AMENDMENT TO MDDP
for
COTTAGES AT WOODMEN HEIGHTS
and
FINAL DRAINAGE REPORT
for
COTTAGES AT WOODMEN HEIGHTS FILINGS NO. 1 & 2

Colorado Springs, Colorado

May 10, 2022

Prepared for:

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Project #: 21369-00CSCV

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AMENDMENT TO MDDP FOR COTTAGES AT WOODMEN HEIGHTS AND

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1.0 CERTIFICATION STATEMENTS

Engineer's Statement

This report and plan for the drainage design of Cottages at Woodmen Heights Filings No. 1 & 2 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.

SIGNATURE (Affix Seal): ______________________

For and on behalf of Drexel, Barrell & Co. 5-10-22 Date
Tim D. McConnell, P.E. #33797

COLORADO REGISTERED PROFESSIONAL ENGINEER TIM D. McCONNELL 33797

Developer's Statement

Goodwin Knight hereby certifies that the drainage facilities for Cottages at Woodmen Heights Filings No. 1 & 2 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 Cottages at Woodmen Heights Filings No. 1 & 2 guarantee that the final drainage design review will absolve Goodwin Knight 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.

______________________ 5/10/22

Authorized Signature — Date
Bryan Kniep
Goodwin Knight

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.

______________________ 2022/05/20

For City Engineer — Date
Conditions:

AMENDMENT TO MDDP FOR COTTAGES AT WOODMEN HEIGHTS AND

FINAL DRAINAGE REPORT FOR COTTAGES AT WOODMEN HEIGHTS FILINGS NO. 1 & 2

2.0 PURPOSE

The purpose of this MDDP and Final Drainage Report for Cottages at Woodmen Heights Filings No. 1 & 2 is to identify the existing and proposed runoff patterns and drainage facilities required for the proposed development, and to present the ability to safely route developed storm water to adequate outfalls. The previous project number for the Amendment to the MDDP is STM-REV21-1574. It was never brought to final approval, however all review comments have been addressed within the body of this report. The MDDP was approved by the City on 8/3/20.

3.0 GENERAL SITE DESCRIPTION

Location

Cottages at Woodmen Heights is an approximate 38.44 acre property located in the northeast quarter of Section 8, Township 13 South, Range 67 West of the 6th Principal Meridian in the County of El Paso, State of Colorado. The overall development is to include some disturbed area along Woodmen Road, described later in Section 8.0, which brings the total development area to approximately 40.08 acres. The site is located south of Adventure Way, which is just south of E. Woodmen Rd. Adventure Way ends to the east at the entrance to the proposed site. The site is bounded to the west by an unplatted property owned by Vantage Homes, to the north by Adventure Way, to the east by an unplatted property owned by Woodmen Road Metropolitan District, and to the south by Tract C of Indigo Ranch at Stetson Ridge Filing No. 15 and by a residential property (Lot 1 Longenecker Subdivision).

Soils

According to the Soil Survey of El Paso County Area, Colorado, prepared by the U.S. Department of Agriculture Natural Resources Conservation Service (NCRS), the site is underlain by Blakeland-Fluvaquentic Haplaquolis. This soil is classified as hydrological soil group A. Runoff coefficients corresponding to group A were used for the purposes of the site drainage analysis.

Climate

This area of El Paso County can be described as the foothills, with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry, and summers relatively warm and dry. Precipitation ranges from 12 to 14 inches per year, with the majority of this moisture occurring in the spring and summer in the form of rainfall. Thunderstorms are common during the summer months.

Floodplain Statement

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel 08041C0533G (December 7, 2018), the east portion of the site lies within a designated 100-year floodplain. This portion of the site will be left undeveloped, all new development will take place outside of the 100-year floodplain.

4.0 DRAINAGE CRITERIA

The drainage analysis has been prepared in accordance with the current City of Colorado Springs Drainage Criteria Manual, Vol 1 and the Urban Storm Drainage Criteria Manual. Calculations were performed to determine runoff quantities during the 5 year and 100 year frequency storms for historic and developed conditions using the Rational Method as required for basins containing less than 100 acres.

5.0 EXISTING CONDITION

The existing site contains some large concrete areas, a small building and parking lot and a couple of sheds. The remainder of the site is undeveloped and covered with native vegetation that consists mostly of grasses as well as some shrubs. The site generally slopes from north to south at approximately 2-4%. The site lies within the Sand Creek Drainage Basin. See Existing Conditions Map in Appendix.

The Rational Method was used to determine runoff quantities for the 5- and 100-year storm recurrence intervals. See below for a summary runoff table.

Rational Method Runoff Summary

BASIN	AREA (AC)	% IMPERV	Q5 (cfs)	Q100 (cfs)
OS1	16.80	65%	4.7	22.0
OS2	2.69	27%	3.7	11.0
OS3	2.58	55%	6.2	14.0
OS4	3.18	48%	6.8	16.1
OS5	0.62	55%	1.6	3.6
OS6	0.32	41%	0.6	1.6
OS7	0.62	37%	1.3	3.3
1	17.52	0%	7.3	41.0
2	8.36	44%	12.4	30.3
3	8.45	1%	3.9	20.6
4	1.03	0%	0.4	2.4
5	3.19	0%	1.4	7.7

DP	AREA (AC)	Q5 (cfs)	Q100 (cfs)
OS1	16.80	4.7	22.0
OS2	2.69	3.7	11.0
OS3	5.27	9.3	23.5
OS4	8.45	15.5	38.2
OS5	0.62	1.6	3.6
OS6	0.32	0.6	1.6
OS7	0.62	1.3	3.3
1	43.39	33.7	96.8
2	8.68	10.5	25.7
3	9.07	4.0	19.6
4	1.03	0.4	2.4
5	3.19	1.4	7.7

Basin OS1 is located north of Woodmen Rd. across from the project site. The flows from this site sheet flow at approximately 2% slope to the private streets and are captured by a private detention pond, where the flows are then slowly released into a private 18" RCP storm pipe that then routes to a public 54" RCP storm pipe that goes under Woodmen Rd and discharges onto the project site. These flows were found in the report "Amendment to Woodmen Heights Business Park MDDP and Final Report for the Pines at Forest Meadows Filing Nos. 1, 2, 3, 4, 5 & 6" by M&S Civil Consultants, Inc., March 2017.

Basin OS2 is located north of Woodmen Rd. across from the project site. The flows from this basin sheet flow at approximately 1.5% slope across undeveloped land into an existing public inlet at Woodmen Rd. The flows for this basin were calculated using the Rational Method.

Basin OS3 is located in the median of Woodmen Rd. The flows from this basin flow at approximately 0.8% slope across pasture/meadow to an existing public inlet, where the flows from OS2 combine with OS3. The flows for this basin were calculated using the Rational Method.

DP-OS3 is located at the existing public inlet in Basin OS3. The flows leave this inlet via an existing public 30" RCP storm pipe. This design point captures all of the flows from Basins OS2 and OS3.

Basin OS4 is located at the south (eastbound) portion of Woodmen Rd. The flows from this basin sheet flow at approximately 5.2% slope across pasture/meadow and asphalt to an existing public inlet, where the flows from OS3 combine with OS4. The flows leave this inlet via an existing public 30" RCP storm pipe where it then discharges onto the project site. The flows for this basin were calculated using the Rational Method.

DP-OS4 is located at the existing public inlet in Basin OS4. The flows leave this inlet via an existing public 30" RCP storm pipe. This design point captures all of the flows from Basins OS2, OS3 and OS4.

Basin OS5 is located south of Woodmen Rd., but north of the project site. The flows from this basin sheet flow at approximately 3.3% slope across pasture/meadow and asphalt onto the project site. The flows for this basin were calculated using the Rational Method.

Basin OS6 is located south of Woodmen Rd., but north of the project site. The flows from this basin sheet flow at approximately 3.3% slope across pasture/meadow and asphalt onto the project site. The flows for this basin were calculated using the Rational Method.

Basin OS7 is located at the south (eastbound) portion of Woodmen Rd. The flows from this basin sheet flow at approximately 7.6% slope across pasture/meadow and asphalt onto the project site. The flows for this basin were calculated using the Rational Method.

Basin 1 is located at the west end of the project site. The flows from this basin sheet flow at approximately 2.5% slope across pasture/meadow into a drainage way that exits the site at the south end.

DP-1 is located at the south end of the project site and represents the flows from Basins OS1 through OS5 and Basin 1 leaving the site to the south into the drainage way that then goes on to join Sand Creek approximately 615' south of DP-1.

Basin 2 is located at the center of the project site. The flows from this basin sheet flow at approximately 2.1% slope across pasture/meadow and concrete before leaving the site at the south end.

DP-2 is located at the south end of the project site and represents the flows from Basin OS6 and Basin 2 leaving the site to the south into Sand Creek.

Basin 3 is located at the east end of the project site. The flows from this basin sheet flow at approximately 2.8% slope across mostly pasture/meadow and into Sand Creek.

DP-3 is located in Basin 3 and represents the flows from Basin OS7 and Basin 3 that flow into Sand Creek.

Basin 4 is located at the southwest corner of the project site. The flows from this basin sheet flow at approximately 2.2% slope across pasture/meadow before leaving the site at the south end.

Basin 5 is located at the south end of the project site. The flows from this basin sheet flow at approximately 2.8% slope across pasture/meadow before leaving the site at the south end.

6.0 DEVELOPED CONDITION

The proposed site will consist of townhome units, associated parking, drive aisles and landscaping. Flows from existing properties to the north will be passed through the site and discharged into the existing drainage way. Basin 24 is largely in the 100-year floodplain and will remain undeveloped. There will be two proposed Extended Detention Basins on site. The first is a smaller EDB to the west that will capture flows from Basins 1 through 4. The second is to the south and will capture flows from Basins 5 through 20, which is the majority of the proposed site. The flows from Basins 21 through 24 will not be captured and treated. Basins 21 & 22 will be graded, but will be reseeded and no impervious area will be added. Basins 23 & 24 will remain primarily undeveloped with native vegetation left in place and also no impervious area will be added. See Proposed Conditions Map in Appendix.

The Rational Method was used to determine runoff quantities for the 5- and 100-year storm recurrence intervals.

Rational Method Runoff Summary

BASIN	AREA (AC)	% IMPERV	Q5 (cfs)	Q100 (cfs)
1	0.41	56%	1.2	2.7
2	1.36	44%	2.7	6.7
3	1.64	51%	3.6	8.4
4	0.25	0%	0.2	1.1
5	1.94	95%	8.0	14.6
6	1.15	65%	2.7	6.0
7	0.43	65%	1.0	2.3
8	0.31	65%	0.8	1.7
9	0.84	65%	1.9	4.1
10	0.76	65%	1.6	3.6
11	0.41	65%	0.9	2.1
12	1.59	65%	2.9	6.5
13	1.03	65%	2.0	4.5
14	1.16	65%	2.2	4.8
15	1.46	65%	2.6	5.9
16	1.39	65%	3.1	6.9
17	0.58	65%	1.1	2.4
18	1.61	65%	3.0	6.6
19	7.38	65%	15.9	35.4
20	1.19	0%	0.8	4.7
21	0.87	0%	0.6	3.1
22	1.15	0%	0.6	3.5
23	3.59	0%	2.0	11.5
24	7.58	0%	4.0	22.5

DP	AREA (AC)	Q5 (cfs)	Q100 (cfs)
1	0.41	1.2	2.7
2	1.77	3.7	8.9
3	3.41	7.2	17.1
4	3.66	7.4	17.9
5	1.94	8.0	14.6
6	1.15	2.7	6.0
J1	3.09	10.1	19.5
7	0.43	1.0	2.3
8	0.31	0.8	1.7
9	1.15	2.5	5.7
J2	4.67	13.0	26.2
10	0.76	1.6	3.6
J3	5.43	14.3	29.1
11	0.41	0.9	2.1
J4	5.84	15.0	30.6
12	1.59	2.9	6.5
13	2.62	4.7	10.5
14	1.16	2.2	4.8
15	2.62	4.8	10.6
J5	11.08	22.0	46.8
16	1.39	3.1	6.9
J6	12.47	24.1	51.5
17	13.05	25.0	53.6
18	1.61	3.0	6.6
19	7.38	15.9	35.4
J7	8.99	16.6	36.9
20	23.23	41.4	92.1
SP		0.6	16.9
OS1-4	25.25	20.2	60.2
21	26.12	20.8	63.3
22	27.27	21.4	66.8
J8	30.93	21.4	69.3
23	57.75	24.1	97.7
24	7.58	4.0	22.5

Basin 1 is located at the west end of the project site. The flows from this basin sheet flow at approximately 4.2% slope across pasture/meadow and asphalt.

DP-1 is located at the proposed private sump 5' Type R inlet in Basin 1. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 1.

Basin 2 is located at the west end of the project site. The flows from this basin sheet flow at approximately 2.9% slope across pasture/meadow and asphalt.

DP-2 is located at the proposed private Type C area inlet in Basin 2. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basins 1 and 2.

Basin 3 is located at the west end of the project site. The flows from this basin sheet flow at approximately 2.0% slope across pasture/meadow and asphalt.

DP-3 is located at the proposed private Type C area inlet in Basin 3. The flows leave this inlet via a proposed private 18" storm pipe and discharges into the west Extended Detention Basin. This design point captures all of the flows from Basins 1 through 3.

Basin 4 is located at the west end of the project site. The flows from this basin sheet flow at approximately 4.8% slope across pasture/meadow.

DP-4 is located at the bottom of the proposed private Extended Detention Basin in Basin 4. This EDB captures all of the flows from Basins 1 through 4. This pond has been sized using UD-Detention spreadsheet, which can be found in the Appendix. This EDB will have a private outlet structure that will release the WQCV volume in 40 hours and the EURV volume in 72 hours into the drainage channel to the east of the pond. This channel joins Sand Creek approximately 840' to the south.

Basin 5 is located at the north end of the project site. The layout of this basin has not yet been determined, but it will be used as a commercial property. The flows from this basin will flow at approximately 3.5% slope across roofs, asphalt and landscaped areas.

DP-5 is located at the proposed public sump 10' Type R inlet in Basin 5. The flows leave this inlet via a proposed public 24" storm pipe. This design point captures all of the flows from Basin 5.

Basin 6 is located at the north end of the project site. The flows from this basin will flow at approximately 4.0% slope across roofs, asphalt and landscaped areas.

DP-6 is located at the proposed private sump 5' Type R inlet in Basin 6. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 6.

DP-J1 is located at the proposed private manhole in Basin 10. The flows leave this manhole via a proposed private 24" storm pipe. This design point captures all of the flows from Basins 5 and 6.

Basin 7 is located at the north end of the project site. The flows from this basin will flow at approximately 9.2% slope across asphalt and landscaped areas.

DP-7 is located at the proposed private sump 5' Type R inlet in Basin 7. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 7.

Basin 8 is located at the north end of the project site. The flows from this basin will flow at approximately 2.5% slope across asphalt and landscaped areas.

DP-8 is located at the proposed private sump 5' Type R inlet in Basin 8. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 8.

Basin 9 is located at the north end of the project site. The flows from this basin will flow at approximately 2.5% slope across roofs, asphalt and landscaped areas.

DP-9 is located at the proposed private sump 5' Type R inlet in Basin 9. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basins 8 and 9.

DP-J2 is located at the proposed private manhole in Basin 10. The flows leave this manhole via a proposed private 30" storm pipe. This design point captures all of the flows from Basins 5 through 9.

Basin 10 is located at the center of the project site. The flows from this basin will flow at approximately 2.5% slope across roofs, asphalt and landscaped areas.

DP-10 is located at the proposed private sump 5' Type R inlet in Basin 10. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 10.

DP-J3 is located at the proposed private manhole in Basin 10. The flows leave this manhole via a proposed private 30" storm pipe. This design point captures all of the flows from Basins 5 through 10.

Basin 11 is located at the center of the project site. The flows from this basin will flow at approximately 3.0% slope across roofs, asphalt and landscaped areas.

DP-11 is located at the proposed private sump 5' Type R inlet in Basin 11. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 11.

DP-J4 is located at the proposed private manhole in Basin 11. The flows leave this manhole via a proposed private 30" storm pipe. This design point captures all of the flows from Basins 5 through 11.

Basin 12 is located at the west end of the project site. The flows from this basin will flow at approximately 2.5% slope across roofs, asphalt and landscaped areas.

DP-12 is located at the proposed private at-grade 5' Type R inlet in Basin 12. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 12.

Basin 13 is located at the west end of the project site. The flows from this basin will flow at approximately 2.0% slope across roofs, asphalt and landscaped areas.

DP-13 is located at the proposed private sump 5' Type R inlet in Basin 13. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basins 12 and 13.

Basin 14 is located in the center of the project site. The flows from this basin will flow at approximately 2.5% slope across roofs, asphalt and landscaped areas.

DP-14 is located at the proposed private sump 5' Type R inlet in Basin 14. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 14.

Basin 15 is located in the center of the project site. The flows from this basin will flow at approximately 2.0% slope across roofs, asphalt and landscaped areas.

DP-15 is located at the proposed private sump 5' Type R inlet in Basin 15. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basins 14 and 15.

DP-J5 is located at the proposed private manhole in Basin 16. The flows leave this manhole via a proposed private 53"x34" elliptical storm pipe. This design point captures all of the flows from Basins 5 through 15.

Basin 16 is located at the south end of the project site. The flows from this basin will flow at approximately 2.0% slope across roofs, asphalt and landscaped areas.

DP-16 is located at the proposed private sump 5' Type R inlet in Basin 16. The flows leave this inlet via a proposed private 18" storm pipe. This design point captures all of the flows from Basin 16.

DP-J6 is located at the proposed private manhole in Basin 16. The flows leave this manhole via a proposed private 53"x349" elliptical storm pipe. This design point captures all of the flows from Basins 5 through 16. This elliptical pipe is necessary for clearances with other utility crossings.

Basin 17 is located at the south end of the project site. The flows from this basin will flow at approximately 1.0% slope across roofs, asphalt and landscaped areas.

DP-17 is located at the proposed private Type D area inlet in Basin 17. The flows leave this inlet via a proposed private 36" storm pipe. This design point captures all of the flows from Basins 5 through 17.

Basin 18 is located at the south end of the project site. The flows from this basin will flow at approximately 1.0% slope across roofs, asphalt and landscaped areas.

DP-18 is located at the crosspan into the south EDB in Basin 20. This design point captures all of the flows from Basin 18.

Basin 19 is located at the east end of the project site. The flows from this basin will flow at approximately 2.5% slope across roofs, asphalt and landscaped areas.

DP-19 is located at the crosspan into the south EDB in Basin 20. This design point captures all of the flows from Basin 19.

DP-J7 is located at the crosspan into the south EDB in Basin 20. This design point captures the total flows from Basins 18 and 19.

Basin 20 is located at the south end of the project site. The flows from this basin will flow at approximately 10.0% slope across pasture/meadow.

DP-20 is located at the bottom of the proposed private Extended Detention Basin in Basin 20. This EDB captures all of the flows from Basins 5 through 20. This pond has been sized using UD-Detention spreadsheet, which can be found in the Appendix. This EDB will have a private outlet structure that will release the WQCV volume in 40 hours and the EURV volume in 72 hours into the drainage channel to the west of the pond. This channel joins Sand Creek to the south.

DP-SP represents the flows being released from the outlet structure in the south pond.

DP-OS1-4 is located at the north end of the site where the offsite flows are picked up by the proposed private storm pipe that will bypass the flows through the site and discharge into the drainage channel. This design point represents the flows from offsite basins OS1 through OS4. The flows for Basin OS-1 were found in the report "Amendment to Woodmen Heights Business Park MDDP and Final Report for the Pines at Forest Meadows Filing Nos. 1, 2, 3, 4, 5 & 6" by M&S Civil Consultants, Inc., March 2017. The flows for Basins OS-2 through OS-4 were calculated using the Rational Method.

Basin 21 is located at the west end of the project site. The flows from this basin will flow at approximately 4.0% slope across pasture/meadow.

DP-21 is located at the proposed private Type D area inlet in Basin 21. The flows leave this inlet via a proposed private 36" storm pipe. This design point captures all of the flows from Basins OS1-4 and 21.

Basin 22 is located at the west end of the project site. The flows from this basin will flow at approximately 2.0% slope across pasture/meadow.

DP-22 is located at the proposed private Type D area inlet in Basin 22. The flows leave this inlet via a proposed private 36" storm pipe. This design point captures all of the flows from Basins OS1-4, 21 and 22.

DP-J8 is located at the proposed private manhole in Basin 23. The flows leave this manhole via a proposed private 36" storm pipe. This design point captures all of the flows from Basins OS1-4, 21, 22 and the west pond outlet structure release.

Basin 23 is includes half of the south end of the site. The flows from this basin will flow at approximately 3.5% slope across pasture/meadow eventually into the drainage ways, leaving the site to the south.

DP-23 represents the flows leaving the majority of the proposed site at below historical levels via an existing drainage channel which joins the main stem of Sand Creek further to the south. It includes the flows from offsite properties to the north of Woodmen Road, discharges from the two proposed on-site ponds as well as the flows from undeveloped Basin 23. There is an existing private 30" CMP culvert with headwall offsite to the south that goes under a private driveway for the property at 7595 California Drive. DP-23 shows Q_5=23.8 cfs and Q_{100}=91.3 cfs leaving the site. The culvert has a capacity of 38 cfs to the shoulder of road elevation (See Appendix for Chart) and therefore meets the requirement of handling the 5-year (minor) developed flows.

In addition to meeting the minor storm capacity requirements, this driveway culvert was installed prior to the development of the Forest Meadows/Woodmen Heights development to the north of this project site. The drainage channel that reaches this driveway crossing used to run far to the north of Woodmen Road and collect a much larger tributary area as noted by the culverts crossing Woodmen Road and discharging into the noted channel. When Woodmen Road was improved to 4 lanes, the County installed culverts consisting of a 30" RCP and a 54" RCP that discharge into the existing channel and eventually flow to the noted driveway culvert. Since the construction of the current 4 lane Woodmen Road, most of the runoff from Forest Meadows/Woodmen Heights to the north has now been re-directed to detention ponds north of Woodmen Road and the only flows entering our site from north of Woodmen Road now come from the small pond at the east end of the Pines at Forest Meadows development with a release rate of only Q_{100}=22 cfs. This combined with the Cottages at Woodmen Heights releasing at or below historical flow levels means any flows reaching the indicated downstream driveway culvert will see reduced flows from historic conditions.

Basin 24 is undeveloped and is located at the east end of the site and half of the south end of the site adjacent to the main stem of Sand Creek. The flows from this basin will flow at approximately 2.5% slope across pasture/meadow eventually into Sand Creek, leaving the site to the south. As part of this project a proposed grade control structure and a proposed drop structure are being constructed in Sand Creek. The approved full Channel Design Report (STM-REV21-1560) and the Variance Letter (STM-REV21-0760) will be added to the appendix once approved.

DP-24 is located at the southeast corner of the site where Sand Creek exits the site. This design point represents all of the flows from Basin 24.

The only requested variance for this project is for the Sand Creek Drainage channel improvements (STM-REV21-0760).

7.0 PROPOSED DETENTION FACILITIES

The proposed west on-site detention is a proposed full-spectrum Extended Detention System located at the west end of the project site. The basins contributing to the storm runoff volume are Basins 1 through 4 for a total area of 3.66 acres at 45.4% imperviousness. The required volume when using the watershed area for 100-yr detention is 0.304 acre-feet. It will capture then release the flows at a reduced flow rate into a proposed 18" private pipe, which discharges to the east into a drainage channel which then flows into Sand Creek. 24" thick Type M riprap will be placed at the outfall, which is more than required. A weir plate and an orifice plate restricts the flows to release the WQCV over a 40-hour period. In the case of a large storm event, the emergency overflow routing for the pond would be over the spillway on the east side of the pond and then into the drainage channel which carry the flows to the south.

The proposed south on-site detention is a proposed full-spectrum Extended Detention System located at the south end of the project site. The basins contributing to the storm runoff volume are Basins 5 through 20 for a total area of 22.08 acres at 63.9% imperviousness. The required volume when using the watershed area for 100-yr detention is 2.607 acre-feet. It will capture then release the flows at a reduced flow rate into a proposed 18" private pipe, which discharges to the west into a drainage channel which then flows into Sand Creek. 24" thick Type M riprap will be placed at the outfall. A weir plate and an orifice plate restricts the flows to release the WQCV over a 40-hour period. In the case of a large storm event, the emergency overflow routing for the pond would be over the spillway on the west side of the pond and then into the drainage channel which carry the flows to the south. Basins 5, 6, 12 & 19 extend to the north beyond the property boundary. These areas are being developed as part of this project and are included in the Rational Method calculations included in the Appendix.

Sizing calculations are provided in the appendix for the on-site extended detention basins. All calculations meet the criteria from the City of Colorado Springs Drainage Criteria Manual Vol. 2.

The flows from Basins 21 through 24 will not be captured and treated. Basins 21 & 22 will be graded, but will be reseeded and no impervious area will be added. Basins 23 & 24 will remain primarily undeveloped with native vegetation left in place and also no impervious area will be added. The flows from these basins will not change from existing conditions.

Private maintenance agreements and O&M manuals will be established for the two detention systems as required by the City. Both EDB's will be privately owned and maintained by the Cottages at Woodmen Heights Homeowners Association.

8.0 FOUR-STEP PROCESS

This project conforms to the City of Colorado Springs/El Paso County Four Step Process. The process focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage ways, and implementing long-term source controls.

1. ***Employ Runoff Reduction Practices:*** Proposed impervious areas on this site (roofs, asphalt/sidewalk) will sheet flow across landscaped ground as much as possible to slow runoff and increase time of concentration prior to being conveyed to the proposed public streets and storm sewer system. This will minimize directly connected impervious areas within the project site.

2. ***Implement BMP's that provide a Water Quality Capture Volume with slow release:*** Runoff from this project will be treated through capture and slow release of the WQCV in two permanent Extended Detention Basin facilities designed per current City of Colorado Springs/El Paso County drainage criteria.

3. ***Stabilize Drainage Ways:*** Flows from the EDB's are released into the drainage ways that eventually feed into Sand Creek. The release rates are below historical rates. An analysis of the channel has been completed and it has been found that a grade control structure and a drop structure will be required to improve the channel. All new and re-development projects are required to construct or participate in the funding of channel stabilization measures. Drainage basin fees paid, at the time of platting, go towards channel stabilization within the drainage basin.

4. ***Implement Site Specific and Other Source Control BMP's:*** A site specific storm water quality and erosion control plan and narrative will be submitted and approved by El Paso County Engineering prior to any disturbance within the project area. Details such as site specific source control construction BMP's as well as permanent BMP's will be detailed in this plan and narrative to protect receiving waters.

9.0 DRAINAGE AND BRIDGE FEES

Cottages at Woodmen Heights is located within the Sand Creek Drainage Basin. Drainage fees will be due at plat recordation. 2022 Drainage, Bridge and Pond fees are estimated as follows:

Filing 1: Drainage fee/acre	$20,160	x 27.27 ac =	$549,763.20
Filing 2: Drainage fee/acre	$20,160	x 12.17 ac =	$245,347.20
Overall: Drainage fee/acre	$20,160	x 38.44 ac =	$774,950.40

10.0 CONSTRUCTION COST ESTIMATE

Private (Non-Reimbursable)

Description	Quantity		Unit Cost		Cost
Type C Area Inlet	3	EA	$4,800	/EA	$14,400
Type D Area Inlet	2	EA	$5,930	/EA	$11,860
5' Type R Inlet	12	EA	$5,700	/EA	$68,400
Type II Manhole	9	EA	$5,000	/EA	$45,000
18" RCP storm	1911	LF	$67	/LF	$128,037
24" RCP storm	238	LF	$81	/LF	$19,278
30" RCP storm	382	LF	$200	/LF	$76,400
36" RCP storm	1152	LF	$124	/LF	$142,848
45"x29" ellip. Stm	283	LF	$186	/LF	$52,638
18" FES	1	EA	$402	/EA	$402
36" FES	1	EA	$744	/EA	$744
West EDB	1	EA	$35,000	/EA	$35,000
South EDB	1	EA	$75,000	/EA	$75,000
				Subtotal	$670,007
				Contingency (10%)	$67,001
				TOTAL	$737,008

Public (Non-Reimbursable)

Description	Quantity		Unit Cost		Cost
Type C Area Inlet	1	EA	$4,800	/EA	$4,800
10' Type R Inlet	1	EA	$7,894	/EA	$7,894
Type I Manhole	1	EA	$7,000	/EA	$7,000
Type II Manhole	1	EA	$5,000	/EA	$5,000
24" RCP storm	103	LF	$81	/LF	$8,311
30" RCP storm	293	LF	$200	/LF	$58,640
36" RCP storm	22	LF	$124	/LF	$2,778
				Subtotal	$94,422
				Contingency (10%)	$9,442
				TOTAL	$103,864

Sand Creek Drop Structure & Grade Control per DBPS

Public (Reimbursable)

Description	Quantity		Unit Cost		Cost
Clearing And Grubbing	1	LS	$10,000	/EA	$10,000
Removal Of Fence	84	LF	$30	/LF	$2,520
Unclassified Excavation With Offsite Disposal	750	CY	$150	/CY	$112,500
Unclassified Excavation (Complete In Place)	300	CY	$100	/CY	$30,000
Potholing	8	HR	$500	/HR	$4,000
8" Type II Granular Bedding	78	CY	$100	/CY	$7,800
Topsoil	62	CY	$100	/CY	$6,200
Stockpile Wetland Topsoil	40	CY	$150	/CY	$6,000
Sediment Control Log (9 Inch)	350	LF	$20	/LF	$7,000
Concrete Washout Structure	1	EA	$3,500	/EA	$3,500
Water Control	1	LS	$40,000	/LS	$40,000
Seeding (Native Uplands Seed Mix)	0.11	ACRE	$7,000	/ACRE	$770
Mulching (Hydraulic)	0.11	ACRE	$7,000	/ACRE	$770
Soil Retention Blanket (Coconut)	208	SY	$10	/SY	$2,080
Grouted Boulders (B24)	153	CY	$500	/CY	$76,500
Soil Riprap (Vh, D50=12")	232	CY	$300	/CY	$69,600
Cutoff Wall (Concrete/Grout In Trench)	60	CY	$1,500	/CY	$90,000
Sanitation Facility	1	EA	$3,500	/EA	$3,500
Mobilization	1	LS	$50,000	/LS	$50,000
				Subtotal	$522,740
				Cntgency (10%)	$52,274
				TOTAL	$575,014

11.0 SUMMARY

The Cottages at Woodmen Heights project has been designed in accordance with the City of Colorado Springs criteria. The Extended Detention Basins have been designed to limit the release of storm runoff and is now less than the existing conditions. This development will not negatively impact the downstream and surrounding developments.

12.0 REFERENCES

The sources of information used in the development of this study are listed below:

1. City of Colorado Springs Drainage Criteria Manual Volumes 1 & 2, 2014, revised January 2021.

2. Urban Storm Drainage Criteria Manuals, Urban Drainage and Flood Control District. June 2001, Revised October 2019.

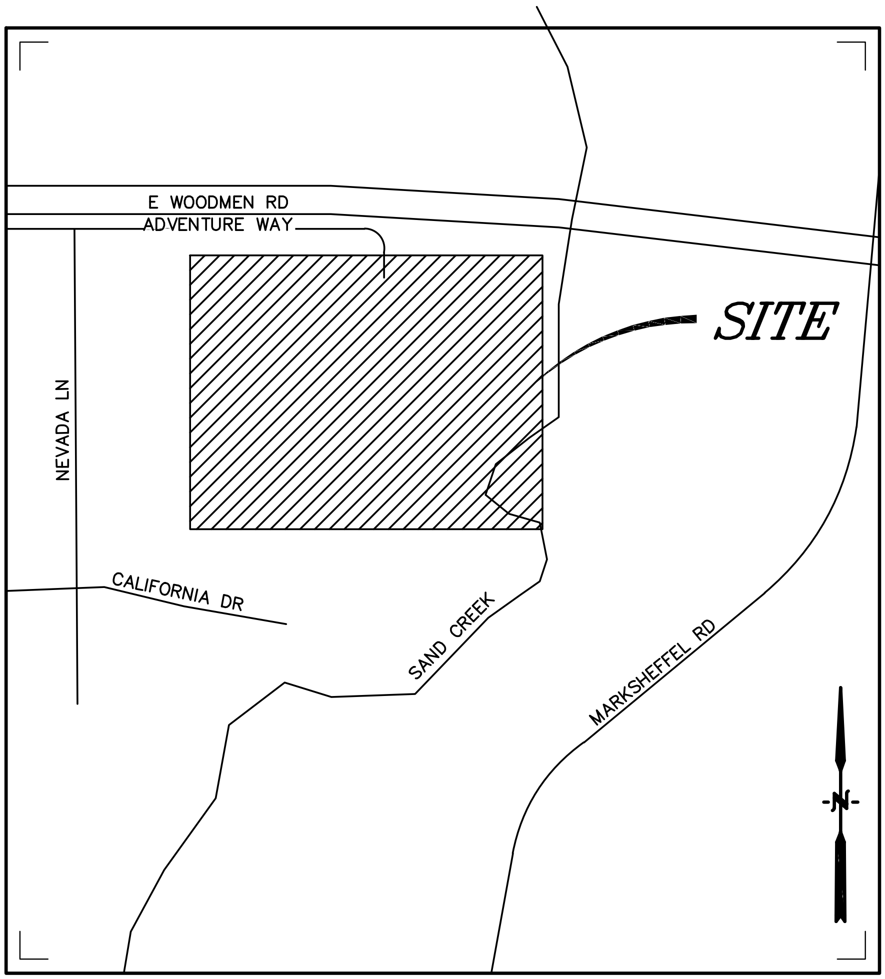
3. Amendment to Woodmen Heights Business Park MDDP and Final Report for the Pines at Forest Meadows, Filing Nos. 1, 2, 3, 4, 5 & 6, by M&S Civil Consultants, Inc., March 2017.

4. MDDP Drainage Report for Cottages at Woodmen Heights, by Drexel Barrell & Co., July 2020.

5. Natural Resources Conservation Service (NRCS) Web Soil Survey

6. Federal Emergency Management Agency, Flood Insurance Rate Map, El Paso County, Colorado, Effective Date December 7, 2018

APPENDIX

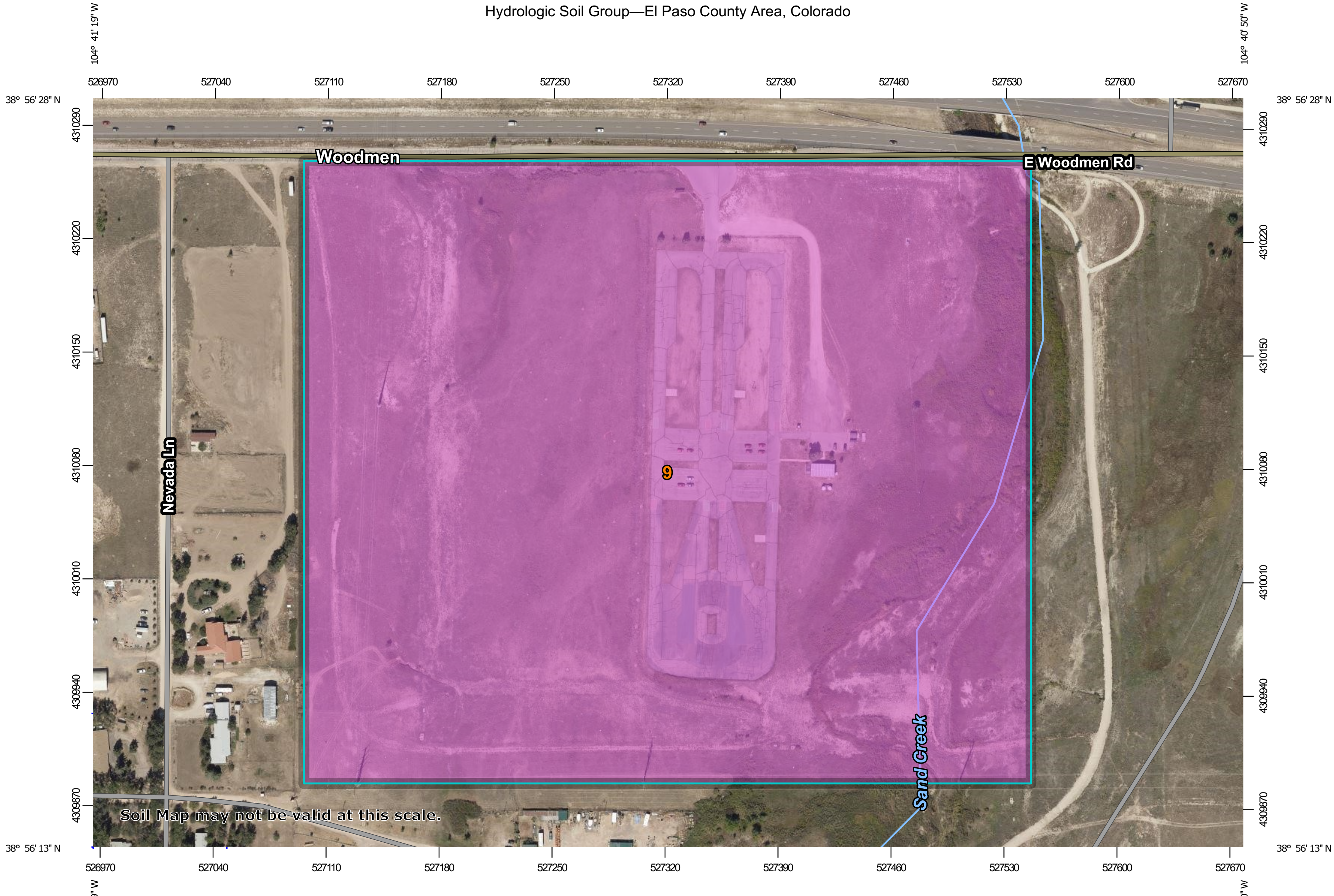


Vicinity Map
Not to scale

COTTAGES AT WOODMEN HEIGHTS
COLORADO SPRINGS, CO
VICINITY MAP

Drexel, Barrell & Co.
Engineers • Surveyors

DATE:	DWG. NO. VMAP
JOB NO: 21369-00CSCV	SHEET 1 OF 1



Map Scale: 1:3,260 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 45, 90, 180, 270

Feet: 0, 150, 300, 600, 900

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

MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
9	Blakeland-Fluvaquentic Haplaquolls	A	43.0	100.0%
Totals for Area of Interest			**43.0**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

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

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

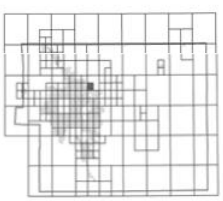
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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

El Paso County Vertical Datum Offset Table

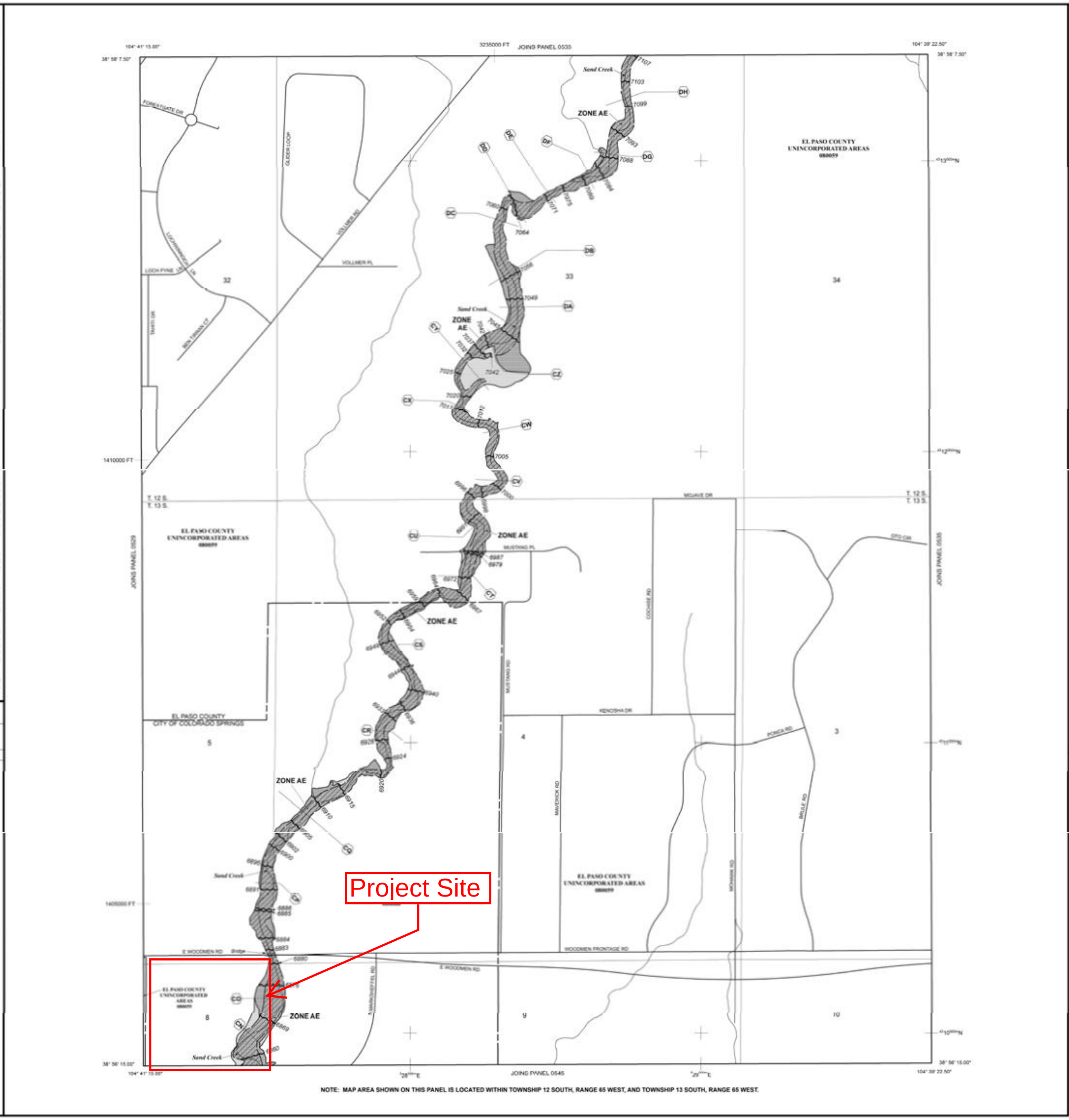
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- **ZONE A** No Base Flood Elevations determined.
- **ZONE AE** Base Flood Elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- **ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE AR** Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- **ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- **ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- **ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

- **ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- **ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D Boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- ~~~ 513 ~~~ Base Flood Elevation line and value; elevation in feet*
- (EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A—A Cross section line
- 23—23 Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
- DX5510 Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0533G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 533 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	[illegible]	[illegible]	G
EL PASO COUNTY	[illegible]	[illegible]	G

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

MAP NUMBER
08041C0533G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

PROJECT INFORMATION

Drexel, Barrell & Co.

PROJECT:	Cottages at Woodmen Heights
PROJECT NO:	21369-00
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	11/17/2021
Soil Type: A	

	C2*	C5*	C10*	C100*	% IMPERV
Pasture/Meadow		0.15		0.50	0
Roofs		0.73		0.81	90
1/8 ac residential		0.49		0.65	65
Asphalt/Sidewalk		0.90		0.96	100

*C-Values and Basin Imperviousness based on Table 6-6, City of Colorado Springs "Drainage Criteria Manual"

EXISTING

SUB-BASIN	SURFACE DESIGNATION	AREA	COMPOSITE RUNOFF COEFFICIENTS				% IMPERV
		ACRE	C2	C5	C10	C100	
OS2	Pasture/Meadow	1.97		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.72		0.90		0.96	100
	WEIGHTED AVERAGE			0.35		0.62	27%
TOTAL OS2		2.69					
OS3	Pasture/Meadow	1.16		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	1.42		0.90		0.96	100
	WEIGHTED AVERAGE			0.56		0.75	55%
TOTAL OS3		2.58					
OS4	Pasture/Meadow	1.64		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	1.54		0.90		0.96	100
	WEIGHTED AVERAGE			0.51		0.72	48%
TOTAL OS4		3.18					
OS5	Pasture/Meadow	0.28		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.34		0.90		0.96	100
	WEIGHTED AVERAGE			0.56		0.75	55%
TOTAL OS5		0.62					
OS6	Pasture/Meadow	0.19		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.13		0.90		0.96	100
	WEIGHTED AVERAGE			0.45		0.69	41%
TOTAL OS6		0.32					

OS7	Pasture/Meadow	0.39		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.23		0.90		0.96	100
	WEIGHTED AVERAGE			0.43		0.67	37%
TOTAL OS7		0.62					
1	Pasture/Meadow	17.52		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.15		0.50	0%
TOTAL 1		17.52					
2	Pasture/Meadow	4.66		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	3.70		0.90		0.96	100
	WEIGHTED AVERAGE			0.48		0.70	44%
TOTAL 2		8.36					
3	Pasture/Meadow	8.33		0.15		0.50	0
	Roofs	0.03		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.09		0.90		0.96	100
	WEIGHTED AVERAGE			0.16		0.51	1%
TOTAL 3		8.45					
4	Pasture/Meadow	1.03		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.15		0.50	0%
TOTAL 4		1.03					
5	Pasture/Meadow	3.19		0.15		0.50	0
	Roofs	0.00		0.73		0.81	90
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.15		0.50	0%
TOTAL 5		3.19					
TOTAL SITE		**48.56**		**0.28**		**0.58**	**16.9%**

PROJECT INFORMATION

PROJECT: Cottages at Woodmen Heights
PROJECT NO: 21369-00
DESIGN BY: SBN
REV. BY: TDM
AGENCY: City of Colorado Springs
REPORT TYPE: Final
DATE: 11/17/2021

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

EXISTING **TIME OF CONCENTRATION STANDARD FORM SF-2**

SUB-BASIN DATA					INITIAL/OVERLAND TIME (t_i)				TRAVEL TIME (t_t)					TIME OF CONC. t_c		FINAL t_c
BASIN	DESIGN PT:	C_5	C_{100}	AREA	LENGTH	HT	SLOPE	t_i	LENGTH	HT	SLOPE	VEL.	t_t	COMP.	MINIMUM	
				Ac	Ft	FT	%	Min	Ft	FT	%	FPS	Min	t_c	t_c	**Min**
OS2	OS2	0.35	0.62	2.69	105	4	3.8	9.2	425	4.5	1.1	3.3	2.2	11.4	5	**11.4**
OS3		0.56	0.75	2.58	35	0.7	2.0	4.7	1290	10	0.8	5.2	4.1	8.8	5	**8.8**
	OS3	0.45	0.69	5.27					85	0.6	0.7	5.7	0.2	11.6	5	**11.6**
OS4		0.51	0.72	3.18	40	0.8	2.0	5.5	1290	10	0.8	5.2	4.1	9.6	5	**9.6**
	OS4	0.48	0.70	8.45					75	0.7	0.9	6.4	0.2	11.8	5	**11.8**
OS5	OS5	0.56	0.75	0.62	120	4	3.3	7.4						7.4	5	**7.4**
OS6	OS6	0.45	0.69	0.32	120	4	3.3	8.8						8.8	5	**8.8**
OS7	OS7	0.43	0.67	0.62	105	8	7.6	6.5						6.5	5	**6.5**
1		0.15	0.50	17.52	300	13	4.3	18.9	1170	23	2.0	4.39	4.4	23.3	5	**23.3**
	1	0.35	0.60	43.39										35.1	5	**35.1**
2		0.48	0.70	8.36	300	7	2.3	15.1	1135	24	2.1	4.50	4.2	19.3	5	**19.3**
	2	0.48	0.70	8.68										28.1	5	**28.1**
3		0.16	0.51	8.45	300	9	3.0	21.1	295	8	2.7	5.10	1.0	22.1	5	**22.1**
	3	0.18	0.52	9.07										28.6	5	**28.6**
4		0.15	0.50	1.03	300	7	2.3	23.2	275	6	2.2	4.60	1.0	24.2	5	**24.2**
5		0.15	0.50	3.19	300	9	3.0	21.3	235	6	2.6	5.00	0.8	22.1	5	**22.1**

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AGENCY: City of Colorado Springs
REPORT TYPE: Final
DATE: 11/17/2021

Drexel, Barrell & Co.

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

EXISTING | **RUNOFF** **5 YR STORM** | **P1=** 1.50

			DIRECT RUNOFF				
BASIN (S)	DESIGN POINT	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C * A	I (IN/HR)	Q (CFS)
OS1	OS1	16.80	0.49				**4.7**
OS2	OS2	2.69	0.35	11.4	0.94	3.90	**3.7**
OS3		2.58	0.56	8.8	1.45	4.30	**6.2**
	OS3	5.27	0.45	11.6	2.40	3.87	**9.3**
OS4		3.18	0.51	9.6	1.63	4.16	**6.8**
	OS4	8.45	0.48	11.8	4.03	3.84	**15.5**
OS5	OS5	0.62	0.56	7.4	0.35	4.56	**1.6**
OS6	OS6	0.32	0.45	8.8	0.15	4.29	**0.6**
OS7	OS7	0.62	0.43	6.5	0.27	4.74	**1.3**
1		17.52	0.15	23.3	2.63	2.78	**7.3**
	1	43.39	0.35	35.1	15.24	2.21	**33.7**
2		8.36	0.48	19.3	4.03	3.07	**12.4**
	2	8.68	0.48	28.1	4.17	2.51	**10.5**
3		8.45	0.16	22.1	1.35	2.86	**3.9**
	3	9.07	0.18	28.6	1.62	2.49	**4.0**
4	4	1.03	0.15	24.2	0.15	2.73	**0.4**
5	5	3.19	0.15	22.1	0.48	2.86	**1.4**

PROJECT INFORMATION

Drexel, Barrell & Co.

PROJECT:	Cottages at Woodmen Heights
PROJECT NO:	21369-00
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	11/17/2021

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

EXISTING **RUNOFF** **100 YR STORM** **P1=** 2.52

			DIRECT RUNOFF				
BASIN (S)	**DESIGN POINT**	**AREA (AC)**	**RUNOFF COEFF**	**t_c (MIN)**	**C * A**	**I (IN/HR)**	**Q (CFS)**
OS1	OS1	16.80	0.65				**22.0**
OS2	OS2	2.69	0.62	11.4	1.68	6.55	**11.0**
OS3		2.58	0.75	8.8	1.94	7.22	**14.0**
	OS3	5.27	0.69	11.6	3.62	6.50	**23.5**
OS4		3.18	0.72	9.6	2.30	6.99	**16.1**
	OS4	8.45	0.70	11.8	5.92	6.45	**38.2**
OS5	OS5	0.62	0.75	7.4	0.47	7.67	**3.6**
OS6	OS6	0.32	0.69	8.8	0.22	7.21	**1.6**
OS7	OS7	0.62	0.67	6.5	0.42	7.96	**3.3**
1		17.52	0.50	23.3	8.76	4.68	**41.0**
	1	43.39	0.60	35.1	26.06	3.71	**96.8**
2		8.36	0.70	19.3	5.88	5.16	**30.3**
	2	8.68	0.70	28.1	6.10	4.22	**25.7**
3		8.45	0.51	22.1	4.28	4.81	**20.6**
	3	9.07	0.52	28.6	4.69	4.18	**19.6**
4	4	1.03	0.50	24.2	0.52	4.58	**2.4**
5	5	3.19	0.50	22.1	1.60	4.81	**7.7**

PROJECT INFORMATION

PROJECT:	Cottages at Woodmen Heights					
PROJECT NO:	21369-00					
DESIGN BY:	SBN					Drexel, Barrell & Co.
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AGENCY:	City of Colorado Springs					
REPORT TYPE:	Final					
DATE:	4/12/2022					
Soil Type: A						

	C2*	C5*	C10*	C100*	% IMPERV
Pasture/Meadow		0.15		0.50	0
1/8 ac residential		0.49		0.65	65
Asphalt/Sidewalk		0.90		0.96	100
Roofs		0.73		0.81	90
Commercial Areas		0.81		0.88	95

*C-Values and Basin Imperviousness based on Table 6-6, City of Colorado Springs "Drainage Criteria Manual"

PROPOSED

SUB-BASIN	SURFACE DESIGNATION	AREA	COMPOSITE RUNOFF COEFFICIENTS				% IMPERV
		ACRE	C2	C5	C10	C100	
1	Pasture/Meadow	0.18		0.15		0.50	0
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.23		0.90		0.96	100
	WEIGHTED AVERAGE			0.57		0.76	56%
TOTAL 1		0.41					
2	Pasture/Meadow	0.76		0.15		0.50	0
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.60		0.90		0.96	100
	WEIGHTED AVERAGE			0.48		0.70	44%
TOTAL 2		1.36					
3	Pasture/Meadow	0.80		0.15		0.50	0
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.84		0.90		0.96	100
	WEIGHTED AVERAGE			0.53		0.74	51%
TOTAL 3		1.64					
4	Pasture/Meadow	0.25		0.15		0.50	0
	1/8 ac residential	0.00		0.49		0.65	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.15		0.50	0%
TOTAL 4		0.25					
5	Pasture/Meadow	0.00		0.15		0.50	0
	Commercial Areas	1.94		0.81		0.88	95
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.81		0.88	95%
TOTAL 5		1.94					
6	Pasture/Meadow	0.00		0.15		0.50	0
	1/8 ac residential	1.15		0.49		0.65	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.49		0.65	65%
TOTAL 6		1.15					
7	Pasture/Meadow	0.00		0.15		0.50	0
	1/8 ac residential	0.43		0.49		0.65	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.49		0.65	65%
TOTAL 7		0.43					

8	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		0.31		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 8			0.31					
9	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		0.84		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 9			0.84					
10	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		0.76		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 10			0.76					
11	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		0.41		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 11			0.41					
12	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		1.59		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 12			1.59					
13	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		1.03		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 13			1.03					
14	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		1.16		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 14			1.16					
15	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		1.46		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 15			1.46					
16	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		1.39		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 16			1.39					
17	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		0.58		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 17			0.58					
18	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		1.61		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 18			1.61					

19	Pasture/Meadow		0.00		0.15		0.50	0
	1/8 ac residential		7.38		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.49		0.65	65%
TOTAL 19			7.38					
20	Pasture/Meadow		1.19		0.15		0.50	0
	1/8 ac residential		0.00		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.15		0.50	0%
TOTAL 20			1.19					
21	Pasture/Meadow		0.87		0.15		0.50	0
	1/8 ac residential		0.00		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.15		0.50	0%
TOTAL 21			0.87					
22	Pasture/Meadow		1.15		0.15		0.50	0
	1/8 ac residential		0.00		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.15		0.50	0%
TOTAL 22			1.15					
23	Pasture/Meadow		3.59		0.15		0.50	0
	1/8 ac residential		0.00		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.15		0.50	0%
TOTAL 23			3.59					
24	Pasture/Meadow		7.58		0.15		0.50	0
	1/8 ac residential		0.00		0.49		0.65	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.15		0.50	0%
TOTAL 24			7.58					
TOTAL DEVELOPED AREA			**40.08**		**0.38**		**0.61**	**41.4%**
WEST POND			**3.66**		**0.49**		**0.71**	**45.6%**
SOUTH POND			**23.23**		**0.50**		**0.66**	**64.2%**

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REPORT TYPE: Final
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Drexel, Barrell & Co.

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

PROPOSED **TIME OF CONCENTRATION STANDARD FORM SF-2**

SUB-BASIN DATA					INITIAL/OVERLAND TIME (t_i)				TRAVEL TIME (t_t)					PIPE TRAVEL TIME (t_p)				TIME OF CONC. t_c		FINAL t_c
BASIN	DESIGN PT:	C_5	C_{100}	AREA	LENGTH	HT	SLOPE	t_i	LENGTH	HT	SLOPE	VEL.	t_t	LENGTH	SLOPE	VEL.	t_t	COMP.	MINIMUM	
				Ac	Ft	FT	%	Min	Ft	FT	%	FPS	Min	Ft	%	FPS	Min	t_c	t_c	**Min**
1	1	0.57	0.76	0.41	75	4	5.3	4.9	90	3	3.3	10.6	0.1					5.0	5	**5.0**
2		0.48	0.70	1.36	100	3	3.0	8.0	430	12	2.8	5.2	1.4					9.4	5	**9.4**
	2	0.50	0.72	1.77										390	9.0	14.5	0.4	9.4	5	**9.4**
3		0.53	0.74	1.64	95	2	2.1	8.0	455	8	1.8	4.2	1.8					9.9	5	**9.9**
	3	0.52	0.73	3.41										455	8.0	13.7	0.6	10.0	5	**10.0**
4		0.15	0.50	0.25	25	2	8.0	4.4	100	4	4.0	6.2	0.3					4.7	5	**5.0**
	4	0.49	0.71	3.66										55	5.0	13.1	0.1	10.0	5	**10.0**
5	5	0.81	0.88	1.94	100	5	5.0	3.2	160	4	2.5	4.9	0.5					3.7	5	**5.0**
6	6	0.49	0.65	1.15	100	7	7.0	6.0	305	9	3.0	10.1	0.5					6.5	5	**6.5**
	J1	0.69	0.79	3.09										20	1.0	4.8	0.1	6.5	5	**6.5**
7	7	0.49	0.65	0.43	100	9	9.0	5.5	115	3	2.6	9.4	0.2					5.7	5	**5.7**
8	8	0.49	0.65	0.31	60	3	5.0	5.2	200	3	1.5	7.2	0.5					5.6	5	**5.6**
9		0.49	0.65	0.84	100	4	4.0	7.2	205	4	2.0	8.3	0.4					7.6	5	**7.6**
	9	0.49	0.65	1.15										240	1.0	4.8	0.8	7.6	5	**7.6**
	J2	0.62	0.75	4.67										75	1.0	4.8	0.3	7.9	5	**7.9**
10	10	0.49	0.65	0.76	100	3	3.0	7.9	240	5	2.1	8.5	0.5					8.4	5	**8.4**
	J3	0.60	0.73	5.43										20	1.0	4.8	0.1	8.4	5	**8.4**
11	11	0.49	0.65	0.41	100	5	5.0	6.7	165	3	1.8	7.8	0.4					7.0	5	**7.0**
	J4	0.60	0.73	5.84										135	1.0	5.85	0.4	8.8	5	**8.8**
12	12	0.49	0.65	1.59	100	1	1.0	11.4	710	19	2.7	9.6	1.2					12.6	5	**12.6**
13		0.49	0.65	1.03	100	2	2.0	9.1	360	6	1.7	4.0	1.5					10.5	5	**10.5**
	13	0.49	0.65	2.62										180	1.0	4.83	0.6	13.3	5	**13.3**
14	14	0.49	0.65	1.16	100	1	1.0	11.4	355	10	2.8	9.8	0.6					12.0	5	**12.0**
15		0.49	0.65	1.46	100	1	1.0	11.4	395	8	2.0	4.4	1.5					12.9	5	**12.9**
	15	0.49	0.65	2.62										190	1.0	4.83	0.7	12.9	5	**12.9**
	J5	0.55	0.69	11.08										40	1.0	4.83	0.1	13.4	5	**13.4**
16	16	0.49	0.65	1.39	100	5	5.0	6.7	305	4	1.3	6.7	0.8					7.4	5	**7.4**
	J6	0.54	0.69	12.47										200	1.0	6.79	0.5	13.9	5	**13.9**
17		0.49	0.65	0.58	100	1	1.0	11.4	410	5	1.2	6.4	1.1					12.5	5	**12.5**
	17	0.54	0.68	13.05										85	3.0	11.76	0.1	14.0	5	**14.0**
18	18	0.49	0.65	1.61	100	1	1.0	11.4	380	4	1.1	6.1	1.0					12.4	5	**12.4**
19	19	0.49	0.65	7.38	100	7	7.0	6.0	1105	21	1.9	8.1	2.3					8.2	5	**8.2**
	J7	0.49	0.65	8.99														12.4	5	**12.4**
20		0.15	0.50	1.19	70	7	10.0	6.9										6.9	5	**6.9**
	20	0.50	0.66	23.23	25	5	20.0	2.1						25	20.0	30.36	0.0	14.0	5	**14.0**
21	21	0.15	0.50	0.87	80	6	7.5	8.1	275	8	2.9	5.3	0.9					9.0	5	**9.0**
22		0.15	0.50	1.15	80	2	2.5	11.7	450	9	2.0	4.4	1.7					13.4	5	**13.4**
	22	0.15	0.50	2.02														13.4	5	**13.4**
23		0.15	0.50	3.59	100	4	4.0	11.2	310	10	3.2	5.6	0.9					12.1	5	**12.1**
24	24	0.15	0.50	7.58	100	8	8.0	8.9	1565	37	2.4	4.81	5.4					14.3	5	**14.3**

PROJECT INFORMATION

Drexel, Barrell & Co.

