.67
Total Site	8.99	2.93	0.57	1.89	3.60	57%	0.50	0.72

Runoff Coefficient Equations (from USDCM Vol. 1)		
	NRCS Soil Group	C/D
2-year		0.83(i)^1.122
5-year		0.82(i)+0.035
100-year		0.41(i)+0.484

Project Name: Avilla Founders Village
 Project No: 210431
 Date: 07/29/22
 Revised: 10/12/22

STANDARD FORM SF-2
TIME OF CONCENTRATION
Post-Development

Designed By: RCP
 Checked By: RCP

SUB-BASIN DATA			INITIAL/OVERLAND TIME (Ti)			TRAVEL TIME (Ti)					Tc CHECK (URBANIZED BASINS)			FINAL	REMARKS
BASIN	AREA (AC)	C _s	LENGTH (FT)	SLOPE %	Ti (MIN)	LENGTH (FT)	SLOPE %	C _v	VELOCITY (FPS)	Tt (MIN)	COMPOS. Tc (MIN)	TOTAL LENGTH	Tc = (L/180) + 10 (MIN)	Tc (MIN)	
A	0.66	0.56	44	2.00	5.23	149	1.00	20	2.00	1.24	6.47	193	11.07	6.47	
B	0.57	0.43	44	2.00	6.51	170	1.00	7	0.70	4.05	10.55	214	11.19	10.55	
C	0.44	0.43	50	2.00	6.89	145	2.00	7	0.99	2.44	9.34	195	11.08	9.34	
D	0.54	0.71	42	2.00	3.69	300	3.00	20	3.46	1.44	5.13	342	11.90	5.13	
E	0.59	0.42	36	20.00	2.74	160	2.00	7	0.99	2.69	5.44	196	11.09	5.44	
F	0.77	0.46	44	2.00	6.15	100	1.00	7	0.70	2.38	8.53	144	10.80	8.53	
G	0.28	0.68	5	1.50	1.49	160	4.00	20	4.00	0.67	5.00	165	10.92	5.00	
I	0.55	0.40	44	2.00	6.76	150	0.70	7	0.59	4.27	11.03	194	11.08	11.03	
J	1.25	0.57	44	2.00	5.08	200	4.00	20	4.00	0.83	5.92	244	11.36	5.92	
K	0.58	0.52	44	2.00	5.64	160	2.00	20	2.83	0.94	6.58	204	11.13	6.58	
L	0.76	0.45	44	2.00	6.30	150	1.00	7	0.70	3.57	9.87	194	11.08	9.87	
M	0.49	0.44	55	2.00	7.09	180	2.00	7	0.99	3.03	10.12	235	11.31	10.12	
N	0.61	0.37	30	20.00	2.71	330	2.00	7	0.99	5.56	8.26	360	12.00	8.26	
O	0.37	0.75	41	2.00	3.29	165	2.00	20	2.83	0.97	5.00	206	11.14	5.00	
P	0.11	0.83	25	2.00	1.99	270	2.50	20	3.16	1.42	5.00	295	11.64	5.00	
Q	0.15	0.82	42	1.00	3.28	45	2.50	20	3.16	0.24	5.00	87	10.48	5.00	
OS-1	0.27	0.05	182	4.81	15.36	0	0.00	15	0.00	0.00	15.36	182	11.01	11.01	
F1	0.22	0.40	29.5	1.00	6.98	84.84	2.00	15	2.12	0.67	7.65	114	10.64	7.65	

Project Name:		Avilla Founders Village		STANDARD FORM SF-2								Designed By:		RCP			
Project No:		210431		Post-Development								Checked By:		RCP			
Date:		07/29/22		Rational Method Procedure								Design Storm:		5 YR			
Revised:		10/12/22															

BASIN (s)	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				STREET/INLET					STORM SEWER PIPE				TRAVEL TIME			CARRYOVER FLOWS					REMARKS
		AREA (AC)	RUNOFF COEFF	Tc (min)	C x A (AC)	I (IN/HR)	DIRECT RUNOFF, Q (CFS)	Tc (min)	Σ(C x A) (AC)	I (IN/HR)	TOTAL RUNOFF, Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	INLET DESIGN FLOW (CFS)	STREET OR INLET INTERCEPTION (CFS)	CARRYOVER (CFS)	DESIGN FLOW (CFS)	PIPE SLOPE (%)	PIPE SIZE (IN)	Q _{FULL} (CFS)	LENGTH (FT)	VELOCITY (FPS)	Tt (min)	Σ(C x A) BYPASS (AC)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	Tt (min)	
A	1	0.66	0.56	6.47	0.37	4.51	1.7									1.7	0.5	18	9.7	43	1.1	0.68						BASIN A DIRECT RUNOFF	
B	2	0.57	0.43	10.55	0.24	3.79	0.9									0.9	0.5	18	9.7	48	1.1	0.76						BASIN B DIRECT RUNOFF	
ΣDP1 + ΣDP2								11.31	0.61	3.68	2.3					2.3	0.5	18	9.7	92	1.1	1.44						COMBINED FLOW IN PIPE	
C	3	0.44	0.43	9.34	0.19	3.97	0.8									0.8	0.5	18	9.7	31	1.1	0.48						BASIN C DIRECT RUNOFF	
D	4	0.54	0.71	5.13	0.38	4.82	1.8									2.2	0.5	18	9.7	95	1.1	1.50						BASIN D DIRECT RUNOFF	
ΣBasin C + Basin D + Pipe Flow								9.82	0.57	3.90	2.2					2.2	0.5	18	9.7	152	1.1	2.39						COMBINED FLOW IN PIPE	
ΣDP1 + ΣDP2 + ΣDP3 + ΣDP4								12.75	1.19	3.50	4.1					4.1	0.5	24	20.8	152	1.1	2.39						COMBINED FLOW IN PIPE	
F	5	0.77	0.46	8.53	0.35	4.11	1.5									1.5	0.5	18	9.7	52	1.1	0.82						BASIN F DIRECT RUNOFF	
G	6	0.28	0.68	5.00	0.19	4.85	0.9									2.2	0.5	18	9.7	14	1.1	0.21						BASIN G DIRECT RUNOFF	
ΣDP5 +ΣDP6								9.35	0.55	3.97	2.2					2.2	0.5	18	9.7	14	1.1	0.21						COMBINED FLOW IN PIPE	
E	7	0.59	0.42	5.44	0.25	4.74	1.2									1.2	0.5	18	9.7	63	1.1	0.99						BASIN E DIRECT RUNOFF	
ΣDP5 + ΣDP6 + ΣDP7 + Pipe Flow								15.14	1.98	3.23	6.4					6.4	0.5	24	20.8	194	1.1	3.04						COMBINED FLOW IN PIPE	
I	8	0.55	0.40	11.03	0.22	3.72	0.8									0.8	2.6	18	21.9	90	2.4	0.62						BASIN I DIRECT RUNOFF	
J	9	1.25	0.57	5.92	0.72	4.63	3.3									3.3	2.0	18	19.3	13	2.1	0.10						BASIN J DIRECT RUNOFF	
ΣDP8 + ΣDP9 + Pipe Flow								18.18	2.92	2.95	8.6					8.6	0.5	24	20.8	65	1.1	1.02						COMBINED FLOW IN PIPE	
K	10	0.58	0.52	6.58	0.30	4.48	1.3									1.3	3.0	18	23.7	67	2.6	0.43						BASIN K DIRECT RUNOFF	
ΣDP10 + Pipe Flow								19.20	3.22	2.87	9.2					9.2	0.5	24	20.8	87	1.1	1.37						COMBINED FLOW IN PIPE	
Q	11	0.15	0.82	5.00	0.12	4.85	0.6									0.6	3.0	18	23.7	12	2.6	0.08						BASIN Q DIRECT RUNOFF	
ΣDP11 + Pipe Flow								20.57	3.34	2.77	9.3					9.3	0.5	24	20.8	91	1.1	1.43						COMBINED FLOW IN PIPE	
M	12	0.49	0.44	10.12	0.22	3.85	0.8									0.8	5.0	18	30.5	47	3.4	0.23						BASIN M DIRECT RUNOFF	
ΣDP12 + Pipe Flow								22.00	3.56	2.67	9.5					9.5	0.5	24	20.8	39	1.1	0.62						COMBINED FLOW IN PIPE	
L	13	0.76	0.45	9.87	0.34	3.89	1.3									1.3	3.0	18	23.7	14	2.6	0.09						BASIN L DIRECT RUNOFF	
ΣDP13 + Pipe Flow								22.61	3.90	2.63	10.3					10.3	0.5	30	37.7	71	1.1	1.11						COMBINED FLOW IN PIPE	
P	14	0.11	0.83	5.00	0.09	4.85	0.5									0.5	2.0	18	19.3	29	2.1	0.23						BASIN P DIRECT RUNOFF	
O	15	0.37	0.75	5.00	0.27	4.85	1.3																					BASIN O DIRECT RUNOFF	
ΣDP14 + ΣDP15 + Pipe Flow								5.23	0.37	4.79	1.8					1.8	2.0	18	19.3	35	2.1	0.27						COMBINED FLOW IN PIPE	
ΣDP13 + ΣDP14 + ΣDP15 + Pipe Flow								23.72	4.27	2.57	10.9					10.9	0.5	30	37.7	121	1.1	1.90						COMBINED FLOW IN PIPE	
N	16	0.61	0.37	8.26	0.22	4.16	0.9									0.9	2.0	36	122.6	327	2.1	2.57						BASIN N DIRECT RUNOFF	
Outfall Connection to Existing Main	17							25.62	4.49	2.46	11.0																	TOTAL FLOW TO PR STORM CD22-0011	
Off-Site Flows																													
OS-1	18	0.27	0.05	11.01	0.01	3.72	0.1																					BASIN OS-1 DIRECT RUNOFF	
Swale Analysis Basin																													
F1		0.22	0.40	7.65	0.09	4.27	0.4																						

Project Name:		Avilla Founders Village		STANDARD FORM SF-2								Designed By:		RCP	
Project No:		210431		Post-Development								Checked By:		RCP	
Date:		07/29/22		Rational Method Procedure								Design Storm:		100 YR	
Revised:		10/12/22													

BASIN (s)	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				STREET/INLET					STORM SEWER PIPE				TRAVEL TIME			CARRYOVER FLOWS					REMARKS
		AREA (AC)	RUNOFF COEFF	Tc (min)	C x A (AC)	I (IN/HR)	DIRECT RUNOFF, Q (CFS)	Tc (min)	Σ(C x A) (AC)	I (IN/HR)	TOTAL RUNOFF, Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	INLET DESIGN FLOW (CFS)	STREET OR INLET INTERCEPTION (CFS)	CARRYOVER (CFS)	DESIGN FLOW (CFS)	PIPE SLOPE (%)	PIPE SIZE (IN)	Q _{FULL} (CFS)	LENGTH (FT)	VELOCITY (FPS)	Tt (min)	Σ(C x A) BYPASS (AC)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	Tt (min)	
A	1	0.66	0.75	6.47	0.49	8.19	4.1									4.1	0.5	18	9.7	43	1.1	0.68						BASIN A DIRECT RUNOFF	
B	2	0.57	0.68	10.55	0.39	6.88	2.7	11.31	0.88	6.69	5.9					2.7	0.5	18	9.7	48	1.1	0.76						BASIN B DIRECT RUNOFF	
ΣDP1 + ΣDP2																5.9	0.5	18	9.7	92	1.1	1.44						COMBINED FLOW IN PIPE	
C	3	0.44	0.68	9.34	0.30	7.22	2.2									2.2	0.5	18	9.7	31	1.1	0.48						BASIN C DIRECT RUNOFF	
D	4	0.54	0.82	5.13	0.44	8.76	3.9	9.82	0.74	7.08	5.3					5.3	0.5	18	9.7	95	1.1	1.50						BASIN D DIRECT RUNOFF	
ΣBasin C + Basin D + Pipe Flow																												COMBINED FLOW IN PIPE	
ΣDP1 + ΣDP2 + ΣDP3 + ΣDP4								12.75	1.63	6.36	10.3					10.3	0.5	24	20.8	152	1.1	2.39							COMBINED FLOW IN PIPE
F	5	0.77	0.70	8.53	0.53	7.47	4.0									4.0	0.5	18	9.7	52	1.1	0.82						BASIN F DIRECT RUNOFF	
G	6	0.28	0.81	5.00	0.23	8.82	2.0	9.35	0.76	7.22	5.5					5.5	0.5	18	9.7	14	1.1	0.21						BASIN G DIRECT RUNOFF	
ΣDP5 +ΣDP6																												COMBINED FLOW IN PIPE	
E	7	0.59	0.68	5.44	0.40	8.62	3.4	15.14	2.79	5.88	16.4					3.4	0.5	18	9.7	63	1.1	0.99						BASIN E DIRECT RUNOFF	
ΣDP5 + ΣDP6 + ΣDP7 + Pipe Flow																16.4	0.5	24	20.8	194	1.1	3.04						COMBINED FLOW IN PIPE	
I	8	0.55	0.67	11.03	0.36	6.76	2.5									2.5	2.6	18	21.9	90	2.4	0.62						BASIN I DIRECT RUNOFF	
J	9	1.25	0.75	5.92	0.95	8.42	8.0									8.0	2.0	18	19.3	13	2.1	0.10						BASIN J DIRECT RUNOFF	
ΣDP8 + ΣDP9 + Pipe Flow								18.18	4.10	5.37	22.0					22.0	0.5	24	20.8	65	1.1	1.02							COMBINED FLOW IN PIPE
K	10	0.58	0.72	6.58	0.42	8.15	3.4									3.4	3.0	18	23.7	67	2.6	0.43						BASIN K DIRECT RUNOFF	
ΣDP10 + Pipe Flow								19.20	4.52	5.22	23.6					23.6	0.5	24	20.8	87	1.1	1.37							COMBINED FLOW IN PIPE
Q	11	0.15	0.88	5.00	0.13	8.82	1.2									1.2	3.0	18	23.7	12	2.6	0.08						BASIN Q DIRECT RUNOFF	
ΣDP11 + Pipe Flow								20.57	4.65	5.04	23.4					23.4	0.5	24	20.8	91	1.1	1.43							COMBINED FLOW IN PIPE
M	12	0.49	0.69	10.12	0.34	7.00	2.4									2.4	5.0	18	30.5	47	3.4	0.23						BASIN M DIRECT RUNOFF	
ΣDP12 + Pipe Flow								22.00	4.98	4.86	24.2					24.2	0.5	24	20.8	39	1.1	0.62							COMBINED FLOW IN PIPE
L	13	0.76	0.69	9.87	0.52	7.07	3.7									3.7	3.0	18	23.7	14	2.6	0.09						BASIN L DIRECT RUNOFF	
ΣDP13 + Pipe Flow								22.61	5.51	4.79	26.4					26.4	0.5	30	37.7	71	1.1	1.11							COMBINED FLOW IN PIPE
P	14	0.11	0.88	5.00	0.10	8.82	0.9									0.9	2.0	18	19.3	29	2.1	0.23						BASIN P DIRECT RUNOFF	
O	15	0.37	0.84	5.00	0.31	8.82	2.7																					BASIN O DIRECT RUNOFF	
ΣDP14 + ΣDP15 + Pipe Flow								5.23	0.41	8.71	3.6					3.6	2.0	18	19.3	35	2.1	0.27							COMBINED FLOW IN PIPE
ΣDP13 + ΣDP14 + ΣDP15 + Pipe Flow								23.72	5.92	4.66	27.6					27.6	0.5	30	37.7	121	1.1	1.90							COMBINED FLOW IN PIPE
N	16	0.61	0.65	8.26	0.40	7.55	3.0									3.0	2.0	36	122.6	327	2.1	2.57						BASIN N DIRECT RUNOFF	
Outfall Connection to Existing Main	17							25.62	6.31	4.47	28.2																		TOTAL FLOW TO PR STORM CD22-0011
Off-Site Flows																													
OS-1	18	0.27	0.49	11.01	0.13	6.77	0.9																						BASIN OS-1 DIRECT RUNOFF
Swale Analysis Basin																													
F1	18	0.22	0.67	7.65	0.14	7.76	1.1																						

1-HR Rainfall

<u>Return Interval (YR)</u>	<u>1-hour Rainfall</u>
2	0.97
5	1.43
10	1.55
100	2.6

ONE-HOUR RAINFALL DESIGN VALUES
FROM TCR STORM DRAINAGE DESIGN
AND TECHNICAL CRITERIA MANUAL

DIRECT RUNOFF SUMMARY TABLE			
BASIN	AREA (AC)	Q ₅ (CFS)	Q ₁₀₀ (CFS)
A	0.66	1.7	4.1
B	0.57	0.9	2.7
C	0.44	0.8	2.2
D	0.54	1.8	3.9
E	0.59	1.2	3.4
F	0.77	1.5	4.0
G	0.28	0.9	2.0
I	0.55	0.8	2.5
J	1.25	3.3	8.0
K	0.58	1.3	3.4
L	0.76	1.3	3.7
M	0.49	0.8	2.4
N	0.61	0.9	3.0
O	0.37	1.3	2.7
P	0.11	0.5	0.9
Q	0.15	0.6	1.2
OS-1	0.27	0.1	0.9

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

Project:		Project#		Applicant:
Section	Questions	Response	Check those that apply	Instructions
1	Non-applicable Sites			
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			
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.

Section	Questions	Response	Check those that apply	Instructions
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.
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 No	☐ ☒	Proceed to next line. Proceed to 3.3.2.
	Is the project site greater than 10% impervious?	No Yes	☐ ☐	Project is excluded. Submit variance for <u>Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
	Is the project site greater than 20% impervious?	Yes No	☐ ☐	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	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>Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.

Section	Questions	Response	Check those that apply	Instructions
3.3.2	Will 100% of the runoff from the residential or commercial site be captured?	Yes No	☒ ☐	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is all or a portion of the site undeveloped or will it remain undeveloped after construction?	Yes No	☐ ☐	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. Proceed to next line.
	Is the remaining untreated impervious area greater than 20% of the site?	Yes No	☐ ☐	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is the remaining untreated impervious area greater than one acre?	Yes No	☐ ☐	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is it practicable to capture runoff from portions of the site that will not drain to a control measure?	No Yes	☐ ☐	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. This exclusion does not apply. Permanent water quality is required.



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 AVILLA FOUNDERS VILLAGE

Project Owner DEVELOPER: NEXMETRO COMMUNITIES

Project Location NORTHWEST CORNER OF MIKELSON BLVD AND MITCHELL STREET

ToCR Project Number CD22-0035

Total Site Area 9.03 acres

Total Size of Common Plan of Development 9.10 acres

Check all that apply:

☐ Project within Plum Creek Basin

☒ Project within Cherry Creek Basin

Estimated construction completion date FALL 2024

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. CD21-0048

☐ 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: _____ acres

Total Site area: _____ acres, _____ % 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

APPENDIX D

Floodplain Modification Letter

Master Report References

Phase III Drainage Report

**Founders Village Filing 24 – 1st Amendment
CD21-0011**

Prepared for:

Fourth Investments, LLC
PO Box 5127
Gypsum, Colorado 81637
(970) 470.2087 voice
Contact: John V. Hill

Prepared by:



May 28, 2021
Project No. 17026.002

Introduction – General Location and Description

INTRODUCTION

This Phase III Drainage Report presents an analysis for the existing and future drainage patterns and requirements for the Founders Village Filing 24 - 1st Amendment, hereafter referred to as the Site. The intent of this application is to replat for open space, future multi-family residential site, and the Public Land Dedication area per the Bella Mesa Planned Development Plan recorded January 22, 2016 (Rec. No. 2016004150).

Site Location

Bella Mesa is located in the Town of Castle Rock, more specifically the project is located within the southeast quarter of Section 8, Township 8 South, Range 66 West of the Sixth Principal Meridian, Douglas County, Colorado. The project is bound by Mikelson Boulevard to the south, Mitchell Street to the east, Mitchell Gulch to the west, and Mesa Middle School to the north. Please see the vicinity map in Appendix A for further reference.

There is an existing regional detention pond to the north of the Site that was designed and constructed as a part of the Public Improvement Construction Plans for Founders Village Filing 24 – Phase 1A by Core Consultants dated December 28, 2018. Runoff from the PLD parcel as well as a portion of the future multi-family parcel will flow to the existing regional detention pond. Existing runoff amounts, routing, and release rates will conform with the Phase III Drainage Report for Founders Village Filing 24 – Phase 1A Construction by Core Consultants dated December 28, 2018, hereafter referred to as the Approved Report. There are no active irrigation facilities on or across the limits of the Site.

Site Description

The existing site encompasses approximately 24.56 acres (3.28 acre Tract A, 12.26 acre Tract B, and 9.02 acre Lot 1). Native grasses and weeds currently cover the site and there is an existing floodplain along the western boundary in the Open Space parcel. The Site generally drains to the west towards Mitchell Gulch at slopes between 1% and 33%.

Proposed Project Description

No development is being proposed with this application. A plat is being provided in order to create 3 parcels, Tract A for drainage and utilities, Tract B for the future Public Land Dedication, and Lot 1 for future multi-family development. The Approved Report had designed runoff from the 'C' Basins to outfall into a swale at Basin C-1 located in Tract B. This swale runs north through the center of Tract B before being collected by a Type 'C' Inlet and ultimately conveyed to the existing detention pond in Tract A. As part of this application, it is being proposed to connect to the existing storm sewer at the discharge point into the Basin C-1 swale, and route these flows

in a proposed storm sewer main to the west then north before out falling into the existing detention pond. By routing these flows further west before conveying it to the pond Tract B will become a more efficient parcel to develop in the future. The proposed storm sewer will be sized to not only accommodate the flows from the 'C' Basins of Founders Village Filing 24 but also future developed flows from Lot 1 and Tract B. This application does not propose an increase in the current impervious area but will approximate the future impervious values in order to ensure the storm sewer is being designed for future developed use.

Flood Hazard and Drainage Studies Relevant to the Site

Based on the FEMA FIRM, Map 08035C0306G, effective date March 16, 2016, which can be found in Appendix A, the PLD parcel and the future multi-family parcel are located within Zone X (Area of Minimal Flood Hazard) and are not located within a 100-year floodplain. Located in the existing Tract S of Founders Village Filing 24 is Mitchell Gulch which contains a FEMA designated Zone AE floodway. Proposed Tracts A, B, and Lot 1 will not encroach into Mitchell Gulch or the regulated FEMA floodplain.

Soil Type

The Natural Resource Conservation Service (NRCS) soil survey site map indicates that the soil on site is primarily Coni rocky loam (79.9%), whose hydrologic soil group is Type D, having a very slow infiltration rate and Fondis clay loam (20.1%), whose hydrologic soil group is Type C, having a slow infiltration rate. A soil map has been included in Appendix A for reference.

Drainage Basin and Sub-Basins

Major Basins

Based on the Founders Village Filing 24 Rock Canyon Phase III Drainage Report by TCB dated April 2006, the Site lies within major Basins H-1 and H-3. These basins generally flowed northwest to Mitchell Gulch on the west side of the property. Mitchell Gulch outfalls to Cherry Creek approximately two miles downstream of the property. These major Basins were divided into sub-basins in the Approved Report by Core Consultants. The intent of this application is to remain in conformance with the Approved Report and modify the sub-basins west of Mitchell Street to better route runoff around Tract B and ultimately to the existing detention pond.

Sub Basins

Basin A1 (5.08 Acres)

Basin A1 is undeveloped land located within Lot 1 on the west side of Mitchell Street. Generally, runoff from this basin sheet flows to the west and is collected in various ravines that outfall into

Mitchell Gulch. The current overall imperviousness is 2%. This condition will remain until future development will be required to treat and detain the runoff. It is anticipated that the future development will have an overall imperviousness of 70% and the runoff will flow northwest to Design Point 1 where it will be collected and enter the proposed storm sewer. Runoff will then be conveyed north in the storm sewer to the existing detention pond. Basin A1 is anticipated to produce approximately 13.0 cfs in the 5-year event and 29.9 cfs in the 100-year event in the fully developed condition.

$$C_5 = 0.61 \quad C_{100} = 0.77$$

$$Q_5 = 13.0 \text{ CFS} \quad Q_{100} = 29.9 \text{ CFS}$$

Basin A2 (8.06 Acres)

Basin A2 is undeveloped land located in Tract B on the west side of Mitchell Street just south of the existing detention pond and Mesa Middle School. Generally, runoff from this basin sheet flows to the north and west. The basin currently contains a swale running from the southeast end of the basin up to the northwestern corner. This swale conveys runoff from the Founders Village Filing 24 development on the east side of Mitchell Street to the existing detention pond.

