

# **AVANTERRA BLACK FOREST FINAL DRAINAGE REPORT AMENDMENT**

## **AMENDMENT TO: MASTER DEVELOPMENT DRAINAGE PLAN FOR WOODMEN HEIGHTS MASTER PLAN**

Prepared for:

**Continental 613 Fund LLC**  
W134 N8675 Executive Parkway  
Menomonee Falls, WI 53051

Contact: Erin Conway  
Phone: 262.613.8680

Prepared by:

**BOWMAN CONSULTING**  
1526 Cole Blvd, Suite 100  
Lakewood, Colorado 80401

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Phone: 303.801.2910

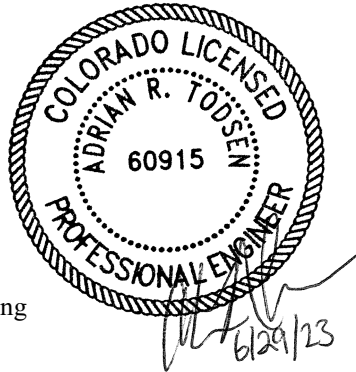
SWENT Project No. STM-REV23-0541  
Bowman Job No. 020439-01-003  
**June 2023**

The logo for Bowman Consulting, featuring the word "Bowman" in a bold, dark green, sans-serif font. The letters are closely spaced and have a slight shadow effect, giving it a three-dimensional appearance. The logo is centered at the bottom of the page.

Signature Page

Engineer's Statement

This report and plan for the drainage design of Avanterra Black Forest was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.



Adrian R. Todsen, PE.  
State of Colorado No. 60915  
For and on behalf of Bowman Consulting

Developer's Statement

Continental 613 Fund LLC hereby certifies that the drainage facilities for Avanterra Black Forest shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Avanterra Black Forest, guarantee that final drainage design review will absolve Continental 613 Fund LLC and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

Continental 613 Fund LLC  
By: Continental Properties Company, Inc., its manager

Name of Developer \_\_\_\_\_

Erin Conway 8-25-22  
Authorized Signature Date

Erin Conway  
Printed Name \_\_\_\_\_

Development Director  
Title \_\_\_\_\_

W134N8675 Executive Parkway  
Menomonee Falls, WI 53051  
Address \_\_\_\_\_

City of Colorado Springs Statement:

Filed in accordance with Section 7.7.906 of the Code of the City of Colorado Springs, 2001, as amended.

Jonathan B. Ivers 06/30/2023  
For City Engineer Date  
Conditions

## **1 Purpose**

The purpose of this report is to amend certain inlet types and locations and certain public storm sewers from the “Avanterra Black Forest Final Drainage Report – Amendment To: Master Development Drainage Plan for Woodmen Heights Master Plan”, prepared by Bowman and approved on October 25, 2022, and to provide relevant updated hydraulic calculations. There are no changes proposed to the drainage basin boundaries, impervious areas, or peak flows included in the previously approved Final Drainage Report.

Changes from the previous report include the following:

- **Revised Report Sections:** 1 Purpose, 3.2 Subbasin Descriptions, 5.3 Drainage Fees, 5.4 Erosion Control Design, 5.5 Construction Cost Opinion, 6 Summary
- **Revised Inlet Types:** A3, A4, A8, A11
- **Revised Culverts:** Increased pipe size from 12” to 18” on the following culverts:
  - HW-8 to HW-9
  - HW-2 to HW-3
  - HW-4 to HW-5
- **Revised Appendices:** Proposed Drainage Basin Map, Inlet Calculations, and Hydraulic Calculations (StormCAD Model Results)

For all other report sections, calculations, and appendices not included in this report, please refer to the approved Final Drainage Report.

## **3 Drainage Basins and Sub-Basins**

### **3.1 Major Basin Descriptions**

Existing available drainage studies that impact the Site are:

- “Master Development Drainage Plan for Woodmen Heights Master Plan”, prepared by Classic Consulting Engineers & Surveyors, LLC, June 2004.
- Circle K- “Preliminary and Final Drainage Report for Blackwood Crossing Fling No. 1A”, prepared by Bowman Consulting, May 2019.
- “Sand Creek Drainage Basin Planning Study Final Report”, prepared by Stantec, January 2021.
- Avanterra Black Forest Preliminary Drainage Plan: Amendment to: “Master Development Drainage Plan for Woodmen Heights Master Plan” prepared by Bowman Consulting, October 2021.
- Avanterra Black Forest Final Drainage Report: Amendment to: “Master Development Drainage Plan for Woodmen Heights Master Plan” prepared by Bowman Consulting, October 2022.

- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), Map No. 08041C0529G (December 2018). This FIRMette map shows that the Site is located within Zone X (area of minimal flood hazard) depicted as above the 500-year flood level. The FIRMette map is included in Appendix A.

### **3.2 Subbasin Description**

**See Appendix A for the revised Proposed Drainage Map.**

#### **Basin A3 (0.72 Ac., $Q_5=1.59$ , $Q_{100}=3.73$ )**

Basin A3 is located on the western side of the Site and is composed of asphalt pavement, curb and gutter, sidewalk, homes, and landscaping area. Runoff from this basin initially sheet flows southeast, then flows along the curb & gutter to a proposed private in-sump double Type-16 Valley inlet which, through a proposed private 18" HP pipe, conveys flows to the proposed storm drain system that conveys the flows to design point 4 on the existing private 30" HDPE storm drain stub located at the northeast corner of the property. This pipe conveys the flows to the existing public Regional Pond 6 located northeast of the proposed Site. In the case of clogging or storm events exceeding the inlet capacity, Basin A3 will overflow to Basin A9.

On the previous report, this inlet was shown as an on-grade double Type 16 combination inlet. This has been revised to a double Type 16 valley inlet due to a driveway conflict and has been corrected to be in-sump based on the approved grading. The new inlet still has sufficient capacity for this subbasin during the minor and major design storm events.

#### **Basin A4 (0.75 Ac., $Q_5=1.81$ , $Q_{100}=4.09$ )**

Basin A4 is located on the north-central side of the Site and is composed of asphalt pavement, curb and gutter, sidewalk, homes, and landscaping area. Runoff from this basin initially sheet flows southeast, then flows along the curb & gutter to a proposed private on-grade double Type R inlet which, through a proposed private 24" HP pipe, conveys flows to the proposed storm drain system that conveys the flows to the existing private 30" HDPE storm drain stub located at the northeast corner of the property. This pipe conveys the flows to design point 6 on the existing public Regional Pond 6 located northeast of the proposed Site. In the case of clogging or storm events exceeding the inlet capacity, Basin A4 will overflow to Basin A11.

On the previous report, this inlet was shown as a double Type 16 combination inlet. This has been revised to a double Type R inlet due to construction availability and was shifted slightly to be off the curb radius. The new inlet has a greater capacity with less bypass flow and only a small amount of bypass in the major storm event that is flowing to Basin A11.

#### **Basin A8 (2.06 Ac., $Q_5=2.84$ , $Q_{100}=7.52$ )**

Basin A8 is located on the east side of the Site and is composed of asphalt pavement, curb and gutter, sidewalk, homes, utility shed, retaining wall, and landscaping area. Runoff from this basin sheet flows north and flows along the curb & gutter north to a proposed private in-sump triple Type R inlet which, through a proposed private 30" RCP pipe, conveys flows to the proposed storm drain system that conveys the flows to the existing private 30" HDPE storm drain stub located at the northeast corner of the property. This pipe conveys



the flows to design point 10 on the existing public Regional Pond 6 located northeast of the proposed Site. In the case of clogging or storm events exceeding the inlet capacity, Basin A8 will overflow to Basin A12. An emergency overflow is located at the northeast corner of the Site. A swale will be constructed to convey emergency overflow overtopping the curb to match the historic drainage pattern. This basin/inlet takes overflow from Inlet A11 which is in Basin A11.

On the previous report, this inlet was shown as a double Type 16 combination inlet. This has been revised to a triple Type R inlet due to construction availability and shifted around the curb radius. The new inlet has sufficient capacity for the major and minor storm events.

**Basin A11 (0.39 Ac.,  $Q_5=0.78$ ,  $Q_{100}=1.89$ )**

Basin A11 is located on the north-central of the Site and is composed of asphalt pavement, curb and gutter, sidewalk, homes, utility shed, retaining wall, and landscaping area. Runoff from this basin initially sheet flows and flows along the curb & gutter east to a proposed private on-grade single Type R inlet which, through a proposed private 24" HP pipe, conveys flows to design point 9 on the proposed storm drain system that conveys the flows to the existing private 30" HDPE storm drain stub located at the northeast corner of the property. This pipe conveys the flows to the existing public Regional Pond 6 located northeast of the proposed Site. In the case of clogging or storm events exceeding the inlet capacity, Basin A11 will overflow to Basin A8.

On the previous report, this inlet was shown as a double Type 16 combination inlet. Due to limited space and conflicts with the proposed sidewalk and parking, this inlet was reduced to a single Type R inlet. The inlet still has full capacity for the minor storm event, but the bypass flow in the major storm event increased slightly and will flow to Basin A8 which has sufficient capacity for the basin and bypass flows. This basin/inlet takes overflow from Inlet A4 which is in Basin A4.

**Basin OS1 (1.10 Ac.,  $Q_5=0.61$ ,  $Q_{100}=2.66$ )**

Basin OS1 is located offsite, wrapping around the west and southwest corner of the Site. It consists of existing asphalt pavement, landscaping area and a proposed swale. Basin OS1 also contains a small portion of undetained onsite area. Runoff from this basin is channeled south through a proposed swale and routed through a proposed 18" culvert. From there, runoff is channeled east through another proposed swale to a proposed FES, where it combines with Discharge Point 13.

The only change to the previous report is to upsize the culvert from a 12" to an 18" pipe.

**Basin OS4 (1.12 Ac.,  $Q_5=0.38$ ,  $Q_{100}=2.59$ )**

Basin OS4 is located offsite north of the Site and south of East Woodmen Road. It consists of proposed sidewalk and landscaping area. This Project proposes to modify the existing swale parallel to the south side of Woodmen Rd to add curbing, sidewalk, and two public 18" RCP culverts. The swale will operate in historic flow pattern to direct runoff east to an existing public area drain, located at the southwest corner of Black Forest Rd and Woodmen Rd. See Existing Offsite Drainage Map in Appendix A.

The only change to the previous report is to upsize the culvert from a 12” to an 18” pipe.

**Unchanged Subbasins:**

A1, A2, A5, A6, A7, A9, A10, A12, OS2, OS3, OS5, OS6

## **4 Drainage Design Criteria**

### **4.1 Development Criteria Reference**

The Site’s drainage analysis is performed in conformance with the current “City of Colorado Springs Drainage Criteria Manual” (DCM)

The drainage design for the Site is influenced by the following previous studies: Sand Creek Drainage Basin Planning Study Final Report, prepared by Stantec in January 2021, “Master Development Drainage Plan for Woodmen Heights Master Plan,” prepared by Classic Consulting Engineers & Surveyors, LLC in June 2004, and “Preliminary and Final Drainage Report for Blackwood Crossing Filing No. 1A”, prepared by Bowman Consulting, May 2019.

The total area of Parcel 9 (32.8 AC) from the original MDDP was originally designated as a Community Commercial land use. This land use is associated with an average imperviousness of 75%, per the Sand Creek Drainage Basin Planning Study (DBPS). A portion of the area adjacent to Black Forest Road within Parcel 9 has already been developed as commercial, including a Circle K gas station, Maverick Convenience Store and Ponderosa Veterinary Clinic. It is assumed that these developments used a maximum impervious area for calculations. A Master Plan Amendment was approved to change the land use for this Site’s ±12 acres of Parcel 9 to Residential land use. This Project proposes to add an additional 1.04 AC to Parcel 9 for a total acreage of 33.84.

The Site in its post development conditions will include attached and detached homes, a swimming pool, fitness center, pet playgrounds, and enclosed yards and has a Site impervious percentage of approximately 51.7% which is less than the 75% designated in the DBPS. Please refer to Appendix A for the Calculations for Imperviousness and Area Increase in Parcel 9 and Exhibit.

### **4.4 Hydraulic Criteria**

Storm capacity calculations and Hydraulic Grade Line calculations are provided in Appendix B of this report. StormCAD was used to calculate hydraulic grade lines.

## **5 Drainage Facility Design**

### **5.3 Drainage Fees**

The final plat for this project has been recorded, and drainage fees were paid at the time of plat recordation as required by Colorado Springs Municipal Code.

### 5.4 Erosion Control Design

A Grading & Erosion Control Plan and CSWMP were approved for this development under separate submittals under STM-REV22-0761, STM-REV22-0762 and STM-REV22-1289. Construction is currently underway. Please refer to those documents for the final grading and erosion control design for this development.

### 5.5 Construction Cost Opinion

Changes to the previous Construction Cost Opinion include the following:

**Private:**

- Updated quantities on proposed yard drains and piping
- Added 1 EA – 5’ Type R Inlet
- Added 1 EA – Double Type 16 Valley Inlet
- Added 1 EA – Double Type R Inlet
- Added 1 EA – Triple Type R Inlet
- Removed 4 EA – Double Type 16 Combination Inlets

**Public:**

- Updated unit pricing
- Added 73 LF – 18” RCP
- Removed 73 LF – 12” RCP

| Private Drainage Facilities |                                  |          |      |           |                     |
|-----------------------------|----------------------------------|----------|------|-----------|---------------------|
| Item #                      | Description                      | Quantity | Unit | Unit Cost | Total Cost          |
| <b>Drainage</b>             |                                  |          |      |           |                     |
| 1                           | 12" HP Pipe                      | 349      | LF   | \$30      | \$10,470.00         |
| 2                           | 15" HP Pipe                      | 234      | LF   | \$55      | \$12,870.00         |
| 3                           | 18" HP Pipe                      | 441      | LF   | \$80      | \$35,280.00         |
| 4                           | 24" HP Pipe                      | 763      | LF   | \$100     | \$76,300.00         |
| 5                           | 30" HP Pipe                      | 49       | LF   | \$110     | \$5,390.00          |
| 6                           | 30" RCP Pipe                     | 133      | LF   | \$350     | \$46,550.00         |
| 7                           | 5' DIA Manhole Type I            | 6        | EA   | \$5,000   | \$30,000.00         |
| 8                           | 4' DIA Manhole Type II           | 5        | EA   | \$4,000   | \$20,000.00         |
| 9                           | Single Type 16 Combination Inlet | 3        | EA   | \$6,500   | \$19,500.00         |
| 10                          | Single Type R Inlet              | 1        | EA   | \$5,000   | \$5,000.00          |
| 11                          | Double Type 16 Valley Inlet      | 1        | EA   | \$9,500   | \$9,500.00          |
| 12                          | Double Type 16 Combination Inlet | 3        | EA   | \$9,500   | \$28,500.00         |
| 13                          | Double Type R Inlet              | 1        | EA   | \$7,500   | \$7,500.00          |
| 14                          | Triple Type R Inlet              | 1        | EA   | \$10,000  | \$10,000.00         |
| 15                          | Triple Type 16 Combination Inlet | 1        | EA   | \$11,500  | \$11,500.00         |
| 16                          | 6" PVC Pipe                      | 1438     | LF   | \$25      | \$35,950.00         |
| 17                          | 12" PVC Pipe                     | 969      | LF   | \$30      | \$29,070.00         |
| 18                          | Yard Drain                       | 44       | EA   | \$600     | \$26,400.00         |
| <b>Subtotal</b>             |                                  |          |      |           | \$419,780.00        |
| <b>10% Contingency</b>      |                                  |          |      |           | \$41,978.00         |
| <b>Total Improvements</b>   |                                  |          |      |           | <b>\$461,758.00</b> |

| Public Drainage Facilities |                               |          |      |           |                     |
|----------------------------|-------------------------------|----------|------|-----------|---------------------|
| Item #                     | Description                   | Quantity | Unit | Unit Cost | Total Cost          |
|                            | <b>Drainage</b>               |          |      |           |                     |
| 1                          | 5' Type R Inlet               | 3        | EA   | \$5,000   | \$15,000.00         |
| 2                          | End Section                   | 8        | EA   | \$2,500   | \$20,000.00         |
| 3                          | Connections to Existing Storm | 3        | EA   | \$500     | \$1,500.00          |
| 4                          | 15' Type R Inlet              | 1        | EA   | \$10,000  | \$10,000.00         |
| 5                          | 4' DIA Manhole Type II        | 2        | EA   | \$4,000   | \$8,000.00          |
| 7                          | 18" RCP Pipe                  | 237      | LF   | \$220     | \$52,140.00         |
|                            | <b>Subtotal</b>               |          |      |           | \$106,640.00        |
|                            | <b>10% Contingency</b>        |          |      |           | \$10,664.00         |
| <b>Total Improvements</b>  |                               |          |      |           | <b>\$117,304.00</b> |

## 6 Summary

The development of this Site will not adversely affect the surrounding development. The developed flows from Avanterra Black Forest will outfall into the existing storm sewer infrastructure in Blackwood Crossing Filing No. 1A. The existing pond, Sand Creek Detention Pond No. 6, was designed to detain and treat flows from the Site. The construction of Avanterra Black Forest is not anticipated to adversely affect the downstream infrastructure of the Woodmen Heights Development. The construction of Sand Creek Regional Detention Pond No. 6 has been completed.

## References

- 1 City of Colorado Springs Drainage Criteria Manual
- 2 Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, September 2001, Vol 1, Revised March 2017, Vol 2, Revised September 2017, Vol 3, Revised November 2015.
- 3 Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), City of Colorado Springs, Colorado and Unincorporated Areas, Panel 338 Map No. 08001C0338H (March 2007).
- 4 Natural Resources Conservation Service Web Soil Survey.
- 5 “Master Development Drainage Plan for Woodmen Heights Master Plan”, prepared by Classic Consulting Engineers, dated June 2004.
- 6 “Preliminary and Final Drainage Report For Blackwood Crossing Filing No. 1A”, prepared by Bowman Consulting, dated December 2017.
- 7 Avanterra Black Forest Preliminary Drainage Plan: Amendment to: “Master Development Drainage Plan for Woodmen Heights Master Plan” prepared by Bowman Consulting, October 2021.
- 8 Avanterra Black Forest Final Drainage Report: Amendment to: “Master Development Drainage Plan for Woodmen Heights Master Plan” prepared by Bowman Consulting, October 2022.

## **APPENDIX A**

**VICINITY MAP – NO CHANGES**

**FEMA FIRM MAP – NO CHANGES**

**SOILS MAP – NO CHANGES**

**COCS APPROVED MASTER PLAN AMENDMENT MAP – NO CHANGES**

**“DEVELOPED CONDITIONS; WOODMEN HEIGHTS; MASTER DEVELOPMENT DRAINAGE PLAN” PREPARED BY CLASSIC CONSULTING ENGINEERS & SURVEYORS, DATED JUNE 2004. – NO CHANGES**

**EXISTING DRAINAGE MAP – NO CHANGES**

**PROPOSED DRAINAGE MAP – REVISED**

**POST DEVELOPMENT DRAINAGE AREA MAP FROM “PRELIMINARY AND FINAL DRAINAGE REPORT FOR BLACKWOOD CROSSING FILING NO. 1A”, PREPARED BY BOWMAN CONSULTING, DATED DECEMBER 2017. – NO CHANGES**