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PROJECT NO:	21369-00
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	4/26/2022

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

PROPOSED — RUNOFF 5 YR STORM — P1= 1.50

			DIRECT RUNOFF				
BASIN (S)	DESIGN POINT	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C * A	I (IN/HR)	Q (CFS)
1	1	0.41	0.57	5.0	0.23	5.09	**1.2**
2		1.36	0.48	9.4	0.65	4.20	**2.7**
	2	1.77	0.50	9.4	0.89	4.20	**3.7**
3		1.64	0.53	9.9	0.88	4.12	**3.6**
	3	3.41	0.52	10.0	1.76	4.11	**7.2**
4		0.25	0.15	5.0	0.04	5.10	**0.2**
	4	3.66	0.49	10.0	1.80	4.10	**7.4**
West Pond Release							**0.05**
5	5	1.94	0.81	5.0	1.57	5.10	**8.0**
6	6	1.15	0.49	6.5	0.56	4.76	**2.7**
	J1	3.09	0.69	6.5	2.13	4.74	**10.1**
7	7	0.43	0.49	5.7	0.21	4.93	**1.0**
8	8	0.31	0.49	5.6	0.15	4.95	**0.8**
9		0.84	0.49	7.6	0.41	4.52	**1.9**
	9	1.15	0.49	7.6	0.56	4.52	**2.5**
	J2	4.67	0.62	7.9	2.91	4.47	**13.0**
10	10	0.76	0.49	8.4	0.37	4.37	**1.6**
	J3	5.43	0.60	8.4	3.28	4.36	**14.3**
11	11	0.41	0.49	7.0	0.20	4.64	**0.9**
	J4	5.84	0.60	8.8	3.48	4.29	**15.0**
12	12	1.59	0.49	12.6	0.78	3.73	**2.9**
13		1.03	0.49	10.5	0.50	4.02	**2.0**
	13	2.62	0.49	13.3	1.28	3.66	**4.7**
14	14	1.16	0.49	12.0	0.57	3.81	**2.2**
15		1.46	0.49	12.9	0.72	3.70	**2.6**
	15	2.62	0.49	12.9	1.28	3.70	**4.8**
	J5	11.08	0.55	13.4	6.05	3.64	**22.0**
16	16	1.39	0.49	7.4	0.68	4.55	**3.1**
	J6	12.47	0.54	13.9	6.73	3.58	**24.1**
17		0.58	0.49	12.5	0.28	3.75	**1.1**
	17	13.05	0.54	14.0	7.02	3.57	**25.0**
18	18	1.61	0.49	12.4	0.79	3.76	**3.0**
19	19	7.38	0.49	8.2	3.62	4.40	**15.9**
	J7	8.99	0.49	12.4	4.41	3.76	**16.6**
20		1.19	0.15	6.9	0.18	4.66	**0.8**
	20	23.23	0.50	14.0	11.60	3.57	**41.4**
South Pond Release	SP						**0.6**
	OS1-4	25.25					**20.2**
21		0.87	0.15	9.0	0.13	4.27	**0.6**

	21	26.12					**20.8**
22		1.15	0.15	13.4	0.17	3.64	**0.6**
	22	27.27					**21.4**
	J8	30.93					**21.4**
23		3.59	0.15	12.1	0.54	3.80	**2.0**
	23	57.75					**24.1**
24	24	7.58	0.15	14.3	1.14	3.54	**4.0**

PROJECT INFORMATION

PROJECT:	Cottages at Woodmen Heights
PROJECT NO:	21369-00
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	4/26/2022

Drexel, Barrell & Co.

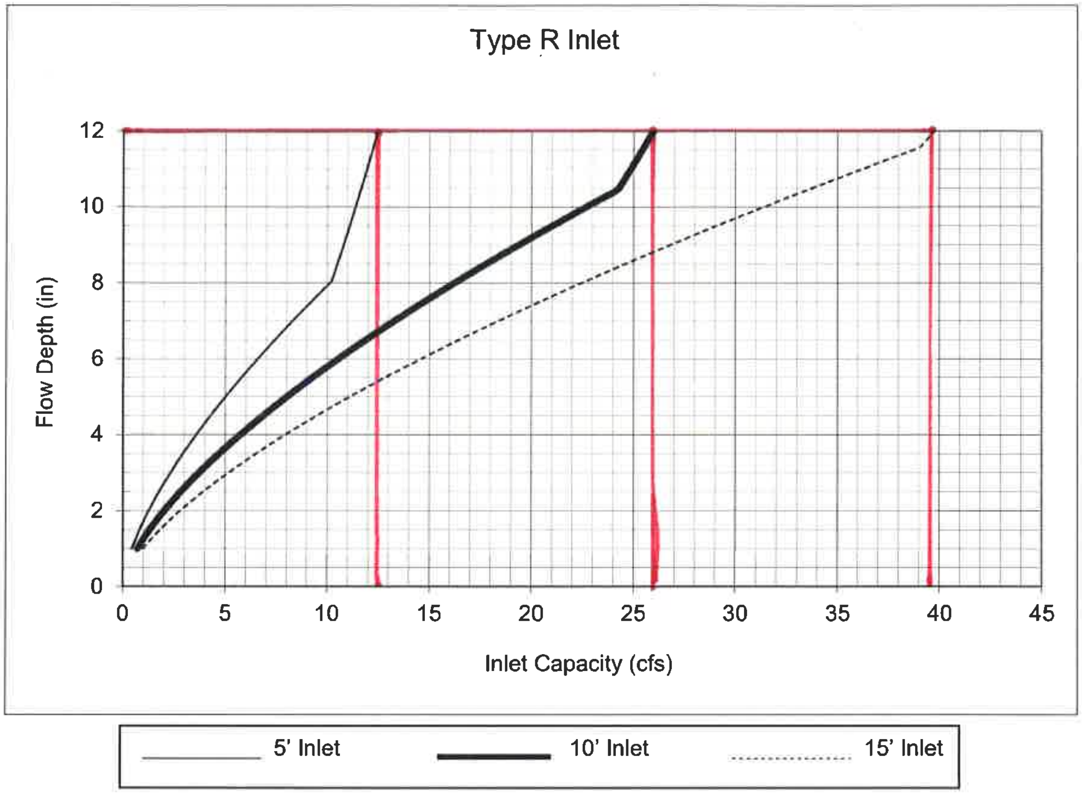
RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

PROPOSED **RUNOFF** **100 YR STORM** **P1=** **2.52**

			DIRECT RUNOFF					PIPE SIZING		
BASIN (S)	**DESIGN POINT**	**AREA (AC)**	**RUNOFF COEFF**	**t_c (MIN)**	**C * A**	**I (IN/HR)**	**Q (CFS)**	**n**	**Slope (ft/ft)**	**Pipe Diameter (in)**
1	1	0.41	0.76	5.0	0.31	8.56	**2.7**	0.012	0.09	7
2		1.36	0.70	9.4	0.96	7.05	**6.7**			
	2	1.77	0.72	9.4	1.27	7.05	**8.9**	0.012	0.08	11
3		1.64	0.74	9.9	1.21	6.93	**8.4**			16
	3	3.41	0.73	10.0	2.47	6.90	**17.1**	0.012	0.05	
4		0.25	0.50	5.0	0.13	8.58	**1.1**			
	4	3.66	0.71	10.0	2.60	6.88	**17.9**	0.012	0.01	18
West Pond Release							**2.5**			
5	5	1.94	0.88	5.0	1.71	8.58	**14.6**	0.012	0.01	20
6	6	1.15	0.65	6.5	0.75	7.99	**6.0**	0.012	0.01	14
	J1	3.09	0.79	6.5	2.45	7.96	**19.5**	0.012	0.01	22
7	7	0.43	0.65	5.7	0.28	8.29	**2.3**	0.012	0.01	10
8	8	0.31	0.65	5.6	0.20	8.31	**1.7**	0.012	0.01	9
9		0.84	0.65	7.6	0.55	7.60	**4.1**			
	9	1.15	0.65	7.6	0.75	7.60	**5.7**	0.012	0.01	14
	J2	4.67	0.75	7.9	3.48	7.51	**26.2**	0.012	0.01	25
10	10	0.76	0.65	8.4	0.49	7.35	**3.6**	0.012	0.01	12
	J3	5.43	0.73	8.4	3.98	7.33	**29.1**	0.012	0.01	26
11	11	0.41	0.65	7.0	0.27	7.79	**2.1**	0.012	0.01	10
	J4	5.84	0.73	8.8	4.24	7.21	**30.6**	0.012	0.01	26
12	12	1.59	0.65	12.6	1.03	6.27	**6.5**	0.012	0.01	15
13		1.03	0.65	10.5	0.67	6.75	**4.5**			
	13	2.62	0.65	13.3	1.70	6.14	**10.5**	0.012	0.01	17
14	14	1.16	0.65	12.0	0.75	6.41	**4.8**	0.012	0.01	13
15		1.46	0.65	12.9	0.95	6.22	**5.9**			
	15	2.62	0.65	12.9	1.70	6.22	**10.6**	0.012	0.01	18
	J5	11.08	0.69	13.4	7.65	6.12	**46.8**	0.012	0.01	31
16	16	1.39	0.65	7.4	0.90	7.65	**6.9**	0.012	0.01	15
	J6	12.47	0.69	13.9	8.55	6.02	**51.5**	0.012	0.01	32
17		0.58	0.65	12.5	0.38	6.31	**2.4**			
	17	13.05	0.68	14.0	8.93	6.00	**53.6**	0.012	0.2	28
18	18	1.61	0.65	12.4	1.05	6.31	**6.6**			
19	19	7.38	0.65	8.2	4.80	7.39	**35.4**			
	J7	8.99	0.65	12.4	5.84	6.31	**36.9**			
20		1.19	0.50	6.9	0.60	7.83	**4.7**			
	20	23.23	0.66	14.0	15.37	6.00	**92.1**	0.012	0.03	18
South Pond Release	SP						**16.9**			
	OS1-4	25.25					**60.2**	0.012		30
21		0.87	0.50	9.0	0.44	7.17	**3.1**			

	21	26.12					**63.3**	0.012	0.02	30
22		1.15	0.50	13.4	0.58	6.11	**3.5**			
	22	27.27					**66.8**	0.012	0.02	31
	J8	30.93					**69.3**	0.012	0.06	25
23		3.59	0.50	12.1	1.80	6.38	**11.5**			
	23	57.75					**97.7**			
24	24	7.58	0.50	14.3	3.79	5.94	**22.5**			

Figure 8-11. Inlet Capacity Chart Sump Conditions , Curb Opening (Type R) Inlet



DP-1: Q100 = 2.7 cfs → 5' inlet
DP-5: Q100 = 14.6 cfs → 10' inlet
DP-6: Q100 = 6.0 cfs → 5' inlet
DP-7: Q100 = 2.3 cfs → 5' inlet
DP-8: Q100 = 1.7 cfs → 5' inlet
DP-9: Q100 = 4.1 cfs → 5' inlet
DP-10: Q100 = 3.6 cfs → 5' inlet
DP-11: Q100 = 2.1 cfs → 5' inlet
DP-13: Q100 = 4.5 cfs → 5' inlet
DP-14: Q100 = 4.8 cfs → 5' inlet

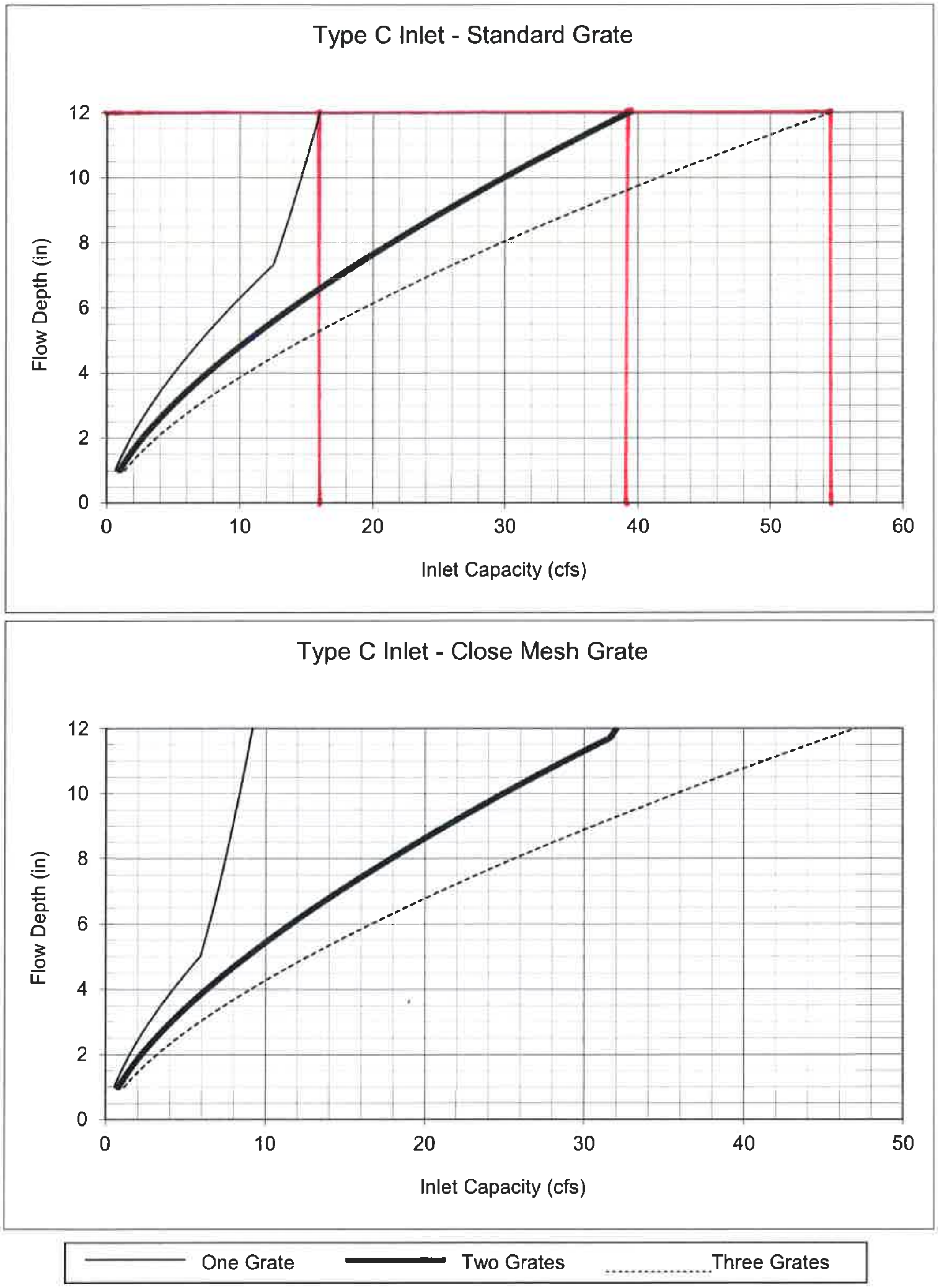
Notes:

1. The standard inlet parameters must apply to use this chart.

DP-15: Q100 = 5.9 cfs → 5' inlet
DP-16: Q100 = 6.9 cfs → 5' inlet

Figure 8-10. Inlet Capacity Chart Sump Conditions, Area (Type C) Inlet

OP-2: Q100 = 6.7 cfs → single
OP-3: Q100 = 8.4 cfs → single
OP-17: Q100 = 2.4 cfs → single

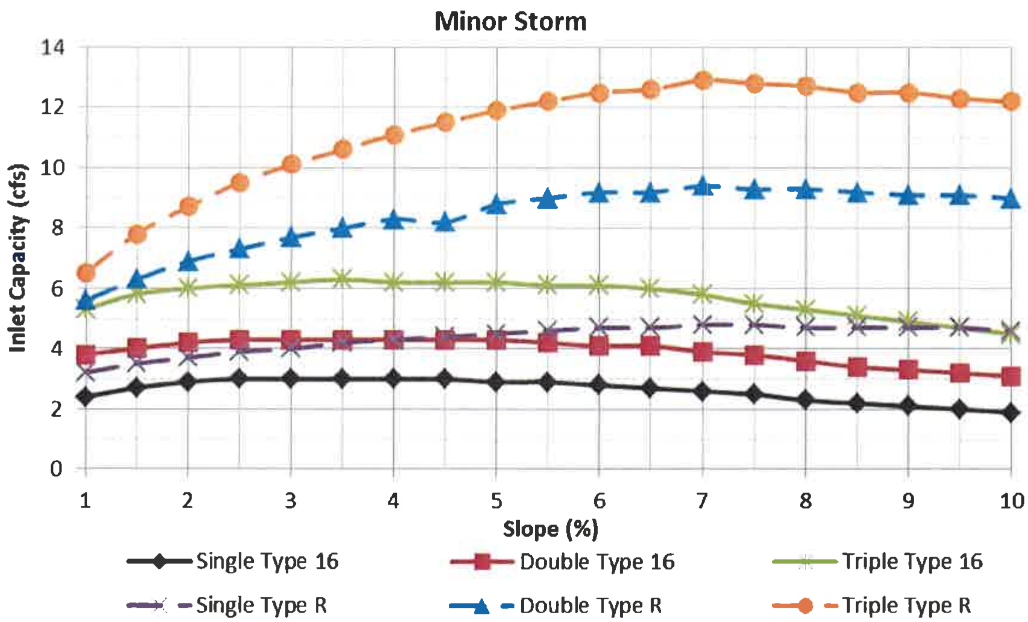


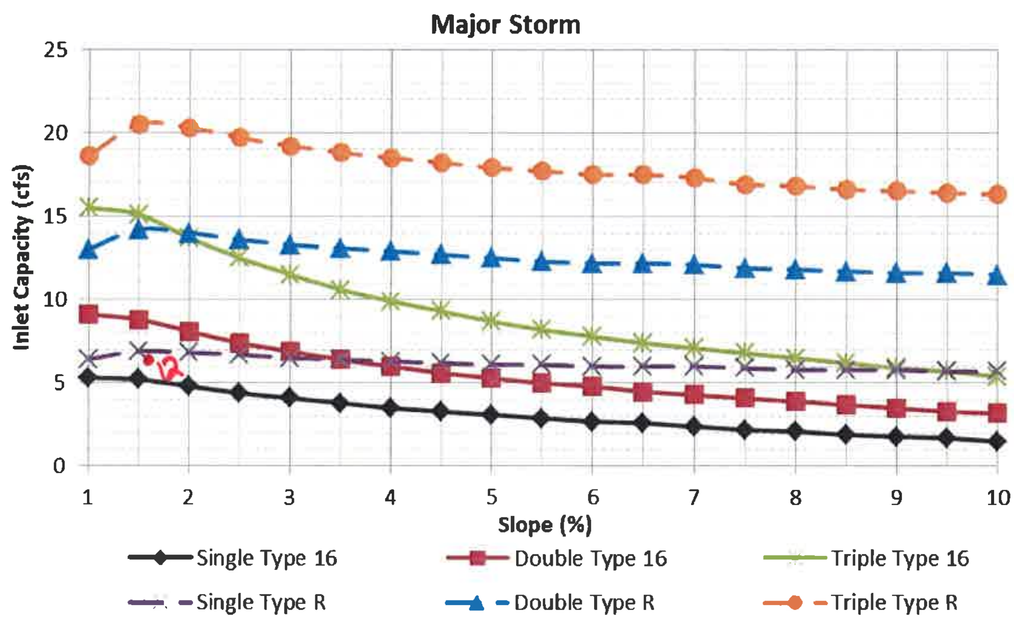
Notes:
1. The standard inlet parameters must apply to use these charts.

Figure 8-9. Inlet Capacity Chart Continuous Grade Conditions, Minor Residential (Local)
(Attached Sidewalk)

Street Section Data: Street Width Flowline to Flowline = 28'
Type of Curb and Gutter = 6" vertical

OP-12 : Q100 = 6.5 cfs → Single Type R



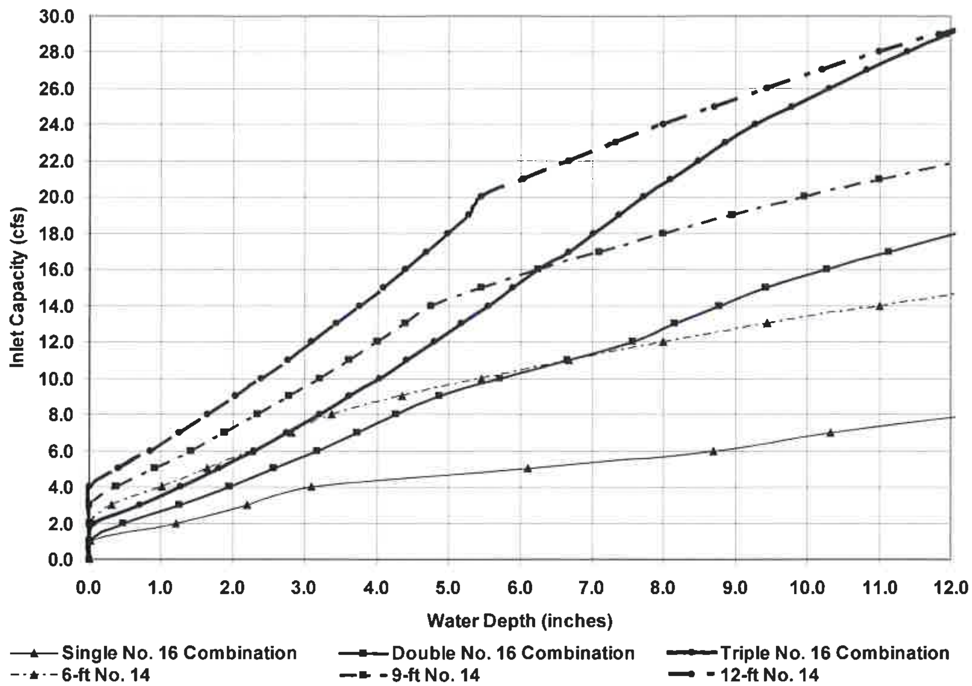


The standard street section parameters as defined in Chapter 7 must apply to use these charts. For non-standard sections, the inlet capacity shall be calculated using the UDFCD spreadsheets. The maximum spread width is limited by the curb height based on no curb overtopping during a minor storm and flow being contained within the public right-of-way during the major storm. Calculations were done using UD-Inlet 3.00.xls, Mar., 2011 with the default clogging factors.

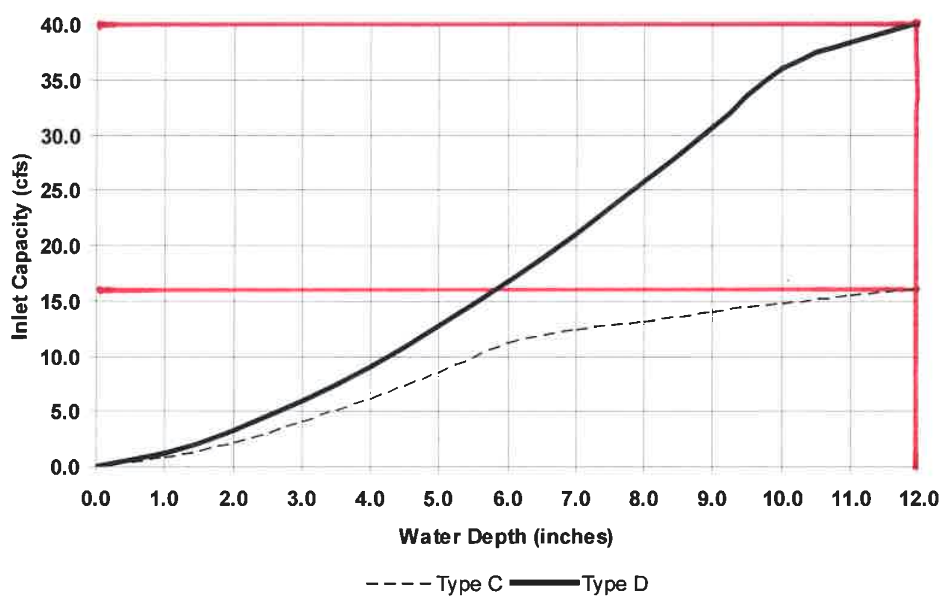
Figure 8.1. Allowable Inlet Capacity— Sump Conditions

Note: See Section 8.3.2 for assumptions.

Type 16 and Type 14 Inlets for Sump Conditions

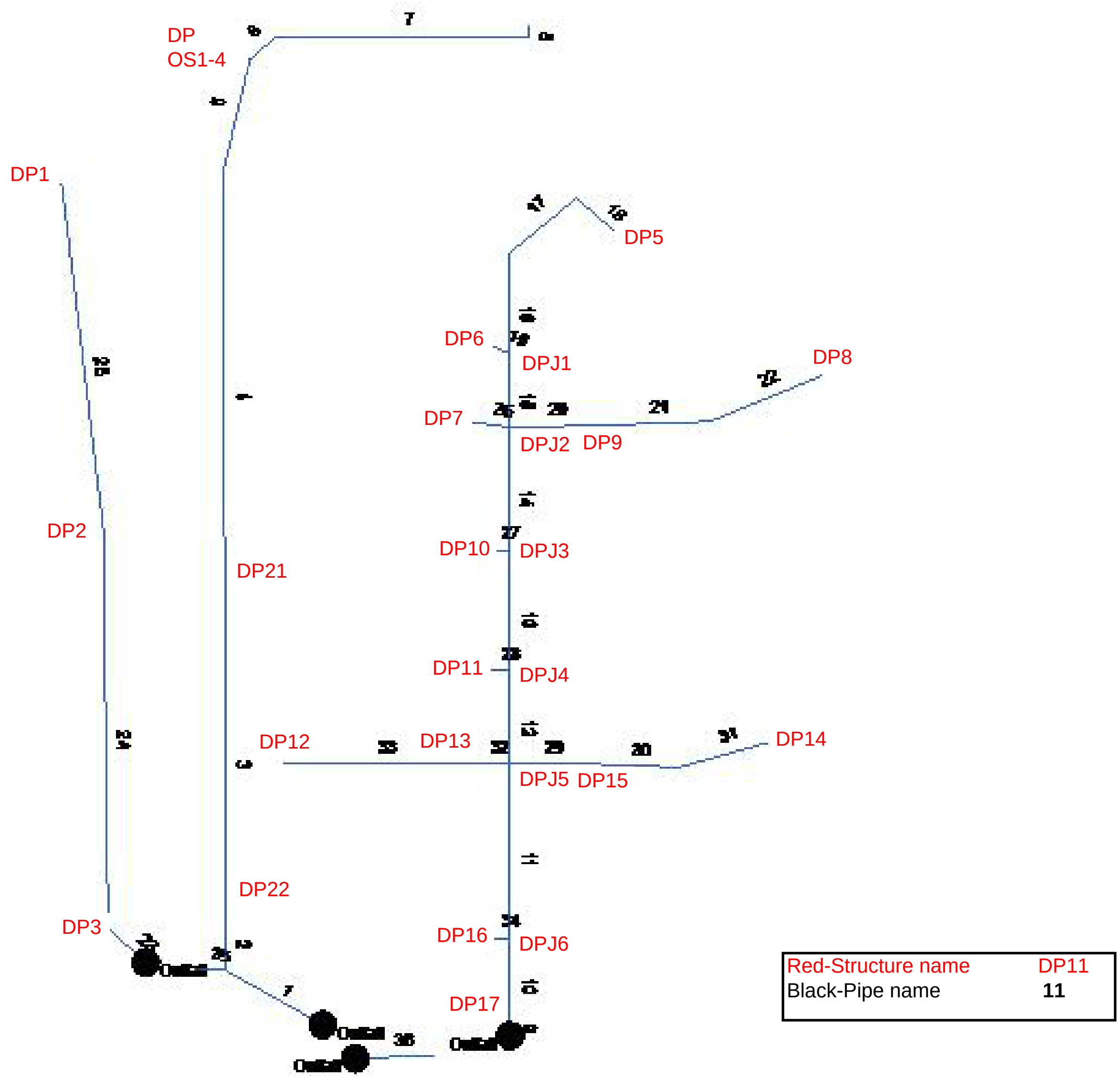


Allowable Inlet Capacity for Type C and D Inlets for Sump Conditions



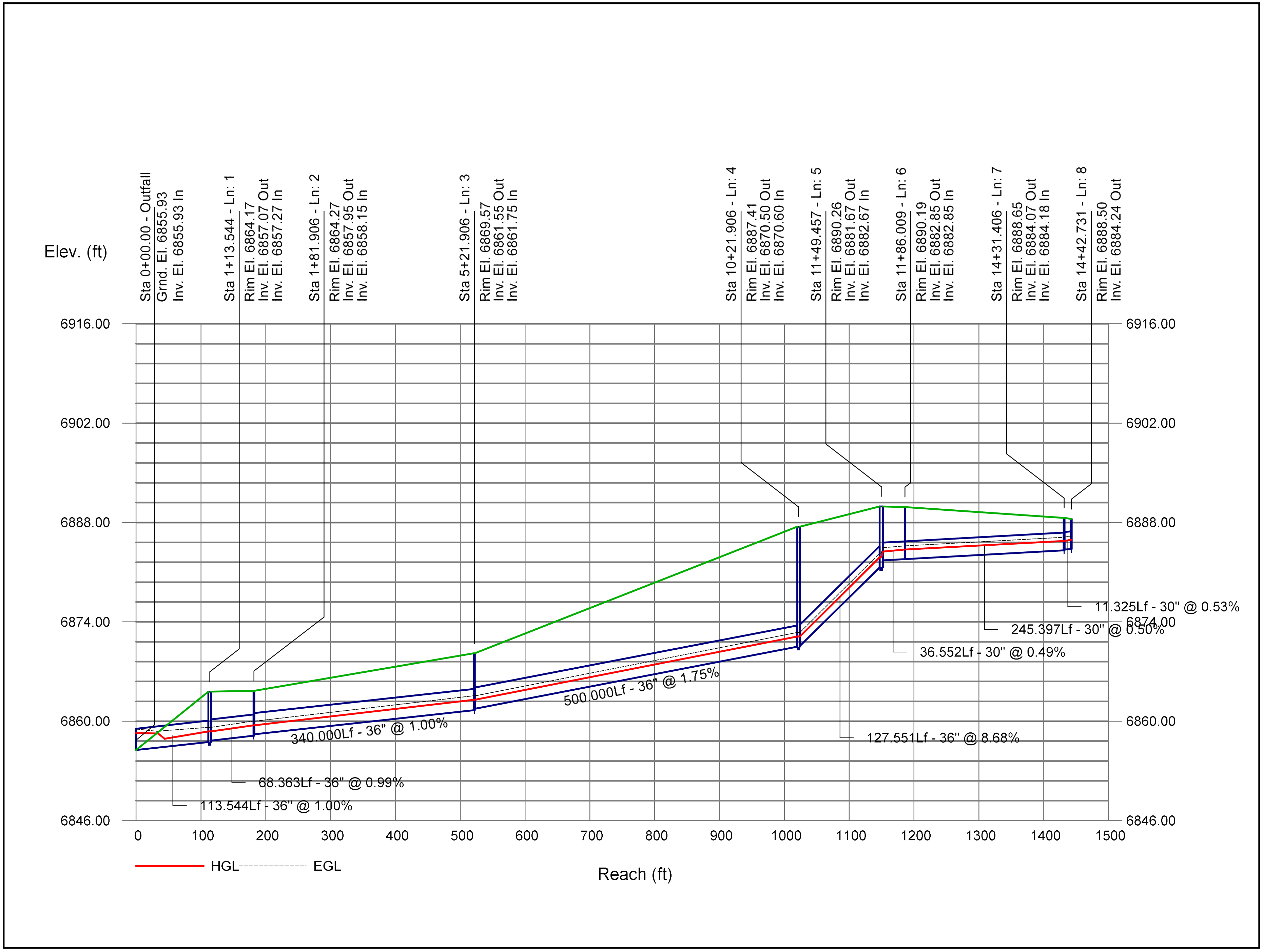
DP-21: Q100 = 3.1 cfs → Type D
DP-22: Q100 = 3.5 cfs → Type D