The current overall imperviousness is 2%. This condition will remain until future development will be required to treat and detain the runoff. It is anticipated that the future development will have an overall imperviousness of 70% and the runoff will flow northwest to Design Point 2 where it will be collected and enter the proposed storm sewer. The anticipated impervious value was provided by the Douglas County School District engineer, the correspondence with the School District engineer can be found in Appendix D. Runoff will then be conveyed north in the storm sewer to the existing detention pond. Basin A2 is anticipated to produce approximately 19.9 cfs in the 5-year event and 45.8 cfs in the 100-year event in the fully developed condition.

$$C_5 = 0.61 \quad C_{100} = 0.77$$

$$Q_5 = 19.9 \text{ CFS} \quad Q_{100} = 45.8 \text{ CFS}$$

Basin A3 (2.60 Acres)

Basin A3 is undeveloped land located in Tract B on the west side of Mitchell Street, just east of the existing detention pond and south of Mesa Middle School. Generally, runoff from this basin sheet flows to the west and is collected in the existing detention pond. The current overall imperviousness is 2%. This condition will remain until future development will be required to treat and detain the runoff. It is anticipated that the future development will have an overall imperviousness of 70% and the runoff will flow west to Design Point 3 where it will enter the

existing detention pond. Basin A3 is anticipated to produce approximately 7.8 cfs in the 5-year event and 17.9 cfs in the 100-year event in the fully developed condition.

$$C_5 = 0.61 \quad C_{100} = 0.77$$

$$Q_5 = 7.8 \text{ CFS} \quad Q_{100} = 17.9 \text{ CFS}$$

Basin B1 (3.76 Acres)

Basin B1 is undeveloped land located in Lot 1 at the northwest corner of Mitchell Street and Mickelson Boulevard. Generally, runoff from this basin sheet flows to the southwest and into Mitchell Gulch. The current overall imperviousness is 2%. This condition will remain until future development will be required to treat and detain the runoff. Since this basin currently flows away from the existing detention pond, it is anticipated that the future development will provide water quality for this runoff and will over-detain in the existing detention pond so the site as a whole remains at historical release rates. It is also anticipated the overall imperviousness of the site will be 70% and the runoff will flow west to Mitchell Gulch at Design Point 4. Basin B1 is anticipated to produce approximately 8.1 cfs in the 5-year event and 18.6 cfs in the 100-year event in the fully developed condition.

$$C_2 = 0.61 \quad C_{100} = 0.77$$

$$Q_2 = 8.1 \text{ CFS} \quad Q_{100} = 18.6 \text{ CFS}$$

Basin B2 (1.46 Acres)

Basin B2 is undeveloped land located in Tract B at the northwest corner of the Site, directly south of the existing detention pond. Generally, runoff from this basin sheet flows to the west and into Mitchell Gulch at Design Point 5. The current overall imperviousness is 2%. This condition will remain, since it is highly unlikely that this basin is developed due to the proximity to Mitchell Gulch and the prevailing existing grades. Basin B2 is anticipated to produce approximately 0.2 cfs in the 5-year event and 4.0 cfs in the 100-year event.

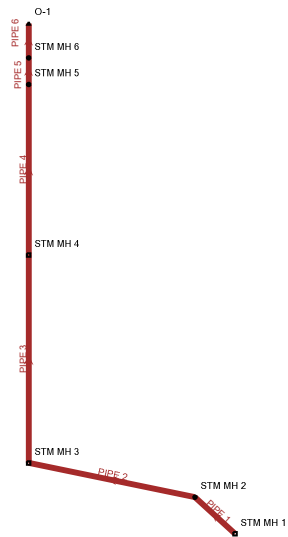
$$C_5 = 0.05 \quad C_{100} = 0.49$$

$$Q_5 = 0.2 \text{ CFS} \quad Q_{100} = 4.0 \text{ CFS}$$

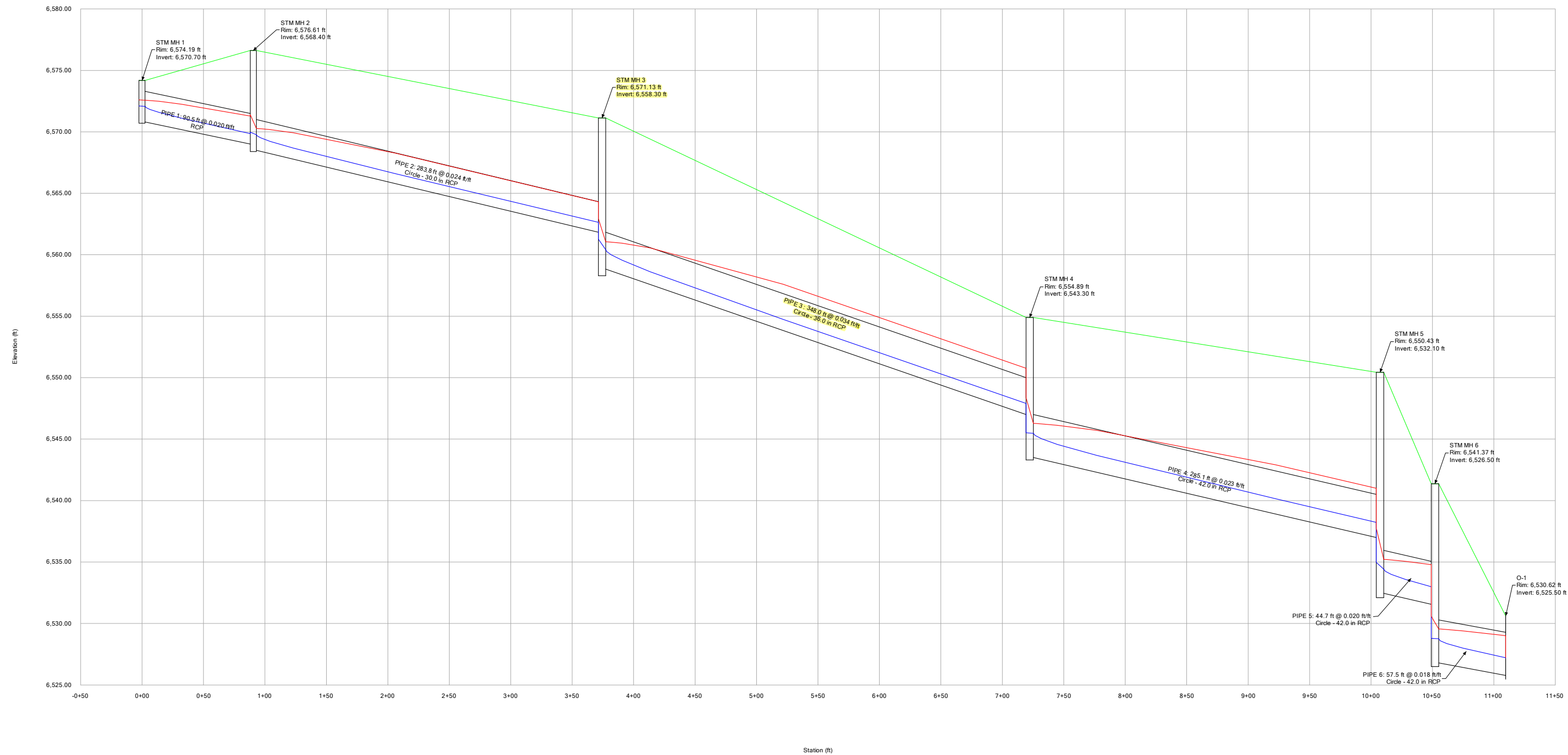
Basin C1 (3.32 Acres)

Basin C1 is undeveloped land located in Tract A at the northwest corner of the Site. Generally, runoff from this basin sheet flows into the existing detention pond and outfalls to Mitchell Gulch at Design Point 6. The current overall imperviousness is 2%. This condition will remain, since it is

STORM SYSTEM MAP



5-YEAR
Profile Report
Engineering Profile - Profile - 1 (17026.002_Bella Mesa PLD_StormCAD.stsw)



5-YEAR

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	External Tc (min)	External CA (acres)	Headloss Coefficient (Standard)	Inlet Type	Hydraulic Grade Line (In) (ft)	Energy Grade Line (Out) (ft)	Energy Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
52	STM MH 3	6,571.13	6,571.13	8.000	3.090	1.320	Full Capture	6,561.26	6,561.06	6,562.93	6,560.42
53	STM MH 4	6,554.89	6,554.89	8.900	4.910	0.050	Full Capture	6,545.52	6,546.28	6,548.37	6,545.48
54	STM MH 1	6,574.19	6,574.19	13.600	4.180	0.050	Full Capture	6,572.10	6,572.58	6,572.60	6,572.07

5-YEAR

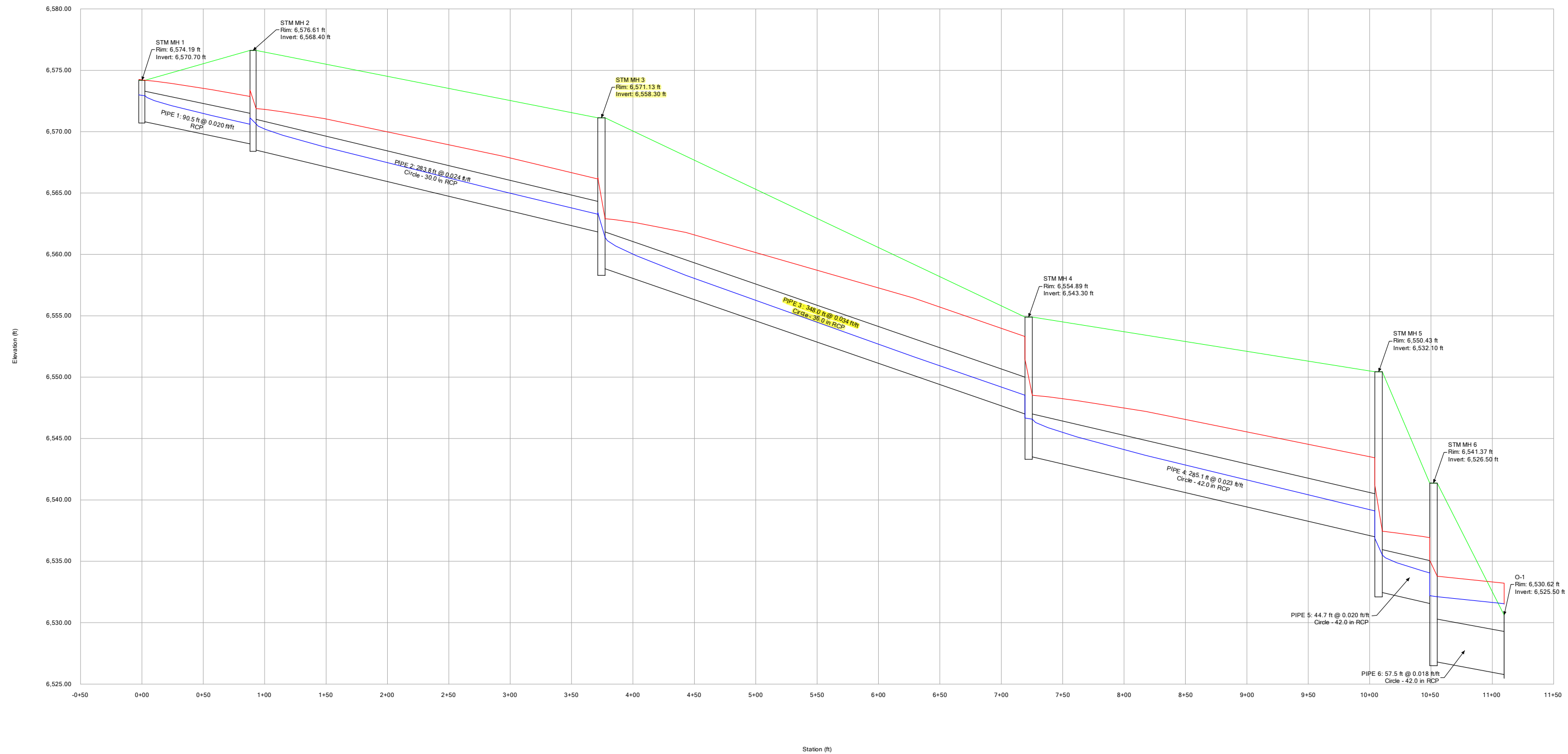
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Velocity (ft/s)	Slope (Calculated) (ft/ft)	Diameter (in)	Length (3D) (ft)	Flow (cfs)	Capacity (Full Flow) (cfs)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Manning's n
PIPE 1	STM MH 1	STM MH 2	6,570.80	6,569.00	9.76	0.020	30.0	90.5	14.31	57.79	6,572.58	6,571.29	6,572.07	6,569.86	0.013
PIPE 2	STM MH 2	STM MH 3	6,568.50	6,561.83	10.36	0.024	30.0	283.9	14.24	62.90	6,570.28	6,564.31	6,569.77	6,562.64	0.013
PIPE 3	STM MH 3	STM MH 4	6,558.83	6,547.00	13.55	0.034	36.0	347.9	24.40	122.98	6,561.06	6,550.76	6,560.42	6,547.91	0.013
PIPE 4	STM MH 4	STM MH 5	6,543.50	6,537.00	13.34	0.023	42.0	285.2	40.32	151.91	6,546.28	6,541.00	6,545.48	6,538.23	0.013
PIPE 5	STM MH 5	STM MH 6	6,532.45	6,531.56	12.67	0.020	42.0	45.0	39.86	142.01	6,535.21	6,534.79	6,534.41	6,532.99	0.013
PIPE 6	STM MH 6	O-1	6,526.79	6,525.78	12.10	0.018	42.0	57.5	39.79	133.32	6,529.55	6,529.00	6,528.75	6,527.21	0.013

100-YEAR

Profile Report

Engineering Profile - Profile - 1 (17026.002_Bella Mesa PLD_StormCAD.stsw)



100-YEAR

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	External Tc (min)	External CA (acres)	Headloss Coefficient (Standard)	Inlet Type	Hydraulic Grade Line (In) (ft)	Energy Grade Line (Out) (ft)	Energy Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
52	STM MH 3	6,571.13	6,571.13	8.000	3.920	1.320	Full Capture	6,563.40	6,562.91	6,566.26	6,561.39
53	STM MH 4	6,554.89	6,554.89	8.900	6.210	0.050	Full Capture	6,546.67	6,548.53	6,551.46	6,546.58
54	STM MH 1	6,574.19	6,574.19	13.600	6.450	0.050	Full Capture	6,573.00	6,574.19	6,574.26	6,572.93

100-YEAR

FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Velocity (ft/s)	Slope (Calculated) (ft/ft)	Diameter (in)	Length (3D) (ft)	Flow (cfs)	Capacity (Full Flow) (cfs)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Manning's n
PIPE 1	STM MH 1	STM MH 2	6,570.80	6,569.00	12.72	0.020	30.0	90.5	40.15	57.79	6,574.19	6,572.87	6,572.93	6,570.61	0.013
PIPE 2	STM MH 2	STM MH 3	6,568.50	6,561.83	13.57	0.024	30.0	283.9	40.00	62.90	6,571.89	6,566.14	6,570.63	6,563.28	0.013
PIPE 3	STM MH 3	STM MH 4	6,558.83	6,547.00	17.55	0.034	36.0	347.9	63.57	122.98	6,562.91	6,553.31	6,561.39	6,548.53	0.013
PIPE 4	STM MH 4	STM MH 5	6,543.50	6,537.00	16.88	0.023	42.0	285.2	100.56	151.91	6,548.53	6,543.43	6,546.58	6,539.10	0.013
PIPE 5	STM MH 5	STM MH 6	6,532.45	6,531.56	15.98	0.020	42.0	45.0	99.65	142.01	6,537.45	6,536.93	6,535.52	6,534.05	0.013
PIPE 6	STM MH 6	O-1	6,526.79	6,525.78	10.34	0.018	42.0	57.5	99.51	133.32	6,533.77	6,533.21	6,532.11	6,531.55	0.013

Memorandum

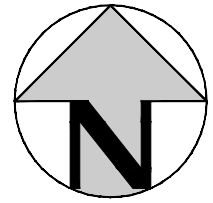
To: Town of Castle Rock, CO
Development Services Department
From: Mark A. West, PE, CFM
CC: Rachel Patton, PE
Date: December 3, 2021
Project No.: 210431
Re: Avilla Bella Mesa – Preliminary Floodplain Modification Study

INTRODUCTION

Harris Kocher Smith was retained by NexMetro Communities to provide engineering services for a proposed single-story residential community, Avilla Bella Mesa, in the Founder's Village subdivision of the Town of Castle Rock, CO ("Town"). The project site is adjacent to Mitchell Gulch and a Zone X (Shaded) flood hazard area, as shown on the FEMA Flood Insurance Rate Map ("FIRM") for Douglas County, CO, Map Number 08035C0306G, revised March 16, 2016. The floodplain shown therein was delineated via approximate methods, corresponding to the 500-year storm event. The area was studied in more detail as part of the Mitchell Gulch Watershed Master Plan Preliminary Design Report ("Master Plan"), completed by C2HM Hill for the Town in 2006. The Town requested that the 100-year floodplain be delineated based on this study to ensure that no lots lie within the floodplain, and that all finished floor elevations ("FFE") are at least two feet above the adjacent floodplain base flood elevations ("BFE"). This request was made for use by the Town only, and no official floodplain modifications shall be submitted to FEMA.

ANALYSIS

A supplemental topographic survey was completed by Harris Kocher Smith in November 2021 for the area surrounding Mitchell Gulch. Water surface elevations ("WSEs") at specific stream stations were derived from the Master Plan's plan and profile sheets 4 and 5. The WSEs were delineated perpendicular to the stream centerline in order to develop the floodplain boundaries and BFEs. This revised existing floodplain boundary may be found in the attached exhibit.



PRELIMINARY FLOODPLAIN MODIFICATION STUDY EXHIBIT

SCALE: 1"=100'



SCALE: 1" = 200'

APPENDIX E

StormCAD Analysis

Inlet Capacity Calculations

Scenario: 5 YR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Label	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)	Notes	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
A-1 (p-storm)	6,558.48	6,557.87	120.8	122.7	0.005	Circle	30.0	0.013	10.90	5.49	2.55	29.00	37.6	42.5	30" RCP	6,560.47	6,560.42
A-2 (p-storm)	6,559.21	6,558.96	50.3	50.3	0.005	Circle	24.0	0.013	10.30	5.40	1.52	15.96	64.6	58.5	24" RCP	6,560.54	6,560.48
A-3 (p-storm)	6,559.56	6,559.46	20.5	20.5	0.005	Circle	24.0	0.013	10.30	5.36	1.15	15.81	65.2	58.8	24" RCP	6,560.74	6,560.61
A-4 (p-storm)	6,560.02	6,559.82	39.3	39.3	0.005	Circle	24.0	0.013	9.50	5.31	1.10	16.00	59.4	55.5	24" RCP	6,561.13	6,560.92
A-5 (p-storm)	6,560.73	6,560.27	90.8	90.8	0.005	Circle	24.0	0.013	9.30	5.28	1.09	16.00	58.1	54.7	24" RCP	6,561.82	6,561.36
A-6 (p-storm)	6,561.41	6,560.97	87.0	87.0	0.005	Circle	24.0	0.013	9.20	5.27	1.08	16.00	57.5	54.4	24" RCP	6,562.50	6,562.06
A-7 (p-storm)	6,561.99	6,561.66	64.9	64.9	0.005	Circle	24.0	0.013	8.60	5.18	1.05	15.97	53.9	52.3	24" RCP	6,563.03	6,562.71
A-8 (p-storm)	6,562.91	6,562.23	134.6	134.6	0.005	Circle	24.0	0.013	6.40	4.81	0.88	16.00	40.0	44.0	24" RCP	6,563.80	6,563.11
A-9 (p-storm)	6,564.64	6,564.34	58.9	58.9	0.005	Circle	24.0	0.013	6.40	4.81	0.88	16.00	40.0	44.0	24" RCP	6,565.53	6,565.22
A-10 (p-storm)	6,565.64	6,564.88	151.8	151.8	0.005	Circle	24.0	0.013	4.10	4.26	0.69	16.00	25.6	34.5	24" RCP	6,566.35	6,565.57
A-11 (p-storm)	6,566.60	6,566.14	91.6	91.6	0.005	Circle	18.0	0.013	2.30	3.70	0.57	7.43	31.0	38.2	18" RCP	6,567.17	6,566.72
A-12 (p-storm)	6,567.07	6,566.85	43.2	44.0	0.005	Circle	18.0	0.013	1.70	3.41	0.49	7.43	22.9	32.5	18" RCP	6,567.56	6,567.34
B-1 (p-storm)	6,567.60	6,567.35	48.4	49.9	0.005	Circle	18.0	0.013	0.90	2.84	0.35	7.43	12.1	23.5	18" RCP	6,567.95	6,567.71
C-1 (p-storm)	6,567.00	6,566.63	73.3	85.3	0.005	Circle	24.0	0.013	2.20	3.58	0.50	16.07	13.7	25.0	18" RCP	6,567.52	6,567.13
C-2 (p-storm)	6,567.73	6,567.50	45.0	43.1	0.005	Circle	18.0	0.013	0.80	2.77	0.33	7.51	10.7	22.0	18" RCP	6,568.06	6,567.83
D-1 (p-storm)	6,565.70	6,565.63	13.7	15.2	0.005	Circle	18.0	0.013	2.20	3.66	0.56	7.43	29.6	37.3	18" RCP	6,566.26	6,566.19
D-2 (p-storm)	6,566.22	6,565.95	55.3	59.3	0.005	Circle	18.0	0.013	1.50	3.25	0.46	7.30	20.6	30.8	18" RCP	6,566.68	6,566.41
E-1 (p-storm)	6,565.95	6,565.63	62.9	64.4	0.005	Circle	18.0	0.013	1.20	3.09	0.41	7.43	16.2	27.2	18" RCP	6,566.36	6,566.04
EX-5 (p-storm)	6,558.84	6,557.37	43.3	43.3	0.034	Circle	36.0	0.013	0.90	5.08	3.05	122.94	0.7	6.1	36" RCP	6,560.42	6,560.42
EX-6b (p-storm)	6,568.51	6,564.78	283.7	283.7	0.013	Circle	36.0	0.013	0.90	3.65	0.23	76.48	1.2	7.6	36" RCP	6,568.81	6,565.01
F-1 (p-storm)	6,563.24	6,562.98	12.8	14.3	0.020	Circle	18.0	0.013	3.30	6.76	0.53	14.85	22.2	32.0	18" RCP	6,563.93	6,563.51
G-1 (p-storm)	6,567.65	6,565.34	90.0	91.4	0.026	Circle	18.0	0.013	0.80	4.89	0.22	16.83	4.8	14.8	18" RCP	6,567.99	6,565.57
H-1 (p-storm)	6,564.48	6,562.41	69.3	71.8	0.030	Circle	18.0	0.013	1.30	5.95	0.27	18.14	7.2	18.1	18" RCP	6,564.91	6,562.69
J-1 (p-storm)	6,562.09	6,561.72	12.1	13.6	0.030	Circle	18.0	0.013	0.60	4.75	0.19	18.19	3.3	12.4	18" RCP	6,562.37	6,561.92
K-1 (p-storm)	6,563.38	6,561.02	47.2	48.6	0.050	Circle	18.0	0.013	0.80	6.18	0.19	23.47	3.4	12.6	18" RCP	6,563.71	6,561.21
L-1 (p-storm)	6,560.97	6,560.56	13.7	15.2	0.030	Circle	18.0	0.013	1.30	5.96	0.29	18.19	7.1	18.1	18" RCP	6,561.40	6,560.85
M-1 (p-storm)	6,560.66	6,559.97	34.6	35.7	0.020	Circle	18.0	0.013	1.80	5.69	0.51	14.85	12.1	23.5	18" RCP	6,561.17	6,560.48
M-2 (p-storm)	6,561.50	6,560.91	29.3	32.3	0.020	Circle	18.0	0.013	0.50	3.90	1.02	14.85	3.4	12.6	18" RCP	6,561.92	6,561.93
N-1 (p-storm)	6,571.08	6,570.01	30.4	31.8	0.035	Circle	18.0	0.013	0.90	5.64	0.22	19.64	4.6	14.6	18" RCP	6,571.43	6,570.23