**AREA MODIFICATION TO THE ORIGINAL MDDP FOR PARCEL 9 EXHIBIT – NO CHANGES**

**CALCULATIONS FOR IMPERVIOUSNESS AND AREA INCREASE IN PARCEL 9 – NO CHANGES**

**PROPOSED DRAINAGE MAP**



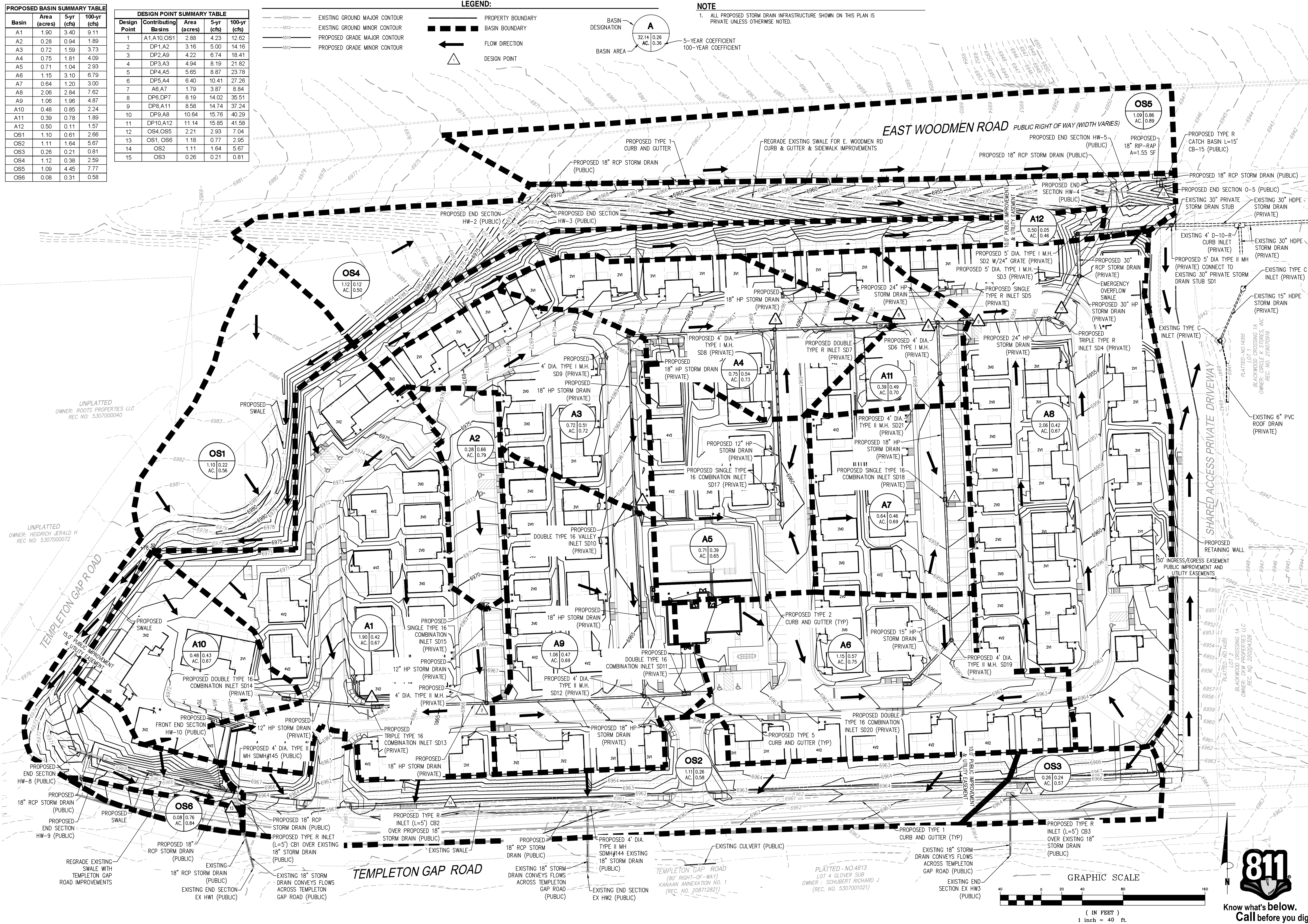
| Basin | Area (acres) | 5-yr (cfs) | 100-yr (cfs) |
|-------|--------------|------------|--------------|
| A1    | 1.90         | 3.40       | 9.11         |
| A2    | 0.28         | 0.94       | 1.89         |
| A3    | 0.72         | 1.59       | 3.73         |
| A4    | 0.75         | 1.81       | 4.09         |
| A5    | 0.71         | 1.04       | 2.93         |
| A6    | 1.15         | 3.10       | 6.79         |
| A7    | 0.64         | 1.20       | 3.00         |
| A8    | 2.06         | 2.84       | 7.62         |
| A9    | 1.06         | 1.96       | 4.87         |
| A10   | 0.48         | 0.85       | 2.24         |
| A11   | 0.39         | 0.78       | 1.89         |
| A12   | 0.50         | 0.11       | 1.57         |
| OS1   | 1.10         | 0.61       | 2.66         |
| OS2   | 1.11         | 1.64       | 5.67         |
| OS3   | 0.26         | 0.21       | 0.81         |
| OS4   | 1.12         | 0.38       | 2.59         |
| OS5   | 1.09         | 4.45       | 7.77         |
| OS6   | 0.08         | 0.31       | 0.58         |

| Design Point | Contributing Basins | Area (acres) | 5-yr (cfs) | 100-yr (cfs) |
|--------------|---------------------|--------------|------------|--------------|
| 1            | A1,A10,OS1          | 2.88         | 4.23       | 12.62        |
| 2            | DP1,A2              | 3.16         | 5.00       | 14.16        |
| 3            | DP2,A9              | 4.22         | 6.74       | 18.41        |
| 4            | DP3,A3              | 4.94         | 8.19       | 21.82        |
| 5            | DP4,A5              | 5.65         | 8.87       | 23.78        |
| 6            | DP5,A4              | 6.40         | 10.41      | 27.26        |
| 7            | A6,A7               | 1.79         | 3.87       | 8.84         |
| 8            | DP6,DP7             | 8.19         | 14.02      | 35.51        |
| 9            | DP8,A11             | 8.58         | 14.74      | 37.24        |
| 10           | DP9,A8              | 10.64        | 15.76      | 40.29        |
| 11           | DP10,A12            | 11.14        | 15.85      | 41.58        |
| 12           | OS4,OS5             | 2.21         | 2.93       | 7.04         |
| 13           | OS1,OS6             | 1.18         | 0.77       | 2.95         |
| 14           | OS2                 | 1.11         | 1.64       | 5.67         |
| 15           | OS3                 | 0.26         | 0.21       | 0.81         |

-5510- EXISTING GROUND MAJOR CONTOUR  
 -5512- EXISTING GROUND MINOR CONTOUR  
 -5510- PROPOSED GRADE MAJOR CONTOUR  
 -5512- PROPOSED GRADE MINOR CONTOUR

**LEGEND:**  
 - - - - - PROPERTY BOUNDARY  
 - - - - - BASIN BOUNDARY  
 - - - - - FLOW DIRECTION  
 ▲ DESIGN POINT

**NOTE:**  
 1. ALL PROPOSED STORM DRAIN INFRASTRUCTURE SHOWN ON THIS PLAN IS PRIVATE UNLESS OTHERWISE NOTED.

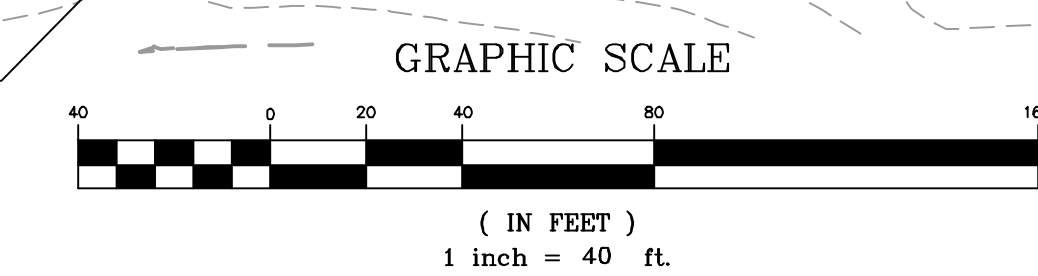


**Bowman**  
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 www.bowman.com

| REVISION | DATE | DESCRIPTION |
|----------|------|-------------|
|          |      |             |
|          |      |             |
|          |      |             |
|          |      |             |
|          |      |             |

**PROPOSED DRAINAGE MAP**  
 AVANTERRA BLACK FOREST  
 DEVELOPMENT PLAN  
 EAST WOODMEN ROAD AND TEMPLETON GAP ROAD  
 COLORADO SPRINGS  
 COLORADO

**NOT FOR CONSTRUCTION**  
 DESIGN ISL CHKD  
 DRAWN ISL DD  
 SCALE H: 1" = 40'  
 V: N/A  
 JOB No. 020439-01-003  
 DATE: 09/23/2022  
 SHEET





## **APPENDIX B**

### **EXISTING BASIN SUMMARY TABLE AND PROPOSED BASIN SUMMARY TABLE – NO CHANGES**

### **UDFCD RUNOFF COEFFICIENTS – NO CHANGES**

### **HYDROLOGY CALCULATIONS – NO CHANGES**

### **INLET CALCULATIONS – REVISED**

### **HYDRAULIC CALCULATIONS (STORMCAD MODEL RESULTS) - REVISED**

### **SWALE FLOWMASTER CALCULATIONS – NO CHANGES**

### **SUMMARY OF PRE VS. POST DEVELOPMENT FLOW RATE COMPARISON FOR TEMPLETON GAP RD – NO CHANGES**

### **CULVERT FLOWMASTER CALCULATIONS – NO CHANGES**

### **RIP RAP CALCULATIONS – NO CHANGES**

### **STORM SEWER VELOCITY VARIANCE REQUEST - NEW**

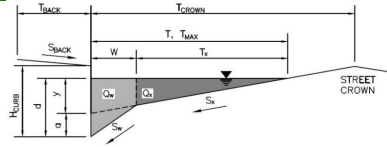


## **INLET CALCULATIONS**

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

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

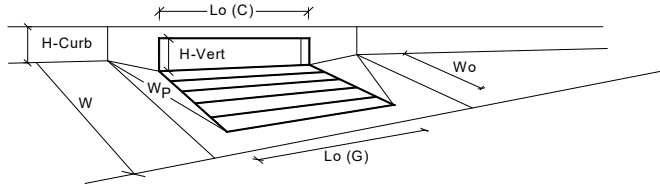
**Project:** Avanterra Black Forest  
**Inlet ID:** A3



**Warning 1**

| <b>Gutter Geometry:</b>  |   |             |             |      |      |
|--|---|-------------|-------------|------|------|
| Maximum Allowable Width for Spread Behind Curb                             | $T_{BACK} = 0.0$ ft   |             |             |      |      |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb)  | $S_{BACK} =$ ft/ft  |             |             |      |      |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020)        | $n_{BACK} = 0.020$  |             |             |      |      |
| Height of Curb at Gutter Flow Line   | $H_{CURB} = 6.00$ inches  |             |             |      |      |
| Distance from Curb Face to Street Crown                                    | $T_{CROWN} = 24.0$ ft   |             |             |      |      |
| Gutter Width   | $W = 2.00$ ft   |             |             |      |      |
| Street Transverse Slope  | $S_x = 0.029$ ft/ft   |             |             |      |      |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)      | $S_w = 0.083$ ft/ft   |             |             |      |      |
| Street Longitudinal Slope - Enter 0 for sump condition                     | $S_o = 0.000$ ft/ft   |             |             |      |      |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET} = 0.016$  |             |             |      |      |
| Max. Allowable Spread for Minor & Major Storm                              | $T_{MAX} =$ <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="padding: 2px;">Minor Storm</td><td style="padding: 2px;">Major Storm</td></tr><tr><td style="padding: 2px;">17.2</td><td style="padding: 2px;">17.2</td></tr></table> ft   | Minor Storm | Major Storm | 17.2 | 17.2 |
| Minor Storm  | Major Storm   |             |             |      |      |
| 17.2   | 17.2  |             |             |      |      |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm            | $d_{MAX} =$ <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="padding: 2px;">Minor Storm</td><td style="padding: 2px;">Major Storm</td></tr><tr><td style="padding: 2px;">6.0</td><td style="padding: 2px;">6.0</td></tr></table> inches | Minor Storm | Major Storm | 6.0  | 6.0  |
| Minor Storm  | Major Storm   |             |             |      |      |
| 6.0  | 6.0   |             |             |      |      |
| Check boxes are not applicable in SUMP conditions                          | <input type="checkbox"/> <input type="checkbox"/>   |             |             |      |      |
| <a href="#">MINOR STORM Allowable Capacity is based on Depth Criterion</a> |   |             |             |      |      |
| <a href="#">MAJOR STORM Allowable Capacity is based on Depth Criterion</a> |   |             |             |      |      |
| <b>Q<sub>allow</sub> =</b>   | <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="padding: 2px;">Minor Storm</td><td style="padding: 2px;">Major Storm</td></tr><tr><td style="padding: 2px;">SUMP</td><td style="padding: 2px;">SUMP</td></tr></table> cfs              | Minor Storm | Major Storm | SUMP | SUMP |
| Minor Storm  | Major Storm   |             |             |      |      |
| SUMP   | SUMP  |             |             |      |      |

## INLET IN A SUMP OR SAG LOCATION

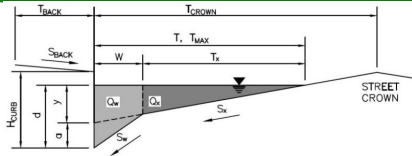


| <b>Design Information (Input)</b>  |  |
|--|--|
| Type of Inlet  | Denver No. 16 Valley Grate                 |
| Local Depression (additional to continuous gutter depression 'a' from above) |  |
| Number of Unit Inlets (Grate or Curb Opening)                                | 2  |
| Water Depth at Flowline (outside of local depression)                        | 6.0  |
| <b>Grate Information</b>   |  |
| Length of a Unit Grate   | 3.33                                       |
| Width of a Unit Grate  | 1.73                                       |
| Area Opening Ratio for a Grate (typical values 0.15-0.90)                    | 0.31                                       |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70)               | 0.50                                       |
| Grate Weir Coefficient (typical value 2.15 - 3.60)                           | 3.60                                       |
| Grate Orifice Coefficient (typical value 0.60 - 0.80)                        | 0.60                                       |
| <b>Curb Opening Information</b>  |  |
| Length of a Unit Curb Opening  | N/A  |
| Height of Vertical Curb Opening in Inches                                    | N/A  |
| Height of Curb Orifice Throat in Inches                                      | N/A  |
| Angle of Throat (see USDCM Figure ST-5)                                      | N/A  |
| Side Width for Depression Pan (typically the gutter width of 2 feet)         | N/A  |
| Clogging Factor for a Single Curb Opening (typical value 0.10)               | N/A  |
| Curb Opening Weir Coefficient (typical value 2.3-3.7)                        | N/A  |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)                 | N/A  |
| <b>Low Head Performance Reduction (Calculated)</b>                           |  |
| Depth for Grate Midwidth   | 0.523                                      |
| Depth for Curb Opening Weir Equation   | N/A  |
| Combination Inlet Performance Reduction Factor for Long Inlets               | N/A  |
| Curb Opening Performance Reduction Factor for Long Inlets                    | N/A  |
| Grated Inlet Performance Reduction Factor for Long Inlets                    | 0.67                                       |
| Total Inlet Interception Capacity (assumes clogged condition)                | <b>Q<sub>a</sub> = 4.2</b> cfs             |
| <b>Inlet Capacity IS GOOD for Minor and Major Storms (&gt; Q PEAK)</b>       | <b>Q<sub>PEAK REQUIRED</sub> = 1.6</b> cfs |

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

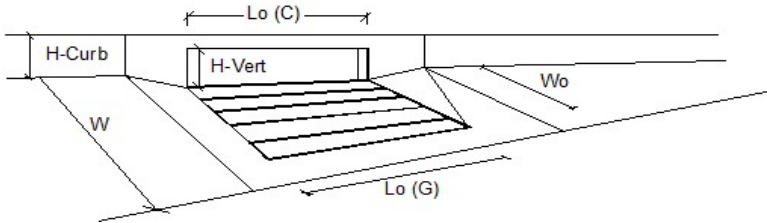
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

**Project:** Avanterra Black Forest  
**Inlet ID:** A4



| <b>Gutter Geometry:</b>  |  |             |             |        |                          |                          |  |
|--|--|-------------|-------------|--------|--------------------------|--------------------------|--|
| Maximum Allowable Width for Spread Behind Curb   | $T_{BACK} = 0.0$ ft  |             |             |        |                          |                          |  |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb)  | $S_{BACK} =$ ft/ft   |             |             |        |                          |                          |  |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020)  | $n_{BACK} = 0.020$   |             |             |        |                          |                          |  |
| Height of Curb at Gutter Flow Line   | $H_{CURB} = 6.00$ inches   |             |             |        |                          |                          |  |
| Distance from Curb Face to Street Crown  | $T_{CROWN} = 24.0$ ft  |             |             |        |                          |                          |  |
| Gutter Width   | $W = 2.00$ ft  |             |             |        |                          |                          |  |
| Street Transverse Slope  | $S_x = 0.020$ ft/ft  |             |             |        |                          |                          |  |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)  | $S_w = 0.083$ ft/ft  |             |             |        |                          |                          |  |
| Street Longitudinal Slope - Enter 0 for sump condition   | $S_o = 0.042$ ft/ft  |             |             |        |                          |                          |  |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020)                                       | $n_{STREET} = 0.016$   |             |             |        |                          |                          |  |
| Max. Allowable Spread for Minor & Major Storm  | <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;">ft</th> </tr> <tr> <td style="padding: 2px;">24.0</td> <td style="padding: 2px;">24.0</td> <td style="padding: 2px;"></td> </tr> </table>  | Minor Storm | Major Storm | ft     | 24.0                     | 24.0                     |  |
| Minor Storm  | Major Storm  | ft          |             |        |                          |                          |  |
| 24.0   | 24.0   |             |             |        |                          |                          |  |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm  | <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;">inches</th> </tr> <tr> <td style="padding: 2px;">5.8</td> <td style="padding: 2px;">5.8</td> <td style="padding: 2px;"></td> </tr> </table>                                      | Minor Storm | Major Storm | inches | 5.8                      | 5.8                      |  |
| Minor Storm  | Major Storm  | inches      |             |        |                          |                          |  |
| 5.8  | 5.8  |             |             |        |                          |                          |  |
| Allow Flow Depth at Street Crown (check box for yes, leave blank for no)   | <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;"></th> </tr> <tr> <td style="padding: 2px;"><input type="checkbox"/></td> <td style="padding: 2px;"><input type="checkbox"/></td> <td style="padding: 2px;"></td> </tr> </table>  | Minor Storm | Major Storm |        | <input type="checkbox"/> | <input type="checkbox"/> |  |
| Minor Storm  | Major Storm  |             |             |        |                          |                          |  |
| <input type="checkbox"/>   | <input type="checkbox"/>   |             |             |        |                          |                          |  |
| MINOR STORM Allowable Capacity is based on Depth Criterion   |  |             |             |        |                          |                          |  |
| MAJOR STORM Allowable Capacity is based on Depth Criterion   |  |             |             |        |                          |                          |  |
| <b>Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'</b> |  |             |             |        |                          |                          |  |
| <b>Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'</b> |  |             |             |        |                          |                          |  |
| <b><math>Q_{allow} =</math></b>  | <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;">cfs</th> </tr> <tr> <td style="padding: 2px; font-weight: bold;">16.1</td> <td style="padding: 2px; font-weight: bold;">16.1</td> <td style="padding: 2px;"></td> </tr> </table> | Minor Storm | Major Storm | cfs    | 16.1                     | 16.1                     |  |
| Minor Storm  | Major Storm  | cfs         |             |        |                          |                          |  |
| 16.1   | 16.1   |             |             |        |                          |                          |  |

## INLET ON A CONTINUOUS GRADE

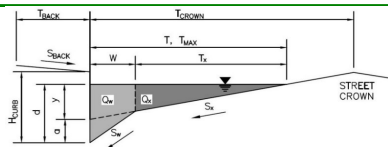


| Design Information (Input)  |                          |
|---|--------------------------|
| Type of Inlet   | CDOT Type R Curb Opening |
| Local Depression (additional to continuous gutter depression 'a')         | $a_{LOCAL} = 3.0$ inches |
| Total Number of Units in the Inlet (Grate or Curb Opening)                | $N_u = 1$                |
| Length of a Single Unit Inlet (Grate or Curb Opening)                     | $L_o = 10.00$ ft         |
| Width of a Unit Grate (cannot be greater than W, Gutter Width)            | $W_o = N/A$ ft           |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5)        | $C_r-G = N/A$            |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1) | $C_r-C = 0.10$           |
| <b>Street Hydraulics: OK - Q &lt; Allowable Street Capacity*</b>          |                          |
| Total Inlet Interception Capacity   | $Q = 1.8$ cfs            |
| Total Inlet Carry-Over Flow (flow bypassing inlet)                        | $Q_b = 0.0$ cfs          |
| Capture Percentage = $Q_i/Q_o =$  | $C\% = 100$ %            |

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

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

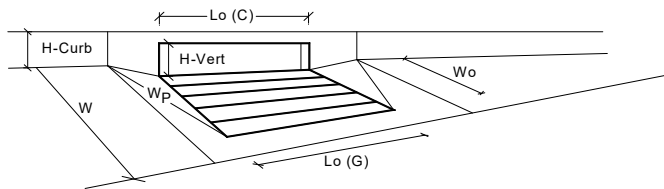
**Project:** Avanterra Black Forest  
**Inlet ID:** A8



**Warning 1**

| <b>Gutter Geometry:</b>  |   |             |             |             |             |
|--|---|-------------|-------------|-------------|-------------|
| Maximum Allowable Width for Spread Behind Curb                             | $T_{BACK} = 0.0$ ft   |             |             |             |             |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb)  | $S_{BACK} =$ ft/ft  |             |             |             |             |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020)        | $n_{BACK} = 0.020$  |             |             |             |             |
| Height of Curb at Gutter Flow Line   | $H_{CURB} = 6.00$ inches  |             |             |             |             |
| Distance from Curb Face to Street Crown                                    | $T_{CROWN} = 24.0$ ft   |             |             |             |             |
| Gutter Width   | $W = 2.00$ ft   |             |             |             |             |
| Street Transverse Slope  | $S_x = 0.020$ ft/ft   |             |             |             |             |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)      | $S_w = 0.083$ ft/ft   |             |             |             |             |
| Street Longitudinal Slope - Enter 0 for sump condition                     | $S_o = 0.000$ ft/ft   |             |             |             |             |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET} = 0.016$  |             |             |             |             |
| Max. Allowable Spread for Minor & Major Storm                              | $T_{MAX} =$ <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><th style="padding: 2px;">Minor Storm</th><th style="padding: 2px;">Major Storm</th></tr><tr><td style="text-align: center;">24.0</td><td style="text-align: center;">24.0</td></tr></table> ft           | Minor Storm | Major Storm | 24.0        | 24.0        |
| Minor Storm  | Major Storm   |             |             |             |             |
| 24.0   | 24.0  |             |             |             |             |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm            | $d_{MAX} =$ <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><th style="padding: 2px;">Minor Storm</th><th style="padding: 2px;">Major Storm</th></tr><tr><td style="text-align: center;">5.8</td><td style="text-align: center;">5.8</td></tr></table> inches         | Minor Storm | Major Storm | 5.8         | 5.8         |
| Minor Storm  | Major Storm   |             |             |             |             |
| 5.8  | 5.8   |             |             |             |             |
| Check boxes are not applicable in SUMP conditions                          | <input type="checkbox"/> <input type="checkbox"/>   |             |             |             |             |
| <a href="#">MINOR STORM Allowable Capacity is based on Depth Criterion</a> |   |             |             |             |             |
| <a href="#">MAJOR STORM Allowable Capacity is based on Depth Criterion</a> |   |             |             |             |             |
| <b>Q<sub>allow</sub> =</b>   | <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><th style="padding: 2px;">Minor Storm</th><th style="padding: 2px;">Major Storm</th></tr><tr><td style="text-align: center;"><b>SUMP</b></td><td style="text-align: center;"><b>SUMP</b></td></tr></table> <b>cfs</b> | Minor Storm | Major Storm | <b>SUMP</b> | <b>SUMP</b> |
| Minor Storm  | Major Storm   |             |             |             |             |
| <b>SUMP</b>  | <b>SUMP</b>   |             |             |             |             |