Hydraflow Storm Sewers Extension for Autodesk Civil 3D



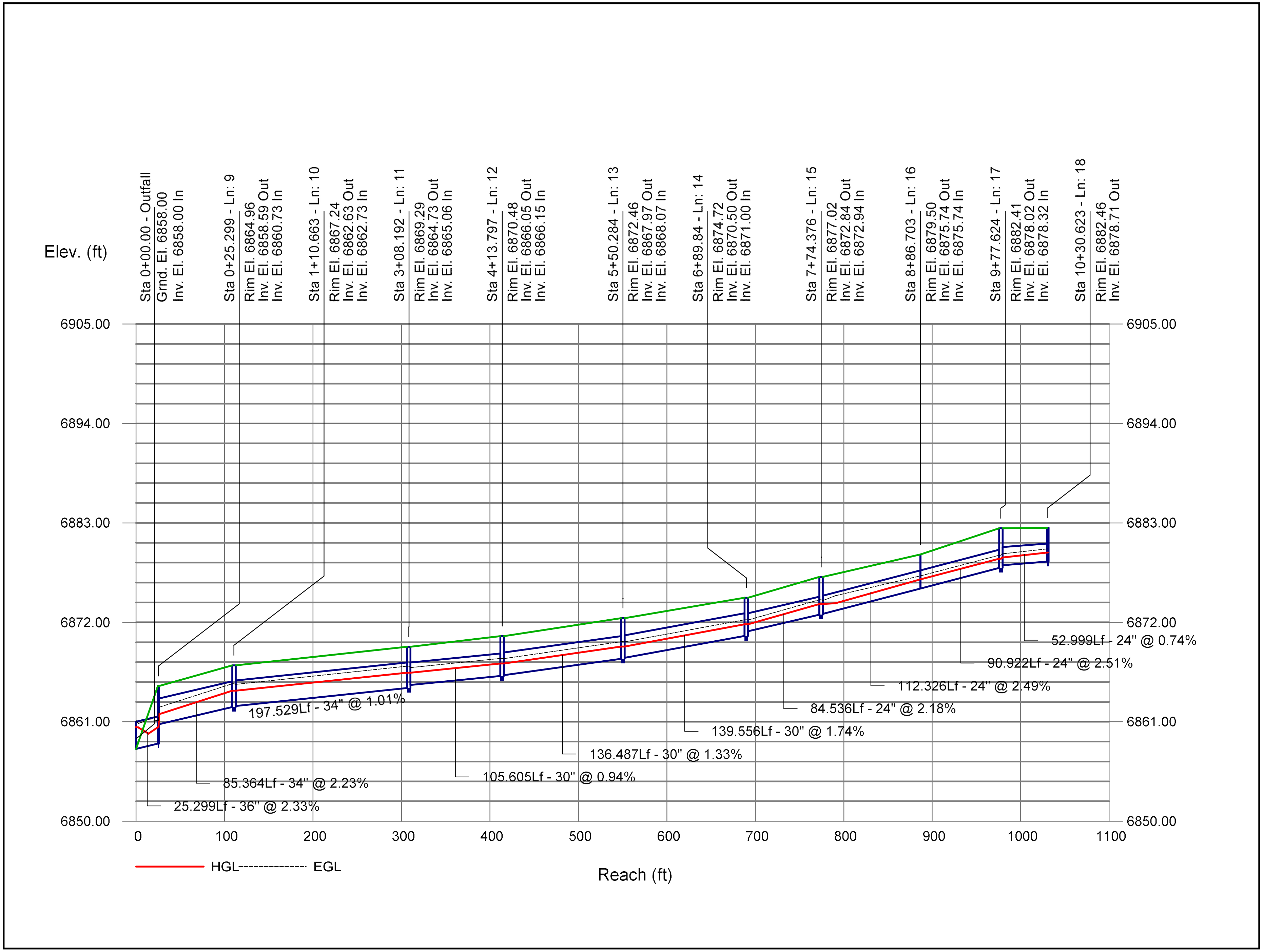
Storm Sewer Profile

Proj. file: HGL 5.stm



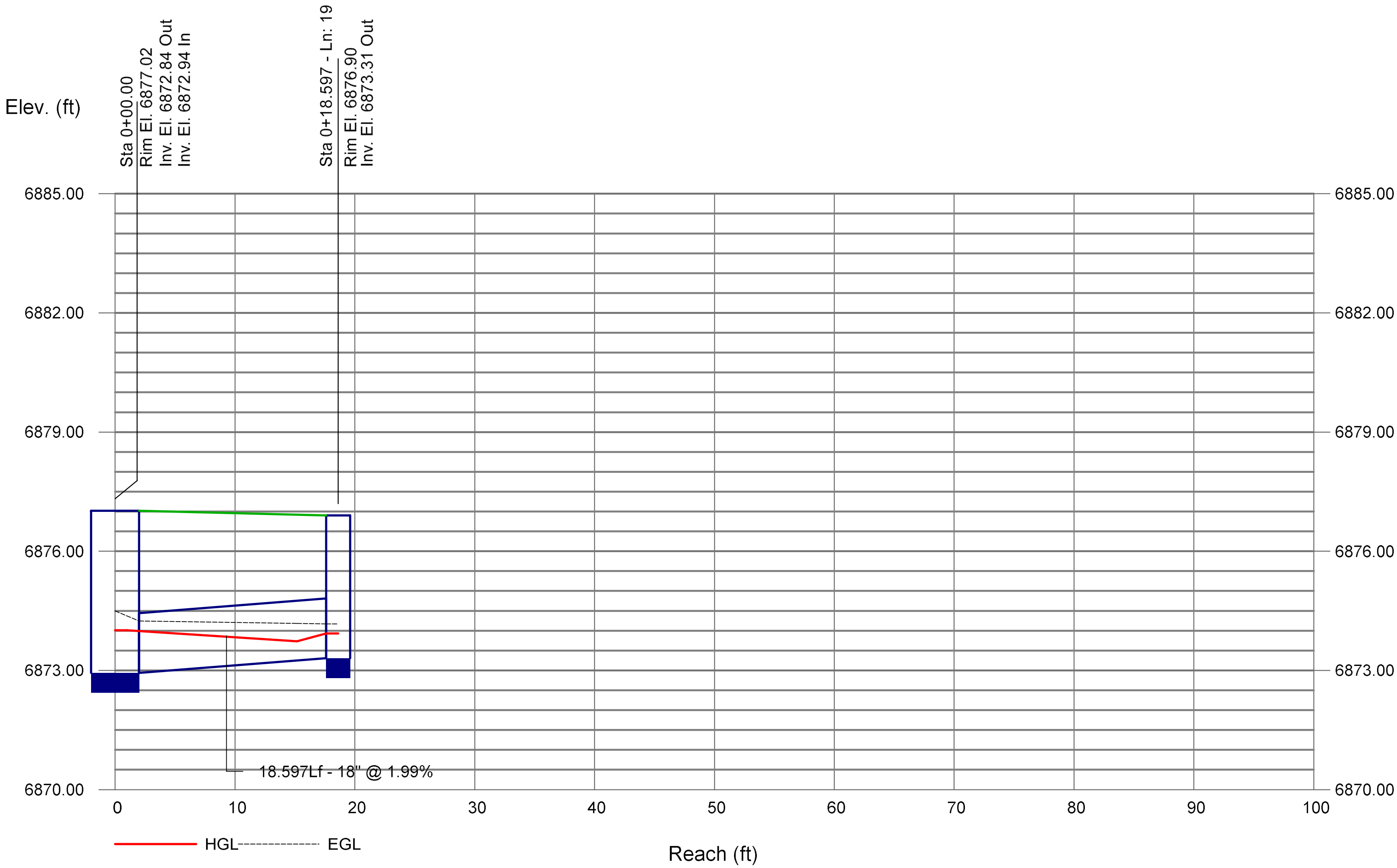
Storm Sewer Profile

Proj. file: HGL 5.stm



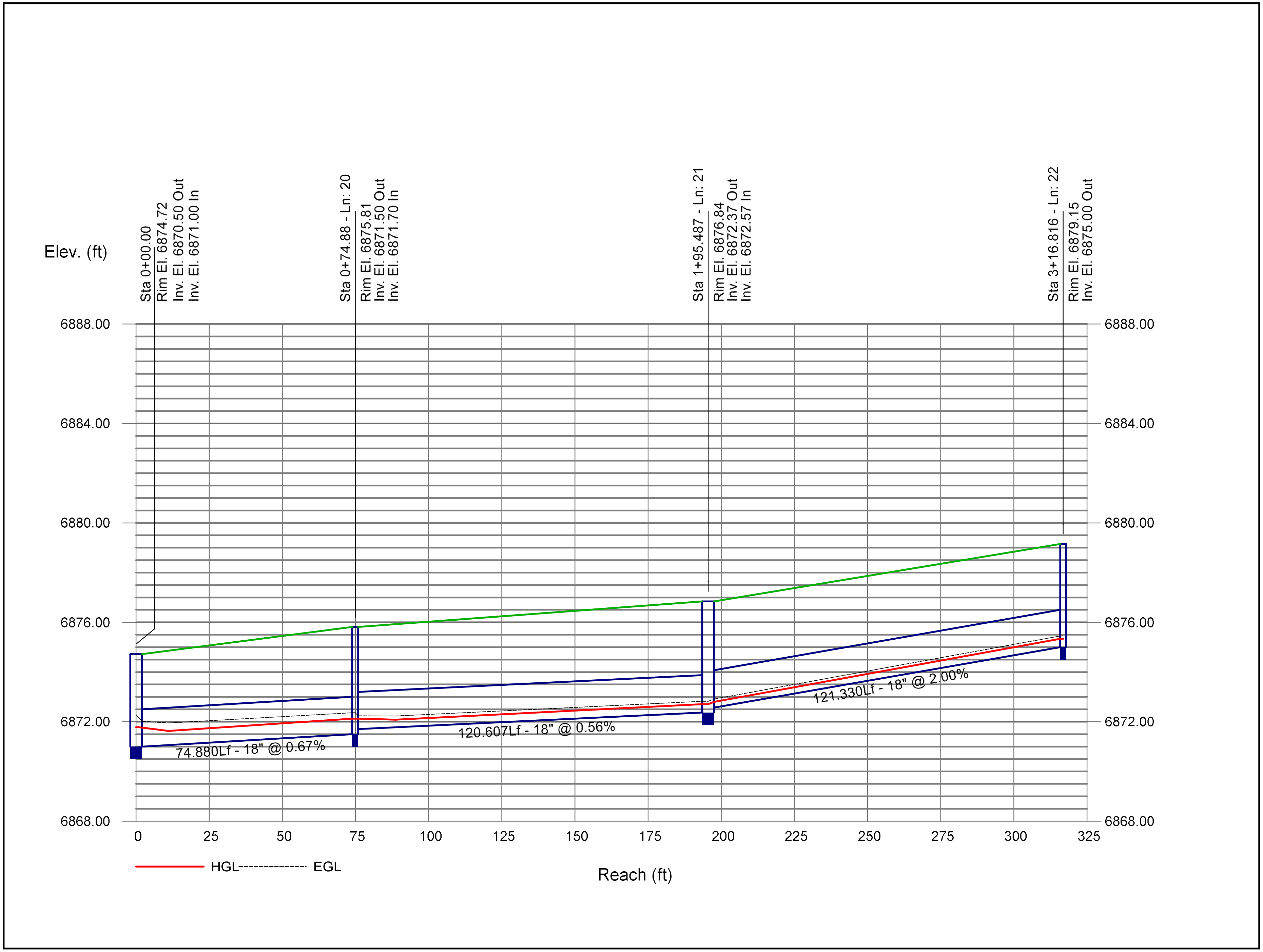
Storm Sewer Profile

Proj. file: HGL 5.stm



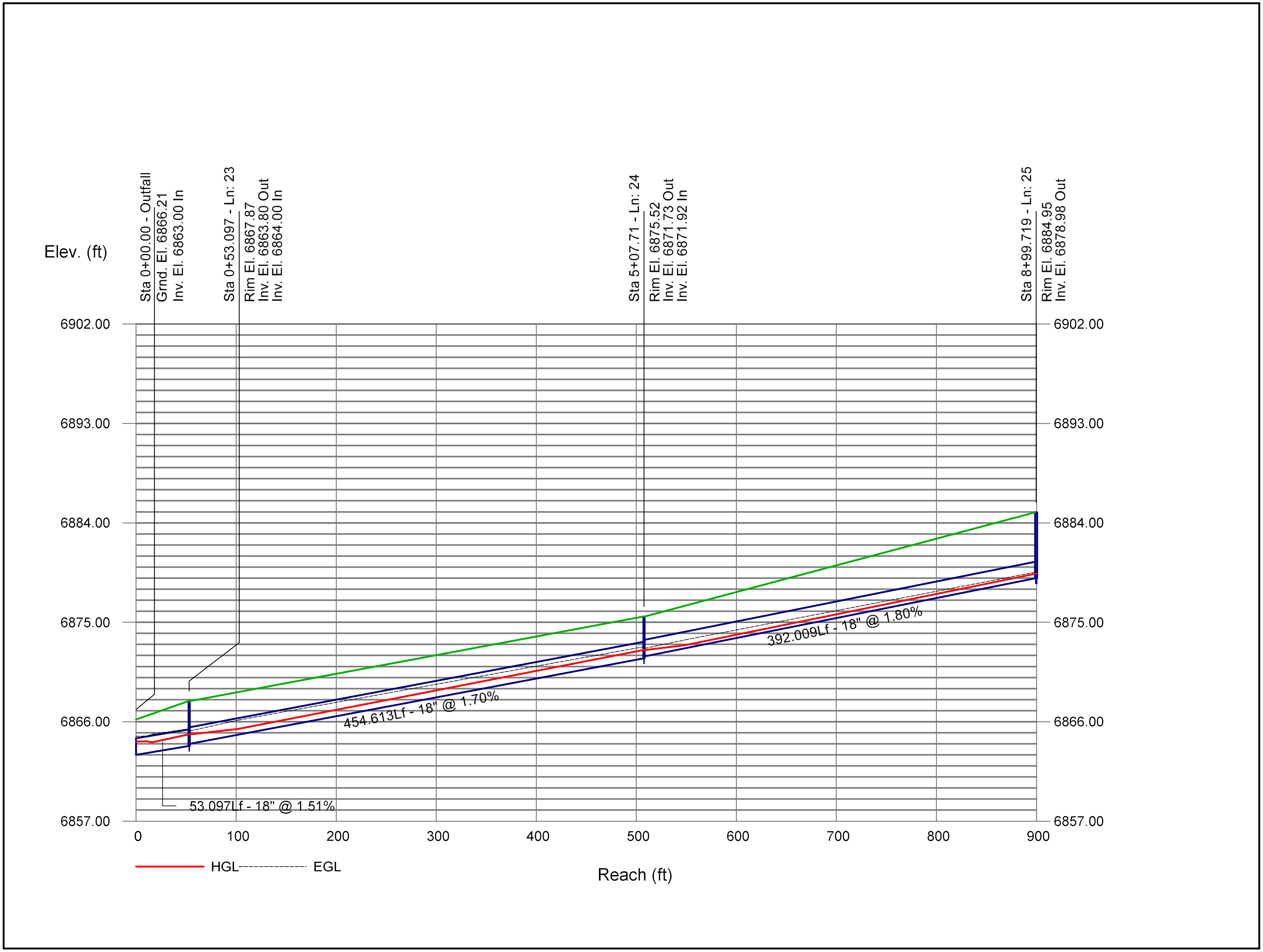
Storm Sewer Profile

Proj. file: HGL 5.stm



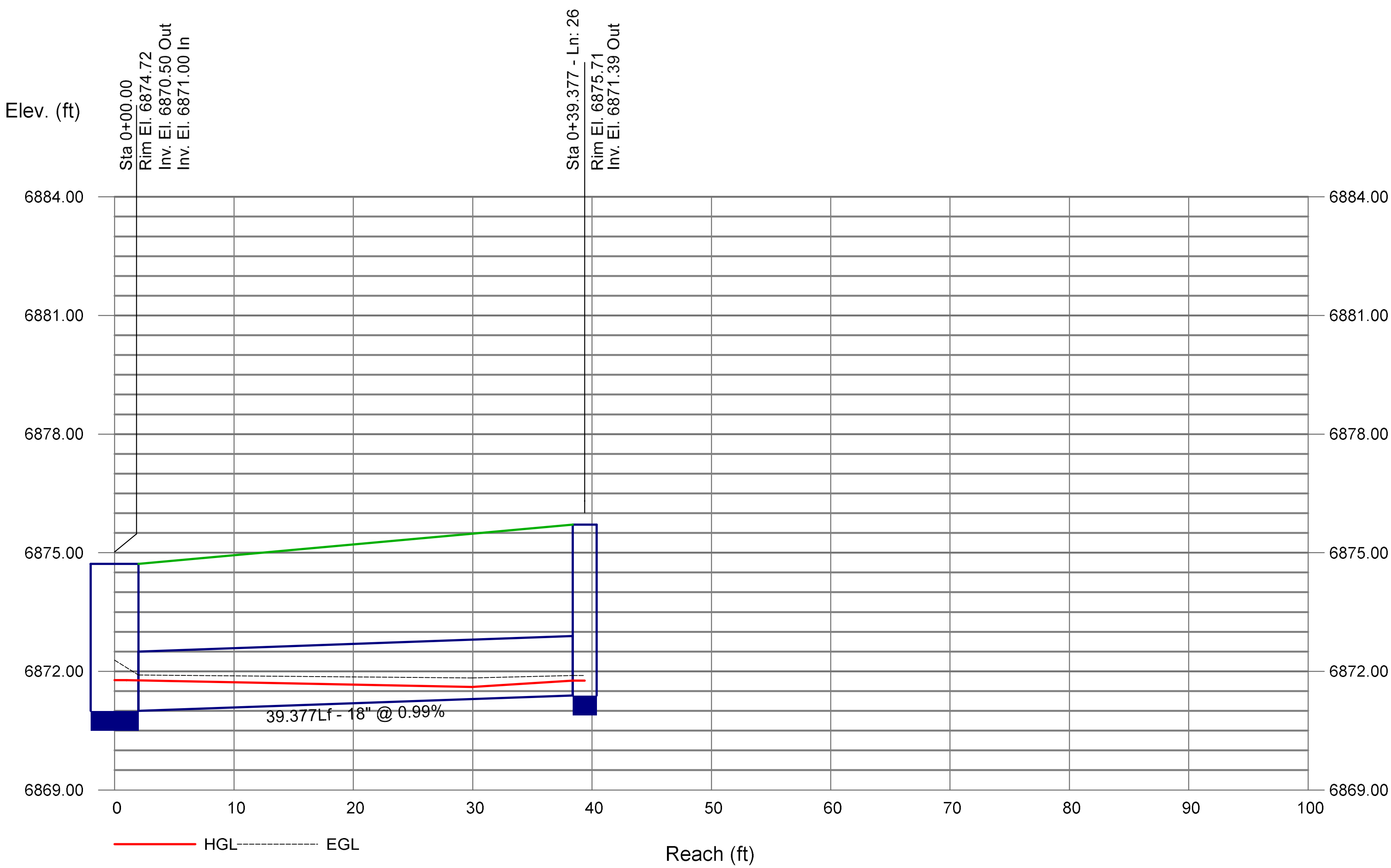
Storm Sewer Profile

Proj. file: HGL 5.stm



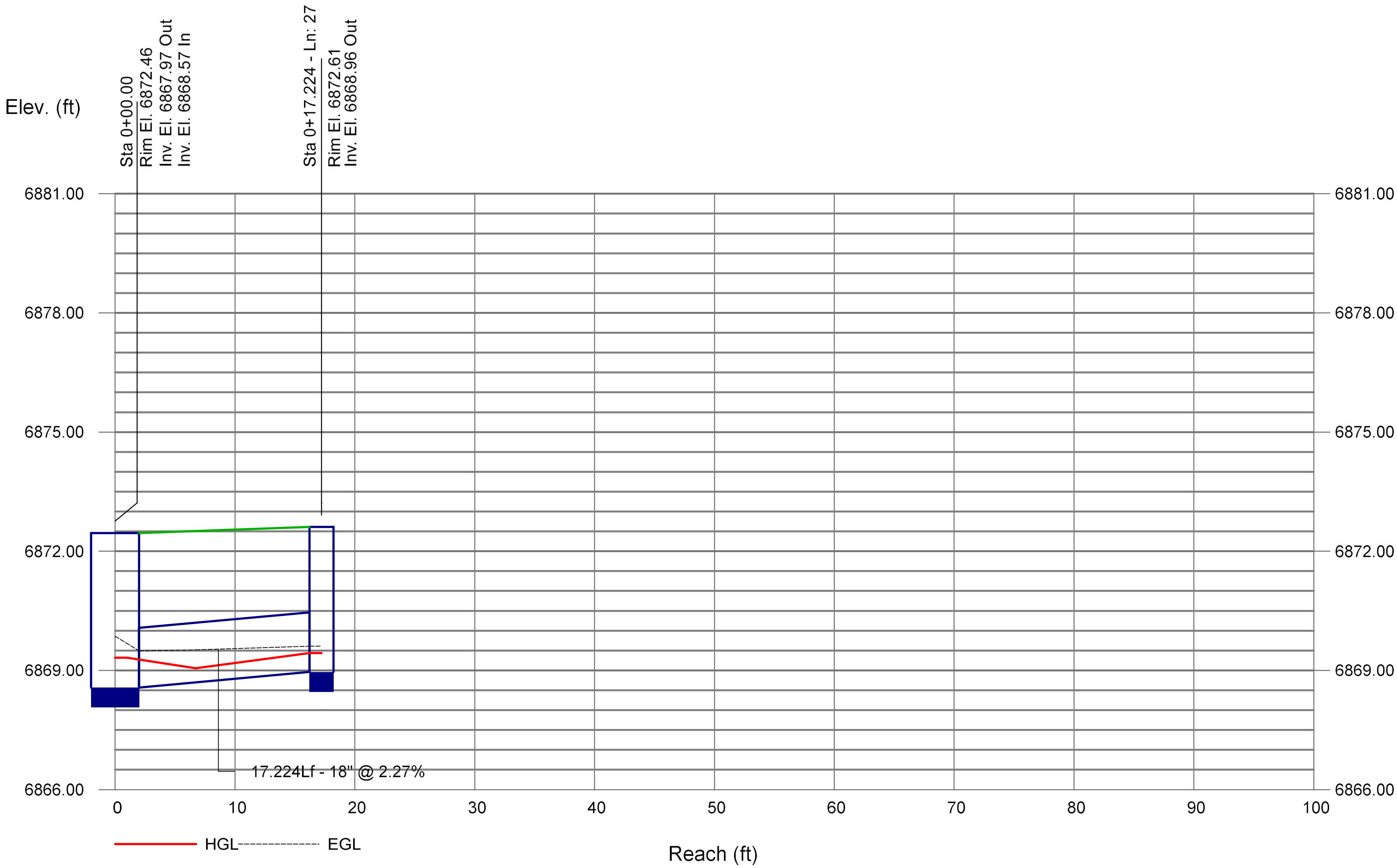
Storm Sewer Profile

Proj. file: HGL 5.stm



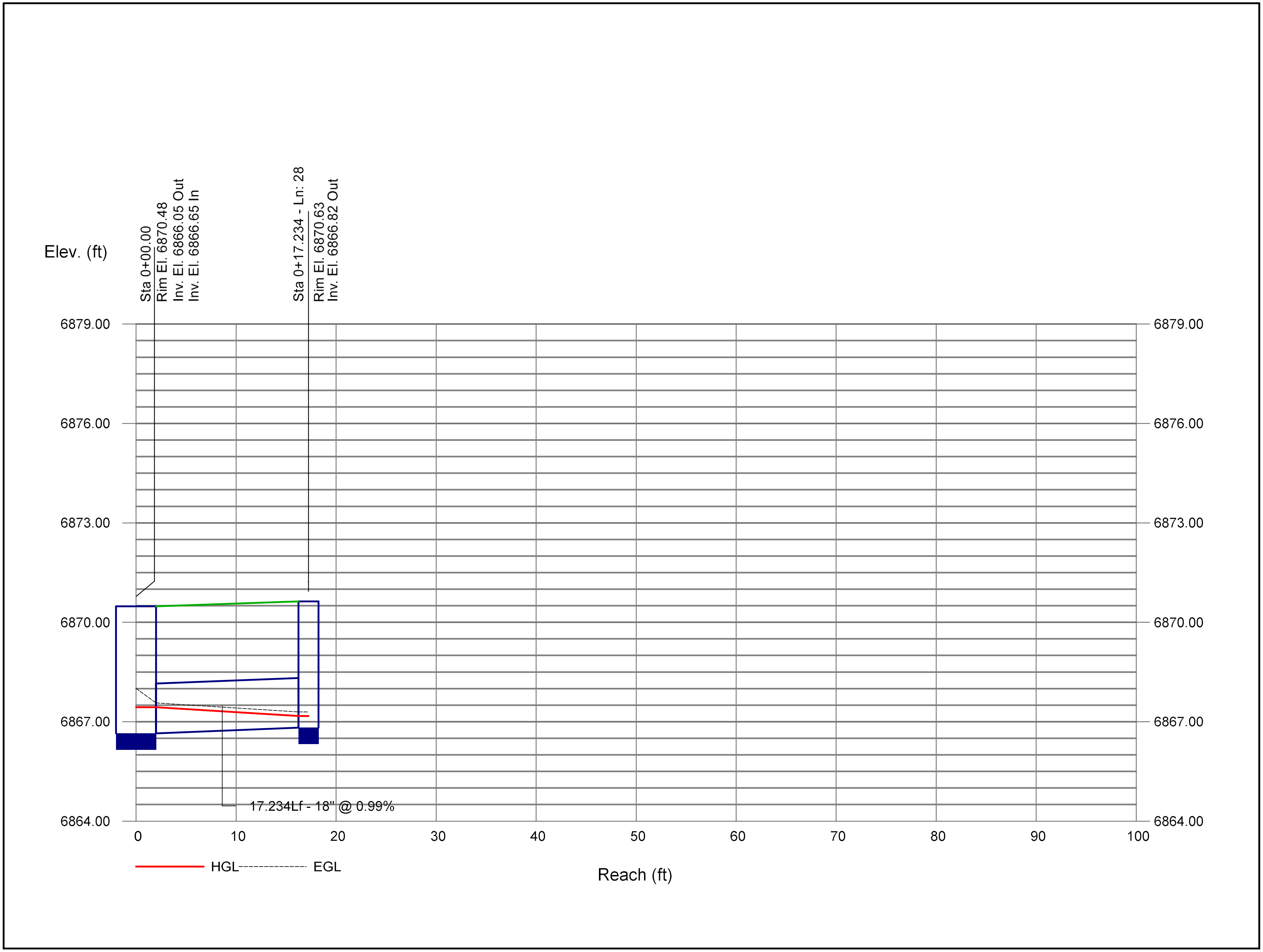
Storm Sewer Profile

Proj. file: HGL 5.stm



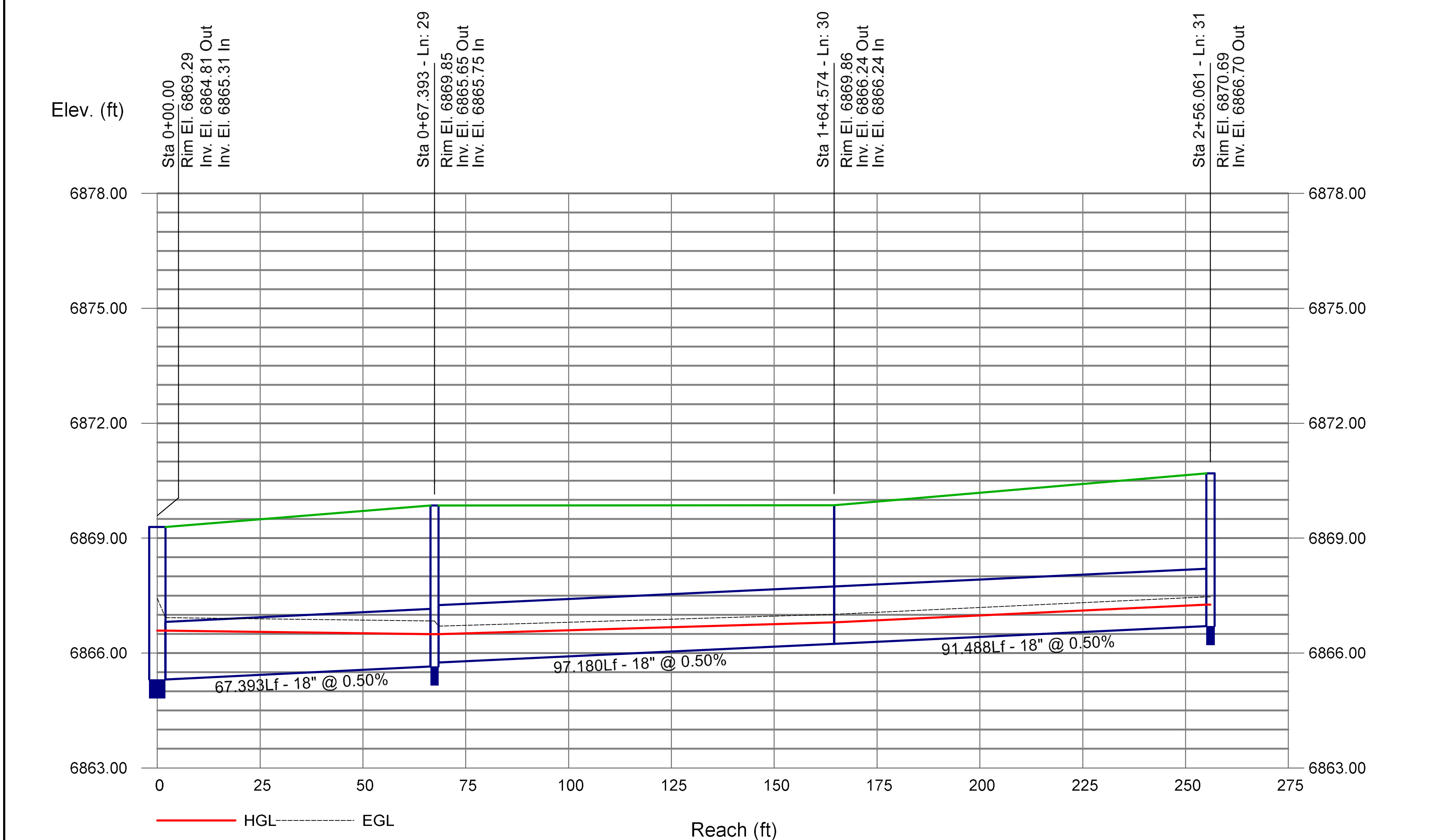
Storm Sewer Profile

Proj. file: HGL 5.stm



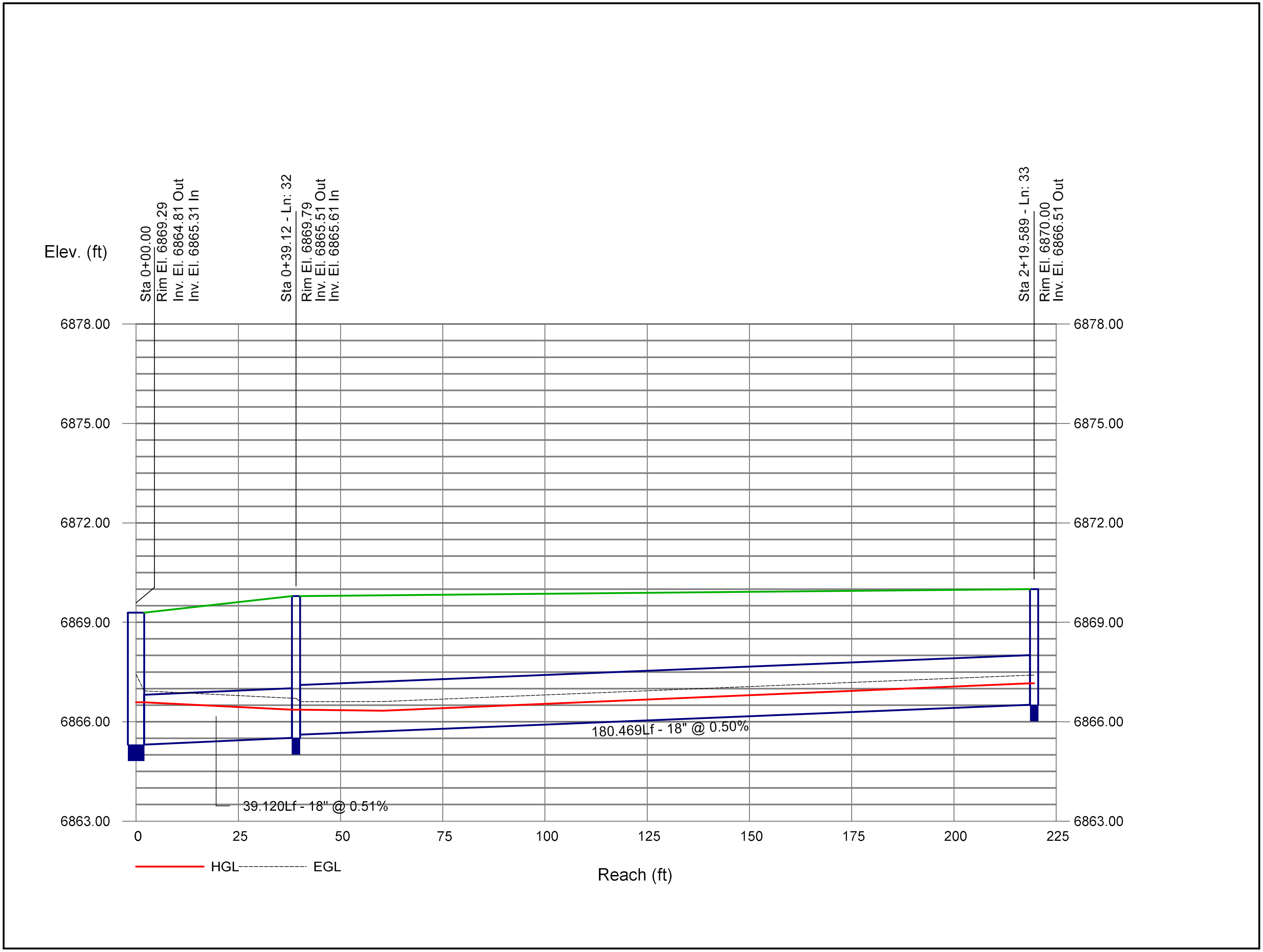
Storm Sewer Profile

Proj. file: HGL 5.stm



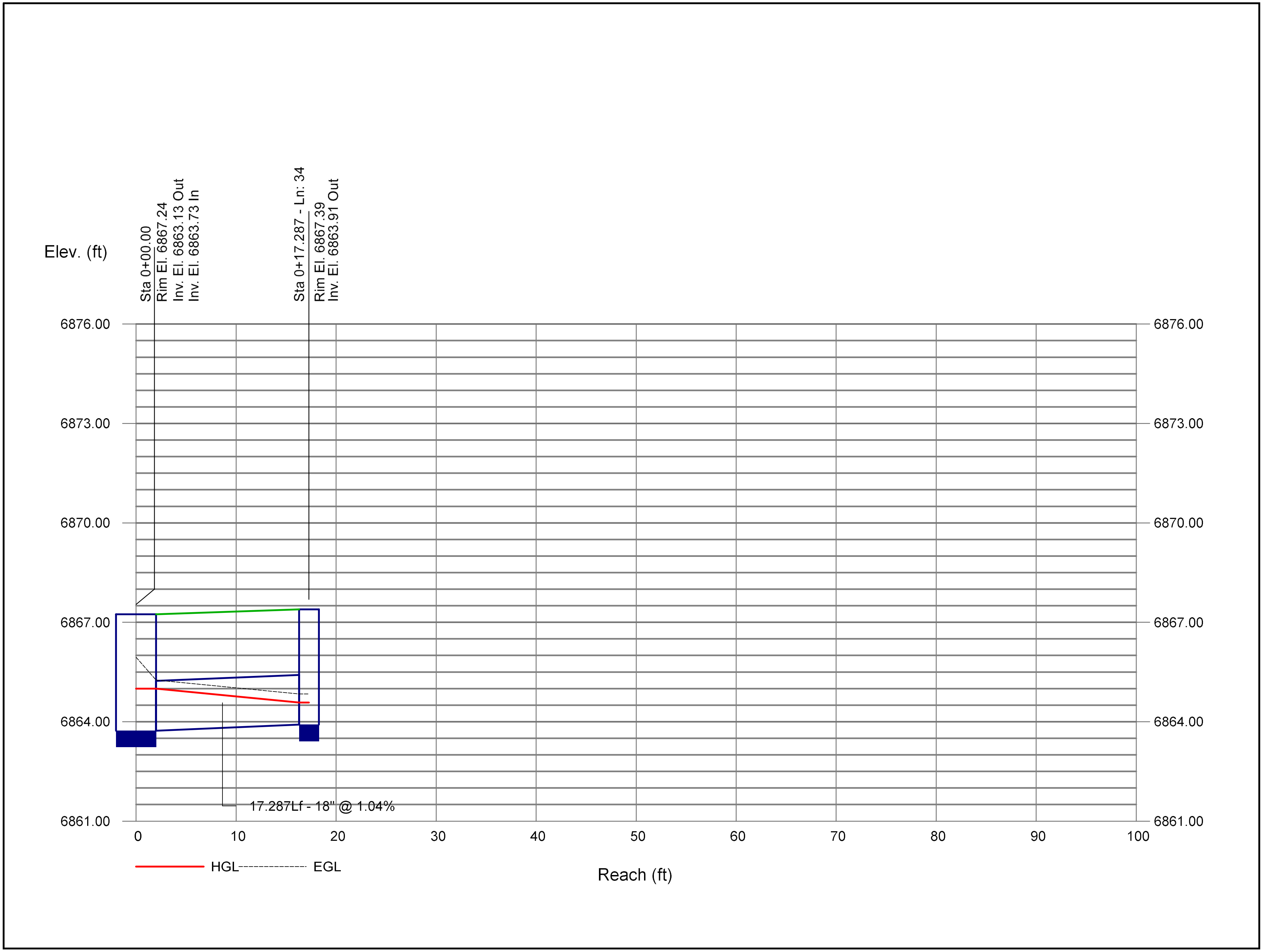
Storm Sewer Profile

Proj. file: HGL 5.stm



Storm Sewer Profile

Proj. file: HGL 5.stm



Storm Sewer Profile

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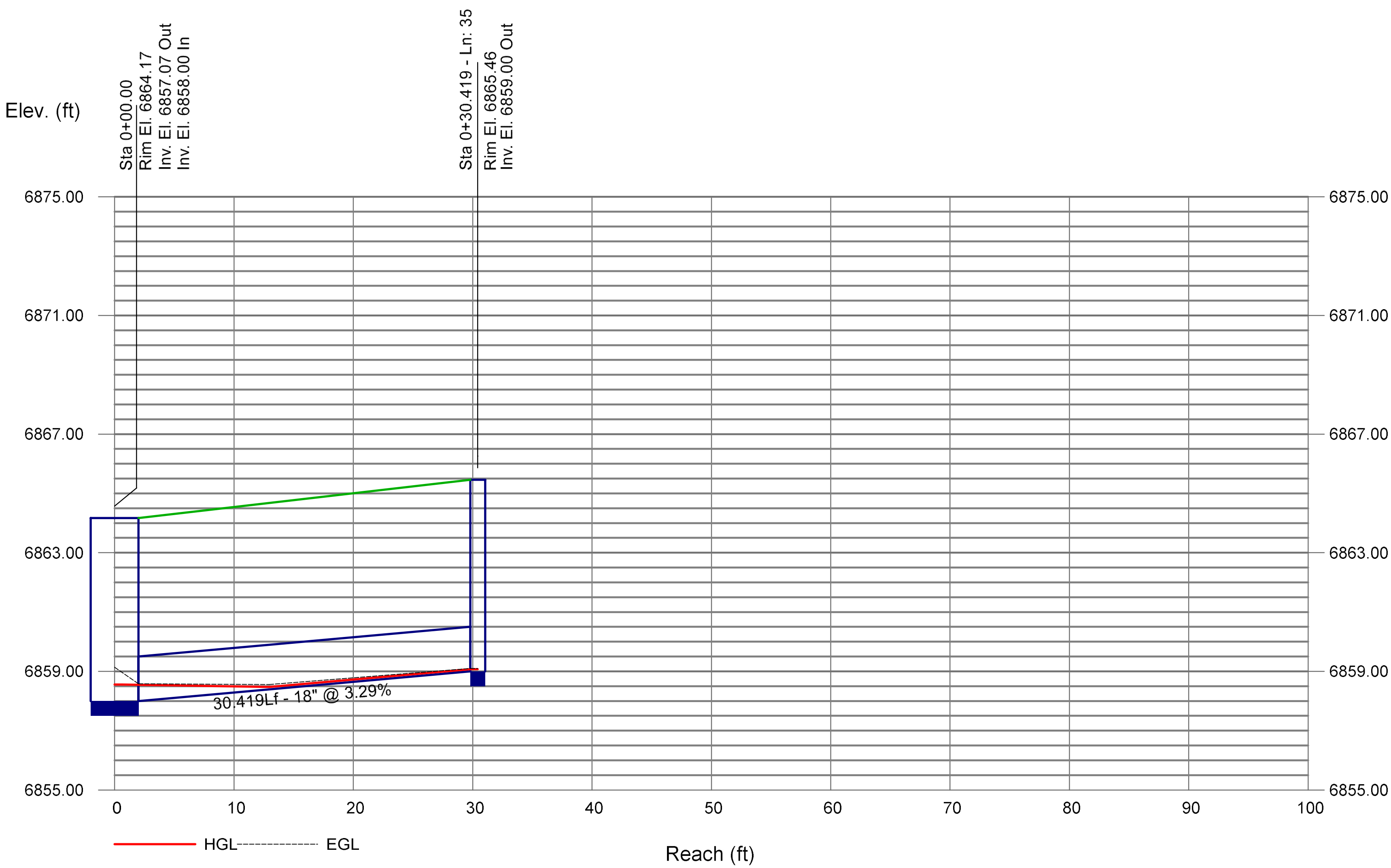

Storm Sewer Profile

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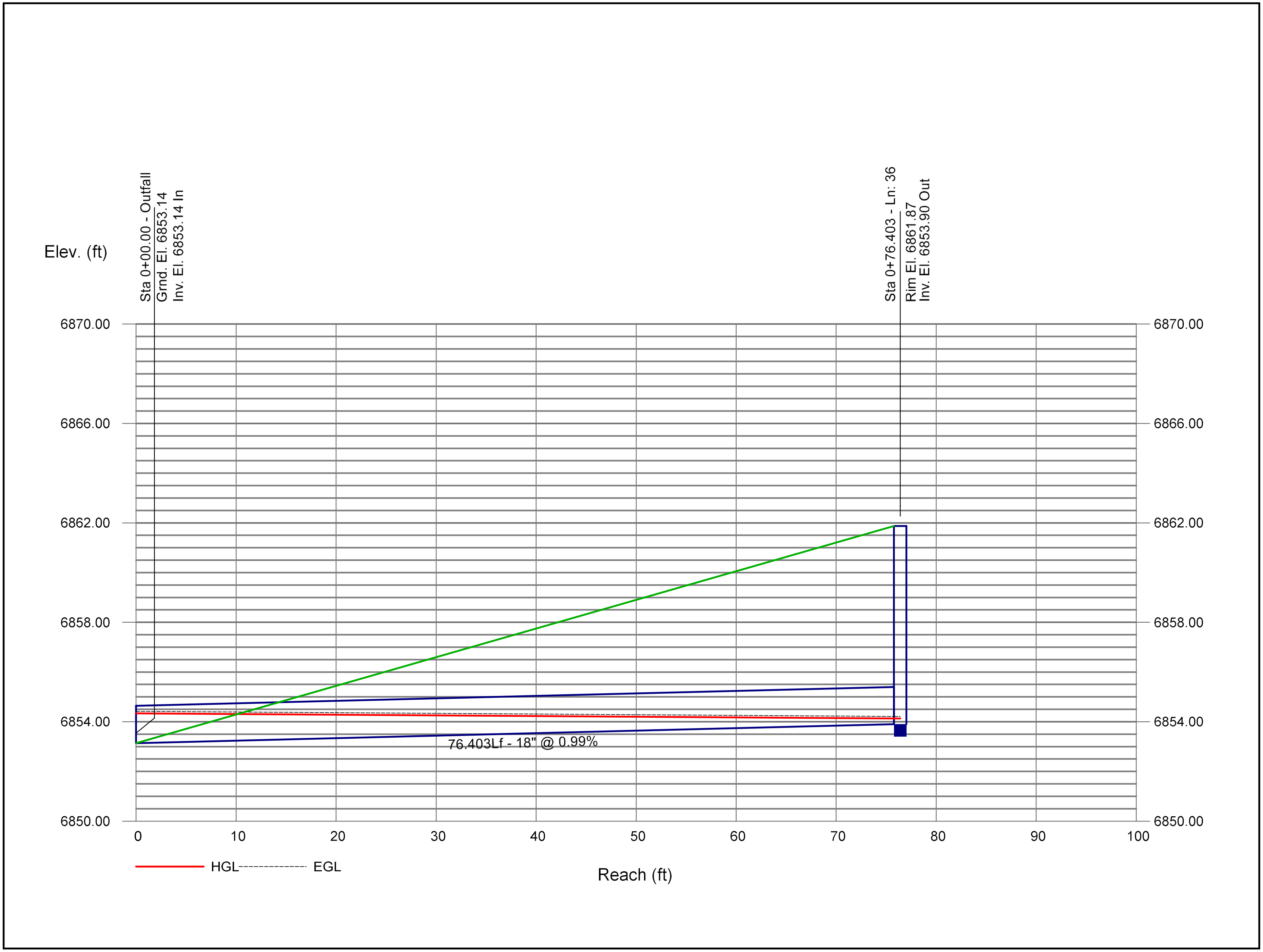
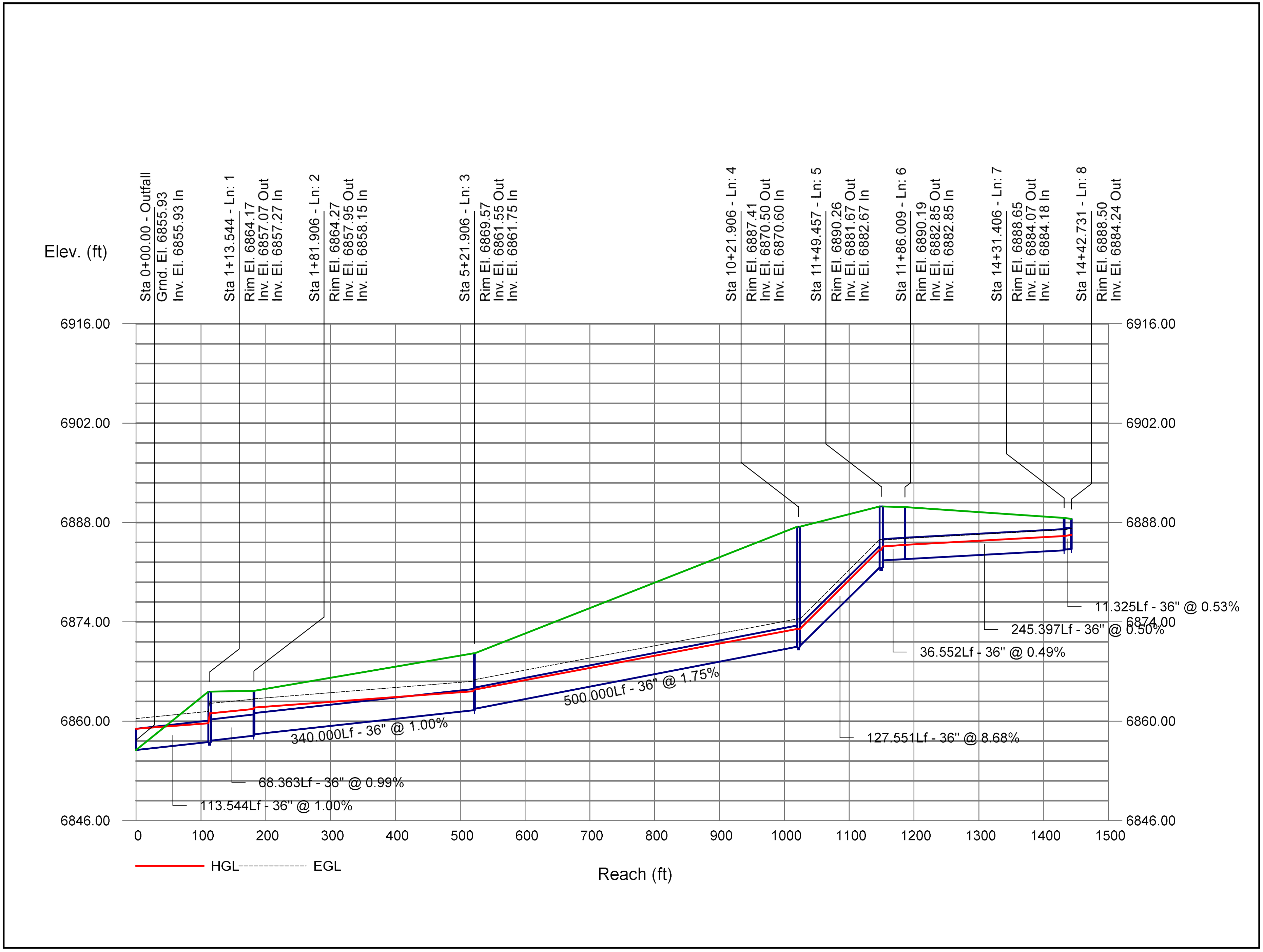


5-yr

Line No.	Flow Rate	Line Size	Line Type	Line Length	Invert Dn	Invert Up	Line Slope	HGL Up	HGL Dn	Minor Loss	HGL Jnct	Vel Ave	n-value Pipe
	(cfs)	(in)		(ft)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(ft/s)	
1	21.44	36	Cir	113.544	6855.93	6857.07	1.00	6858.56 j	6858.33	n/a	6858.56	4.84	0.012
2	21.40	36	Cir	68.363	6857.27	6857.95	0.99	6859.44	6858.56	0.09	6859.44	6.76	0.012
3	20.80	36	Cir	340.000	6858.15	6861.55	1.00	6863.01	6859.44	n/a	6863.01	6.63	0.012
4	20.20	36	Cir	500.000	6861.75	6870.50	1.75	6871.94	6863.01	n/a	6871.94	6.58	0.012
5	20.20	36	Cir	127.551	6870.60	6881.67	8.68	6883.11	6871.94	n/a	6883.11	6.31	0.012
6	15.50	30	Cir	36.552	6882.67	6882.85	0.49	6884.18	6883.92	n/a	6884.18	6.10	0.012
7	15.50	30	Cir	245.397	6882.85	6884.07	0.50	6885.40	6884.18	n/a	6885.40	5.85	0.012
8	15.50	30	Cir	11.325	6884.18	6884.24	0.53	6885.57	6885.40	n/a	6885.57	6.18	0.012
9	30.80	36	Cir	25.299	6858.00	6858.59	2.33	6860.39 j	6860.40	n/a	6860.39	6.02	0.012
10	29.70	34	Cir	85.364	6860.73	6862.63	2.23	6864.42	6861.83	n/a	6864.42	10.06	0.012
11	26.60	34	Cir	197.529	6862.73	6864.73	1.01	6866.42	6864.42	0.71	6866.42	6.76	0.012
12	16.90	30	Cir	105.605	6865.06	6866.05	0.94	6867.44	6866.42	n/a	6867.44	6.10	0.012
13	16.00	30	Cir	136.487	6866.15	6867.97	1.33	6869.32	6867.44	0.54	6869.32	6.10	0.012
14	14.40	30	Cir	139.556	6868.07	6870.50	1.74	6871.78	6869.32	n/a	6871.78	5.79	0.012
15	10.70	24	Cir	84.536	6871.00	6872.84	2.18	6874.01	6871.78	0.46	6874.01	7.54	0.012
16	8.00	24	Cir	112.326	6872.94	6875.74	2.49	6876.75 j	6874.01	n/a	6876.75	4.86	0.012
17	8.00	24	Cir	90.922	6875.74	6878.02	2.51	6879.03	6876.75	0.40	6879.03	5.06	0.012
18	8.00	24	Cir	52.999	6878.32	6878.71	0.74	6879.72	6879.18	0.40	6879.72	5.65	0.012
19	2.70	18	Cir	18.597	6872.94	6873.31	1.99	6873.93 j	6874.01	n/a	6873.93	2.94	0.012
20	2.70	18	Cir	74.880	6871.00	6871.50	0.67	6872.12 j	6871.78	n/a	6872.12	3.41	0.012
21	0.80	18	Cir	120.607	6871.70	6872.37	0.56	6872.70 j	6872.12	n/a	6872.70	2.35	0.012
22	0.80	18	Cir	121.330	6872.57	6875.00	2.00	6875.33	6872.80	n/a	6875.33	3.74	0.012
23	7.50	18	Cir	53.097	6863.00	6863.80	1.51	6864.86 j	6864.20	n/a	6864.86	5.28	0.012
24	3.90	18	Cir	454.613	6864.00	6871.73	1.70	6872.48 j	6864.86	n/a	6872.48	4.05	0.012
25	1.20	18	Cir	392.009	6871.92	6878.98	1.80	6879.39 j	6872.48	n/a	6879.39	2.52	0.012
26	1.00	18	Cir	39.377	6871.00	6871.39	0.99	6871.76 j	6871.78	n/a	6871.76	2.00	0.012
27	1.60	18	Cir	17.224	6868.57	6868.96	2.27	6869.44 j	6869.32	n/a	6869.44	2.57	0.012
28	0.90	18	Cir	17.234	6866.65	6866.82	0.99	6867.17	6867.44	0.13	6867.17	1.90	0.012
29	4.80	18	Cir	67.393	6865.31	6865.65	0.50	6866.49	6866.42	n/a	6866.49	4.06	0.012
30	2.20	18	Cir	97.180	6865.75	6866.24	0.50	6866.80	6866.49	0.08	6866.80	3.09	0.012
31	2.20	18	Cir	91.488	6866.24	6866.70	0.50	6867.26	6866.80	0.21	6867.26	3.66	0.012
32	4.90	18	Cir	39.120	6865.31	6865.51	0.51	6866.36	6866.42	n/a	6866.36	4.11	0.012
33	2.90	18	Cir	180.469	6865.61	6866.51	0.50	6867.16 j	6866.36	n/a	6867.16	3.63	0.012
34	3.10	18	Cir	17.287	6863.73	6863.91	1.04	6864.58 j	6864.42	n/a	6864.58	3.97	0.012
35	0.04	18	Cir	30.419	6858.00	6859.00	3.29	6859.07 j	6858.56	n/a	6859.07	0.66	0.012
36	0.40	18	Cir	76.403	6853.14	6853.90	0.99	6854.13	6854.34	n/a	6854.13	1.27	0.012
	Notes: j-Line contains hyd. jump												