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Scenario: 5 YR
Current Time Step: 0.000 h
FlexTable: Manhole Table

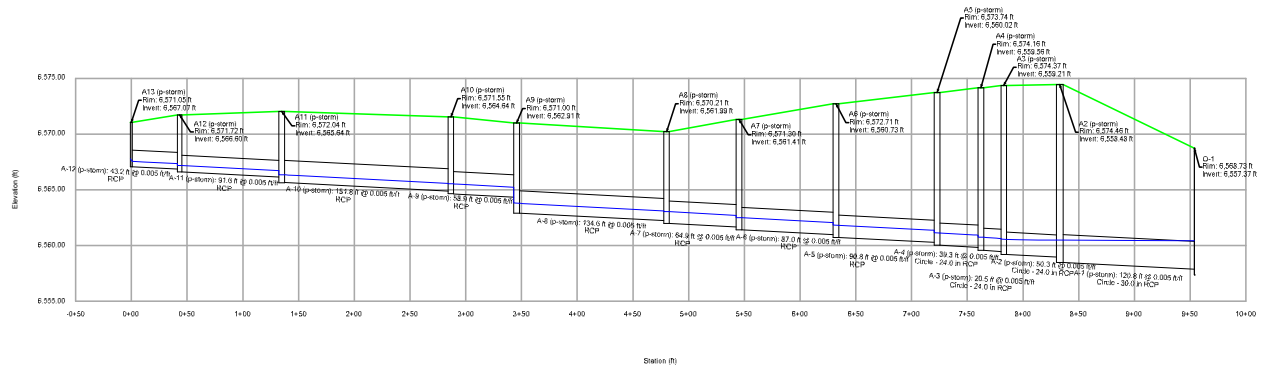
Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)	Notes
A2 (p-storm)	6,574.46	6,574.46	6,558.96	10.90	2.00	6,560.47	HEC-22 Energy (Second Edition)	6,560.48	6"Ø Manhole
A3 (p-storm)	6,574.37	6,574.37	6,559.46	10.30	1.33	6,560.54	HEC-22 Energy (Second Edition)	6,560.56	5"Ø Manhole
A4 (p-storm)	6,574.16	6,574.16	6,560.56	10.30	1.18	6,560.74	HEC-22 Energy (Second Edition)	6,560.74	5"Ø Manhole
A5 (p-storm)	6,573.74	6,573.74	6,561.02	9.50	1.11	6,561.13	HEC-22 Energy (Second Edition)	6,561.14	5"Ø Manhole
A6 (p-storm)	6,572.71	6,572.71	6,561.72	9.30	1.09	6,561.82	HEC-22 Energy (Second Edition)	6,561.83	5"Ø Manhole
A7 (p-storm)	6,571.30	6,571.30	6,562.41	9.20	1.09	6,562.50	HEC-22 Energy (Second Edition)	6,562.50	5"Ø Manhole
A8 (p-storm)	6,570.21	6,570.21	6,565.34	8.60	1.05	6,563.03	Standard	6,563.03	5"Ø Manhole
A9 (p-storm)	6,571.00	6,571.00	6,564.34	6.40	0.90	6,563.80	HEC-22 Energy (Second Edition)	6,563.81	5"Ø Manhole
A10 (p-storm)	6,571.55	6,571.55	6,565.63	6.40	0.90	6,565.53	HEC-22 Energy (Second Edition)	6,565.54	5"Ø Manhole
A11 (p-storm)	6,572.04	6,572.04	6,566.14	4.10	0.71	6,566.35	HEC-22 Energy (Second Edition)	6,566.36	5"Ø Manhole
A12 (p-storm)	6,571.72	6,571.72	6,567.35	2.30	0.57	6,567.17	HEC-22 Energy (Second Edition)	6,567.18	4"Ø Manhole
A13 (p-storm)	6,571.05	6,571.05	(N/A)	1.70	0.49	6,567.56	Standard	6,567.78	Inlet Type 16 Dbl
B1 (p-storm)	6,573.14	6,573.14	(N/A)	0.90	0.35	6,567.95	Standard	6,568.10	Inlet Type C
C1 (p-storm)	6,570.88	6,570.88	6,567.50	2.20	0.52	6,567.52	HEC-22 Energy (Second Edition)	6,567.58	Inlet Type 16 Dbl
C2 (p-storm)	6,570.50	6,570.50	(N/A)	0.80	0.33	6,568.06	Standard	6,568.21	Inlet Type C
D1 (p-storm)	6,571.58	6,571.58	6,565.95	2.20	0.56	6,566.26	HEC-22 Energy (Second Edition)	6,566.34	Inlet Type R 5'
D2 (p-storm)	6,570.81	6,570.81	(N/A)	1.50	0.46	6,566.68	Standard	6,566.89	Inlet Type R 5'
E1 (p-storm)	6,572.48	6,572.48	(N/A)	1.20	0.41	6,566.36	Standard	6,566.54	Inlet Type C
EX5 (p-storm)	6,571.12	6,571.12	6,564.78	0.90	1.58	6,560.42	HEC-22 Energy (Second Edition)	6,560.42	6"Ø Manhole
EX7 (p-storm)	6,576.61	6,576.61	6,570.01	0.90	0.29	6,568.81	HEC-22 Energy (Second Edition)	6,568.81	5"Ø Manhole
F1 (p-storm)	6,570.35	6,570.35	(N/A)	3.30	0.69	6,563.93	Standard	6,564.26	Inlet Type R 10'
G1 (p-storm)	6,572.43	6,572.43	(N/A)	0.80	0.33	6,567.99	Standard	6,568.13	Inlet Type C
H1 (p-storm)	6,571.74	6,571.74	(N/A)	1.30	0.43	6,564.91	Standard	6,565.10	Inlet Type R 5'
J1 (p-storm)	6,572.92	6,572.92	(N/A)	0.60	0.29	6,562.37	Standard	6,562.50	Inlet Type R 5'
K1 (p-storm)	6,575.67	6,575.67	(N/A)	0.80	0.33	6,563.71	Standard	6,563.86	Inlet Type C
L1 (p-storm)	6,574.28	6,574.28	(N/A)	1.30	0.43	6,561.40	Standard	6,561.59	Inlet Type R 5'
M1 (p-storm)	6,572.89	6,572.89	6,560.91	1.80	0.50	6,561.17	HEC-22 Energy (Second Edition)	6,561.93	Inlet Type R 10'
M2 (p-storm)	6,572.11	6,572.11	(N/A)	0.50	0.42	6,561.92	Standard	6,561.95	Inlet Type R 10'
N1 (p-storm)	6,576.65	6,576.65	(N/A)	0.90	0.35	6,571.43	Standard	6,571.59	Inlet Type C

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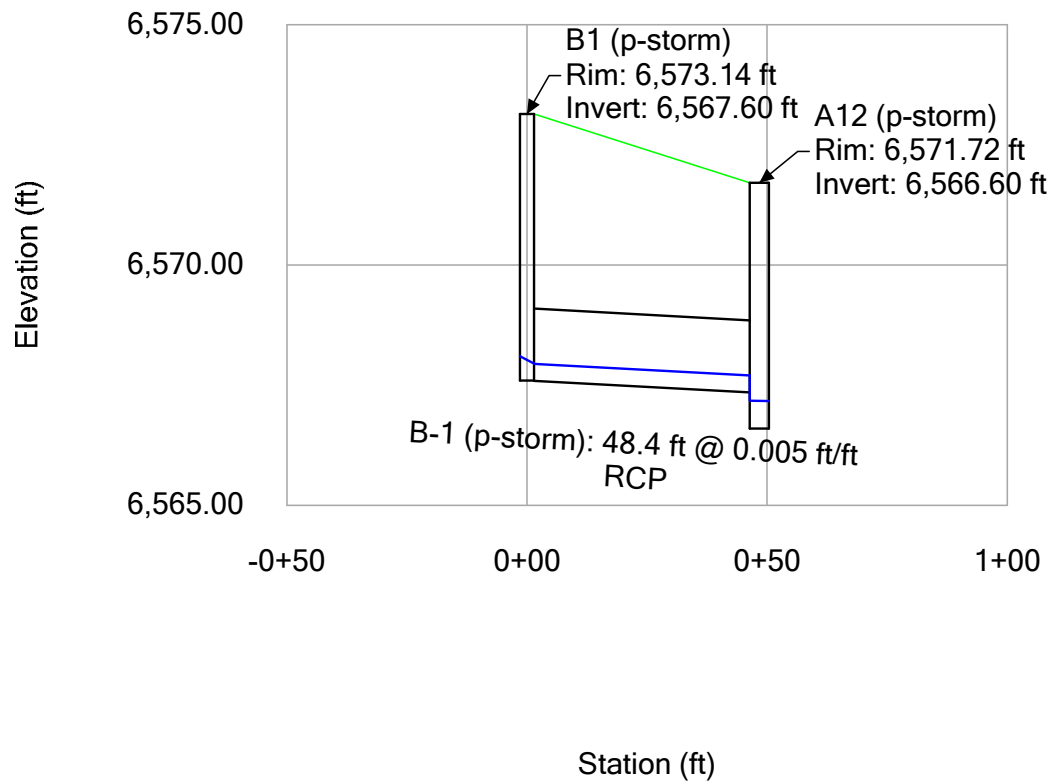
Profile Report

Engineering Profile - Storm Line A (StormCAD.stsw)

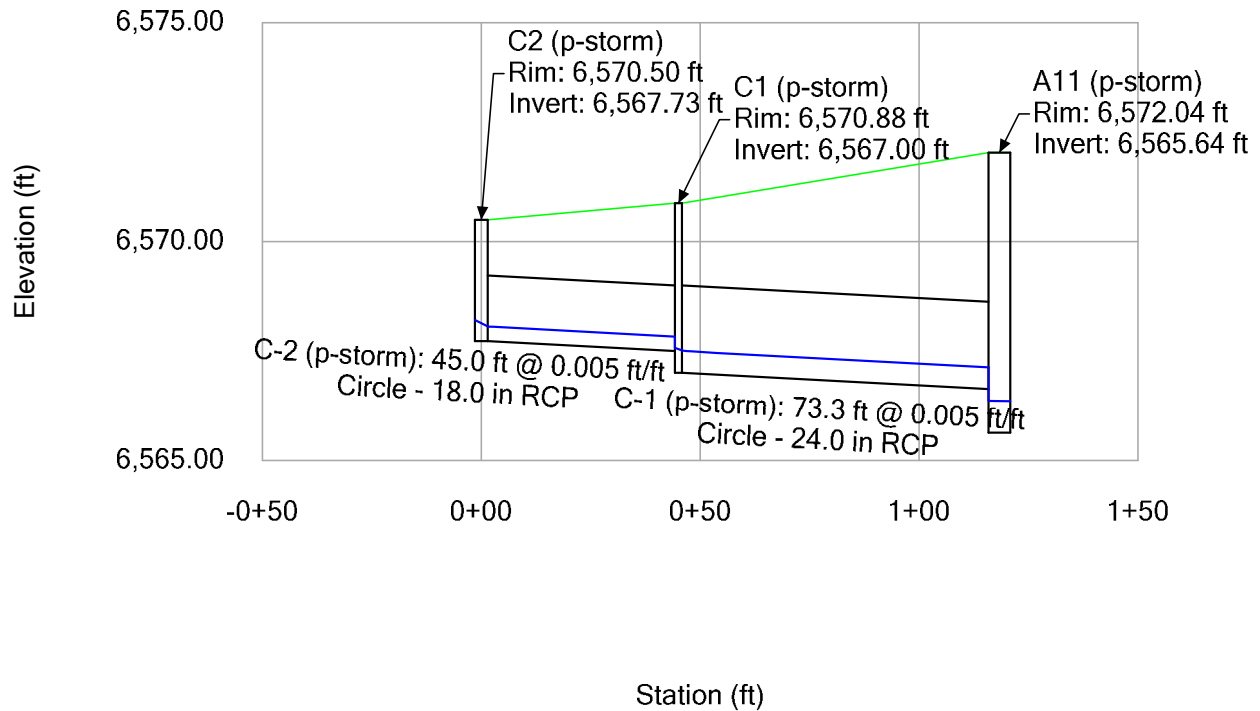
Active Scenario: 5 YR



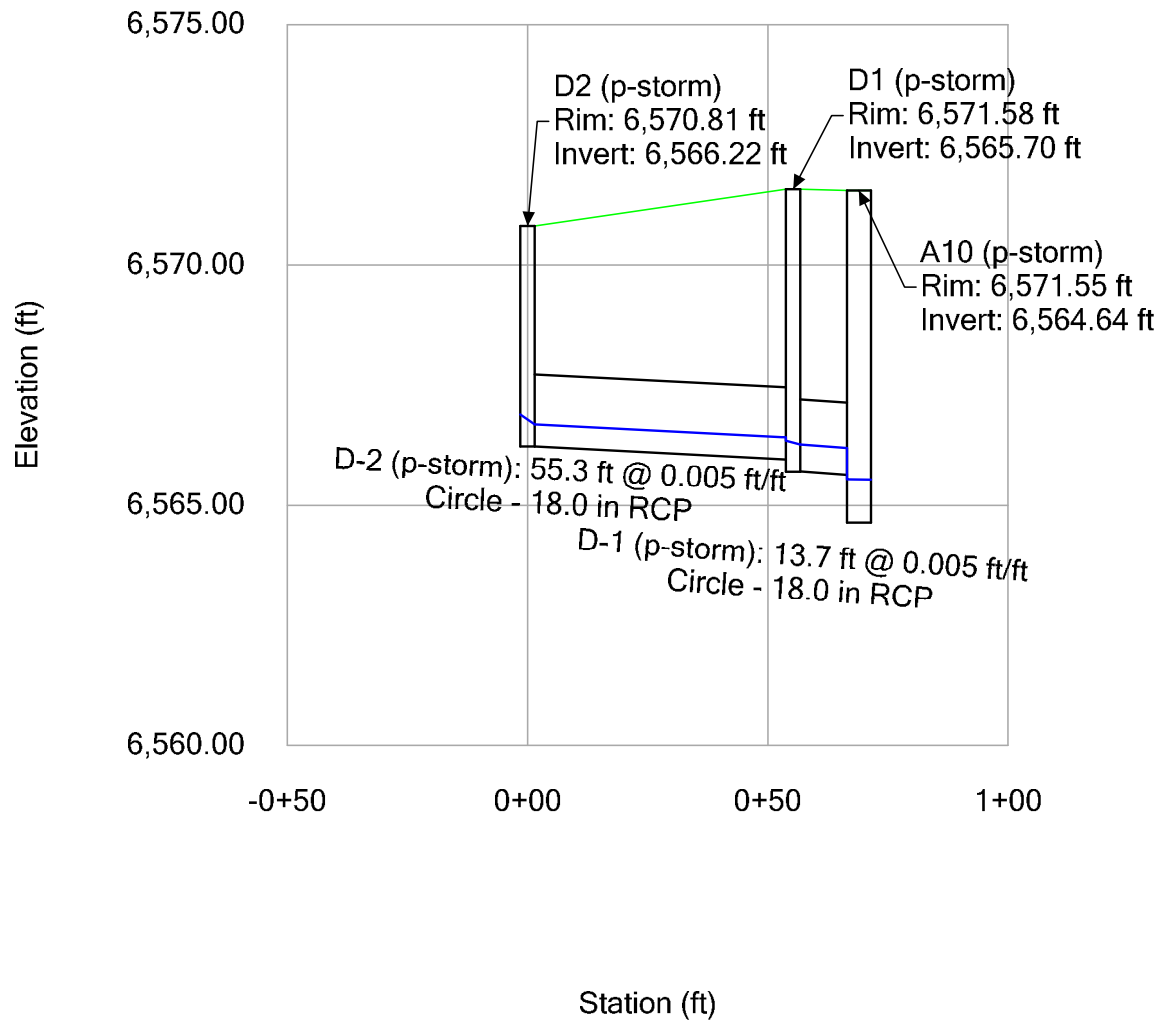
Profile Report
Engineering Profile - Storm Line B (StormCAD.stsw)
Active Scenario: 5 YR



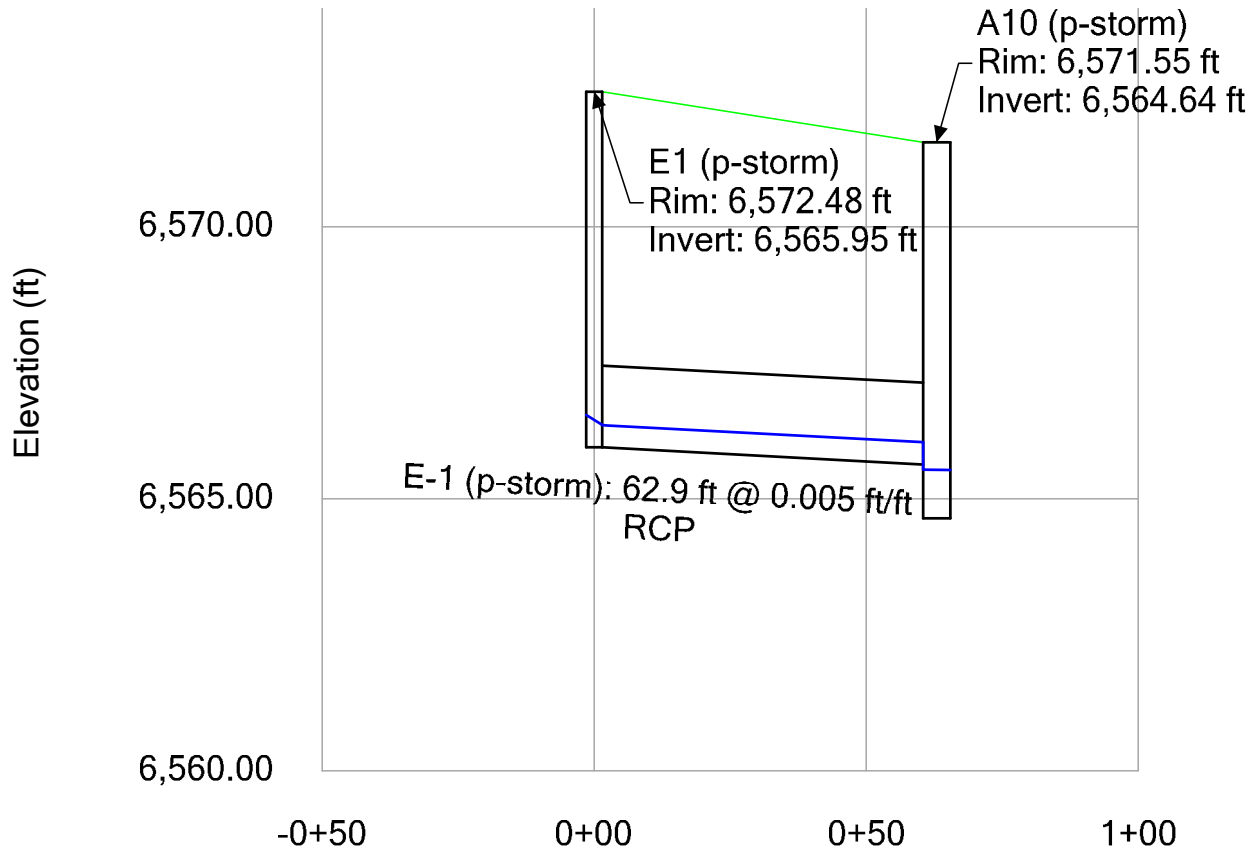
Profile Report
Engineering Profile - Storm Line C (StormCAD.stsw)
Active Scenario: 5 YR



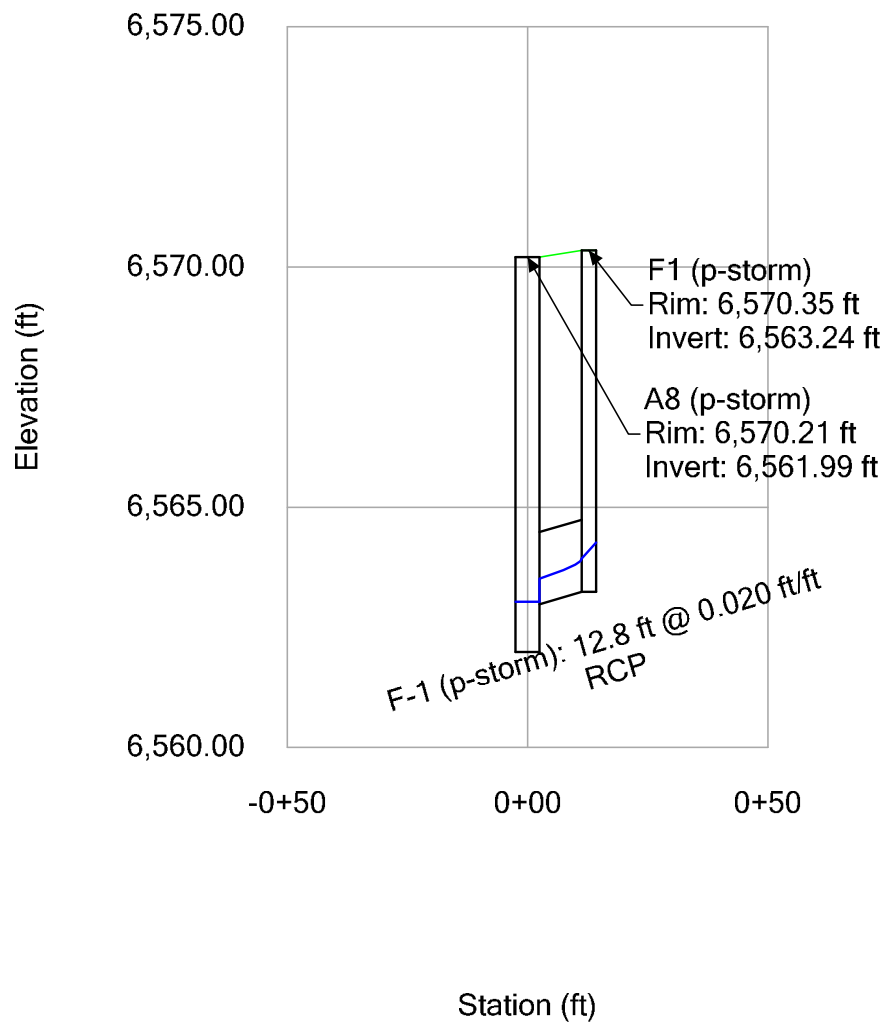
Profile Report
Engineering Profile - Storm Line D (StormCAD.stsw)
Active Scenario: 5 YR