## INLET IN A SUMP OR SAG LOCATION

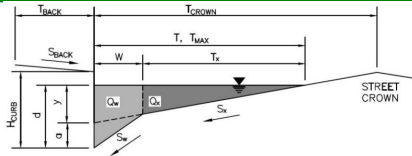


| <b>Design Information (Input)</b>  |                               |
|--|-------------------------------|
| Type of Inlet  | CDOT Type R Curb Opening      |
| Local Depression (additional to continuous gutter depression 'a' from above) |                               |
| Number of Unit Inlets (Grate or Curb Opening)                                | 1                             |
| Water Depth at Flowline (outside of local depression)                        | 5.8 inches                    |
| <b>Grate Information</b>   |                               |
| Length of a Unit Grate   | N/A                           |
| Width of a Unit Grate  | N/A                           |
| Area Opening Ratio for a Grate (typical values 0.15-0.90)                    | N/A                           |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70)               | N/A                           |
| Grate Weir Coefficient (typical value 2.15 - 3.60)                           | N/A                           |
| Grate Orifice Coefficient (typical value 0.60 - 0.80)                        | N/A                           |
| <b>Curb Opening Information</b>  |                               |
| Length of a Unit Curb Opening  | 15.00 feet                    |
| Height of Vertical Curb Opening in Inches                                    | 6.00 inches                   |
| Height of Curb Orifice Throat in Inches                                      | 6.00 inches                   |
| Angle of Throat (see USDCM Figure ST-5)                                      | 63.40 degrees                 |
| Side Width for Depression Pan (typically the gutter width of 2 feet)         | 2.00 feet                     |
| Clogging Factor for a Single Curb Opening (typical value 0.10)               | 0.10                          |
| Curb Opening Weir Coefficient (typical value 2.3-3.7)                        | 3.60                          |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)                 | 0.67                          |
| <b>Low Head Performance Reduction (Calculated)</b>                           |                               |
| Depth for Grate Midwidth   | N/A                           |
| Depth for Curb Opening Weir Equation   | 0.31 ft                       |
| Combination Inlet Performance Reduction Factor for Long Inlets               | 0.54                          |
| Curb Opening Performance Reduction Factor for Long Inlets                    | 0.77                          |
| Grated Inlet Performance Reduction Factor for Long Inlets                    | N/A                           |
| Total Inlet Interception Capacity (assumes clogged condition)                | $Q_a = 8.7$ cfs               |
| <b>Inlet Capacity IS GOOD for Minor and Major Storms (&gt; Q PEAK)</b>       | $Q_{PEAK REQUIRED} = 2.8$ cfs |

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

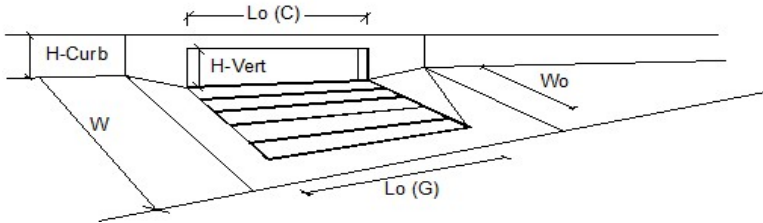
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

**Project:** Avanterra Black Forest  
**Inlet ID:** A11



|  |  |             |             |        |                    |        |
|--|--|-------------|-------------|--------|--------------------|--------|
| <b>Gutter Geometry:</b>  |  |             |             |        |                    |        |
| Maximum Allowable Width for Spread Behind Curb   | $T_{BACK} = 0.0$ ft  |             |             |        |                    |        |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb)  | $S_{BACK} =$ ft/ft   |             |             |        |                    |        |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020)  | $n_{BACK} = 0.020$   |             |             |        |                    |        |
| Height of Curb at Gutter Flow Line   | $H_{CURB} = 6.00$ inches   |             |             |        |                    |        |
| Distance from Curb Face to Street Crown  | $T_{CROWN} = 24.0$ ft  |             |             |        |                    |        |
| Gutter Width   | $W = 2.00$ ft  |             |             |        |                    |        |
| Street Transverse Slope  | $S_x = 0.020$ ft/ft  |             |             |        |                    |        |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)  | $S_w = 0.083$ ft/ft  |             |             |        |                    |        |
| Street Longitudinal Slope - Enter 0 for sump condition   | $S_o = 0.042$ ft/ft  |             |             |        |                    |        |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020)                                       | $n_{STREET} = 0.016$   |             |             |        |                    |        |
| Max. Allowable Spread for Minor & Major Storm  | <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="text-align: center;">Minor Storm</td> <td style="text-align: center;">Major Storm</td> <td rowspan="2" style="text-align: center;">ft</td> </tr> <tr> <td style="text-align: center;"><math>T_{MAX} = 24.0</math></td> <td style="text-align: center;"><math>24.0</math></td> </tr> </table>    | Minor Storm | Major Storm | ft     | $T_{MAX} = 24.0$   | $24.0$ |
| Minor Storm  | Major Storm  | ft          |             |        |                    |        |
| $T_{MAX} = 24.0$   | $24.0$   |             |             |        |                    |        |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm  | <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="text-align: center;">Minor Storm</td> <td style="text-align: center;">Major Storm</td> <td rowspan="2" style="text-align: center;">inches</td> </tr> <tr> <td style="text-align: center;"><math>d_{MAX} = 5.8</math></td> <td style="text-align: center;"><math>5.8</math></td> </tr> </table>  | Minor Storm | Major Storm | inches | $d_{MAX} = 5.8$    | $5.8$  |
| Minor Storm  | Major Storm  | inches      |             |        |                    |        |
| $d_{MAX} = 5.8$  | $5.8$  |             |             |        |                    |        |
| Allow Flow Depth at Street Crown (check box for yes, leave blank for no)   | <input type="checkbox"/> <input type="checkbox"/>  |             |             |        |                    |        |
| MINOR STORM Allowable Capacity is based on Depth Criterion   |  |             |             |        |                    |        |
| MAJOR STORM Allowable Capacity is based on Depth Criterion   |  |             |             |        |                    |        |
| <b>Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'</b> |  |             |             |        |                    |        |
| <b>Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'</b> |  |             |             |        |                    |        |
|  | <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="text-align: center;">Minor Storm</td> <td style="text-align: center;">Major Storm</td> <td rowspan="2" style="text-align: center;">cfs</td> </tr> <tr> <td style="text-align: center;"><math>Q_{allow} = 16.1</math></td> <td style="text-align: center;"><math>16.1</math></td> </tr> </table> | Minor Storm | Major Storm | cfs    | $Q_{allow} = 16.1$ | $16.1$ |
| Minor Storm  | Major Storm  | cfs         |             |        |                    |        |
| $Q_{allow} = 16.1$   | $16.1$   |             |             |        |                    |        |

## INLET ON A CONTINUOUS GRADE



|   |                          |
|---|--------------------------|
| <b>Design Information (Input)</b>   |                          |
| Type of Inlet   | CDOT Type R Curb Opening |
| Local Depression (additional to continuous gutter depression 'a')         | $a_{LOCAL} = 3.0$ inches |
| Total Number of Units in the Inlet (Grate or Curb Opening)                | $N_u = 1$                |
| Length of a Single Unit Inlet (Grate or Curb Opening)                     | $L_u = 5.00$ ft          |
| Width of a Unit Grate (cannot be greater than W, Gutter Width)            | $W_u = N/A$ ft           |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5)        | $C_r-G = N/A$            |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1) | $C_r-C = 0.10$           |
| <b>Street Hydraulics: OK - Q &lt; Allowable Street Capacity</b>           |                          |
| Total Inlet Interception Capacity   | $Q = 0.8$ cfs            |
| Total Inlet Carry-Over Flow (flow bypassing inlet)                        | $Q_b = 0.0$ cfs          |
| Capture Percentage = $Q_i/Q_o =$  | $C\% = 100$ %            |

# **HYDRAULIC CALCULATIONS (STORMCAD MODEL RESULTS)**

## FlexTable: Manhole Table

### Active Scenario: 5-Year

| Label    | Elevation (Rim)<br>(ft) | Elevation (Invert in 1)<br>(ft) | Hydraulic Grade Line (In)<br>(ft) | Flow (Total Out)<br>(cfs) |
|----------|-------------------------|---------------------------------|-----------------------------------|---------------------------|
| SD9      | 6,967.76                | 6,953.13                        | 6,953.87                          | 8.57                      |
| SD12     | 6,966.54                | 6,957.52                        | 6,958.03                          | 5.02                      |
| SD11     | 6,964.01                | 6,955.54                        | 6,955.93                          | 6.98                      |
| SD8      | 6,961.04                | 6,953.09                        | 6,953.13                          | 9.61                      |
| SD19     | 6,960.53                | 6,952.82                        | 6,953.43                          | 3.10                      |
| SD6      | 6,955.99                | 6,946.33                        | 6,946.75                          | 15.61                     |
| SD3      | 6,952.78                | 6,937.39                        | 6,938.77                          | 19.17                     |
| SDMH#144 | 6,960.52                | 6,956.95                        | 6,957.97                          | 1.64                      |
| SD-21    | 6,957.18                | 6,950.86                        | 6,950.66                          | 4.30                      |
| SDMH#145 | 6,965.51                | 6,962.94                        | 6,960.79                          | 0.61                      |

## FlexTable: Catch Basin Table

### Active Scenario: 5-Year

| Label         | Elevation (Ground) (ft) | Set Rim to Ground Elevation? | Elevation (Rim) (ft) | Elevation (Invert) (ft) | Flow (Local from Inflow Collection) (cfs) | Flow (Total Out) (cfs) | Inlet Type      | Flow (Local In) (cfs) | Hydraulic Grade Line (In) (ft) | Inlet Location |
|---------------|-------------------------|------------------------------|----------------------|-------------------------|---|------------------------|-----------------|-----------------------|--------------------------------|----------------|
| SD20          | 6,960.67                | True                         | 6,960.67             | 6,952.62                | 3.10                                      | 3.10                   | Full Capture    | 3.10                  | 6,953.87                       | In Sag         |
| SD5           | 6,955.62                | True                         | 6,955.62             | 6,944.16                | 0.78                                      | 16.33                  | Percent Capture | 0.78                  | 6,945.62                       | On Grade       |
| SD7           | 6,956.75                | True                         | 6,956.75             | 6,946.44                | 1.81                                      | 11.31                  | Percent Capture | 1.81                  | 6,947.65                       | On Grade       |
| SD10          | 6,964.59                | True                         | 6,964.59             | 6,953.98                | 1.59                                      | 8.57                   | Percent Capture | 1.59                  | 6,955.02                       | On Grade       |
| SD16          | 6,963.60                | True                         | 6,963.60             | 6,956.71                | 1.96                                      | 1.96                   | Percent Capture | 1.96                  | 6,957.27                       | On Grade       |
| SD15          | 6,968.91                | True                         | 6,968.91             | 6,960.85                | 0.94                                      | 0.77                   | Percent Capture | 0.94                  | 6,961.22                       | On Grade       |
| SD13          | 6,962.83                | True                         | 6,962.83             | 6,958.44                | 3.40                                      | 4.25                   | Full Capture    | 3.40                  | 6,960.13                       | In Sag         |
| SD14          | 6,965.06                | True                         | 6,965.06             | 6,961.84                | 0.85                                      | 0.85                   | Full Capture    | 0.85                  | 6,962.23                       | In Sag         |
| SD4           | 6,952.75                | True                         | 6,952.75             | 6,938.26                | 2.84                                      | 19.17                  | Full Capture    | 2.84                  | 6,939.75                       | In Sag         |
| SD17          | 6,959.53                | True                         | 6,959.53             | 6,954.57                | 1.04                                      | 1.04                   | Full Capture    | 1.04                  | 6,955.23                       | In Sag         |
| SD18          | 6,956.95                | True                         | 6,956.95             | 6,948.39                | 1.20                                      | 4.30                   | Full Capture    | 1.20                  | 6,952.40                       | In Sag         |
| CB1           | 6,963.93                | True                         | 6,963.93             | 6,959.82                | 0.16                                      | 0.77                   | Percent Capture | 0.16                  | 6,960.64                       | On Grade       |
| CB2           | 6,959.86                | True                         | 6,959.86             | 6,957.57                | 1.64                                      | 1.64                   | Full Capture    | 1.64                  | 6,958.05                       | In Sag         |
| CB3           | 6,964.58                | True                         | 6,964.58             | 6,960.73                | 0.21                                      | 0.21                   | Full Capture    | 0.21                  | 6,961.92                       | In Sag         |
| CB4           | 6,947.10                | True                         | 6,947.10             | 6,944.35                | 4.45                                      | 4.45                   | Full Capture    | 4.45                  | 6,945.82                       | On Grade       |
| SD2 GRATED MH | 6,949.08                | True                         | 6,949.08             | 6,935.65                | 0.11                                      | 19.28                  | Full Capture    | 0.11                  | 6,937.14                       | In Sag         |



## FlexTable: Conduit Table

### Active Scenario: 5-Year

| Start Node    | Invert (Start)<br>(ft) | Stop Node     | Invert (Stop)<br>(ft) | Length (User<br>Defined)<br>(ft) | Slope<br>(Calculated)<br>(ft/ft) | Diameter<br>(in) | Manning's n | Flow<br>(cfs) | Velocity<br>(ft/s) | Capacity<br>(Full Flow)<br>(cfs) | Flow / Capacity<br>(Design)<br>(%) |
|---------------|------------------------|---------------|-----------------------|----------------------------------|----------------------------------|------------------|-------------|---------------|--------------------|----------------------------------|------------------------------------|
| SD15          | 6,960.85               | SD12          | 6,957.52              | 95.2                             | 0.0350                           | 12.0             | 0.013       | 0.77          | 5.66               | 6.66                             | 11.6                               |
| SD14          | 6,961.84               | SD13          | 6,959.59              | 88.0                             | 0.0256                           | 12.0             | 0.013       | 0.85          | 6.28               | 7.41                             | 11.5                               |
| SD8           | 6,952.12               | SD9           | 6,952.83              | 142.5                            | -0.0050                          | 24.0             | 0.013       | 8.57          | 5.17               | 15.97                            | 53.7                               |
| SD9           | 6,953.13               | SD10          | 6,953.98              | 171.1                            | -0.0050                          | 24.0             | 0.013       | 8.57          | 5.17               | 15.94                            | 53.8                               |
| SD12          | 6,957.17               | SD11          | 6,955.54              | 154.2                            | 0.0106                           | 18.0             | 0.013       | 5.02          | 6.00               | 10.80                            | 46.5                               |
| SD13          | 6,959.34               | SD12          | 6,957.17              | 108.2                            | 0.0200                           | 18.0             | 0.013       | 4.25          | 7.26               | 14.87                            | 28.6                               |
| SD10          | 6,954.08               | SD11          | 6,954.99              | 181.3                            | -0.0050                          | 24.0             | 0.013       | 6.98          | 4.92               | 16.03                            | 43.6                               |
| SD16          | 6,956.71               | SD11          | 6,955.54              | 41.0                             | 0.0285                           | 15.0             | 0.013       | 1.96          | 6.73               | 10.91                            | 18.0                               |
| SD7           | 6,946.54               | SD8           | 6,952.02              | 106.0                            | -0.0517                          | 24.0             | 0.013       | 9.61          | 12.54              | 51.44                            | 18.7                               |
| SD17          | 6,954.80               | SD8           | 6,953.09              | 170.8                            | 0.0100                           | 12.0             | 0.013       | 1.04          | 3.94               | 3.56                             | 29.2                               |
| SD19          | 6,952.72               | SD18          | 6,951.89              | 137.7                            | 0.0060                           | 15.0             | 0.013       | 3.10          | 4.30               | 5.02                             | 61.8                               |
| SD20          | 6,953.16               | SD19          | 6,952.82              | 56.4                             | 0.0060                           | 15.0             | 0.013       | 3.10          | 4.30               | 5.02                             | 61.8                               |
| SD6           | 6,945.33               | SD7           | 6,946.44              | 53.5                             | -0.0207                          | 24.0             | 0.013       | 11.31         | 9.43               | 32.58                            | 34.7                               |
| SD5           | 6,944.26               | SD6           | 6,945.33              | 28.3                             | -0.0378                          | 24.0             | 0.013       | 15.61         | 12.81              | 43.97                            | 35.5                               |
| SD4           | 6,938.56               | SD5           | 6,944.16              | 87.5                             | -0.0640                          | 24.0             | 0.013       | 16.33         | 15.71              | 57.23                            | 28.5                               |
| SD2 GRATED MH | 6,936.51               | SD3           | 6,937.29              | 41.2                             | -0.0189                          | 30.0             | 0.013       | 19.17         | 10.39              | 56.42                            | 34.0                               |
| SD3           | 6,937.39               | SD4           | 6,938.26              | 48.6                             | -0.0179                          | 30.0             | 0.013       | 19.17         | 10.19              | 54.89                            | 34.9                               |
| O-1           | 6,930.40               | SD2 GRATED MH | 6,935.65              | 92.0                             | -0.0571                          | 30.0             | 0.013       | 19.28         | 15.51              | 97.98                            | 19.7                               |
| CB3           | 6,960.73               | EX HW3        | 6,960.42              | 58.2                             | 0.0053                           | 18.0             | 0.013       | 0.21          | 1.88               | 7.65                             | 2.7                                |
| CB1           | 6,959.82               | EX HW1        | 6,959.14              | 62.1                             | 0.0110                           | 18.0             | 0.013       | 0.77          | 3.59               | 11.02                            | 7.0                                |
| CB2           | 6,957.57               | SDMH#144      | 6,956.95              | 124.8                            | 0.0050                           | 18.0             | 0.013       | 1.64          | 3.37               | 7.40                             | 22.2                               |
| EX HW2        | 6,956.47               | SDMH#144      | 6,956.95              | 55.8                             | -0.0086                          | 18.0             | 0.013       | 1.64          | 4.10               | 9.74                             | 16.8                               |
| CB4           | 6,944.35               | O-5           | 6,944.31              | 8.4                              | 0.0048                           | 18.0             | 0.013       | 4.45          | 4.32               | 7.26                             | 61.3                               |
| SD18          | 6,951.60               | SD-21         | 6,950.86              | 123.0                            | 0.0060                           | 18.0             | 0.013       | 4.30          | 4.67               | 8.15                             | 52.8                               |
| SD-21         | 6,949.86               | SD6           | 6,946.33              | 49.9                             | 0.0707                           | 18.0             | 0.013       | 4.30          | 11.46              | 27.94                            | 15.4                               |
| HW-2          | 6,969.08               | HW-3          | 6,968.41              | 25.5                             | 0.0263                           | 18.0             | 0.013       | 0.38          | 3.94               | 17.03                            | 2.2                                |
| HW-4          | 6,947.67               | HW-5          | 6,946.67              | 25.5                             | 0.0392                           | 18.0             | 0.013       | 0.38          | 4.54               | 20.80                            | 1.8                                |
| HW-8          | 6,967.59               | HW-9          | 6,967.29              | 21.6                             | 0.0139                           | 18.0             | 0.013       | 0.61          | 3.63               | 12.38                            | 4.9                                |
| HW-10         | 6,963.70               | SDMH#145      | 6,962.94              | 15.3                             | 0.0497                           | 18.0             | 0.024       | 0.61          | 3.70               | 12.68                            | 4.8                                |
| SDMH#145      | 6,960.50               | CB1           | 6,960.02              | 15.9                             | 0.0303                           | 18.0             | 0.013       | 0.61          | 4.78               | 18.27                            | 3.3                                |

## FlexTable: Headwall Table

### Active Scenario: 5-Year

| Label | Local Inflow? | Network Boundary Type | Flow (Total Out) (cfs) | Boundary Condition Type |
|-------|---------------|-----------------------|------------------------|-------------------------|
| HW-2  | True          | Inlet                 | 0.38                   | Free Outfall            |
| HW-3  | False         | Outlet                | 0.38                   | Free Outfall            |
| HW-4  | True          | Inlet                 | 0.38                   | Free Outfall            |
| HW-5  | False         | Outlet                | 0.38                   | Free Outfall            |
| HW-8  | True          | Inlet                 | 0.61                   | Free Outfall            |
| HW-9  | False         | Outlet                | 0.61                   | Free Outfall            |
| HW-10 | True          | Inlet                 | 0.61                   | Free Outfall            |

### FlexTable: Outfall Table

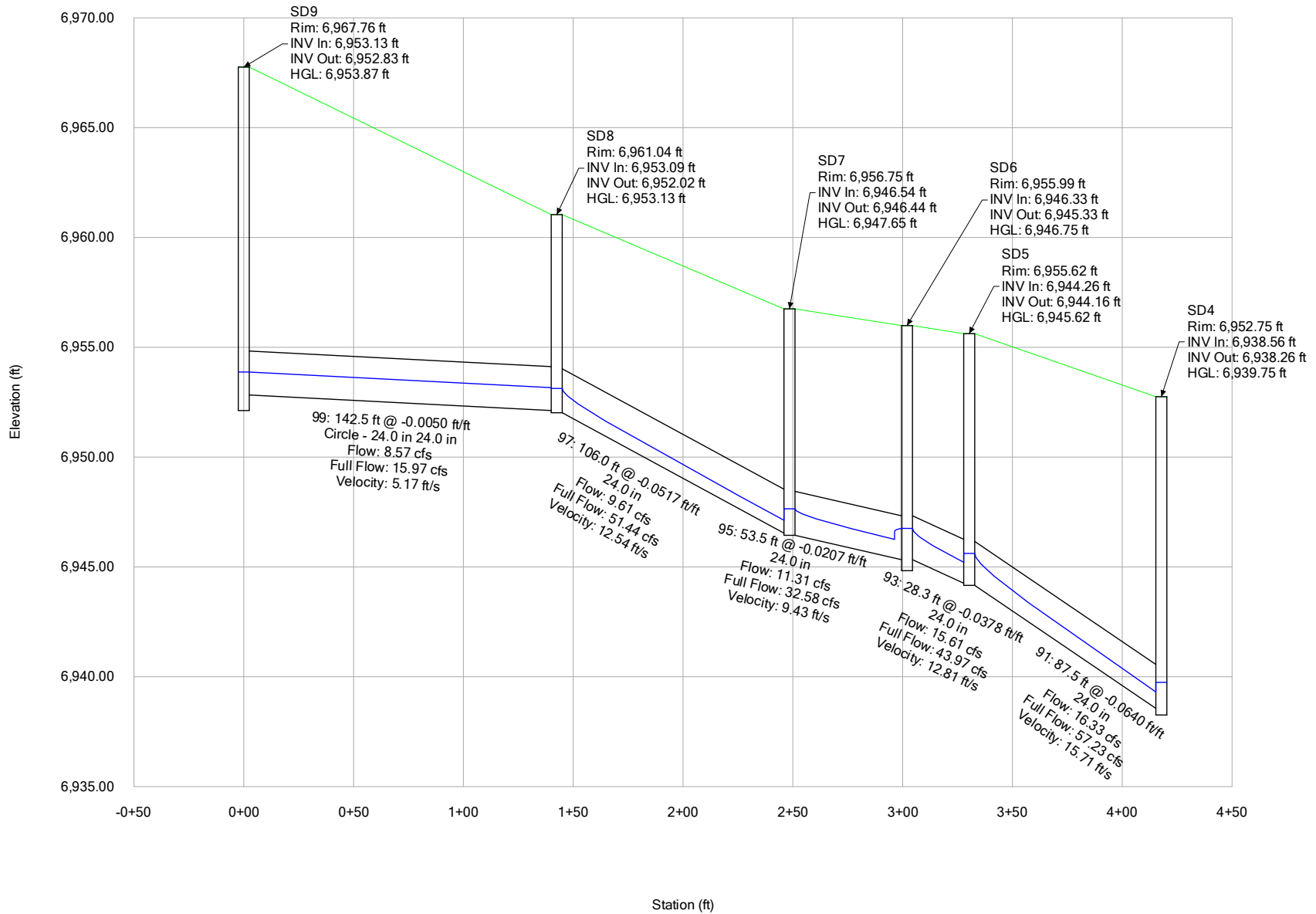
#### Active Scenario: 5-Year

| Label  | Elevation (Ground)<br>(ft) | Set Rim to Ground<br>Elevation? | Elevation (Invert)<br>(ft) | Boundary Condition Type | Flow (Total Out)<br>(cfs) |
|--------|----------------------------|---------------------------------|----------------------------|-------------------------|---------------------------|
| O-1    | 6,945.09                   | True                            | 6,930.20                   | Crown                   | 19.28                     |
| EX HW1 | 6,961.35                   | True                            | 6,959.14                   | Crown                   | 0.77                      |
| EX HW2 | 6,958.68                   | True                            | 6,956.47                   | Crown                   | 1.64                      |
| EX HW3 | 6,962.63                   | True                            | 6,960.42                   | Crown                   | 0.21                      |
| O-5    | 6,946.52                   | True                            | 6,944.31                   | Crown                   | 4.45                      |