Storm Sewer Profile

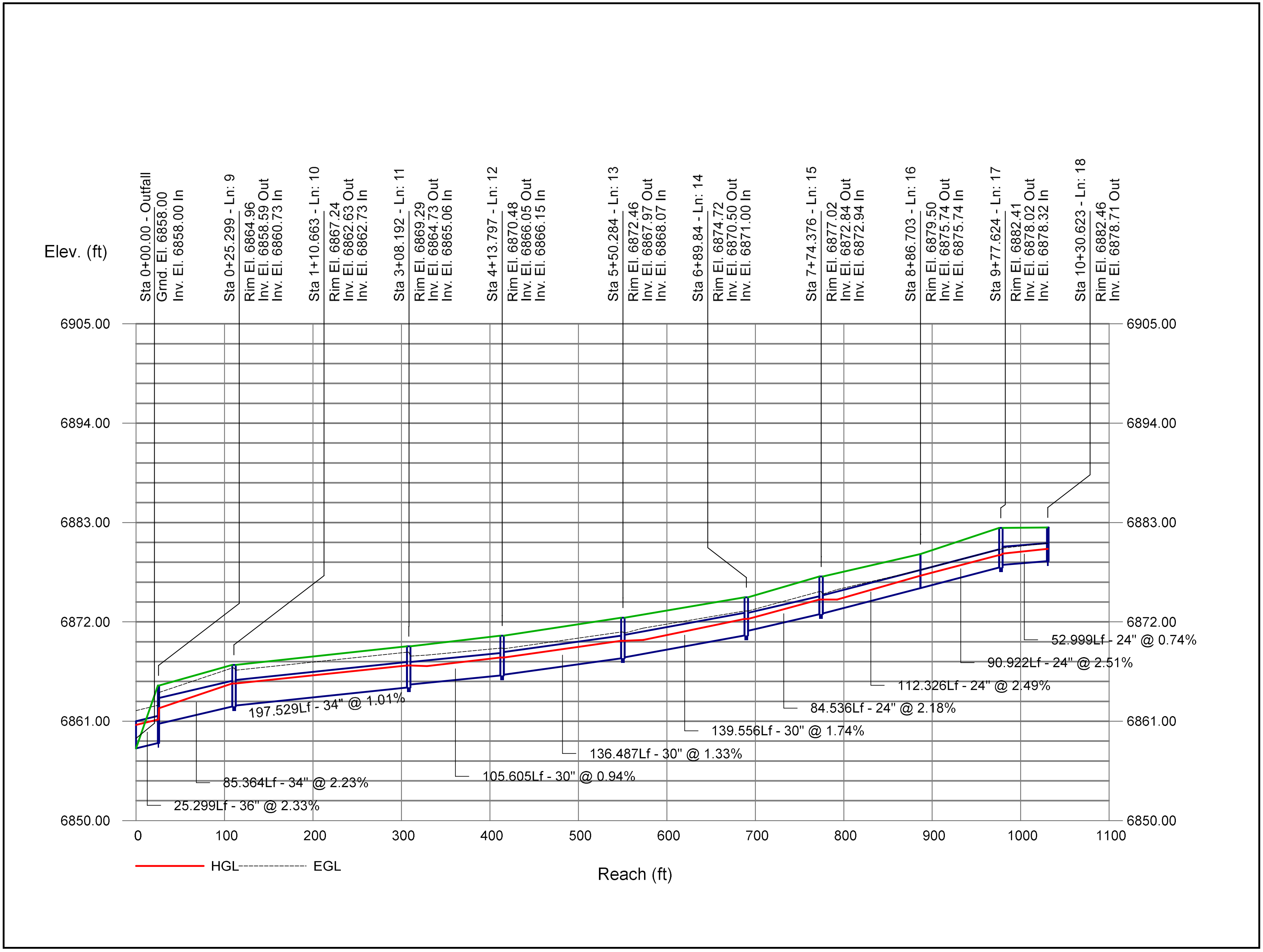
Proj. file: HGL 100.stm



Storm Sewers

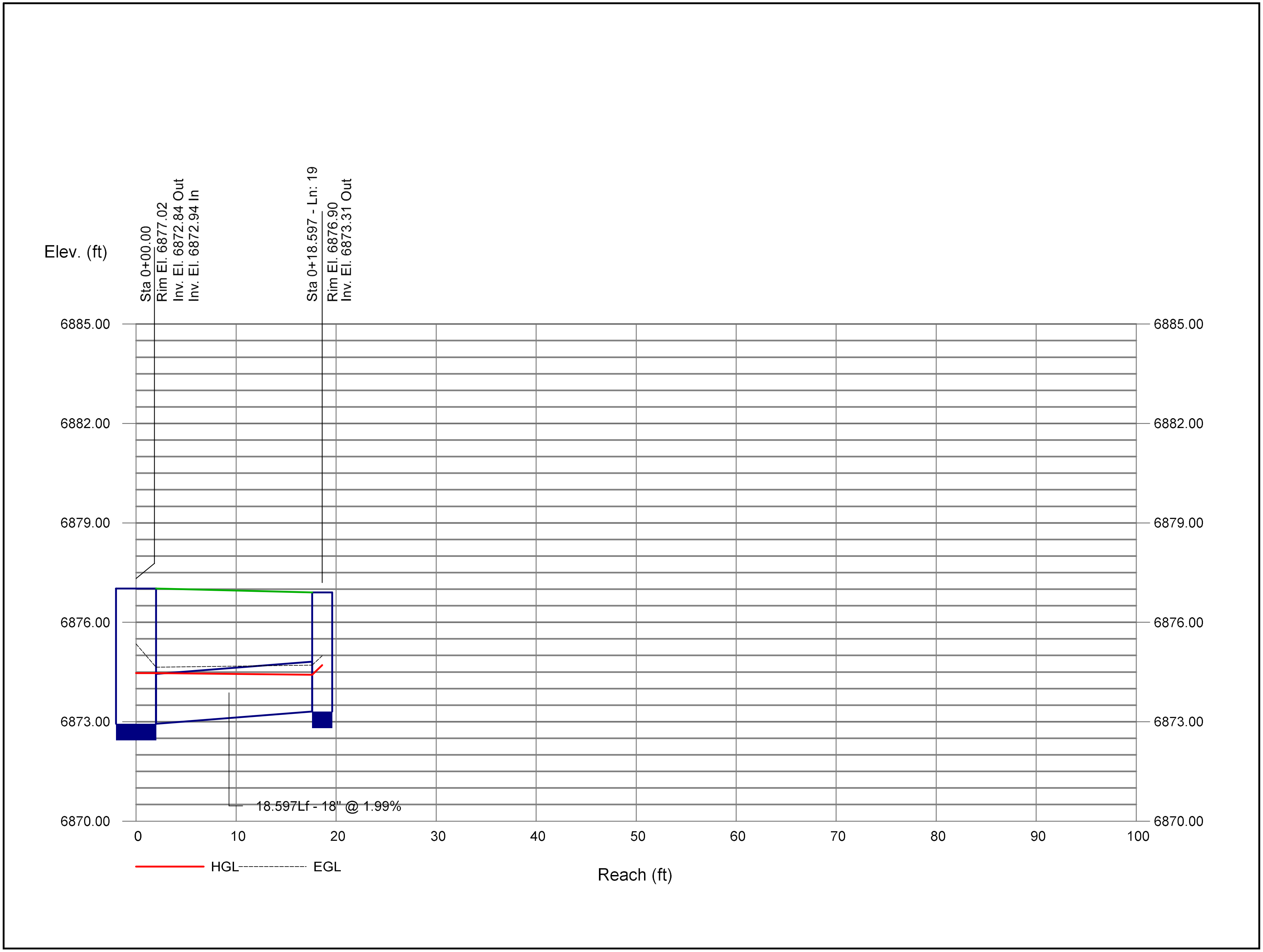
Storm Sewer Profile

Proj. file: HGL 100.stm



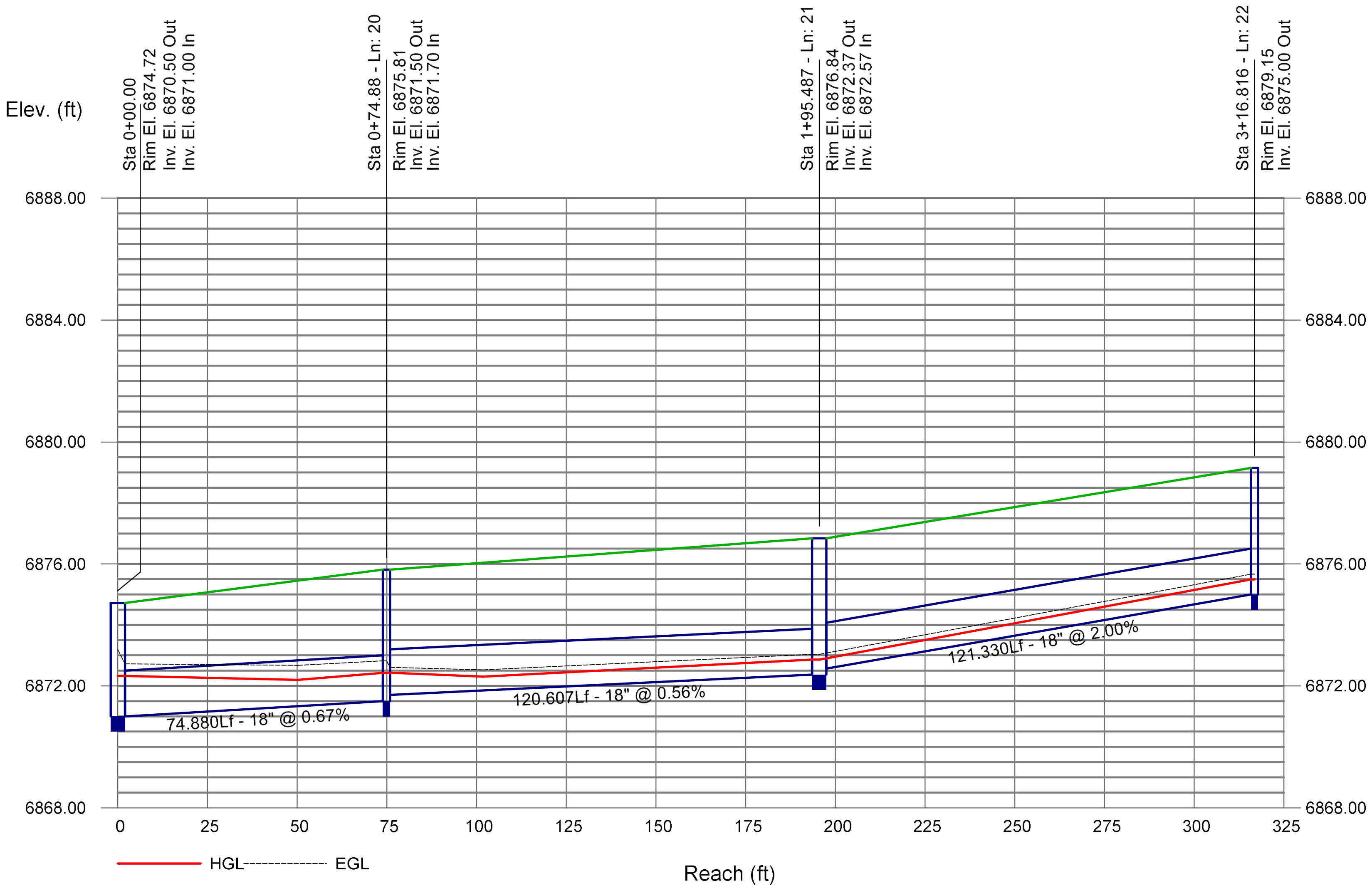
Storm Sewer Profile

Proj. file: HGL 100.stm



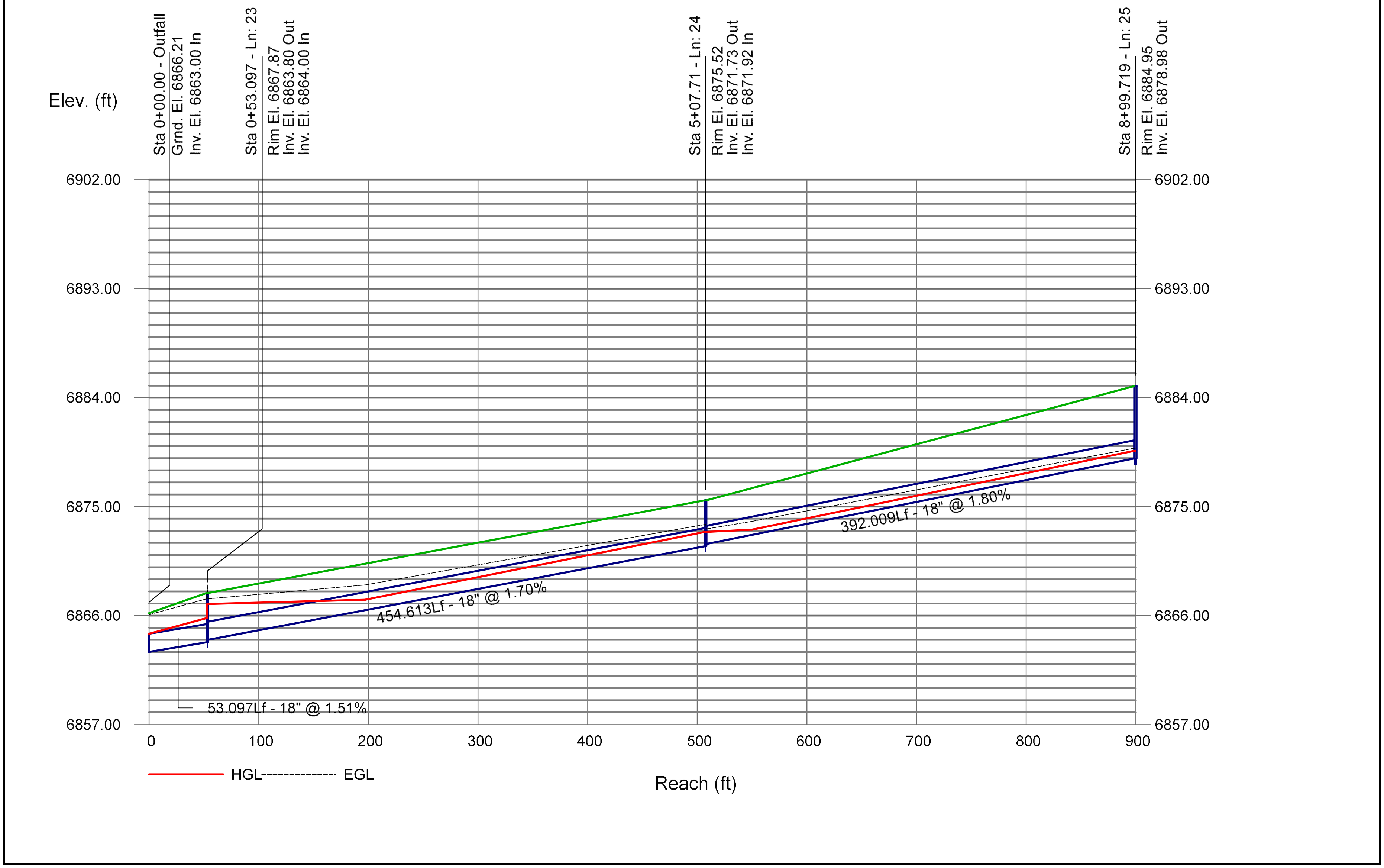
Storm Sewer Profile

Proj. file: HGL 100.stm



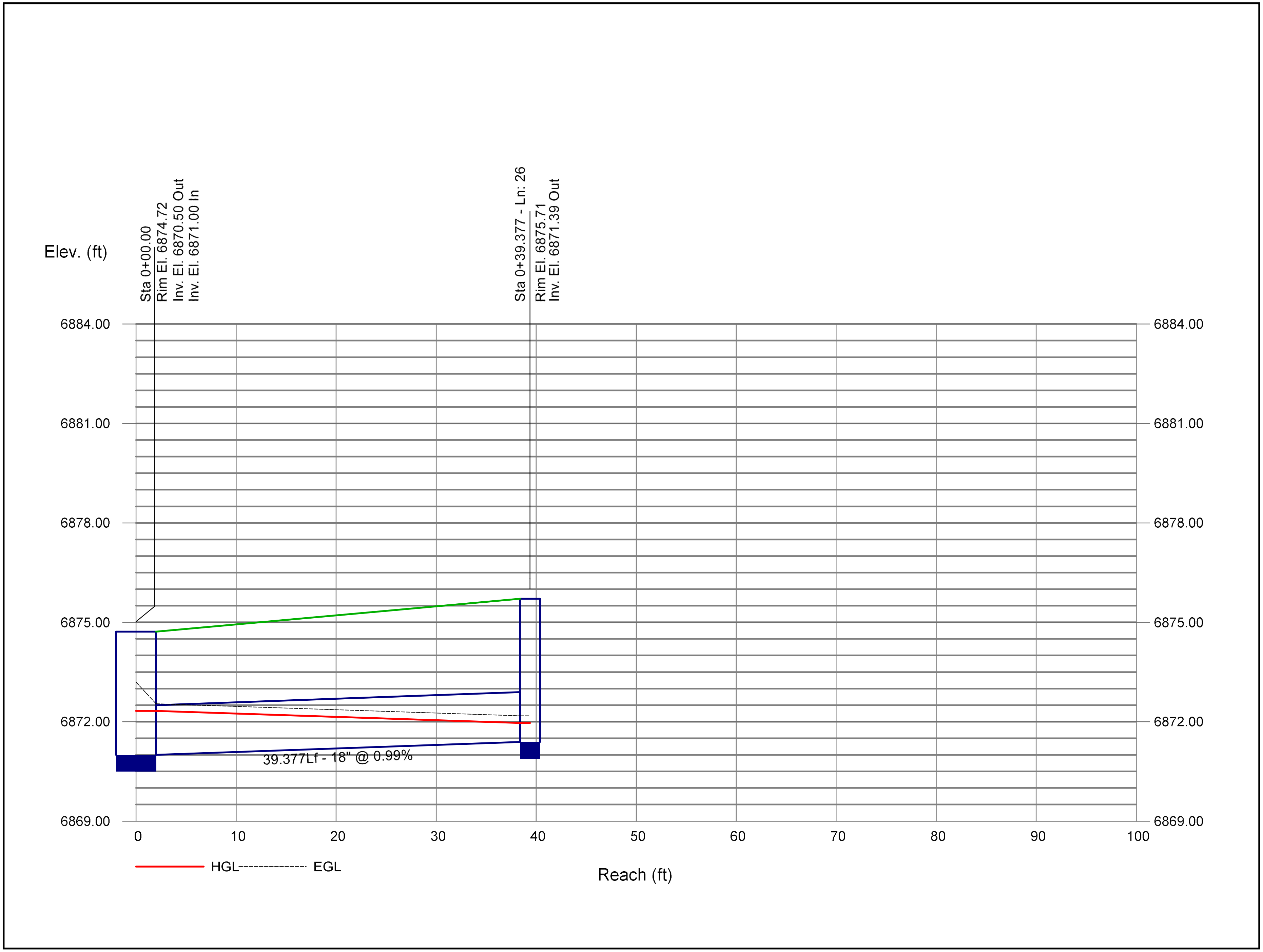
Storm Sewer Profile

Proj. file: HGL 100.stm



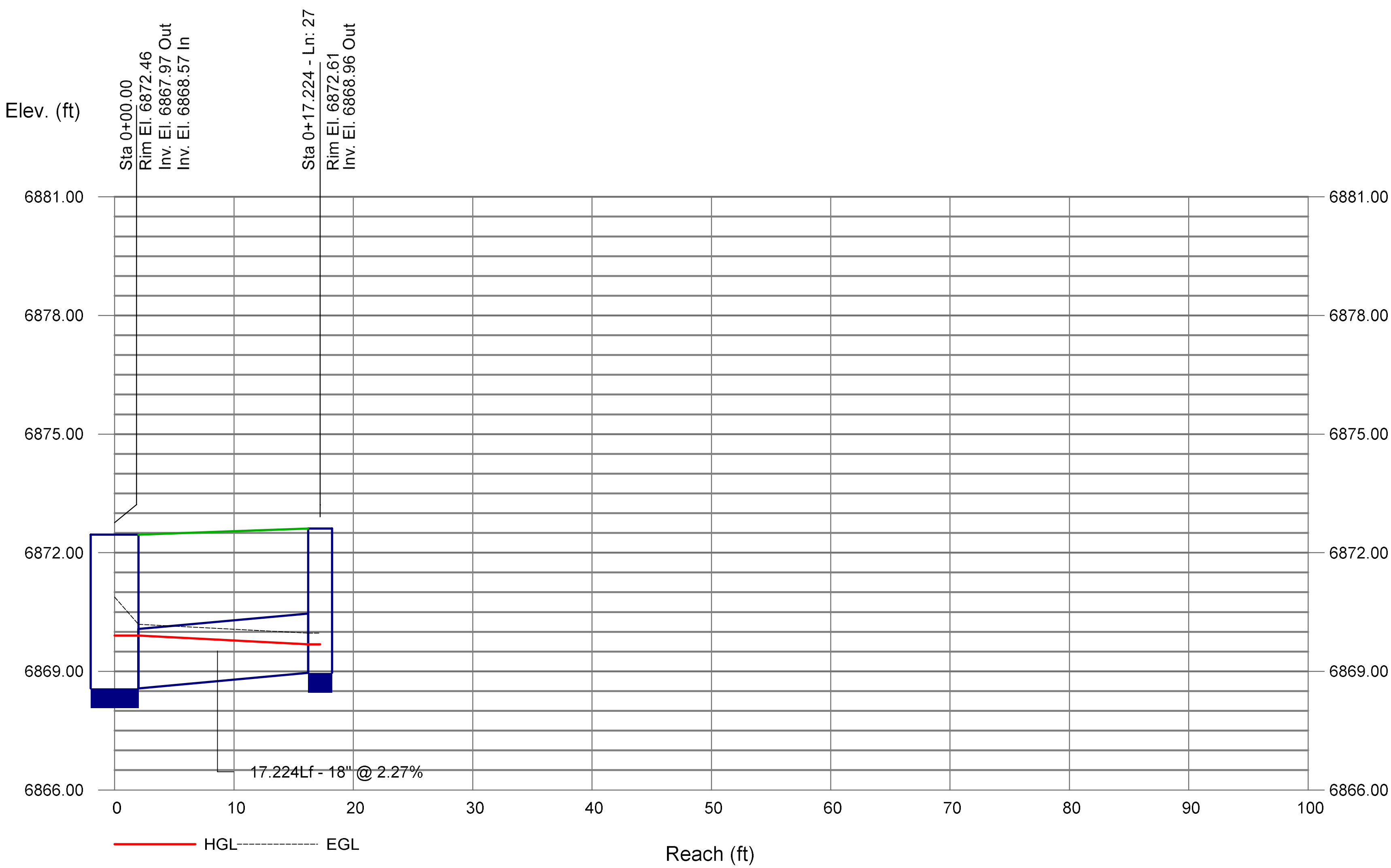
Storm Sewer Profile

Proj. file: HGL 100.stm



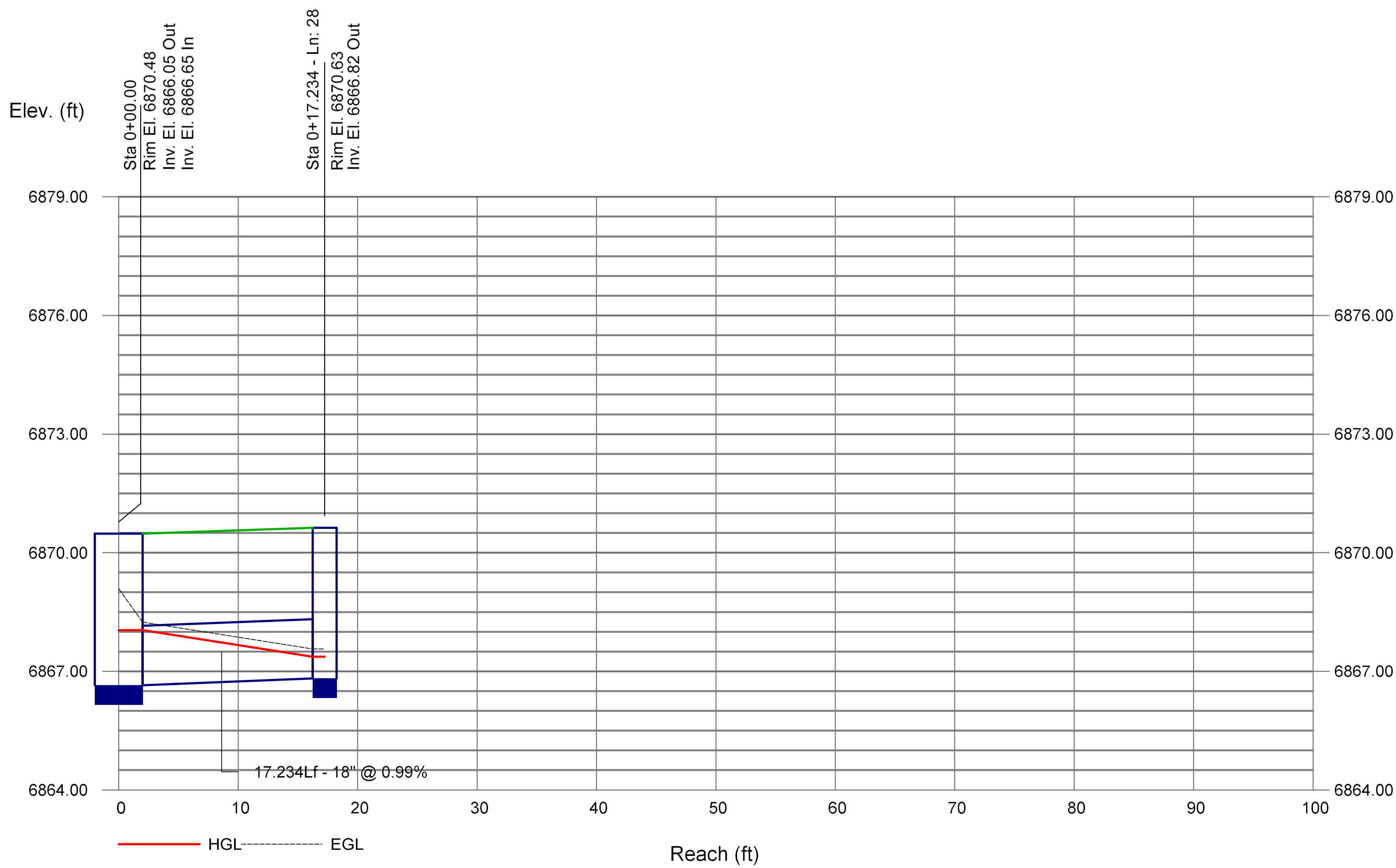
Storm Sewer Profile

Proj. file: HGL 100.stm



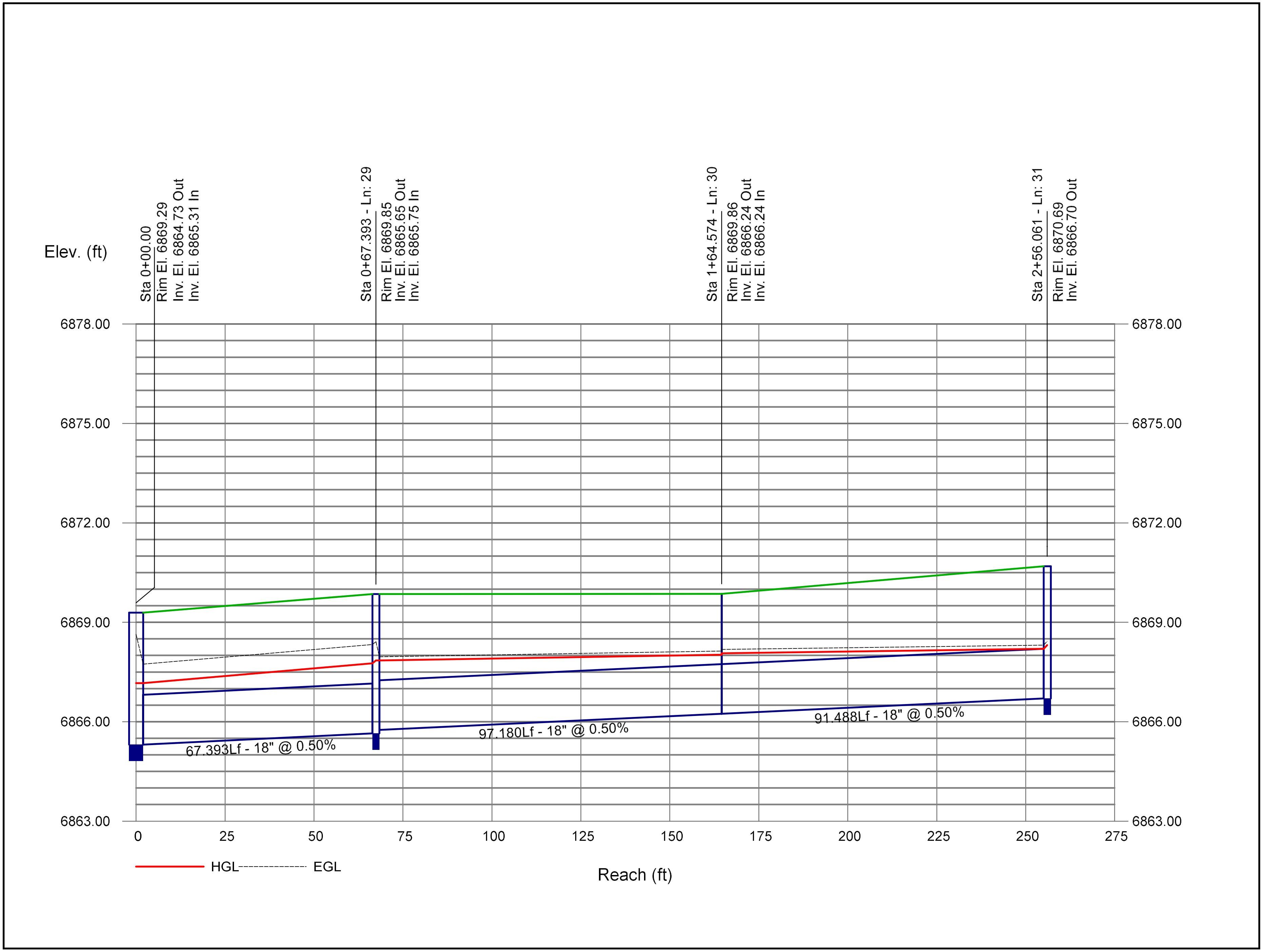
Storm Sewer Profile

Proj. file: HGL 100.stm



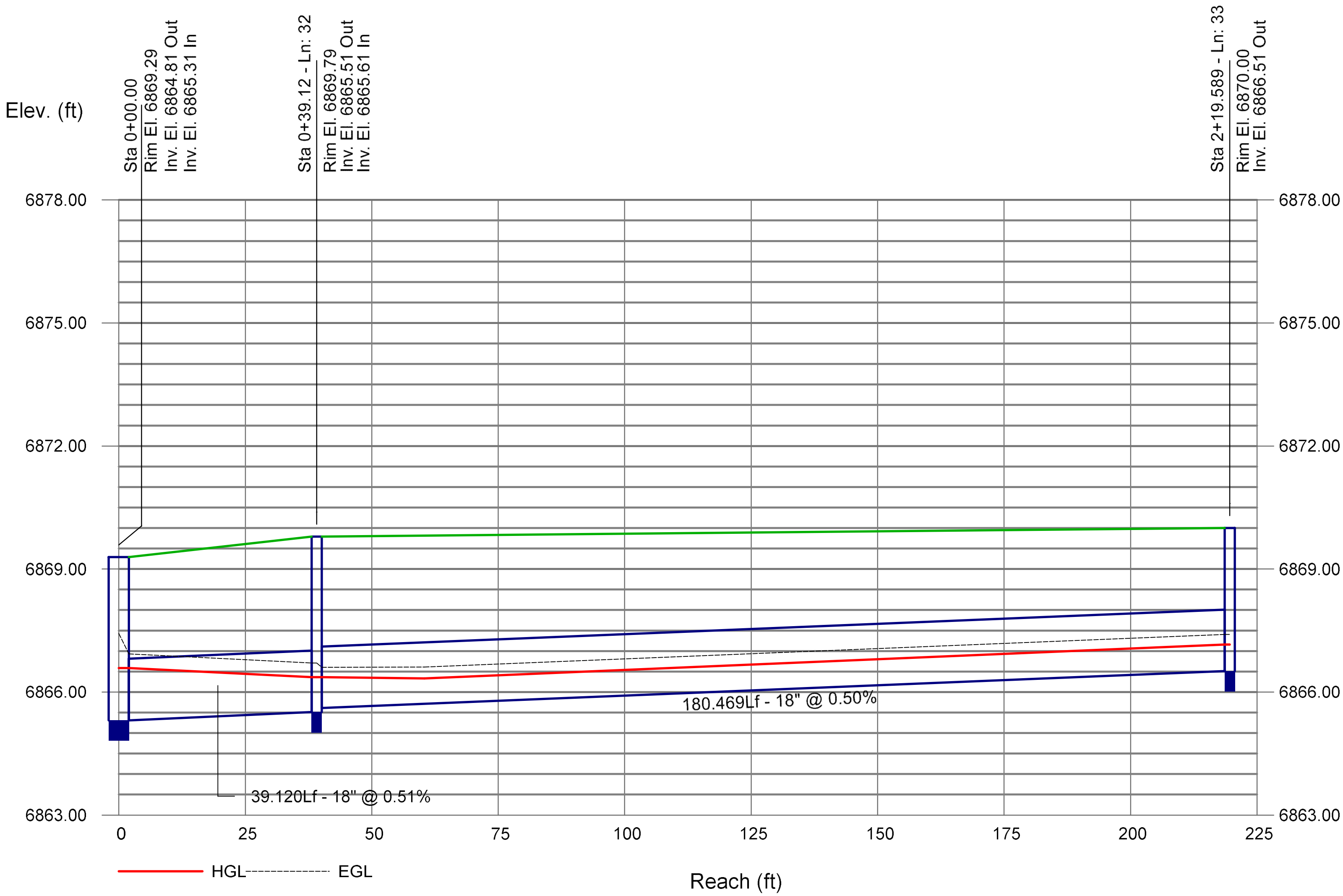
Storm Sewer Profile

Proj. file: HGL 100.stm



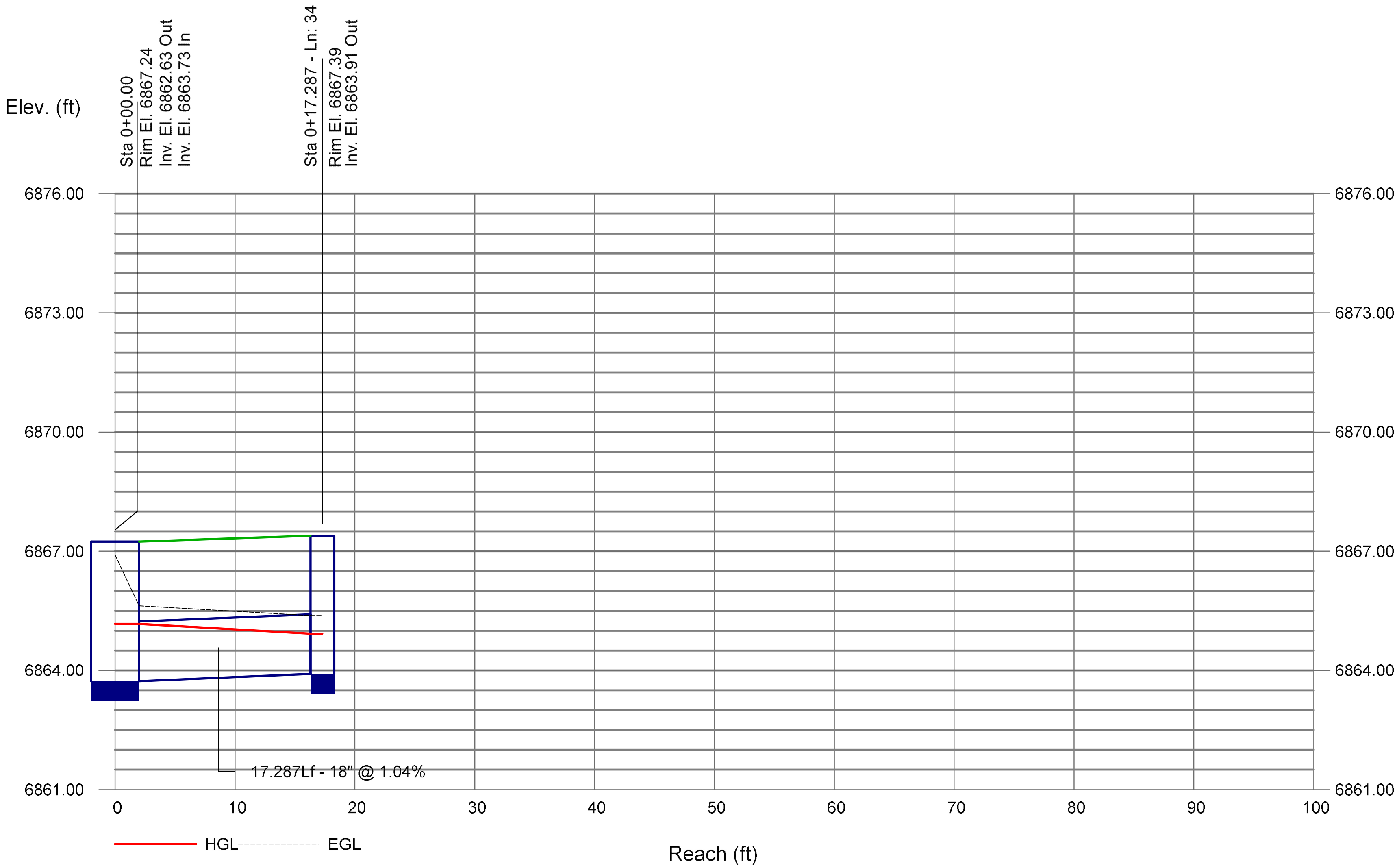
Storm Sewer Profile

Proj. file: HGL 5.stm



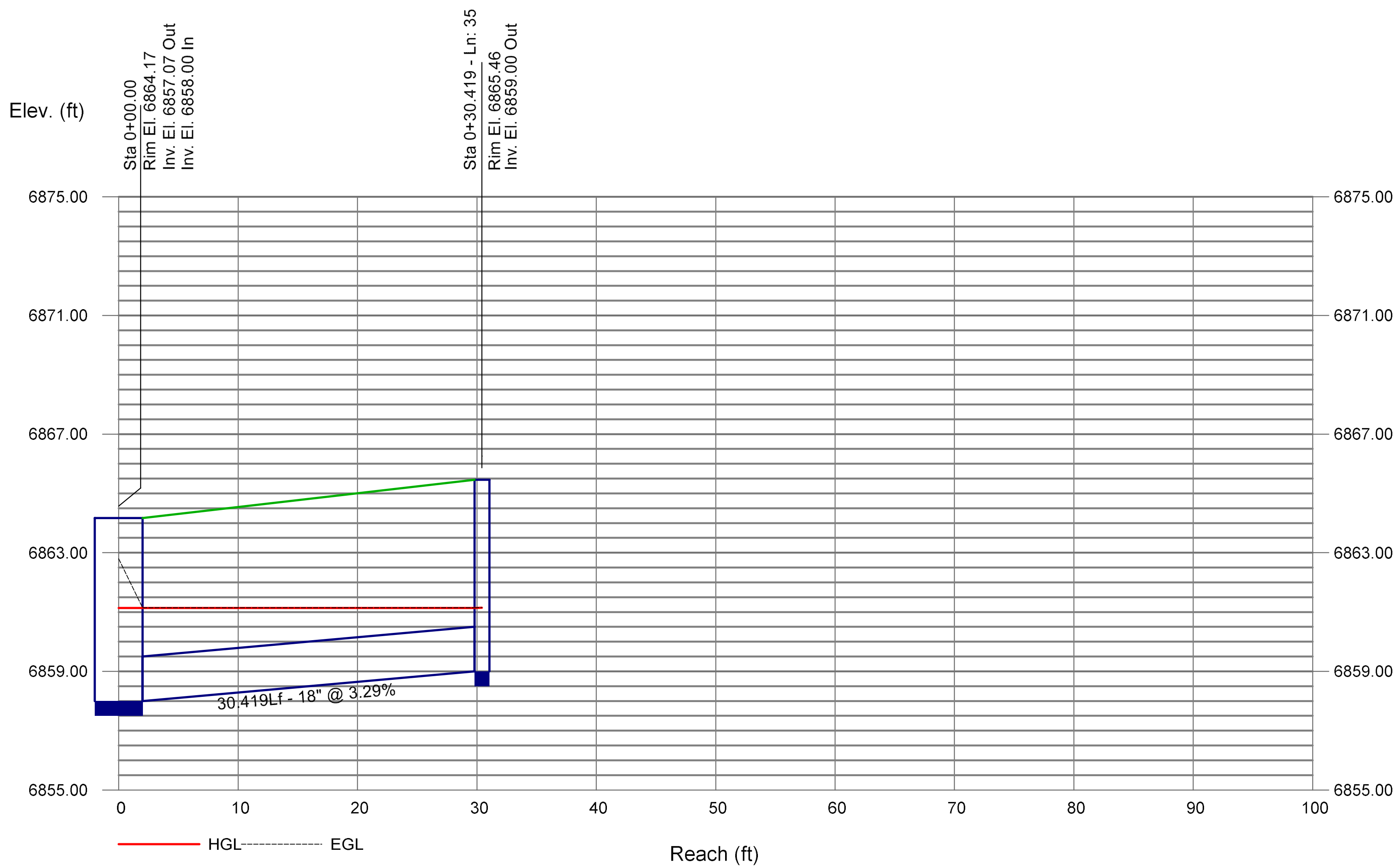
Storm Sewer Profile

Proj. file: HGL 100.stm



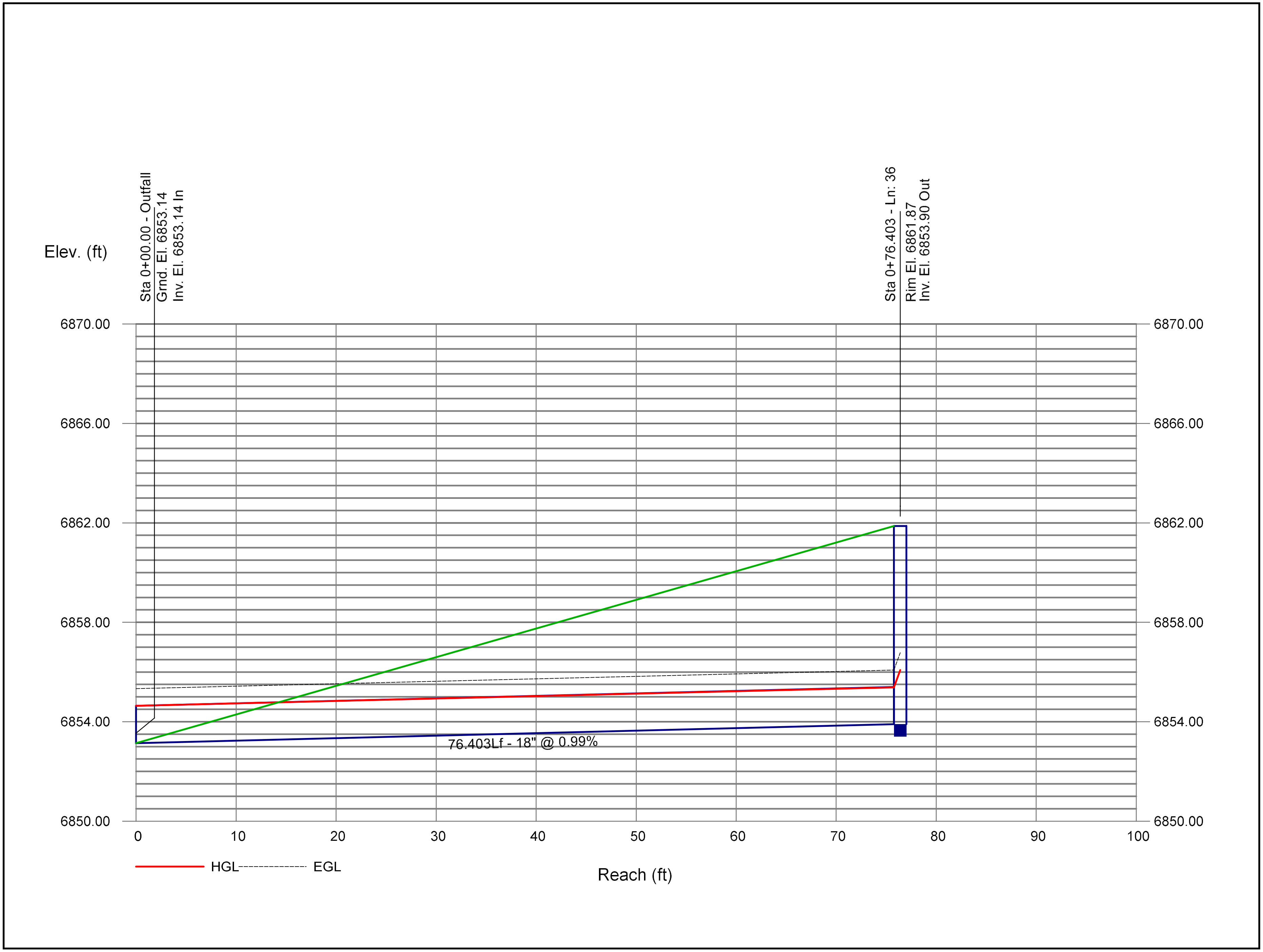
Storm Sewer Profile

Proj. file: HGL 100.stm



Storm Sewer Profile

Proj. file: HGL 100.stm



100-yr

Line No.	Flow Rate	Line Size	Line Type	Line Length	Invert Dn	Invert Up	Line Slope	HGL Up	HGL Dn	Minor Loss	HGL Jnct	Vel Ave	n-value Pipe
	(cfs)	(in)		(ft)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(ft/s)	
1	68.00	36	Cir	113.544	6855.93	6857.07	1.00	6859.70	6858.93	1.43	6861.13	9.98	0.012
2	66.80	36	Cir	68.363	6857.27	6857.95	0.99	6861.72	6861.13	0.21	6861.93	9.45	0.012
3	63.30	36	Cir	340.000	6858.15	6861.55	1.00	6864.24	6861.93	0.21	6864.45	9.22	0.012
4	60.20	36	Cir	500.000	6861.75	6870.50	1.75	6873.00	6864.45	0.34	6873.00	9.27	0.012
5	60.20	36	Cir	127.551	6870.60	6881.67	8.68	6884.17	6873.00	0.87	6884.17	9.74	0.012
6	38.20	36	Cir	36.552	6882.67	6882.85	0.49	6884.86	6884.61	0.67	6884.86	7.73	0.012
7	38.20	36	Cir	245.397	6882.85	6884.07	0.50	6886.08	6884.86	0.90	6886.08	7.59	0.012
8	38.20	36	Cir	11.325	6884.18	6884.24	0.53	6886.25	6886.08	0.90	6886.25	7.84	0.012
9	65.40	36	Cir	25.299	6858.00	6858.59	2.33	6861.18	6860.59	0.24	6861.18	10.08	0.012
10	63.00	34	Cir	85.364	6860.73	6862.63	2.23	6865.17	6862.45	1.74	6865.17	13.18	0.012
11	56.10	34	Cir	197.529	6862.73	6864.73	1.01	6867.17	6865.17	1.47	6867.17	9.72	0.012
12	34.40	30	Cir	105.605	6865.06	6866.05	0.94	6868.04 j	6867.17	n/a	6868.04	8.00	0.012
13	32.30	30	Cir	136.487	6866.15	6867.97	1.33	6869.90	6868.04	n/a	6869.90	8.02	0.012
14	28.70	30	Cir	139.556	6868.07	6870.50	1.74	6872.33 j	6869.90	n/a	6872.33	7.46	0.012
15	20.60	24	Cir	84.536	6871.00	6872.84	2.18	6874.47	6872.33	n/a	6874.47	8.43	0.012
16	14.60	24	Cir	112.326	6872.94	6875.74	2.49	6877.12 j	6874.47	n/a	6877.12	6.01	0.012
17	14.60	24	Cir	90.922	6875.74	6878.02	2.51	6879.40	6877.12	n/a	6879.40	6.34	0.012
18	14.60	24	Cir	52.999	6878.32	6878.71	0.74	6880.09	6879.55	n/a	6880.09	6.78	0.012
19	6.00	18	Cir	18.597	6872.94	6873.31	1.99	6874.42	6874.47	0.29	6874.70	3.84	0.012
20	5.80	18	Cir	74.880	6871.00	6871.50	0.67	6872.43 j	6872.33	n/a	6872.43	4.28	0.012
21	1.70	18	Cir	120.607	6871.70	6872.37	0.56	6872.86 j	6872.43	n/a	6872.86	2.69	0.012
22	1.70	18	Cir	121.330	6872.57	6875.00	2.00	6875.49	6872.90	n/a	6875.49	4.65	0.012
23	17.80	18	Cir	53.097	6863.00	6863.80	1.51	6865.80	6864.50	1.15	6866.95	10.07	0.012
24	9.40	18	Cir	454.613	6864.00	6871.73	1.70	6872.91 j	6866.95	n/a	6872.91	5.80	0.012
25	2.70	18	Cir	392.009	6871.92	6878.98	1.80	6879.60 j	6872.91	n/a	6879.60	3.03	0.012
26	2.30	18	Cir	39.377	6871.00	6871.39	0.99	6871.96	6872.33	n/a	6871.96	2.55	0.012
27	3.60	18	Cir	17.224	6868.57	6868.96	2.27	6869.68	6869.90	0.28	6869.68	3.21	0.012
28	2.10	18	Cir	17.234	6866.65	6866.82	0.99	6867.37	6868.04	n/a	6867.37	2.42	0.012
29	10.70	18	Cir	67.393	6865.31	6865.65	0.50	6867.76	6867.17	0.09	6867.85	6.06	0.012
30	4.80	18	Cir	97.180	6865.75	6866.24	0.50	6868.02	6867.85	0.05	6868.07	2.72	0.012
31	4.80	18	Cir	91.488	6866.24	6866.70	0.50	6868.20	6868.07	0.11	6868.31	2.72	0.012
32	11.00	18	Cir	39.120	6865.31	6865.51	0.51	6867.53	6867.17	0.09	6867.62	6.23	0.012
33	6.50	18	Cir	180.469	6865.61	6866.51	0.50	6868.21	6867.62	0.21	6868.42	3.68	0.012
34	6.90	18	Cir	17.287	6863.73	6863.91	1.04	6864.93	6865.17	0.46	6864.93	4.69	0.012
35	1.20	18	Cir	30.419	6858.00	6859.00	3.29	6861.14	6861.13	0.01	6861.14	0.68	0.012
36	11.80	18	Cir	76.403	6853.14	6853.90	0.99	6855.38	6854.64	0.70	6856.08	6.69	0.012
	Notes: j-Line contains hyd. jump												

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PREPARED BY:

DREXEL, BARRELL & CO.
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3 SOUTH 7TH STREET
COLORADO SPGS, COLORADO 80905
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CLIENT:

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8605 EXPLORER DRIVE, SUITE 250
COLORADO SPRINGS, COLORADO 80920
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CIVIL CONSTRUCTION PLANS
COTTAGES @ WOODMEN HEIGHTS
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
INITIAL ISSUE	02-26-20
LATEST ISSUE	4-12-22

DESIGNED BY:	SBN
DRAWN BY:	SBN
CHECKED BY:	TDM
FILE NAME:	IRF

DRAWING SCALE:
HORIZONTAL: 1" = 60'
VERTICAL: N/A

IRF MAP

PROJECT NO. 21369-00CSCV
DRAWING NO.

IRF

SHEET: 1 OF 1

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.53	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.75	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer: SBN
Company: Drexel Barrell
Date: April 12, 2022
Project: Cottages at Woodmen Heights
Location: West Pond

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**RW**	**TK**	**TC**	**OS**	**POND**									
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand							
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.230	1.430	0.780	1.020	0.200									
Directly Connected Impervious Area (DCIA, acres)	0.230	0.000	0.000	0.000	0.000									
Unconnected Impervious Area (UIA, acres)	0.000	1.430	0.000	0.000	0.000									
Receiving Pervious Area (RPA, acres)	0.000	0.000	0.780	0.000	0.000									
Separate Pervious Area (SPA, acres)	0.000	0.000	0.000	1.020	0.200									
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C	C	C	V									
						MISSING INPUT	MISSING INPUT							

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.230	1.430	0.780	1.020	0.200									
Directly Connected Impervious Area (DCIA, %)	100.0%	0.0%	0.0%	0.0%	0.0%									
Unconnected Impervious Area (UIA, %)	0.0%	100.0%	0.0%	0.0%	0.0%									
Receiving Pervious Area (RPA, %)	0.0%	0.0%	100.0%	0.0%	0.0%									
Separate Pervious Area (SPA, %)	0.0%	0.0%	0.0%	100.0%	100.0%									
A_R (RPA / UIA)	0.000	0.000	0.000	0.000	0.000									
I_a Check	1.000	1.000	1.000	1.000	1.000									
f / I for WQCV Event:	3.6	3.6	3.6	3.6	3.6									
f / I for 10-Year Event:	0.5	0.5	0.5	0.5	0.5									
f / I for 100-Year Event:	0.4	0.4	0.4	0.4	0.4									
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	1.00	1.00	1.00	1.00	0.00									
IRF for 10-Year Event:	1.00	1.00	1.00	1.00	1.00									
IRF for 100-Year Event:	1.00	1.00	1.00	1.00	1.00									
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	100.0%	100.0%	0.0%	0.0%	0.0%									
Effective Imperviousness for WQCV Event:	100.0%	100.0%	0.0%	0.0%	0.0%									
Effective Imperviousness for 10-Year Event:	100.0%	100.0%	0.0%	0.0%	0.0%									
Effective Imperviousness for 100-Year Event:	100.0%	100.0%	0.0%	0.0%	0.0%									
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	0.0%	0.0%	N/A	N/A	N/A			N/A	N/A	N/A	N/A	N/A	N/A	N/A
10-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	N/A	N/A	N/A			N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	N/A	N/A	N/A			N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	45.4%
Total Site Effective Imperviousness for WQCV Event:	45.4%
Total Site Effective Imperviousness for 10-Year Event:	45.4%
Total Site Effective Imperviousness for 100-Year Event:	45.4%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

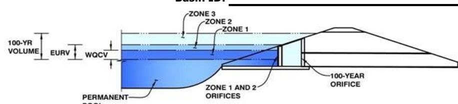
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Cottages at Woodmen Heights - West Pond**

Basin ID:



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**			
Watershed Area =	3.66	acres		
Watershed Length =	1,000	ft		
Watershed Length to Centroid =	500	ft		
Watershed Slope =	0.040	ft/ft		
Watershed Imperviousness =	45.40%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.059	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.186	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.139	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.185	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.222	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.286	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.348	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.427	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.49 in.) =	0.703	acre-feet	3.49	inches
Approximate 2-yr Detention Volume =	0.119	acre-feet		
Approximate 5-yr Detention Volume =	0.158	acre-feet		
Approximate 10-yr Detention Volume =	0.193	acre-feet		
Approximate 25-yr Detention Volume =	0.238	acre-feet		
Approximate 50-yr Detention Volume =	0.267	acre-feet		
Approximate 100-yr Detention Volume =	0.304	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.059	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.127	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.118	acre-feet
Total Detention Basin Volume =	0.304	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	15	0.000		
62	--	0.50	--	--	--	15	0.000	8	0.000
63	--	1.50	--	--	--	1,253	0.029	641	0.015
64	--	2.50	--	--	--	2,779	0.064	2,657	0.061
65	--	3.50	--	--	--	4,243	0.097	6,168	0.142
66	--	4.50	--	--	--	5,810	0.133	11,195	0.257
67	--	5.50	--	--	--	7,478	0.172	17,839	0.410
67.6	--	6.10	--	--	--	8,527	0.196	22,640	0.520
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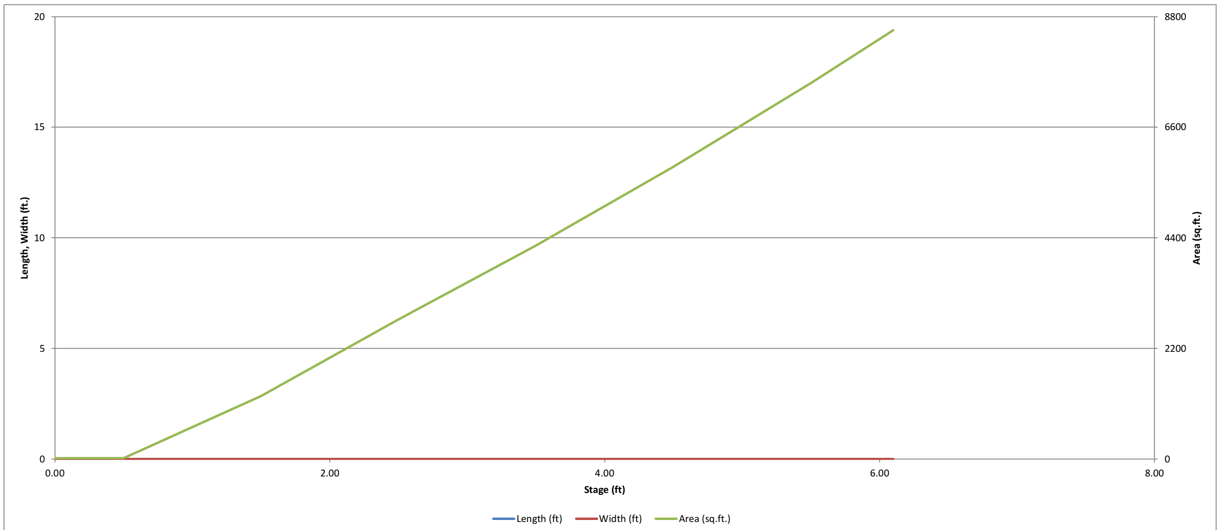
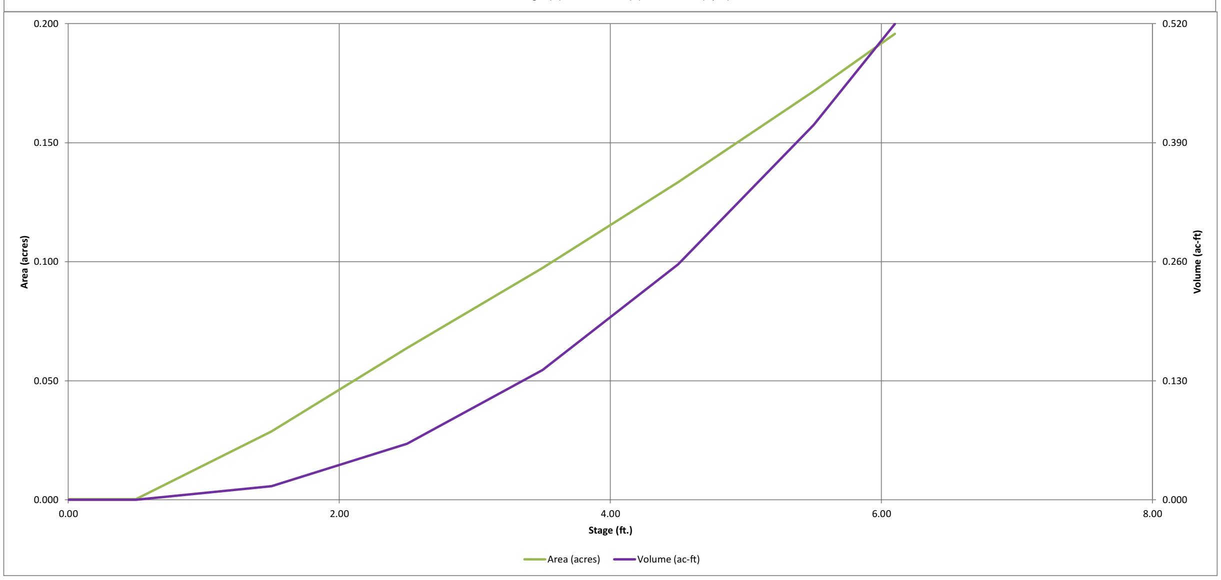
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



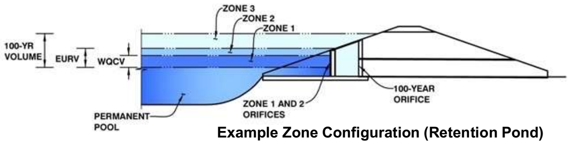


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Cottages at Woodmen Heights - West Pond**

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.48	0.059	Orifice Plate
Zone 2 (EURV)	3.93	0.127	Orifice Plate
Zone 3 (100-year)	4.84	0.118	Weir&Pipe (Restrict)
Total (all zones)		0.304	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.93	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	15.70	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.31	2.62					
Orifice Area (sq. inches)	0.29	0.29	0.45					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.45	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.91	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	3.91	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.45	N/A	feet
Overflow Weir Slope Length =	3.91	N/A	feet
Grate Open Area / 100-yr Orifice Area =	26.56	N/A	
Overflow Grate Open Area w/o Debris =	10.64	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.32	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	5.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.40	N/A	ft^2
Outlet Orifice Centroid =	0.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.11	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.70	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	7.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.36	feet
Stage at Top of Freeboard =	6.06	feet
Basin Area at Top of Freeboard =	0.19	acres
Basin Volume at Top of Freeboard =	0.51	acre-ft

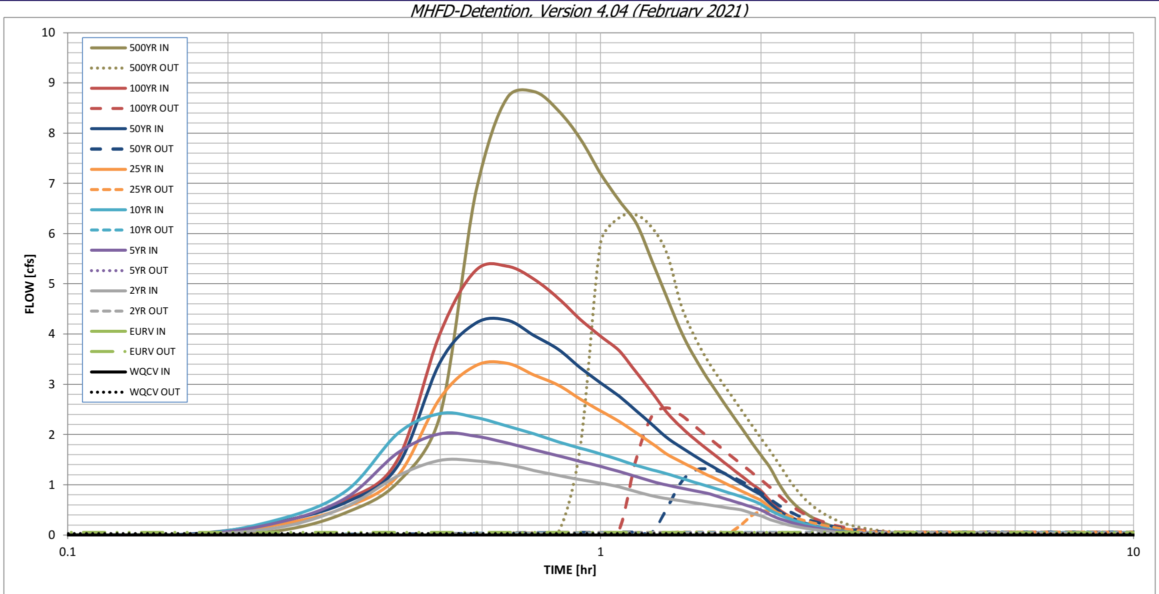
Routed Hydrograph Results

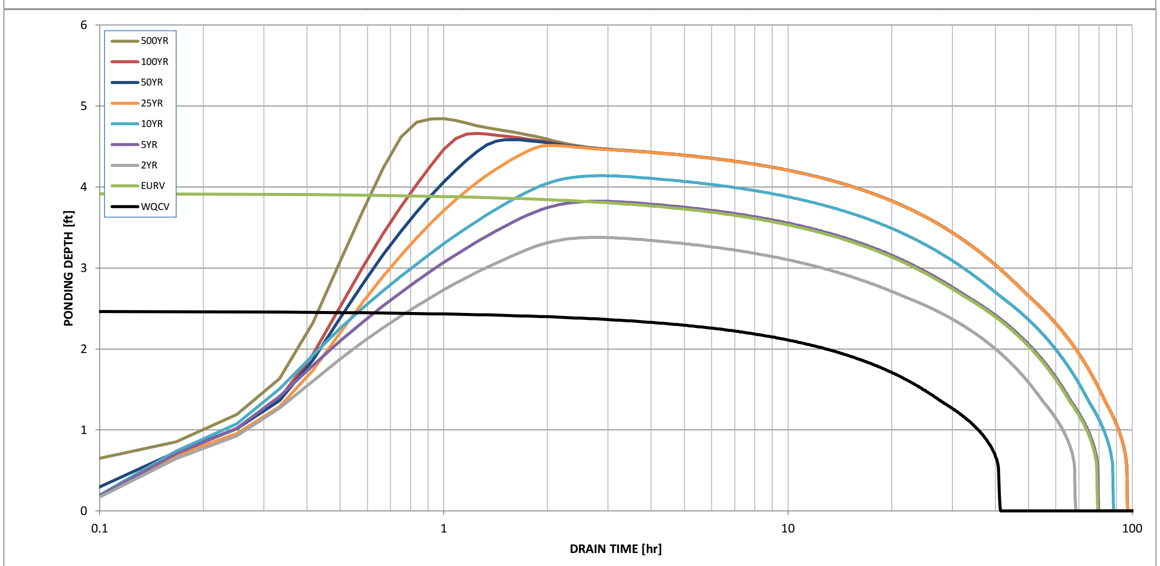
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

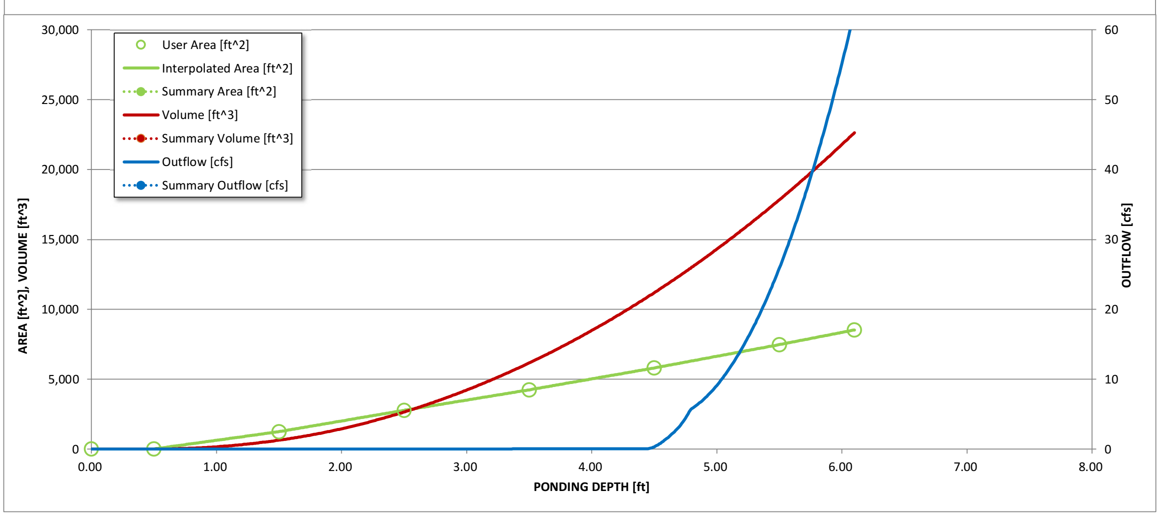
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.49
CUHP Runoff Volume (acre-ft) =	0.059	0.186	0.139	0.185	0.222	0.286	0.348	0.427	0.703
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.139	0.185	0.222	0.286	0.348	0.427	0.703
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.1	0.5	1.0	1.6	3.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.01	0.13	0.27	0.44	1.04
Peak Inflow Q (cfs) =	N/A	N/A	1.5	2.0	2.4	3.4	4.3	5.4	8.8
Peak Outflow Q (cfs) =	0.0	0.1	0.0	0.05	0.1	0.5	1.3	2.5	6.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.3	1.0	1.0	1.3	1.6	1.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.0	0.1	0.2	0.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	72	63	72	79	86	84	82	76
Time to Drain 99% of Inflow Volume (hours) =	**40**	76	66	77	85	93	92	91	88
Maximum Ponding Depth (ft) =	2.47	3.93	3.38	3.83	4.14	4.51	4.59	4.66	4.84
Area at Maximum Ponding Depth (acres) =	0.06	0.11	0.09	0.11	0.12	0.13	0.14	0.14	0.15
Maximum Volume Stored (acre-ft) =	0.059	0.187	0.129	0.175	0.211	0.258	0.268	0.279	0.305

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.09
	0:15:00	0.00	0.00	0.16	0.25	0.32	0.21	0.27	0.26	0.45
	0:20:00	0.00	0.00	0.57	0.74	0.88	0.56	0.66	0.70	1.05
	0:25:00	0.00	0.00	1.18	1.64	2.02	1.18	1.38	1.50	2.39
	0:30:00	0.00	0.00	1.49	2.01	2.42	2.73	3.44	4.02	6.82
	0:35:00	0.00	0.00	1.48	1.96	2.34	3.37	4.22	5.27	8.69
	0:40:00	0.00	0.00	1.40	1.83	2.17	3.42	4.28	5.35	8.83
	0:45:00	0.00	0.00	1.29	1.69	2.01	3.19	3.97	5.09	8.45
	0:50:00	0.00	0.00	1.18	1.58	1.85	2.98	3.70	4.71	7.88
	0:55:00	0.00	0.00	1.10	1.47	1.73	2.70	3.33	4.29	7.19
	1:00:00	0.00	0.00	1.03	1.36	1.61	2.47	3.03	3.96	6.66
	1:05:00	0.00	0.00	0.96	1.26	1.50	2.26	2.77	3.67	6.21
	1:10:00	0.00	0.00	0.86	1.17	1.39	2.03	2.47	3.24	5.44
	1:15:00	0.00	0.00	0.78	1.07	1.30	1.82	2.20	2.83	4.72
	1:20:00	0.00	0.00	0.72	0.99	1.22	1.61	1.93	2.44	4.05
	1:25:00	0.00	0.00	0.68	0.93	1.13	1.46	1.75	2.14	3.54
	1:30:00	0.00	0.00	0.64	0.88	1.05	1.32	1.58	1.91	3.14
	1:35:00	0.00	0.00	0.61	0.83	0.97	1.20	1.43	1.71	2.78
	1:40:00	0.00	0.00	0.57	0.76	0.90	1.09	1.29	1.53	2.46
	1:45:00	0.00	0.00	0.54	0.69	0.84	0.98	1.16	1.35	2.15
	1:50:00	0.00	0.00	0.50	0.63	0.77	0.88	1.03	1.19	1.86
	1:55:00	0.00	0.00	0.44	0.56	0.69	0.78	0.91	1.03	1.59
	2:00:00	0.00	0.00	0.38	0.50	0.61	0.69	0.79	0.88	1.33
	2:05:00	0.00	0.00	0.31	0.40	0.49	0.54	0.62	0.68	1.01
	2:10:00	0.00	0.00	0.25	0.32	0.40	0.42	0.47	0.50	0.75
	2:15:00	0.00	0.00	0.20	0.27	0.33	0.33	0.37	0.39	0.57
	2:20:00	0.00	0.00	0.17	0.22	0.28	0.26	0.30	0.30	0.45
	2:25:00	0.00	0.00	0.14	0.18	0.23	0.21	0.24	0.24	0.35
	2:30:00	0.00	0.00	0.11	0.15	0.19	0.17	0.19	0.19	0.27
	2:35:00	0.00	0.00	0.09	0.12	0.15	0.14	0.16	0.15	0.21
	2:40:00	0.00	0.00	0.07	0.10	0.12	0.11	0.12	0.12	0.16
	2:45:00	0.00	0.00	0.06	0.08	0.10	0.09	0.10	0.09	0.12
	2:50:00	0.00	0.00	0.05	0.06	0.08	0.07	0.08	0.07	0.10
	2:55:00	0.00	0.00	0.04	0.05	0.06	0.06	0.06	0.06	0.08
	3:00:00	0.00	0.00	0.03	0.04	0.05	0.04	0.05	0.05	0.06
	3:05:00	0.00	0.00	0.02	0.03	0.04	0.03	0.04	0.04	0.05
	3:10:00	0.00	0.00	0.02	0.02	0.03	0.03	0.03	0.03	0.03
	3:15:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02
	3:20:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	3:25:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

WEST POND

FOREBAY VOLUME

V=3% x WQCV

WQCV=	0.059	ac-ft
V_{TOTAL}=	0.0018	ac-ft

FOREBAY RELEASE NOTCH WIDTH

$Q=CLH^{2/3}$

Q_{100}=	17.1	cfs
2% of Q=	0.34	cfs
C=	2.6	
H (height of forebay wall)=	1	ft
L=	2	in

West Pond

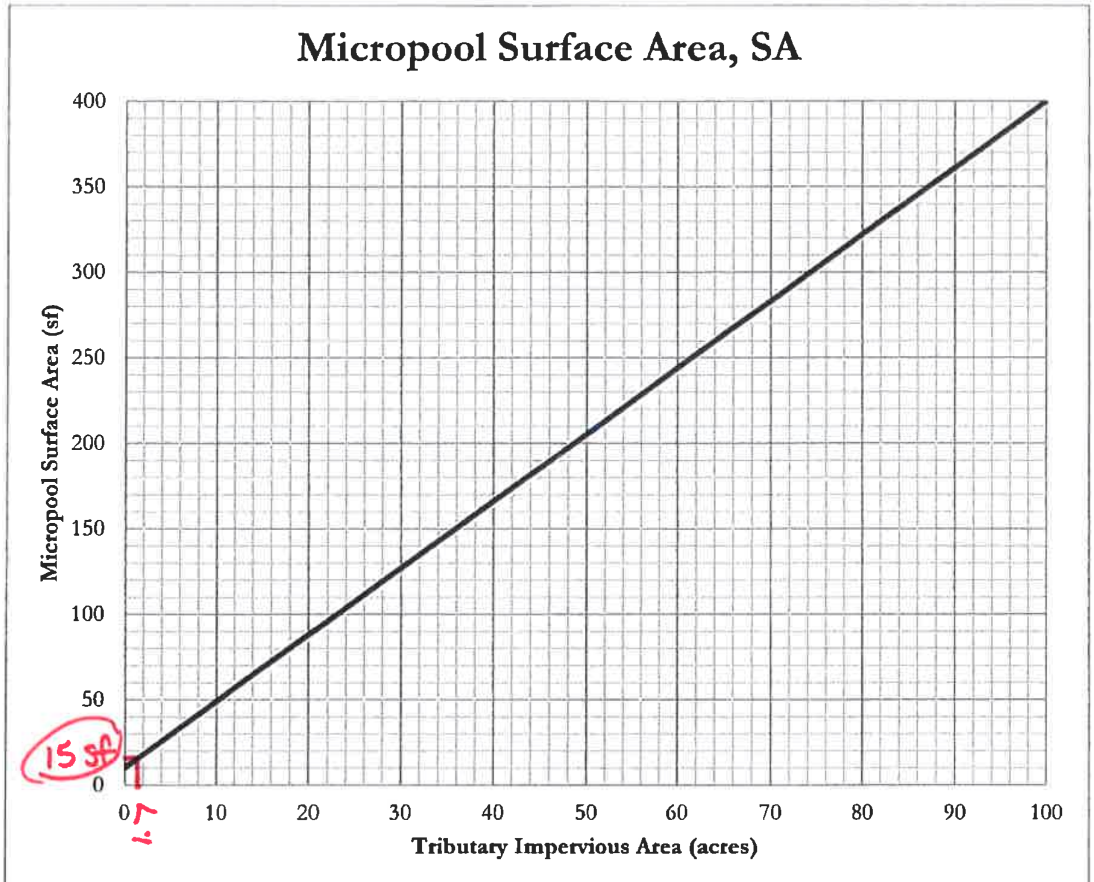


Figure 1 – Micropool surface area (SA) determination chart

The tributary impervious area is the effective number of impervious acres that will be treated by the extended detention basin (EDB). It is calculated by multiplying the tributary area to be treated by the impervious fraction of that area.

$$TIA = I \times A$$

$\frac{45.4}{100} \times 3.66 = 1.7$ ac

TIA = Tributary impervious area (acres)
I = Imperviousness (fraction)
A = Tributary catchment area upstream (acres)

For EDBs with tributary impervious areas greater than 100 acres, the micropool surface area is 400 sf. The initial surcharge depth (ISD) is defined as the depth of the initial surcharge volume (ISV). The surface area determined using Figure 1 assumes an ISD of 4 inches. The initial surcharge volume is thus calculated by multiplying the micropool surface area by 4 inches.

$$ISV = SA \times 4\ inches$$

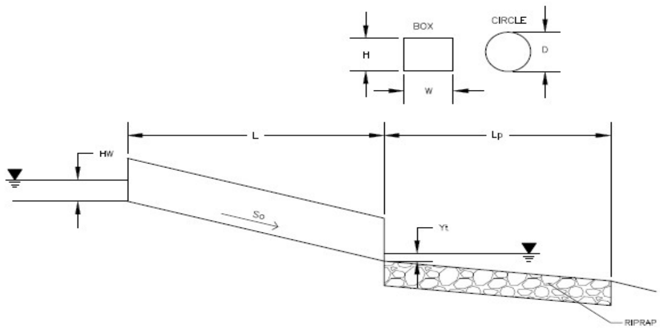
ISV = Initial surcharge volume (cf)
SA = Surface area (from Figure 1, sf)

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Cottages at Woodmen Heights - West Pond outfall**

ID:



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

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	68.7	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	36	inches
Inlet Edge Type (Choose from pull-down list)		Grooved Edge Projecting	
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	6857.07	ft
Outlet Elevation **OR** Slope	Elev OUT =	6855.93	ft
Culvert Length	L =	113.55	ft
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	7.07	ft^2
Culvert Normal Depth	Y_n =	2.33	ft
Culvert Critical Depth	Y_c =	2.64	ft
Froude Number	Fr =	1.34	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.70	
Sum of All Loss Coefficients	k_s =	1.90	ft
Headwater:			
Inlet Control Headwater	HW_I =	5.04	ft
Outlet Control Headwater	HW_O =	4.46	ft
Design Headwater Elevation	**HW =**	**6862.11**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.68**	**HW/D > 1.5!**
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	4.41	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	1.20	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	3.06	
Flow Area at Max Channel Velocity	A_t =	13.74	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	L_p =	**26**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**12**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	2.66	ft
Minimum Theoretical Riprap Size	d_{50} min=	11	in
Nominal Riprap Size	d_{50} nominal=	12	in
MHFD Riprap Type	**Type =**	**M**	

Worksheet
Worksheet for Rectangular Channel

Chase into South Pond

Project Description	
Worksheet	Rectangular Chann
Flow Element	Rectangular Chann
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.013	
Slope	088000	ft/ft
Bottom Width	6.00	ft
Discharge	36.90	cfs

Results		
Depth	0.38	ft
Flow Area	2.3	ft²
Wetted Perim	6.75	ft
Top Width	6.00	ft
Critical Depth	1.06	ft
Critical Slope	0.003615	ft/ft
Velocity	16.34	ft/s
Velocity Head	4.15	ft
Specific Energ	4.52	ft
Froude Numb	4.69	
Flow Type	Supercritical	

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

Designer: SBN
Company: Drexel Barrell
Date: January 10, 2022
Project: Cottages at Woodmen Heights
Location: South Pond

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.53	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.75	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**RW**	**TH**	**SF**	**RF**	**CM**	**OS**	**POND**							
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand							
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	6.920	4.170	4.960	0.100	1.910	3.030	0.990							
Directly Connected Impervious Area (DCIA, acres)	6.920	0.000	1.060	0.000	1.620	0.000	0.000							
Unconnected Impervious Area (UIA, acres)	0.000	3.110	1.300	0.100	0.000	0.000	0.000							
Receiving Pervious Area (RPA, acres)	0.000	0.000	1.230	0.000	0.000	0.000	0.000							
Separate Pervious Area (SPA, acres)	0.000	1.060	1.370	0.000	0.290	3.030	0.990							
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C	C	C	C	C	V							

CALCULATED RESULTS (OUTPUT)

	RW	TH	SF	RF	CM	OS	POND							
Total Calculated Area (ac, check against input)	6.920	4.170	4.960	0.100	1.910	3.030	0.990							
Directly Connected Impervious Area (DCIA, %)	100.0%	0.0%	21.4%	0.0%	84.8%	0.0%	0.0%							
Unconnected Impervious Area (UIA, %)	0.0%	74.6%	26.2%	100.0%	0.0%	0.0%	0.0%							
Receiving Pervious Area (RPA, %)	0.0%	0.0%	24.8%	0.0%	0.0%	0.0%	0.0%							
Separate Pervious Area (SPA, %)	0.0%	25.4%	27.6%	0.0%	15.2%	100.0%	100.0%							
A_R (RPA / UIA)	0.000	0.000	0.946	0.000	0.000	0.000	0.000							
I_a Check	1.000	1.000	0.510	1.000	1.000	1.000	1.000							
f / I for WQCV Event:	3.6	3.6	3.6	3.6	3.6	3.6	3.6							
f / I for 10-Year Event:	0.5	0.5	0.5	0.5	0.5	0.5	0.5							
f / I for 100-Year Event:	0.4	0.4	0.4	0.4	0.4	0.4	0.4							
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	1.00	1.00	0.61	1.00	1.00	1.00	0.00							
IRF for 10-Year Event:	1.00	1.00	0.89	1.00	1.00	1.00	1.00							
IRF for 100-Year Event:	1.00	1.00	0.91	1.00	1.00	1.00	1.00							
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	100.0%	74.6%	47.6%	100.0%	84.8%	0.0%	0.0%							
Effective Imperviousness for WQCV Event:	100.0%	74.6%	37.4%	100.0%	84.8%	0.0%	0.0%							
Effective Imperviousness for 10-Year Event:	100.0%	74.6%	44.8%	100.0%	84.8%	0.0%	0.0%							
Effective Imperviousness for 100-Year Event:	100.0%	74.6%	45.3%	100.0%	84.8%	0.0%	0.0%							
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

	RW	TH	SF	RF	CM	OS	POND							
WQCV Event CREDIT: Reduce Detention By:	0.0%	0.0%	13.5%	0.0%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	6.1%	0.4%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	4.7%	0.3%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**63.9%**
Total Site Effective Imperviousness for WQCV Event:	**61.6%**
Total Site Effective Imperviousness for 10-Year Event:	**63.3%**
Total Site Effective Imperviousness for 100-Year Event:	**63.4%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

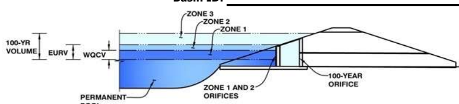
* Use Green-Ampt average infiltration rate values from Table 3-3.
** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Cottages at Woodmen Heights - South Pond**

Basin ID:



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	23.23	acres
Watershed Length =	1,170	ft
Watershed Length to Centroid =	485	ft
Watershed Slope =	0.027	ft/ft
Watershed Imperviousness =	63.90%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.484	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.833	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.310	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.719	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.047	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.479	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.904	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.421	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.49 in.) =	5.218	acre-feet	3.49	inches
Approximate 2-yr Detention Volume =	1.192	acre-feet		
Approximate 5-yr Detention Volume =	1.559	acre-feet		
Approximate 10-yr Detention Volume =	1.880	acre-feet		
Approximate 25-yr Detention Volume =	2.265	acre-feet		
Approximate 50-yr Detention Volume =	2.498	acre-feet		
Approximate 100-yr Detention Volume =	2.742	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.484	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.349	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.909	acre-feet
Total Detention Basin Volume =	2.742	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	70	0.002		
57	--	0.50	--	--	--	70	0.002	35	0.001
58	--	1.50	--	--	--	5,732	0.132	2,936	0.067
59	--	2.50	--	--	--	17,950	0.412	14,777	0.339
60	--	3.50	--	--	--	21,628	0.497	34,566	0.794
61	--	4.50	--	--	--	25,434	0.584	58,097	1.334
62	--	5.50	--	--	--	29,367	0.674	85,497	1.963
63	--	6.50	--	--	--	33,428	0.767	116,895	2.684
64	--	7.50	--	--	--	37,885	0.870	152,551	3.502
65	--	8.50	--	--	--	42,289	0.971	192,638	4.422
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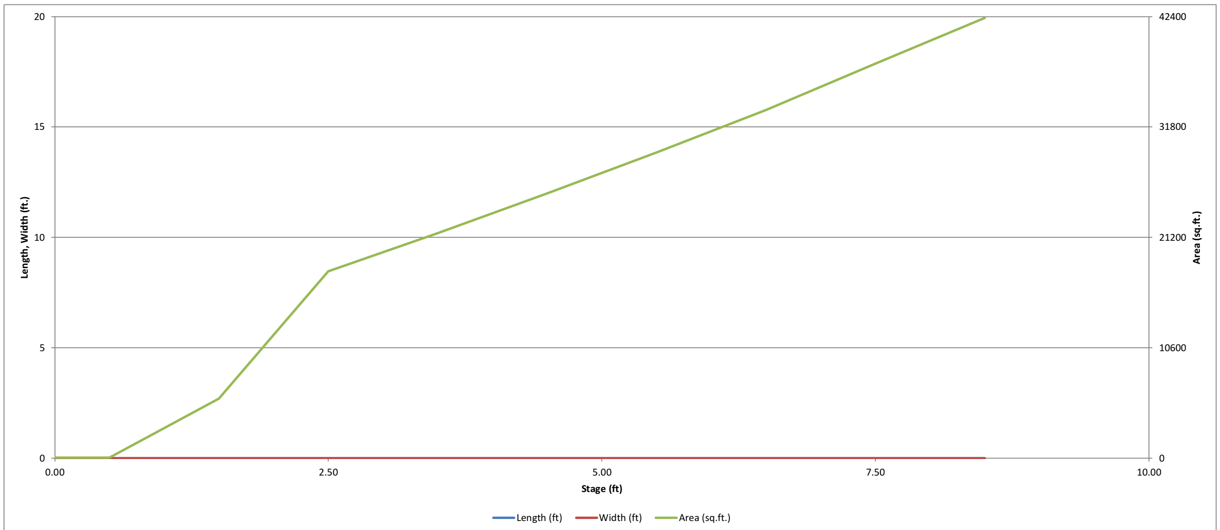
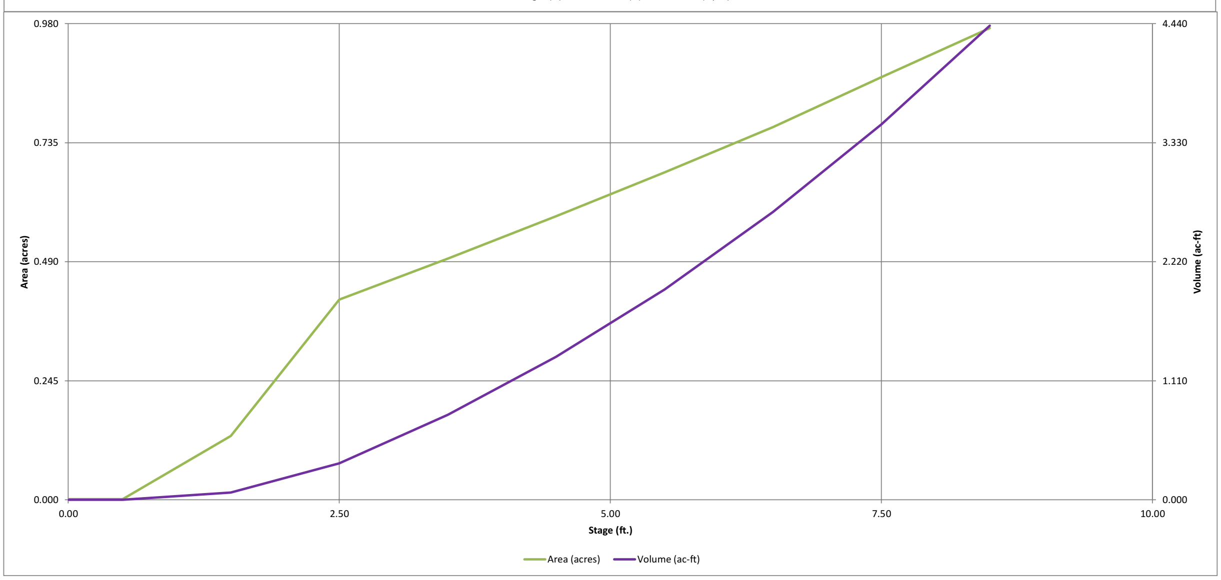
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



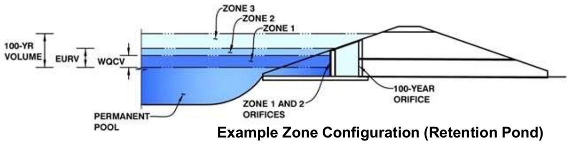


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Cottages at Woodmen Heights - South Pond**

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.84	0.484	Orifice Plate
Zone 2 (EURV)	5.31	1.349	Orifice Plate
Zone 3 (100-year)	6.58	0.909	Weir&Pipe (Restrict)
Total (all zones)		2.742	

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

			Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

			Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	5.31	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	21.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.77	3.54					
Orifice Area (sq. inches)	2.36	2.36	8.25					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.50	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	9.07	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.23	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.55	N/A	feet
Restrictor Plate Height Above Pipe Invert =	11.80		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.89	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.55	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.95	feet
Spillway Crest Length =	23.00	feet	Stage at Top of Freeboard =	8.50	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.97	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	4.42	acre-ft

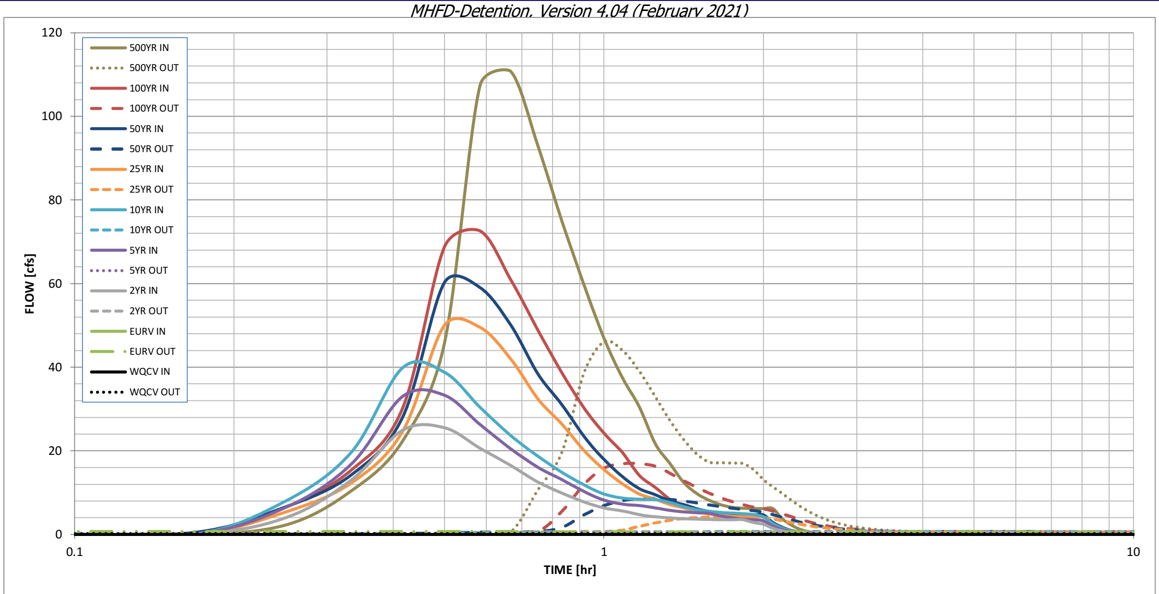
Routed Hydrograph Results

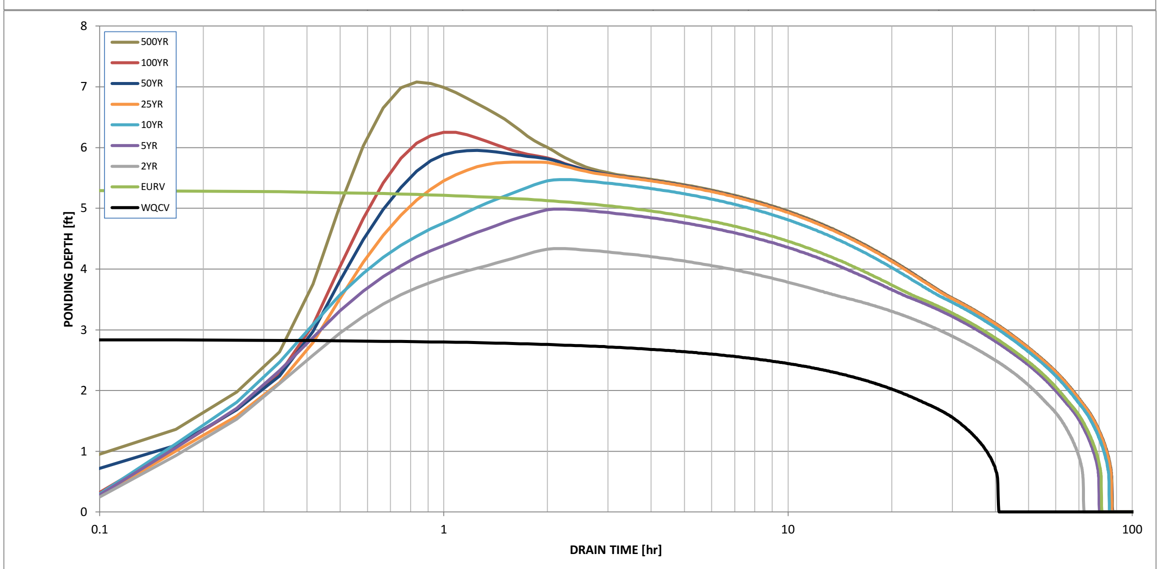
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

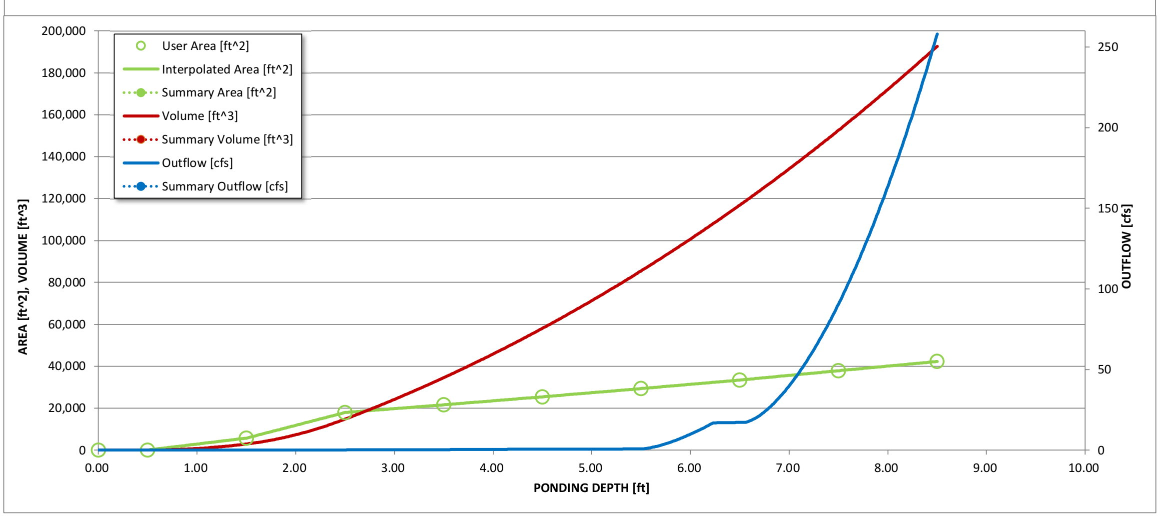
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.49
CUHP Runoff Volume (acre-ft) =	0.484	1.833	1.310	1.719	2.047	2.479	2.904	3.421	5.218
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.310	1.719	2.047	2.479	2.904	3.421	5.218
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.5	0.6	5.7	11.2	18.4	41.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.03	0.24	0.48	0.79	1.80
Peak Inflow Q (cfs) =	N/A	N/A	25.5	33.3	39.9	50.0	60.3	72.6	110.7
Peak Outflow Q (cfs) =	0.2	0.7	0.5	0.6	0.7	4.2	8.6	16.9	46.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.4	1.1	0.7	0.8	0.9	1.1
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.3	0.7	1.4	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	73	66	72	77	77	75	73	68
Time to Drain 99% of Inflow Volume (hours) =	**40**	78	70	77	82	83	83	82	80
Maximum Ponding Depth (ft) =	2.84	5.31	4.34	4.99	5.47	5.76	5.95	6.25	7.08
Area at Maximum Ponding Depth (acres) =	0.44	0.66	0.57	0.63	0.67	0.70	0.72	0.74	0.83
Maximum Volume Stored (acre-ft) =	0.484	1.836	1.236	1.624	1.943	2.141	2.276	2.487	3.138

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.04	2.22
	0:15:00	0.00	0.00	3.95	6.42	7.95	5.35	6.57	6.51	10.44
	0:20:00	0.00	0.00	13.09	16.85	19.71	12.35	14.27	15.45	22.37
	0:25:00	0.00	0.00	24.94	33.00	39.89	24.69	28.04	30.22	45.75
	0:30:00	0.00	0.00	25.55	33.28	38.79	50.03	60.26	68.80	107.32
	0:35:00	0.00	0.00	20.63	26.30	30.44	49.52	59.03	72.63	110.71
	0:40:00	0.00	0.00	16.51	20.50	23.62	42.00	50.08	60.95	92.97
	0:45:00	0.00	0.00	12.56	16.10	18.77	32.44	38.40	48.91	74.92
	0:50:00	0.00	0.00	9.89	13.11	14.87	26.37	31.03	38.65	59.80
	0:55:00	0.00	0.00	7.83	10.28	11.88	20.10	23.48	30.31	46.90
	1:00:00	0.00	0.00	6.35	8.22	9.66	15.52	17.94	24.21	37.49
	1:05:00	0.00	0.00	5.65	7.25	8.74	12.14	13.86	19.59	30.51
	1:10:00	0.00	0.00	4.74	6.92	8.46	9.68	10.98	14.16	21.72
	1:15:00	0.00	0.00	4.23	6.37	8.36	8.45	9.54	11.24	16.91
	1:20:00	0.00	0.00	3.94	5.79	7.64	7.14	8.04	8.40	12.38
	1:25:00	0.00	0.00	3.77	5.42	6.62	6.34	7.14	6.74	9.74
	1:30:00	0.00	0.00	3.66	5.20	5.95	5.46	6.14	5.72	8.13
	1:35:00	0.00	0.00	3.58	5.07	5.53	4.90	5.51	5.07	7.09
	1:40:00	0.00	0.00	3.54	4.40	5.26	4.55	5.11	4.69	6.49
	1:45:00	0.00	0.00	3.54	3.97	5.09	4.35	4.89	4.56	6.31
	1:50:00	0.00	0.00	3.54	3.70	4.98	4.24	4.77	4.49	6.21
	1:55:00	0.00	0.00	2.88	3.55	4.75	4.19	4.71	4.49	6.21
	2:00:00	0.00	0.00	2.45	3.28	4.23	4.16	4.68	4.49	6.21
	2:05:00	0.00	0.00	1.51	2.03	2.63	2.60	2.92	2.80	3.86
	2:10:00	0.00	0.00	0.92	1.23	1.60	1.59	1.79	1.71	2.36
	2:15:00	0.00	0.00	0.53	0.72	0.94	0.94	1.05	1.00	1.38
	2:20:00	0.00	0.00	0.28	0.41	0.52	0.53	0.60	0.57	0.78
	2:25:00	0.00	0.00	0.13	0.21	0.25	0.28	0.31	0.29	0.39
	2:30:00	0.00	0.00	0.05	0.08	0.09	0.10	0.11	0.10	0.13
	2:35:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SOUTH POND