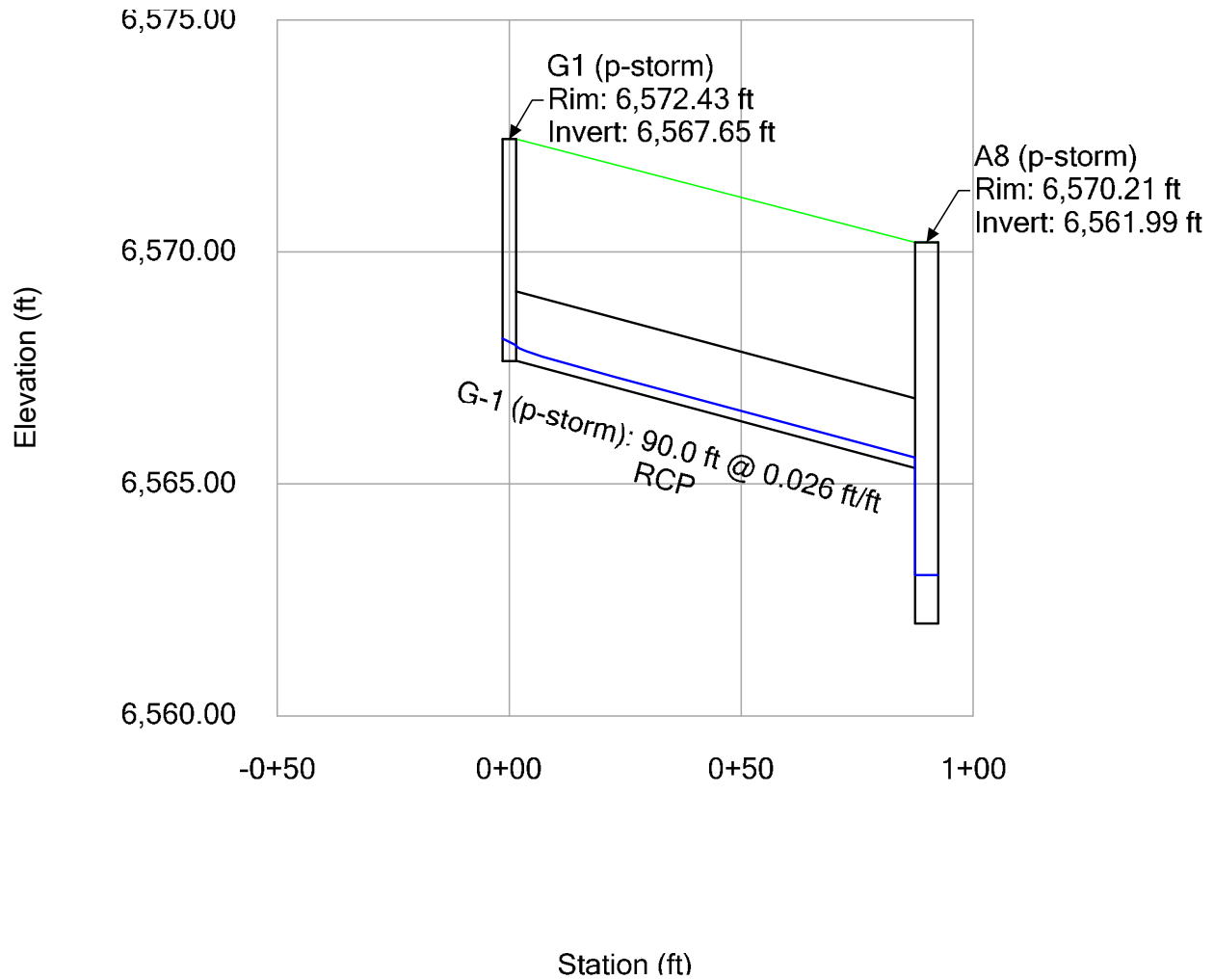
Profile Report
Engineering Profile - Storm Line E (StormCAD.stsw)
Active Scenario: 5 YR



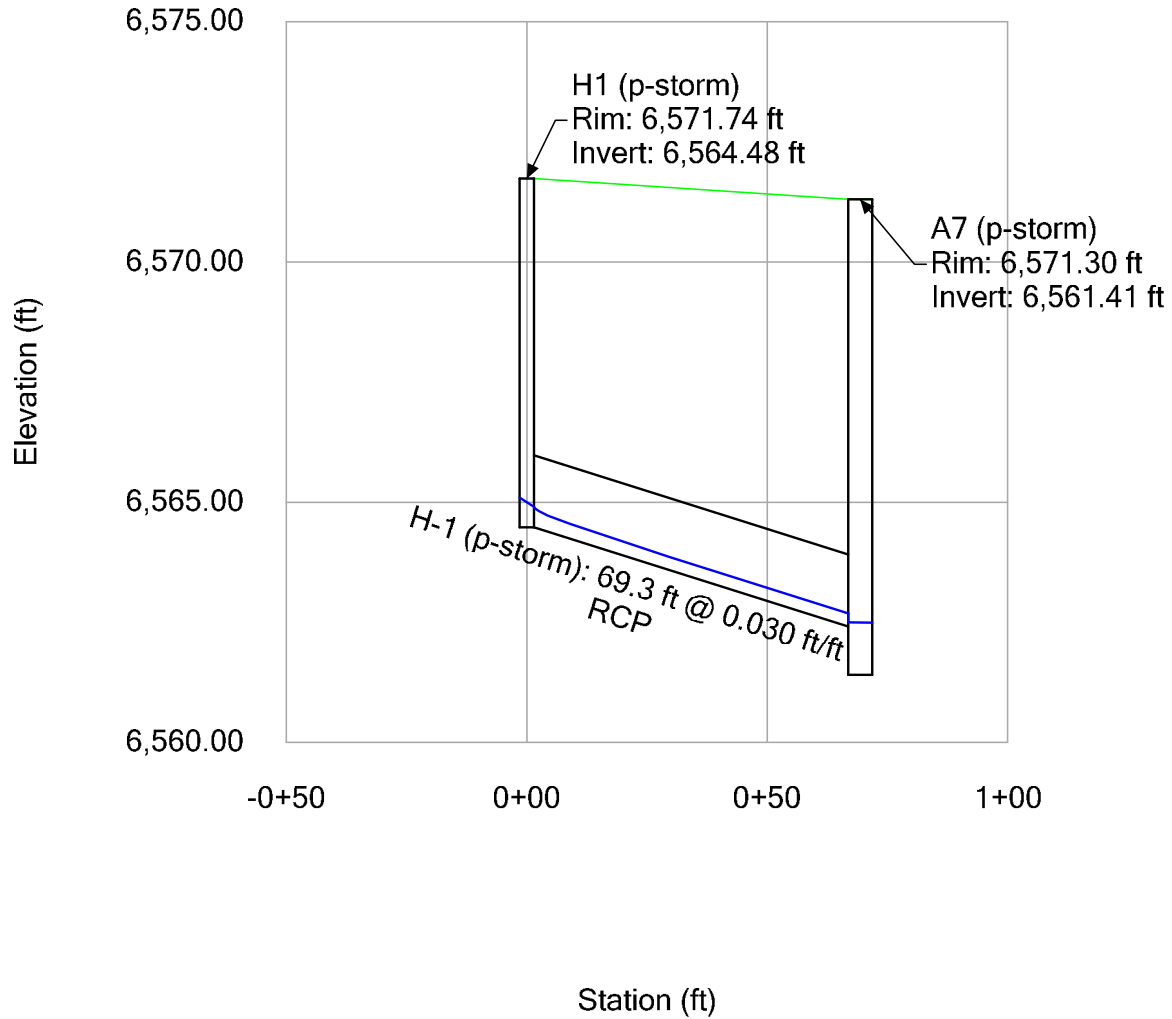
Profile Report
Engineering Profile - Storm Line F (StormCAD.stsw)
Active Scenario: 5 YR



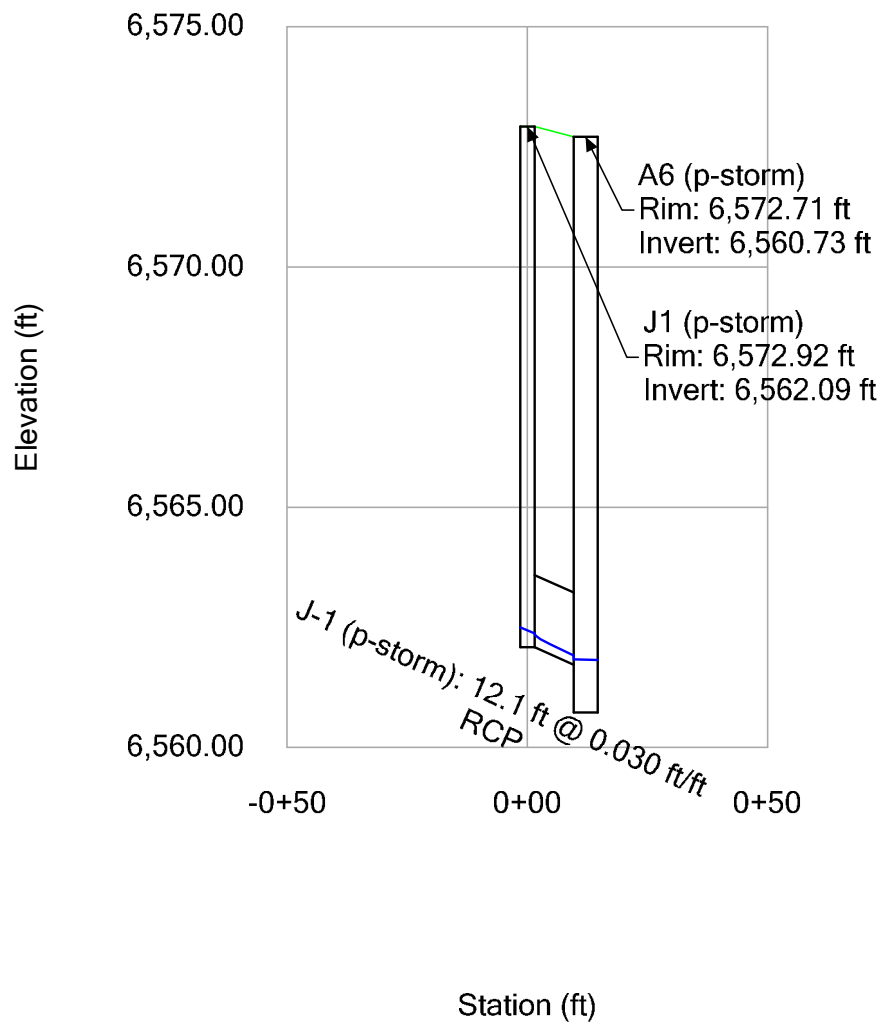
Profile Report
Engineering Profile - Storm Line G (StormCAD.stsw)
Active Scenario: 5 YR



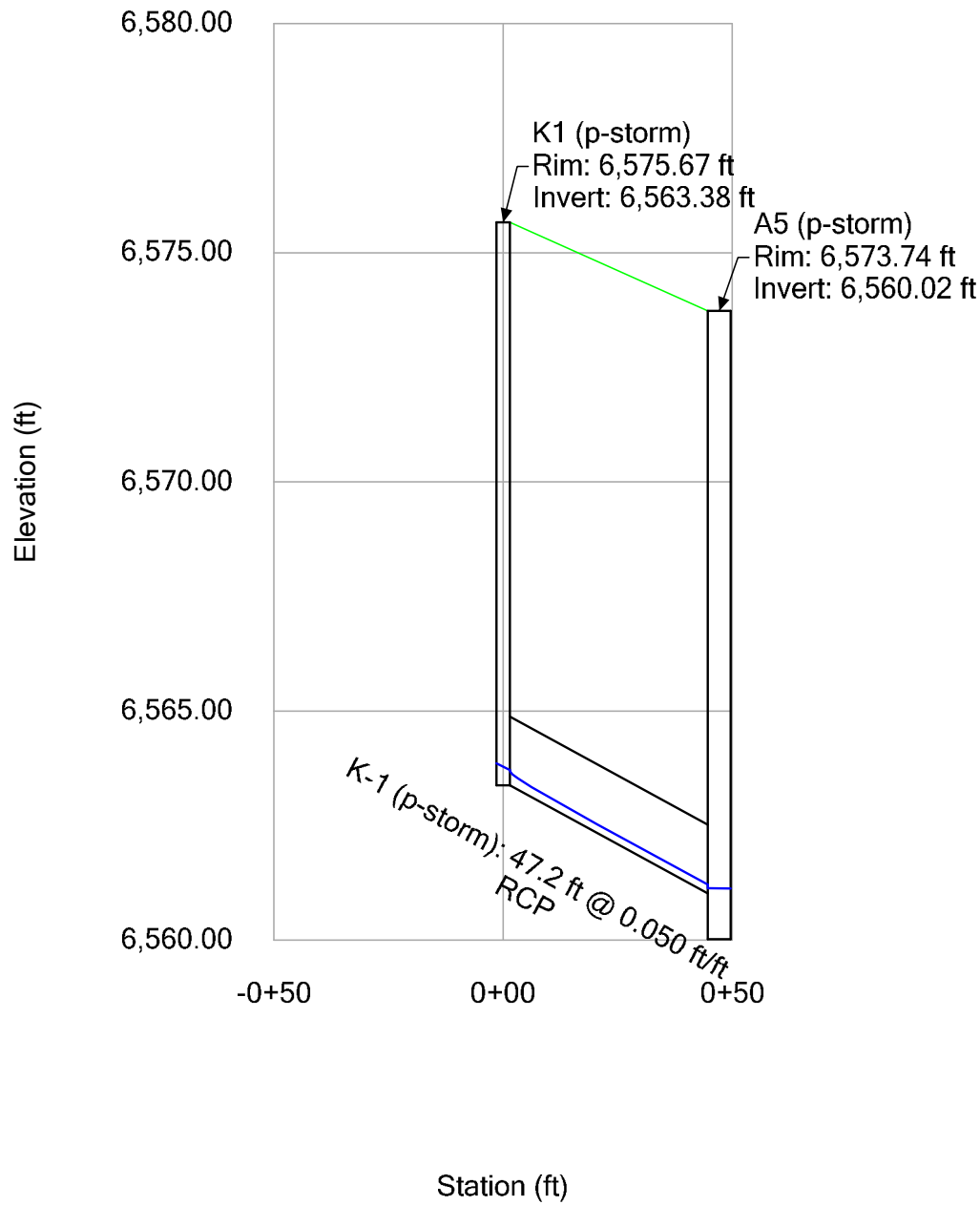
Profile Report
Engineering Profile - Storm Line H (StormCAD.stsw)
Active Scenario: 5 YR



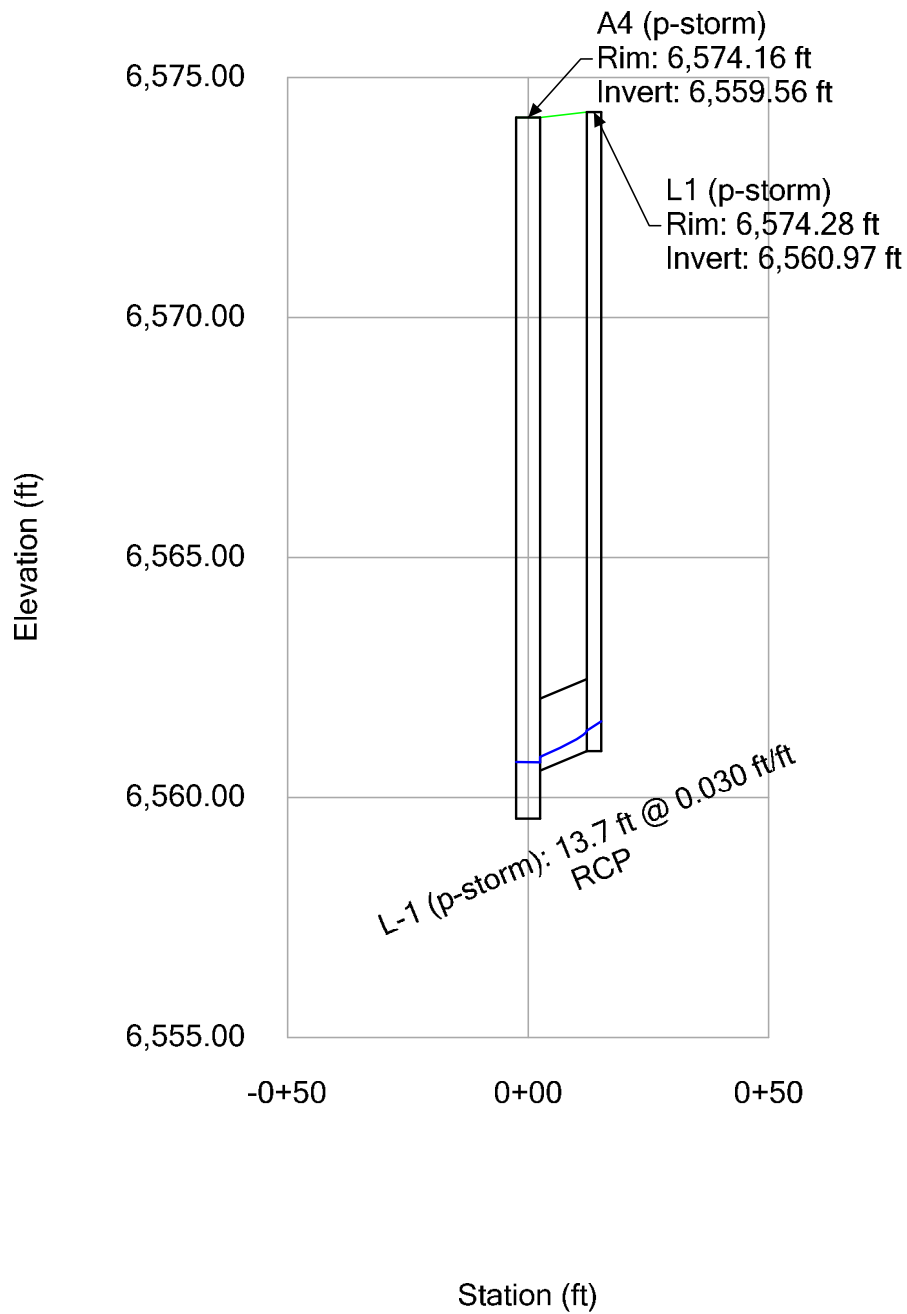
Profile Report **Engineering Profile - Storm Line J (StormCAD.stsw)** **Active Scenario: 5 YR**



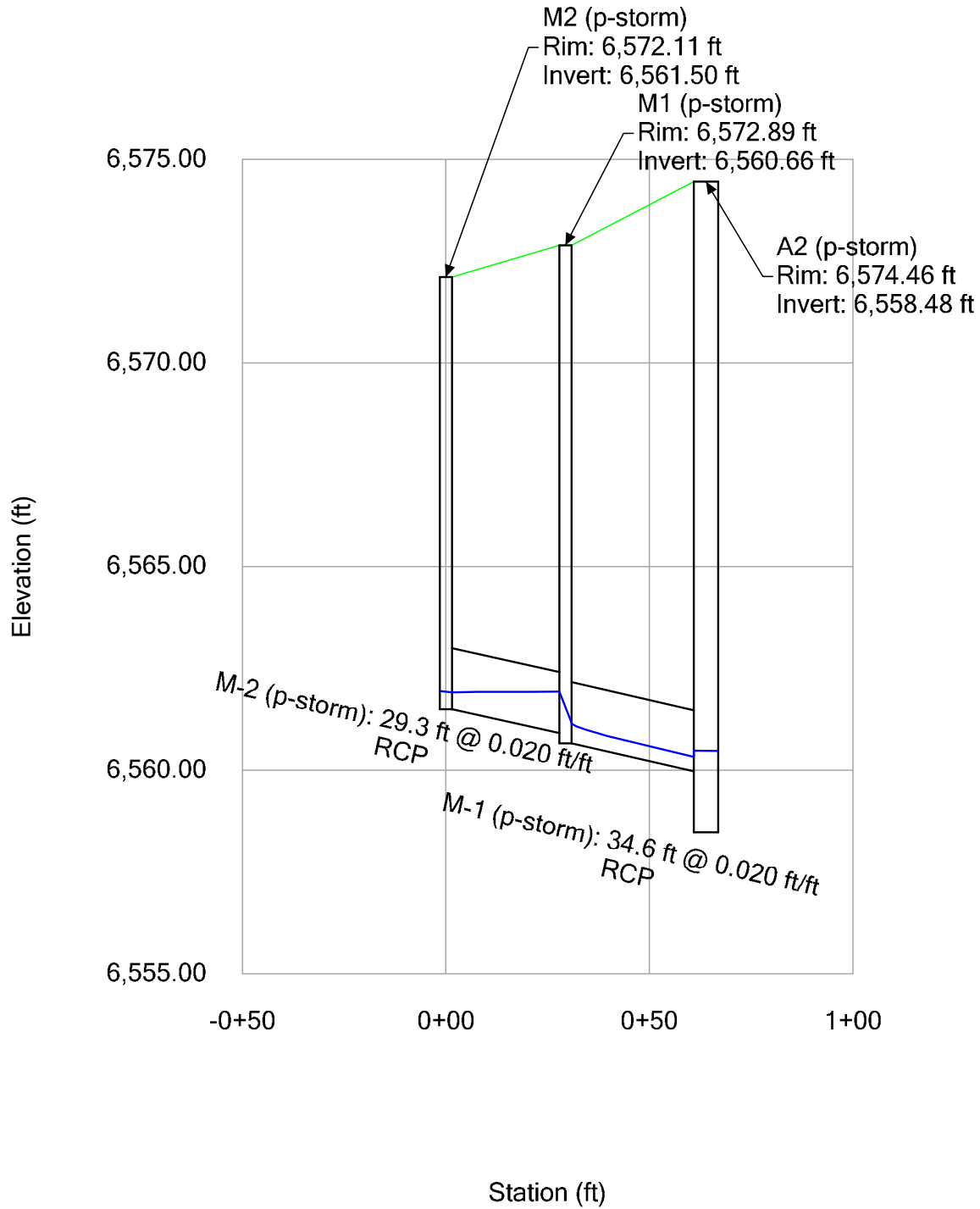
Profile Report
Engineering Profile - Storm Line K (StormCAD.stsw)
Active Scenario: 5 YR



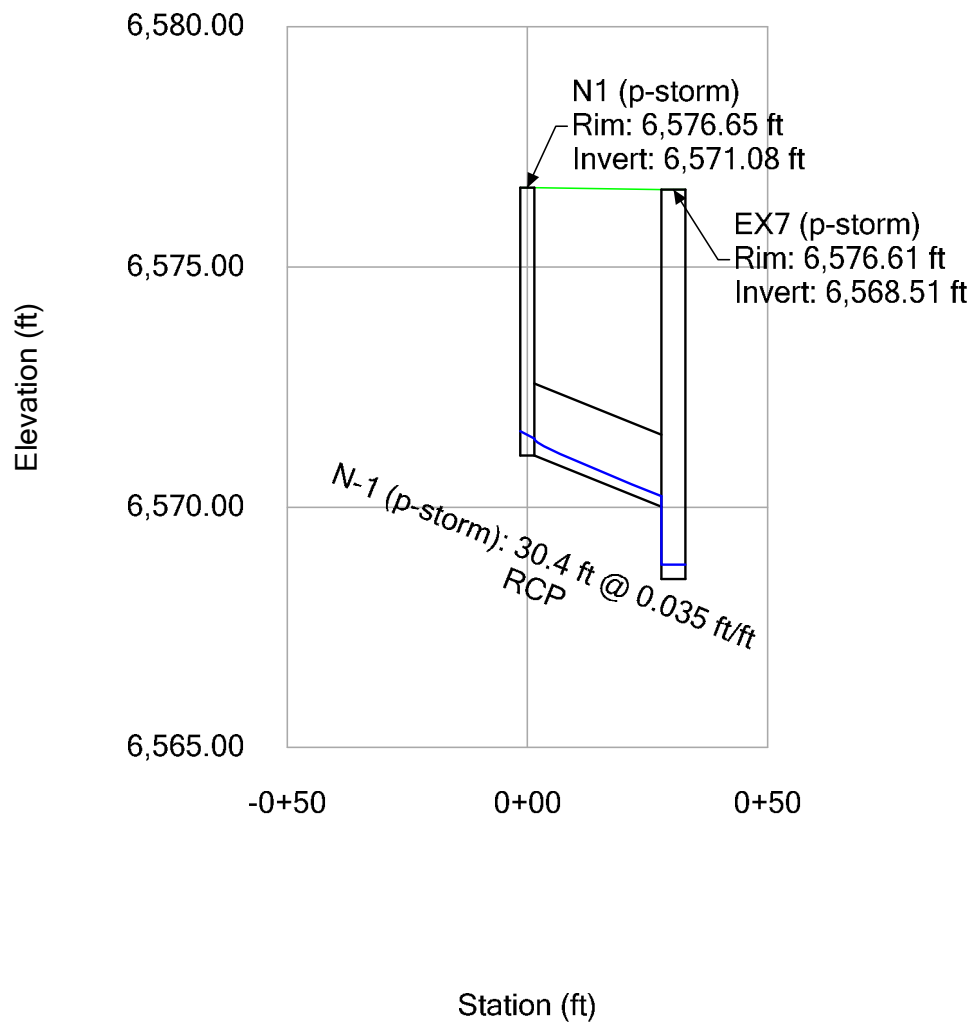
Profile Report **Engineering Profile - Storm Line L (StormCAD.stsw)** **Active Scenario: 5 YR**



Profile Report
Engineering Profile - Storm Line M (StormCAD.stsw)
Active Scenario: 5 YR



Profile Report
Engineering Profile - Storm Line N (StormCAD.stsw)
Active Scenario: 5 YR