# Profile Report

## Engineering Profile - Amber Steppe View (020439-Black Forest.stsw)

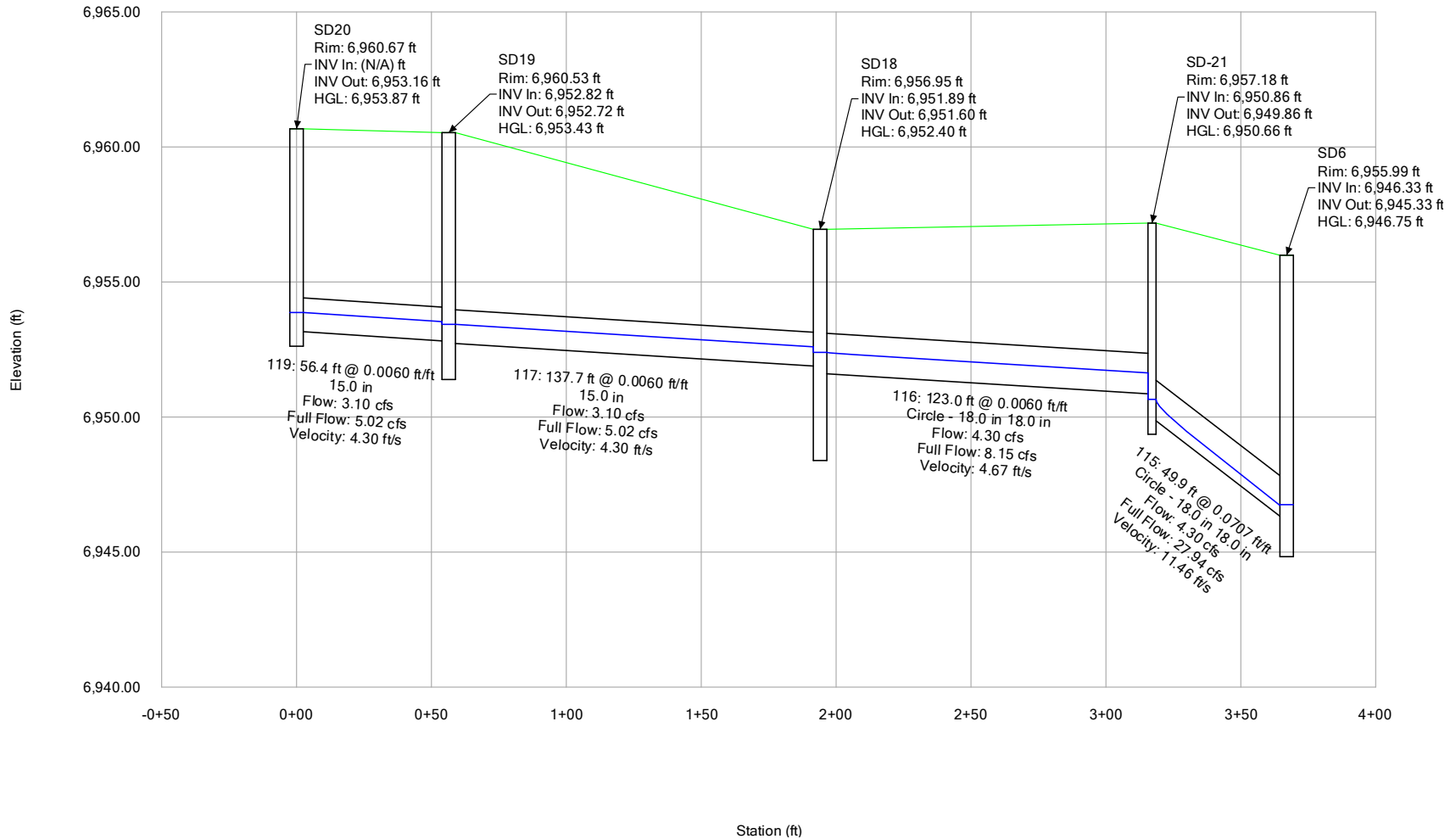
### Active Scenario: 5-Year



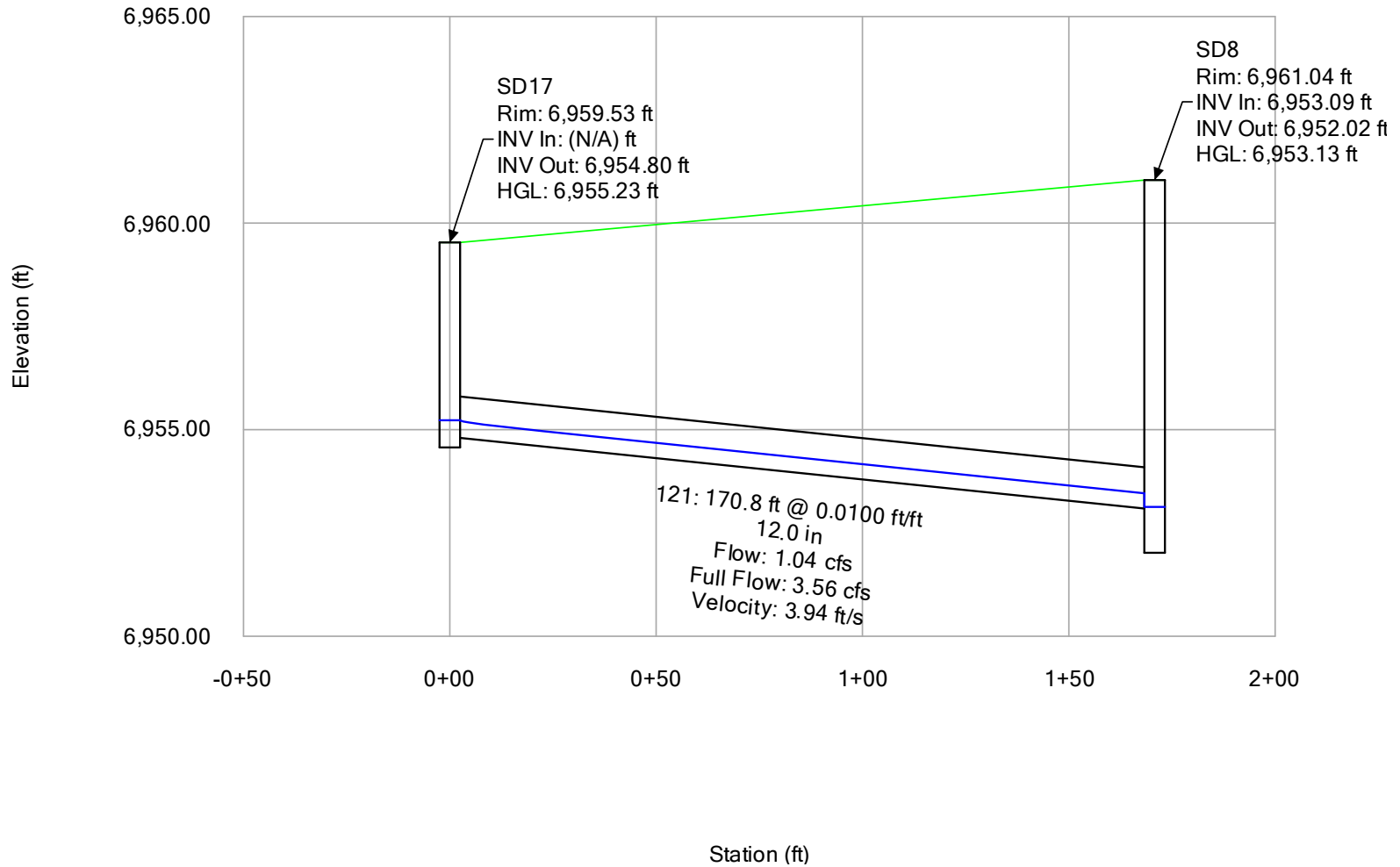
# Profile Report

## Engineering Profile - Guanella Pass Grove (020439-Black Forest.stsw)

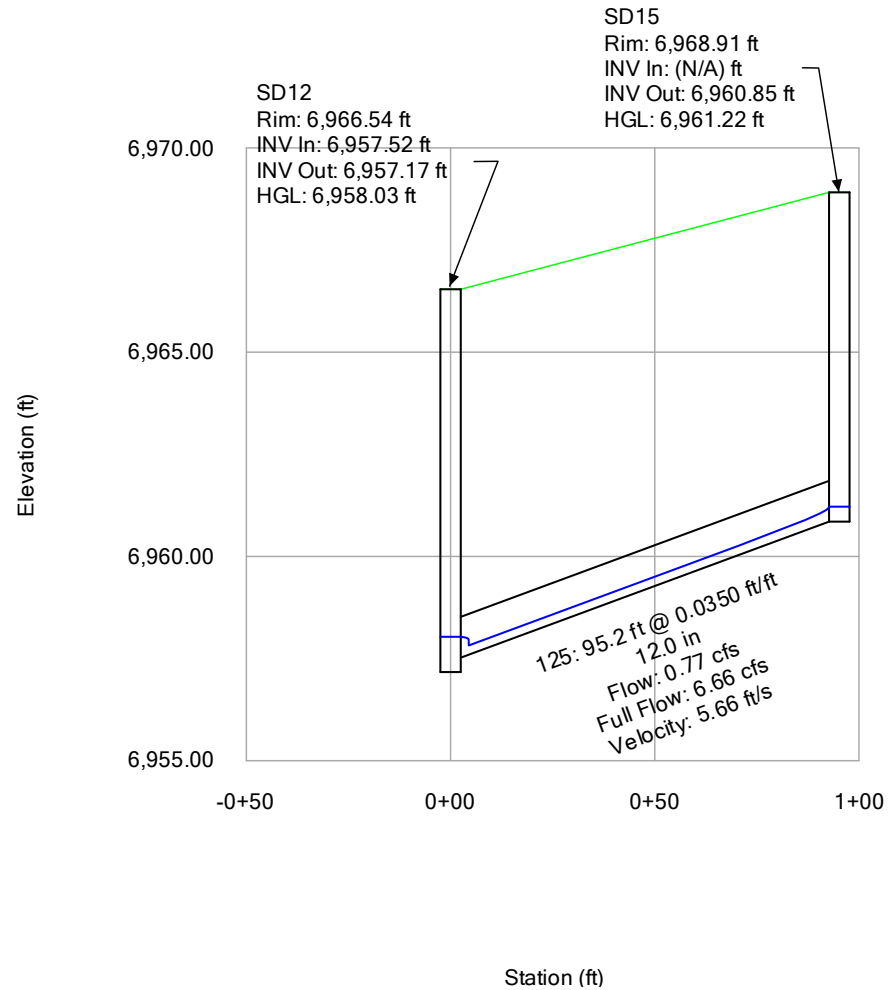
### Active Scenario: 5-Year



**Profile Report**  
**Engineering Profile - Medano Pass View (020439-Black Forest.stsw)**  
**Active Scenario: 5-Year**



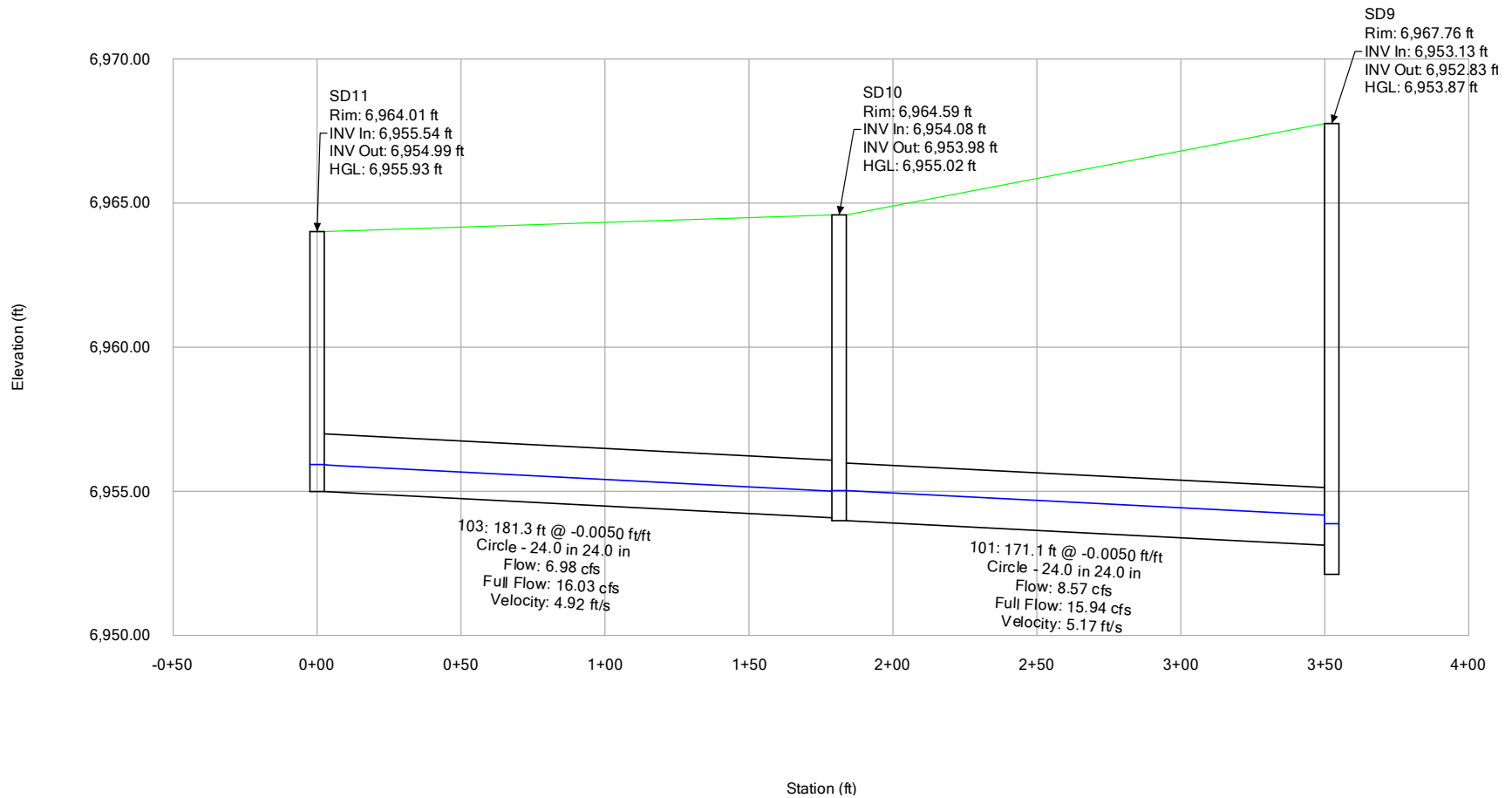
**Profile Report**  
**Engineering Profile - Old Elk Grove (020439-Black Forest.stsw)**  
**Active Scenario: 5-Year**