FOREBAY VOLUME

V=3% x WQCV

WQCV=	0.484	ac-ft
V_{TOTAL}=	0.0145	ac-ft
V_{WEST}=	0.0086	ac-ft
V_{EAST}=	0.0059	ac-ft

FOREBAY RELEASE NOTCH WIDTH - WEST

$Q=CLH^{2/3}$

Q_{100}=	53.6	cfs
2% of Q=	1.07	cfs
C=	2.6	
H (height of forebay wall)=	1	ft
L=	5	in

FOREBAY RELEASE NOTCH WIDTH - EAST

$Q=CLH^{2/3}$

Q_{100}=	36.9	cfs
2% of Q=	0.74	cfs
C=	2.6	
H (height of forebay wall)=	1	ft
L=	3	in

South Pond

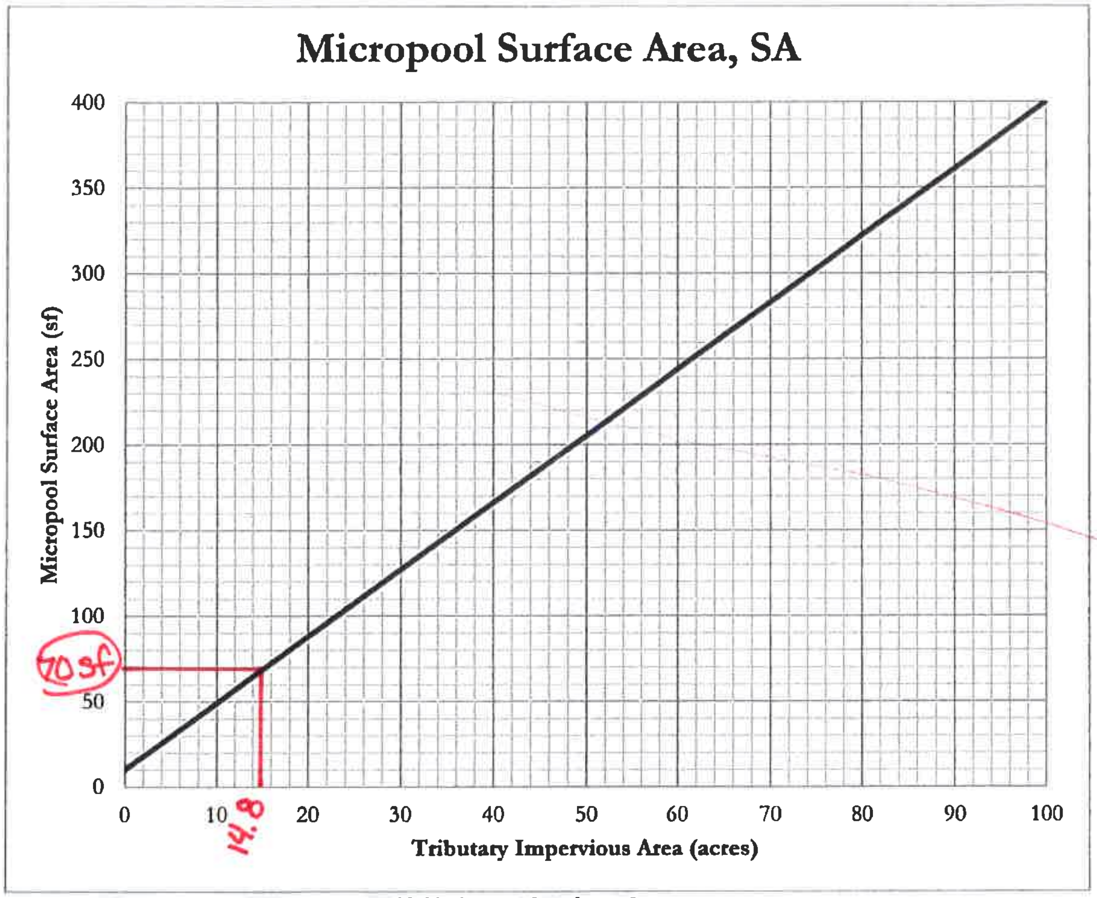


Figure 1 – Micropool surface area (SA) determination chart

The tributary impervious area is the effective number of impervious acres that will be treated by the extended detention basin (EDB). It is calculated by multiplying the tributary area to be treated by the impervious fraction of that area.

$$TIA = I \times A$$

$\frac{63.9}{100} \times 23.23 = 14.8$ ac

TIA = Tributary impervious area (acres)
I = Imperviousness (fraction)
A = Tributary catchment area upstream (acres)

For EDBs with tributary impervious areas greater than 100 acres, the micropool surface area is 400 sf. The initial surcharge depth (ISD) is defined as the depth of the initial surcharge volume (ISV). The surface area determined using Figure 1 assumes an ISD of 4 inches. The initial surcharge volume is thus calculated by multiplying the micropool surface area by 4 inches.

$$ISV = SA \times 4\ inches$$

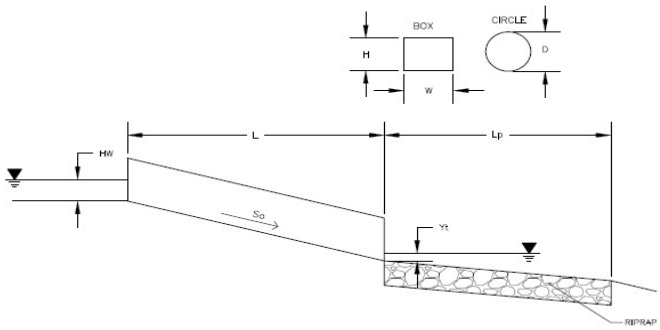
ISV = Initial surcharge volume (cf)
SA = Surface area (from Figure 1, sf)

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Cottages at Woodmen Heights - South Pond outfall**

ID:



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

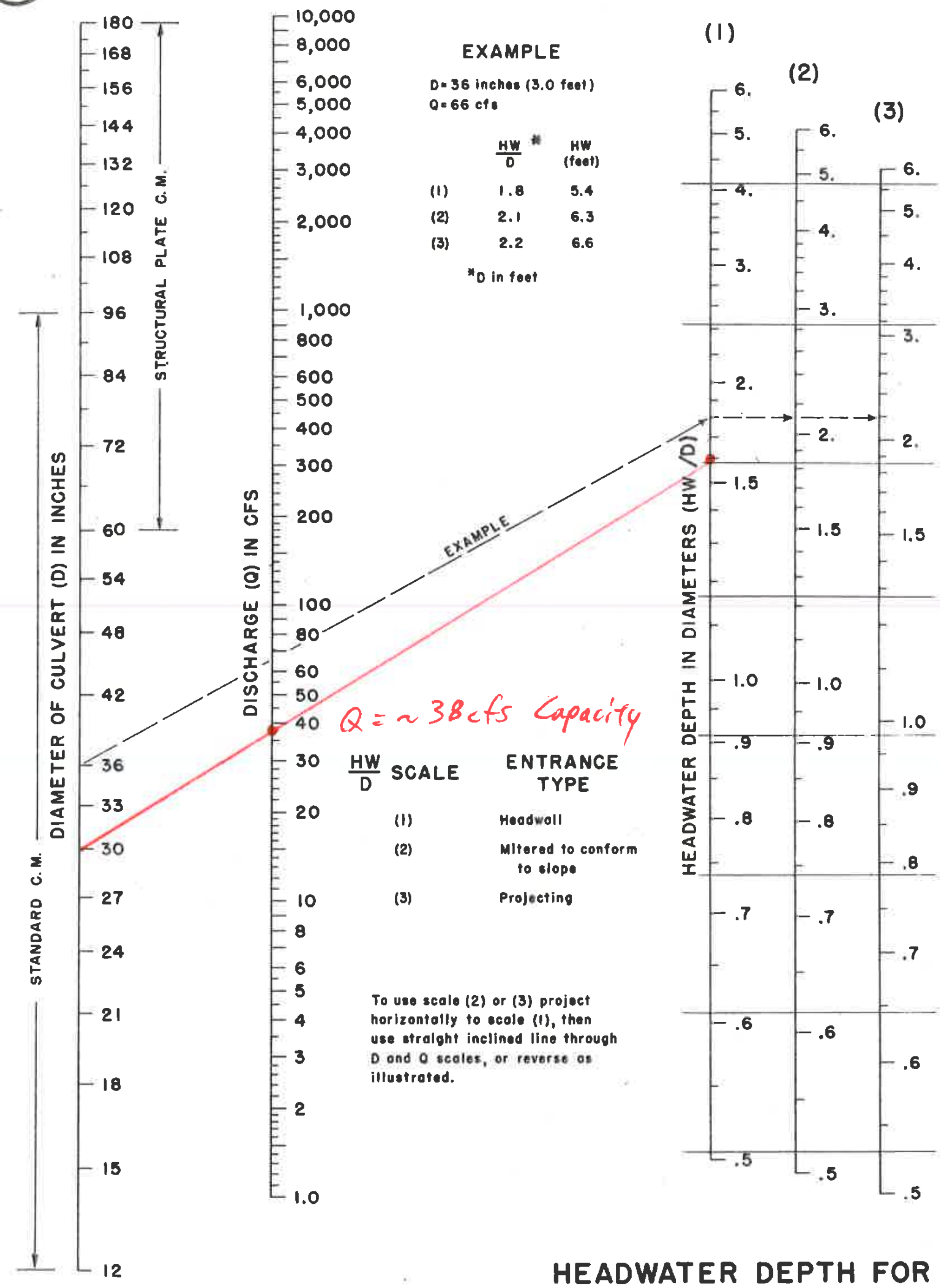
Design Information:

Design Discharge	Q =	16.9	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Grooved Edge Projecting	
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	6853.9	ft
Outlet Elevation **OR** Slope	Elev OUT =	6853.14	ft
Culvert Length	L =	76.41	ft
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	1.77	ft^2
Culvert Normal Depth	Y_n =	1.50	ft
Culvert Critical Depth	Y_c =	1.44	ft
Froude Number	Fr =	-	**Pressure flow!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.18	
Sum of All Loss Coefficients	k_s =	2.38	ft
Headwater:			
Inlet Control Headwater	HW_I =	3.94	ft
Outlet Control Headwater	HW_O =	4.52	ft
Design Headwater Elevation	**HW =**	**6858.42**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**3.02**	**HW/D > 1.5!**
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	6.13	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.60	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	1.82	
Flow Area at Max Channel Velocity	A_t =	3.38	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**8**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**6**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	-	ft
Minimum Theoretical Riprap Size	d_{50} min=	8	in
Nominal Riprap Size	d_{50} nominal=	9	in
MHFD Riprap Type	**Type =**	**L**	

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

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710 11th Avenue, Suite L-45 • Greeley, CO 80631 • 970-351-0645

March 29, 2022

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

Subject: *Cottages at Woodmen Heights – Sand Creek Variance Request*

To: *Erin Powers, City of Colorado Springs*
Tim McConnell, Drexel, Barrell & Co. (DBC)

Goodwin Knight (Applicant) has proposed the construction of a new housing development located south of East Woodmen Road and west of Marksheffel Road in northeast Colorado Springs. The proposed Cottages at Woodmen Heights is shown in **Figure 1**.

Figure 1. Location Map

This document is provided in support of a request for variance from two criteria applicable to the Project. The Project is adjacent to and west of 1,793 feet of Sand Creek. Based on field observations, the majority of this reach of Sand Creek is relatively stable. There are two existing at-grade (buried) grade control structures, and the bed and banks are covered with heavy vegetation, including wetland vegetation. There is headcutting and undermining of the channel bed at the downstream end of the reach, where a drop structure is being proposed. The purpose of this variance request is to show that the guidance provided in the Sand Creek DBPS and the City DCM are not intended to address specific site conditions, and that implementation of the requirements will cause increases to hydraulic parameters (velocities, Froude numbers, tractive forces) above City criteria. This variance will not result in a change in peak flows or water quality in Fountain Creek.

The following criteria are applicable to the proposed drop structure, grade control structure (GCS), and bank protection along Sand Creek associated with the Project.

Recently-approved Sand Creek DBPS – Recommended Stable Slope of 0.2%

The reach of Sand Creek adjacent to the east edge of the Project is referenced as SC1R10 in the 2021 DBPS. The 2021 DBPS recommends a stable slope of 0.2% in the upper basin. To achieve this slope in the 9,223-foot reach of SC1R10, 36 3-foot grade control structures are proposed, spaced at 252-foot increments (Table 6-13 attached). The reach of Sand Creek adjacent to the project is 1,793 feet at an average slope of 1.6%. To achieve the recommended 0.2% slope adjacent to the Project, approximately thirteen 2-foot drop structures would be required, spaced at a maximum of 140 feet apart.

During a site visit on June 2, 2021, the design team, site owner, and City staff discussed adding a mid-reach buried GCS to meet the 0.2% equivalent stable slope for a portion (350 feet) of the reach. This GCS along with the proposed downstream drop structure will help stabilize the reach between the two structures for future watershed development. The slope for the remainder of the reach is shown on the attached channel profile.

Recently-approved Sand Creek DBPS – Recommended Typical Section 6

The 2021 DBPS recommends a typical section 6 for reach SC1R10 with the properties shown in the attached Table 7-1, including a proposed 100-year depth and width of 3.61 and 136.9 feet, respectively. The average future conditions (Q=646 cfs) depth and width along the Project reach are 3.06 and 152.3 feet, respectively. Because these values are relatively similar, there is no need for major channel improvements along this reach. There are no side slope recommendations in the 2021 DBPS.

DCM Table 12.3 – Hydraulic Design Criteria

Table 12-3 in the City DCM provides hydraulic design criteria for natural unlined channels, including maximum velocities, Froude numbers, and tractive forces for the 100-year storm event. The table below provides the velocities, Froude numbers, tractive forces for the 100-year storm event in both existing and proposed conditions along the Project reach of Sand Creek. Locations that exceed the criteria are highlighted in red. In general, the total velocities are below the required 5 fps threshold upstream of the proposed drop. The Froude number and tractive force values are above the criteria for most of the modeled reach.

As a result of the proposed drop, there are slight decreases in hydraulic design parameters through and upstream of the drop. These results suggest that the installation of more drop structures along this reach will not significantly reduce the parameters at all locations and may cause further increases in parameters that are already above the criteria.

According to the attached email from the wetlands consultant for the project (Matrix), the existing channel vegetation consists of a mixture of short native grasses, long native grasses, and willow brush. The Living Streambanks Manual (2016) provides allowable shear stresses of 0.7, 1.2, and 2.86 lb/sf for these three types of materials, respectively. The average of these values is 1.6 lb/sf, which is at the upper range of the proposed conditions shear stresses upstream of the proposed drop structure. Therefore, the existing vegetation should be able to withstand the future shear stresses.

	Sand Creek 100-year Future Q = 646 cfs								
	Existing Conditions				**Proposed Conditions**				
River Sta	W.S. Elev (ft)	Fr # XS	Vel Total (ft/s)	Shear Total (lb/sq ft)	W.S. Elev (ft)	Fr # XS	Vel Total (ft/s)	Shear Total (lb/sq ft)	Notes
111	6882.2	0.54	4.07	1.3	6882.2	0.54	4.07	1.3	
110	6880.1	0.74	3.85	1.63	6880.1	0.74	3.85	1.63	North limit of Project. Existing GCS
109	6876.0	0.61	3.75	1.64	6876.0	0.61	3.75	1.64	
108	6873.4	0.55	2.33	0.45	6873.4	0.55	2.33	0.45	
107	6869.8	1.03	3.38	1.04	6869.8	1.03	3.38	1.04	
106	6866.8	0.47	2.49	0.73	6866.8	0.47	2.49	0.73	Proposed GCS
105	6864.3	0.96	4.05	1.51	6864.3	0.96	4.05	1.51	
104	6862.0	0.41	2.66	0.84	6862.0	0.41	2.66	0.84	Existing GCS
103	6860.1	0.6	2.98	0.65	6860.1	0.6	2.98	0.65	
102	6858.7	0.93	3.7	1.41	6858.7	0.93	3.56	1.24	South limit of Project
101.9					6858.2	1.04	4.16	1.17	Upstream Drop
101.1					6857.4	0.79	5.21	1.04	Downstream Drop
101	6856.2	1	9.62	6.82	6856.2	1	9.62	6.82	
100	6854.5	0.66	5.94	2.68	6854.5	0.66	5.94	2.68	
Average (Dvmt)		0.70	3.24	1.10		0.70	3.23	1.08	
Average (Total)		**0.71**	**4.07**	**1.73**		**0.74**	**4.15**	**1.62**	
Criteria Exceeded (in red)		F > 0.6	V > 5 fps	S > 0.6 lb/sf		F > 0.6	V > 5 fps	S > 0.6 lb/sf	

In summary, the purpose of this document is to provide support of a request for variance from two criteria (Sand Creek DBPS and City DCM) applicable to the Project. Please contact me if you have any further questions or comments.

Sincerely,
Drexel, Barrell & Co.

Michelle Iblings, P.E., CFM
miblings@drexelbarrell.com
(303) 442-4338

1800 38th St. • Boulder, CO 80301 • 303.442.4338 • 303.442.4373 fax
3 South 7th St. • Colorado Springs, CO 80905 • 719-260-0887 • 719-260-8352 fax
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Select Tables from the 2021 Sand Creek DBPS

Table 6-13. Alternative 2 Conveyance Improvements Downstream of Regional Pond 1

				Channel Geometry			Grade Control Structures		
ReachName	Type	Channel_ID	Length	Typical Section	Topwidth (ft)	Maximum Depth (ft)	Number	Height (ft)	Spacing (ft)
SC1R1	Type 2 - Improved - Existing or future problems		1274				12	3	767
SC1R10	Type 3 - Unimproved - Existing or future problems	6	9223	6	144	5	36	3	252

Table 7-1. Properties of Channel Improvement Theme ID

	Engineered Channel Section				Natural Engineered Channel Section			
Channel ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
BW	16	22	32	44	20	32	42	64
Bankfull depth	0.90	1.29	1.87	2.62	0.6	1.05	1.35	1.95
Bankfull width	23.24	32.34	46.99	64.96	24.84	40.37	52.78	79.6
Bankfull w/d	26	25	25	25	41	38	39	41
10yr depth	2.09	3.03	4.37	5.72	1.44	2.38	2.99	4.78
10yr width	51.59	76.24	106.97	137.2	59.52	87.01	119.91	186.25
10yr w/d	25	25	24	24	41	37	40	39
100yr depth	3.22	4.44	6.3	7.97	1.89	3.61	4.2	6.99
100yr width	77.78	107.51	154.41	193.71	75.16	136.9	170.75	275.93
100yr w/d	24	24	25	24	40	38	41	39
TW	92	120	168	200	84	144	188	284
Total depth	5	6	8	9	3	5	6	8
Slope	0.30%	0.30%	0.30%	0.30%	0.20%	0.20%	0.20%	0.20%

LEGEND

HEC-RAS CROSS SECTION	12345
SAND CREEK CENTERLINE	
FEMA EFFECTIVE FLOODWAY (12/07/2018)	
FEMA EFFECTIVE 100-YEAR FLOODPLAIN (12/07/2018)	
BOUNDARY BETWEEN SURVEYED CONTOURS AND LIDAR CONTOURS	
EXISTING MAJOR CONTOUR	
EXISTING MINOR CONTOUR	
PROPOSED MAJOR CONTOUR	
PROPOSED MINOR CONTOUR	

80 40 0 80 160

SCALE: 1"=80'

Know what's below. Call before you dig.

CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

PREPARED BY:

DREXEL, BARRELL & CO.
Engineers • Surveyors
3 SOUTH 7TH STREET
COLORADO SPGS, COLORADO 80905
CONTACT: TIM D. McCONNELL, P.E.
(719)260-0887
BOULDER • COLORADO SPRINGS • GREELEY

CLIENT:

GOODWIN KNIGHT

8605 EXPLORER DRIVE, SUITE 250
COLORADO SPRINGS,
COLORADO 80920

(719)-598-5192

100% CONSTRUCTION PLANS
SAND CREEK DROP STRUCTURE
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

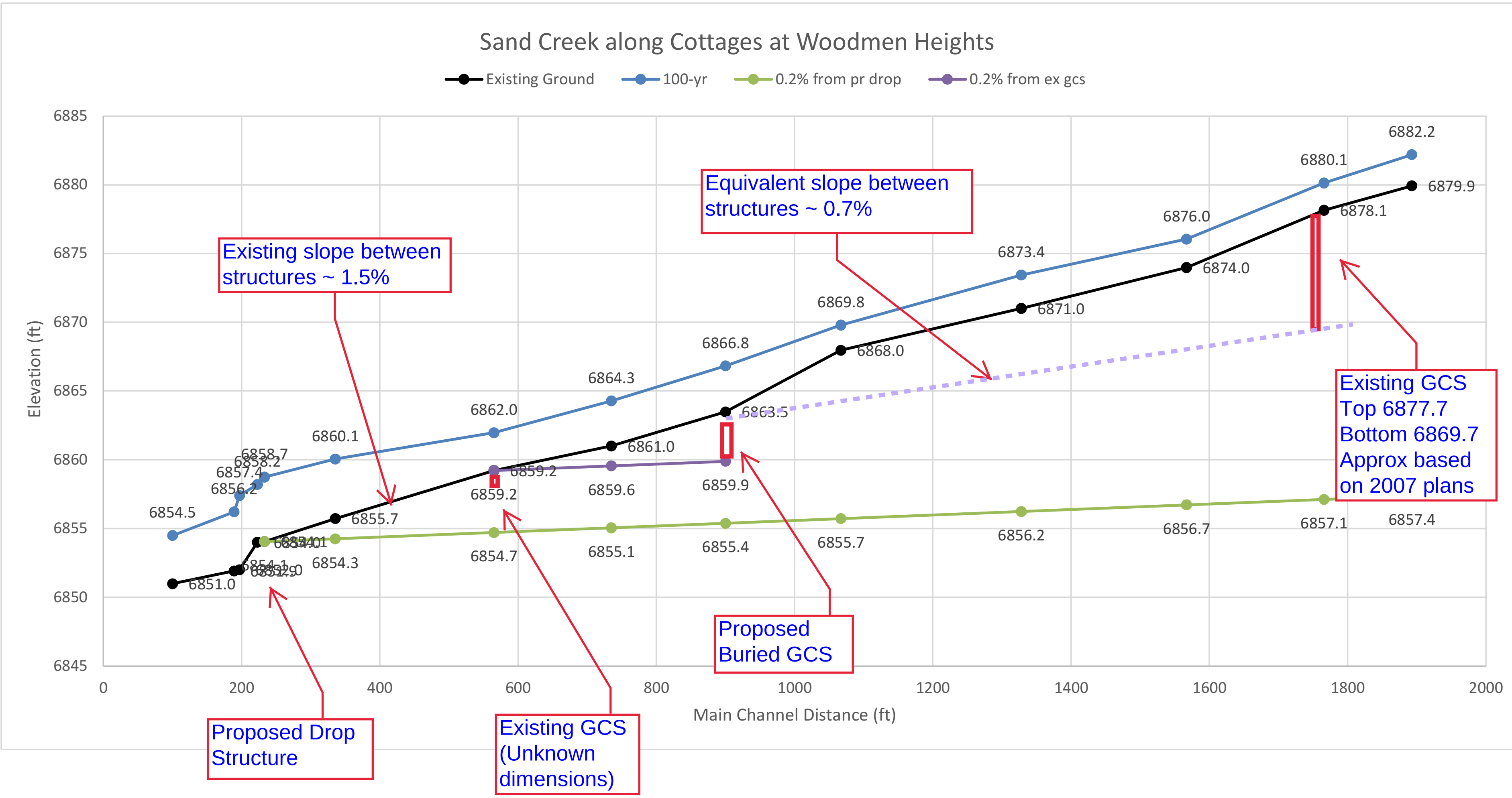
ISSUE	DATE
75% SUBMITTAL	10-30-20
90% SUBMITTAL	10-21-21
100% SUBMITTAL	01-07-22

DESIGNED BY:	TDM
DRAWN BY:	SLG
CHECKED BY:	TDM
FILE NAME:	21369-00 SAND CREEK

DRAWING SCALE:
HORIZONTAL: 1" = 100"
VERTICAL: N/A

CHANNEL IMPROVEMENTS EXHIBIT

PROJECT NO. 21369-00CSCV
DRAWING NO.



Sand Creek along Cottages at Woodmen Heights
Existing Ground
100-yr
0.2% from pr drop
0.2% from ex gcs
Elevation (ft)
Main Channel Distance (ft)
6885
6880
6875
6870
6865
6860
6855
6850
6845
0
200
400
600
800
1000
1200
1400
1600
1800
2000
6882.2
6880.1
6879.9
6878.1
6876.0
6874.0
6873.4
6871.0
6869.8
6868.0
6866.8
6864.3
6863.5
6862.0
6861.0
6860.1
6859.2
6859.2
6859.6
6859.9
6858.7
6858.2
6857.4
6856.2
6855.7
6854.5
6854.3
6854.7
6855.1
6855.4
6855.7
6856.2
6856.7
6857.1
6857.4
6851.0
Existing slope between structures ~ 1.5%
Equivalent slope between structures ~ 0.7%
Existing GCS
Top 6877.7
Bottom 6869.7
Approx based on 2007 plans
Proposed Buried GCS
Proposed Drop Structure
Existing GCS (Unknown dimensions)

Michelle Iblings

From: Nicole Schanel <Nicole_Schanel@matrixdesigngroup.com>
Sent: Thursday, March 24, 2022 1:01 PM
To: Michelle Iblings; Tori Mack
Cc: Tim McConnell
Subject: RE: Sand Creek Improvements - USACE Permit
Attachments: Biostabilization Manual Draft 102916.pdf

Hi Michelle –

For this project, we can only speak to the wetlands that we located. The delineation was focused between cross sections 107 and 100 as shown in Drexel's RAS model. In these sections, the primary species included willows, grasses, and herbaceous species. The soils are Blakeland-Fluvaquentic Haplaquolls which have low cohesive properties.

I have attached the Living Streambanks Manual. We believe that the existing vegetation would fall into short or long native grasses which puts you into the 0.7-0.95 or 1.2-1.7 range, respectively; likely on the lower end due to the soil type. The willow brush does not seem to be present uniformly, rather in clumps, so this may not be appropriate to use as a primary classifier.

Summary:

Vegetation Type	Shear (lb/ft2)	Velocity (ft/s)
Short native grasses*	0.7-0.95	3-4
Long native grasses	1.2-1.7	4-6
Grass Mix, easily eroded soil, 0-5% slope		4
Willow brush (3-4 seasons old)	2.86	
Willow brush (immediately after construction)	0.41	

Please let me know if you have any questions.

Thanks,

Nicole Schanel, PE
Deputy Director, Civil South
Senior Project Manager
Matrix Design Group, Inc.
O 719.575.0100 | **C** 719.659.6141
nicole.schanel@matrixdesigngroup.com
2435 ResearchPkwy | Suite 300 | Colorado Springs, CO 80920
matrixdesigngroup.com

CHANNEL DESIGN REPORT
for
Sand Creek Drop Structure and Grade Control

Associated with
Cottages at Woodmen Heights Development

East Woodmen Road west of Marksheffel Road
Colorado Springs, Colorado

April 27, 2022

Prepared for:

City of Colorado Springs Stormwater Enterprise
30 S. Nevada Avenue, Suite 401
Colorado Springs, CO 80903
Contact: Erin Powers
(719) 358-5918

Prepared by:

Drexel, Barrell & Co.
1800 38th Street
Boulder, CO 80301
Contact: Michelle Iblings, P.E.
(303) 442-4338

TABLE OF CONTENTS

APPENDICES

CHANNEL DESIGN REPORT
for
Sand Creek Drop Structure and Grade Control

2.0 PURPOSE

The purpose of this Channel Design Report is to provide the background information and supporting calculations for proposed drop and grade control structures along Sand Creek associated with the nearby Cottages at Woodmen Heights development (Project).

3.0 PREVIOUS REPORTS AND JURISDICTIONAL REQUIREMENTS

Sand Creek DBPS

The Sand Creek DBPS was originally developed in 1996 and was recently updated and approved in 2021. The reach of Sand Creek adjacent to the east edge of the Project is referencPage ed as Reach SC-7 in the 1996 DBPS. Three buried check structures and left bank protection were proposed along this reach, as shown in the Appendices.

The reach of Sand Creek adjacent to the east edge of the Project is also referenced as SC1R10 in the 2021 DBPS. The 2021 DBPS recommends a stable slope of 0.2% in the upper basin. To achieve this slope in the 9,223-foot reach of SC1R10, 36 3-foot grade control structures are proposed in the DBPS, spaced at 252-foot increments.

The 1996 and 2021 (labeled as 2019) drainage areas and 100-year flow rates at Woodmen Road are summarized below. The reason for the reduced flow rate is the construction of a regional pond upstream of E. Woodmen Road. In coordination with the City, DBC is using the future 100-year flow rate of 646 cfs (Table 3-13 from the 2019 DBPS) for design of the drop structure and the hydraulic analysis of Sand Creek.

1996 Drainage Area (mi2)	2019 Drainage Area (mi2)	1996 Existing (cfs)	2019 Existing (cfs)	1996 Future (cfs)	2019 Future (cfs)
5.4	4.4	2,630	14	3,300	646

FEMA Regulations

The reach of Sand Creek adjacent to the east edge of the Project is located within the 100-year floodplain as determined by the FIRM number 08041C0533G, effective 12/7/2018. The FEMA Effective 100-year flow rate for Sand Creek at Woodmen Road is 2,600 cfs (established prior to the currently adopted DBPS). The proposed improvements will require coordination with the Pikes Peak Regional Building Department (PPRBD). A separate no-rise analysis will be submitted to the PPRPD.

US Fish and Wildlife Service Requirements

The USFWS requirements associated with this Project are covered by another consultant.

CHANNEL DESIGN REPORT
for
Sand Creek Drop Structure and Grade Control

1.0 CERTIFICATION STATEMENTS

Engineer's Statement

This report and plan for the drainage design of a drop structure and grade control along Sand Creek associated with the Cottages at Woodmen Heights 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 Sand Creek 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.

SIGNATURE (Affix Seal):
Michelle Iblings, Colorado P.E. #43515

COLORADO LICENSED PROFESSIONAL ENGINEER MICHELLE IBLINGS 43515 4/25/22

Developer's Statement

Goodwin Knight hereby certifies that the drainage facilities for the drop structure and grade control along Sand Creek associated with the Cottages at Woodmen Heights 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 the Cottages at Woodmen Heights, guarantee that the final drainage design review will absolve Goodwin Knight 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.

4.27.2022

Authorized Signature — Date
Bryan D. Kniep, Vice President – Planning & Community Development
Goodwin Knight, 8605 Explorer Drive, Colorado Springs, CO 80920

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.

2022/04/29

For City Engineer — Date
Conditions:

US Army Corps of Engineers Requirements

The USACE requirements associated with this Project are covered by another consultant. This report and the associated plans were sent to the USACE with a permit application.

4.0 SITE DESCRIPTION

The Project is located south of E. Woodmen Road and west of Marksheffel Road in the City of Colorado Springs, County of El Paso, Colorado as shown on **Figure 1**. Sand Creek flows from north to south along 1,800 feet of the eastern edge of the Project, outside of the Project limits.

Figure 1. Location Map

The channel slope ranges from 1 to 5%, with an average of 2% over the Project reach. Near the proposed drop structure, the left (east) bank slopes range from 1.4 to 1.5 (H:1V), and the right (west) bank slopes range from 1.8 to 2.7 (H:1V). The creek has two large bends at the downstream end of the Project reach, showing evidence of migration over time. There is an overhead electric and underground water line crossing near and upstream of the proposed drop structure, as shown in the attached design plans. There are also two existing grade control structures along the Project reach. The downstream grade control structure is 250 feet in length and was constructed in 2008 to protect a water line from channel erosion and scour. It consists of a one-foot-wide concrete wall upstream of buried riprap. The depth and width of the buried riprap is uncertain, but some of it was observed as exposed in the field.

During site visits in June 2020 and June 2021, the active channel width was observed to be very narrow compared to the floodplain. The channel and overbanks are densely covered with grasses and wetland vegetation as shown in the pictures in the Appendices.

Evidence of bed and bank erosion was also observed at the downstream end of the study reach, but the middle and upstream reaches appeared to be stable.

Other proposed improvements in the vicinity include design plans for the Sand Creek Stabilization at Aspen Meadows (Subdivision Filing No. 1), February 2020. The plans include grade control features along a 3,800-foot reach of Sand Creek upstream of E. Woodmen Road and centered at the future extension of N. Marksheffel Road. Various boulder drop structures and rock cross vanes were designed for a 100-year flow rate of 2,062 cfs.

Soils

According to the attached Soil Survey of El Paso County Area, Colorado, prepared by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), the site is underlain by the Blakeland-Fluvaquentic Haplaquolls (Hydrologic Soil Group A).

Climate

This area of El Paso County is in the foothills of the Rocky Mountains, with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry, and summers relatively warm and dry. Precipitation ranges from 12 to 14 inches per year, with the majority of this moisture occurring in the spring and summer in the form of rainfall. Thunderstorms are common during the summer months.

5.0 PROPOSED CONDITIONS

The proposed drop and grade control structures are shown on the construction plans in the Appendix.

The purpose of the proposed drop structure is to isolate and dissipate channel energy at and downstream of the drop, and to reduce the potential for future degradation, scour, and migration of the active channel. It is located near the check structure proposed at Station 702+00 in the 1996 DBPS and situated at the steepest portion of the reach. Left (east) bank protection adjacent to and upstream of the drop structure is also proposed due to the steep bank slopes in this area.

The purpose of the proposed grade control structure (GCS) in the middle of the study reach is to provide an equivalent stable slope of 0.2% for approximately 350 feet, extending downstream from the proposed GCS to the existing 250-foot-long GCS.

The Project area is owned and maintained by the City, with various Colorado Springs Utilities easements. It is assumed that the existing gravel maintenance road east of Sand Creek can be used to access the site for construction.

There are no other proposed stormwater facilities.

6.0 CHANNEL AND STRUCTURE DESIGN

H&H Criteria

A hydraulic model of Sand Creek was created in HEC RAS version 5.0.7. The model study reach extends 1,800 feet from the upstream limit immediately south of E. Woodmen Road to approximately 200 feet downstream of the Project. The purpose of the hydraulic analysis is to estimate hydraulic parameters to determine the potential for bed and bank erosion, as well as those necessary to design the drop structure and bank protection.

The hydraulic analysis has been prepared in accordance with the current City of Colorado Springs Drainage Criteria Manual (DCM) and is not meant to be used for any FEMA regulatory purposes.

Site Constraints

The location of the proposed drop structure was chosen for several reasons, including channel steepness, existing channel bed and bank erosion, conformance with the 1996 DBPS, and various utility crossings. There are buried and overhead electric lines across the proposed drop structure. We are currently coordinating with Colorado Springs Utilities for work in their easement, and their approval is pending.

The location of the proposed GCS was chosen mid-reach to meet the equivalent 0.2% stable slope for a portion (350 feet) of the reach. There is an existing underground electric line that crosses the proposed GCS and should be protected during construction.

Drop Structure Components

The grouted sloped boulder (GSB) drop structure is designed using the Simplified Design Procedure in Chapter 9 of the USDCM Volume 2. The drop includes 24" grouted boulders on the 27-ft wide v-shaped low-flow channel bottom, extending from the drop crest at Elev 6854 downstream 26 feet to the drop toe at Elev 6852. There are riprap approach sections 8.5 feet upstream and 14 feet downstream of the drop. Cutoff walls of 6-ft depth extend across the low-flow section at the crest and toe and provide transition between the drop and approach sections.

Soil riprap is proposed along both banks above the 24" boulders through the drop structure section. Cutoff walls (in the direction of flow) are also proposed between the 24" boulders and the soil riprap. The combined boulder-riprap bank protection extends upstream of the drop on the left (east) bank for approximately 100 linear feet due to the steep slopes in this area. The boulder placement, grout placement, materials, and riprap gradations are specified in the construction plans in the Appendix.

The soil riprap was designed using Chapter 8 of the USDCM Volume 2. The drop structure and riprap calculations are provided in the Appendix.

GCS Components

The proposed GCS extends across the channel for 50 feet and includes 24" grouted boulders on a 30-ft wide v-shaped low-flow channel bottom. There are 10-ft wide riprap sections on either side of the boulders. The GCS is set at a 4H:1V slope along the channel and includes an 8-ft long upstream approach riprap section. The entire GCS is buried 4-

6 inches below the existing grade, allowing the existing soils to be stockpiled during construction and reused to restore the existing vegetation.

Hydraulic Analysis and Results

The existing conditions geometry is based on a combination of Lidar contours provided by Colorado Springs and survey obtained by Barron Land Surveying dated February 2020, as shown in the attached Channel Improvements Exhibit. Twelve channel XS were placed at points of perceived major changes in channel planform and vertical grade. XS 104 and 110 were placed at the existing grade control structures. XS 101 and 102 were placed at the proposed drop structure. An AutoCAD surface was created and used to extract the channel centerline alignment and elevations, as well as station-elevation and downstream distance data for each XS.

Existing conditions channel and overbank Manning's n-values of 0.06 and 0.08 respectively are based on field observations of dense vegetation. There are no existing structures modeled in the reach. Ineffective flow areas (IFA's) were applied at high points within XS 103 through 107 to contain flows within the effective floodplain. The subcritical downstream boundary condition was set to normal depth with a slope of 0.0177 ft/ft. The model was executed for the steady-state future 100-year peak flow rate of 646 cfs.

The existing conditions geometry was modified to include a two-foot-high drop structure between XS 101 and 102 to represent proposed conditions. XS 102 was copied 10 feet downstream to XS 101.9 and modified to represent the top/crest of the drop. XS 101 was copied 8 feet upstream to XS 101.1 and modified to represent the bottom/toe of the drop. A roughness coefficient of 0.06 was used to represent the boulders and riprap through the drop structure and bank protection sections. The Cottages at Woodmen Heights Project grading is located outside of the FEMA Effective 100-year floodplain and does not affect the existing channel geometry. Therefore, no changes were made to the existing conditions geometry from XS 102 to 111.

Table 1 below provides the velocities, Froude numbers, tractive forces, and WSE for the 100-year storm event in both existing and proposed conditions. Table 12-3 in the City DCM provides hydraulic design criteria for natural unlined channels, including maximum velocities, Froude numbers and tractive forces. Locations that exceed these criteria are highlighted in red in Table 1. The full hydraulic model results are provided in the Appendix.

In general, the existing and proposed velocities are below the criteria upstream of the drop and above the criteria downstream of the drop. The existing and proposed Froude numbers are slightly above the criteria at many locations, and the tractive forces are well above the criteria. The proposed parameters are slightly lower than existing upstream of the drop structure. There is no rise in 100-year WSE's from this Project.

According to the attached email from the wetlands consultant for the project (Matrix), the existing channel vegetation consists of a mixture of short native grasses, long native grasses, and willow brush. The Living Streambanks Manual (2016) provides allowable shear stresses of 0.7, 1.2, and 2.86 lb/sf for these three types of materials, respectively. The average of these values is 1.6 lb/sf, which is at the upper range of the proposed conditions shear stresses page upstream of the proposed drop structure. Therefore, the existing vegetation should be able to withstand the future shear stresses.

Rip-rap Design and Analysis
Riprap calculations are provided in the Appendix.

Table 1. Summary of Sand Creek existing and proposed conditions hydraulic results

	Sand Creek 100-year Future Q = 646 cfs								
River Sta	Existing Conditions				Proposed Conditions				
	W.S. Elev (ft)	Fr # XS	Vel Total (ft/s)	Shear Total (lb/sq ft)	W.S. Elev (ft)	Fr # XS	Vel Total (ft/s)	Shear Total (lb/sq ft)	Notes
111	6882.2	0.54	4.07	1.3	6882.2	0.54	4.07	1.3	
110	6880.1	0.74	3.85	1.63	6880.1	0.74	3.85	1.63	North limit of Project. Existing GCS
109	6876.0	0.61	3.75	1.64	6876.0	0.61	3.75	1.64	
108	6873.4	0.55	2.33	0.45	6873.4	0.55	2.33	0.45	
107	6869.8	1.03	3.38	1.04	6869.8	1.03	3.38	1.04	
106	6866.8	0.47	2.49	0.73	6866.8	0.47	2.49	0.73	Proposed GCS
105	6864.3	0.96	4.05	1.51	6864.3	0.96	4.05	1.51	
104	6862.0	0.41	2.66	0.84	6862.0	0.41	2.66	0.84	Existing GCS
103	6860.1	0.6	2.98	0.65	6860.1	0.6	2.98	0.65	
102	6858.7	0.93	3.7	1.41	6858.7	0.93	3.56	1.24	South limit of Project
101.9					6858.2	1.04	4.16	1.17	Upstream Drop
101.1					6857.4	0.79	5.21	1.04	Downstream Drop
101	6856.2	1	9.62	6.82	6856.2	1	9.62	6.82	
100	6854.5	0.66	5.94	2.68	6854.5	0.66	5.94	2.68	
Average (Dvmt)		0.70	3.24	1.10		0.70	3.23	1.08	
Average (Total)		**0.71**	**4.07**	**1.73**		**0.74**	**4.15**	**1.62**	
Criteria Exceeded (in red)		F > 0.6	V > 5 fps	S > 0.6 lb/sf		F > 0.6	V > 5 fps	S > 0.6 lb/sf	

7.0 DRAINAGE FEES

The Project is located within the Sand Creek Drainage Basin. The proposed 2021 Drainage Fee for the Sand Creek Basin is $18,841 per acre.

8.0 CONSTRUCTION COST OPINION

A construction cost opinion is provided in the Appendix.

9.0 PHASING

The general timeline of construction will be addressed as part of the Cottages at Woodmen Heights development plans.

<u>Grading and Erosion Control Plan</u>
In accordance with the City of Colorado Springs DCM, a Grading and Erosion Control Plan will be submitted as part of the Cottages at Woodmen Heights development plans.

10.0 SUMMARY

Based on field observations and the hydraulic model results, there is currently the potential for continued bed and bank erosion along the study reach of Sand Creek. The average velocities are generally within City criteria along the Project development reach. The proposed development does not cause any significant change to the erosion potential for Sand Creek. There are no increases in flow rates, water surface elevations, velocities, Froude numbers, or tractive forces due to the Cottages at Woodmen Heights development project.

The findings of this report are in general conformance with the Sand Creek DBPS. The 1993 DBPS proposed three grade control structures. There are already two existing grade control structures along the reach, so we have designed a third structure between XS 101 and 102. We have also designed a mid-reach buried grade control structure that meets the recommended equivalent 0.2% stable slope (2021 DBPS) for a portion (350 feet) of the reach. The facility will be designed safely.

11.0 REFERENCES

The sources of information used in the development of this study are listed below:

1. City of Colorado Springs Drainage Criteria Manual Volume 1, January 2021.

2. City of Colorado Springs Drainage Criteria Manual Volume 2, December 2020.

3. Urban Storm Drainage Criteria Manual Volume 1, Mile High Flood District, August 2018.

4. Urban Storm Drainage Criteria Manual Volume 2, Mile High Flood District, September 2017.

5. Sand Creek Drainage Basin Planning Study (DBPS), Kiowa Engineering Corporation, March 1996.

6. Sand Creek Drainage Basin Planning Study (DBPS), Stantec, January 2021.

APPENDICES

CHANNEL IMPROVEMENTS EXHIBIT

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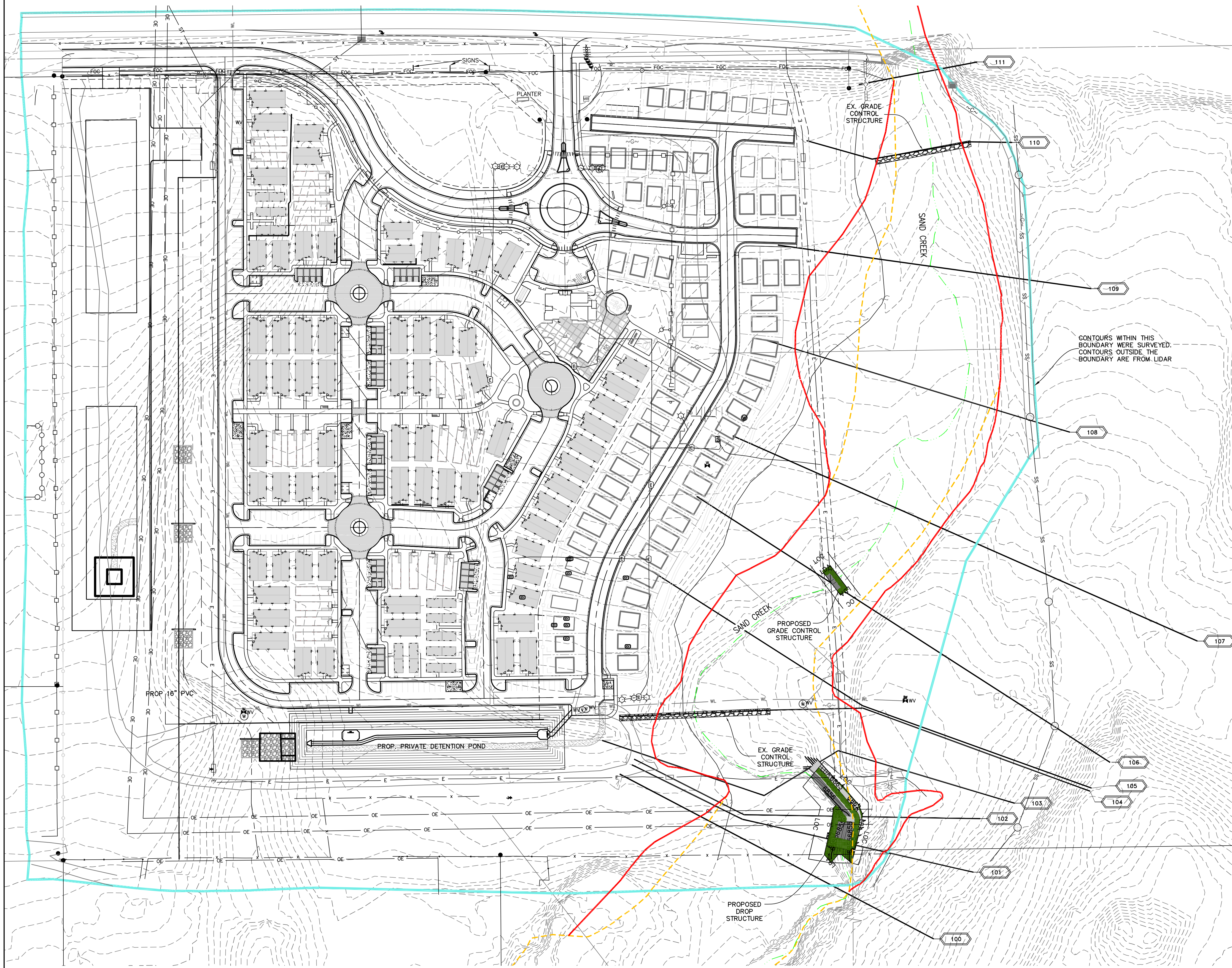

LEGEND

HEC-RAS CROSS SECTION	12345
SAND CREEK CENTERLINE	
FEMA EFFECTIVE FLOODWAY (12/07/2018)	
FEMA EFFECTIVE 100-YEAR FLOODPLAIN (12/07/2018)	
BOUNDARY BETWEEN SURVEYED CONTOURS AND LIDAR CONTOURS	
EXISTING MAJOR CONTOUR	
EXISTING MINOR CONTOUR	
PROPOSED MAJOR CONTOUR	
PROPOSED MINOR CONTOUR	

80 40 0 80 160

SCALE: 1"=80'

811 Know what's below. Call before you dig.

CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

PREPARED BY:

DREXEL, BARRELL & CO.
Engineers • Surveyors
3 SOUTH 7TH STREET
COLORADO SPGS, COLORADO 80905
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(719)260-0887
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CLIENT:

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7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

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DRAWN BY:	SLG
CHECKED BY:	TDM
FILE NAME:	21369-00 SAND CREEK

DRAWING SCALE:
HORIZONTAL: 1" = 100'
VERTICAL: N/A

CHANNEL IMPROVEMENTS EXHIBIT

PROJECT NO. 21369-00CSCV

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PROJECT NO. 21369–00CSCV
DRAWING NO.

SHEET: 2 OF 2

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Photo 1: Looking north near XS 104

Photo 2: Looking north near XS 103

Photo 3: Existing grade control structure at XS 104

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

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

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

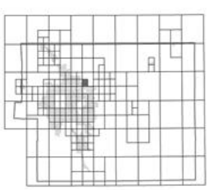
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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

El Paso County Vertical Datum Offset Table

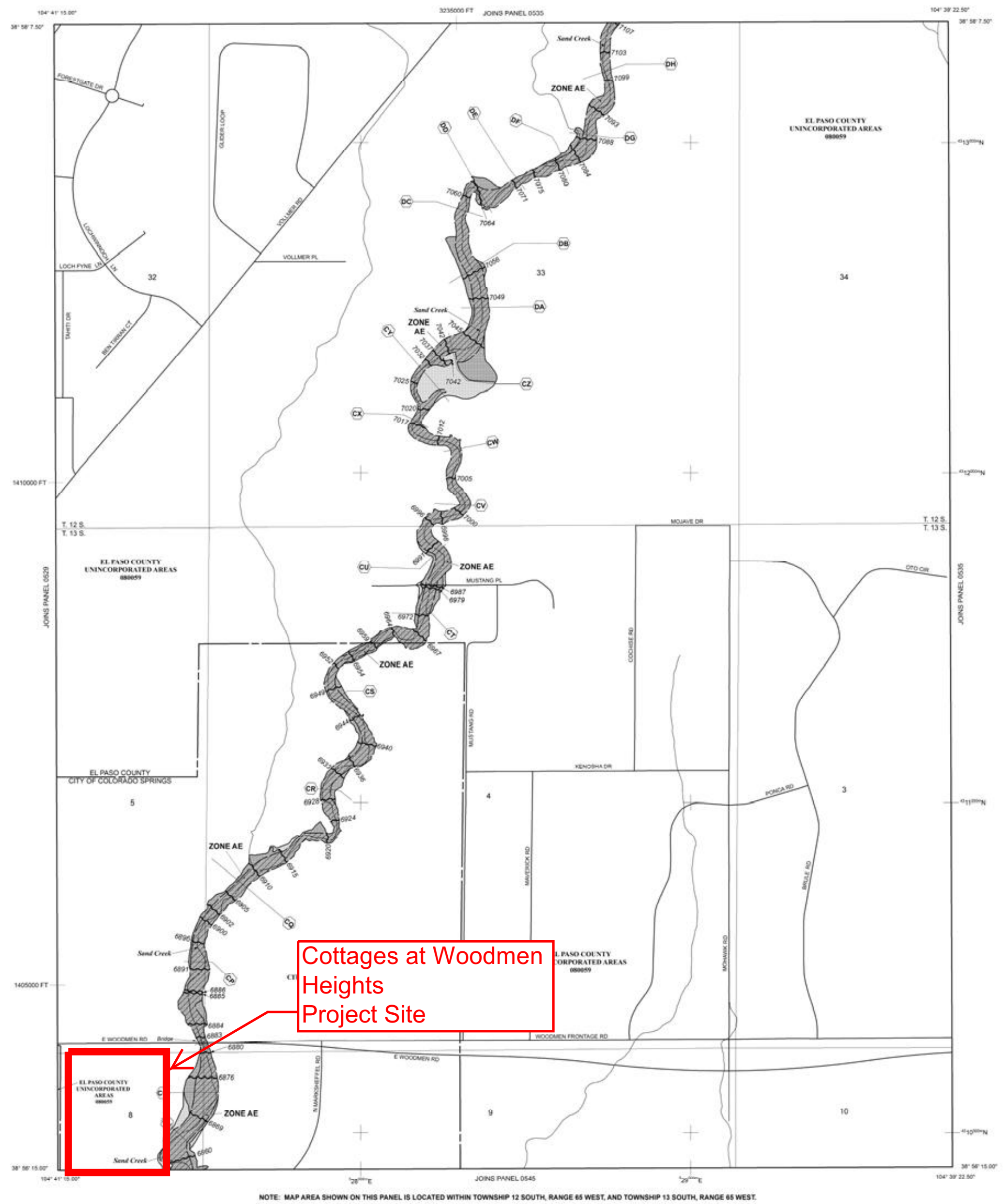
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST, AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

OTHER AREAS

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

MAP SCALE 1" = 500'

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0533G

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 533 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

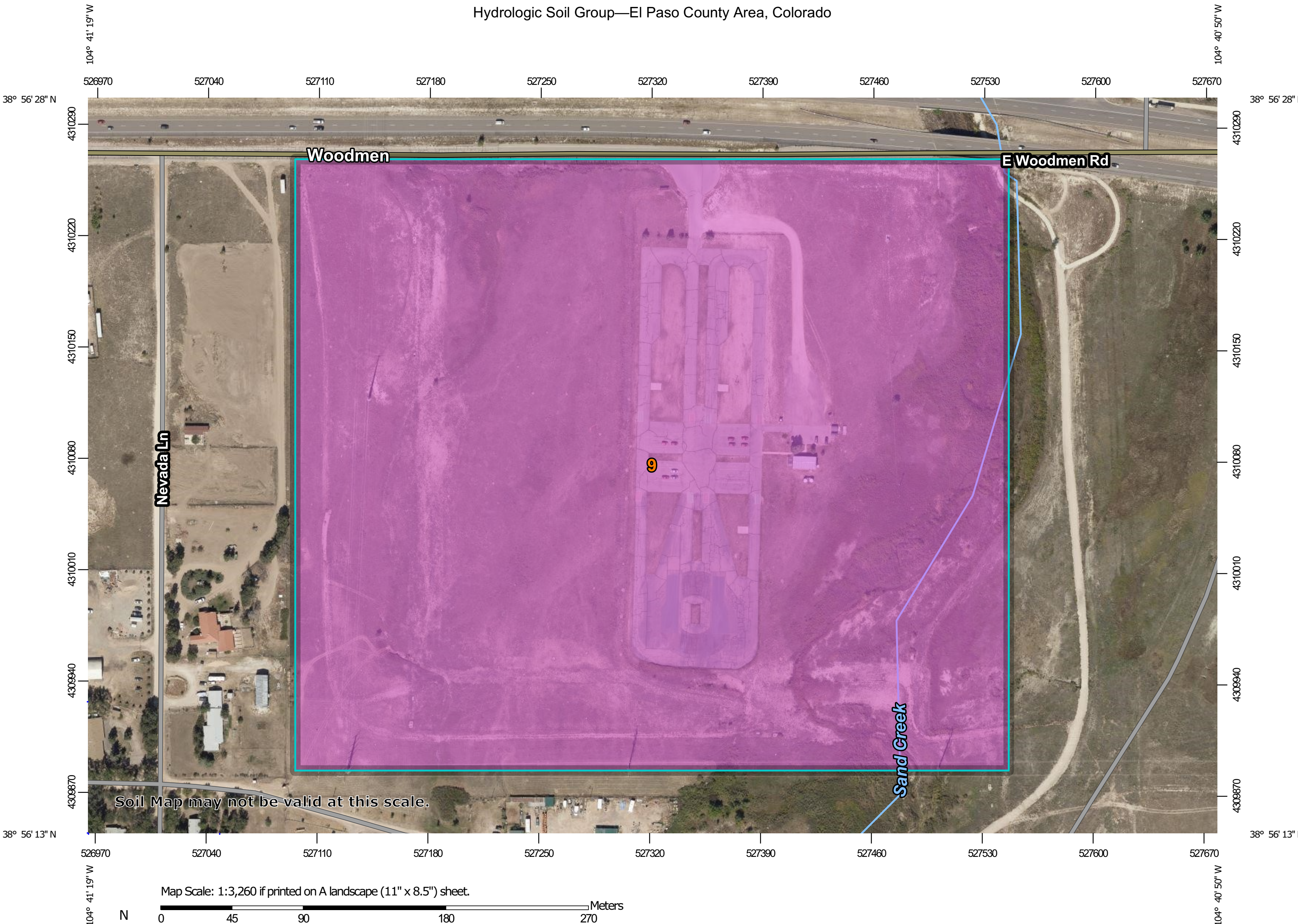
COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0533	G
EL PASO COUNTY	080059	0533	G

MAP NUMBER
08041C0533G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Hydrologic Soil Group—El Paso County Area, Colorado



Map Scale: 1:3,260 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 45, 90, 180, 270

Feet: 0, 150, 300, 600, 900

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
9	Blakeland-Fluvaquentic Haplaquolls	A	43.0	100.0%
Totals for Area of Interest			**43.0**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Sand Creek Drop Structure and Grade Control, Colorado Springs
Boulder & Riprap Sizing 1/12/2022

HEC-RAS Output at Crest Drop, RS 102

Cross Section Output

File Type Options Help

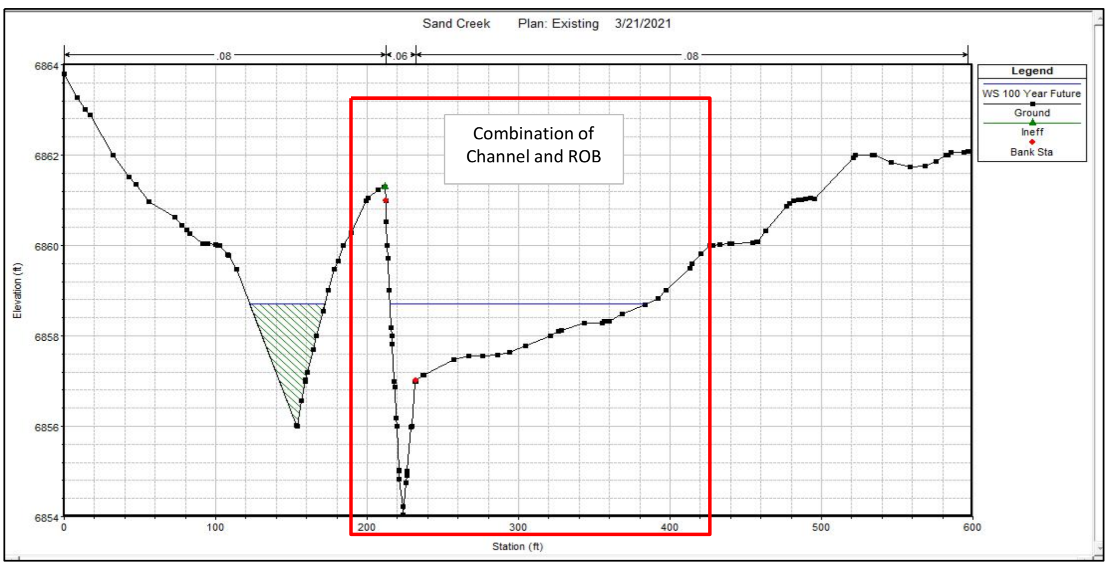
River: Sand Creek Profile: 100 Year Future

Reach Sand Creek CL RS: 102 Plan: Existing

Plan: Existing Sand Creek Sand Creek CL RS: 102 Profile: 100 Year Future

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6859.14	Wt. n-Val.		0.060	0.080
Vel Head (ft)	0.44	Reach Len. (ft)	43.89	43.89	43.89
W.S. Elev (ft)	6858.70	Flow Area (sq ft)		48.93	125.53
Crit W.S. (ft)	6858.70	Area (sq ft)	64.91	48.93	125.53
E.G. Slope (ft/ft)	0.022082	Flow (cfs)		341.14	304.86
Q Total (cfs)	646.00	Top Width (ft)	49.32	16.99	152.07
Top Width (ft)	218.38	Avg. Vel. (ft/s)		6.97	2.43
Vel Total (ft/s)	3.70	Hydr. Depth (ft)		2.88	0.83
Max Chl Dpth (ft)	4.65	Conv. (cfs)		2295.7	2051.5
Conv. Total (cfs)	4347.2	Wetted Per. (ft)		18.77	152.08
Length Wtd. (ft)	43.89	Shear (lb/sq ft)		3.59	1.14
Min Ch El (ft)	6854.05	Stream Power (lb/ft s)		25.06	2.76
Alpha	2.07	Cum Volume (acre-ft)	0.09	0.24	0.06
Frctn Loss (ft)	1.05	Cum SA (acres)	0.07	0.09	0.08
C & E Loss (ft)	0.03				

Variable		Location				Combined Unit Discharge cfs/ft		Boulder Size per MHFD Figure 9-1
		Channel	Right OB	Combined				
Q total	cfs	341.14	304.86	646				
Top Width	ft	16.99	152.07	169.06				
Unit Discharge	cfs/ft	20.1	2.0	3.8	=>	3.8	=>	B24 Boulder Size



Riprap Sizing, per Design Procedure, CSU 1988

Parameter	Eqn/Ref	Value	Notes		
Slope, S		0.01	Slope of channel up/downstream of drop		
Unit peak discharge (UPD), q	MHFD Fig 9-1.	12.5			
Cf	CSU 7.1	3.0	High probability of channelized flow		
Design UPD, q'	CSU 7.1	37.5	cfs/ft		
Adjusted UPD, q*	CSU 7.2	50.6	cfs/ft		
D50, angular	CSU 7.3	6.5	inches		
D50, design	MHFD 8.1.2	9.8	inches, 1.5 SF	=>	Use 12", Type M

Cottages at Woodmen Heights Development
Sand Creek, Colorado Springs
21369-02

Roughness Coefficient Calculations
1/12/2022

y =	4.5	feet (XS 102)
D =	2	feet
y/D =	2.25	
n =	0.06	Equation 9-1

The following equations may be used to find the recommended Manning's n as a function of flow depth over height of the boulders, y/D, as represented by the curves in Figure 9-3:

When the upper one-half (plus or minus 1inch) of the rock height is ungrouted, the equation for n is:

$$n_{24"-42"(1/2)} = \frac{0.097(y/D)^{0.16}}{\ln(2.55y/D)} \quad \text{Equation 9-1}$$

When the upper one-third (plus or minus 1 inch) of the rock height is ungrouted, the equation for n is:

$$n_{24"-42"(2/3)} = \frac{0.086(y/D)^{0.16}}{\ln(2.55y/D)} \quad \text{Equation 9-2}$$

Where:

y = depth of flow above top of rock (feet)

D = diameter of the boulder (feet)

The upper limit for Equation 9-1 is $n \leq 0.104$ and for Equation 9-2 is $n \leq 0.092$. Determine the value for "y" by reviewing the HEC_RAS cross sections and determining an appropriate representation of the average flow depth over the structure. If the value for y/D is < 1, use 1.