Scenario: 100 YR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Label	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)	Notes	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
A-1 (p-storm)	6,558.48	6,557.87	120.8	122.7	0.005	Circle	30.0	0.013	27.60	5.62	3.52	29.00	95.2	77.9	30" RCP	6,561.94	6,561.39
A-2 (p-storm)	6,559.21	6,558.96	50.3	50.3	0.005	Circle	24.0	0.013	26.40	8.40	3.06	15.96	165.5	(N/A)	24" RCP	6,562.71	6,562.02
A-3 (p-storm)	6,559.56	6,559.46	20.5	20.5	0.005	Circle	24.0	0.013	26.40	8.40	3.63	15.81	167.0	(N/A)	24" RCP	6,563.37	6,563.09
A-4 (p-storm)	6,560.02	6,559.82	39.3	39.3	0.005	Circle	24.0	0.013	24.20	7.70	3.65	16.00	151.3	(N/A)	24" RCP	6,563.92	6,563.47
A-5 (p-storm)	6,560.73	6,560.27	90.8	90.8	0.005	Circle	24.0	0.013	23.40	7.45	3.73	16.00	146.3	(N/A)	24" RCP	6,564.98	6,564.00
A-6 (p-storm)	6,561.41	6,560.97	87.0	87.0	0.005	Circle	24.0	0.013	23.60	7.51	4.21	16.00	147.5	(N/A)	24" RCP	6,566.13	6,565.19
A-7 (p-storm)	6,561.99	6,561.66	64.9	64.9	0.005	Circle	24.0	0.013	22.00	7.00	4.59	15.97	137.8	(N/A)	24" RCP	6,566.87	6,566.25
A-8 (p-storm)	6,562.91	6,562.23	134.6	134.6	0.005	Circle	24.0	0.013	16.40	5.22	4.63	16.00	102.5	84.4	24" RCP	6,567.58	6,566.87
A-9 (p-storm)	6,564.64	6,564.34	58.9	58.9	0.005	Circle	24.0	0.013	16.40	5.22	3.36	16.00	102.5	84.4	24" RCP	6,568.01	6,567.70
A-10 (p-storm)	6,565.64	6,564.88	151.8	151.8	0.005	Circle	24.0	0.013	10.30	3.28	3.16	16.00	64.4	58.4	24" RCP	6,568.36	6,568.04
A-11 (p-storm)	6,566.60	6,566.14	91.6	91.6	0.005	Circle	18.0	0.013	5.90	3.34	2.22	7.43	79.4	67.3	18" RCP	6,568.65	6,568.36
A-12 (p-storm)	6,567.07	6,566.85	43.2	44.0	0.005	Circle	18.0	0.013	4.10	2.32	1.82	7.43	55.2	53.0	18" RCP	6,568.74	6,568.67
B-1 (p-storm)	6,567.60	6,567.35	48.4	49.9	0.005	Circle	18.0	0.013	2.70	3.87	1.35	7.43	36.4	41.7	18" RCP	6,568.72	6,568.70
C-1 (p-storm)	6,567.00	6,566.63	73.3	85.3	0.005	Circle	24.0	0.013	5.30	4.59	1.77	16.07	33.0	39.5	18" RCP	6,568.42	6,568.40
C-2 (p-storm)	6,567.73	6,567.50	45.0	43.1	0.005	Circle	18.0	0.013	2.20	3.69	0.97	7.51	29.3	37.1	18" RCP	6,568.47	6,568.47
D-1 (p-storm)	6,565.70	6,565.63	13.7	15.2	0.005	Circle	18.0	0.013	5.50	3.11	2.56	7.43	74.1	64.0	18" RCP	6,568.23	6,568.20
D-2 (p-storm)	6,566.22	6,565.95	55.3	59.3	0.005	Circle	18.0	0.013	4.00	2.26	2.38	7.30	54.8	52.8	18" RCP	6,568.42	6,568.34
E-1 (p-storm)	6,565.95	6,565.63	62.9	64.4	0.005	Circle	18.0	0.013	3.40	1.92	2.56	7.43	45.8	47.5	18" RCP	6,568.26	6,568.19
EX-5 (p-storm)	6,558.84	6,557.37	43.3	43.3	0.034	Circle	36.0	0.013	3.00	7.31	4.02	122.94	2.4	10.8	36" RCP	6,561.39	6,561.39
EX-6b (p-storm)	6,568.51	6,564.78	283.7	283.7	0.013	Circle	36.0	0.013	3.00	5.25	0.41	76.48	3.9	13.5	36" RCP	6,569.05	6,565.19
F-1 (p-storm)	6,563.24	6,562.98	12.8	14.3	0.020	Circle	18.0	0.013	8.00	4.53	3.88	14.85	53.9	52.3	18" RCP	6,566.94	6,566.87
G-1 (p-storm)	6,567.65	6,565.34	90.0	91.4	0.026	Circle	18.0	0.013	2.50	6.83	1.52	16.83	14.9	26.0	18" RCP	6,568.25	6,566.87
H-1 (p-storm)	6,564.48	6,562.41	69.3	71.8	0.030	Circle	18.0	0.013	3.40	1.92	4.48	18.14	18.7	29.3	18" RCP	6,566.97	6,566.90
J-1 (p-storm)	6,562.09	6,561.72	12.1	13.6	0.030	Circle	18.0	0.013	1.20	0.68	3.86	18.19	6.6	17.4	18" RCP	6,565.58	6,565.58
K-1 (p-storm)	6,563.38	6,561.02	47.2	48.6	0.050	Circle	18.0	0.013	2.40	8.55	3.44	23.47	10.2	21.6	18" RCP	6,564.47	6,564.47
L-1 (p-storm)	6,560.97	6,560.56	13.7	15.2	0.030	Circle	18.0	0.013	3.70	2.09	3.43	18.19	20.3	30.6	18" RCP	6,564.01	6,563.99
M-1 (p-storm)	6,560.66	6,559.97	34.6	35.7	0.020	Circle	18.0	0.013	3.60	6.93	2.10	14.85	24.2	33.5	18" RCP	6,562.11	6,562.08
M-2 (p-storm)	6,561.50	6,560.91	29.3	32.3	0.020	Circle	18.0	0.013	0.90	4.64	1.67	14.85	6.1	16.7	18" RCP	6,562.59	6,562.59
N-1 (p-storm)	6,571.08	6,570.01	30.4	31.8	0.035	Circle	18.0	0.013	3.00	8.04	0.41	19.64	15.3	26.4	18" RCP	6,571.74	6,570.42

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Scenario: 100 YR
Current Time Step: 0.000 h
FlexTable: Manhole Table

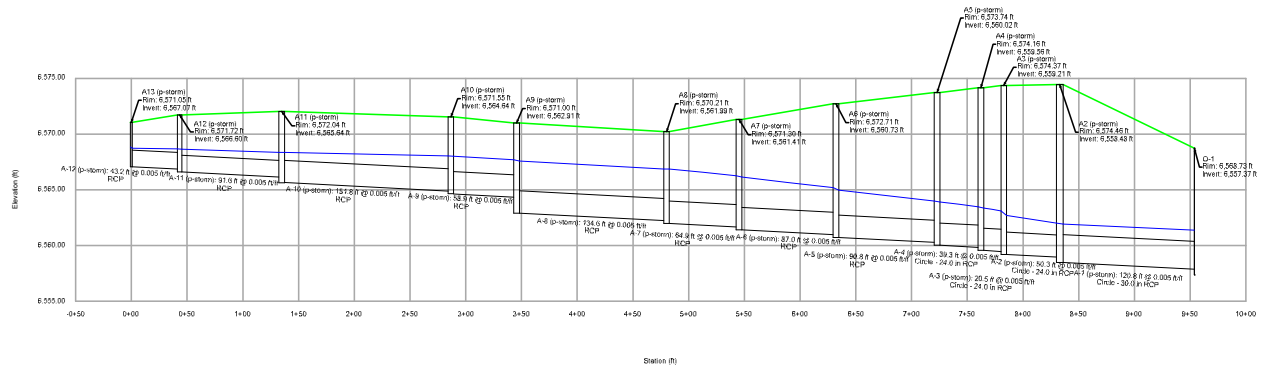
Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)	Notes
A2 (p-storm)	6,574.46	6,574.46	6,558.96	27.60	3.46	6,561.94	HEC-22 Energy (Second Edition)	6,562.02	6" Manhole
A3 (p-storm)	6,574.37	6,574.37	6,559.46	26.40	3.50	6,562.71	HEC-22 Energy (Second Edition)	6,563.09	5" Manhole
A4 (p-storm)	6,574.16	6,574.16	6,560.56	26.40	3.81	6,563.37	HEC-22 Energy (Second Edition)	6,563.47	5" Manhole
A5 (p-storm)	6,573.74	6,573.74	6,561.02	24.20	3.90	6,563.92	HEC-22 Energy (Second Edition)	6,564.00	5" Manhole
A6 (p-storm)	6,572.71	6,572.71	6,561.72	23.40	4.25	6,564.98	HEC-22 Energy (Second Edition)	6,565.19	5" Manhole
A7 (p-storm)	6,571.30	6,571.30	6,562.41	23.60	4.73	6,566.13	HEC-22 Energy (Second Edition)	6,566.25	5" Manhole
A8 (p-storm)	6,570.21	6,570.21	6,565.34	22.00	4.88	6,566.87	Standard	6,566.87	5" Manhole
A9 (p-storm)	6,571.00	6,571.00	6,564.34	16.40	4.67	6,567.58	HEC-22 Energy (Second Edition)	6,567.70	5" Manhole
A10 (p-storm)	6,571.55	6,571.55	6,565.63	16.40	3.37	6,568.01	HEC-22 Energy (Second Edition)	6,568.04	5" Manhole
A11 (p-storm)	6,572.04	6,572.04	6,566.14	10.30	2.71	6,568.36	HEC-22 Energy (Second Edition)	6,568.36	5" Manhole
A12 (p-storm)	6,571.72	6,571.72	6,567.35	5.90	2.05	6,568.65	HEC-22 Energy (Second Edition)	6,568.67	4" Manhole
A13 (p-storm)	6,571.05	6,571.05	(N/A)	4.10	1.67	6,568.74	Standard	6,568.84	Inlet Type 16 Dbl
B1 (p-storm)	6,573.14	6,573.14	(N/A)	2.70	1.12	6,568.72	Standard	6,568.79	Inlet Type C
C1 (p-storm)	6,570.88	6,570.88	6,567.50	5.30	1.42	6,568.42	HEC-22 Energy (Second Edition)	6,568.47	Inlet Type 16 Dbl
C2 (p-storm)	6,570.50	6,570.50	(N/A)	2.20	0.74	6,568.47	Standard	6,568.60	Inlet Type C
D1 (p-storm)	6,571.58	6,571.58	6,565.95	5.50	2.53	6,568.23	HEC-22 Energy (Second Edition)	6,568.34	Inlet Type R 5'
D2 (p-storm)	6,570.81	6,570.81	(N/A)	4.00	2.20	6,568.42	Standard	6,568.52	Inlet Type R 5'
E1 (p-storm)	6,572.48	6,572.48	(N/A)	3.40	2.31	6,568.26	Standard	6,568.33	Inlet Type C
EX5 (p-storm)	6,571.12	6,571.12	6,564.78	3.00	2.55	6,561.39	HEC-22 Energy (Second Edition)	6,561.39	6" Manhole
EX7 (p-storm)	6,576.61	6,576.61	6,570.01	3.00	0.54	6,569.05	HEC-22 Energy (Second Edition)	6,569.06	5" Manhole
F1 (p-storm)	6,570.35	6,570.35	(N/A)	8.00	3.70	6,566.94	Standard	6,567.34	Inlet Type R 10'
G1 (p-storm)	6,572.43	6,572.43	(N/A)	2.50	0.60	6,568.25	Standard	6,568.53	Inlet Type C
H1 (p-storm)	6,571.74	6,571.74	(N/A)	3.40	2.49	6,566.97	Standard	6,567.04	Inlet Type R 5'
J1 (p-storm)	6,572.92	6,572.92	(N/A)	1.20	3.49	6,565.58	Standard	6,565.59	Inlet Type R 5'
K1 (p-storm)	6,575.67	6,575.67	(N/A)	2.40	1.09	6,564.47	Standard	6,564.53	Inlet Type C
L1 (p-storm)	6,574.28	6,574.28	(N/A)	3.70	3.04	6,564.01	Standard	6,564.10	Inlet Type R 5'
M1 (p-storm)	6,572.89	6,572.89	6,560.91	3.60	1.45	6,562.11	HEC-22 Energy (Second Edition)	6,562.59	Inlet Type R 10'
M2 (p-storm)	6,572.11	6,572.11	(N/A)	0.90	1.09	6,562.59	Standard	6,562.59	Inlet Type R 10'
N1 (p-storm)	6,576.65	6,576.65	(N/A)	3.00	0.66	6,571.74	Standard	6,572.05	Inlet Type C

K:\210431\Documents\Drainage\Calcs\StormCAD\StormCAD.stsw

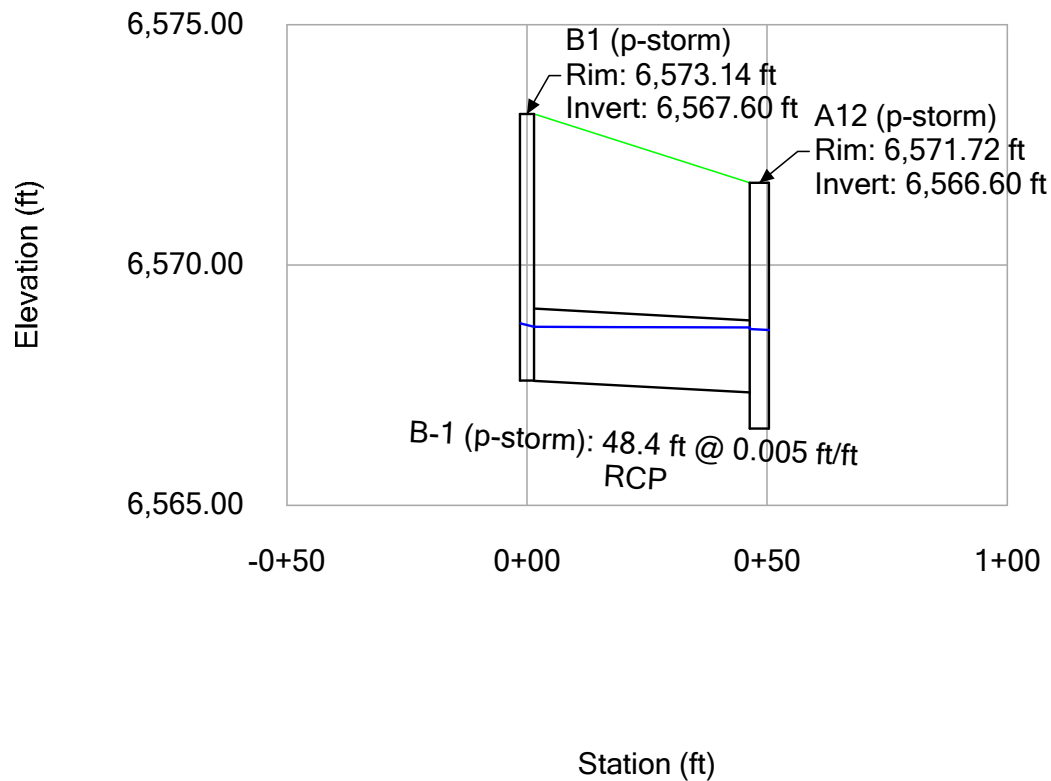
Profile Report

Engineering Profile - Storm Line A (StormCAD.stsw)

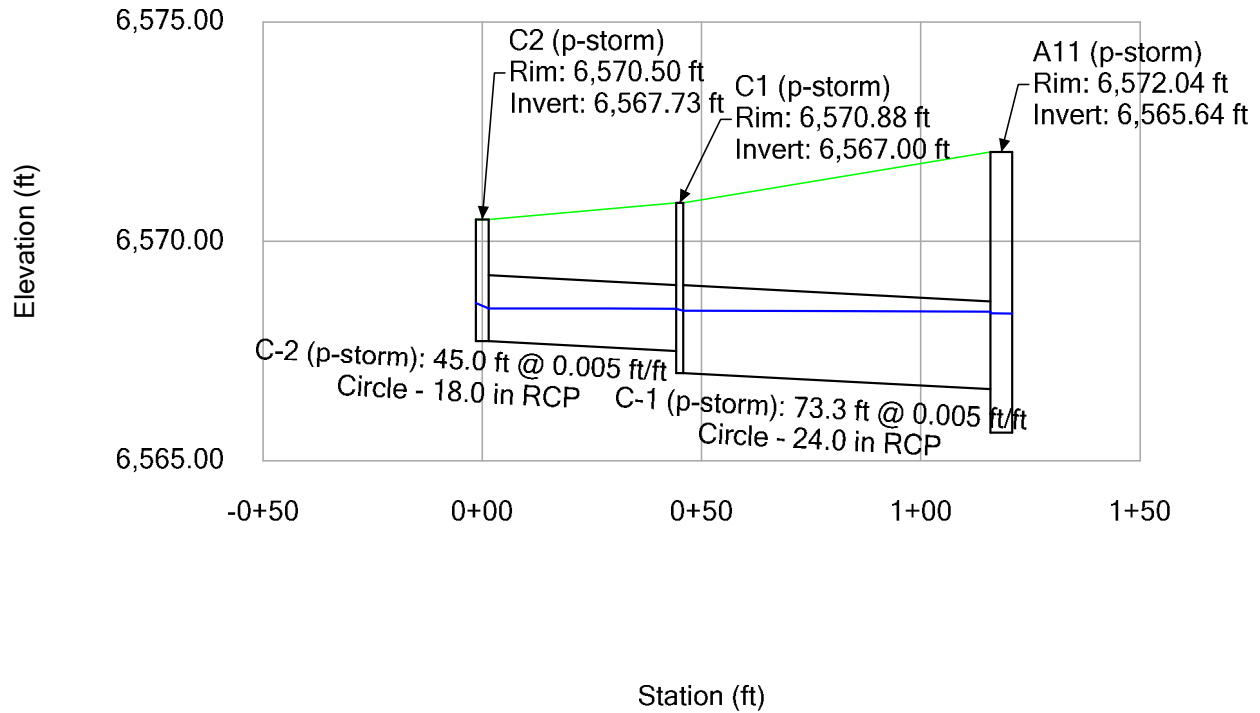
Active Scenario: 100 YR



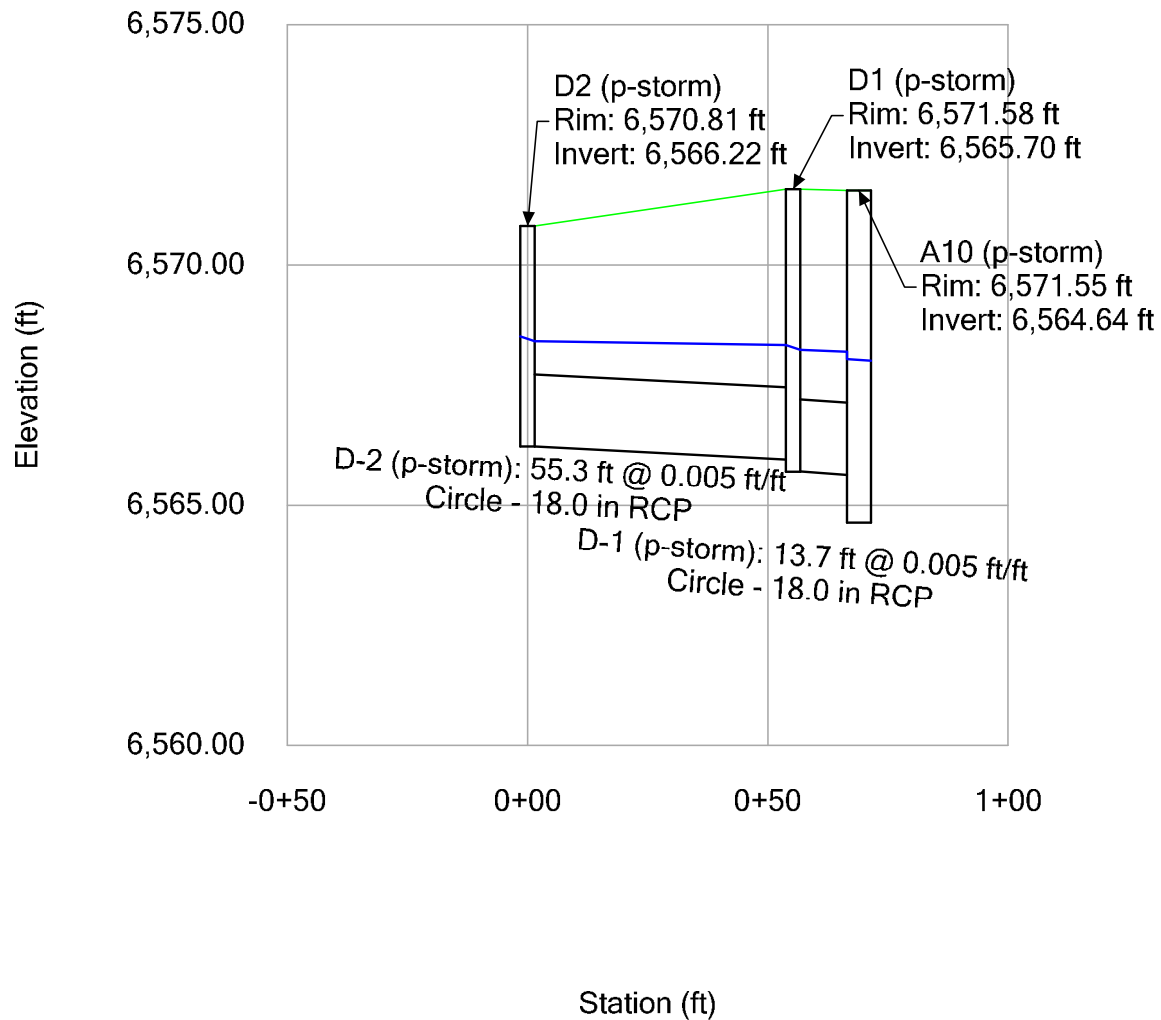
Profile Report
Engineering Profile - Storm Line B (StormCAD.stsw)
Active Scenario: 100 YR



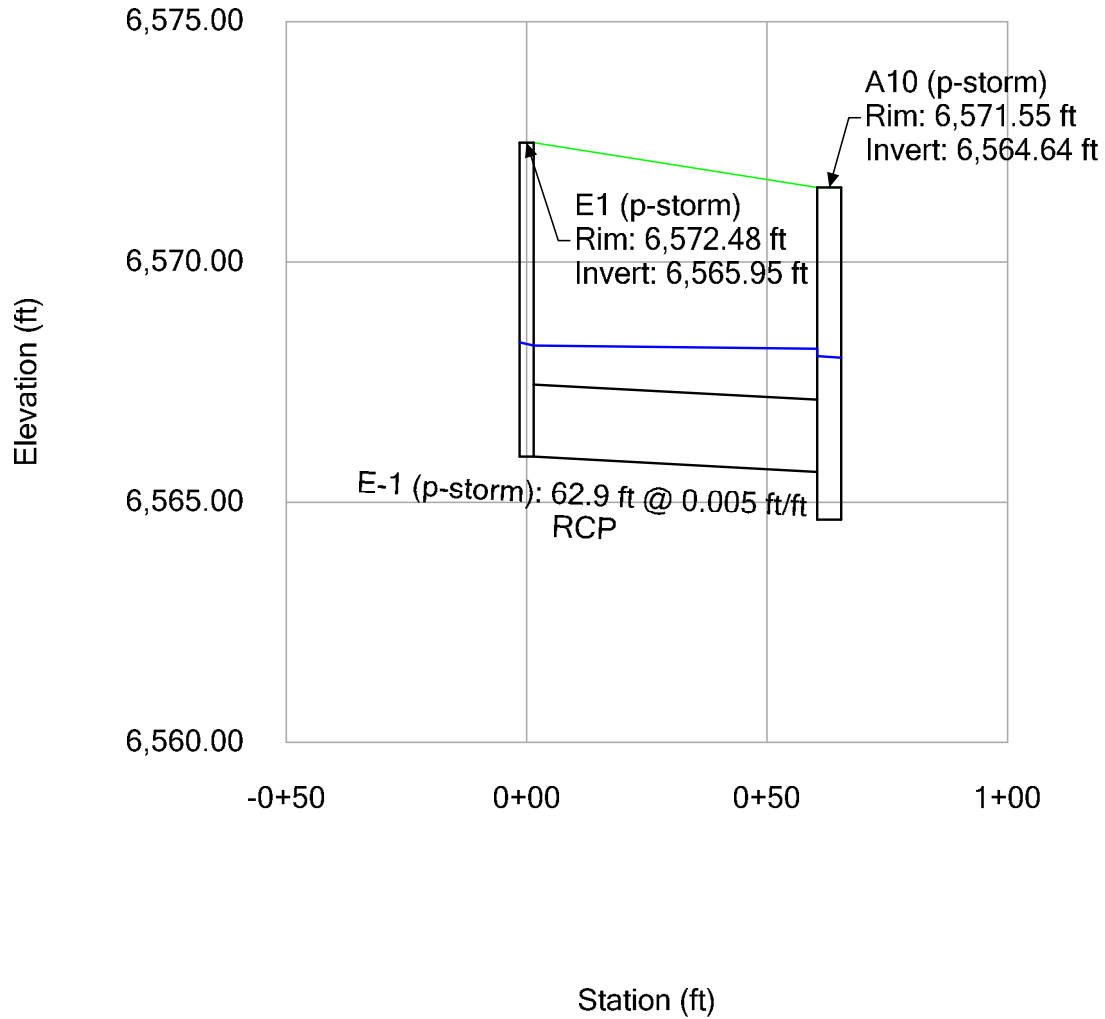
Profile Report
Engineering Profile - Storm Line C (StormCAD.stsw)
Active Scenario: 100 YR