# Profile Report

## Engineering Profile - Rocky Top Terrace (020439-Black Forest.stsw)

### Active Scenario: 5-Year

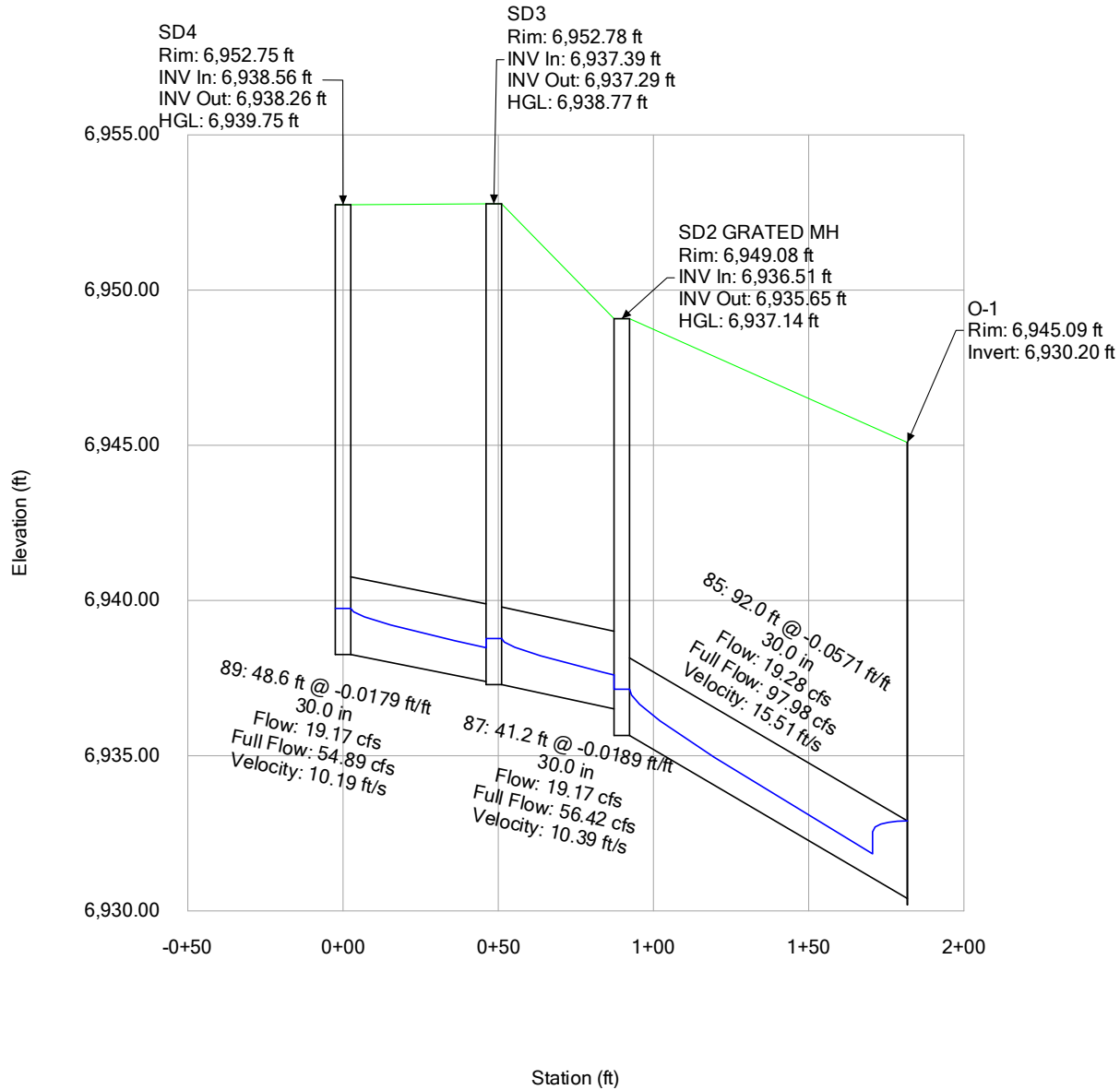




# Profile Report

## Engineering Profile - Storm-1 Line (020439-Black Forest.stsw)

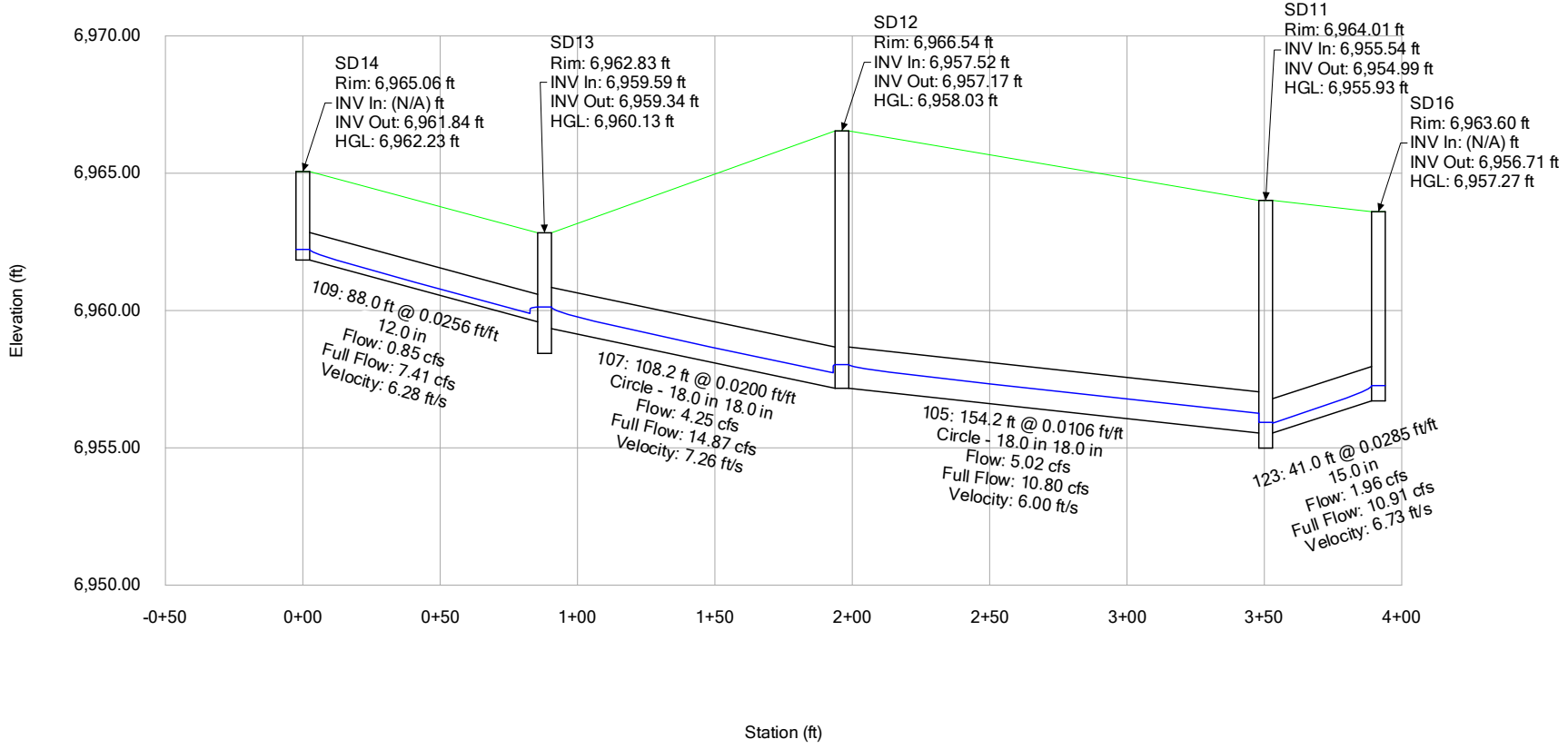
**Active Scenario: 5-Year**



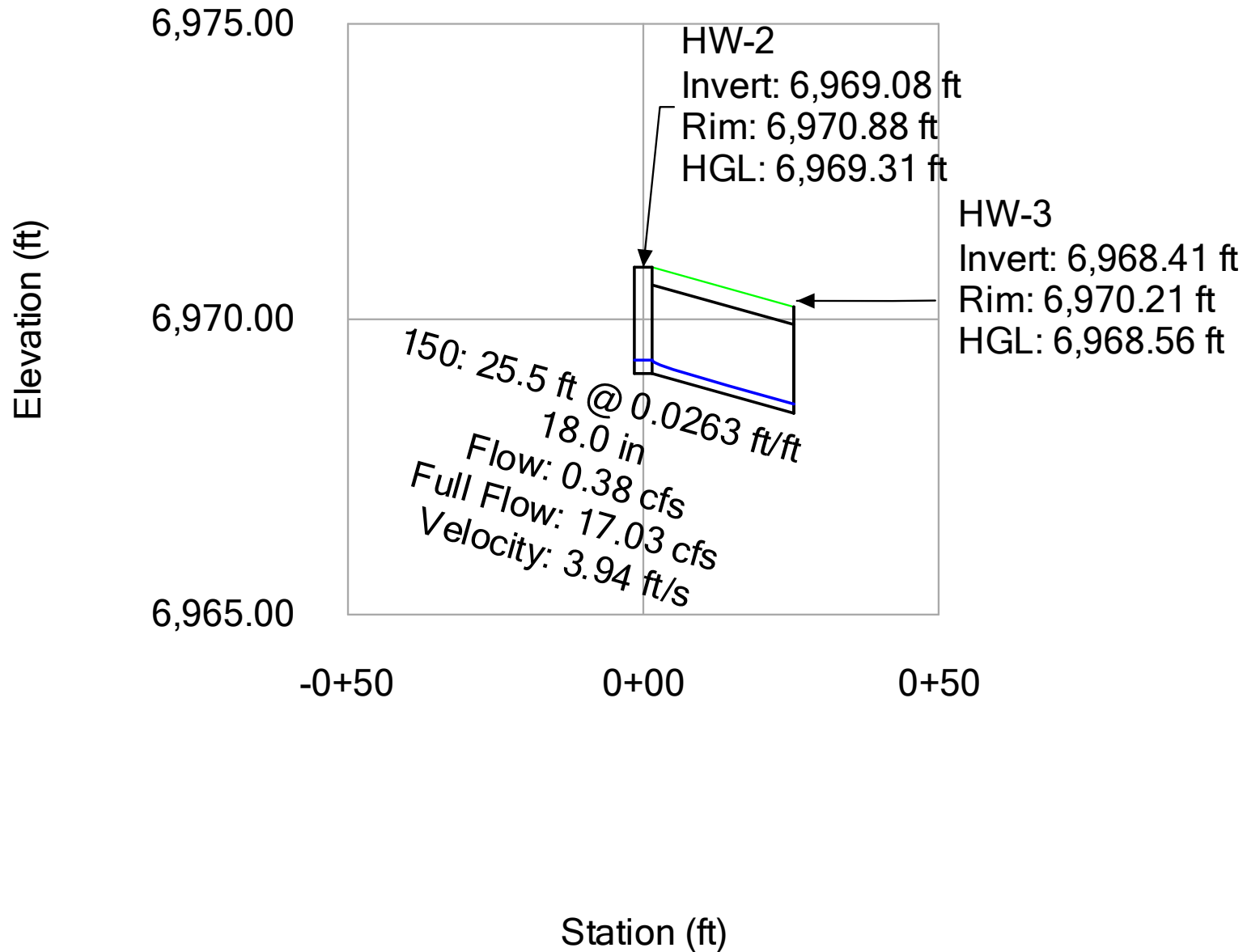
# Profile Report

## Engineering Profile - White Lodge Point (020439-Black Forest.stsw)

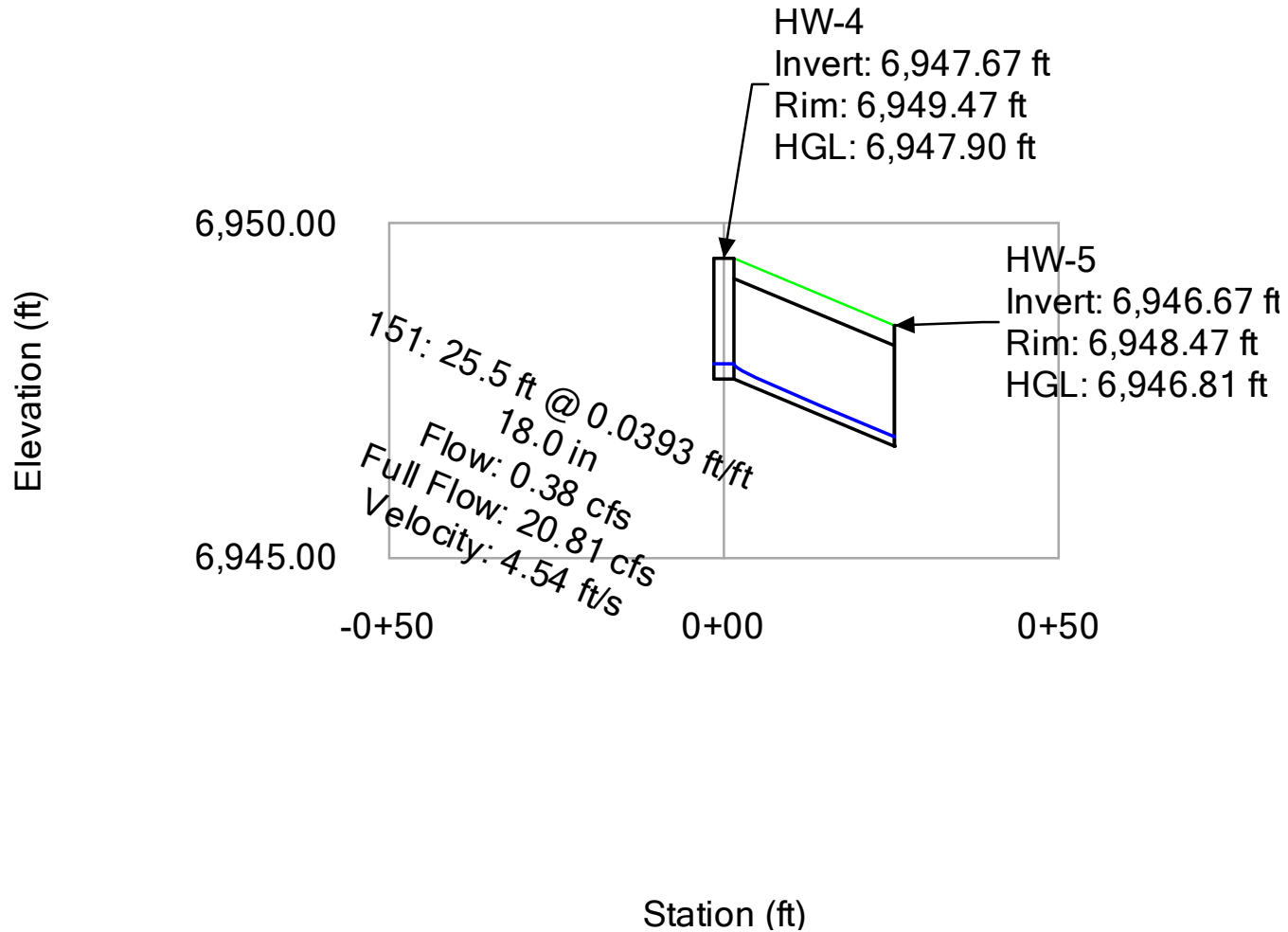
### Active Scenario: 5-Year



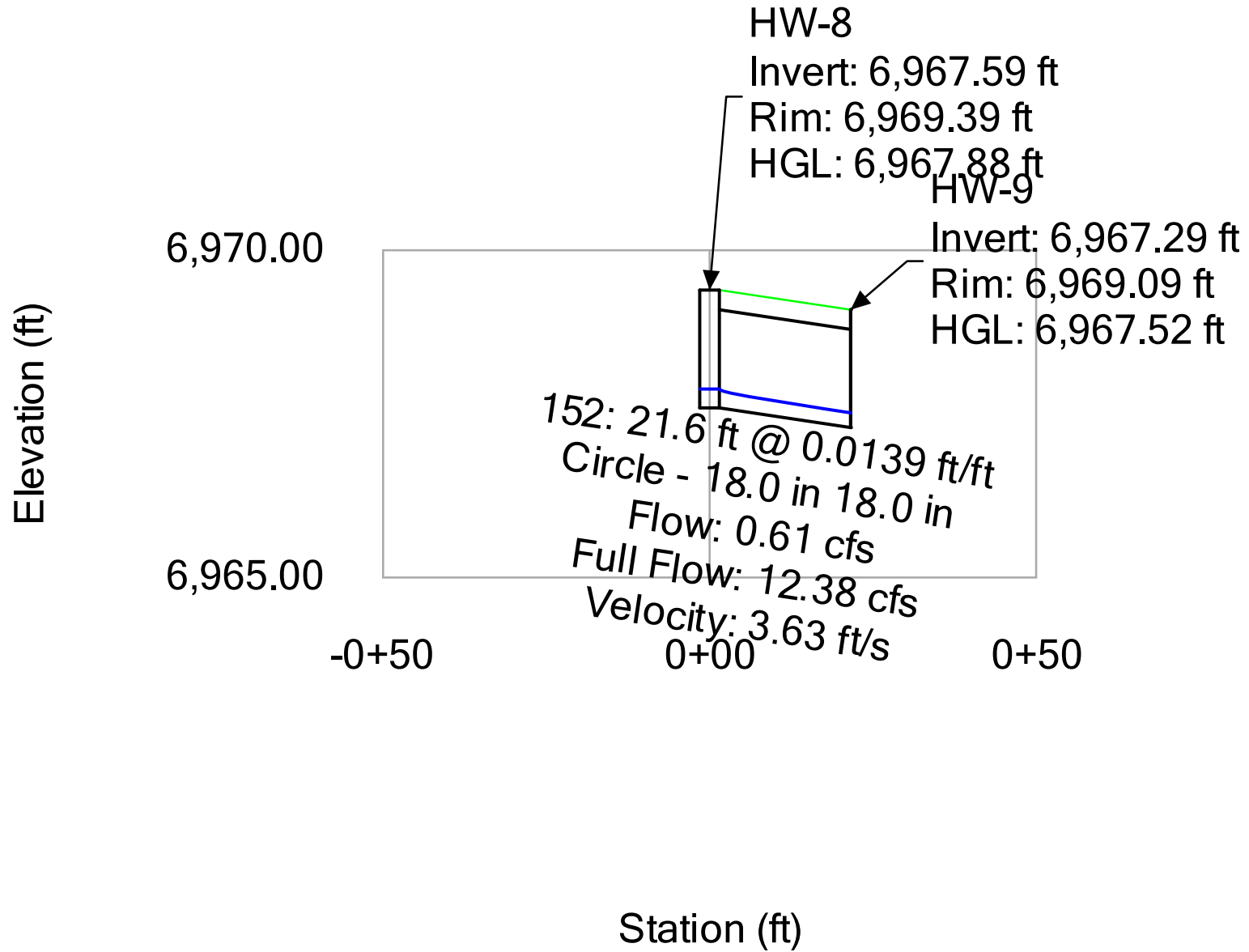
**Profile Report**  
**Engineering Profile - Storm-OFF4 Line (020439-Black Forest.stsw)**  
**Active Scenario: 5-Year**



**Profile Report**  
**Engineering Profile - Storm-OFF5 Line (020439-Black Forest.stsw)**  
**Active Scenario: 5-Year**



**Profile Report**  
**Engineering Profile - Storm-OFF8 Line (020439-Black Forest.stsw)**  
**Active Scenario: 5-Year**



**FlexTable: Manhole Table**  
**Active Scenario: 100-Year**

| Label    | Elevation (Rim)<br>(ft) | Elevation (Invert in 1)<br>(ft) | Hydraulic Grade Line (In)<br>(ft) | Flow (Total Out)<br>(cfs) |
|----------|-------------------------|---------------------------------|-----------------------------------|---------------------------|
| SD9      | 6,967.76                | 6,953.13                        | 6,955.22                          | 21.50                     |
| SD12     | 6,966.54                | 6,957.52                        | 6,960.21                          | 12.90                     |
| SD11     | 6,964.01                | 6,955.54                        | 6,957.89                          | 17.77                     |
| SD8      | 6,961.04                | 6,953.09                        | 6,953.77                          | 24.43                     |
| SD19     | 6,960.53                | 6,952.82                        | 6,954.76                          | 6.79                      |
| SD6      | 6,955.99                | 6,946.33                        | 6,947.27                          | 38.06                     |
| SD3      | 6,952.78                | 6,937.39                        | 6,939.55                          | 47.42                     |
| SDMH#144 | 6,960.52                | 6,956.95                        | 6,958.02                          | 5.67                      |
| SD-21    | 6,957.18                | 6,950.86                        | 6,951.07                          | 9.79                      |
| SDMH#145 | 6,965.51                | 6,962.94                        | 6,961.12                          | 2.66                      |

**FlexTable: Catch Basin Table**  
**Active Scenario: 100-Year**

| Label         | Elevation (Ground) (ft) | Set Rim to Ground Elevation? | Elevation (Rim) (ft) | Elevation (Invert) (ft) | Flow (Local from Inflow Collection) (cfs) | Flow (Total Out) (cfs) | Inlet Type      | Flow (Local In) (cfs) | Hydraulic Grade Line (In) (ft) | Inlet Location |
|---------------|-------------------------|------------------------------|----------------------|-------------------------|---|------------------------|-----------------|-----------------------|--------------------------------|----------------|
| SD20          | 6,960.67                | True                         | 6,960.67             | 6,952.62                | 6.79                                      | 6.79                   | Full Capture    | 6.79                  | 6,955.39                       | In Sag         |
| SD5           | 6,955.62                | True                         | 6,955.62             | 6,944.16                | 1.89                                      | 39.80                  | Percent Capture | 1.89                  | 6,946.11                       | On Grade       |
| SD7           | 6,956.75                | True                         | 6,956.75             | 6,946.44                | 4.09                                      | 28.27                  | Percent Capture | 4.09                  | 6,948.27                       | On Grade       |
| SD10          | 6,964.59                | True                         | 6,964.59             | 6,953.98                | 3.73                                      | 21.50                  | Percent Capture | 3.73                  | 6,956.77                       | On Grade       |
| SD16          | 6,963.60                | True                         | 6,963.60             | 6,956.71                | 4.87                                      | 4.87                   | Percent Capture | 4.87                  | 6,958.12                       | On Grade       |
| SD15          | 6,968.91                | True                         | 6,968.91             | 6,960.85                | 1.89                                      | 1.55                   | Percent Capture | 1.89                  | 6,961.38                       | On Grade       |
| SD13          | 6,962.83                | True                         | 6,962.83             | 6,958.44                | 9.11                                      | 11.35                  | Full Capture    | 9.11                  | 6,961.48                       | In Sag         |
| SD14          | 6,965.06                | True                         | 6,965.06             | 6,961.84                | 2.24                                      | 2.24                   | Full Capture    | 2.24                  | 6,962.48                       | In Sag         |
| SD4           | 6,952.75                | True                         | 6,952.75             | 6,938.26                | 7.62                                      | 47.42                  | Full Capture    | 7.62                  | 6,940.52                       | In Sag         |
| SD17          | 6,959.53                | True                         | 6,959.53             | 6,954.57                | 2.93                                      | 2.93                   | Full Capture    | 2.93                  | 6,955.53                       | In Sag         |
| SD18          | 6,956.95                | True                         | 6,956.95             | 6,948.39                | 3.00                                      | 9.79                   | Full Capture    | 3.00                  | 6,953.24                       | In Sag         |
| CB1           | 6,963.93                | True                         | 6,963.93             | 6,959.82                | 0.29                                      | 2.95                   | Percent Capture | 0.29                  | 6,960.59                       | On Grade       |
| CB2           | 6,959.86                | True                         | 6,959.86             | 6,957.57                | 5.67                                      | 5.67                   | Full Capture    | 5.67                  | 6,958.55                       | In Sag         |
| CB3           | 6,964.58                | True                         | 6,964.58             | 6,960.73                | 0.81                                      | 0.81                   | Full Capture    | 0.81                  | 6,961.92                       | In Sag         |
| CB4           | 6,947.10                | True                         | 6,947.10             | 6,944.35                | 7.77                                      | 7.77                   | Full Capture    | 7.77                  | 6,945.86                       | On Grade       |
| SD2 GRATED MH | 6,949.08                | True                         | 6,949.08             | 6,935.65                | 0.11                                      | 47.53                  | Full Capture    | 0.11                  | 6,937.92                       | In Sag         |