In non-cohesive soil channels and channels where future degradation is expected, especially where there is no drop structure immediately downstream, it is generally recommended that the stilling basin be eliminated and the sloping face extended five feet below the downstream future channel invert elevation (after accounting for future streambed degradation). A scour hole will form naturally downstream of a structure in non-cohesive soils and construction of a hard basin is an unnecessary cost. Additionally, a hard basin would be at risk for undermining. See Figure 9-12 for the profile of the GSB and Figure 9-17 for that of an SC in this configuration. In some cases, the structure may have a net drop height of zero immediately after construction, but is designed with a long-term net height of 3 to 5 feet to accommodate future lowering of the channel invert.

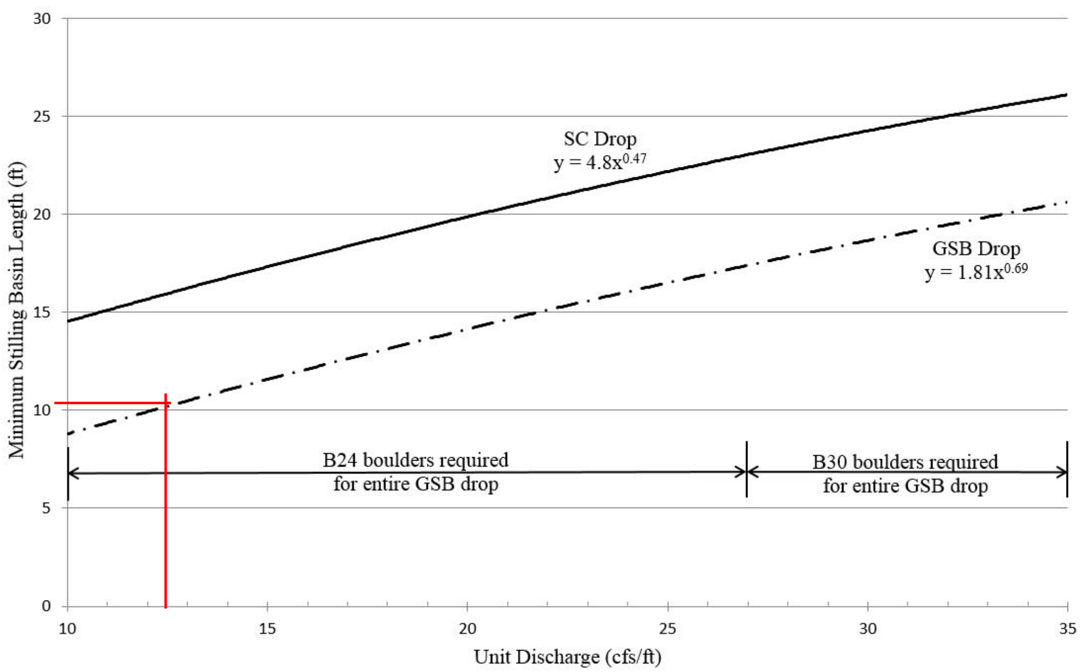


Figure 9-1. Stilling basin length based on unit discharge (for simplified design procedure)

2.2.6 Seepage Analysis and Cutoff Wall Design

The simplified drop structure design only applies to drops with cutoffs located in cohesive soils. Therefore, it is necessary to determine surface and subsurface soil conditions in the vicinity of a proposed drop structure prior to being able to use the simplified approach for cutoff design. For a drop structure constructed in cohesive soils meeting all requirements of a simplified design, the cutoff wall must be a minimum of six feet deep for concrete and ten feet deep for sheet pile.

If a proposed drop structure meets the requirements of the simplified approach, but is located in non-cohesive soils, guidance on determining the required cutoff wall depth is described in Section 2.4.

8.1 Riprap Sizing

Procedures for sizing rock to be used in soil riprap, void-filled riprap, and riprap over bedding are the same.

8.1.1 Mild Slope Conditions

When subcritical flow conditions occur and/or slopes are mild (less than 2 percent), UDFCD recommends the following equation (Hughes, et al, 1983):

$$d_{50} \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}} \right]^2 \qquad \text{Equation 8-11}$$

Where:

V = mean channel velocity (ft/sec)

S = longitudinal channel slope (ft/ft)

d_{50} = mean rock size (ft)

Gs = specific gravity of stone (minimum = 2.50, typically 2.5 to 2.7), Note: In this equation (Gs -1) considers the buoyancy of the water, in that the specific gravity of water is subtracted from the specific gravity of the rock.

Note that Equation 8-11 is applicable for sizing riprap for channel lining with a longitudinal slope of no more than 2%. This equation is not intended for use in sizing riprap for steep slopes (typically in excess of 2 percent), rundowns, or protection downstream of culverts. Information on rundowns is provided in Section 7.0 of the *Hydraulic Structures* chapter of the USDCM, and protection downstream of culverts is discussed in the *Culverts and Bridges* chapter. For channel slopes greater than 2% use one of the methods presented in 8.1.2.

Rock size does not need to be increased for steeper channel side slopes, provided the side slopes are no steeper than 2.5H:1V (UDFCD 1982). Channel side slopes steeper than 2.5H:1V are not recommended because of stability, safety, and maintenance considerations. See Figure 8-34 for riprap placement specifications. At the upstream and downstream termination of a riprap lining, the thickness should be increased 50% for at least 3 feet to prevent undercutting.

8.1.2 Steep Slope Conditions

Steep slope rock sizing equations are used for applications where the slope is greater than 2 percent and/or flows are in the supercritical flow regime. The following rock sizing equations may be referred to for riprap design analysis on steep slopes:

- CSU Equation, *Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase II* (prepared by S.R. Abt, et al, Colorado State University, 1988). This method was developed for steep slopes from 2 to 20 percent.

- USDA- Agricultural Research Service Equations, *Design of Rock Chutes* (by K.M. Robinson, et al, USDA- ARS, 1998 Transactions of ASAE) and *An Excel Program to Design Rock Chutes for Grade*

Stabilization, (K.M. Robinson, et al, USDA- ARS, 2000 ASAE Meeting Presentation). This method is based on laboratory data for slopes from 2 to 40 percent.

- USACE Steep Slope Riprap Equation, *Hydraulic Design of Flood Control Channels, EM1110-2-1601*, (June 1994). This method is applicable for slopes from 2 to 20 percent.

All three of the steep slope methods are based on two key parameters: unit discharge and slope. Flow concentration is one of the main problems that can develop along steep riprap slopes; both CSU and USACE methods recommend that the design unit discharge be increased by a flow concentration factor. When using the CSU equation or the USDA method, increase the largest rock size by approximately 30% when specifying standard UDFCD riprap gradations. This increase accounts for the fact that the steep slope equations were developed using poorly graded rock (uniform in size) unlike the well-graded gradations in UDFCD specifications. Additionally, for the reasons described in the following section, it is typical to also apply a safety factor of 1.5 or more times the calculated D50 riprap size when using any of these steep slope riprap sizing methods. When using the CSU equation or the USDA method apply the safety factor after increasing the largest rock size by 30%.

8.1.3 Design Safety Factor

Whether in mild slope or steep slope conditions, consider a safety factor when specifying the sides of riprap. Sizing methods presented in this manual were developed from controlled laboratory conditions. Field installation of rock is much less precise compared to laboratory conditions. It is difficult to grade riprap flat across a channel bottom or in a manner that provides a uniform slope. Sometimes the riprap delivered from local quarries is slightly smaller than specified. Flow conditions in streams can be affected by a variety of elements including debris, sedimentation, vegetation, etc. and can result in flow concentrations. It is important to include a safety factor when using these equations because the variability associated with conditions in the field cannot be quantified.

8.2 Boulder and Riprap Specifications

Specific material and installation specifications for riprap and boulders can be found in UDFCD's Construction Specifications, available at www.udfcd.org.

8.2.1 Boulders

Boulders may be placed and grouted or placed without grout. When not grouted, boulders require careful design to provide a firm foundation and stable configuration as well as properly graded backfill material sized to prevent migration of fine subgrade material through voids in the boulders. All stacked boulders require consideration of stability and any stacked boulder configuration over six feet in height requires a structural analysis to confirm proper design. Additionally, some municipalities require structural analysis and a building permit for walls greater than four feet.

Grouted boulders should follow the general guidelines described as part of the sections on grouted boulder grade control structures in the *Hydraulic Structures* Chapter and in the UDFCD Construction Specifications. See Figure 8-36 for typical construction of a grouted boulder bank protection.

8.2.2 Soil Riprap

Soil riprap is intended for use in applications where vegetative cover can be established in the riprap. When installed outside of the low-flow channel, UDFCD frequently specifies 4 to 6 inches of topsoil on top of soil riprap to help establish vegetation. Soil used in the voids and placed on top of the soil riprap should meet the description for viable topsoil composition for Colorado native plant establishment and upland areas as defined in the *Revegetation* chapter. See Figure 8-34 for gradation and placement of both riprap and soil riprap. Also see Figure 13 –19 in the *Revegetation* chapter for a fabric staking detail that can be used where fabric is specified over soil riprap. The combination of straw and coir mat is frequently used to help retain soil and seed. This is especially useful when topsoil is placed on top of soil riprap and then seeded. Specifications for mixing and installing soil riprap are further addressed in the UDFCD Construction Specifications.

8.2.3 Void-Filled Riprap

Void-filled riprap contains a well-graded mix of cobbles, gravels, sands, and soil that fills all voids and acts as an internal filter.

In addition to specifying the D_{50} rock size, individual material components that will make up the mix needed to be specified. The gradation of each material component should be specified by identifying a variety of particle sizes (from large to small) and the range of allowable "passing" percentages for each particle size. See Figure 8-35 for typical mixes of various sized rock, however, the designer should specify any mix adjustments based on the requirements of a particular project.

Photograph 8-18. Void-filled riprap is designed to emulate natural riffles, consisting of a mix of rock, gravels and sands that is densely-packed and able to support riparian vegetation.

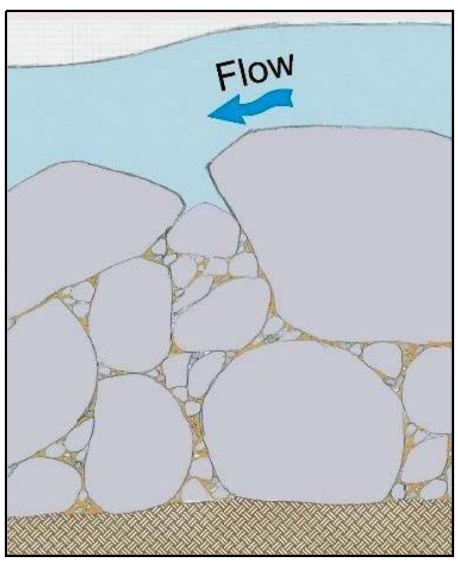


Figure 8-33. Small rock of void-filled riprap becomes "wedged in" under larger rock (Source: Muller Engineering Company)

7. RECOMMENDED DESIGN PROCEDURE

The Phase I and Phase II studies report the findings of 90 laboratory tests that address the application of riprap for protecting embankment slopes from overtopping flows. Although the data base is limited, it is possible to provide the user with a design procedure for sizing riprap. This chapter will outline the assumptions, equations, and/or graphics necessary to apply the findings of the Phase I and Phase II studies.

7.1 DESIGN PROCEDURE

Step 1. Determine the design unit discharge

Determine the design embankment slope(s) and the peak unit discharge, q, resulting from the tributary runoff at a point near the toe-of-the-slope (Nelson et al. 1987), and determine the shape of available rock sources (angular or round). Define the initial design unit discharge by adjusting the tributary unit discharge with the flow concentration factor, C_f, as

$$q'_{design} = q \times C_f \ , \qquad (7.1)$$

where C_f = 1.0 for overland sheet flow,
2.0 for a high probability of concentrated flow, and
3.0 for a high probability of channelized flow.

The values of the flow concentration factor is based on data from Abt et al. (1987).

Step 2. Estimate the median stone size (D_{50}) of the riprap layer

To size the median stone and prevent stone movement, adjust the design unit discharge by

$$q^*_{design} = 1.35\ q'_{design} \ . \qquad (7.2)$$

Then, estimate the median stone size as

Angular stone

Apply Eq. 4.1, using the embankment slope from Step 1:

$$D_{50} = 5.23\ S^{0.43}\ (q^*_{design})^{0.56} \ , \qquad (7.3)$$

where D_{50} is expressed in inches.

Rounded rock

Compute a conditional value of the rock size, D_c, where

$$D_c = 5.23\ S^{0.43}\ (q^*_{design})^{0.56} \ . \qquad (7.4)$$

Then, from Fig. 4.10, obtain the median stone size for rounded-shape riprap, as D_{50}, expressed in inches.

Step 3. Estimate the riprap layer thickness

Estimate the minimum riprap layer thickness, t_r, using the median stone size, D_{50}, computed in Step 2 by

$$t_r = 1.5\ D_{50} \tag{7.5}$$

or

$$t_r = D_{100}\ , \tag{7.6}$$

whichever thickness is greater. A riprap layer thickness greater than that prescribed in Eq. 7.5 or Eq. 7.6 can be specified.

Step 4. Estimate interstitial discharge

The average velocity of flow through the riprap layer can be determined by one of two means developed in the Phase I and Phase II reports. Method I requires that extensive testing of the rock source be conducted. Method II allows the user the opportunity to estimate interstitial velocities without significant testing of the rock source.

Method I

The average velocity of flow through the stone layer, V_i, can be estimated by determining the embankment slope, S; the coefficient of uniformity, $C_u = D_{60}/D_{10}$; the porosity, n_p; and the median stone size, D_{50}, of the source riprap. The average velocity through the riprap layer is computed by Eq. 1.1 as

$$V_i = 19.29\ [C_u^{-0.74}\ S^{0.46}\ n_p^{4.14}]^{1.064}\ (g\ D_{50})^{0.5}\ , \tag{7.7}$$

where velocity is in feet per second.

Method II

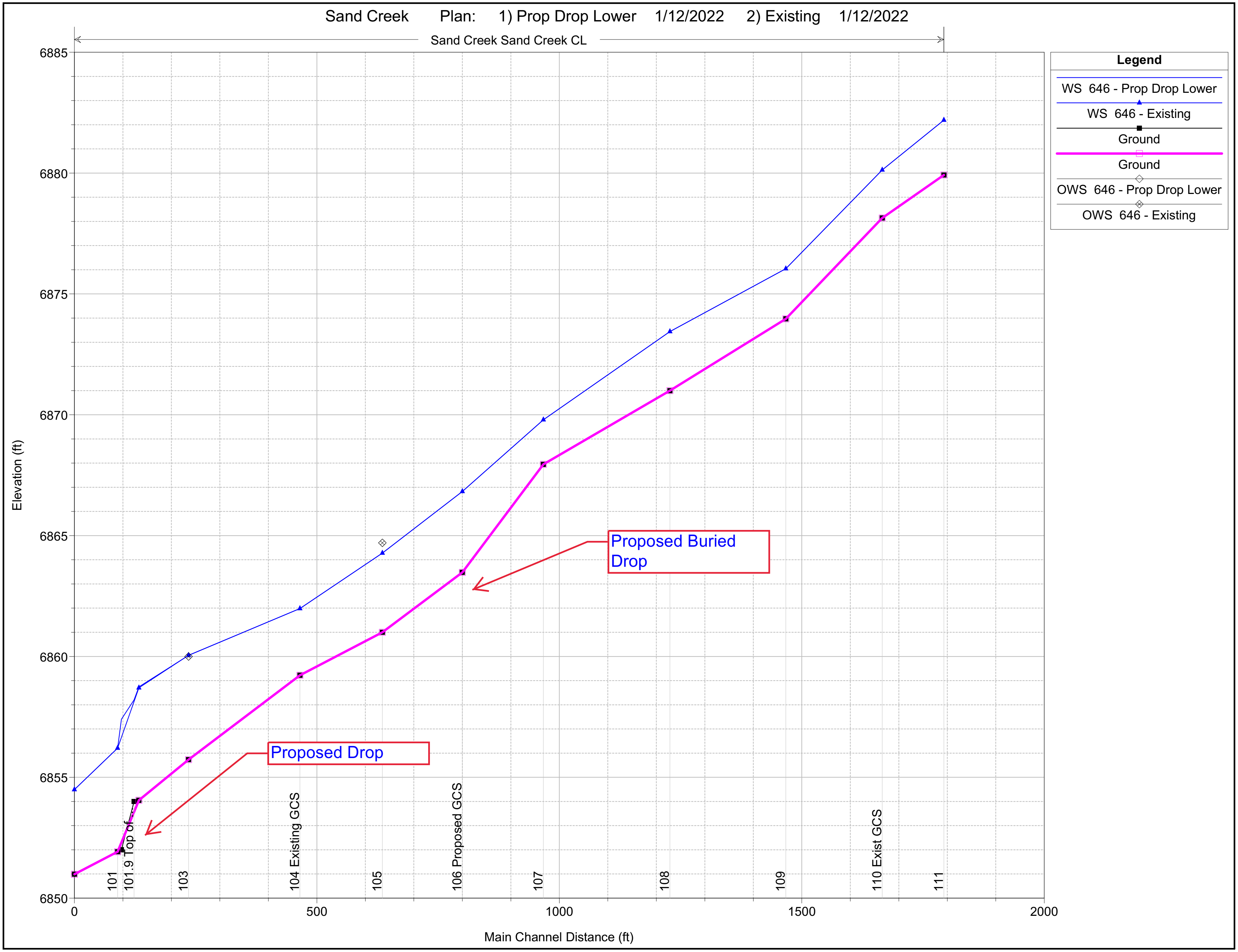
The average velocity of flow through the stone layer, V_i, can be estimated by determining the embankment slope, S, and the soil particle size at which 10% of the soil weight is finer, D_{10}. The average velocity is computed by Eq. 5.2 as

$$V_i = 0.232\ (g\ D_{10}\ S)^{1/2}\ , \tag{7.8}$$

where velocity is in feet per second and g is the acceleration of gravity, 32.2 ft/s^2.

Interstitial Discharge

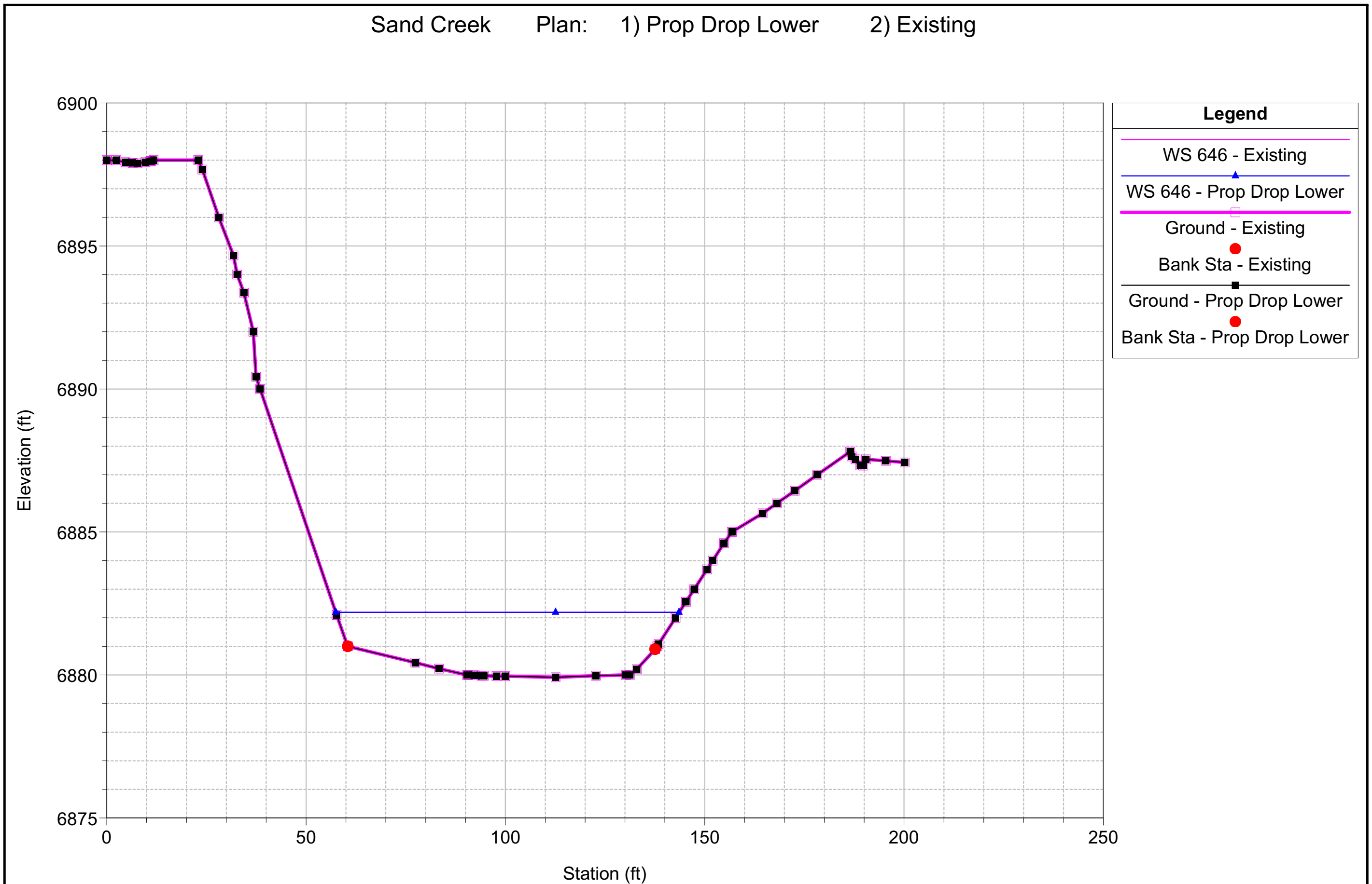
The interstitial unit discharge, q_i, is estimated by multiplying the interstitial velocity, V_i, (using either Eq. 7.7 or Eq. 7.8) by the thickness of the rock layer, t_r expressed in feet, and multiplying by 1.0 foot, yielding

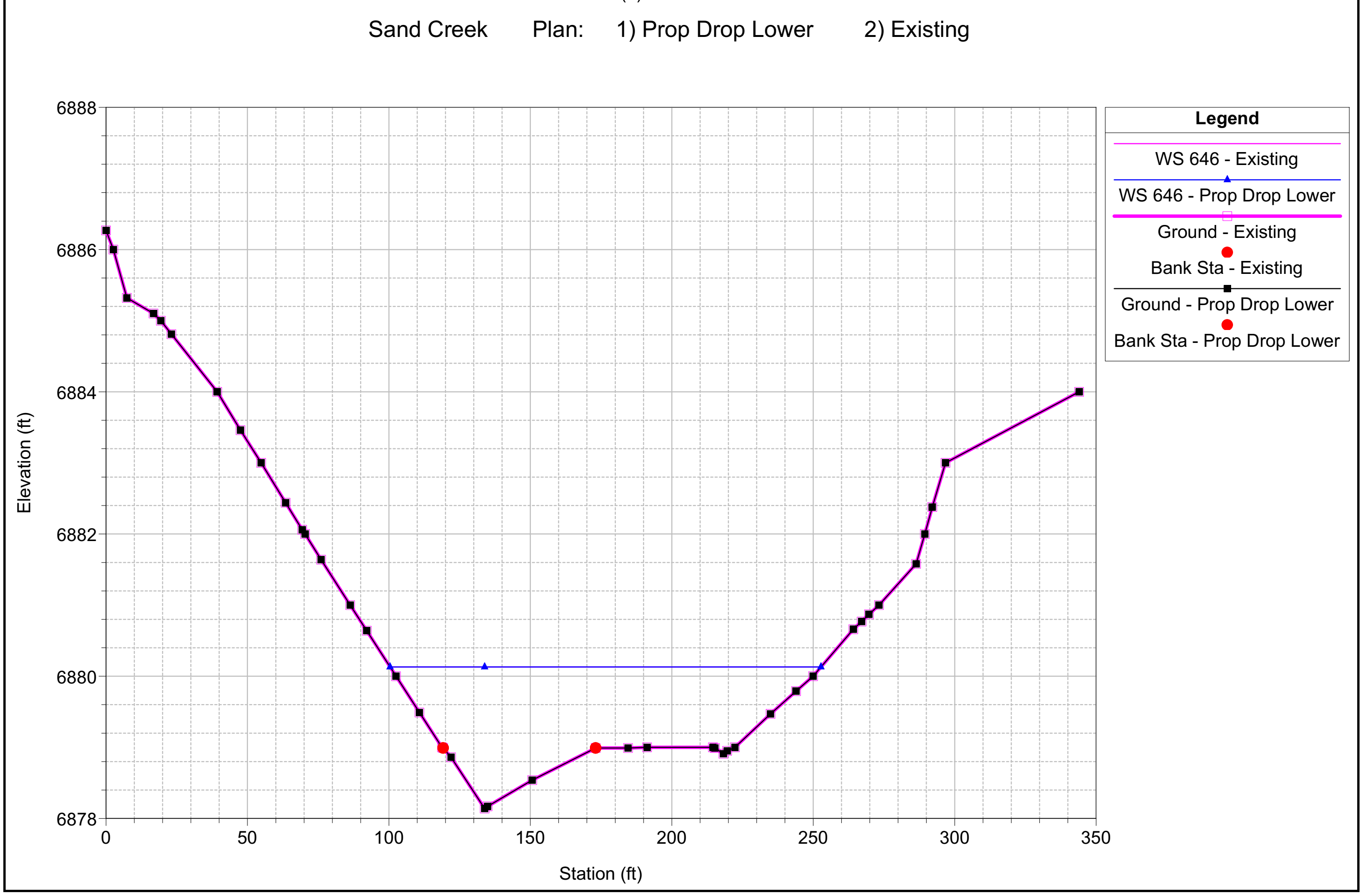


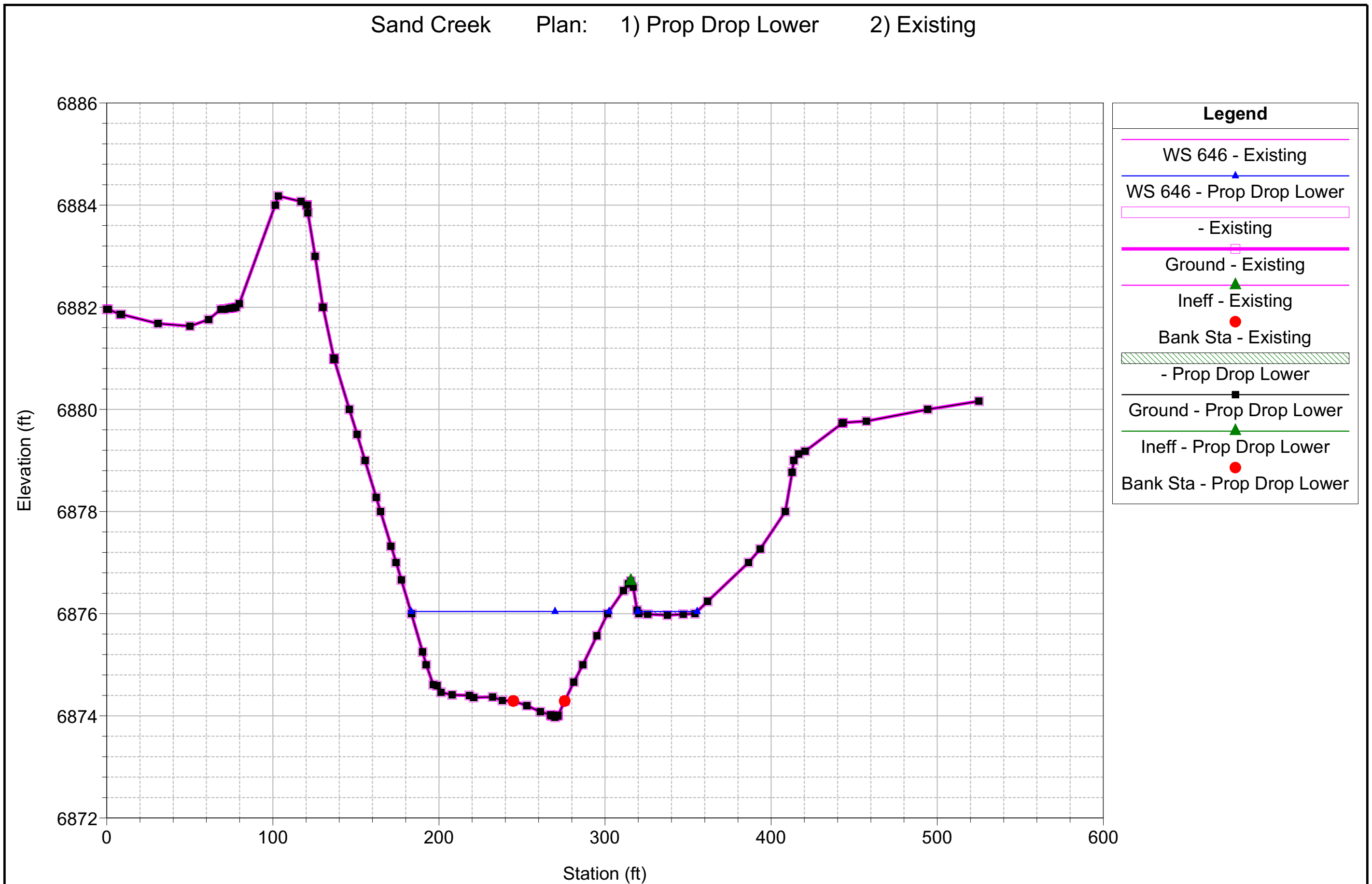
Sand Creek Plan: 1) Prop Drop Lower 1/12/2022 2) Existing 1/12/2022
Sand Creek Sand Creek CL
Legend
WS 646 - Prop Drop Lower
WS 646 - Existing
Ground
Ground
OWS 646 - Prop Drop Lower
OWS 646 - Existing
Proposed Buried Drop
Proposed Drop
Elevation (ft)
Main Channel Distance (ft)
6885
6880
6875
6870
6865
6860
6855
6850
0
500
1000
1500
2000
101
101.9 Top of
103
104 Existing GCS
105
106 Proposed GCS
107
108
109
110 Exist GCS
111

HEC-RAS River: Sand Creek Reach: Sand Creek CL Profile: 646

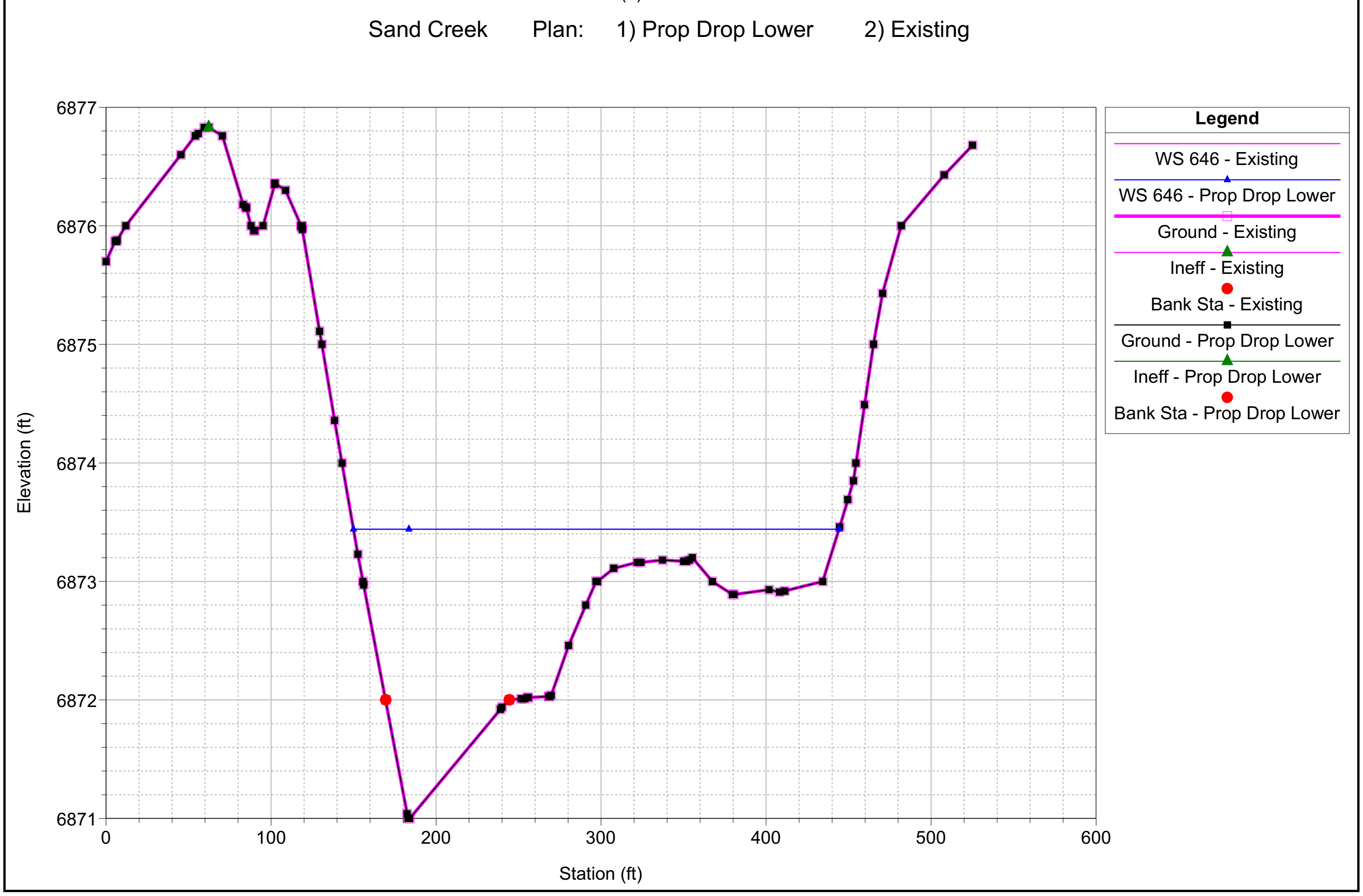
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Sand Creek CL	111	646	Prop Drop Lower	646.00	6879.92	6882.2		6882.46	0.011386	4.17	158.68	86.11	0.52
Sand Creek CL	111	646	Existing	646.00	6879.92	6882.2		6882.46	0.011386	4.17	158.68	86.11	0.52
Sand Creek CL	110	646	Prop Drop Lower	646.00	6878.14	6880.1	6879.90	6880.43	0.023730	5.10	167.70	152.33	0.72
Sand Creek CL	110	646	Existing	646.00	6878.14	6880.1	6879.90	6880.43	0.023730	5.10	167.70	152.33	0.72
Sand Creek CL	109	646	Prop Drop Lower	646.00	6873.97	6876.0	6875.60	6876.32	0.018196	5.15	172.09	155.07	0.66
Sand Creek CL	109	646	Existing	646.00	6873.97	6876.0	6875.60	6876.32	0.018196	5.15	172.09	155.07	0.66
Sand Creek CL	108	646	Prop Drop Lower	646.00	6871.00	6873.4	6872.75	6873.58	0.007690	3.38	277.84	294.24	0.43
Sand Creek CL	108	646	Existing	646.00	6871.00	6873.4	6872.75	6873.58	0.007690	3.38	277.84	294.24	0.43
Sand Creek CL	107	646	Prop Drop Lower	646.00	6867.95	6869.8	6869.79	6870.11	0.027633	5.14	191.16	490.14	0.77
Sand Creek CL	107	646	Existing	646.00	6867.95	6869.8	6869.79	6870.11	0.027633	5.14	191.16	490.14	0.77
Sand Creek CL	106	646	Prop Drop Lower	646.00	6863.48	6866.8	6866.26	6866.98	0.008492	4.38	259.92	530.51	0.47
Sand Creek CL	106	646	Existing	646.00	6863.48	6866.8	6866.26	6866.98	0.008492	4.38	259.92	530.51	0.47
Sand Creek CL	105	646	Prop Drop Lower	646.00	6861.00	6864.3	6864.28	6864.74	0.023995	6.54	159.47	427.06	0.76
Sand Creek CL	105	646	Existing	646.00	6861.00	6864.3	6864.28	6864.74	0.023995	6.54	159.47	427.06	0.76
Sand Creek CL	104	646	Prop Drop Lower	646.00	6859.22	6862.0	6861.16	6862.12	0.008144	3.91	242.93	357.66	0.45
Sand Creek CL	104	646	Existing	646.00	6859.22	6862.0	6861.16	6862.12	0.008158	3.91	242.79	357.57	0.45
Sand Creek CL	103	646	Prop Drop Lower	646.00	6855.73	6860.0	6859.44	6860.27	0.008625	4.18	216.49	299.67	0.47
Sand Creek CL	103	646	Existing	646.00	6855.73	6860.0	6859.44	6860.27	0.008576	4.17	217.01	299.95	0.47
Sand Creek CL	102	646	Prop Drop Lower	646.00	6854.05	6858.7	6858.74	6859.20	0.019056	7.22	181.28	221.62	0.70
Sand Creek CL	102	646	Existing	646.00	6854.05	6858.7	6858.70	6859.14	0.022082	6.97	174.46	218.38	0.72
Sand Creek CL	101.9	646	Prop Drop Lower	646.00	6854.00	6858.2	6858.20	6858.75	0.018869	6.71	155.39	200.55	0.70
Sand Creek CL	101.1	646	Prop Drop Lower	646.00	6852.00	6857.4	6856.13	6857.89	0.010879	5.63	123.96	129.48	0.54
Sand Creek CL	101	646	Prop Drop Lower	646.00	6851.92	6856.2	6856.21	6857.65	0.041392	9.62	67.16	54.61	1.00
Sand Creek CL	101	646	Existing	646.00	6851.92	6856.2	6856.21	6857.65	0.041392	9.62	67.16	54.61	1.00
Sand Creek CL	100	646	Prop Drop Lower	646.00	6850.99	6854.5	6853.82	6855.04	0.017701	5.94	108.74	43.51	0.66
Sand Creek CL	100	646	Existing	646.00	6850.99	6854.5	6853.82	6855.04	0.017701	5.94	108.74	43.51	0.66


Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
Ground - Existing
Bank Sta - Existing
Ground - Prop Drop Lower
Bank Sta - Prop Drop Lower
Elevation (ft)
6900
6895
6890
6885
6880
6875
Station (ft)
0
50
100
150
200
250

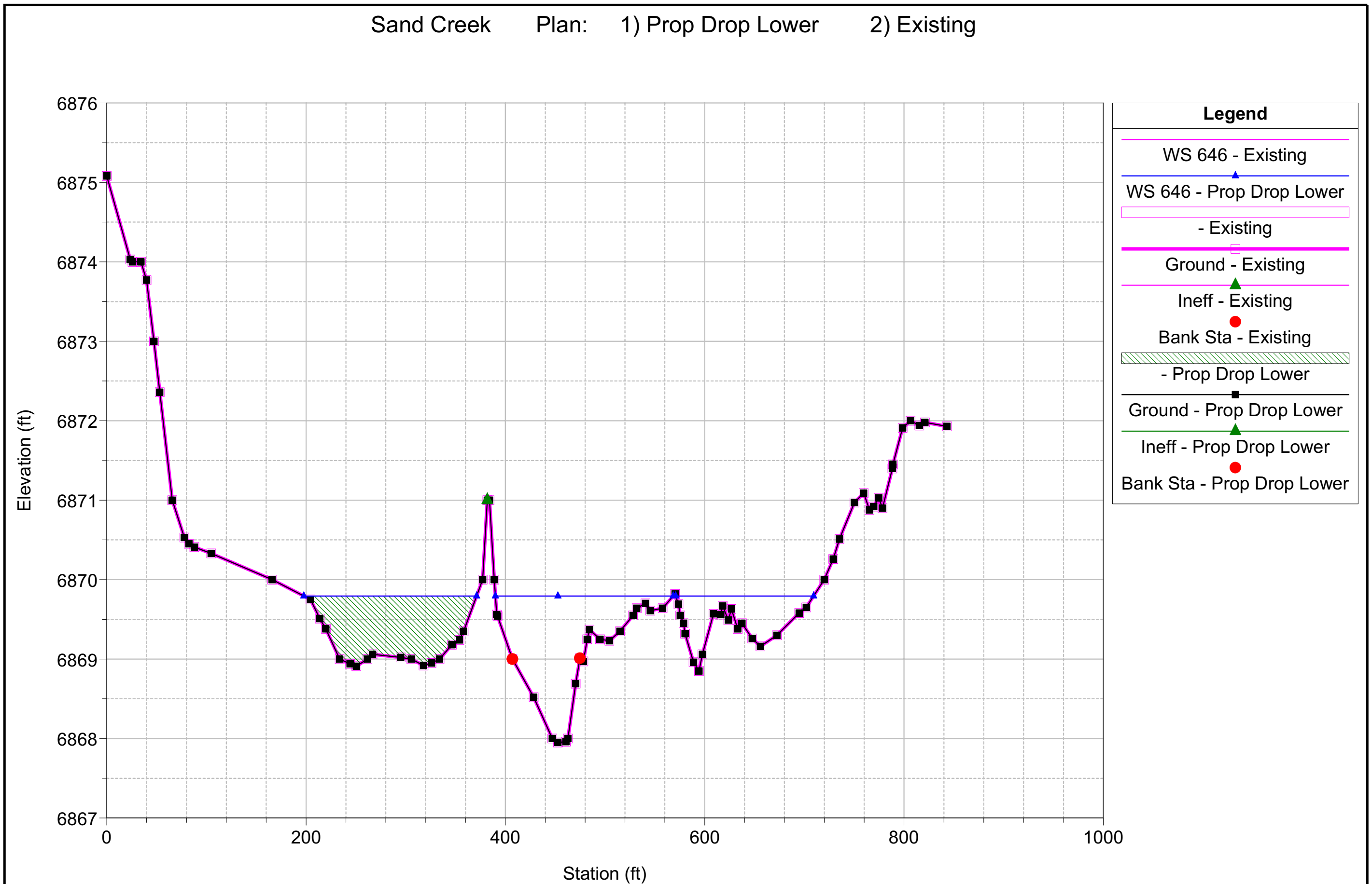

Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
Ground - Existing
Bank Sta - Existing
Ground - Prop Drop Lower
Bank Sta - Prop Drop Lower
Elevation (ft)
6888
6886
6884
6882
6880
6878
Station (ft)
0
50
100
150
200
250
300
350



Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Elevation (ft)
6886
6884
6882
6880
6878
6876
6874
6872
0
100
200
300
400
500
600
Station (ft)
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
- Existing
Ground - Existing
Ineff - Existing
Bank Sta - Existing
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower



Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Elevation (ft)
6877
6876
6875
6874
6873
6872
6871
0
100
200
300
400
500
600
Station (ft)
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
Ground - Existing
Ineff - Existing
Bank Sta - Existing
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower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Elevation (ft)
Station (ft)
Legend
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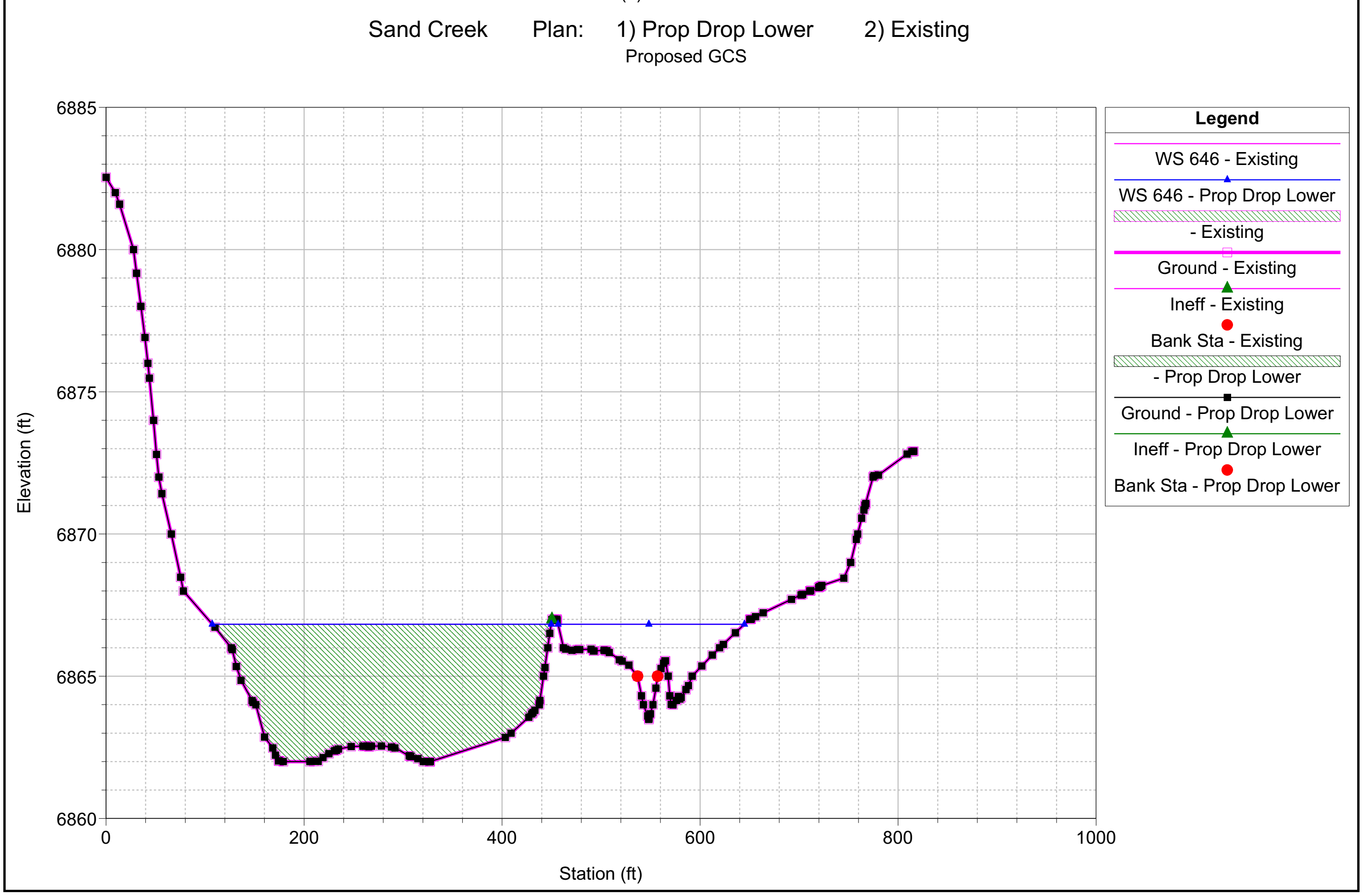
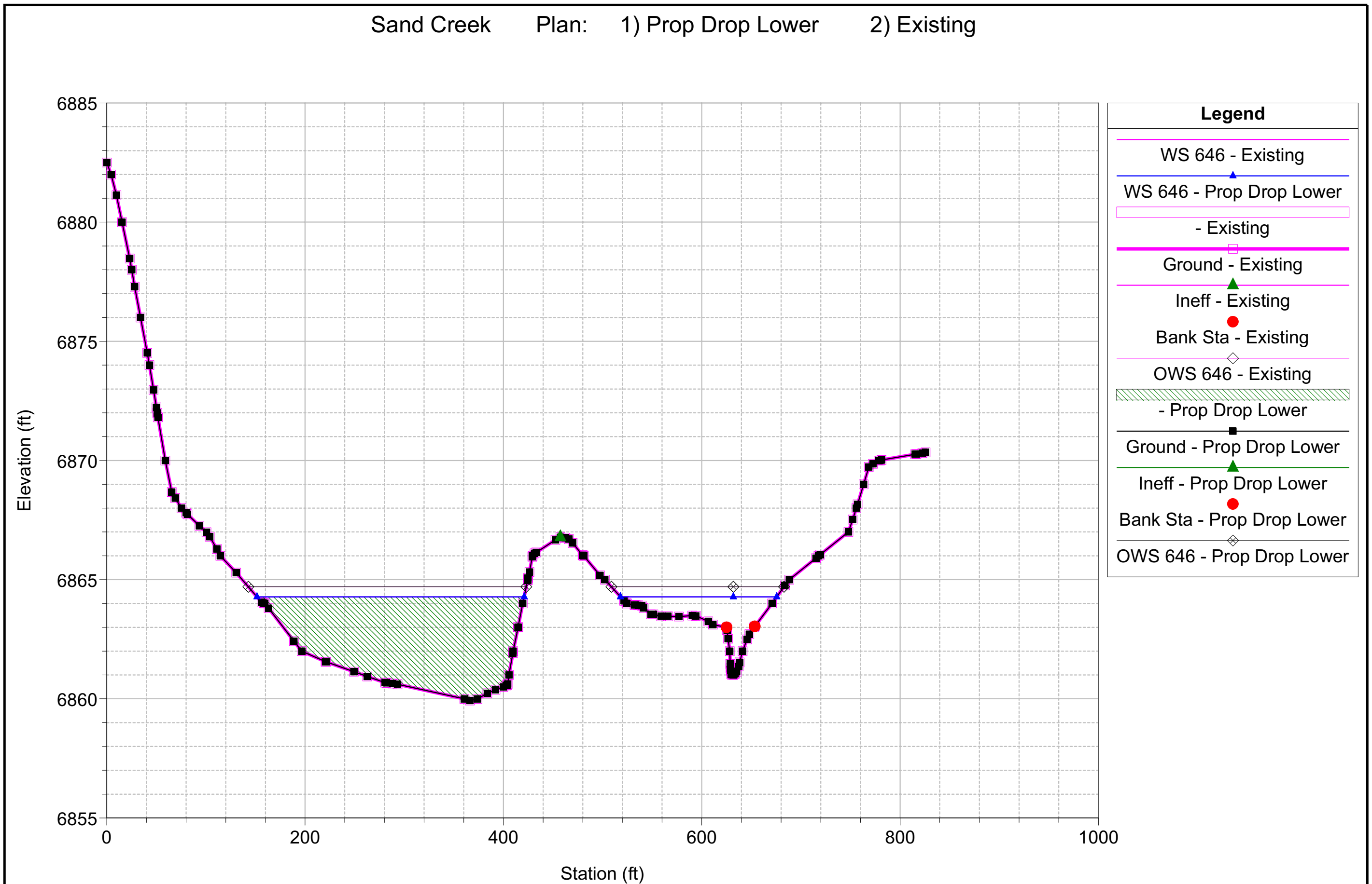
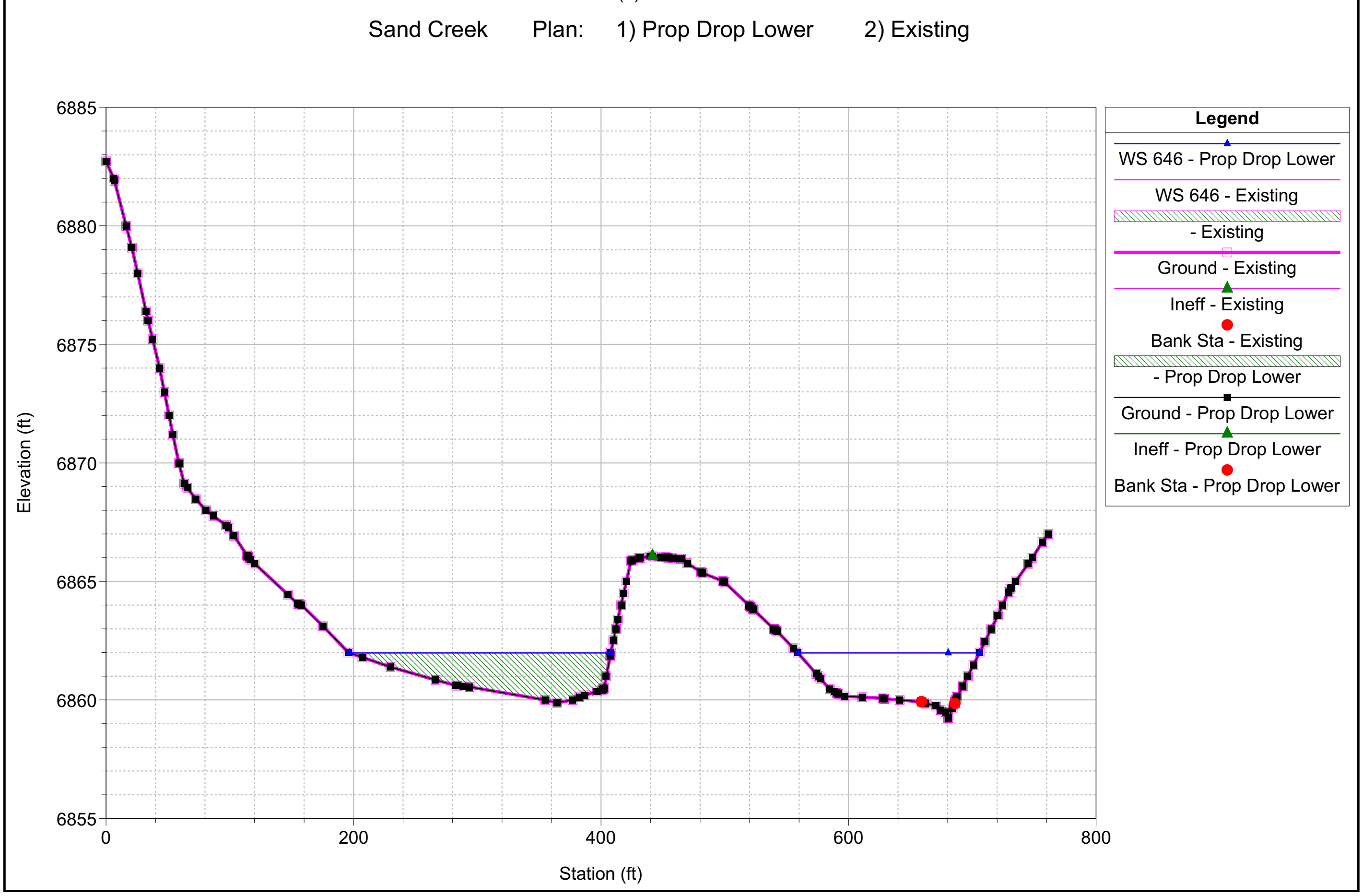
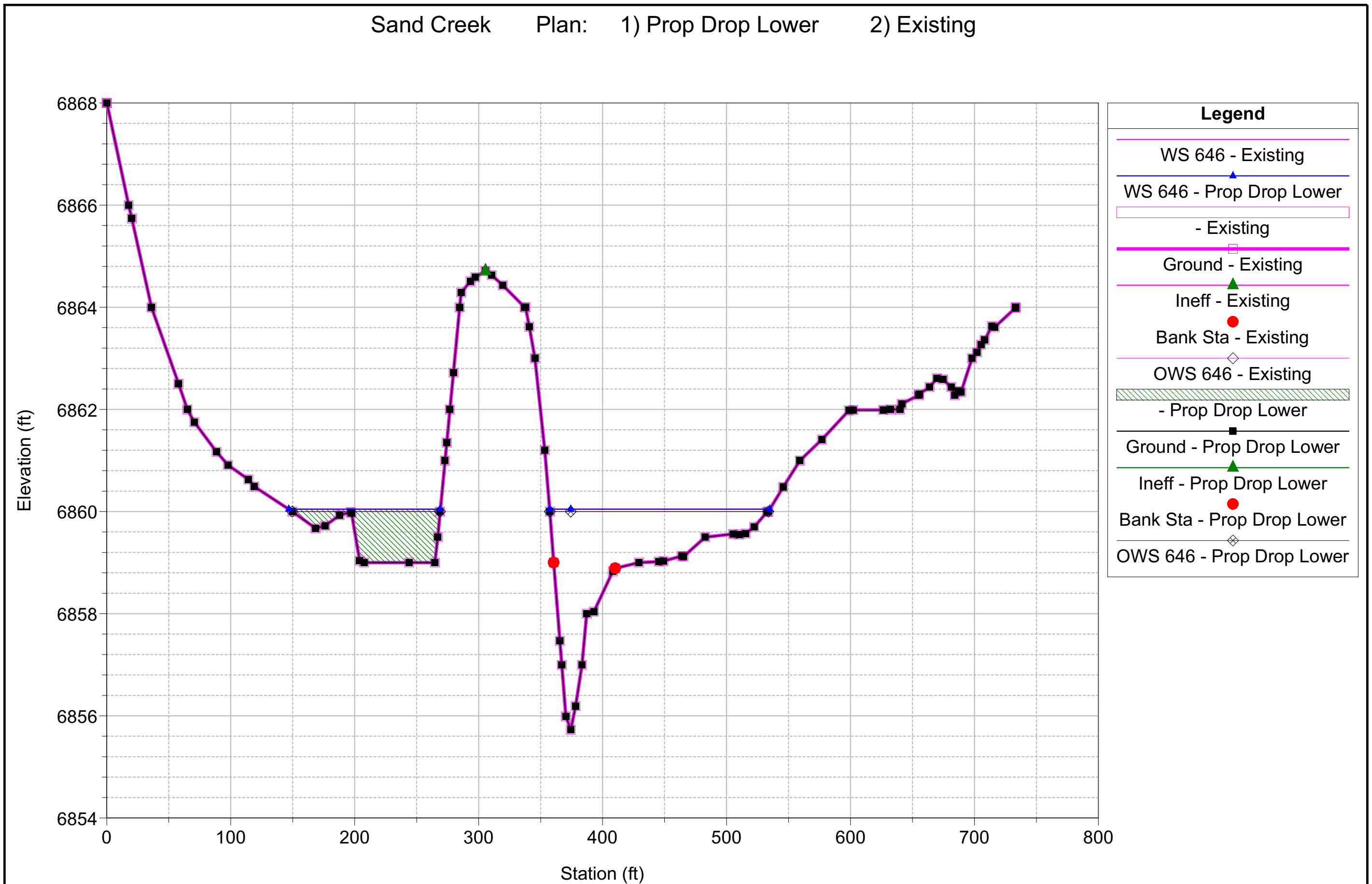
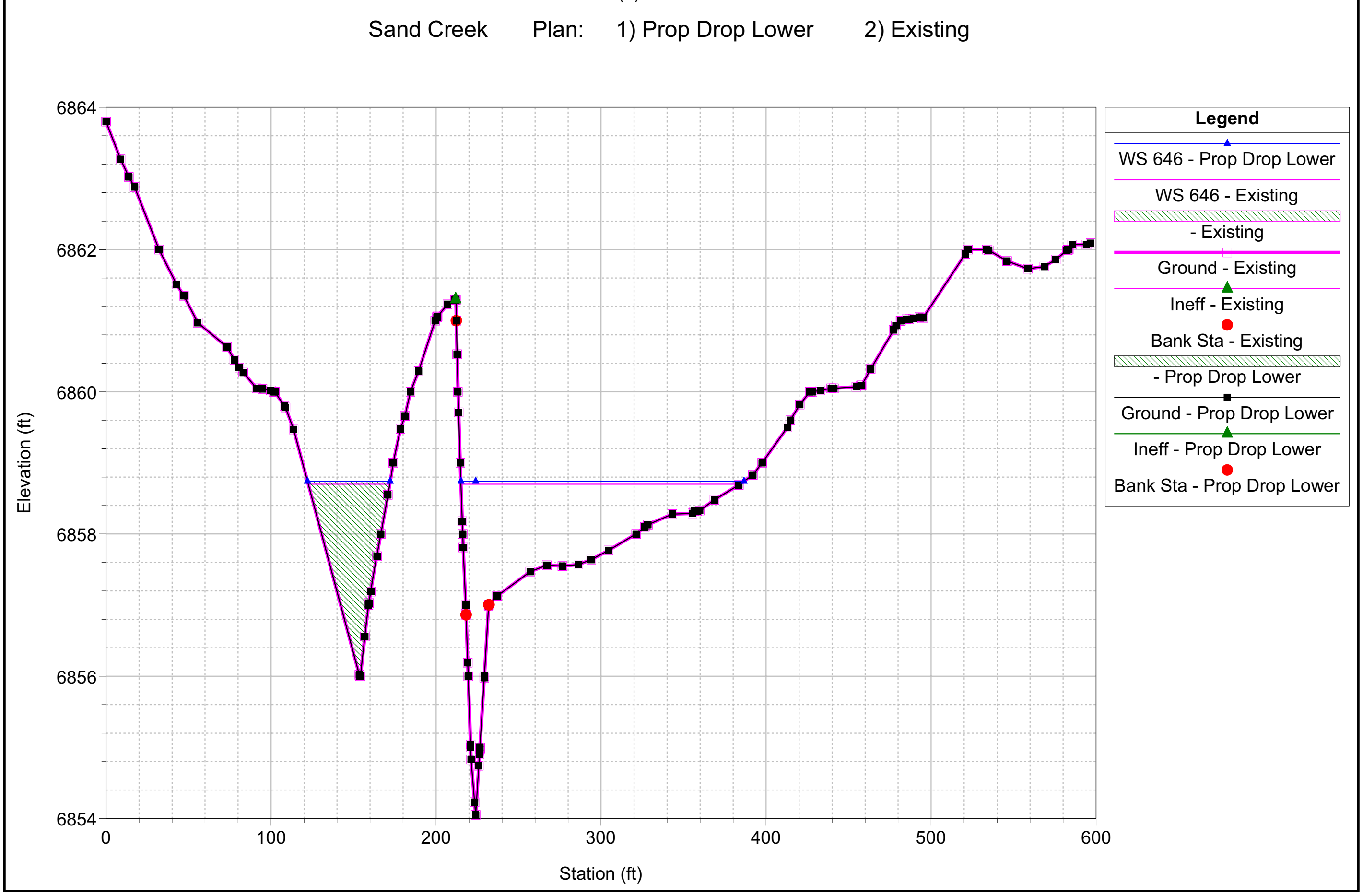
WS 646 - Prop Drop Lower
- Existing
Ground - Existing
Ineff - Existing
Bank Sta - Existing
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower