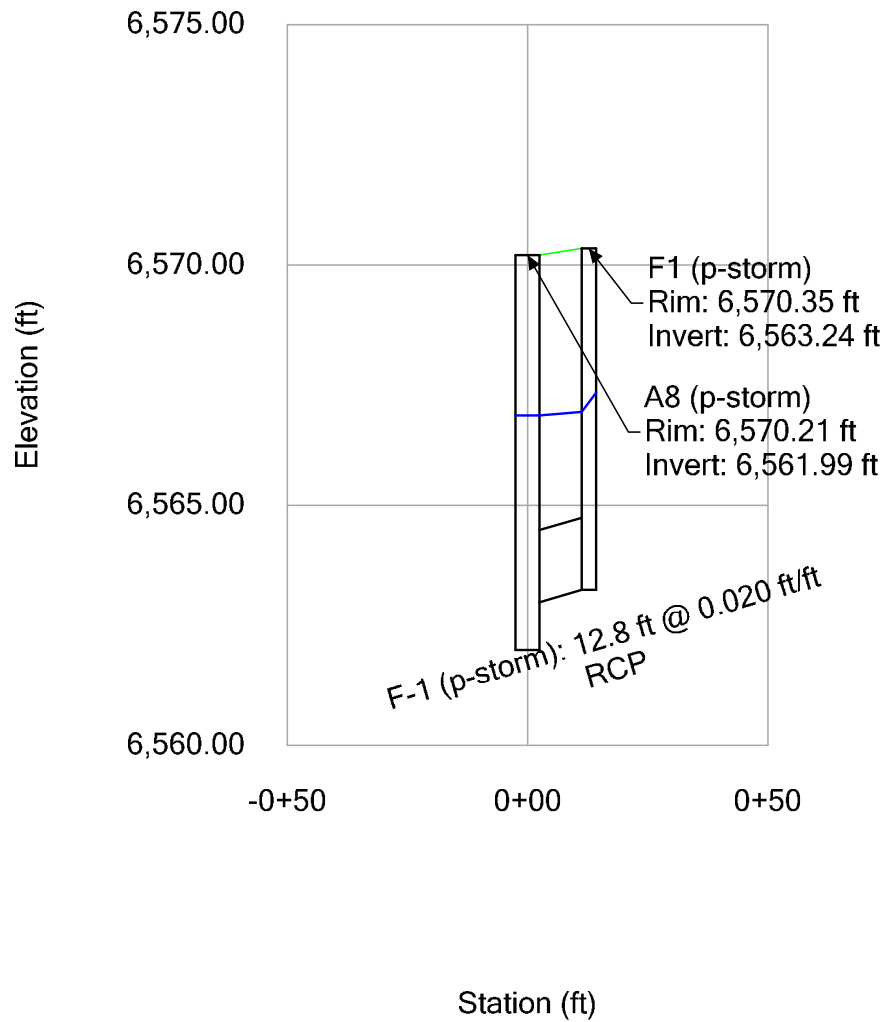
Profile Report
Engineering Profile - Storm Line D (StormCAD.stsw)
Active Scenario: 100 YR



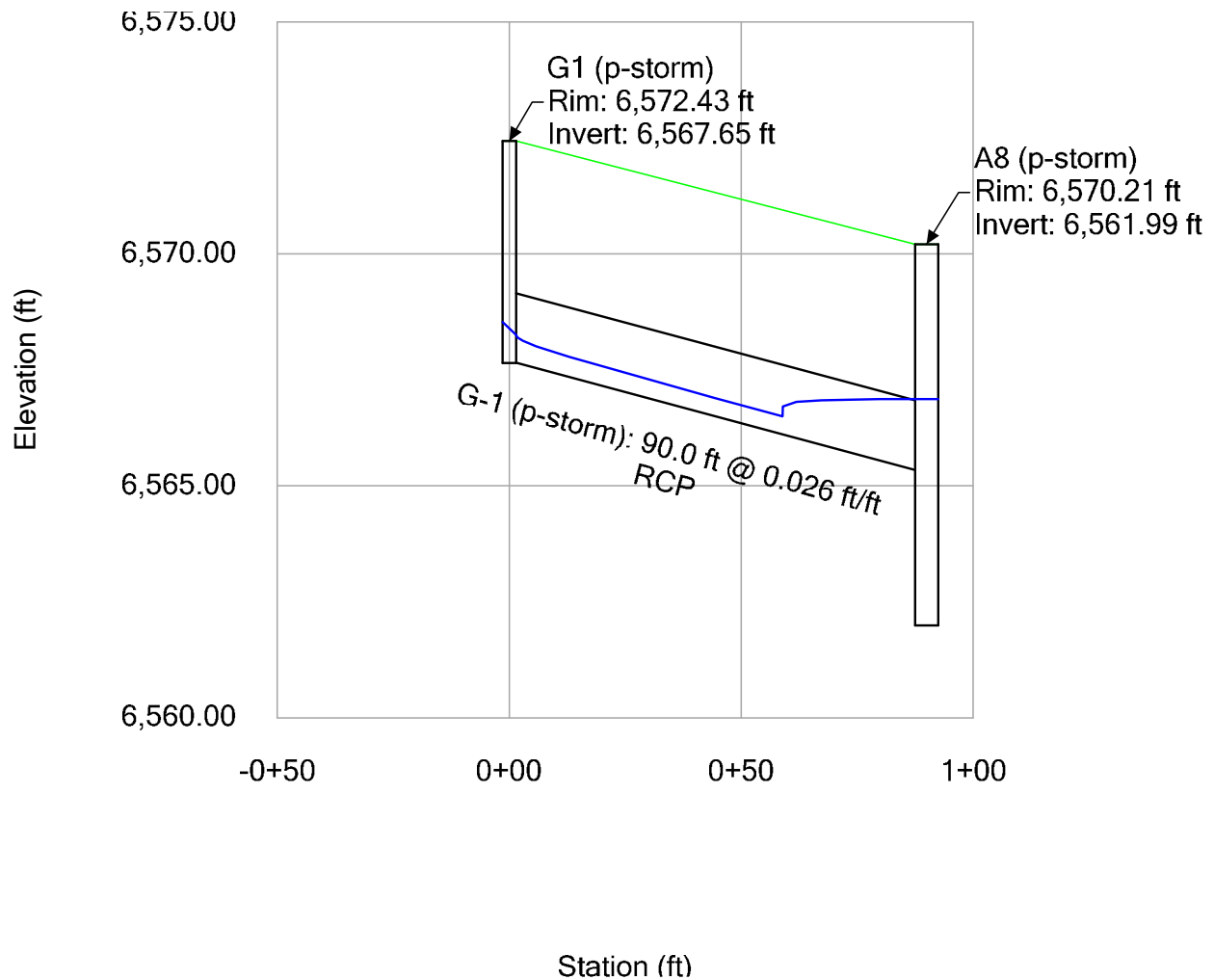
Profile Report
Engineering Profile - Storm Line E (StormCAD.stsw)
Active Scenario: 100 YR



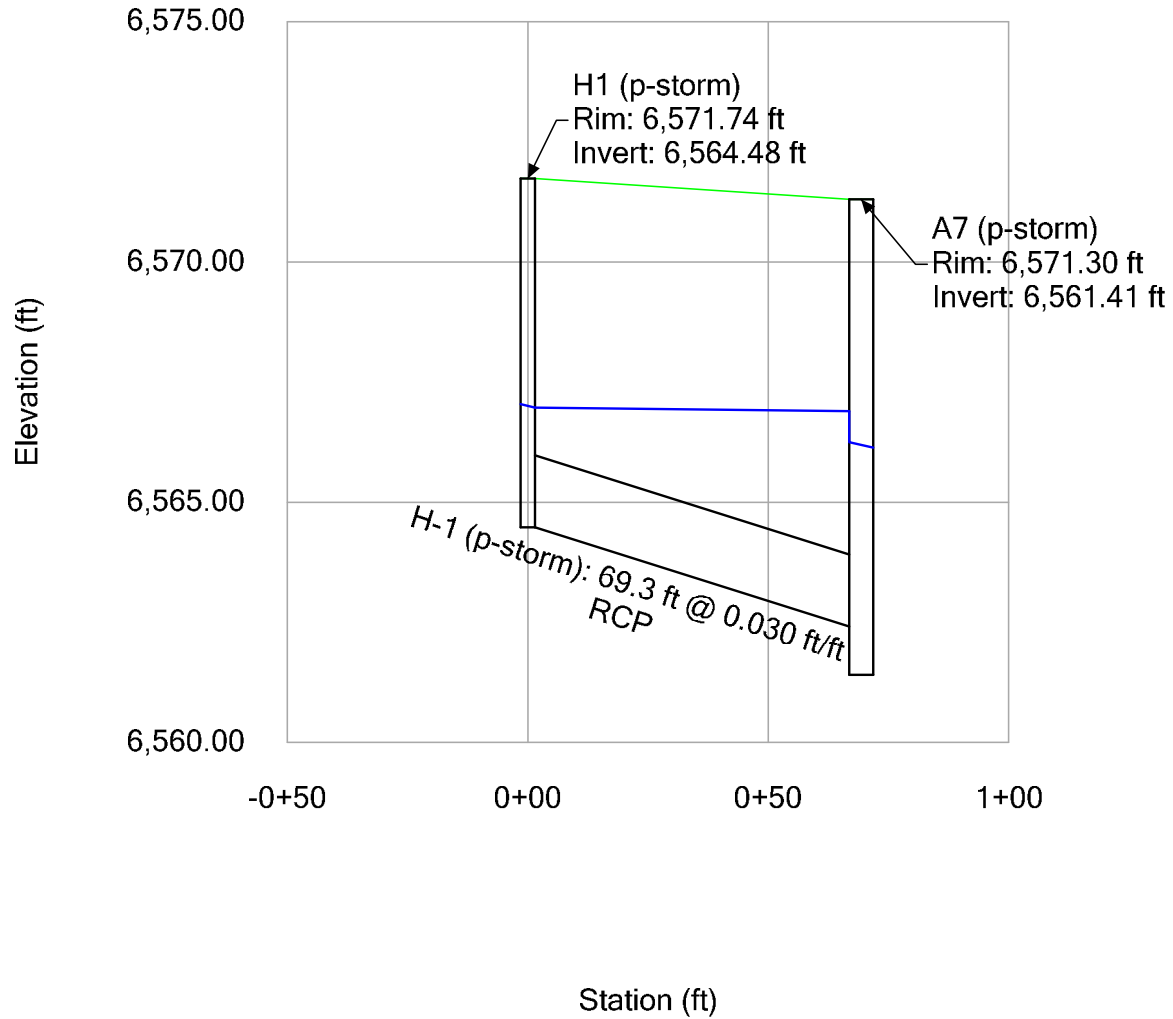
Profile Report
Engineering Profile - Storm Line F (StormCAD.stsw)
Active Scenario: 100 YR



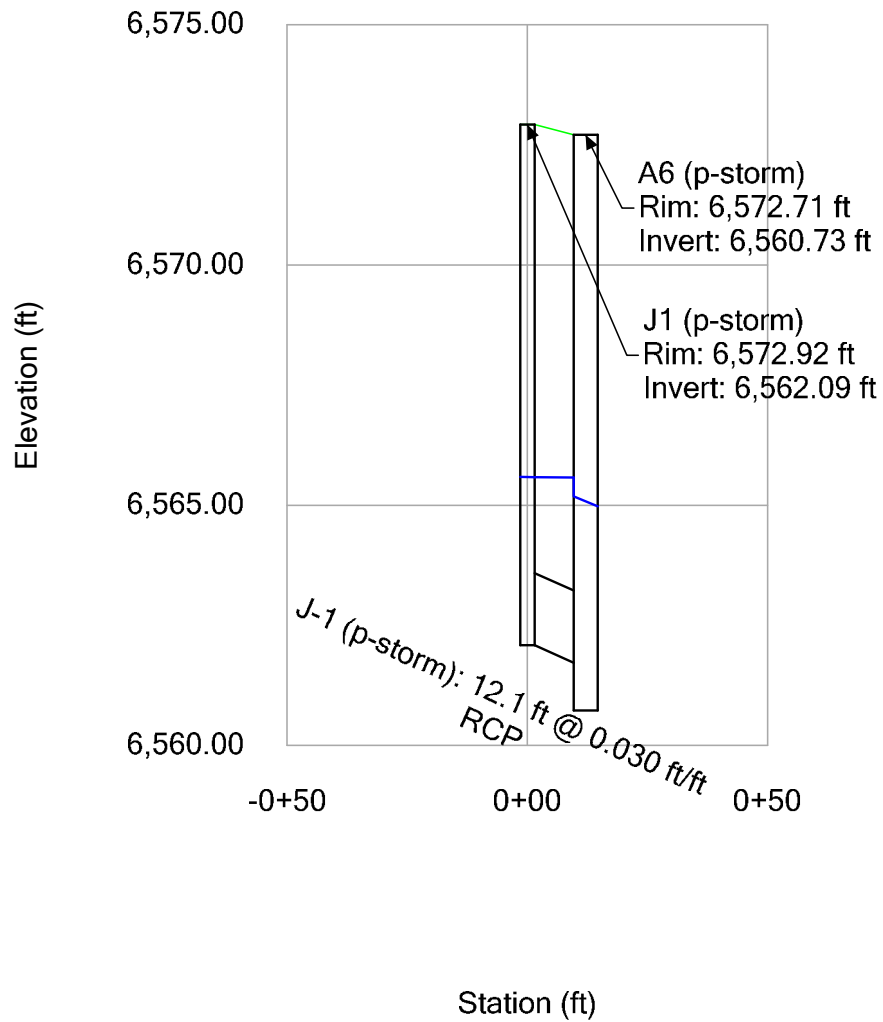
Profile Report **Engineering Profile - Storm Line G (StormCAD.stsw)** **Active Scenario: 100 YR**



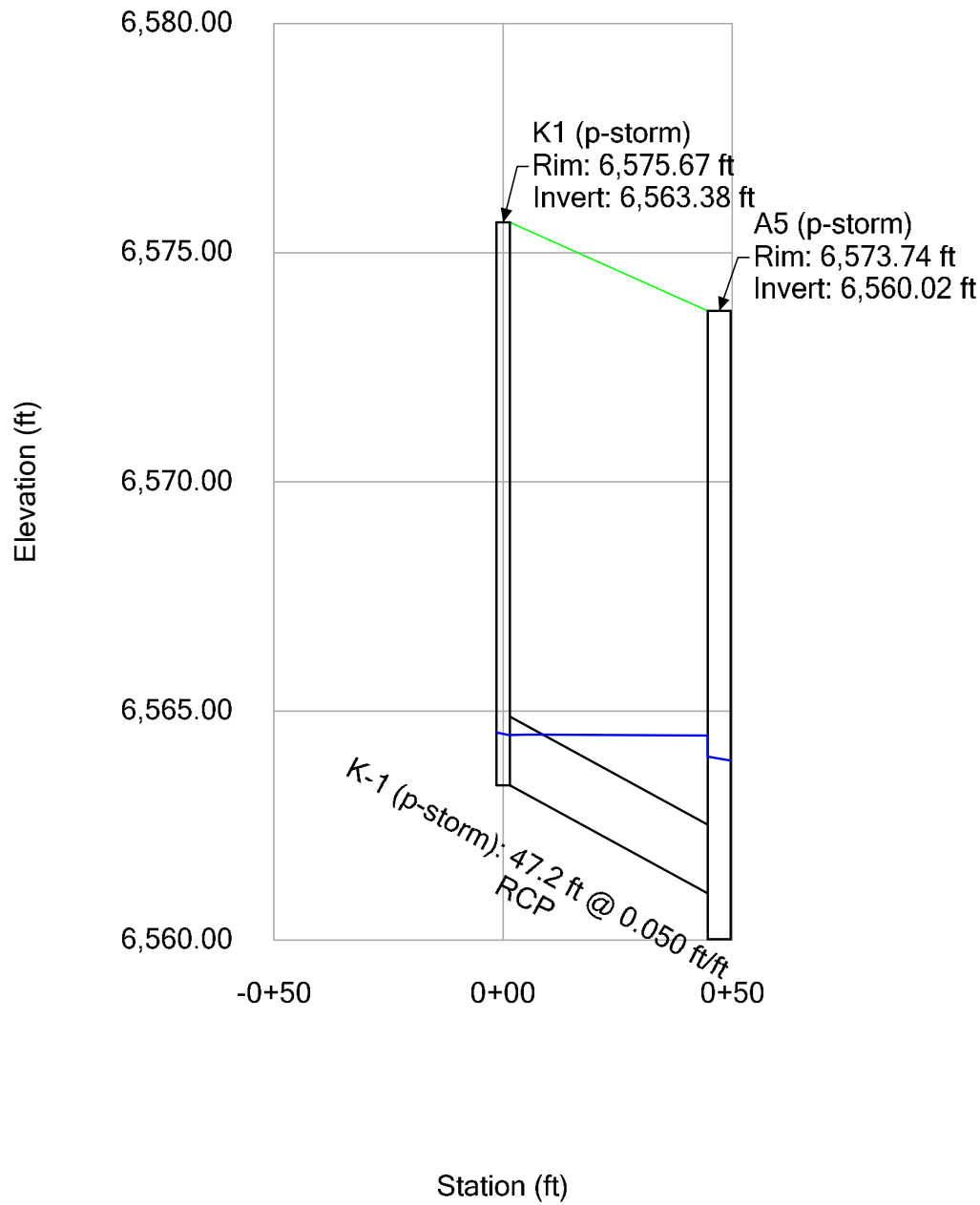
Profile Report
Engineering Profile - Storm Line H (StormCAD.stsw)
Active Scenario: 100 YR



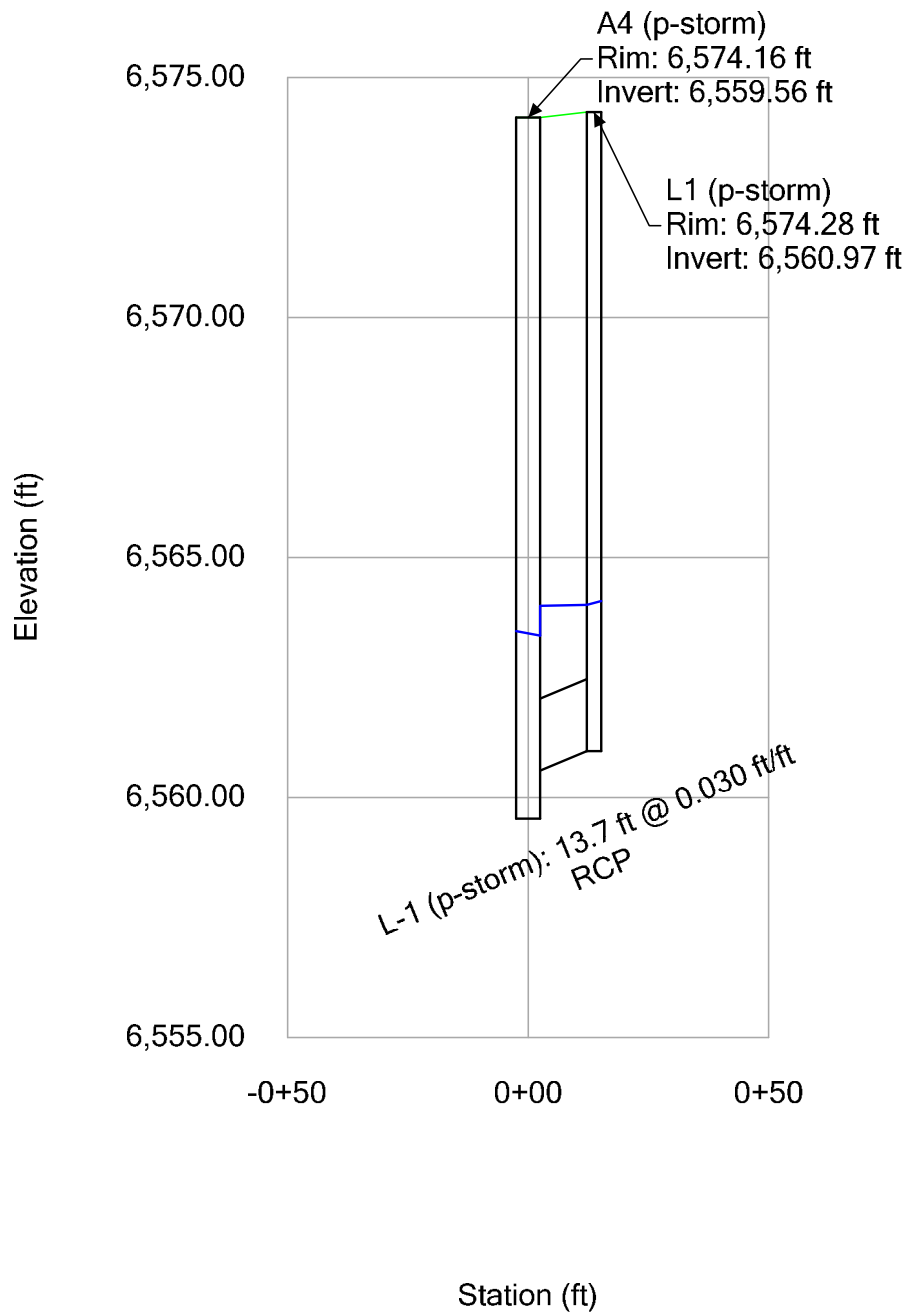
Profile Report
Engineering Profile - Storm Line J (StormCAD.stsw)
Active Scenario: 100 YR