**FlexTable: Conduit Table**  
**Active Scenario: 100-Year**

| Start Node    | Invert (Start)<br>(ft) | Stop Node     | Invert (Stop)<br>(ft) | Length (User<br>Defined)<br>(ft) | Slope<br>(Calculated)<br>(ft/ft) | Diameter<br>(in) | Manning's n | Flow<br>(cfs) | Velocity<br>(ft/s) | Capacity (Full<br>Flow)<br>(cfs) | Flow / Capacity<br>(Design)<br>(%) |
|---------------|------------------------|---------------|-----------------------|----------------------------------|----------------------------------|------------------|-------------|---------------|--------------------|----------------------------------|------------------------------------|
| SD15          | 6,960.85               | SD12          | 6,957.52              | 95.2                             | 0.0350                           | 12.0             | 0.013       | 1.55          | 6.91               | 6.66                             | 23.3                               |
| SD14          | 6,961.84               | SD13          | 6,959.59              | 88.0                             | 0.0256                           | 12.0             | 0.013       | 2.24          | 5.48               | 7.41                             | 30.2                               |
| SD8           | 6,952.12               | SD9           | 6,952.83              | 142.5                            | -0.0050                          | 24.0             | 0.013       | 21.50         | 6.84               | 15.97                            | 134.7                              |
| SD9           | 6,953.13               | SD10          | 6,953.98              | 171.1                            | -0.0050                          | 24.0             | 0.013       | 21.50         | 6.84               | 15.94                            | 134.8                              |
| SD12          | 6,957.17               | SD11          | 6,955.54              | 154.2                            | 0.0106                           | 18.0             | 0.013       | 12.90         | 7.30               | 10.80                            | 119.5                              |
| SD13          | 6,959.34               | SD12          | 6,957.17              | 108.2                            | 0.0200                           | 18.0             | 0.013       | 11.35         | 6.42               | 14.87                            | 76.3                               |
| SD10          | 6,954.08               | SD11          | 6,954.99              | 181.3                            | -0.0050                          | 24.0             | 0.013       | 17.77         | 5.66               | 16.03                            | 110.9                              |
| SD16          | 6,956.71               | SD11          | 6,955.54              | 41.0                             | 0.0285                           | 15.0             | 0.013       | 4.87          | 3.97               | 10.91                            | 44.6                               |
| SD7           | 6,946.54               | SD8           | 6,952.02              | 106.0                            | -0.0517                          | 24.0             | 0.013       | 24.43         | 16.16              | 51.44                            | 47.5                               |
| SD17          | 6,954.80               | SD8           | 6,953.09              | 170.8                            | 0.0100                           | 12.0             | 0.013       | 2.93          | 5.07               | 3.56                             | 82.2                               |
| SD19          | 6,952.72               | SD18          | 6,951.89              | 137.7                            | 0.0060                           | 15.0             | 0.013       | 6.79          | 5.53               | 5.02                             | 135.4                              |
| SD20          | 6,953.16               | SD19          | 6,952.82              | 56.4                             | 0.0060                           | 15.0             | 0.013       | 6.79          | 5.53               | 5.02                             | 135.4                              |
| SD6           | 6,945.33               | SD7           | 6,946.44              | 53.5                             | -0.0207                          | 24.0             | 0.013       | 28.27         | 11.68              | 32.58                            | 86.8                               |
| SD5           | 6,944.26               | SD6           | 6,945.33              | 28.3                             | -0.0378                          | 24.0             | 0.013       | 38.06         | 15.75              | 43.97                            | 86.6                               |
| SD4           | 6,938.56               | SD5           | 6,944.16              | 87.5                             | -0.0640                          | 24.0             | 0.013       | 39.80         | 19.68              | 57.23                            | 69.5                               |
| SD2 GRATED MH | 6,936.51               | SD3           | 6,937.29              | 41.2                             | -0.0189                          | 30.0             | 0.013       | 47.42         | 12.88              | 56.42                            | 84.1                               |
| SD3           | 6,937.39               | SD4           | 6,938.26              | 48.6                             | -0.0179                          | 30.0             | 0.013       | 47.42         | 12.58              | 54.89                            | 86.4                               |
| O-1           | 6,930.40               | SD2 GRATED MH | 6,935.65              | 92.0                             | -0.0571                          | 30.0             | 0.013       | 47.53         | 19.81              | 97.98                            | 48.5                               |
| CB3           | 6,960.73               | EX HW3        | 6,960.42              | 58.2                             | 0.0053                           | 18.0             | 0.013       | 0.81          | 2.81               | 7.65                             | 10.6                               |
| CB1           | 6,959.82               | EX HW1        | 6,959.14              | 62.1                             | 0.0110                           | 18.0             | 0.013       | 2.95          | 5.28               | 11.02                            | 26.8                               |
| CB2           | 6,957.57               | SDMH#144      | 6,956.95              | 124.8                            | 0.0050                           | 18.0             | 0.013       | 5.67          | 4.62               | 7.40                             | 76.6                               |
| EX HW2        | 6,956.47               | SDMH#144      | 6,956.95              | 55.8                             | -0.0086                          | 18.0             | 0.013       | 5.67          | 5.72               | 9.74                             | 58.2                               |
| CB4           | 6,944.35               | O-5           | 6,944.31              | 8.4                              | 0.0048                           | 18.0             | 0.013       | 7.77          | 4.60               | 7.26                             | 107.0                              |
| SD18          | 6,951.60               | SD-21         | 6,950.86              | 123.0                            | 0.0060                           | 18.0             | 0.013       | 9.79          | 5.54               | 8.15                             | 120.2                              |
| SD-21         | 6,949.86               | SD6           | 6,946.33              | 49.9                             | 0.0707                           | 18.0             | 0.013       | 9.79          | 14.41              | 27.94                            | 35.0                               |
| HW-2          | 6,969.08               | HW-3          | 6,968.41              | 25.5                             | 0.0263                           | 18.0             | 0.013       | 2.59          | 6.96               | 17.03                            | 15.2                               |
| HW-4          | 6,947.67               | HW-5          | 6,946.67              | 25.5                             | 0.0392                           | 18.0             | 0.013       | 2.59          | 8.02               | 20.80                            | 12.5                               |
| HW-8          | 6,967.59               | HW-9          | 6,967.29              | 21.6                             | 0.0139                           | 18.0             | 0.013       | 2.66          | 5.58               | 12.38                            | 21.5                               |
| HW-10         | 6,963.70               | SDMH#145      | 6,962.94              | 15.3                             | 0.0497                           | 18.0             | 0.024       | 2.66          | 5.68               | 12.68                            | 21.0                               |
| SDMH#145      | 6,960.50               | CB1           | 6,960.02              | 15.9                             | 0.0303                           | 18.0             | 0.013       | 2.66          | 7.37               | 18.27                            | 14.6                               |



**FlexTable: Headwall Table**  
**Active Scenario: 100-Year**

| Label | Local Inflow? | Network Boundary Type | Flow (Total Out) (cfs) | Boundary Condition Type |
|-------|---------------|-----------------------|------------------------|-------------------------|
| HW-2  | True          | Inlet                 | 2.59                   | Free Outfall            |
| HW-3  | False         | Outlet                | 2.59                   | Free Outfall            |
| HW-4  | True          | Inlet                 | 2.59                   | Free Outfall            |
| HW-5  | False         | Outlet                | 2.59                   | Free Outfall            |
| HW-8  | True          | Inlet                 | 2.66                   | Free Outfall            |
| HW-9  | False         | Outlet                | 2.66                   | Free Outfall            |
| HW-10 | True          | Inlet                 | 2.66                   | Free Outfall            |

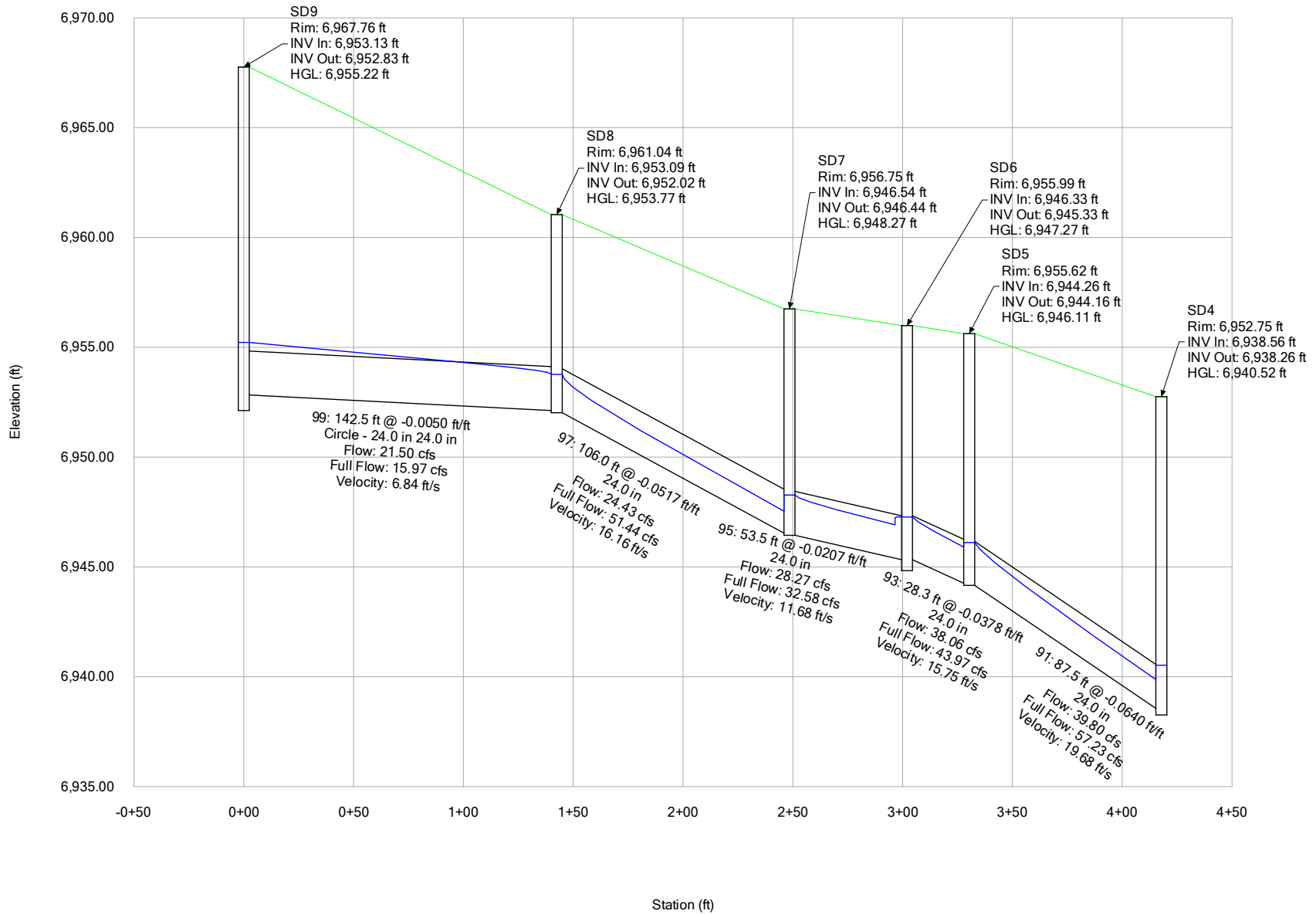
**FlexTable: Outfall Table**  
**Active Scenario: 100-Year**

| Label  | Elevation (Ground)<br>(ft) | Set Rim to Ground<br>Elevation? | Elevation (Invert)<br>(ft) | Boundary Condition Type | Flow (Total Out)<br>(cfs) |
|--------|----------------------------|---------------------------------|----------------------------|-------------------------|---------------------------|
| O-1    | 6,945.09                   | True                            | 6,930.20                   | Crown                   | 47.53                     |
| EX HW1 | 6,961.35                   | True                            | 6,959.14                   | Crown                   | 2.95                      |
| EX HW2 | 6,958.68                   | True                            | 6,956.47                   | Crown                   | 5.67                      |
| EX HW3 | 6,962.63                   | True                            | 6,960.42                   | Crown                   | 0.81                      |
| O-5    | 6,946.52                   | True                            | 6,944.31                   | Crown                   | 7.77                      |

# Profile Report

## Engineering Profile - Amber Steppe View (020439-Black Forest.stsw)

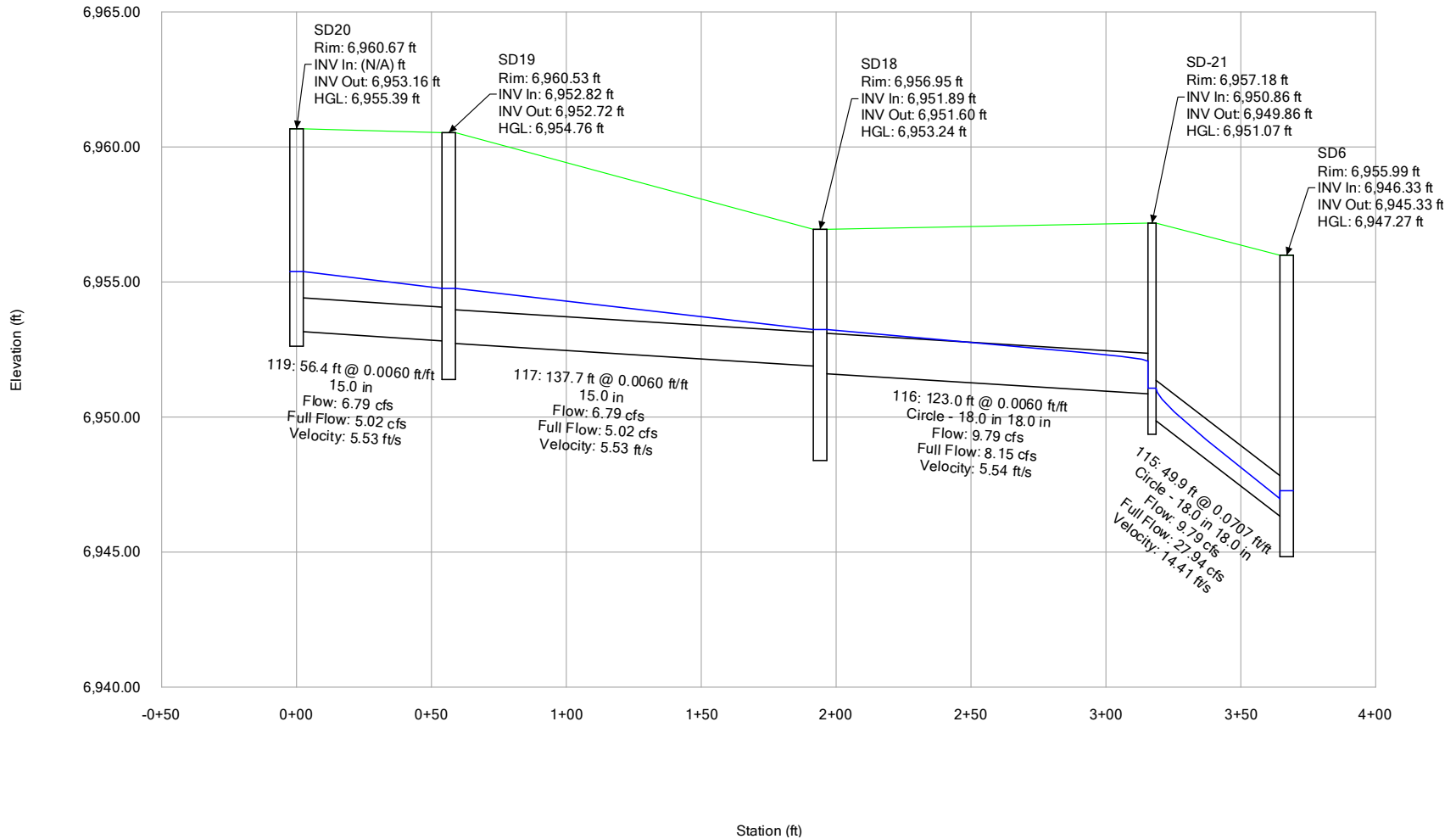
### Active Scenario: 100-Year



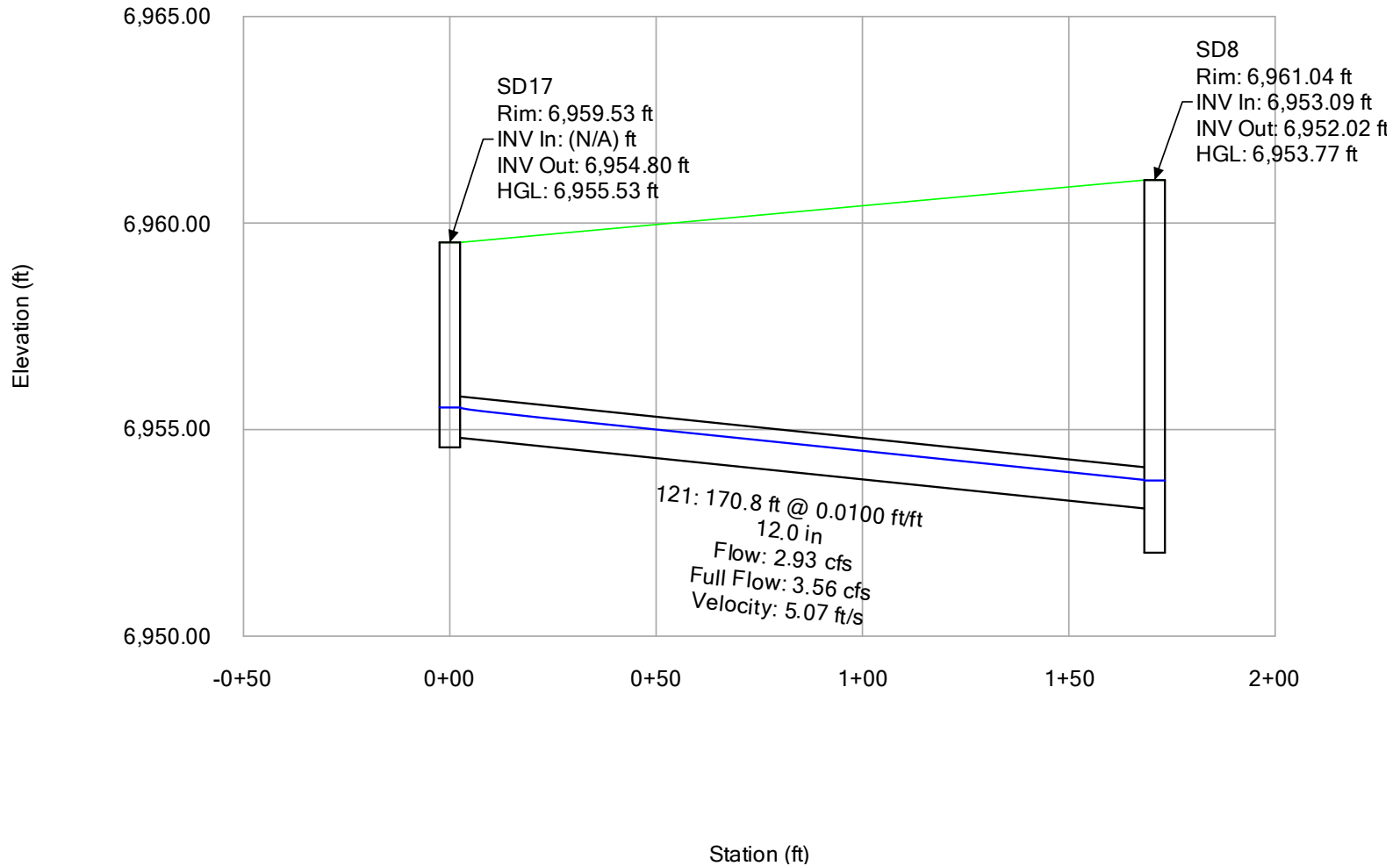
# Profile Report

## Engineering Profile - Guanella Pass Grove (020439-Black Forest.stsw)

### Active Scenario: 100-Year



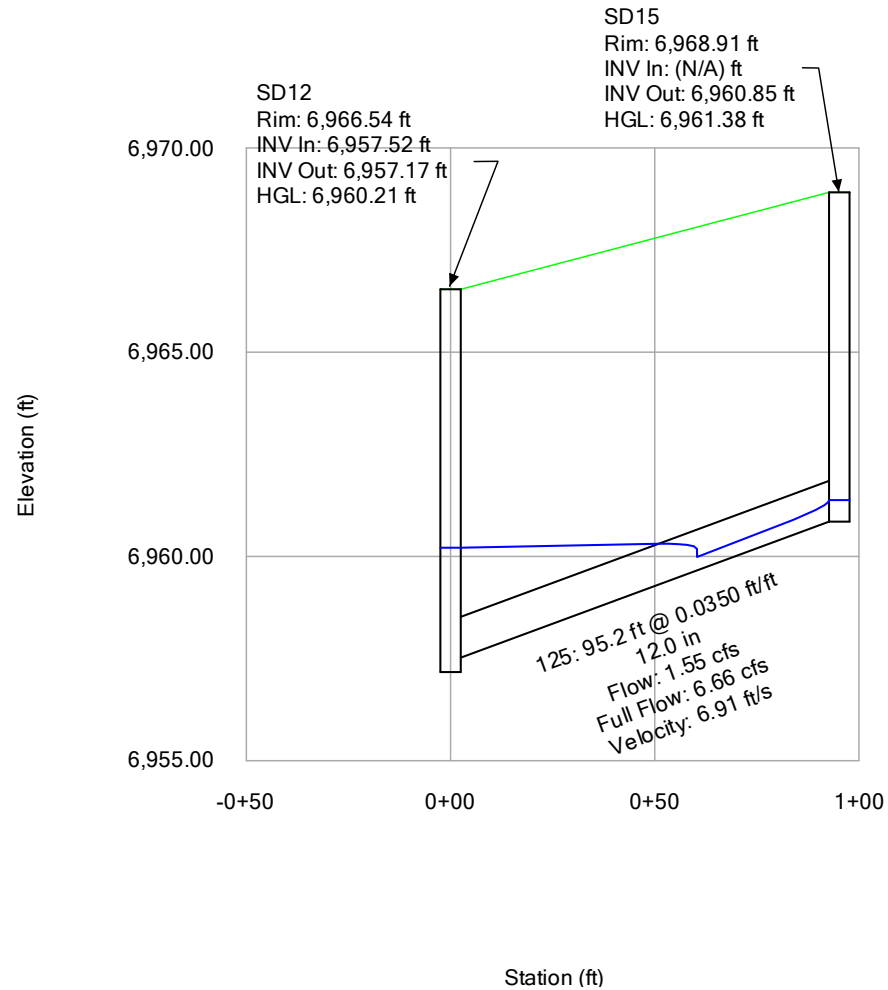
**Profile Report**  
**Engineering Profile - Medano Pass View (020439-Black Forest.stsw)**  
**Active Scenario: 100-Year**