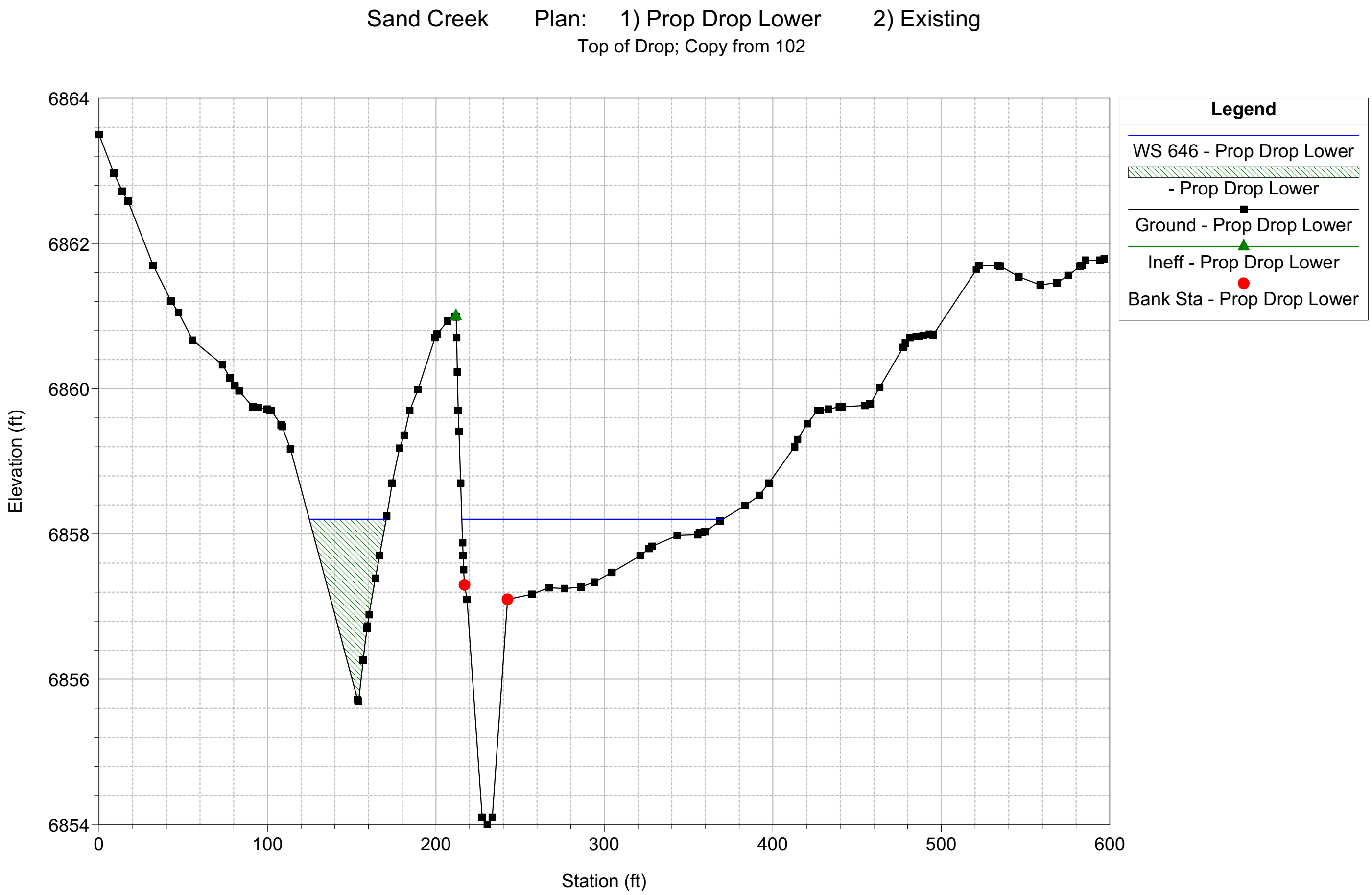

Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Proposed GCS
Elevation (ft)
Station (ft)
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
- Existing
Ground - Existing
Ineff - Existing
Bank Sta - Existing
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower

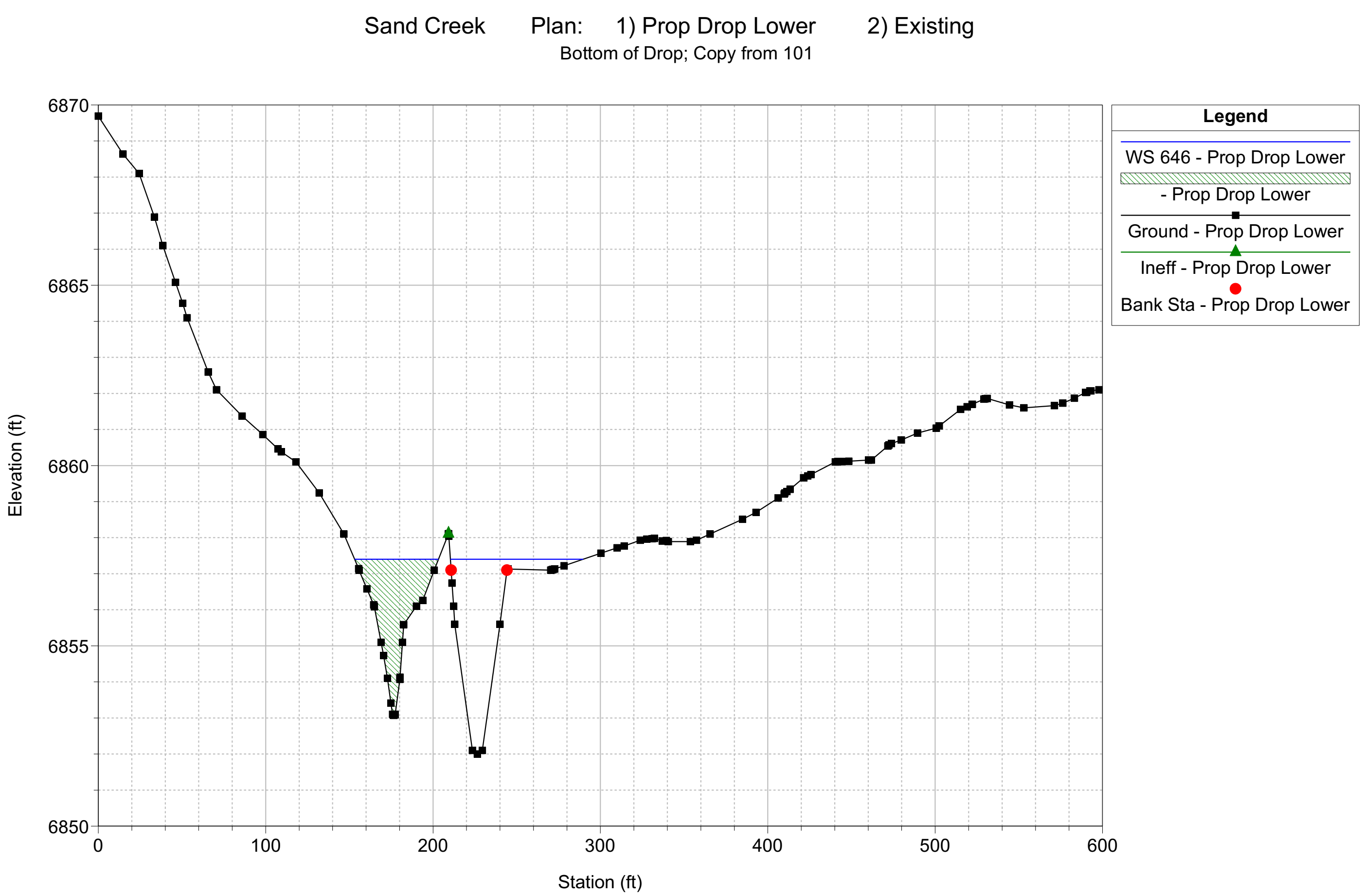

Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Elevation (ft)
Station (ft)
6885
6880
6875
6870
6865
6860
6855
0
200
400
600
800
1000
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
- Existing
Ground - Existing
Ineff - Existing
Bank Sta - Existing
OWS 646 - Existing
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower
OWS 646 - Prop Drop Lower


Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Elevation (ft)
Station (ft)
6885
6880
6875
6870
6865
6860
6855
0
200
400
600
800
Legend
WS 646 - Prop Drop Lower
WS 646 - Existing
- Existing
Ground - Existing
Ineff - Existing
Bank Sta - Existing
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower


Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
- Existing
Ground - Existing
Ineff - Existing
Bank Sta - Existing
OWS 646 - Existing
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower
OWS 646 - Prop Drop Lower
Elevation (ft)
Station (ft)
6868
6866
6864
6862
6860
6858
6856
6854
0
100
200
300
400
500
600
700
800


Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Legend
WS 646 - Prop Drop Lower
WS 646 - Existing
- Existing
Ground - Existing
Ineff - Existing
Bank Sta - Existing
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower
Elevation (ft)
Station (ft)
6864
6862
6860
6858
6856
6854
0
100
200
300
400
500
600


Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Top of Drop; Copy from 102
Legend
WS 646 - Prop Drop Lower
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower
Elevation (ft)
Station (ft)
6864
6862
6860
6858
6856
6854
0
100
200
300
400
500
600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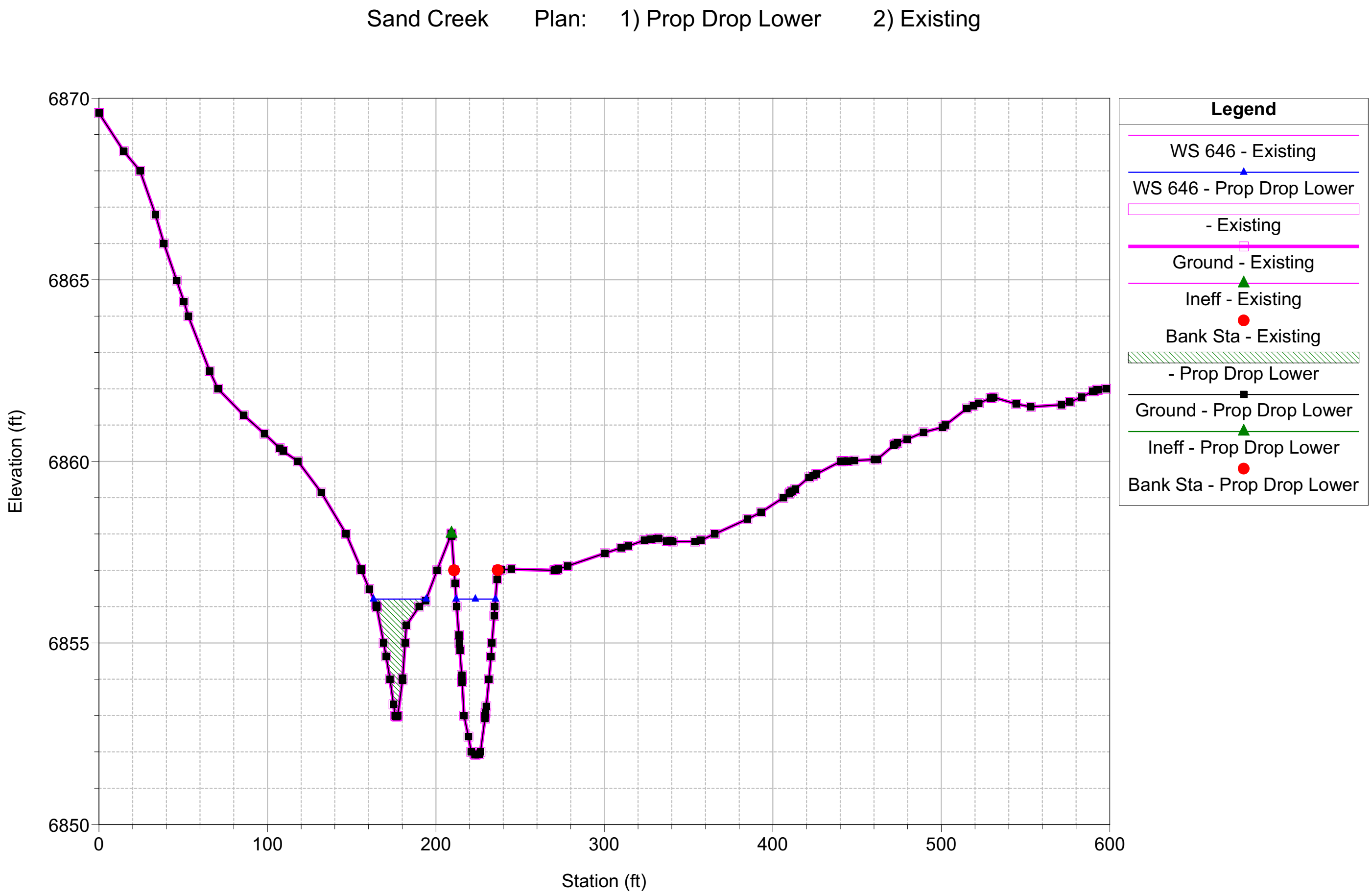
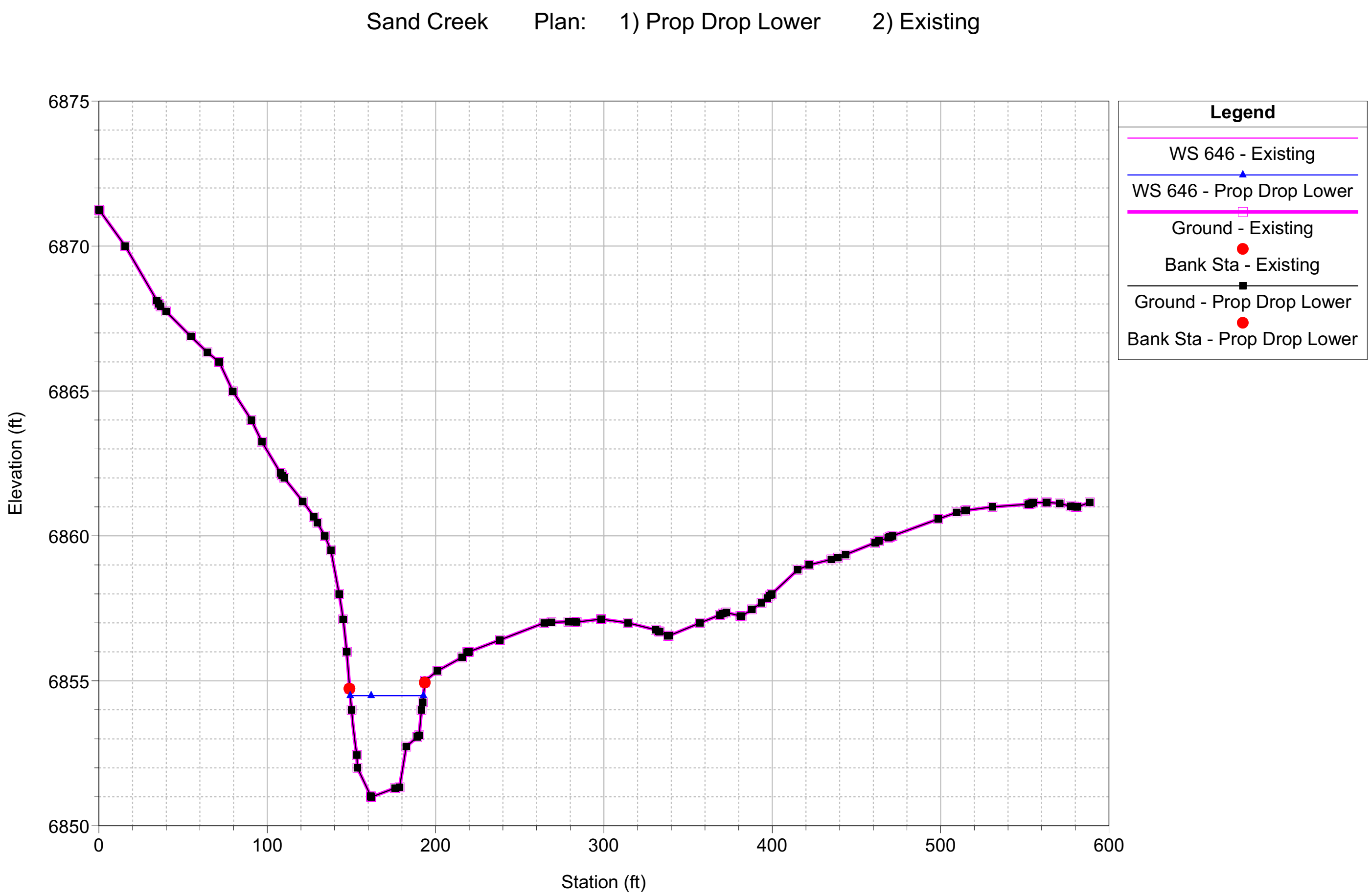
Bottom of Drop; Copy from 101
Legend
WS 646 - Prop Drop Lower
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower
Elevation (ft)
Station (ft)
6870
6865
6860
6855
6850
0
100
200
300
400
500
600


Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Elevation (ft)
Station (ft)
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
- Existing
Ground - Existing
Ineff - Existing
Bank Sta - Existing
- Prop Drop Lower
Ground - Prop Drop Lower
Ineff - Prop Drop Lower
Bank Sta - Prop Drop Lower


Sand Creek Plan: 1) Prop Drop Lower 2) Existing
Elevation (ft)
Station (ft)
Legend
WS 646 - Existing
WS 646 - Prop Drop Lower
Ground - Existing
Bank Sta - Existing
Ground - Prop Drop Lower
Bank Sta - Prop Drop Lower

Michelle Iblings

From: Nicole Schanel <Nicole_Schanel@matrixdesigngroup.com>
Sent: Thursday, March 24, 2022 1:01 PM
To: Michelle Iblings; Tori Mack
Cc: Tim McConnell
Subject: RE: Sand Creek Improvements - USACE Permit
Attachments: Biostabilization Manual Draft 102916.pdf

Hi Michelle –

For this project, we can only speak to the wetlands that we located. The delineation was focused between cross sections 107 and 100 as shown in Drexel's RAS model. In these sections, the primary species included willows, grasses, and herbaceous species. The soils are Blakeland-Fluvaquentic Haplaquolls which have low cohesive properties.

I have attached the Living Streambanks Manual. We believe that the existing vegetation would fall into short or long native grasses which puts you into the 0.7-0.95 or 1.2-1.7 range, respectively; likely on the lower end due to the soil type. The willow brush does not seem to be present uniformly, rather in clumps, so this may not be appropriate to use as a primary classifier.

Summary:

Vegetation Type	Shear (lb/ft2)	Velocity (ft/s)
Short native grasses*	0.7-0.95	3-4
Long native grasses	1.2-1.7	4-6
Grass Mix, easily eroded soil, 0-5% slope		4
Willow brush (3-4 seasons old)	2.86	
Willow brush (immediately after construction)	0.41	

Please let me know if you have any questions.

Thanks,

Matrix
Excellence by Design

Nicole Schanel, PE
Deputy Director, Civil South
Senior Project Manager
Matrix Design Group, Inc.
O 719.575.0100 | **C** 719.659.6141
nicole.schanel@matrixdesigngroup.com
2435 ResearchPkwy | Suite 300 | Colorado Springs, CO 80920
matrixdesigngroup.com

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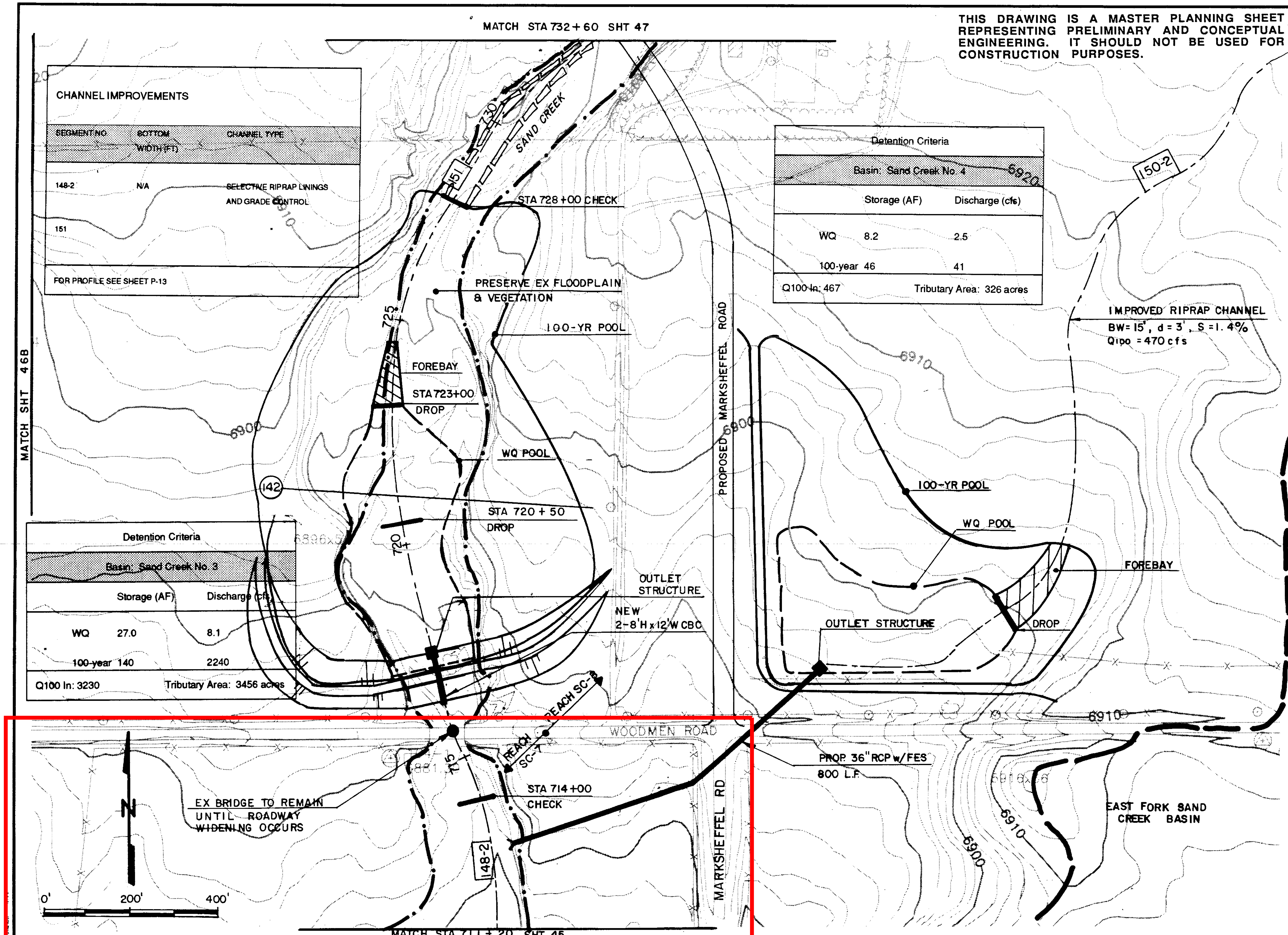


CHANNEL IMPROVEMENTS

SEGMENT NO.	BOTTOM WIDTH (FT)	CHANNEL TYPE
148-2	N/A	SELECTIVE RIPRAP LININGS AND GRADE CONTROL
151		

FOR PROFILE SEE SHEET P-13

Detention Criteria

Basin: Sand Creek No. 4

	Storage (AF)	Discharge (cfs)
WQ	8.2	2.5
100-year	46	41

Q100 In: 467 Tributary Area: 326 acres

Detention Criteria

Basin: Sand Creek No. 3

	Storage (AF)	Discharge (cfs)
WQ	27.0	8.1
100-year	140	2240

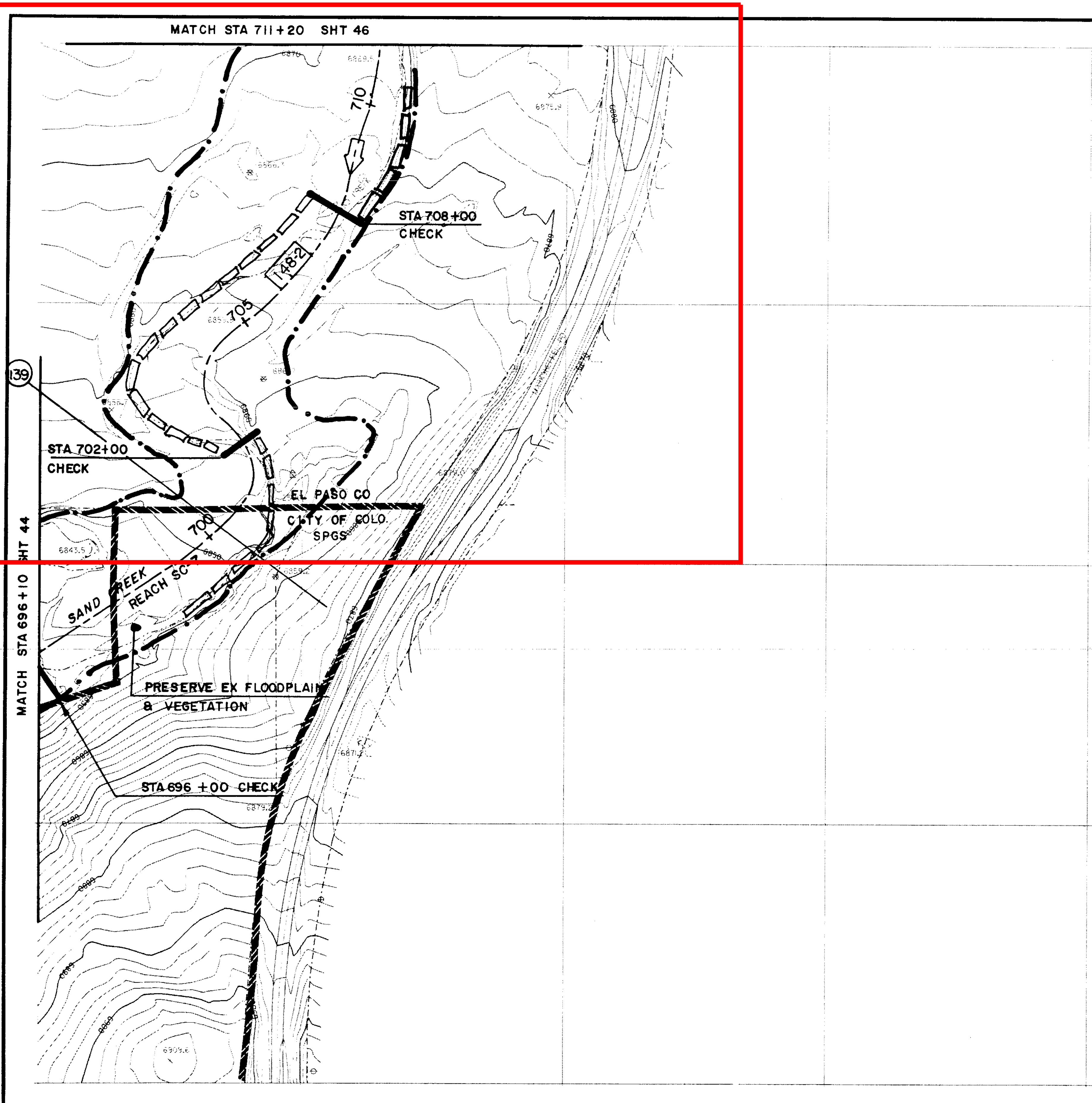
Q100 In: 3230 Tributary Area: 3456 acres

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN PLANS

Project No	90-04-09
Date:	9-92
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	



THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.

CHANNEL IMPROVEMENTS

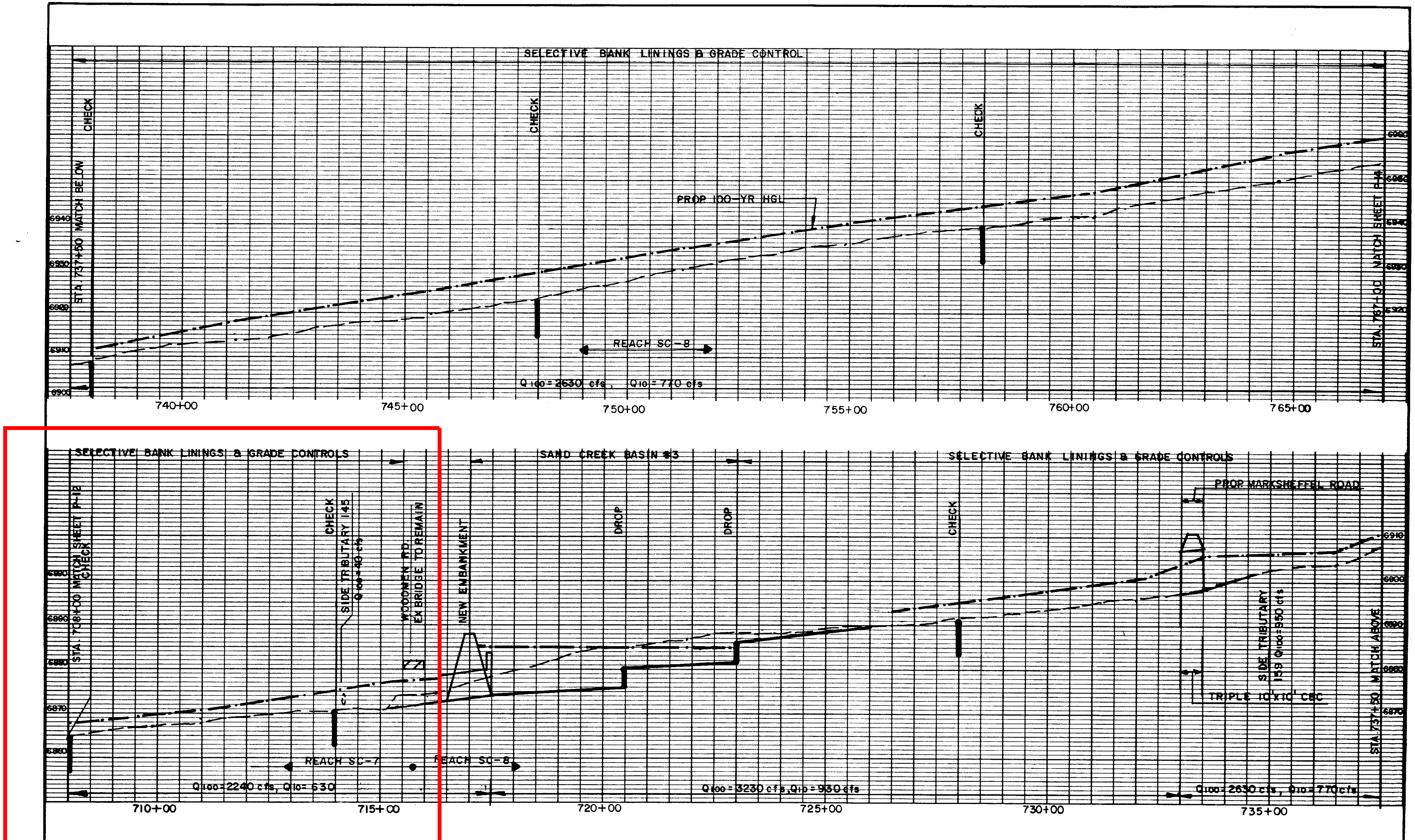
SEGMENT NO.	BOTTOM WIDTH (FT)	CHANNEL TYPE
148-2	N/A	SELECTIVE RIPRAP LININGS AND GRADE CONTROL

FOR PROFILE SEE SHEETS P-12 AND P-13

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN PLANS

Project No	90-04-09
Date:	9-92
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	



Kiowa Engineering Corporation

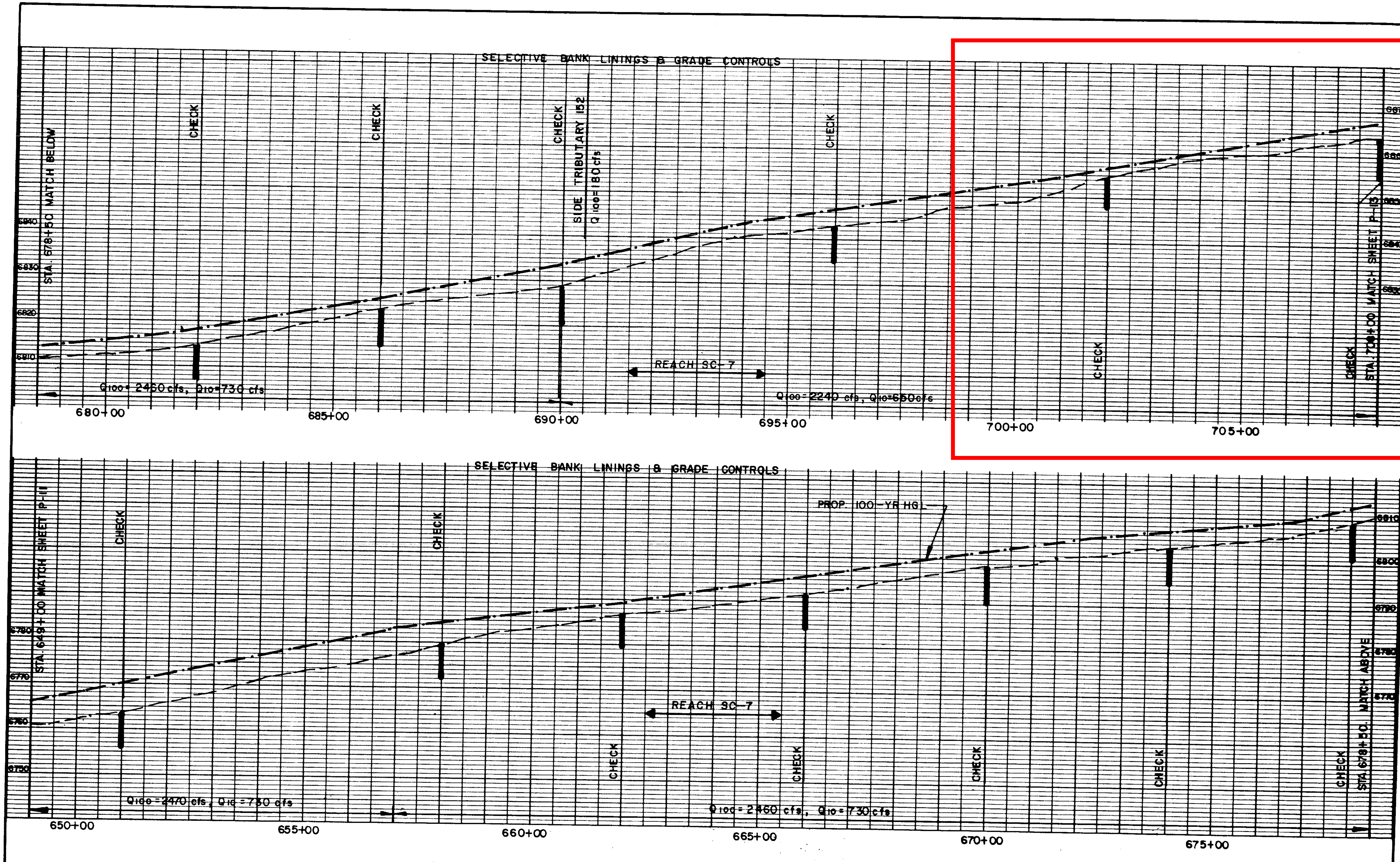
DESIGNED RNW	DATE
CHECKED JYC	DATE
DRAWN EAK	DATE 7/92
REVISED	DATE

SAND CREEK DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN PROFILES

CITY OF COLORADO SPRINGS
EL PASO COUNTY, COLORADO

SAND CREEK
Station 708+00 to 767+00

P-13



Kiowa Engineering Corporation	DESIGNED RNW DATE CHECKED JYC DATE DRAWN EAK DATE 7/92 REVISED DATE	SAND CREEK DRAINAGE BASIN PLANNING STUDY PRELIMINARY DESIGN PROFILES	CITY OF COLORADO SPRINGS EL PASO COUNTY, COLORADO	SAND CREEK Station 649+00 to 708+00	P-12

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Select Tables from the 2021 Sand Creek DBPS

Table 6-13. Alternative 2 Conveyance Improvements Downstream of Regional Pond 1

				Channel Geometry			Grade Control Structures		
ReachName	Type	Channel_ID	Length	Typical Section	Topwidth (ft)	Maximum Depth (ft)	Number	Height (ft)	Spacing (ft)
SC1R1	Type 2 - Improved - Existing or future problems	-	1274	-	-	-	12	3	767
SC1R10	Type 3 - Unimproved - Existing or future problems	6	9223	6	144	5	36	3	252

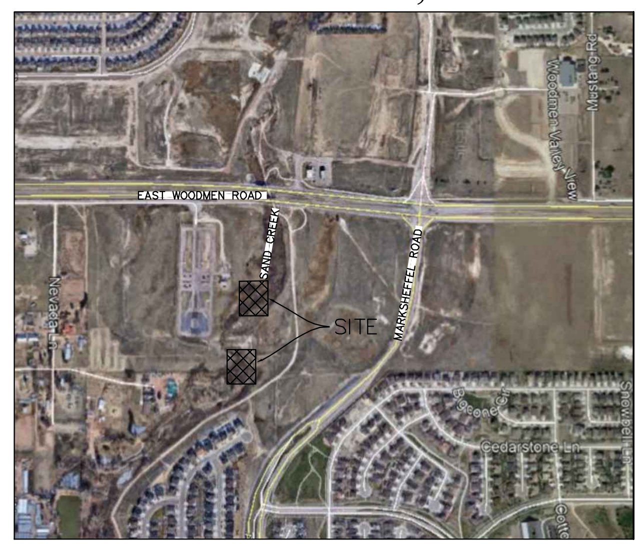
Table 7-1. Properties of Channel Improvement Theme ID

	Engineered Channel Section				Natural Engineered Channel Section			
Channel ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
BW	16	22	32	44	20	32	42	64
Bankfull depth	0.90	1.29	1.87	2.62	0.6	1.05	1.35	1.95
Bankfull width	23.24	32.34	46.99	64.96	24.84	40.37	52.78	79.6
Bankfull w/d	26	25	25	25	41	38	39	41
10yr depth	2.09	3.03	4.37	5.72	1.44	2.38	2.99	4.78
10yr width	51.59	76.24	106.97	137.2	59.52	87.01	119.91	186.25
10yr w/d	25	25	24	24	41	37	40	39
100yr depth	3.22	4.44	6.3	7.97	1.89	3.61	4.2	6.99
100yr width	77.78	107.51	154.41	193.71	75.16	136.9	170.75	275.93
100yr w/d	24	24	25	24	40	38	41	39
TW	92	120	168	200	84	144	188	284
Total depth	5	6	8	9	3	5	6	8
Slope	0.30%	0.30%	0.30%	0.30%	0.20%	0.20%	0.20%	0.20%

Table 3-13. Future Conditions Peak Flow Rates at Analysis Points

Major Drainage Way	Model Node ID	Location Description	Contributing Area (mi^2)	DARF (%)	Percent of Point Precipitation (%)	100-Year Flow (cfs)	50-Year Flow (cfs)	25-Year Flow (cfs)	10-Year Flow (cfs)	5-Year Flow [cfs]	2-Year Flow (cfs)
Sand Creek	DNSPT_SACR1_54	Upstream reach of Sand Creek	2.2	0	100	259	219	185	146	122	97
	SC_POND_3_OUT2	Sand Creek Upstream E Woodman Rd (Regional Detention Pond #3 Outlet)	4.4	0	100	646	453	286	137	105	63
	DSNPT_SACR1_42	Sand Creek Upstream of Dublin Blvd	7.5	0	100	973	748	524	290	220	151
	DSNPT_DS_SACR1_37	Sand Creek Upstream of Stetson Hills Blvd	9.3	0	100	1,104	893	731	555	456	354
	DSNPT_SACR1_34	Sand Creek Upstream of Barnes Rd	11.6	4	96	1,979	1,646	1,352	1,023	837	647
	DSNPT_SACR1_30	Sand Creek upstream of Carefree Cir. (Downstream of Regional Detention Pond #2)	13	4	96	2,489	2,081	1,718	1,310	1,064	807
	DS7_SACR1_25	Sand Creek Downstream of Constitution Ave. (Regional Detention Pond #1 Outlet)	15.2	4	96	3,493	2,937	2,430	1,825	1,463	1,082
	DSNPT_SACR1_25	Sand Creek Upstream of N Powers Blvd and upstream of City Corporate limits	15.7	4	96	3,679	3,092	2,555	1,913	1,532	1,133
	DSNPT_SACR1_23	Sand Creek Upstream of Palmer Park Blvd	16	4	96	3,775	3,170	2,614	1,951	1,562	1,156
	DSNPT_SACR1_18	Sand Creek Upstream of E Platte Ave.	16.7	4	96	3,999	3,352	2,756	2,042	1,635	1,208
	DSNPT_SACR1_17	Sand Creek West Fork at confluence with Sand Creek	22.2	4	96	6,105	5,111	4,192	3,096	2,456	1,797
	CH1_SACR1_13	Sand Creek upstream of confluence with East Fork Sand Creek	22.7	4	96	6,263	5,231	4,279	3,155	2,504	1,833
	DSNPT_SACR1_13	Sand Creek East Fork at confluence with Sand Creek	49	8	92	11,305	9,411	7,644	5,738	4,359	3,244
	OUTLET_SACR1	Sand Creek Confluence with Fountain Creek (Sand Creek Outlet)	60.8	8	92	13,601	11,268	8,961	6,493	4,930	3,648
Sand Creek Center Tributary	DSNPT_SACR2_3N6_E	Sand Creek Center Subtributary Upstream of Omaha Blvd	0.26	0	100	109	91	76	58	49	39
	DSNPT_SACR2_3N4	Sand Creek Center Subtributary Upstream of Platte Ave.	1.22	0	100	538	449	373	288	238	191
	DSNPT_SACR2_3N2	Sand Creek Center Subtributary Upstream 024G	1.52	0	100	683	571	473	365	301	242
Sand Creek East Fork	DSNPT_SACR2_12N10_E2	Sand Creek East Fork (W1) Upstream of E Woodman Rd	0.2	0	100	43	34	29	24	20	19
	DSNPT_SACR2_12N8_E	Sand Creek East Fork (E branch) Upstream of Dublin Ave.	0.51	0	100	137	116	97	76	62	49

SAND CREEK
DROP STRUCTURE & GRADE CONTROL
100% CONSTRUCTION PLANS
COTTAGES AT WOODMEN HEIGHTS
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO



VICINITY MAP
NOT TO SCALE

SHEET INDEX

ENGINEER'S STATEMENT:

THESE DETAILED PLANS AND SPECIFICATIONS WERE PREPARED UNDER MY DIRECTION AND SUPERVISION. SAID DETAILED PLANSAND SPECIFICATIONS HAVE BEEN PREPARED ACCORDING TO THE ESTABLISHED CRITERIA FOR DETAILED DRAINAGE PLANS AND SPECIFICATIONS, AND SAID DETAILED PLANS AND SPECIFICATIONS ARE IN CONFORMITY WITH THE MASTER PLAN OF THE DRAINAGE BASIN. SAID DETAILED DRAINAGE PLANS AND SPECIFICATIONS MEET THE PURPOSES FOR WHICH THE PARTICULAR DRAINAGE FACILITY(S) IS DESIGNED. I ACCEPT RESPONSIBILITY FOR ANY LIABILITY CAUSED BY ANY NEGLIGENT ACTS, ERRORS OR OMISSIONS ON MY PART IN PREPARATION OF THE DETAILED DRAINAGE PLANS AND SPECIFICATIONS.

SIGNED: ______________________ DATE: ______________

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.

FOR CITY ENGINEER: ______________ DATE: ______________

CONDITIONS:

THE CITY OF COLORADO SPRINGS APPROVES THESE PLANS BASED UPON THE NON–JURISDICTIONAL STATUS OF THE FACILITY. IT IS THE DESIGN ENGINEER'S RESPONSIBILITY TO FOLLOW UP WITH THE STATE DIVISION OF WATER RESOURCES FOR JURISDICTIONAL DETERMINATION. IF, UPON STATE REVIEW, THE CLASSIFICATION CHANGES TO JURISDICTIONAL, ADDITIONAL CITY REVIEW AND APPROVAL WILL BE NECESSARY.

OWNER / DEVELOPER:

______________________ DATE: ______________

GOODWIN KNIGHT
8605 EXPLORER DRIVE, SUITE 250
COLORADO SPRINGS, CO 80920

LEGAL DESCRIPTION:

THE NORTHEAST QUARTER OF THE NORTHEAST QUARTER OF SECTION 8, TOWNSHIP 13 SOUTH, RANGE 65 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO, EXCEPT THAT PART TO THE COUNTY FOR ROAD AND EXCEPT TRACT OF LAND CONVEYED AT RECEPTION NO. 207123363.

(PER THE TUSTEE'S DEED RECORDED UNDER RECEPTION NO. 210117435)

ADDRESS OF RECORD: E. WOODMEN ROAD, COLORADO SPRINGS, CO

BENCHMARK:

SITE BENCHMARK IS A CHISLED "+" IN THE SOUTHWEST CORNER OF THE BRIDGE HEADWALL AS SHOWN HEREON. (ELEVATION=6897.52 NAVD88). THE SITE BENCHMARK WAS ESTABLISHED FROM USING RTK DERIVED GPS COORDINATES FROM THE LEICA SMARTNET NETWORK WITH A VERTICAL CHECK/REFERENCE TO NGS MONUMENT 4 BB RESET (ELEVATION=7570.8 NAVD 88) BEING A 3.25" BRASS DISK IN CONCRETE AT THE NORTHWEST CORNER OF HIGHWAY 83 AND HODGEN ROAD.

AERIAL PHOTO FROM GOOGLE EARTH

CLIENT
GOODWIN KNIGHT
8605 EXPLORER DRIVE, SUITE 250
COLORADO SPRINGS,
COLORADO 80920
(719)–598–5192

CIVIL ENGINEER
Drexel, Barrell & Co.
3 SOUTH 7TH STREET
COLORADO SPRINGS,
COLORADO 80905
CONTACT: TIM D. McCONNELL, P.E.
tmconnell@drexelbarrell.com
(719)260–0887

PLAN REVIEW BY CITY OF COLORADO SPRINGS IS PROVIDED ONLY FOR GENERAL CONFORMANCE WITH DESIGN CRITERIA. THE CITY OF COLORADO SPRINGS IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, DIMENSIONS, AND/OR ELEVATIONS WHICH SHALL BE CONFIRMED AT THE JOB SITE. THE CITY OF COLORADO SPRINGS, THROUGH THE APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

811 Know what's below. Call before you dig.
CALL 2–BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

CITY LAND USE REVIEW FILE NO.: CPC PUD 20–00054

PREPARED BY:

DREXEL, BARRELL & CO.
Engineers • Surveyors
3 SOUTH 7TH STREET
COLORADO SPGS, COLORADO 80905
CONTACT: TIM D. McCONNELL, P.E.
(719)260-0887
BOULDER • COLORADO SPRINGS • GREELEY

CLIENT:

GOODWIN KNIGHT
8605 EXPLORER DRIVE, SUITE 250
COLORADO SPRINGS,
COLORADO 80920
(719)–598–5192

100% CONSTRUCTION PLANS
SAND CREEK
DROP STRUCTURE
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
75% SUBMITTAL	10–30–20
90% SUBMITTAL	10–21–21
100% SUBMITTAL	01–07–22

DESIGNED BY:	GSG
DRAWN BY:	GSG
CHECKED BY:	MLI
FILE NAME:	21369–CV01

DRAWING SCALE:
HORIZONTAL: N/A
VERTICAL: N/A

COVER SHEET

PROJECT NO. 21369–00CSCV

DRAWING NO.

C1

SHEET: 1 OF 8

H:\21369-00CSCV\Plans\Sand Creek - BOULDER\21369-CV01.dwg, 1/7/2022 9:52:24 AM

GENERAL NOTES:

1. THE EXISTING BOUNDARY INFORMATION TAKEN FROM THE SURVEY PREPARED BY DREXEL, BARRELL & CO. ISSUED FEBRUARY 2020.
2. THE CONTRACTOR SHALL VERIFY THE EXISTENCE AND LOCATIONS OF ALL UNDERGROUND UTILITIES, (PUBLIC AND PRIVATE) PRIOR TO THE COMMENCEMENT OF CONSTRUCTION. CALL THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811, AND ALSO PROCURE PRIVATE UTILITY LOCATES WHICH MAY BE NECESSARY.
3. THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY UPON DISCOVERING ANY CONFLICTS OR OTHER PROBLEMS IN CONFORMING TO THE APPROVED CONSTRUCTION DRAWINGS, SPECIFICATIONS, OR DETAILS FOR ANY ELEMENT OF THE PROPOSED IMPROVEMENTS PRIOR TO PROCEEDING WITH ITS CONSTRUCTION.
4. THE CONTRACTOR SHALL PROVIDE WRITTEN NOTIFICATION TO ALL APPROPRIATE GOVERNING AGENCIES AND DEPARTMENTS AT LEAST 48 HOURS PRIOR TO THE STARTING OF ANY CONSTRUCTION.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE COORDINATION OF THE INSTALLATION OR RELOCATION OF THE DRY UTILITIES FACILITIES. COST OF THE DRY UTILITY WORK SHALL BE BORNE BY THE OWNER, EXCEPT AS INDICATED IN THE PLANS AND SPECIFICATIONS.
6. THE CONTRACTOR SHALL PROVIDE THE OWNER, ENGINEER, THEIR CONSULTANTS, INDEPENDENT TESTING LABORATORIES, ANY GOVERNMENTAL AGENCIES WITH JURISDICTIONAL INTERESTS, OTHER REPRESENTATIVES AND PERSONNEL ACCESS TO THE SITE AND THE WORK AT REASONABLE TIMES FOR THEIR OBSERVATION, INSPECTING, AND TESTING. THE CONTRACTOR SHALL PROVIDE THEM PROPER AND SAFE CONDITIONS FOR SUCH ACCESS AND ADVISE THEM OF THE CONTRACTOR'S SITE SAFETY PROCEDURES AND PROGRAMS SO THAT THEY MAY COMPLY THEREWITH AS IS APPLICABLE.
7. THE CONTRACTOR SHALL LIMIT OPERATIONS TO THE PROJECT SITE AND STAY WITHIN CITY RIGHT OF WAY AND EASEMENTS.
8. ACCESS TO ALL ADJACENT PROPERTIES AND FACILITIES SHALL BE MAINTAINED AT ALL TIMES. REQUIRED INTERRUPTION OF ACCESS SHALL BE COORDINATED WITH THE PROJECT OWNER.
9. IF HAZARDOUS MATERIAL OR SUSPECT MATERIAL IS ENCOUNTERED THE CONTRACTOR SHALL NOTIFY OWNER AND ENGINEER BEFORE CONTINUING WORK. HAZARDOUS MATERIALS SHALL BE REMOVED BY OWNER UNDER A SEPARATE CONTRACT.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY OFF SITE SOIL TRACKING. ALL SOIL TRACKED SHALL BE IMMEDIATELY CLEANED.
11. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TEMPORARY EROSION AND SEDIMENT CONTROL DURING CONSTRUCTION. THE CONTRACTOR SHALL COMPLY WITH LOCAL, STATE AND FEDERAL LAWS AND PERMITS FOR THE CONTROL OF EROSION AND SEDIMENT. THE CONSTRUCTION MANAGEMENT PLAN AND REQUIRED DOCUMENTATION SHALL BE KEPT ON SITE AND BE AVAILABLE TO THE GOVERNING AGENCY AT ANY TIME.
12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SOURCE OF CONSTRUCTION WATER ON THIS PROJECT.
13. IN AREAS OF THE PROJECT WHERE WORK IS REQUIRED NEAR OR ADJACENT TO THE EXISTING RIGHT-OF-WAY, THE CONTRACTOR SHALL PERFORM THE WORK FROM THE PROJECT SIDE OF THE RIGHT-OF-WAY AND NOT TRESPASS ONTO PRIVATE PROPERTY.
14. THE CONTRACTOR SHALL PROTECT ALL EXISTING SURVEY MONUMENTATION DESIGNATED TO REMAIN FROM DAMAGE DURING CONSTRUCTION OPERATIONS. ANY MONUMENTS DISTURBED BY THE CONTRACTOR THAT ARE NOT DESIGNATED FOR RELOCATION, SHALL BE RESET AT THE CONTRACTOR'S EXPENSE. THE CONTRACTOR SHALL NOTE THOSE MONUMENTS IN THE FIELD PRIOR TO CONSTRUCTION.
15. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS AND THE MOST RECENT CITY OF COLORADO SPRINGS STANDARDS AND SPECIFICATIONS.
16. ALL EXCESS EXCAVATION MATERIAL TO BE DISPOSED OF OFFSITE.
17. THE CONTRACTOR SHALL PROVIDE TEMPORARY SANITATION FACILITY.
18. THE CONTRACTOR SHALL PROVIDE TRAFFIC AND PEDESTRIAN CONTROL.
19. THE LOCATIONS OF EXISTING ABOVE GROUND AND UNDERGROUND UTILITIES ARE SHOWN IN THEIR APPROXIMATE LOCATIONS ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. CONTRACTOR TO CALL FOR UTILITY LOCATOR AT LEAST 3 CALENDAR DAYS BEFORE EARTHWORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY THEIR FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL ABOVE GROUND AND UNDERGROUND UTILITIES. IN THE EVENT THAT THE CONTRACTOR UTILITY VERIFICATION RESULTS IN EXISTING STRUCTURES OR UTILITIES BEING IN CONFLICT WITH THE PROPOSED WORK OF THIS CONTRACT, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY UTILITIES AND COORDINATE ANY NEEDED MODIFICATIONS TO THE PROPOSED WORK AS DIRECTED BY AFFECTED AGENCY OR UTILITY.
20. THE CONTRACTOR SHALL COORDINATE WITH ALL AFFECTED UTILITY OWNERS TO ESTABLISH THE REQUIREMENTS AND METHODS TO ACCOMMODATE THE PROTECTION, TEMPORARY SUPPORT, ADJUSTMENT OR RELOCATION OF UTILITIES PRIOR TO THE START OF CONSTRUCTION.
21. OVERHEAD UTILITIES ARE NOT INDICATED ON PROFILE OR SECTION DRAWINGS.
22. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING AND MAINTAINING IN CONTINUOUS OPERATION, ALL EXISTING STRUCTURES. NOT ALL POTENTIALLY IMPACTED STRUCTURES MAY BE SHOWN ON THE DRAWINGS AND IT IS THE CONTRACTOR'S RESPONSIBILITY TO IDENTIFY AND PROTECT ALL STRUCTURES INCLUDING BUT NOT LIMITED TO STREETS, CURB AND GUTTER, BRIDGE PIERS AND ABUTMENTS, CREEK BANK PROTECTION OF VARIOUS TYPES, CREEK DROP STRUCTURES, SIGNS, PEDESTRIAN WALKS, RETAINING WALLS AND FENCING. IN THE EVENT THAT A STRUCTURE OR UTILITY IS DAMAGED DURING CONSTRUCTION THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE OWNER OF THE FACILITY IN WRITING AND COORDINATE AND COOPERATE WITH NEEDED REPAIRS PER THE APPROPRIATE SPECIFICATIONS ACCORDING TO THE OWNER'S DIRECTION.
23. THE CONTRACTOR SHALL CONFIRM THE RECEIPT OF ALL NECESSARY PERMITS AND APPROVALS BEFORE THE START OF CONSTRUCTION.
24. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE STANDARDS OF THE CITY OF COLORADO SPRINGS UNLESS SPECIFICALLY DETAILED OTHERWISE ON THESE PLANS AND ASSOCIATED SPECIFICATIONS.
25. THE CONTRACTOR SHALL MAINTAIN AT THE SITE AT ALL TIMES ONE SIGNED COPY OF THE PROJECT DRAWINGS AND SPECIFICATIONS, ONE COPY OF THE STORMWATER MANAGEMENT PLAN AND ONE COPY OF ALL REQUIRED PERMITS.
26. THE CONTRACTOR SHALL CONDUCT THEIR OPERATIONS IN SUCH A WAY THAT THE AREA OF DISTURBANCE IS MINIMIZED. ALL EXISTING TREES, SHRUBS AND VEGETATION SHALL BE PROTECTED UNLESS OTHERWISE NOTED ON THE DRAWINGS. NO TREES SHALL BE REMOVED WITHOUT APPROVAL. DESIGNATED ACCESS SHALL BE MINIMAL AND AGREED UPON WITH THE ENGINEER PRIOR TO CONSTRUCTION ACTIVITIES.
27. FOR ALL SITE GRADING, SMOOTH, PARABOLIC TRANSITIONS SHALL BE MADE BETWEEN CHANGES IN SLOPE.
28. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR PROVIDING STABLE EXCAVATIONS AND TEMPORARY SLOPES AND FOR SATISFYING ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS.
29. CONSTRUCTION OF THE PROPOSED WORK WILL TAKE PLACE WITHIN THE CHANNEL AND WATER CONTROL MEASURES WILL BE REQUIRED. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE ACCEPTANCE AND CONTROL OF DRAINAGE WATER FROM AREAS ADJACENT TO SAND CREEK AND FOR FLOW WITHIN SAND CREEK AND ITS TRIBUTARIES INCLUDING STORMWATER OUTFALLS. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ESTABLISHING MEANS AND METHODS OF GROUND AND SURFACE WATER CONTROL APPROPRIATE FOR CONSTRUCTION IN ACCORDANCE WITH THE REQUIREMENTS OF THE PROJECT DRAWINGS AND SPECIFICATIONS AND ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS AND PERMITS.
30. THE CONTRACTOR SHALL PROVIDE AND MAINTAIN ON-SITE SURVEY CONTROL AND CONSTRUCTION STAKING.
31. CONTRACTOR SHALL FENCE OFF CRITICAL AREAS TO BE PROTECTED AT THE DISCRETION OF THE CITY OF COLORADO SPRINGS.
32. THE CONTRACTOR SHALL DEVELOP A TRAFFIC CONTROL PLAN FOR PLANNED ACCESS TO THE SITE AND FOR EXITING AND ENTERING PUBLIC ROADS.
33. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IDENTIFYING AND MAINTAINING PHYSICAL AND LEGAL ACCESS TO THE PROJECT SITE AND SHALL LIMIT TRANSPORTATION TO AND FROM THE SITE TO THOSE APPROVED BY THE CITY OF COLORADO SPRINGS.
34. THE CONTRACTOR SHALL TAKE MEASURES TO PREVENT AND MANAGE SPILLS OF TOXIC MATERIALS, SUCH AS EQUIPMENT FUELS.
35. ALL MATERIALS USED SHALL BE NEW AND WITHOUT FLAWS OR DEFECTS OF ANY TYPE AND SHALL BE THE BEST OF THEIR CLASS AND KIND.
36. WORK INCLUDES FURNISHING OF LABOR, MATERIALS, TOOLS, AND EQUIPMENT TO COMPLETE THE CONSTRUCTION OF ALL ELEMENTS OF THE DESIGN PLANS.