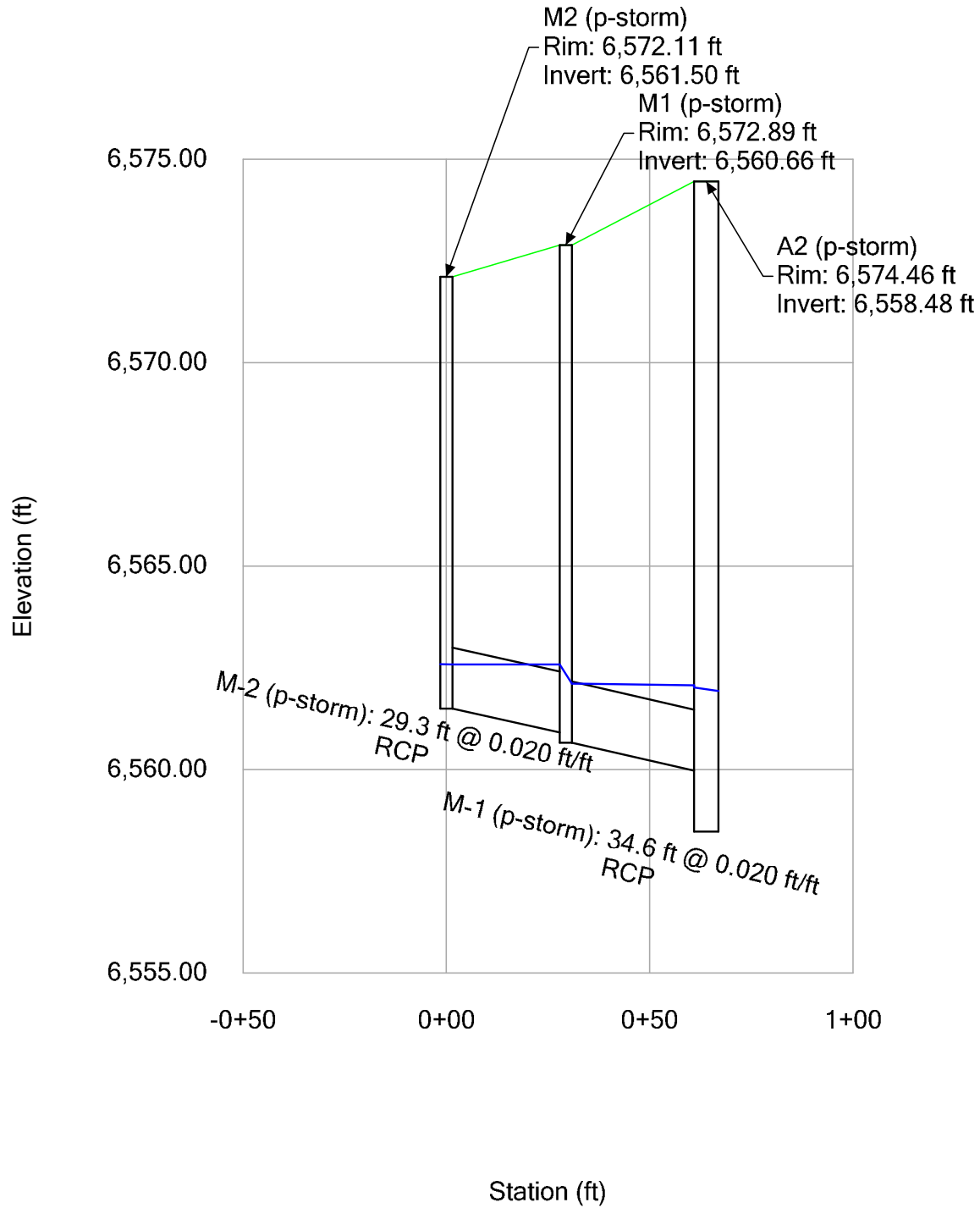
Profile Report **Engineering Profile - Storm Line K (StormCAD.stsw)** **Active Scenario: 100 YR**



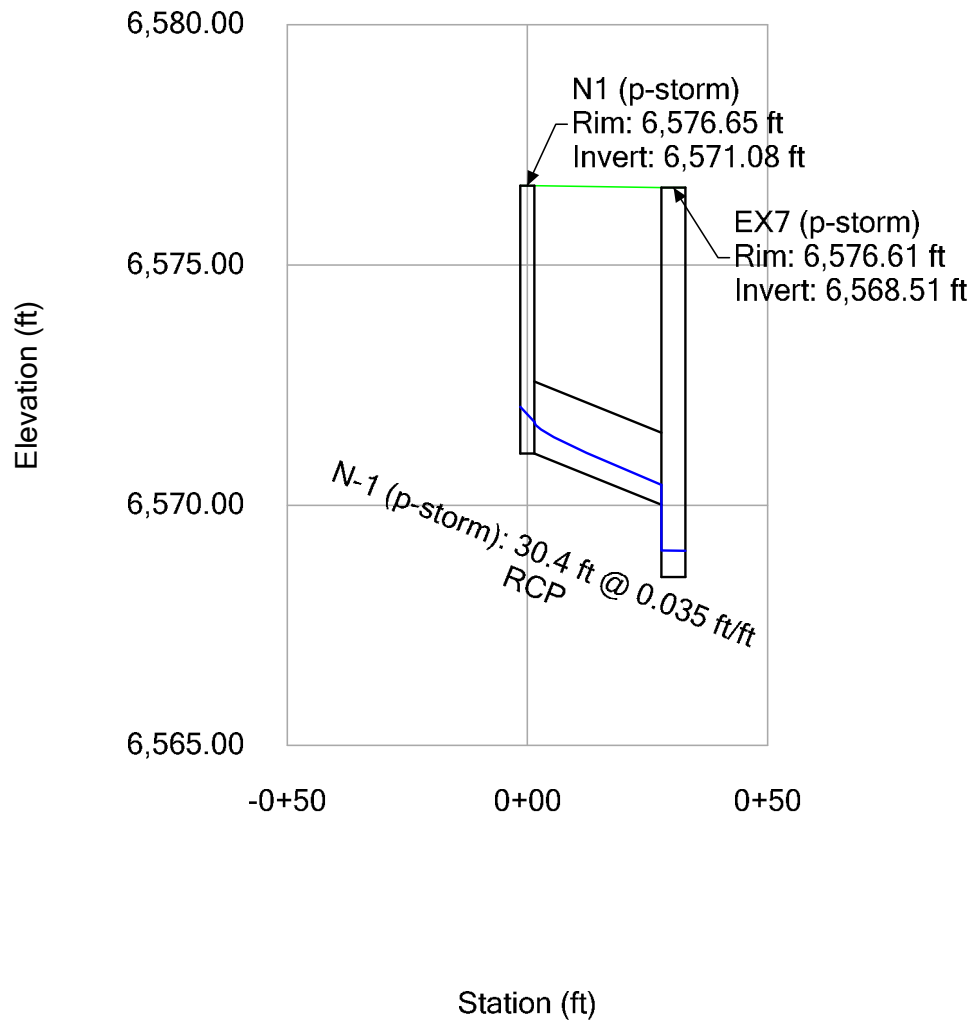
Profile Report
Engineering Profile - Storm Line L (StormCAD.stsw)
Active Scenario: 100 YR



Profile Report
Engineering Profile - Storm Line M (StormCAD.stsw)
Active Scenario: 100 YR



Profile Report
Engineering Profile - Storm Line N (StormCAD.stsw)
Active Scenario: 100 YR



INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin A (Inlet A13)	Basin B (Inlet B1)	Basin C (Inlet C2)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	AREA	AREA
Hydraulic Condition	In Sump	Swale	Swale
Inlet Type	Denver No. 16 Valley Grate	CDOT Type C	CDOT Type C

USER-DEFINED INPUT**User-Defined Design Flows**

Minor Q_{Known} (cfs)	1.7	0.9	0.8
Major Q_{Known} (cfs)	4.1	2.7	2.2

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	1.7	0.9	0.8
Major Total Design Peak Flow, Q (cfs)	4.1	2.7	2.2
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	0.0	0.0

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin D (Inlet C1)	Basin E (Inlet E1)	Basin F (Inlet D2)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	AREA	STREET
Hydraulic Condition	In Sump	Swale	In Sump
Inlet Type	Denver No. 16 Valley Grate	CDOT Type C	CDOT Type R Curb Opening

USER-DEFINED INPUT**User-Defined Design Flows**

Minor Q_{Known} (cfs)	1.8	1.2	1.5
Major Q_{Known} (cfs)	3.9	3.4	4.0

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	1.8	1.2	1.5
Major Total Design Peak Flow, Q (cfs)	3.9	3.4	4.0
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	0.0	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	0.0	N/A

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin G (Inlet D1)	Basin I (Inlet G1)	Basin J (Inlet F1)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	AREA	STREET
Hydraulic Condition	In Sump	Swale	In Sump
Inlet Type	CDOT Type R Curb Opening	CDOT Type C	CDOT Type R Curb Opening

USER-DEFINED INPUT**User-Defined Design Flows**

Minor Q_{Known} (cfs)	0.9	0.8	3.3
Major Q_{Known} (cfs)	2.0	2.5	8.0

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	0.9	0.8	3.3
Major Total Design Peak Flow, Q (cfs)	2.0	2.5	8.0
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	0.0	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	0.0	N/A

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin K (Inlet H1)	Basin L (Inlet L1)	Basin M (Inlet K1)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	AREA
Hydraulic Condition	In Sump	In Sump	Swale
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type C

USER-DEFINED INPUT**User-Defined Design Flows**

Minor Q_{Known} (cfs)	1.3	1.3	0.8
Major Q_{Known} (cfs)	3.4	3.7	2.4

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	1.3	1.3	0.8
Major Total Design Peak Flow, Q (cfs)	3.4	3.7	2.4
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A	0.0

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin N (Inlet N1)	Basin O (Inlet M1)	Basin P (Inlet M2)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	AREA	STREET	STREET
Hydraulic Condition	Swale	On Grade	On Grade
Inlet Type	CDOT Type C	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT**User-Defined Design Flows**

Minor Q_{Known} (cfs)	0.9	1.3	0.5
Major Q_{Known} (cfs)	3.0	2.7	0.9

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

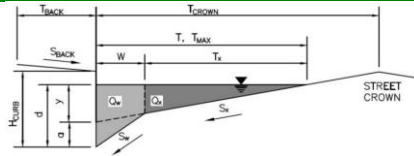
CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	0.9	1.3	0.5
Major Total Design Peak Flow, Q (cfs)	3.0	2.7	0.9
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	0.0

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

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

Project:

Inlet ID: **Basin A (Inlet A13)****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)

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 Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

$T_{BACK} =$	0.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.016	

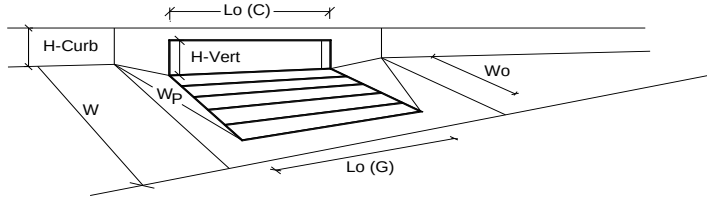
$H_{CURB} =$	7.32	inches
$T_{CROWN} =$	36.0	ft
$W =$	4.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.000	ft/ft
$n_{STREET} =$	0.016	

	Minor Storm	Major Storm	
$T_{MAX} =$	26.0	36.0	ft
$d_{MAX} =$	7.3	7.3	inches
	☐	☐	

	Minor Storm	Major Storm	
$Q_{allow} =$	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

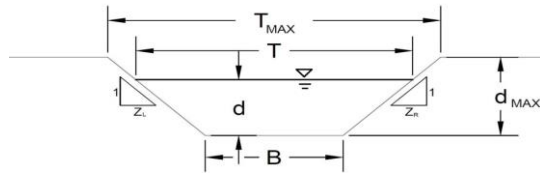


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	Denver No. 16 Valley Grate	Type =	Denver No. 16 Valley Grate		
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	2	2	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	7.3	7.3	inches
Grate Information			MINOR	MAJOR	☐ 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
Area Opening 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			MINOR	MAJOR	
Length of a Unit Curb Opening		L _o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _o =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C _f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C _w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	N/A	N/A	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d _{Grate} =	0.669	0.669	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	0.86	0.86	
Total Inlet Interception Capacity (assumes clogged condition)			MINOR	MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _s =	6.9	6.9	cfs
		Q _{PEAK REQUIRED} =	1.7	4.1	cfs

MHFD-Inlet, Version 5.01 (April 2021)

AREA INLET IN A SWALE

Basin B (Inlet B1)



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using 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 =

C
see details below
$S_o = 0.0200$ ft/ft
$B = 3.00$ ft
$Z1 = 4.00$ ft/ft
$Z2 = 4.00$ 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
$T_{MAX} =$	8.60	8.60
$d_{MAX} =$	1.00	1.00

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
$Q_{allow} =$	2.8	2.8
$d_{allow} =$	0.70	0.70

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

$Q_o =$	0.9	2.7
$d =$	0.59	0.69

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'

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

Basin B (Inlet B1)

Inlet Design Information (Input)

Type of Inlet

CDOT Type C

Inlet Type =

CDOT Type C

Angle of Inclined Grate (must be ≤ 30 degrees)

Width of Grate

Length of Grate

Open Area Ratio

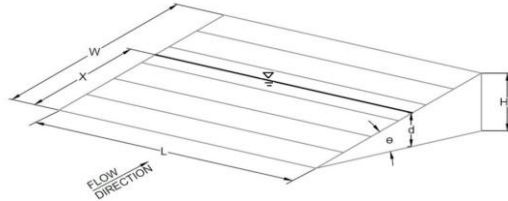
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



$\theta =$ 0.00 degrees

$W =$ 3.00 ft

$L =$ 3.00 ft

$A_{RATIO} =$ 0.70

$H_B =$ 0.00 ft

$C_f =$ 0.50

$C_d =$ 0.96

$C_o =$ 0.64

$C_w =$ 2.05

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

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

Capture Percentage = Q_a/Q_o

MINOR

MAJOR

$d =$ 0.59 0.69

$Q_a =$ 8.4 10.7 cfs

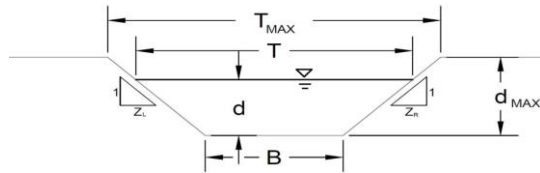
$Q_b =$ 0.0 0.0 cfs

$C\% =$ 100 100 %

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AREA INLET IN A SWALE

Basin C (Inlet C2)



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using 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 =

C
see details below
$S_o = 0.0200$ ft/ft
$B = 3.00$ ft
$Z1 = 4.00$ ft/ft
$Z2 = 4.00$ 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	
$T_{MAX} =$	26.00	26.00	ft
$d_{MAX} =$	1.00	1.00	ft

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	15.0	15.0	cfs
$d_{allow} =$	1.00	1.00	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

$Q_o =$	0.8	2.2	cfs
$d =$	0.57	0.67	ft

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'

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

Basin C (Inlet C2)

Inlet Design Information (Input)

Type of Inlet

CDOT Type C

Inlet Type =

CDOT Type C

Angle of Inclined Gate (must be ≤ 30 degrees)

Width of Gate

Length of Gate

Open Area Ratio

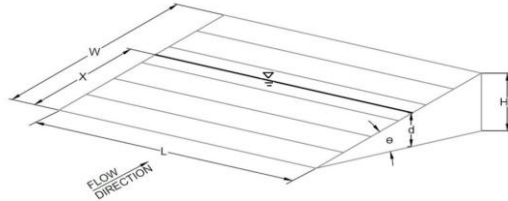
Height of Inclined Gate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



$\theta =$ 0.00 degrees

$W =$ 3.00 ft

$L =$ 3.00 ft

$A_{RATIO} =$ 0.70

$H_B =$ 0.00 ft

$C_f =$ 0.50

$C_d =$ 0.96

$C_o =$ 0.64

$C_w =$ 2.05

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

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

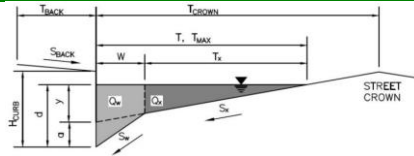
Capture Percentage = Q_a/Q_o

	MINOR	MAJOR	
$d =$	0.57	0.67	
$Q_a =$	7.9	10.2	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:

Inlet ID: **Basin D (Inlet C1)****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)

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 Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

$$\begin{aligned} T_{\text{BACK}} &= 20.5 \text{ ft} \\ S_{\text{BACK}} &= 0.020 \text{ ft/ft} \\ n_{\text{BACK}} &= 0.016 \end{aligned}$$

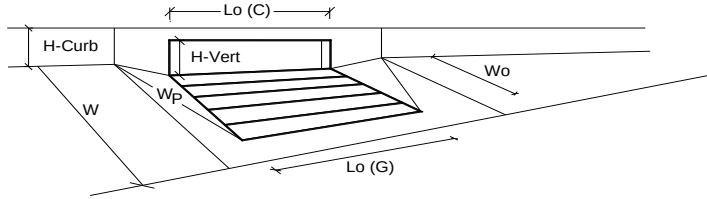
$$\begin{aligned} H_{\text{CURB}} &= 6.00 \text{ inches} \\ T_{\text{CROWN}} &= 38.0 \text{ ft} \\ W &= 4.00 \text{ ft} \\ S_x &= 0.020 \text{ ft/ft} \\ S_w &= 0.083 \text{ ft/ft} \\ S_o &= 0.000 \text{ ft/ft} \\ n_{\text{STREET}} &= 0.016 \end{aligned}$$

	Minor Storm	Major Storm	
T_{MAX}	10.0	24.0	ft
d_{MAX}	6.0	12.0	inches

	Minor Storm	Major Storm	
Q_{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

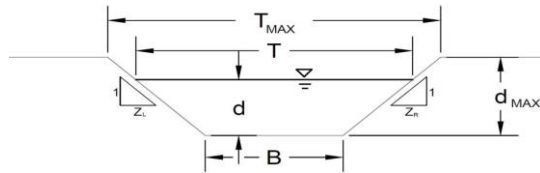


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	Denver No. 16 Valley Grate	Type =	Denver No. 16 Valley Grate		
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	2	2	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.4	8.8	inches
<u>Grate Information</u>			MINOR	MAJOR	☐ 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
Area Opening 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	
<u>Curb Opening Information</u>			MINOR	MAJOR	
Length of a Unit Curb Opening		L _o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _o =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C _f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C _w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	N/A	N/A	
<u>Low Head Performance Reduction (Calculated)</u>			MINOR	MAJOR	
Depth for Grate Midwidth		d _{Grate} =	0.511	0.791	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	0.64	1.00	
Total Inlet Interception Capacity (assumes clogged condition)			MINOR	MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _s =	3.6	8.6	cfs
		Q _{PEAK REQUIRED} =	1.8	3.9	cfs

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AREA INLET IN A SWALE

Basin E (Inlet E1)



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using 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 =

C
see details below
$S_o = 0.0200$ ft/ft
$B = 3.00$ ft
$Z1 = 4.00$ ft/ft
$Z2 = 4.00$ 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
$T_{MAX} =$	26.00	26.00
$d_{MAX} =$	1.00	1.00

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm
$Q_{allow} =$	15.0	15.0
$d_{allow} =$	1.00	1.00

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

$Q_o =$	1.2	3.4
$d =$	0.63	0.72

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'

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

Basin E (Inlet E1)

Inlet Design Information (Input)

Type of Inlet

CDOT Type C

Inlet Type =

CDOT Type C

Angle of Inclined Gate (must be ≤ 30 degrees)

Width of Gate

Length of Gate

Open Area Ratio

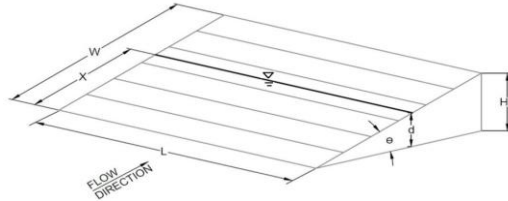
Height of Inclined Gate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



$\theta = 0.00$ degrees

$W = 3.00$ ft

$L = 3.00$ ft

$A_{RATIO} = 0.70$

$H_B = 0.00$ ft

$C_f = 0.50$

$C_d = 0.96$

$C_o = 0.64$

$C_w = 2.05$

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

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

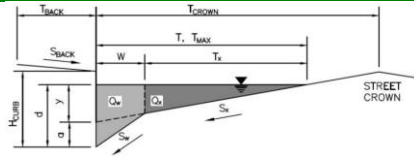
Capture Percentage = Q_a/Q_o

	MINOR	MAJOR	
$d =$	0.63	0.72	
$Q_a =$	9.3	11.4	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:

Inlet ID: **Basin F (Inlet D2)****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)

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 Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

$T_{BACK} =$	0.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.020	

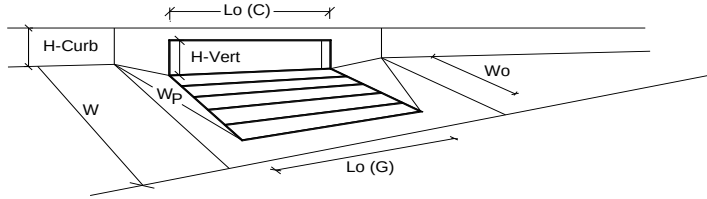
$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	56.0	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.000	ft/ft
$n_{STREET} =$	0.016	

	Minor Storm	Major Storm	
$T_{MAX} =$	30.0	40.0	ft
$d_{MAX} =$	6.0	6.0	inches

	Minor Storm	Major Storm	
$Q_{allow} =$	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

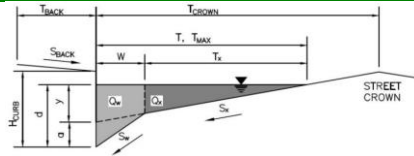


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		L _o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _o =	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) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d _{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.77	0.77	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _s =	5.4	5.4	cfs
		Q _{PEAK REQUIRED} =	1.5	4.0	cfs

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

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

Project:

Inlet ID: **Basin G (Inlet D1)****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)

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 Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

T_{BACK}	=	0.0	ft
S_{BACK}	=	0.020	ft/ft
n_{BACK}	=	0.020	

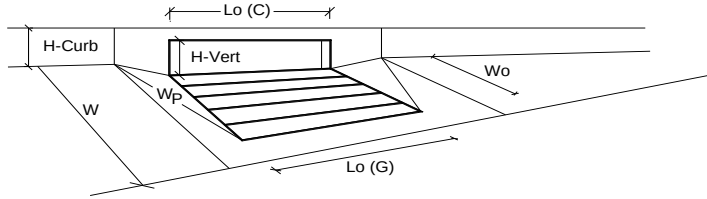
H_{CURB}	=	6.00	inches
T_{CROWN}	=	56.0	ft
W	=	2.00	ft
S_X	=	0.020	ft/ft
S_W	=	0.083	ft/ft
S_O	=	0.000	ft/ft
n_{STREET}	=	0.016	

	Minor Storm	Major Storm	
T_{MAX}	=	20.0	ft
d_{MAX}	=	6.0	inches
	☐	☐	

	Minor Storm	Major Storm	
Q_{allow}	=	SUMP	cfs
		SUMP	

INLET IN A SUMP OR SAG LOCATION

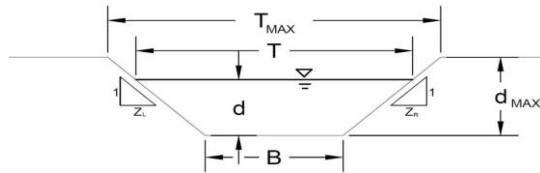
MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		L _o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _o =	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) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d _{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.77	0.77	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		Q _s =	5.4	5.4	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _{PEAK REQUIRED} =	0.9	2.0	cfs

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

Basin I (Inlet G1)



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using 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 =

C
see details below
$S_o = 0.0200$ ft/ft
$B = 3.00$ ft
$Z1 = 4.00$ ft/ft
$Z2 = 4.00$ 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	
$T_{MAX} =$	9.00	9.00	ft
$d_{MAX} =$	0.73	0.73	ft

Maximum Channel Capacity Based On Allowable Top Width

Maximum Allowable Top Width

Water Depth

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Maximum Flow Based on Allowable Water Depth

	Minor Storm	Major Storm	
$T_{MAX} =$	9.00	9.00	ft
$d =$	0.75	0.75	ft
$A =$	4.50	4.50	sq ft
$P =$	9.18	9.18	ft
$R =$	0.49	0.49	ft
$n =$	0.139	0.139	
$V =$	0.94	0.94	fps
$VR =$	0.46	0.46	ft ² /s
$D =$	0.50	0.50	ft
$Fr =$	0.24	0.24	
$Q_T =$	4.2	4.2	cfs

Maximum Channel Capacity Based On Allowable Water Depth

Maximum Allowable Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Maximum Flow Based on Allowable Water Depth

	Minor Storm	Major Storm	
$d_{MAX} =$	0.73	0.73	ft
$T =$	8.80	8.80	ft
$A =$	4.28	4.28	sq ft
$P =$	8.98	8.98	ft
$R =$	0.48	0.48	ft
$n =$	0.160	0.160	
$V =$	0.80	0.80	fps
$VR =$	0.38	0.38	ft ² /s
$D =$	0.49	0.49	ft
$Fr =$	0.20	0.20	
$Q_d =$	3.4	3.4	cfs

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

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 based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