# Profile Report

## Engineering Profile - Old Elk Grove (020439-Black Forest.stsw)

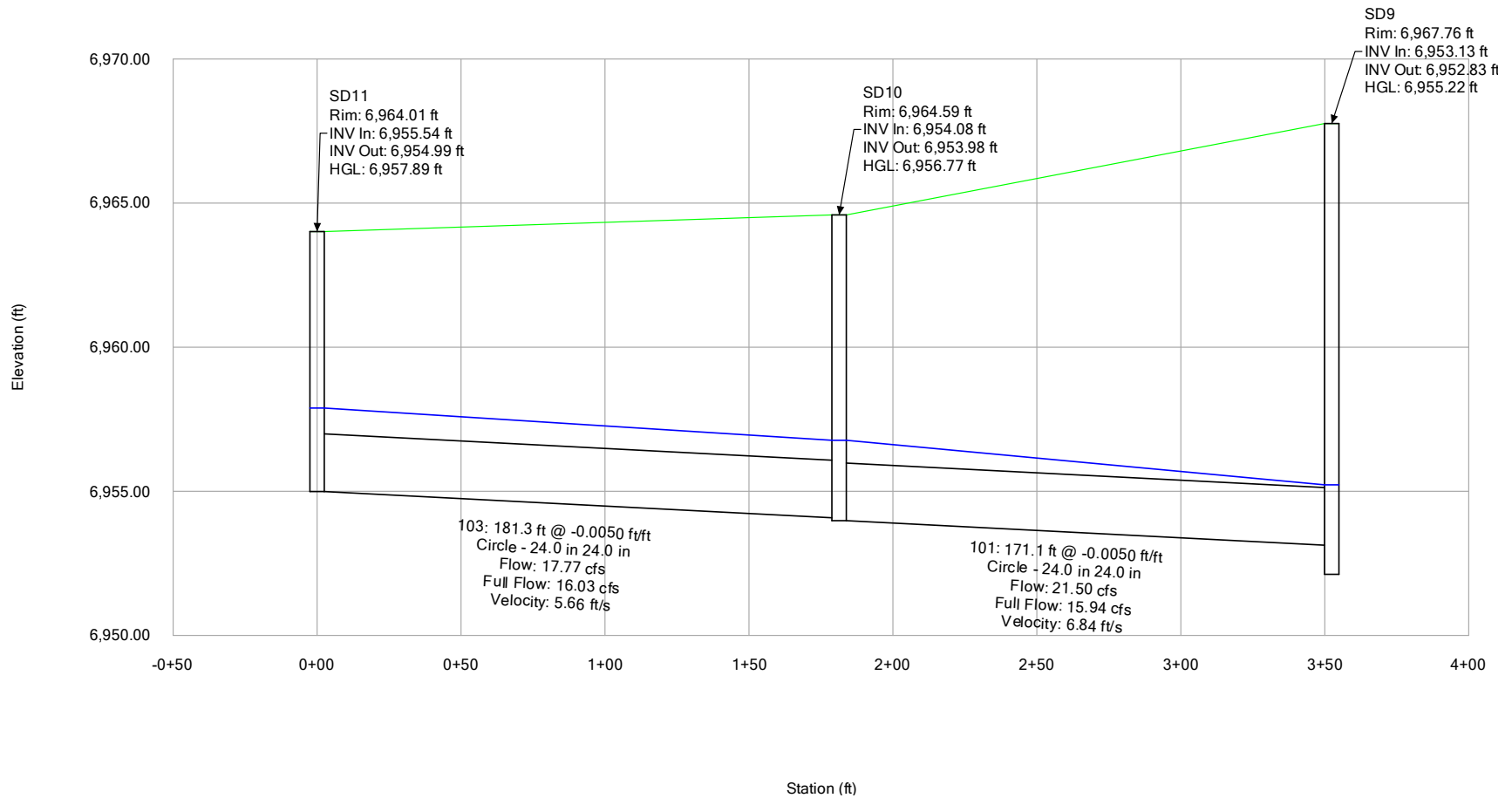
### Active Scenario: 100-Year



# Profile Report

## Engineering Profile - Rocky Top Terrace (020439-Black Forest.stsw)

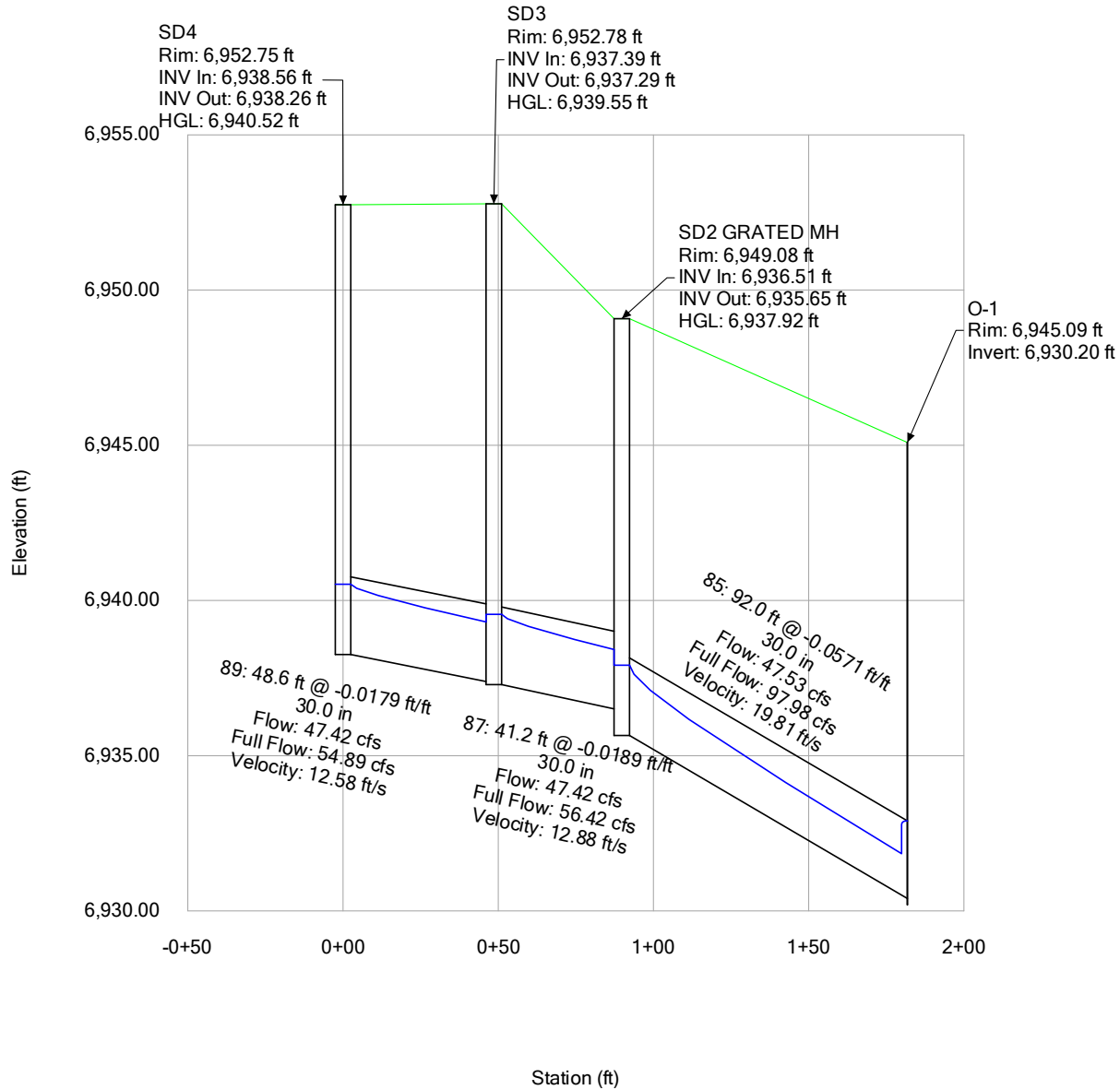
### Active Scenario: 100-Year



# Profile Report

## Engineering Profile - Storm-1 Line (020439-Black Forest.stsw)

### Active Scenario: 100-Year

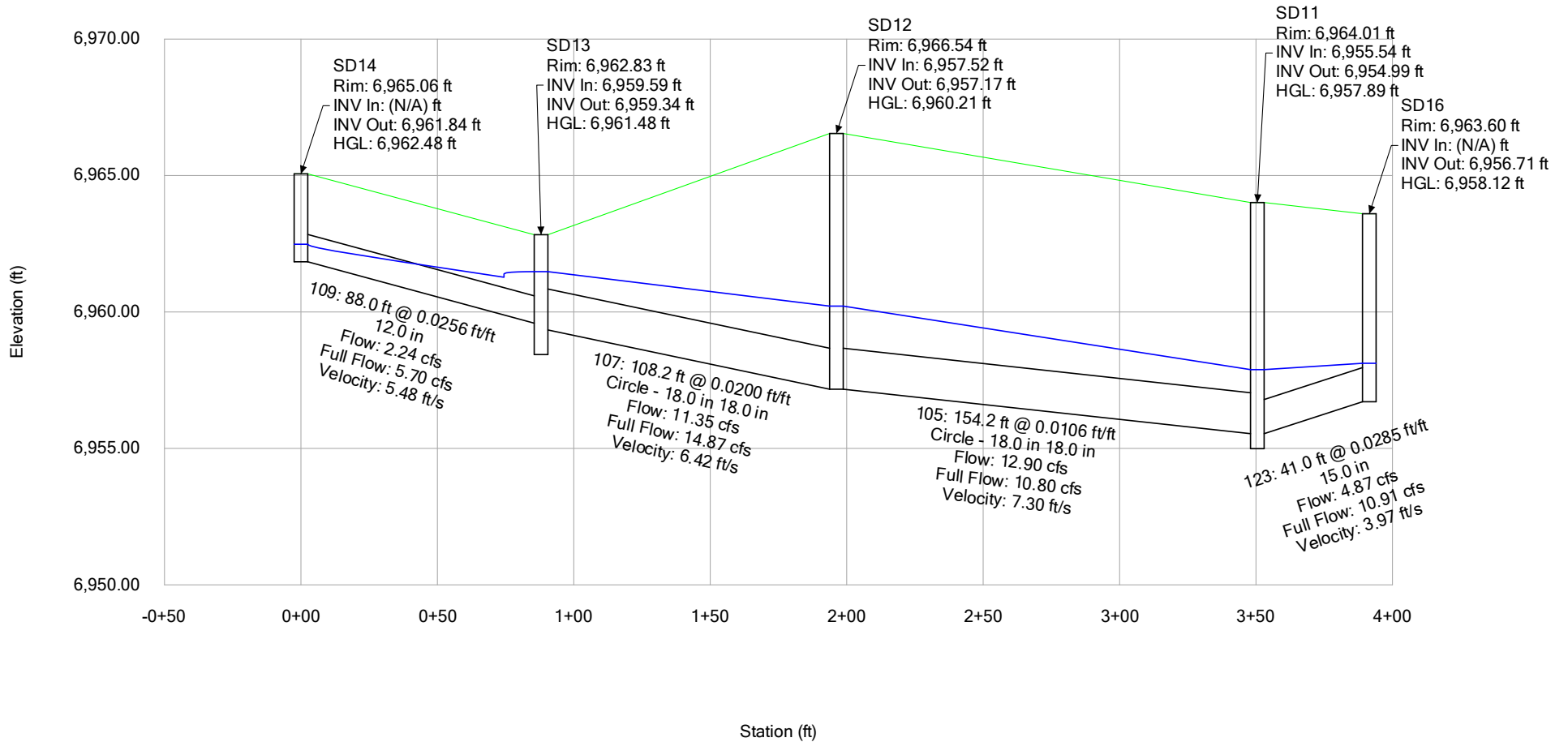




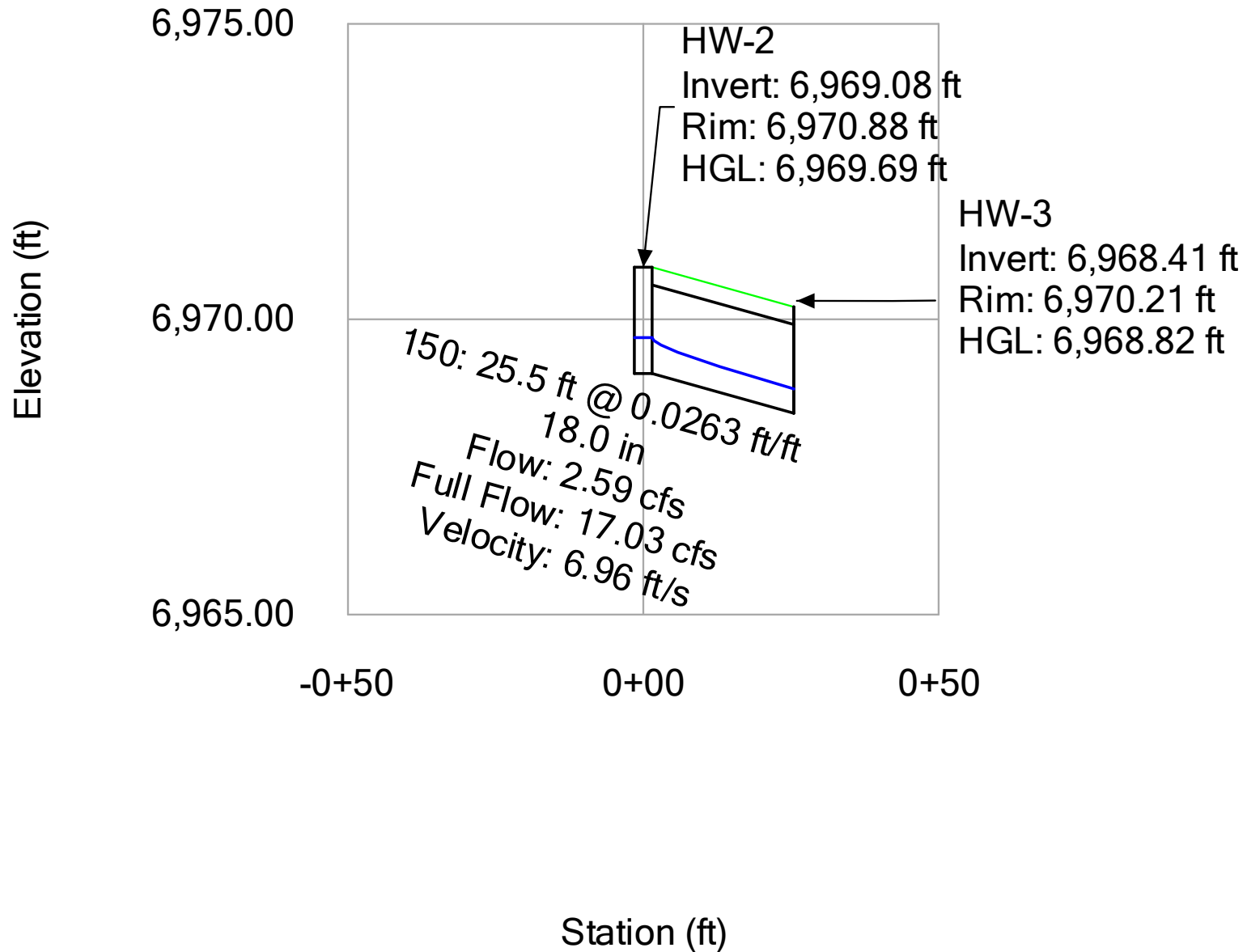
# Profile Report

## Engineering Profile - White Lodge Point (020439-Black Forest.stsw)

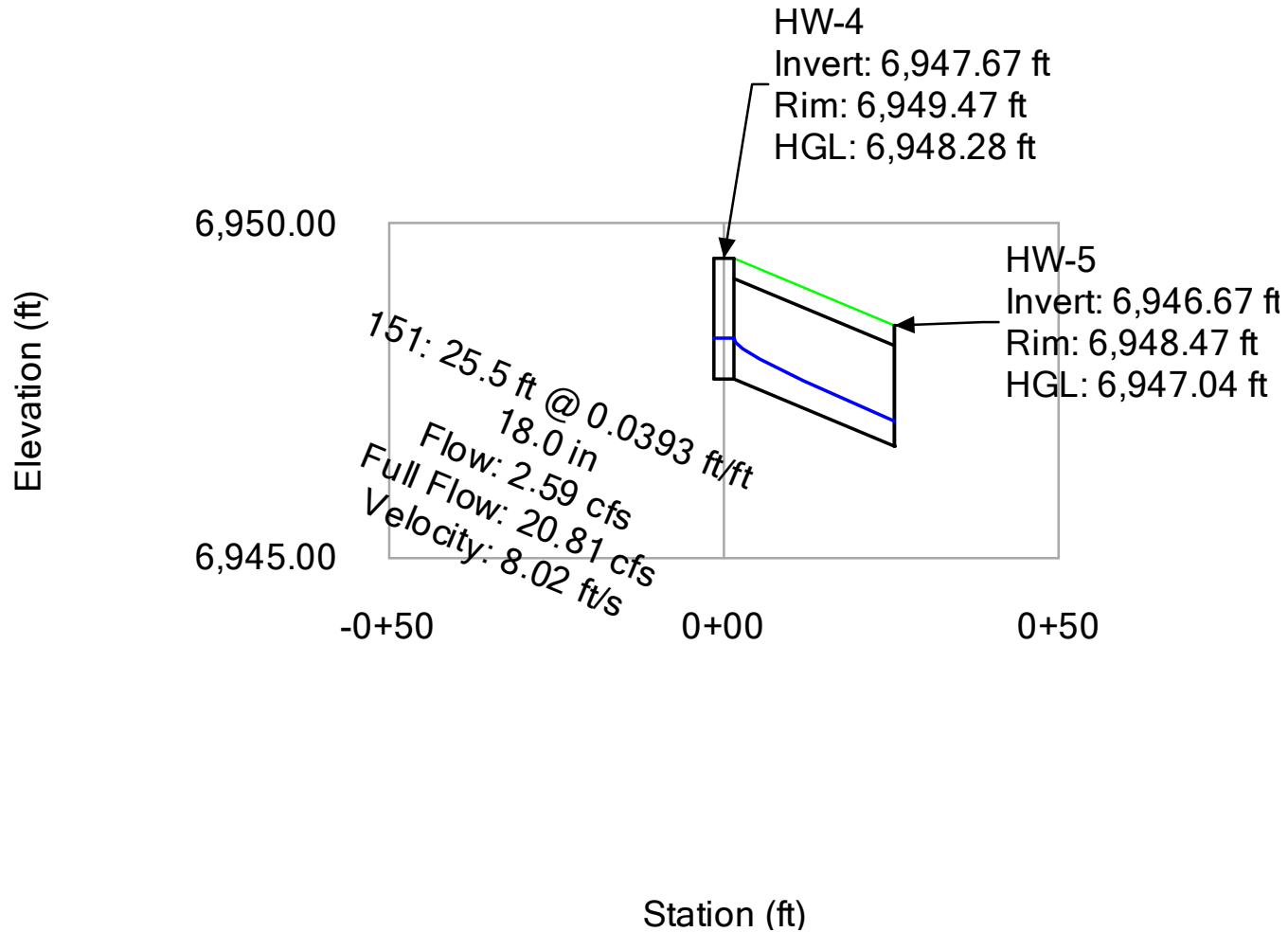
### Active Scenario: 100-Year



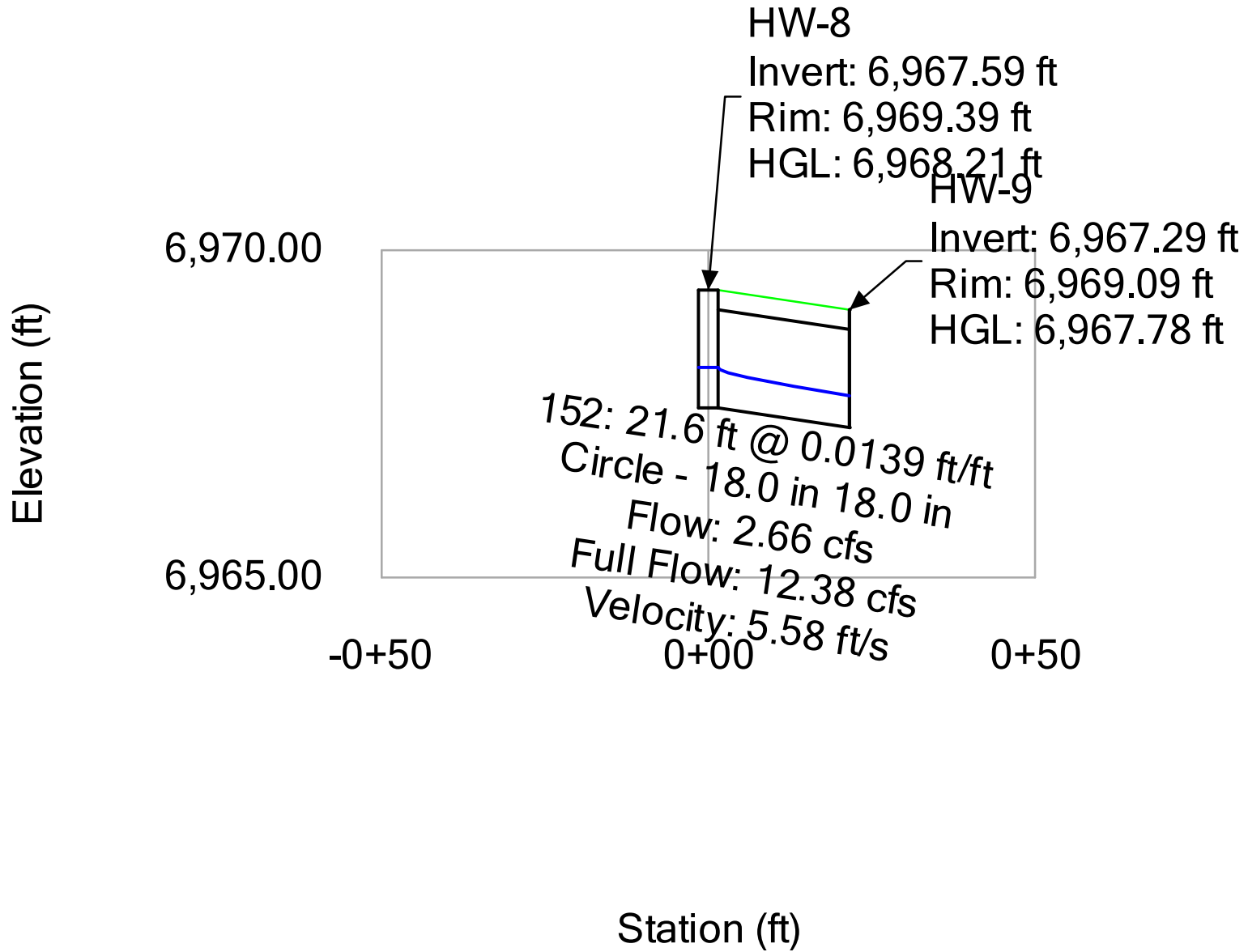
**Profile Report**  
**Engineering Profile - Storm-OFF4 Line (020439-Black Forest.stsw)**  
**Active Scenario: 100-Year**



**Profile Report**  
**Engineering Profile - Storm-OFF5 Line (020439-Black Forest.stsw)**  
**Active Scenario: 100-Year**



**Profile Report**  
**Engineering Profile - Storm-OFF8 Line (020439-Black Forest.stsw)**  
**Active Scenario: 100-Year**



# **STORM SEWER VELOCITY VARIANCE REQUEST**



June 13, 2023

Stormwater Enterprise  
City of Colorado Springs  
30 S. Nevada Avenue, Suite 401  
Colorado Springs, CO 80903

ATTN: Mr. Jonathan Scherer

RE: Storm Sewer Velocity Variance Request for Avanterra Black Forest

Dear Mr. Scherer,

On behalf of our client, Continental 613 Fund LLC, we respectfully request the City's consideration of this variance to the following requirement:

- City of Colorado Springs Drainage Criteria Manual (DCM), Volume 1, Chapter 9, Section 7.1.1

Avanterra Black Forest is a proposed residential development located between East Woodmen Road and Templeton Gap Road and west of Black Forest Road. This development has one ownership as all of the residences are rental properties, so the entire development is on one lot. The site is on an approximately 11.796-acre tract that has been replatted and recorded with the El Paso County Office of the Clerk and Recorder under Reception No. 222715053. The tract is located in the northwest corner of Section 7, Township 13 South, Range 65 West of the Sixth Principal Meridian in the City of Colorado Springs, County of El Paso, State of Colorado.

The Final Drainage Report for the project, titled "Avanterra Black Forest Final Drainage Report: Amendment to Master Development Drainage Plan for Woodmen Heights Master Plan", was previously approved on 10/25/22 under SWENT Project # STM-REV21-1847. A Final Drainage Report Amendment has been submitted for review to make minor adjustments to certain inlet locations and types within the project.

The following variance is being requested:

- Per the DCM Volume 1, Chapter 9, Section 7.1.1, "...the maximum velocity in all storm sewers shall be limited to 18 feet per second (ft/sec) for all design flows."
- We are requesting a variance to allow a velocity of greater than 18 feet per second within the proposed storm sewers due to two of the conduits having a modeled velocity above 18 ft/sec in the 100-year storm event.

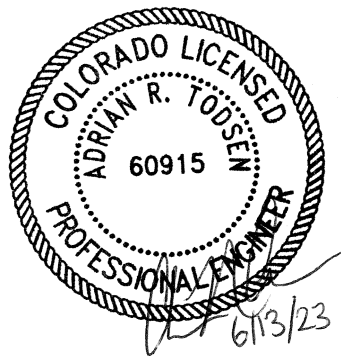
As discussed in the approved Final Drainage Report, the proposed storm sewer ties into an existing 30" storm sewer stubbed out to the site at the northeast corner of the tract. Per the "Preliminary and Final Drainage Report for Blackwood Crossing Filing No. 1A", this stub out was sized for a peak flow of 50 CFS in the 100-year storm event which is greater than our proposed peak flow at the connection. Due to the high elevation difference between our site and the storm sewer stub-out, we had to use steeper pipe runs in

order to connect to the existing invert, which caused high velocities in certain pipes. Because the downstream pipe was sufficiently sized for our proposed flows and the storm sewer run to the Sand Creek Regional Detention Facility No. 6 is over 1,100 LF from our point of connection, it is our professional engineering opinion that the approval of this variance will not adversely impact the downstream storm sewer system or properties within the design storm events. If granted, this variance will not result in any increase in peak flows, nor will it result in any decrease in water quality in Fountain Creek. This variance will not negate the minimum requirements of the City of Colorado Springs Drainage Criteria Manual Four Step Process.

We respectfully request your consideration in favor of this variance.

Sincerely,

Adrian Todsen, PE  
Project Manager



## **Appendices**

Appendix A – Vicinity Map

Appendix B – Proposed Drainage Area Map from Avanterra Black Forest FDR Amendment

Appendix C – StormCAD Exhibit and Conduit Table for 100-year Storm Event



**Appendix A**  
**Vicinity Map**



Not to Scale

## Vicinity Map

**Appendix B**

**Proposed Drainage Basin Map from**

**Avanterra Black Forest FDR Amendment**



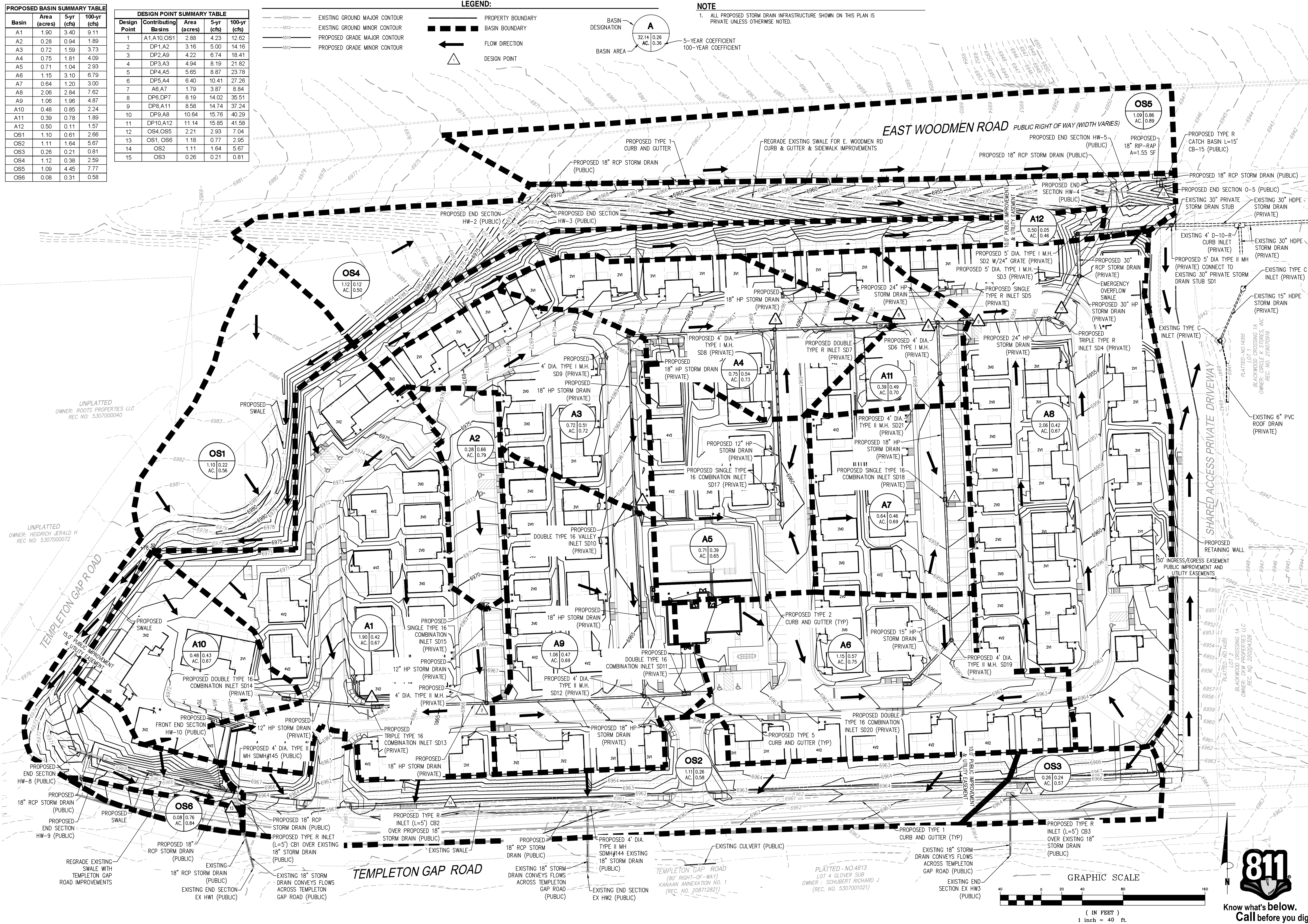
| Basin | Area (acres) | 5-yr (cfs) | 100-yr (cfs) |
|-------|--------------|------------|--------------|
| A1    | 1.90         | 3.40       | 9.11         |
| A2    | 0.28         | 0.94       | 1.89         |
| A3    | 0.72         | 1.59       | 3.73         |
| A4    | 0.75         | 1.81       | 4.09         |
| A5    | 0.71         | 1.04       | 2.93         |
| A6    | 1.15         | 3.10       | 6.79         |
| A7    | 0.64         | 1.20       | 3.00         |
| A8    | 2.06         | 2.84       | 7.62         |
| A9    | 1.06         | 1.96       | 4.87         |
| A10   | 0.48         | 0.85       | 2.24         |
| A11   | 0.39         | 0.78       | 1.89         |
| A12   | 0.50         | 0.11       | 1.57         |
| OS1   | 1.10         | 0.61       | 2.66         |
| OS2   | 1.11         | 1.64       | 5.67         |
| OS3   | 0.26         | 0.21       | 0.81         |
| OS4   | 1.12         | 0.38       | 2.59         |
| OS5   | 1.09         | 4.45       | 7.77         |
| OS6   | 0.08         | 0.31       | 0.58         |

| Design Point | Contributing Basins | Area (acres) | 5-yr (cfs) | 100-yr (cfs) |
|--------------|---------------------|--------------|------------|--------------|
| 1            | A1,A10,OS1          | 2.88         | 4.23       | 12.62        |
| 2            | DP1,A2              | 3.16         | 5.00       | 14.16        |
| 3            | DP2,A9              | 4.22         | 6.74       | 18.41        |
| 4            | DP3,A3              | 4.94         | 8.19       | 21.82        |
| 5            | DP4,A5              | 5.65         | 8.87       | 23.78        |
| 6            | DP5,A4              | 6.40         | 10.41      | 27.26        |
| 7            | A6,A7               | 1.79         | 3.87       | 8.84         |
| 8            | DP6,DP7             | 8.19         | 14.02      | 35.51        |
| 9            | DP8,A11             | 8.58         | 14.74      | 37.24        |
| 10           | DP9,A8              | 10.64        | 15.76      | 40.29        |
| 11           | DP10,A12            | 11.14        | 15.85      | 41.58        |
| 12           | OS4,OS5             | 2.21         | 2.93       | 7.04         |
| 13           | OS1,OS6             | 1.18         | 0.77       | 2.95         |
| 14           | OS2                 | 1.11         | 1.64       | 5.67         |
| 15           | OS3                 | 0.26         | 0.21       | 0.81         |

-5510- EXISTING GROUND MAJOR CONTOUR  
 -5512- EXISTING GROUND MINOR CONTOUR  
 -5510- PROPOSED GRADE MAJOR CONTOUR  
 -5512- PROPOSED GRADE MINOR CONTOUR

**LEGEND:**  
 - - - - - PROPERTY BOUNDARY  
 - - - - - BASIN BOUNDARY  
 - - - - - FLOW DIRECTION  
 ▲ DESIGN POINT

**NOTE:**  
 1. ALL PROPOSED STORM DRAIN INFRASTRUCTURE SHOWN ON THIS PLAN IS PRIVATE UNLESS OTHERWISE NOTED.

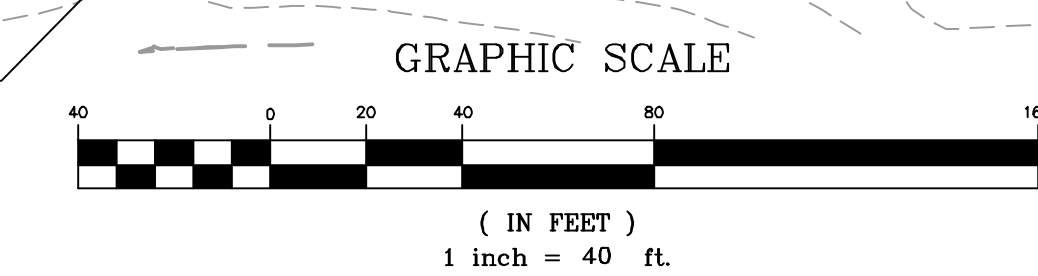


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 1526 Cole Blvd., Suite 100  
 Lakewood, CO 80401  
 Phone: (303) 801-2900  
 www.bowman.com

| REVISION | DATE | DESCRIPTION |
|----------|------|-------------|
|          |      |             |
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|          |      |             |
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**PROPOSED DRAINAGE MAP**  
 AVANTERRA BLACK FOREST  
 DEVELOPMENT PLAN  
 EAST WOODMEN ROAD AND TEMPLETON GAP ROAD  
 COLORADO SPRINGS  
 COLORADO

|         |               |      |
|---------|---------------|------|
| DESIGN  | DRAWN         | CHKD |
| ISL     | ISL           | DD   |
| SCALE   | H: 1" = 40'   |      |
|         | V: N/A        |      |
| JOB No. | 020439-01-003 |      |
| DATE:   | 09/23/2022    |      |
| SHEET   |               |      |



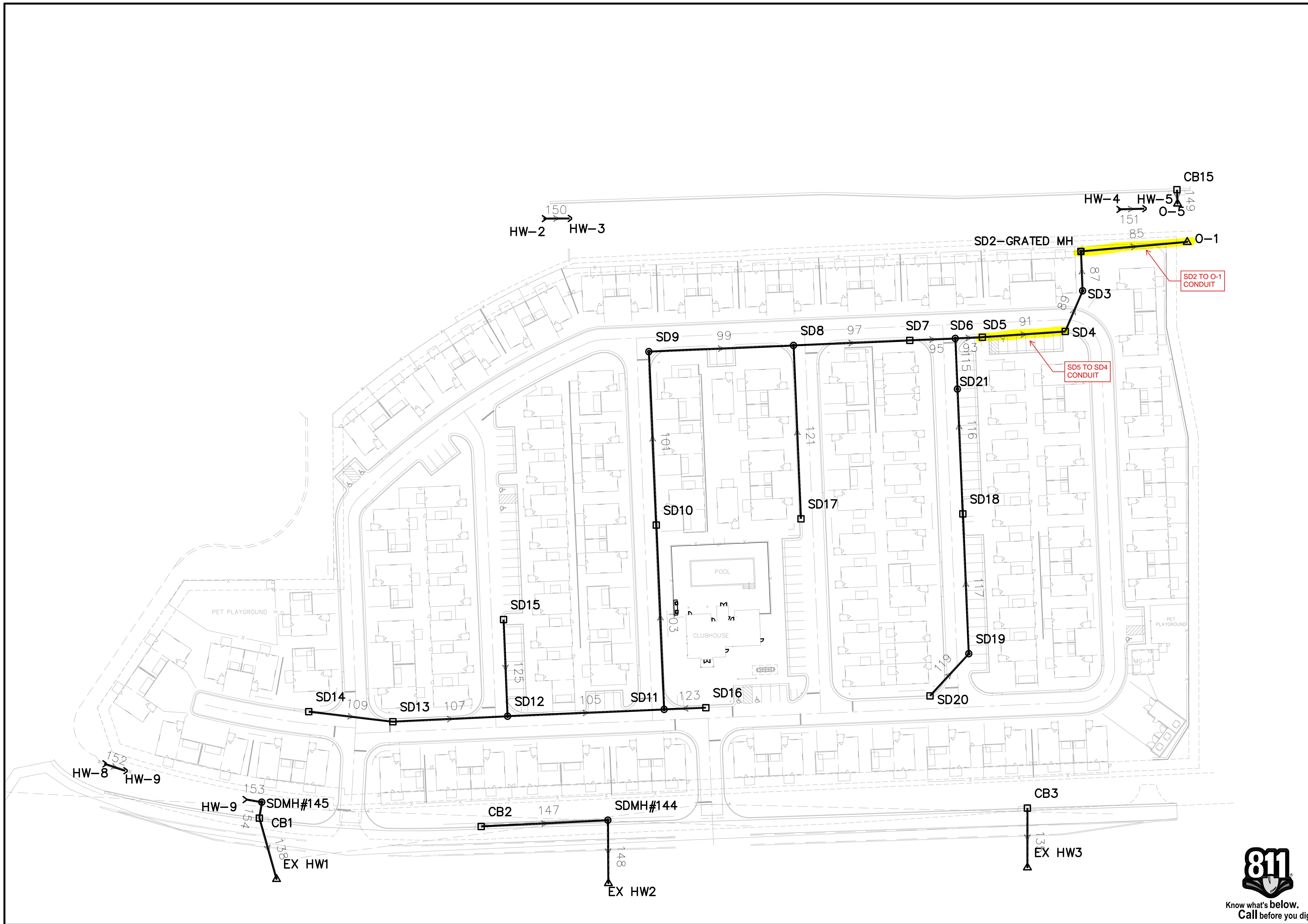


**Appendix C**  
**StormCAD Exhibit and Conduit Table for 100-year**  
**Storm Event**

**FlexTable: Conduit Table**  
**Active Scenario: 100-Year**

| Start Node    | Invert (Start) (ft) | Stop Node     | Invert (Stop) (ft) | Length (User Defined) (ft) | Slope (Calculated) (ft/ft) | Diameter (in) | Manning's n | Flow (cfs) | Velocity (ft/s) | Capacity (Full Flow) (cfs) | Flow / Capacity (Design) (%) |
|---------------|---------------------|---------------|--------------------|----------------------------|----------------------------|---------------|-------------|------------|-----------------|----------------------------|------------------------------|
| SD15          | 6,960.85            | SD12          | 6,957.52           | 95.2                       | 0.0350                     | 12.0          | 0.013       | 1.55       | 6.91            | 6.66                       | 23.3                         |
| SD14          | 6,961.84            | SD13          | 6,960.59           | 88.0                       | 0.0142                     | 12.0          | 0.013       | 2.24       | 5.48            | 4.25                       | 52.8                         |
| SD8           | 6,952.12            | SD9           | 6,952.83           | 142.5                      | -0.0050                    | 24.0          | 0.013       | 21.50      | 6.84            | 15.97                      | 134.7                        |
| SD9           | 6,953.13            | SD10          | 6,953.98           | 171.1                      | -0.0050                    | 24.0          | 0.013       | 21.50      | 6.84            | 15.94                      | 134.8                        |
| SD12          | 6,957.17            | SD11          | 6,955.54           | 154.2                      | 0.0106                     | 18.0          | 0.013       | 12.90      | 7.30            | 10.80                      | 119.5                        |
| SD13          | 6,959.34            | SD12          | 6,957.17           | 108.2                      | 0.0200                     | 18.0          | 0.013       | 11.35      | 6.42            | 14.87                      | 76.3                         |
| SD10          | 6,954.08            | SD11          | 6,954.99           | 181.3                      | -0.0050                    | 24.0          | 0.013       | 17.77      | 5.66            | 16.03                      | 110.9                        |
| SD16          | 6,956.71            | SD11          | 6,955.54           | 41.0                       | 0.0285                     | 15.0          | 0.013       | 4.87       | 3.97            | 10.91                      | 44.6                         |
| SD7           | 6,946.54            | SD8           | 6,952.02           | 106.0                      | -0.0517                    | 24.0          | 0.013       | 24.43      | 16.16           | 51.44                      | 47.5                         |
| SD17          | 6,954.80            | SD8           | 6,953.09           | 170.8                      | 0.0100                     | 12.0          | 0.013       | 2.93       | 5.07            | 3.56                       | 82.2                         |
| SD19          | 6,952.72            | SD18          | 6,951.89           | 137.7                      | 0.0060                     | 15.0          | 0.013       | 6.79       | 5.53            | 5.02                       | 135.4                        |
| SD20          | 6,953.16            | SD19          | 6,952.82           | 56.4                       | 0.0060                     | 15.0          | 0.013       | 6.79       | 5.53            | 5.02                       | 135.4                        |
| SD6           | 6,945.33            | SD7           | 6,946.44           | 53.5                       | -0.0207                    | 24.0          | 0.013       | 28.27      | 11.68           | 32.58                      | 86.8                         |
| SD5           | 6,944.26            | SD6           | 6,945.33           | 28.3                       | -0.0378                    | 24.0          | 0.013       | 38.06      | 15.75           | 43.97                      | 86.6                         |
| SD4           | 6,938.56            | SD5           | 6,944.16           | 87.5                       | -0.0640                    | 24.0          | 0.013       | 39.80      | 19.68           | 57.23                      | 69.5                         |
| SD2 GRATED MH | 6,936.51            | SD3           | 6,937.29           | 41.2                       | -0.0189                    | 30.0          | 0.013       | 47.42      | 12.88           | 56.42                      | 84.1                         |
| SD3           | 6,937.39            | SD4           | 6,938.26           | 48.6                       | -0.0179                    | 30.0          | 0.013       | 47.42      | 12.58           | 54.89                      | 86.4                         |
| O-1           | 6,930.40            | SD2 GRATED MH | 6,935.65           | 92.0                       | -0.0571                    | 30.0          | 0.013       | 47.53      | 19.81           | 97.98                      | 48.5                         |
| CB3           | 6,960.73            | EX HW3        | 6,960.42           | 58.2                       | 0.0053                     | 18.0          | 0.013       | 0.81       | 2.81            | 7.65                       | 10.6                         |
| CB1           | 6,959.82            | EX HW1        | 6,959.14           | 62.1                       | 0.0110                     | 18.0          | 0.013       | 2.95       | 5.28            | 11.02                      | 26.8                         |
| CB2           | 6,957.57            | SDMH#144      | 6,956.95           | 124.8                      | 0.0050                     | 18.0          | 0.013       | 5.67       | 4.62            | 7.40                       | 76.6                         |
| EX HW2        | 6,956.47            | SDMH#144      | 6,956.95           | 55.8                       | -0.0086                    | 18.0          | 0.013       | 5.67       | 5.72            | 9.74                       | 58.2                         |
| CB4           | 6,944.35            | O-5           | 6,944.31           | 8.4                        | 0.0048                     | 18.0          | 0.013       | 7.77       | 4.60            | 7.26                       | 107.0                        |
| SD18          | 6,951.60            | SD-21         | 6,950.86           | 123.0                      | 0.0060                     | 18.0          | 0.013       | 9.79       | 5.54            | 8.15                       | 120.2                        |
| SD-21         | 6,949.86            | SD6           | 6,946.33           | 49.9                       | 0.0707                     | 18.0          | 0.013       | 9.79       | 14.41           | 27.94                      | 35.0                         |
| HW-2          | 6,966.26            | HW-3          | 6,965.27           |                            | 0.0389                     | 18.0          | 0.013       | 2.59       | 8.00            | 20.71                      | 12.5                         |
| HW-4          | 6,945.95            | HW-5          | 6,945.14           |                            | 0.0318                     | 18.0          | 0.013       | 2.59       | 7.45            | 18.73                      | 13.8                         |
| HW-8          | 6,970.40            | HW-9          | 6,969.85           |                            | 0.0254                     | 18.0          | 0.013       | 2.66       | 6.93            | 16.74                      | 15.9                         |

CONDUITS EXCEEDING 18 FT/SEC



| REVISION | DESCRIPTION | DATE |
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|          |             |      |
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**STORMCAD EXHIBIT**  
 AVANTERRA BLACK FOREST  
 DEVELOPMENT PLAN  
 EAST WOODMEN ROAD AND TEMPLETON GAP ROAD  
 COLORADO SPRINGS COLORADO

SEAL  
**NOT FOR CONSTRUCTION**

|         |               |      |
|---------|---------------|------|
| DESIGN  | DRAWN         | CHKD |
| ISL     | ISL           | DD   |
| SCALE   | H:            | V:   |
| JOB No. | 020439-01-003 |      |
| DATE    | 09/23/2022    |      |
| SHEET   |               |      |