	Minor Storm	Major Storm	
$Q_o =$	0.8	2.5	cfs
$d =$	0.57	0.72	ft
$T =$	7.55	8.77	ft
$A =$	3.00	4.25	sq ft
$P =$	7.69	8.95	ft
$R =$	0.39	0.47	ft
$n =$	0.422	0.218	
$V =$	0.27	0.59	fps
$VR =$	0.10	0.28	ft ² /s
$D =$	0.40	0.48	ft
$Fr =$	0.07	0.15	

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'

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

Basin I (Inlet G1)

Inlet Design Information (Input)

Type of Inlet

CDOT Type C

Inlet Type =

CDOT Type C

Angle of Inclined Grate (must be ≤ 30 degrees)

Width of Grate

Length of Grate

Open Area Ratio

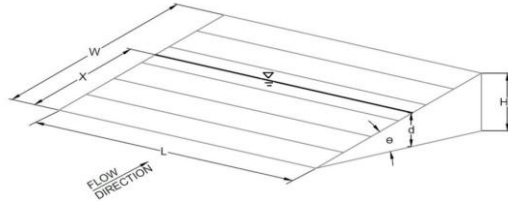
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



$\theta = 0.00$ degrees

$W = 3.00$ ft

$L = 3.00$ ft

$A_{RATIO} = 0.70$

$H_B = 0.00$ ft

$C_f = 0.50$

$C_d = 0.96$

$C_o = 0.64$

$C_w = 2.05$

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

	MINOR	MAJOR
$d =$	0.57	0.72

Grate Capacity as a Weir

Submerged Side Weir Length

Inclined Side Weir Flow

Base Weir Flow

Interception Without Clogging

Interception With Clogging

	MINOR	MAJOR	
$X =$	3.00	3.00	ft
$Q_{ws} =$	4.6	6.6	cfs
$Q_{wb} =$	6.6	9.4	cfs
$Q_{wi} =$	15.9	22.7	cfs
$Q_{wa} =$	7.9	11.3	cfs

Grate Capacity as an Orifice

Interception Without Clogging

Interception With Clogging

$Q_{oi} =$	24.4	27.5	cfs
$Q_{oa} =$	12.2	13.7	cfs

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

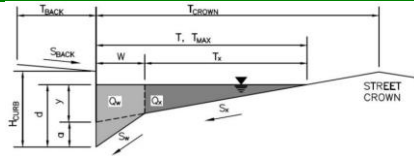
Capture Percentage = Q_a/Q_o

$Q_a =$	7.9	11.3	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:

Inlet ID: **Basin J (Inlet F1)****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)

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 Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

T_{BACK}	=	0.0	ft
S_{BACK}	=	0.020	ft/ft
n_{BACK}	=	0.020	

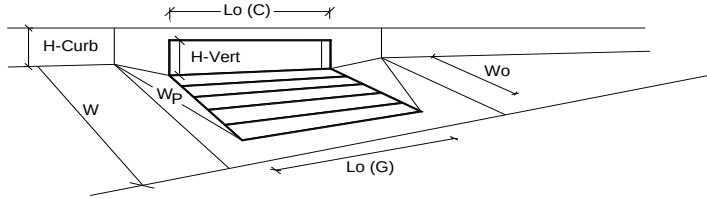
H_{CURB}	=	6.00	inches
T_{CROWN}	=	40.0	ft
W	=	2.00	ft
S_X	=	0.020	ft/ft
S_W	=	0.083	ft/ft
S_O	=	0.000	ft/ft
n_{STREET}	=	0.016	

	Minor Storm	Major Storm		
T_{MAX}	=	20.0	40.0	ft
d_{MAX}	=	6.0	6.0	inches
	☐	☐		

	Minor Storm	Major Storm		
Q_{allow}	=	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

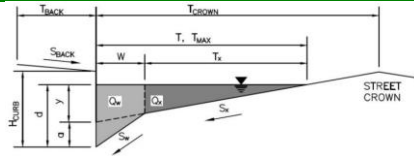


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		L _o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _o =	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) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d _{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.57	0.57	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	0.93	0.93	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _s =	8.3	8.3	cfs
		Q _{PEAK REQUIRED} =	3.3	8.0	cfs

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

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

Project:

Inlet ID: **Basin K (Inlet H1)****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)

$T_{BACK} =$	0.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	40.0	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.000	ft/ft
$n_{STREET} =$	0.016	

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	
$T_{MAX} =$	20.0	20.0	ft
$d_{MAX} =$	6.0	6.0	inches

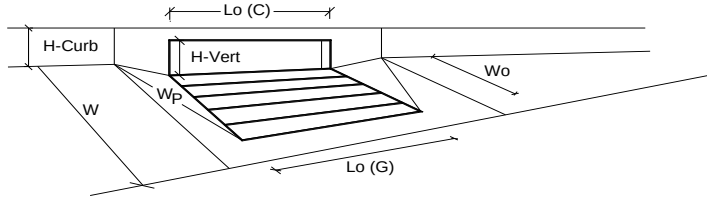
MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

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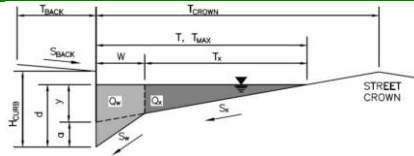


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		L _o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _o =	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) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d _{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.77	0.77	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		Q _s =	5.4	5.4	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _{PEAK REQUIRED} =	1.3	3.4	cfs

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

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

Project:

Inlet ID: **Basin L (Inlet L1)****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)

$T_{BACK} =$	0.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	40.0	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.000	ft/ft
$n_{STREET} =$	0.016	

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	
$T_{MAX} =$	20.0	20.0	ft
$d_{MAX} =$	6.0	6.0	inches

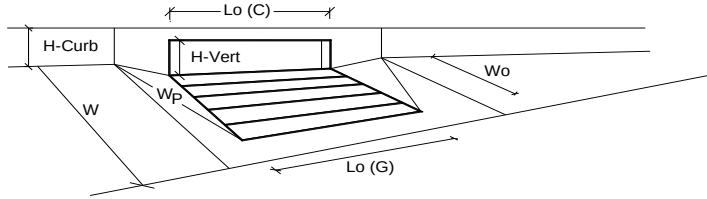
MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

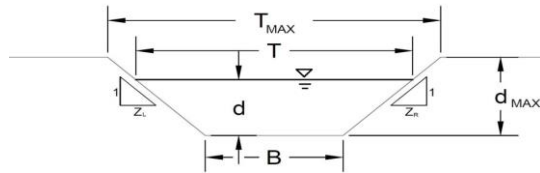


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		L _o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _o =	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) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d _{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.77	0.77	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{Grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _s =	5.4	5.4	cfs
		Q _{PEAK REQUIRED} =	1.3	3.7	cfs

MHFD-Inlet, Version 5.01 (April 2021)

AREA INLET IN A SWALE

Basin M (Inlet K1)



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using 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 =

C
see details below
$S_o = 0.0200$ ft/ft
$B = 3.00$ ft
$Z1 = 4.00$ ft/ft
$Z2 = 4.00$ 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

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	
$Q_{allow} =$	9.3	9.3	cfs
$d_{allow} =$	0.88	0.88	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

$Q_o =$	0.8	2.4	cfs
$d =$	0.57	0.71	ft

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'

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

Basin M (Inlet K1)

Inlet Design Information (Input)

Type of Inlet

CDOT Type C

Inlet Type =

CDOT Type C

Angle of Inclined Gate (must be ≤ 30 degrees)

Width of Gate

Length of Gate

Open Area Ratio

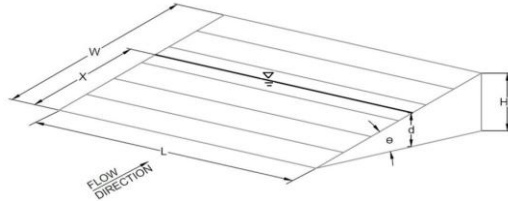
Height of Inclined Gate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



$\theta =$ 0.00 degrees

$W =$ 3.00 ft

$L =$ 3.00 ft

$A_{RATIO} =$ 0.70

$H_B =$ 0.00 ft

$C_f =$ 0.50

$C_d =$ 0.96

$C_o =$ 0.64

$C_w =$ 2.05

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

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

Capture Percentage = Q_a/Q_o

MINOR

MAJOR

$d =$ 0.57 0.71

$Q_a =$ 7.9 11.0 cfs

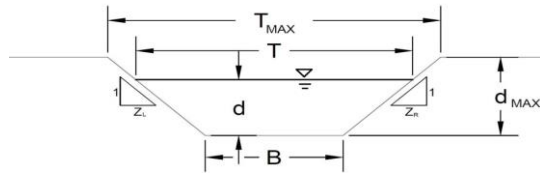
$Q_b =$ 0.0 0.0 cfs

$C\% =$ 100 100 %

MHFD-Inlet, Version 5.01 (April 2021)

AREA INLET IN A SWALE

Basin N (Inlet N1)



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using 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 =

C
see details below
$S_o = 0.0200$ ft/ft
$B = 3.00$ ft
$Z1 = 4.00$ ft/ft
$Z2 = 4.00$ 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

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	
$Q_{allow} =$	9.3	9.3	cfs
$d_{allow} =$	0.88	0.88	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

$Q_o =$	0.9	3.0	cfs
$d =$	0.59	0.71	ft

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'

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

Basin N (Inlet N1)

Inlet Design Information (Input)

Type of Inlet

CDOT Type C

Inlet Type =

CDOT Type C

Angle of Inclined Gate (must be ≤ 30 degrees)

Width of Gate

Length of Gate

Open Area Ratio

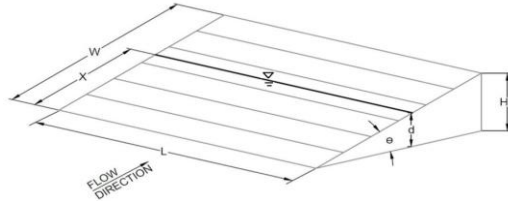
Height of Inclined Gate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



$\theta = 0.00$ degrees

$W = 3.00$ ft

$L = 3.00$ ft

$A_{RATIO} = 0.70$

$H_B = 0.00$ ft

$C_f = 0.50$

$C_d = 0.96$

$C_o = 0.64$

$C_w = 2.05$

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

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

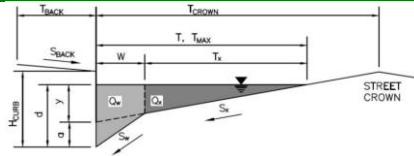
Capture Percentage = Q_a/Q_o

	MINOR	MAJOR	
$d =$	0.59	0.71	
$Q_a =$	8.4	11.0	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:

Inlet ID: **Basin O (Inlet M1)****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)

$T_{BACK} =$	0.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	14.0	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.022	ft/ft
$n_{STREET} =$	0.016	

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	
$T_{MAX} =$	14.0	14.0	ft
$d_{MAX} =$	6.0	6.0	inches
	☐	☐	

MINOR STORM Allowable Capacity is based on Spread Criterion

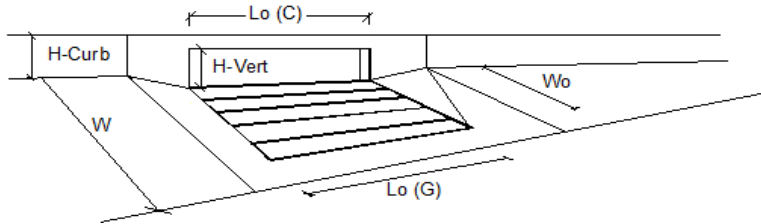
MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	10.0	10.0	cfs

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'**

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)

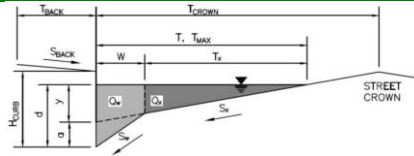


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a _{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		L _o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W _o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C _{r-G} =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C _{r-C} =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity					
Total Inlet Interception Capacity		Q =	1.3	2.7	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q _b =	0.0	0.0	cfs
Capture Percentage = Q _i /Q _a =		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:

Inlet ID: **Basin P (Inlet M2)****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)

$T_{BACK} =$	0.0	ft
$S_{BACK} =$	0.020	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	14.0	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.022	ft/ft
$n_{STREET} =$	0.016	

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	
$T_{MAX} =$	14.0	14.0	ft
$d_{MAX} =$	6.0	6.0	inches
	☐	☐	

MINOR STORM Allowable Capacity is based on Spread Criterion

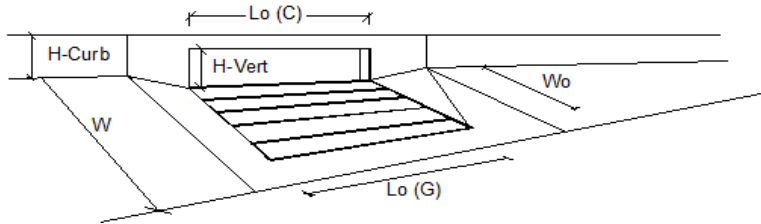
MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	10.0	10.0	cfs

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'**

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)

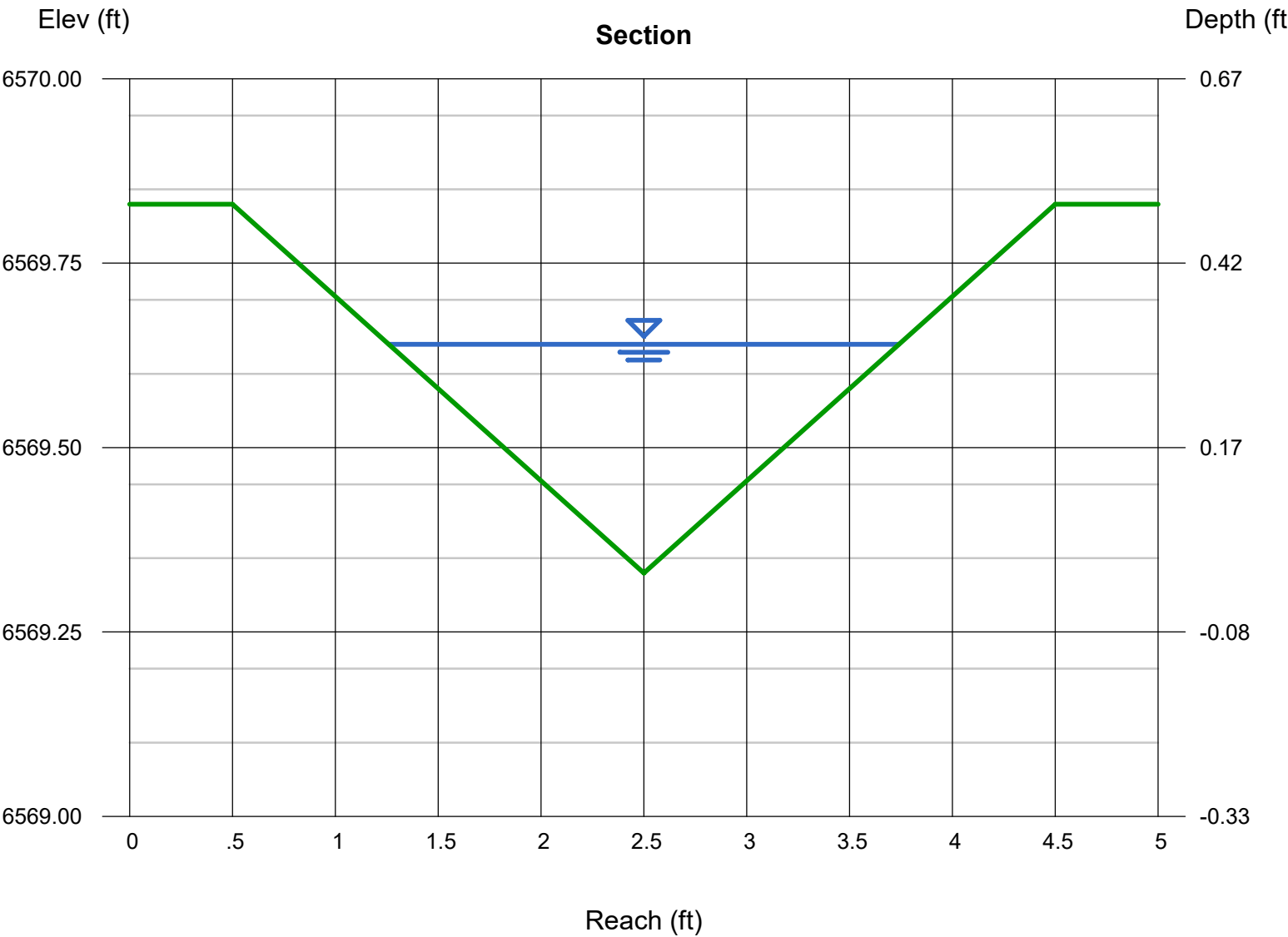


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a')		Type =			
Total Number of Units in the Inlet (Grate or Curb Opening)		a _{LOCAL} =	3.0	3.0	inches
Length of a Single Unit Inlet (Grate or Curb Opening)		No =	2	2	
Width of a Unit Grate (cannot be greater than W, Gutter Width)		L _o =	5.00	5.00	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		W _o =	N/A	N/A	ft
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C _{r-G} =	N/A	N/A	
		C _{-C} =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity		MINOR		MAJOR	
Total Inlet Interception Capacity		Q =	0.5	0.9	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)		Q _b =	0.0	0.0	cfs
Capture Percentage = Q _i /Q _a =		C% =	100	100	%

Channel Report

SWALE SECTION ANALYSIS

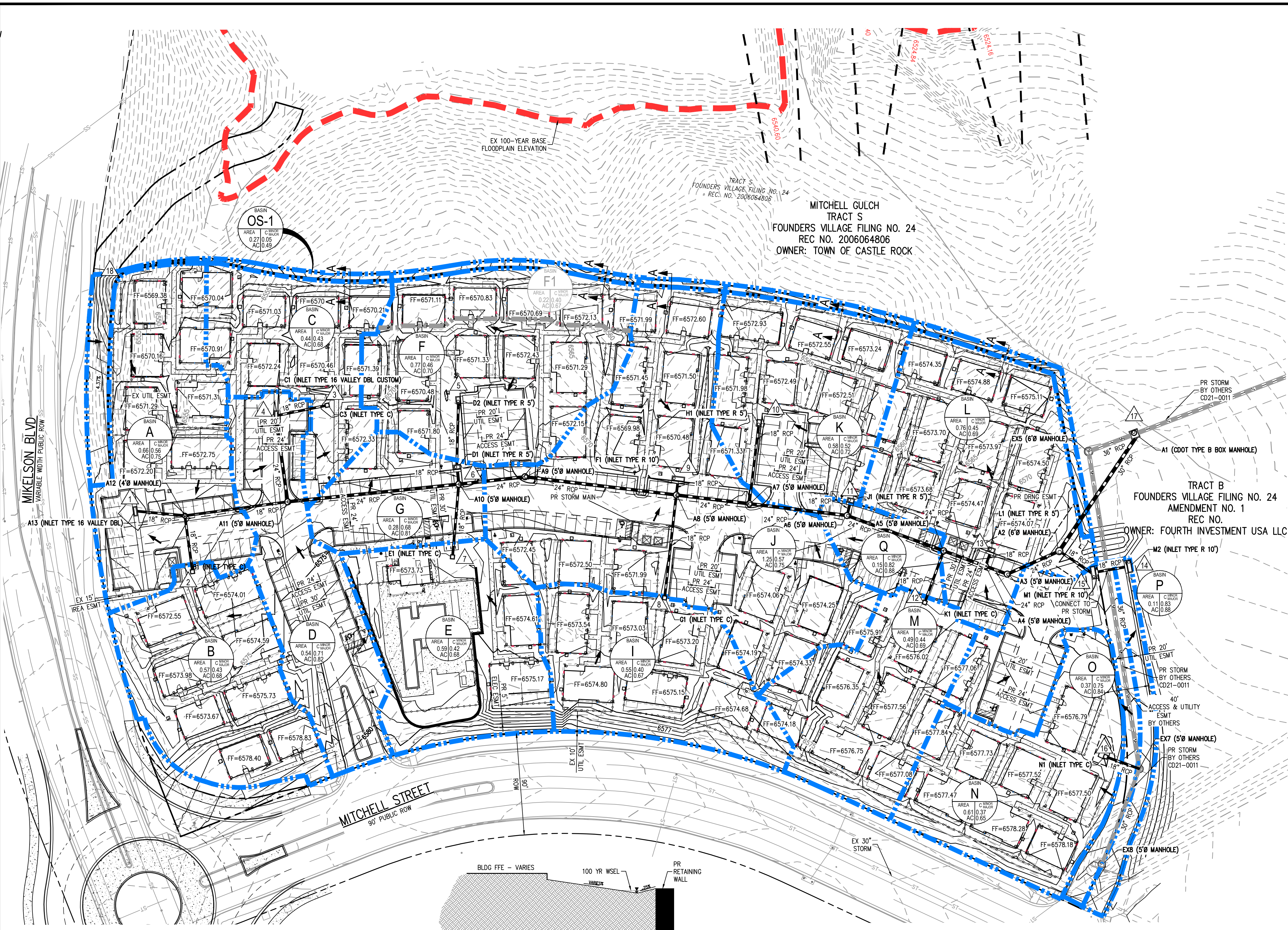
Triangular		Highlighted	
Side Slopes (z:1)	= 4.00, 4.00	Depth (ft)	= 0.31
Total Depth (ft)	= 0.50	Q (cfs)	= 1.100
		Area (sqft)	= 0.38
Invert Elev (ft)	= 6569.33	Velocity (ft/s)	= 2.86
Slope (%)	= 2.00	Wetted Perim (ft)	= 2.56
N-Value	= 0.020	Crit Depth, Yc (ft)	= 0.35
		Top Width (ft)	= 2.48
		EGL (ft)	= 0.44
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 1.10		



APPENDIX F

Final Drainage Plan

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT THE WRITTEN PERMISSION OF HARRIS KOCHER SMITH.
FILE PATH: K:\210431\ENGINEERING\DRAINAGE\PHILL - DRAINAGE PLAN DWG LAYOUT LAYOUT1
DESIGNED BY: RCP
CHECKED BY: RCP
DRAWN BY: RCP
PLOTTED: THU 10/13/22 4:48:39 PM BY: BRAD WEAVER



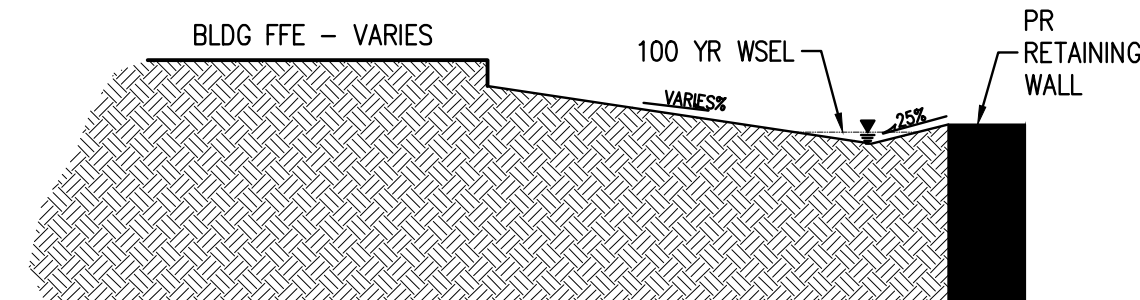
LEGEND

- PROPERTY LINE
- PROPOSED DRAINAGE EASEMENT
- EXISTING RIGHT-OF-WAY
- EXISTING CONTOURS
- PROPOSED CONTOURS
- PROPOSED STORM SEWER
- PROPOSED DRAINAGE FLOW
- PROPOSED PHASE III DRAINAGE BASIN

BASIN DESIGNATION
OS 1
AREA: 1.23 AC
C: 0.45
AC: 0.67

5-YR RATIONAL C COEFFICIENT
100-YR RATIONAL C COEFFICIENT

BASIN DESIGN POINT



SECTION A-A
NTS



ISSUE DATE: 07-29-2022	
DATE	REVISION COMMENTS
10-13-2022	PER CITY COMMENTS

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HarrisKocherSmith.com



AVILLA FOUNDERS VILLAGE
FINAL DRAINAGE PLAN

PRELIMINARY
NOT FOR
CONSTRUCTION

PROJECT #: 210431
SHEET NUMBER
1
1 OF 1