LEGEND

PROPERTY BOUNDARY
EXISTING EASEMENT
EX INTERMEDIATE CONTOUR — 5364
EX INDEX CONTOUR — 5365
EX FENCE
EX EDGE OF ASPHALT
SAND CREEK CENTERLINE
EX BURIED ELECTRIC LINE — E
EX BURIED SANITARY LINE — SS
EX OVERHEAD ELECTRIC — OE
EX WATERLINE — WL
EX CULVERT

PROPOSED INTERMEDIATE CONTOUR — 5364
PROPOSED INDEX CONTOUR — 5365
LIMITS OF DISTURBANCE — LDA
LIMITS OF CONSTRUCTION — LOC
PROPOSED FENCE
PROPOSED CREEK FL
ORDINARY HIGH WATER MARK (OHWM)
PROPOSED (DESIGN) CENTERLINE
FEMA CENTERLINE
FEMA FLOODWAY
FEMA 100-YEAR FLOODPLAIN

SOIL RETENTION BLANKET

PERMANENT SEEDING
TOPSOIL (4 INCH)
MULCHING (WEED FREE HAY)

SOIL RIPRAP

GROUTED BOULDER

CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

PREPARED BY:

DREXEL, BARRELL & CO.
Engineers • Surveyors
3 SOUTH 7TH STREET
COLORADO SPGS, COLORADO 80905
CONTACT: TIM D. McCONNELL, P.E.
(719)260-0887
BOULDER • COLORADO SPRINGS • GREELEY

CLIENT:

GOODWIN KNIGHT
8605 EXPLORER DRIVE, SUITE 250
COLORADO SPRINGS, COLORADO 80920
(719)-598-5192

100% CONSTRUCTION PLANS
SAND CREEK DROP STRUCTURE
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
75% SUBMITTAL	10-30-20
90% SUBMITTAL	10-21-21
100% SUBMITTAL	01-07-22

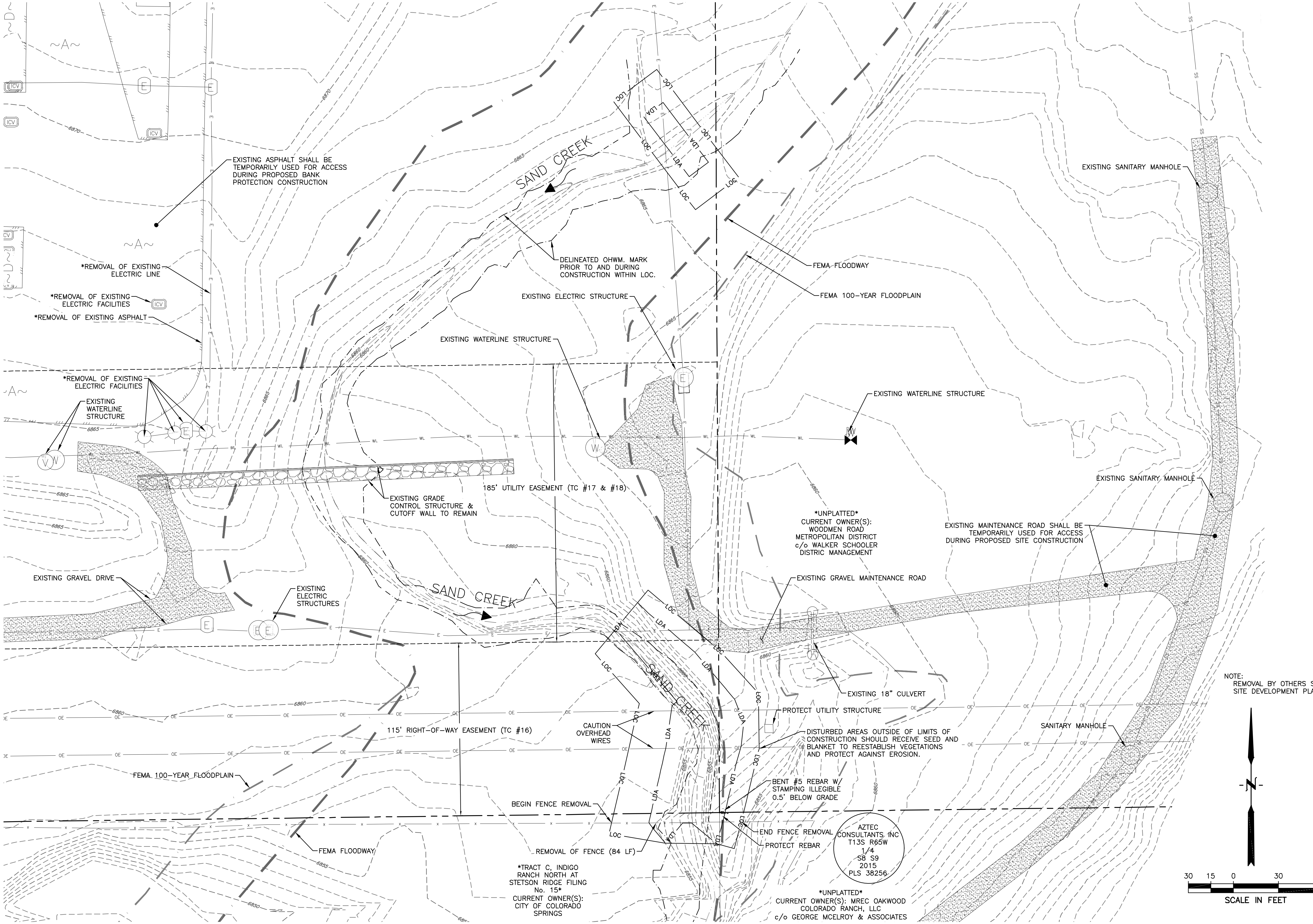
DESIGNED BY:	GSG
DRAWN BY:	GSG
CHECKED BY:	MLI
FILE NAME:	21369-GN01

DRAWING SCALE:
HORIZONTAL: N/A
VERTICAL: N/A

GENERAL NOTES & LEGEND

PROJECT NO. 21369-00CSCV
DRAWING NO.

C2



CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

PREPARED BY:

DREXEL, BARRELL & CO.
Engineers • Surveyors
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COLORADO SPGS, COLORADO 80905
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CLIENT:

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(719)-598-5192

100% CONSTRUCTION PLANS

SAND CREEK DROP STRUCTURE

7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
75% SUBMITTAL	10-30-20
90% SUBMITTAL	10-21-21
100% SUBMITTAL	01-07-22

DESIGNED BY:	SKG
DRAWN BY:	SKG
CHECKED BY:	SDL
FILE NAME:	21369-DM01

DRAWING SCALE:
HORIZONTAL: SEE PLAN
VERTICAL: SEE PLAN

EXISTING CONDITIONS & DEMOLITION PLAN

PROJECT NO. 21369-00CSCV

DRAWING NO.

C3

SHEET: 3 OF 8

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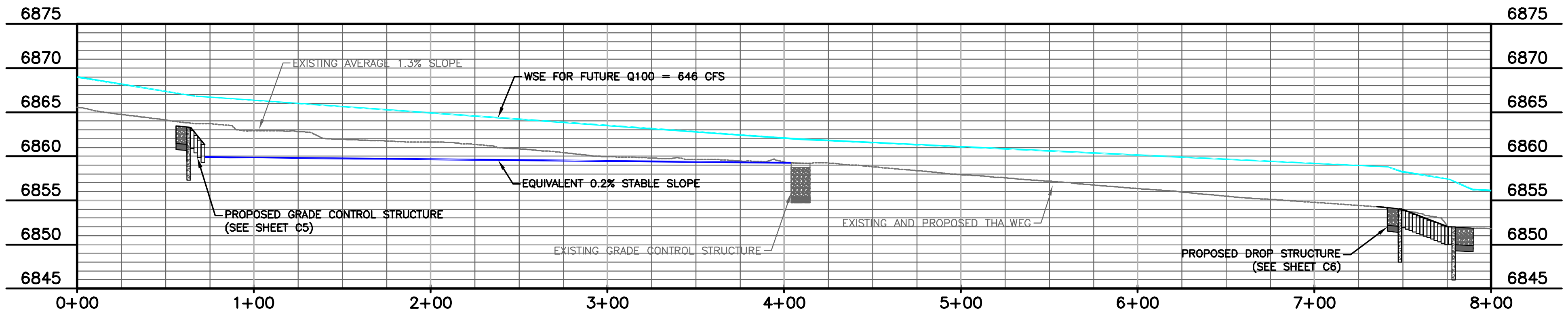

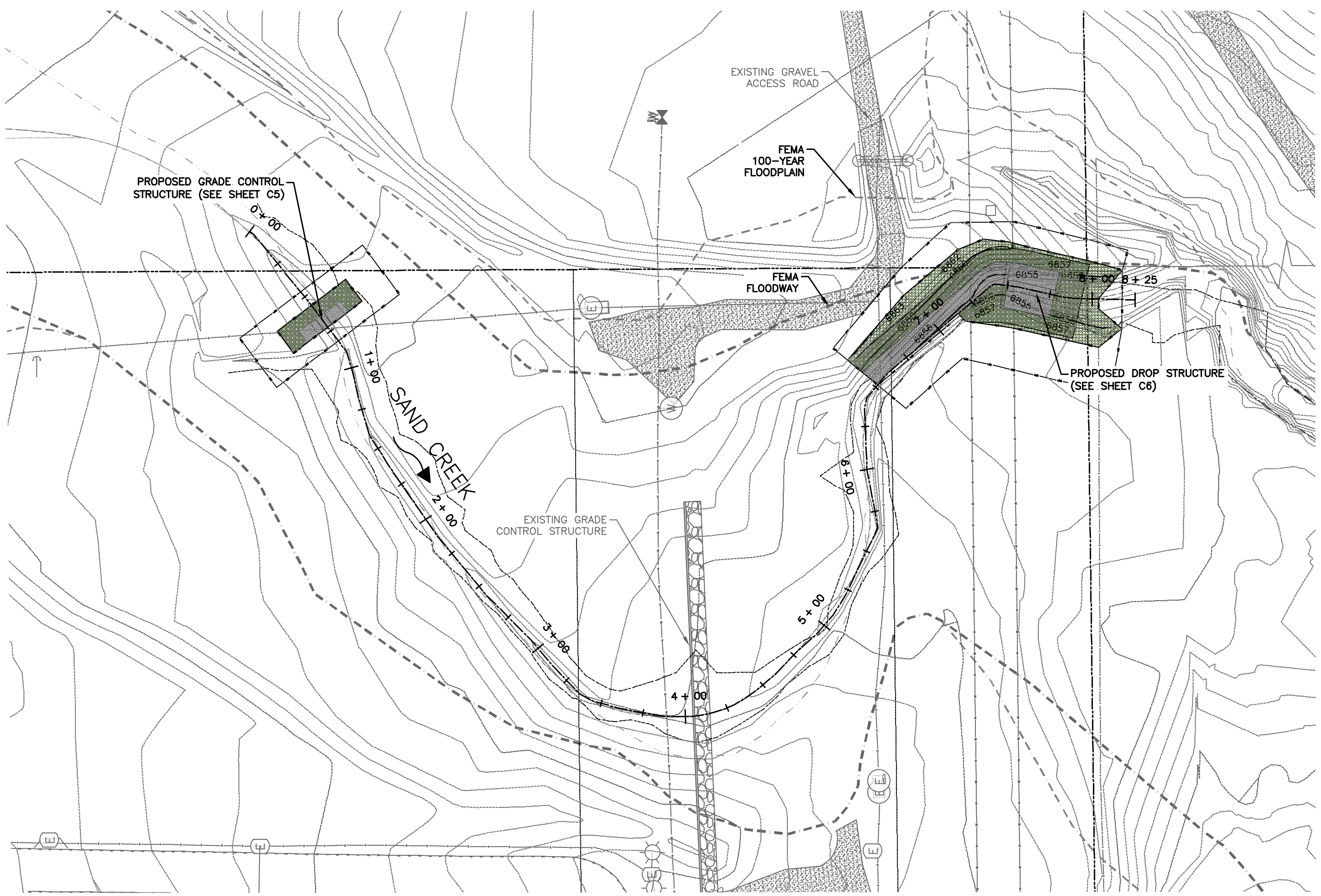

40 20 0 40 80
SCALE IN FEET

CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

PREPARED BY:

DREXEL, BARRELL & CO.
Engineers • Surveyors
3 SOUTH 7TH STREET
COLORADO SPGS, COLORADO 80905
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CLIENT:

GOODWIN KNIGHT
8605 EXPLORER DRIVE, SUITE 250
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CONSTRUCTION PLANS
SAND CREEK DROP STRUCTURE
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
75% SUBMITTAL	10-30-20
90% SUBMITTAL	10-21-21
100% SUBMITTAL	01-07-22

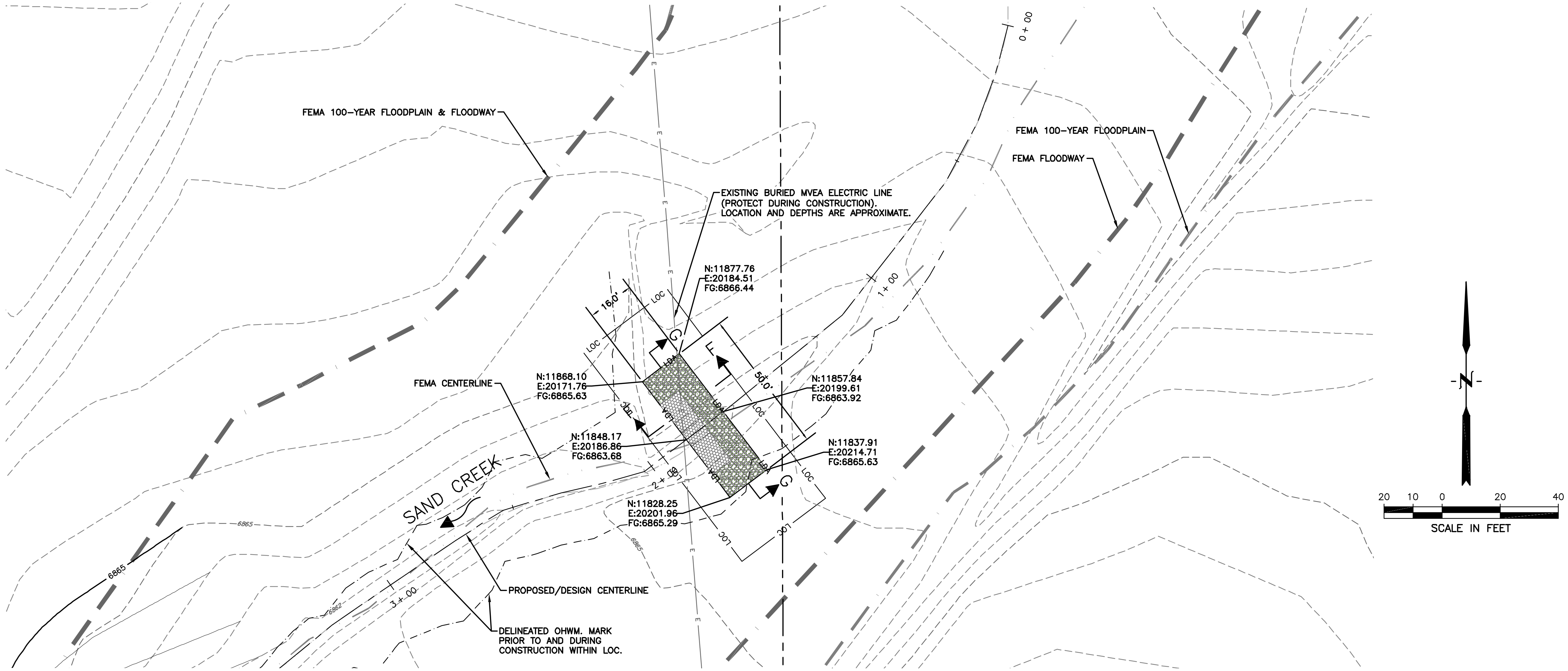
DESIGNED BY:	CAM
DRAWN BY:	CAM
CHECKED BY:	MLI
FILE NAME:	21369-PP01

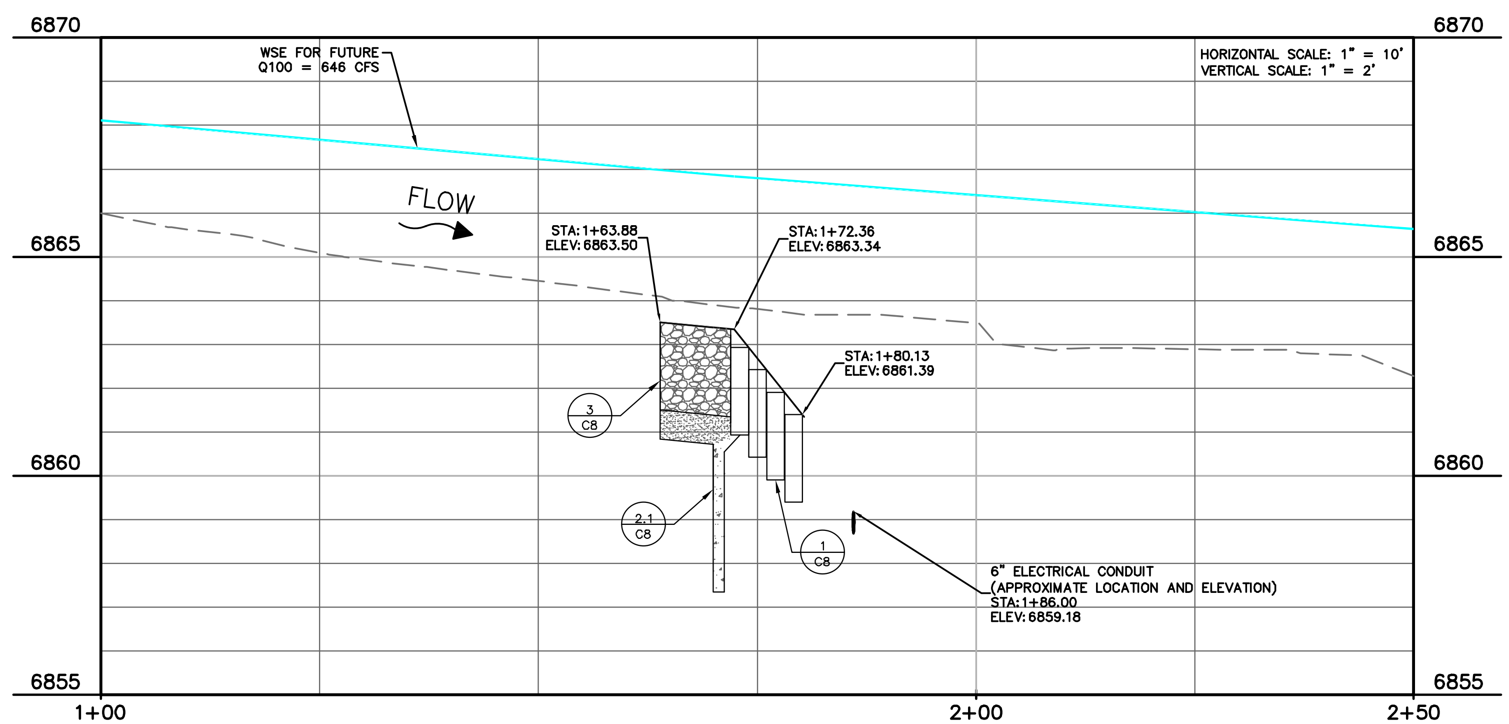
DRAWING SCALE:
HORIZONTAL: SEE PLAN
VERTICAL: SEE PLAN

OVERALL SITE PLAN & PROFILE

PROJECT NO. 21369-00CSCV
DRAWING NO.
C4
SHEET: 4 OF 8

H:\21369-00CSCV\Plans\Sand Creek - BOULDER\21369-PP01.dwg, 1/7/2022 12:49:04 PM





CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

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PREPARED BY:

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CLIENT:

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100% CONSTRUCTION PLANS
SAND CREEK
DROP STRUCTURE
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
75% SUBMITTAL	10-30-20
90% SUBMITTAL	10-21-21
100% SUBMITTAL	01-07-22

DESIGNED BY:	GSG
DRAWN BY:	GSG
CHECKED BY:	MLI
FILE NAME:	21369-PP02

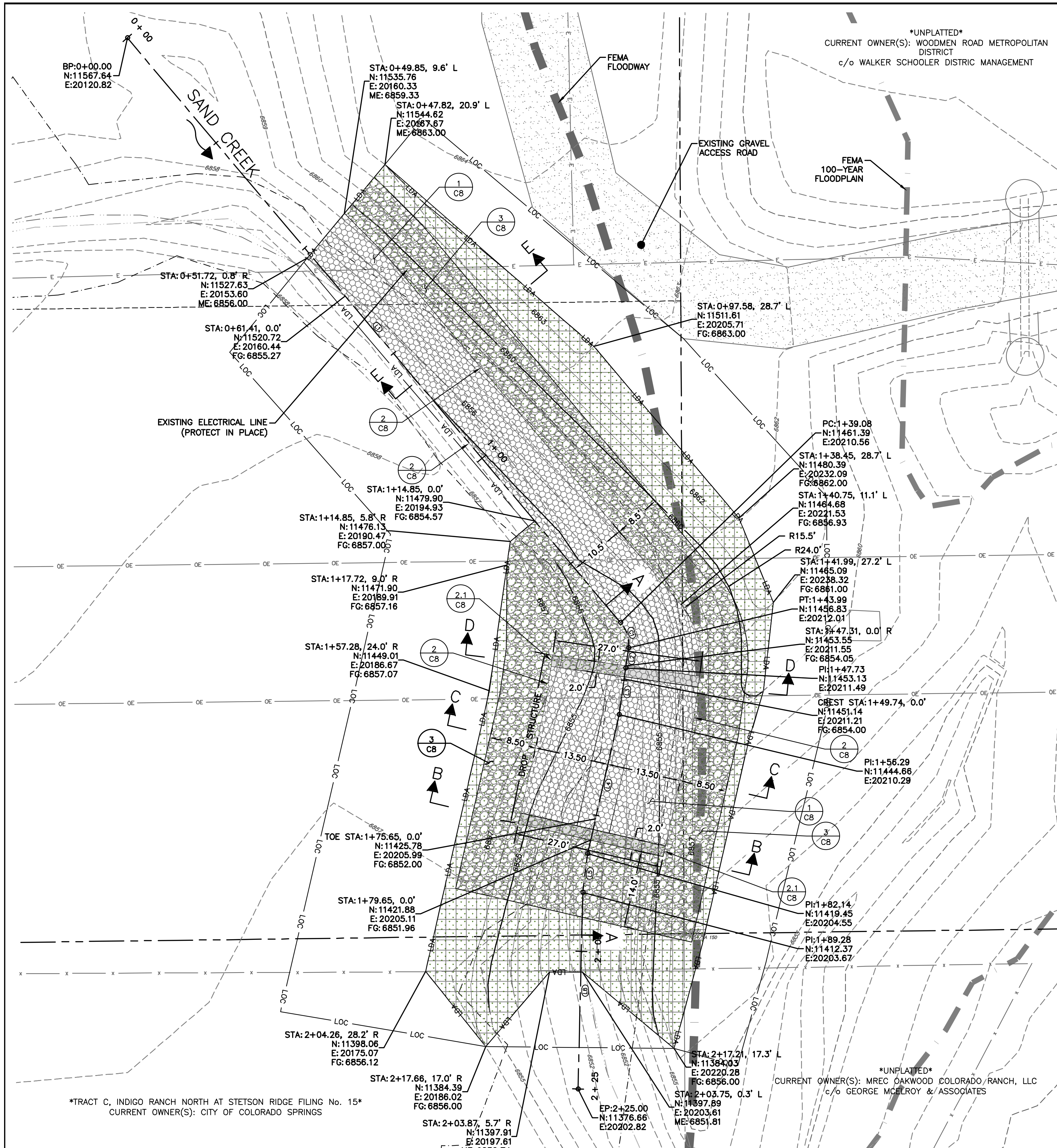
DRAWING SCALE:
HORIZONTAL: SEE PLAN
VERTICAL: SEE PLAN

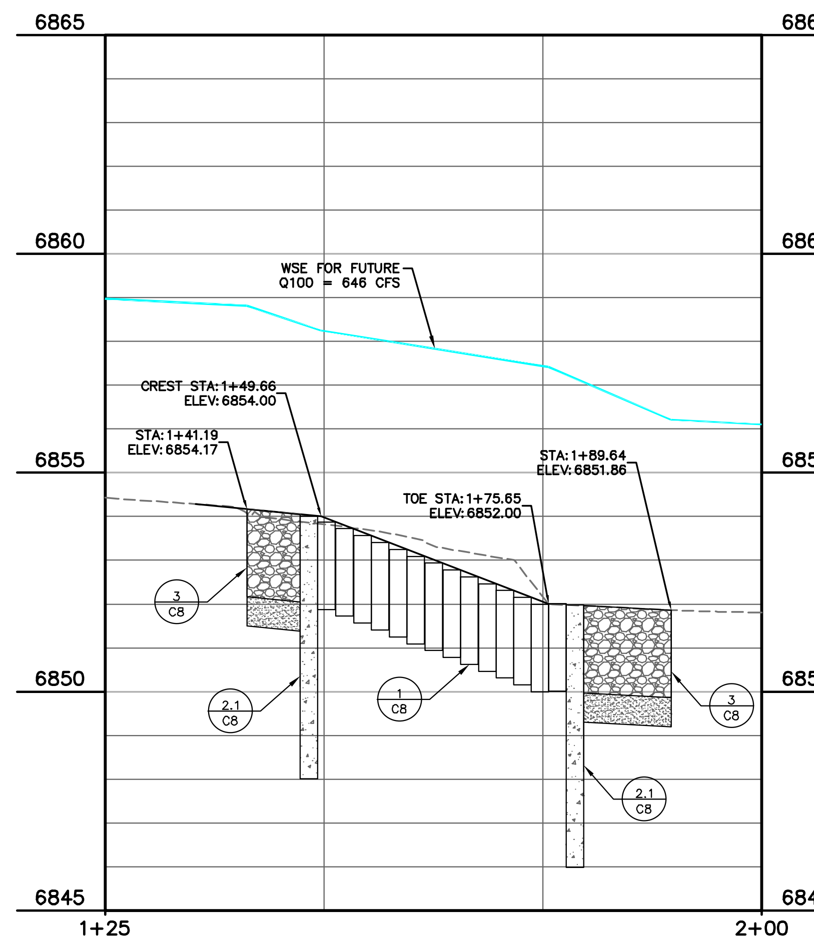
GRADE CONTROL STRUCTURE PLAN & PROFILE

PROJECT NO. 21369-00CSCV
DRAWING NO.

C5

SHEET: 5 OF 8





HORIZONTAL CONTROL TABLE			
NUMBER	LENGTH	RADIUS	BEARING/DELTA
L1	139.08		S40°11'17"E
C1	4.92	6.09	46°15'19"
L2	3.74		S8°03'38"W
L3	8.56		S8°03'38"W
L4	25.86		S12°49'03"W
L5	7.13		S7°06'55"W
L6	35.72		S1°21'29"W

SCALE IN FEET: 10 5 0 10 20

CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

PREPARED BY:

DREXEL, BARRELL & CO.
Engineers • Surveyors
3 SOUTH 7TH STREET
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SAND CREEK DROP STRUCTURE
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
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90% SUBMITTAL	10-21-21
100% SUBMITTAL	01-07-22

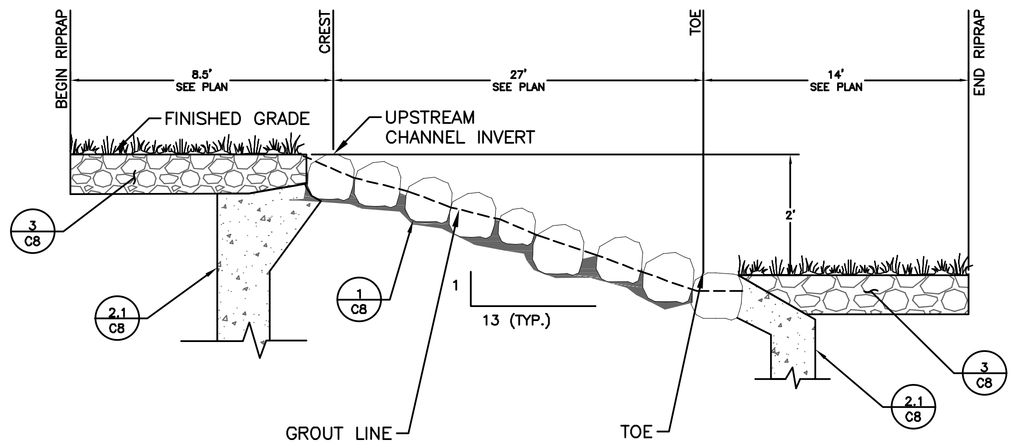
DESIGNED BY:	CAM
DRAWN BY:	CAM
CHECKED BY:	MLI
FILE NAME:	21369-PP03

DRAWING SCALE:
HORIZONTAL: SEE PLAN
VERTICAL: SEE PLAN

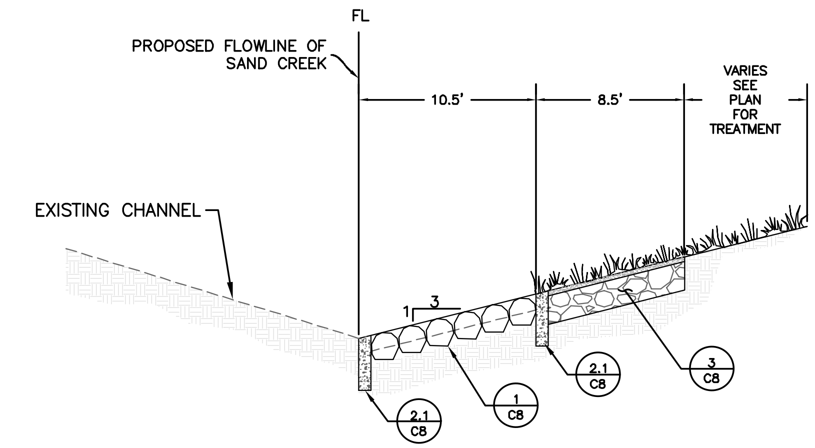
DROP STRUCTURE PLAN & PROFILE

PROJECT NO. 21369-00CSCV
DRAWING NO.
C6

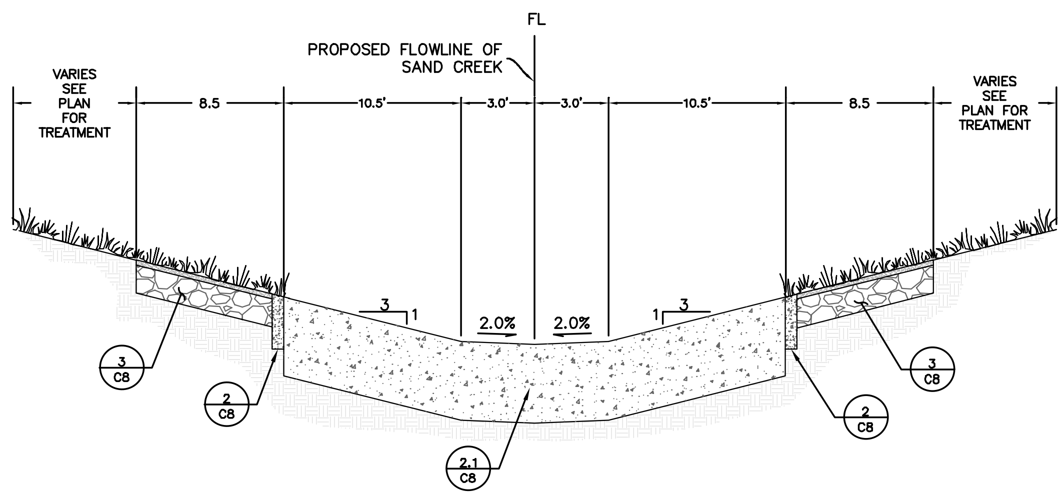
H:\21369-00CSCV\Plans\Sand Creek - BOULDER\21369-PP03.dwg, 1/7/2022 1:51:06 PM



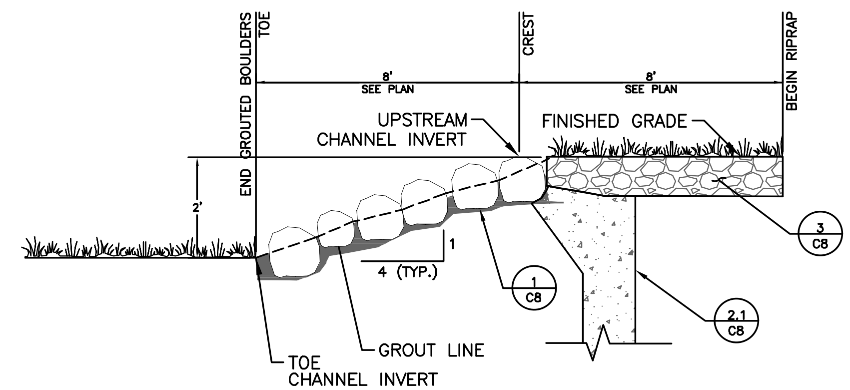
DROP STRUCTURE SECTION A
NTS



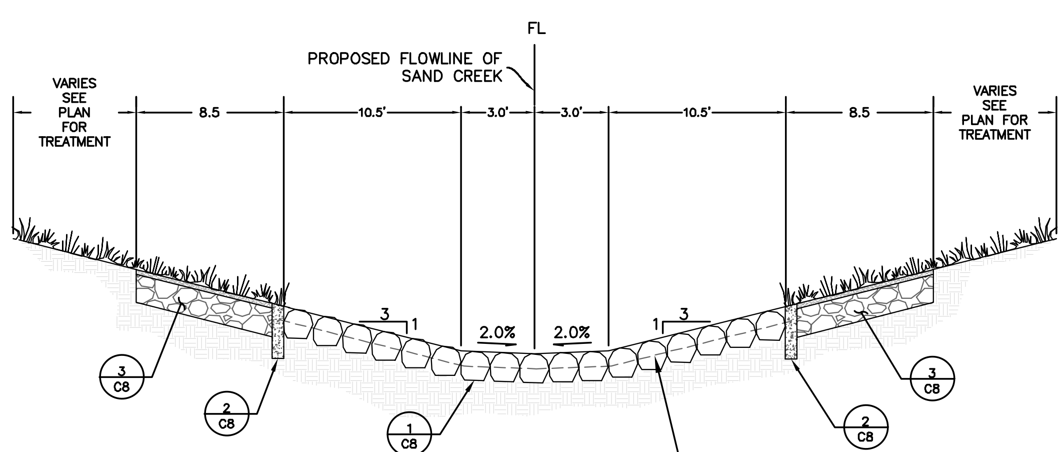
BANK PROTECTION SECTION E
NTS



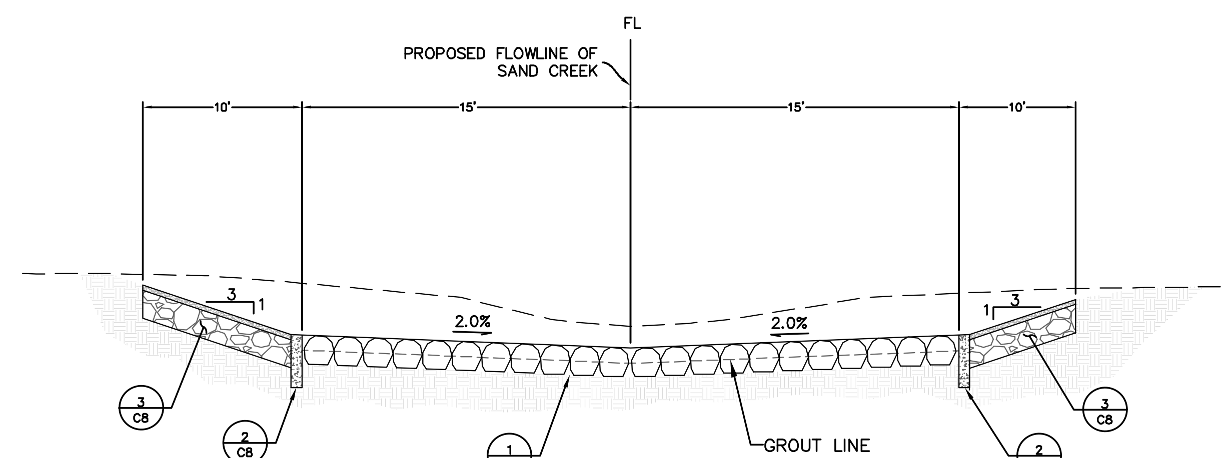
DROP STRUCTURE SECTION B & D (CREST & TOE)
NTS



GRADE CONTROL STRUCTURE SECTION F
NTS



DROP STRUCTURE SECTION C
NTS



GRADE CONTROL STRUCTURE SECTION G
NTS

CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

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PREPARED BY:

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100% CONSTRUCTION PLANS
SAND CREEK
DROP STRUCTURE
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
75% SUBMITTAL	10-30-20
90% SUBMITTAL	10-21-21
100% SUBMITTAL	01-07-22

DESIGNED BY:	GSG
DRAWN BY:	GSG
CHECKED BY:	MLI
FILE NAME:	21369-TS01

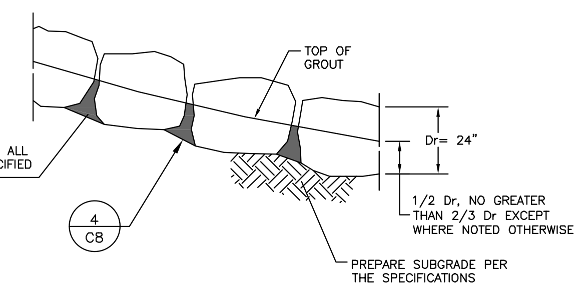
DRAWING SCALE:
HORIZONTAL: N/A
VERTICAL: N/A

TYPICAL SECTIONS

PROJECT NO. 21369-00CSCV
DRAWING NO.

C7

SHEET: 7 OF 8



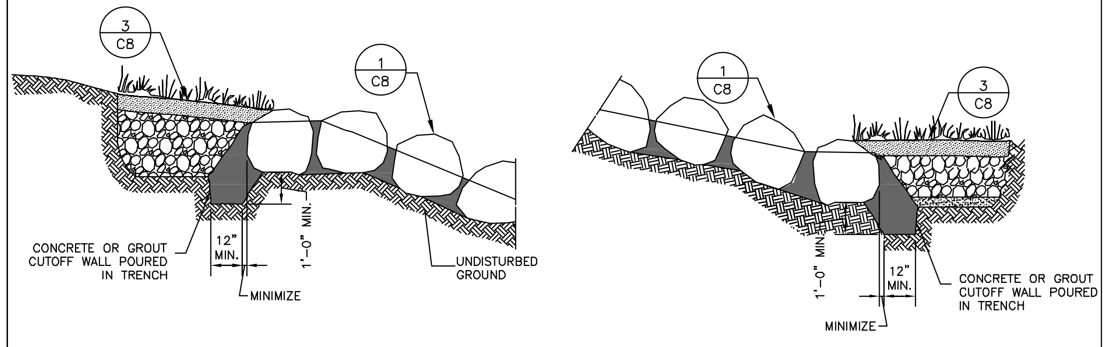
BOULDER PLACEMENT NOTES:
1. PLACE BOULDERS WITH THE REQUIRED BOULDER HEIGHT VERTICAL. PLACE BOULDERS AS TIGHTLY TOGETHER AS POSSIBLE (WITHOUT TOUCHING) WHILE PROVIDING ENOUGH ROOM BETWEEN THEM TO THOROUGHLY VIBRATE THE GROUT AND TO ENSURE NO GAPS IN THE GROUT. THE SMALL DIMENSION OF A 2X4 CAN BE USED AS A GUIDE TO CHECK MINIMUM SPACING.
2. BEFORE GROUTING, CLEAN ALL DIRT AND MATERIAL FROM ROCK THAT COULD PREVENT THE GROUT FROM BINDING TO THE ROCK. KEEP BOULDERS FROM TOUCHING. AVOID SLIDING BOULDERS AGAINST SUBGRADE TO PROPERLY POSITION.

MATERIAL SPECIFICATIONS:
1. ALL GROUT SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH EQUAL TO 3200 PSI.
2. ONE CUBIC YARD OF GROUT SHALL HAVE A MINIMUM OF SIX (6) SACKS OF TYPE II PORTLAND CEMENT.
3. A MAXIMUM OF 25% TYPE F FLY ASH MAY BE SUBSTITUTED FOR THE PORTLAND CEMENT.
4. THE AGGREGATE SHALL BE COMPRISED OF 70% NATURAL SAND (FINES) AND 30% ⅜-INCH ROCK (COARSE).
5. THE GROUT SLUMP SHALL BE BETWEEN 4-INCHES TO 6-INCHES.
6. AIR ENTRAINMENT SHALL BE BETWEEN 5.5% AND 7.5%.
7. TO CONTROL SHRINKAGE AND CRACKING, 1.5 POUNDS OF FIBERMESH, OR EQUIVALENT, SHALL BE USED PER CUBIC YARD OF GROUT.
8. COLOR ADDITIVE IN REQUIRED AMOUNTS SHALL BE USED WHEN SO SPECIFIED BY CONTRACT.

GROUT PLACEMENT SPECIFICATIONS:
1. SPECIAL PROCEDURES SHALL BE REQUIRED FOR GROUT PLACEMENT WHEN THE AIR TEMPERATURES ARE LESS THAN 40°F OR GREATER THAN 90°F. CONTRACTOR SHALL OBTAIN PRIOR APPROVAL FROM THE DESIGN ENGINEER OF THE PROCEDURES TO BE USED FOR PROTECTING THE GROUT.
2. GROUT SHALL BE DELIVERED BY MEANS OF A LOW PRESSURE (LESS THAN 10 PSI) GROUT PUMP USING A 2-INCH DIAMETER (MAXIMUM) NOZZLE.
3. FULL DEPTH PENETRATION OF THE GROUT INTO THE BOULDER VOIDS SHALL BE ACHIEVED BY INJECTING GROUT STARTING WITH THE NOZZLE NEAR THE BOTTOM AND RAISING IT AS THE GROUT FILLS, WHILE VIBRATING GROUT INTO PLACE USING A PENCIL VIBRATOR.
4. ALL GROUT BETWEEN BOULDERS SHALL BE TREATED WITH A BROOM FINISH.
5. AFTER GROUT PLACEMENT, EXPOSED BOULDER FACES SHALL BE CLEANED AND FREE OF GROUT.
6. ALL FINISHED GROUT SURFACES SHALL BE SPRAYED WITH A CLEAR LIQUID MEMBRANE CURING COMPOUND AS SPECIFIED IN ASTM C309.

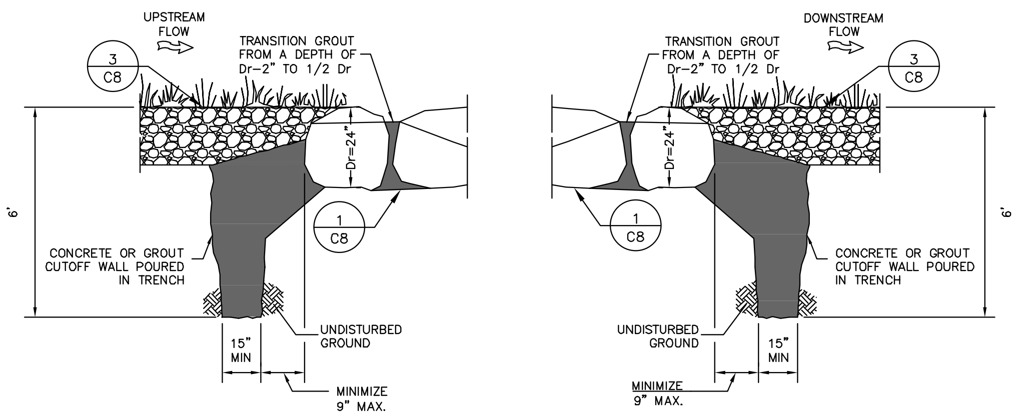
1 C8 GROUTED BOULDER DETAIL

NTS



2 C8 STRUCTURE EDGE WALL DETAIL

NTS



2.1 C8 TRENCHED VERTICAL WALL DETAIL (UPSTREAM & DOWNSTREAM OF DROP STRUCTURE PERPENDICULAR TO FLOW PATH)

NTS

Permeant boulders shall meet the following specifications:

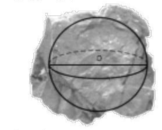
Table 1:

Boulder Dimensions

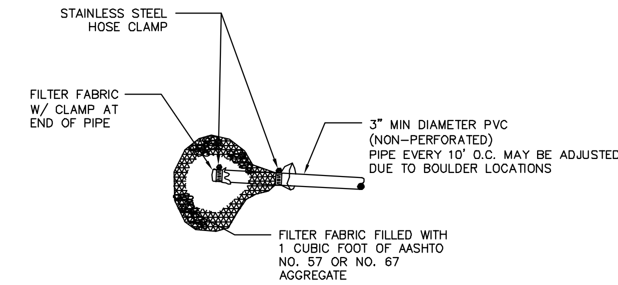
Boulder Nominal Size (inches)	Height		Length and Width	
	Minimum (inches)	Maximum (inches)	Minimum (inches)	Maximum (inches)
24	22	30	20	36
30	27	38	24	45
36	32	45	28	54
42	38	53	32	63
48	43	60	36	72

Notes:

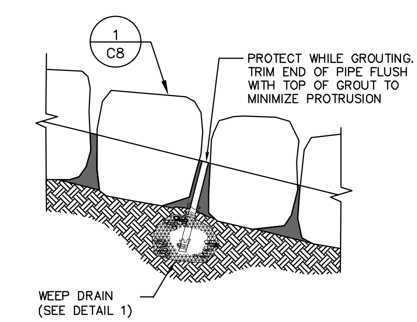
1. Maximum ratio of any two dimensions (length, width, or height) shall be 1.5 for all boulders.
2. Boulder bulk must fill a sphere with a diameter (D) equal to the minimum required dimension for length and width as specified in Table 1.
   Example:



3. Boulders shall be roughly cube shaped.
4. The bulk specific gravity (SSD) of the boulders shall be greater than 2.5 AASHTO T85 or ASTM C 127.
5. The boulders shall have a less than 10 percent loss after 12 cycles of freeze/thaw when tested in accordance with AASHTO T-103 for ledge rock, Procedure A or 35 cycles of ASTM D5312M is acceptable as an alternative.
6. The boulders shall have a loss of not more than 10 percent after 10 cycles when tested in accordance with AASTHO T-104 or ASTM D5240 using magnesium sulfate
7. Rock shall be free of calcite intrusions.
8. Rock shall be free of rhyolite.
9. Rock shall not have linear planes of micaceous minerals.
10. Boulders shall be able to withstand a "drop test" from approximately 10 feet onto a similarly shaped rock and not lose more than 20 percent of the original boulder mass.
11. The color of the boulder shall be consistent throughout the project.

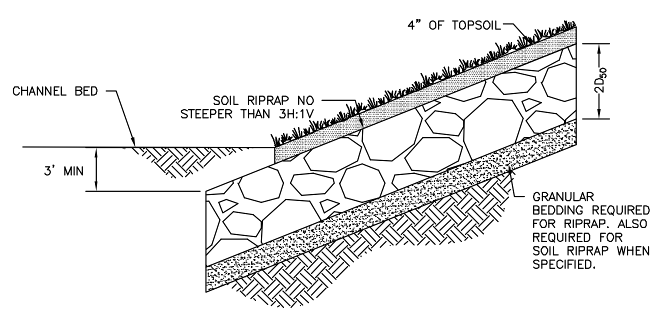


NOTE: INSTALL WEEP DRAINS AT 10' O.C. COST FOR WEEP DRAINS IS INCLUSIVE WITH GROUTED BOULDERS LINE ITEM.



GROUTED BOULDER INSTALLATION

4 C8 WEEP DRAIN DETAIL



RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D_{50}* (INCHES)
TYPE M	70 -100 50 - 70 35 - 50 2 - 10	30 18 12 4	12
*D_{50} = MEAN ROCK SIZE			

3 C8 SOIL RIPRAP DETAIL W/ PLACEMENT AND GRADATION

SOIL RIPRAP NOTES:

1. ELEVATION TOLERANCES FOR THE SOIL RIPRAP SHALL BE 0.10 FEET. THICKNESS OF SOIL RIPRAP SHALL BE NO LESS THAN THICKNESS SHOWN AND NO MORE THAN 2-INCHES GREATER THAN THE THICKNESS SHOWN.
2. WHERE SOIL RIPRAP IS DESIGNATED ON THE CONTRACT DRAWINGS, RIPRAP VOIDS ARE

   TO BE FILLED WITH NATIVE SOIL. THE RIPRAP SHALL BE PRE-MIXED WITH THE NATIVE SOIL AT THE FOLLOWING PROPORTIONS BY VOLUME: 65 PERCENT RIPRAP AND 35 PERCENT SOIL. THE SOIL USED FOR MIXING SHALL BE NATIVE TOPSOIL AND SHALL HAVE A MINIMUM FINES CONTENT OF 15 PERCENT. THE SOIL RIPRAP SHALL BE INSTALLED IN A MANNER THAT RESULTS IN A DENSE, INTERLOCKED LAYER OF RIPRAP WITH RIPRAP VOIDS FILLED COMPLETELY WITH SOIL. SEGREGATION OF MATERIALS SHALL BE AVOIDED AND IN NO CASE SHALL THE COMBINED MATERIAL CONSIST PRIMARILY OF SOIL; THE DENSITY AND INTERLOCKING NATURE OF RIPRAP IN THE MIXED MATERIAL SHALL ESSENTIALLY BE THE SAME AS IF THE RIPRAP WAS PLACED WITHOUT SOIL.
3. WHERE SPECIFIED (TYPICALLY AS ?BURIED SOIL RIPRAP?), A SURFACE LAYER OF TOPSOIL SHALL BE PLACED OVER THE SOIL RIPRAP ACCORDING TO THE THICKNESS SPECIFIED ON THE CONTRACT DRAWINGS. THE TOPSOIL SURFACE LAYER SHALL BE COMPACTED TO APPROXIMATELY 85% OF MAXIMUM DENSITY AND WITHIN TWO PERCENTAGE POINTS OF OPTIMUM MOISTURE IN ACCORDANCE WITH ASTM D698. TOPSOIL SHALL BE ADDED TO ANY AREAS THAT SETTLE.
4. ALL SOIL RIPRAP THAT IS BURIED WITH TOPSOIL SHALL BE REVIEWED AND APPROVED BY THE ENGINEER PRIOR TO ANY TOPSOIL PLACEMENT.

GRADATION FOR GRANULAR BEDDING		
U.S. STANDARD SIEVE SIZE	PERCENT PASSING BY WEIGHT	
	TYPE I CDOT SECT. 703.01	TYPE II CDOT SECT. 703.09 CLASS A
3 INCHES	–	90 – 100
1½ INCHES	–	–
¾ INCHES	–	20 – 90
⅜ INCHES	100	–
#4	95 – 100	0 – 20
#16	45 – 80	–
#50	10 – 30	–
#100	2 – 10	–
#200	0 – 2	0 – 3

GRANULAR BEDDING

THICKNESS REQUIREMENTS FOR GRANULAR BEDDING			
RIPRAP DESIGNATION	MINIMUM BEDDING THICKNESS (INCHES)		
	FINE-GRAINED SOILS [1]		COARSE-GRAINED SOILS [2]
	TYPE I (LOWER LAYER)	TYPE II (UPPER LAYER)	TYPE II
M (D_{50} = 12 IN)	4	4	6

NOTES:
1. MAY SUBSTITUTE ONE 12-INCH LAYER OF TYPE II BEDDING. THE SUBSTITUTION OF ONE LAYER OF TYPE II BEDDING SHALL NOT BE PERMITTED AT DROP STRUCTURES. THE USE OF A COMBINATION OF FILTER FABRIC AND TYPE II BEDDING AT DROP STRUCTURES IS ACCEPTABLE.
2. FIFTY PERCENT OR MORE BY WEIGHT RETAINED ON THE #40 SIEVE.

CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

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DESIGNED BY:	GSG
DRAWN BY:	GSG
CHECKED BY:	MLI
FILE NAME:	21369-DT01

DRAWING SCALE:
HORIZONTAL: N/A
VERTICAL: N/A

SITE DETAILS

PROJECT NO. 21369-00CSCV

DRAWING NO.

C8

SHEET: 8 OF 8

H:\21369-00CSCV\Plans\Sand Creek - BOULDER\21369-DT01.dwg, 1/7/2022 3:09:12 PM

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March 29, 2022

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

Subject: *Cottages at Woodmen Heights – Sand Creek Variance Request*

To: *Erin Powers, City of Colorado Springs*
Tim McConnell, Drexel, Barrell & Co. (DBC)

Goodwin Knight (Applicant) has proposed the construction of a new housing development located south of East Woodmen Road and west of Marksheffel Road in northeast Colorado Springs. The proposed Cottages at Woodmen Heights is shown in **Figure 1**.

Figure 1. Location Map

This document is provided in support of a request for variance from two criteria applicable to the Project. The Project is adjacent to and west of 1,793 feet of Sand Creek. Based on field observations, the majority of this reach of Sand Creek is relatively stable. There are two existing at-grade (buried) grade control structures, and the bed and banks are covered with heavy vegetation, including wetland vegetation. There is headcutting and undermining of the channel bed at the downstream end of the reach, where a drop structure is being proposed. The purpose of this variance request is to show that the guidance provided in the Sand Creek DBPS and the City DCM are not intended to address specific site conditions, and that implementation of the requirements will cause increases to hydraulic parameters (velocities, Froude numbers, tractive forces) above City criteria. This variance will not result in a change in peak flows or water quality in Fountain Creek.

The following criteria are applicable to the proposed drop structure, grade control structure (GCS), and bank protection along Sand Creek associated with the Project.

Recently-approved Sand Creek DBPS – Recommended Stable Slope of 0.2%

The reach of Sand Creek adjacent to the east edge of the Project is referenced as SC1R10 in the 2021 DBPS. The 2021 DBPS recommends a stable slope of 0.2% in the upper basin. To achieve this slope in the 9,223-foot reach of SC1R10, 36 3-foot grade control structures are proposed, spaced at 252-foot increments (Table 6-13 attached). The reach of Sand Creek adjacent to the project is 1,793 feet at an average slope of 1.6%. To achieve the recommended 0.2% slope adjacent to the Project, approximately thirteen 2-foot drop structures would be required, spaced at a maximum of 140 feet apart.

During a site visit on June 2, 2021, the design team, site owner, and City staff discussed adding a mid-reach buried GCS to meet the 0.2% equivalent stable slope for a portion (350 feet) of the reach. This GCS along with the proposed downstream drop structure will help stabilize the reach between the two structures for future watershed development. The slope for the remainder of the reach is shown on the attached channel profile.

Recently-approved Sand Creek DBPS – Recommended Typical Section 6

The 2021 DBPS recommends a typical section 6 for reach SC1R10 with the properties shown in the attached Table 7-1, including a proposed 100-year depth and width of 3.61 and 136.9 feet, respectively. The average future conditions (Q=646 cfs) depth and width along the Project reach are 3.06 and 152.3 feet, respectively. Because these values are relatively similar, there is no need for major channel improvements along this reach. There are no side slope recommendations in the 2021 DBPS.

DCM Table 12.3 – Hydraulic Design Criteria

Table 12-3 in the City DCM provides hydraulic design criteria for natural unlined channels, including maximum velocities, Froude numbers, and tractive forces for the 100-year storm event. The table below provides the velocities, Froude numbers, tractive forces for the 100-year storm event in both existing and proposed conditions along the Project reach of Sand Creek. Locations that exceed the criteria are highlighted in red. In general, the total velocities are below the required 5 fps threshold upstream of the proposed drop. The Froude number and tractive force values are above the criteria for most of the modeled reach.

As a result of the proposed drop, there are slight decreases in hydraulic design parameters through and upstream of the drop. These results suggest that the installation of more drop structures along this reach will not significantly reduce the parameters at all locations and may cause further increases in parameters that are already above the criteria.

According to the attached email from the wetlands consultant for the project (Matrix), the existing channel vegetation consists of a mixture of short native grasses, long native grasses, and willow brush. The Living Streambanks Manual (2016) provides allowable shear stresses of 0.7, 1.2, and 2.86 lb/sf for these three types of materials, respectively. The average of these values is 1.6 lb/sf, which is at the upper range of the proposed conditions shear stresses upstream of the proposed drop structure. Therefore, the existing vegetation should be able to withstand the future shear stresses.

	Sand Creek 100-year Future Q = 646 cfs								
River Sta	**Existing Conditions**				**Proposed Conditions**				
	W.S. Elev (ft)	Fr # XS	Vel Total (ft/s)	Shear Total (lb/sq ft)	W.S. Elev (ft)	Fr # XS	Vel Total (ft/s)	Shear Total (lb/sq ft)	Notes
111	6882.2	0.54	4.07	1.3	6882.2	0.54	4.07	1.3	
110	6880.1	0.74	3.85	1.63	6880.1	0.74	3.85	1.63	North limit of Project. Existing GCS
109	6876.0	0.61	3.75	1.64	6876.0	0.61	3.75	1.64	
108	6873.4	0.55	2.33	0.45	6873.4	0.55	2.33	0.45	
107	6869.8	1.03	3.38	1.04	6869.8	1.03	3.38	1.04	
106	6866.8	0.47	2.49	0.73	6866.8	0.47	2.49	0.73	Proposed GCS
105	6864.3	0.96	4.05	1.51	6864.3	0.96	4.05	1.51	
104	6862.0	0.41	2.66	0.84	6862.0	0.41	2.66	0.84	Existing GCS
103	6860.1	0.6	2.98	0.65	6860.1	0.6	2.98	0.65	
102	6858.7	0.93	3.7	1.41	6858.7	0.93	3.56	1.24	South limit of Project
101.9					6858.2	1.04	4.16	1.17	Upstream Drop
101.1					6857.4	0.79	5.21	1.04	Downstream Drop
101	6856.2	1	9.62	6.82	6856.2	1	9.62	6.82	
100	6854.5	0.66	5.94	2.68	6854.5	0.66	5.94	2.68	
Average (Dvmt)		0.70	3.24	1.10		0.70	3.23	1.08	
Average (Total)		**0.71**	**4.07**	**1.73**		**0.74**	**4.15**	**1.62**	
Criteria Exceeded (in red)		F > 0.6	V > 5 fps	S > 0.6 lb/sf		F > 0.6	V > 5 fps	S > 0.6 lb/sf	

In summary, the purpose of this document is to provide support of a request for variance from two criteria (Sand Creek DBPS and City DCM) applicable to the Project. Please contact me if you have any further questions or comments.

Sincerely,
Drexel, Barrell & Co.

Michelle Iblings, P.E., CFM
miblings@drexelbarrell.com
(303) 442-4338

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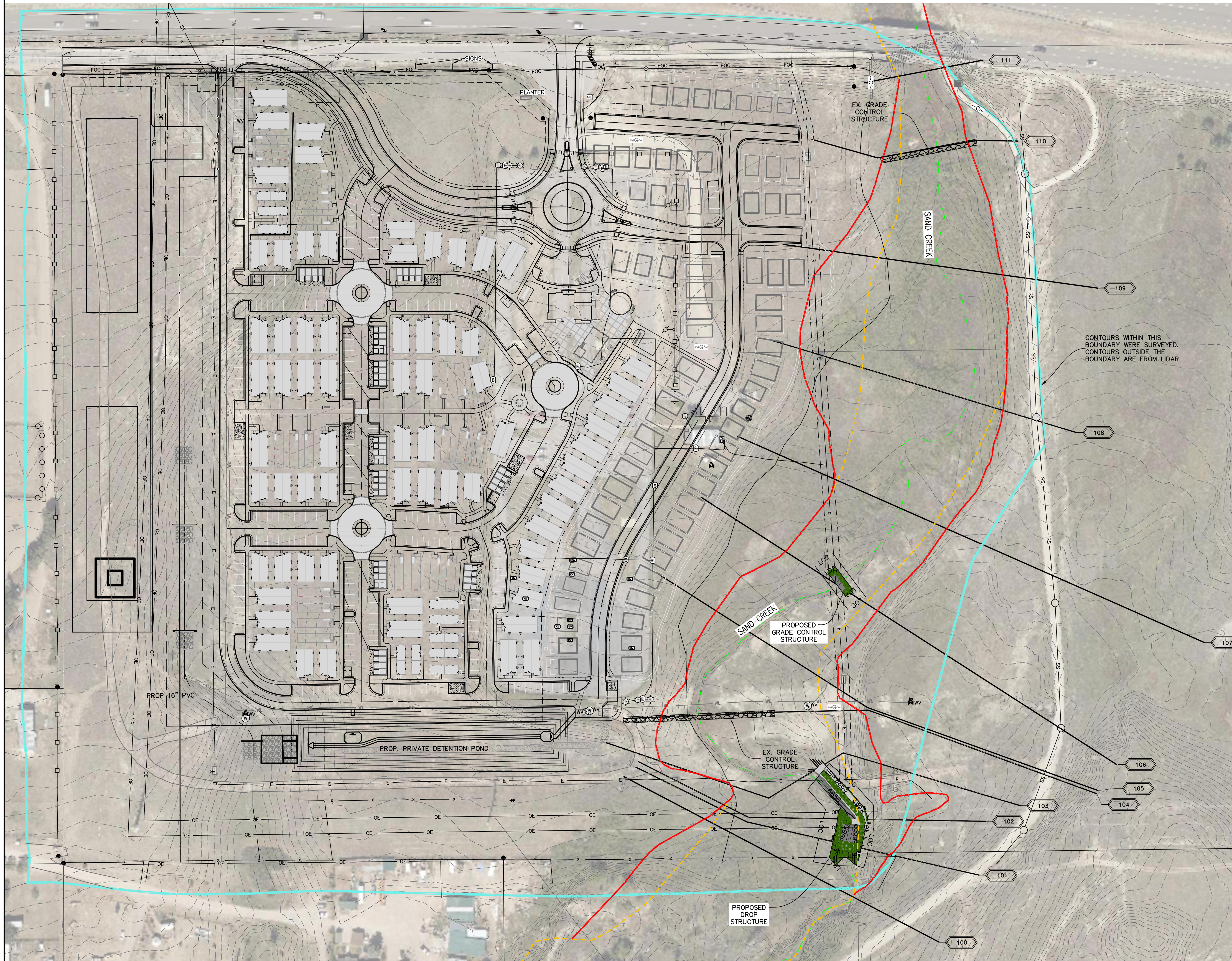
Select Tables from the 2021 Sand Creek DBPS

Table 6-13. Alternative 2 Conveyance Improvements Downstream of Regional Pond 1

				Channel Geometry			Grade Control Structures		
ReachName	Type	Channel_ID	Length	Typical Section	Topwidth (ft)	Maximum Depth (ft)	Number	Height (ft)	Spacing (ft)
SC1R1	Type 2 - Improved - Existing or future problems		1274				12	3	767
SC1R10	Type 3 - Unimproved - Existing or future problems	6	9223	6	144	5	36	3	252

Table 7-1. Properties of Channel Improvement Theme ID

	Engineered Channel Section				Natural Engineered Channel Section			
Channel ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
BW	16	22	32	44	20	32	42	64
Bankfull depth	0.90	1.29	1.87	2.62	0.6	1.05	1.35	1.95
Bankfull width	23.24	32.34	46.99	64.96	24.84	40.37	52.78	79.6
Bankfull w/d	26	25	25	25	41	38	39	41
10yr depth	2.09	3.03	4.37	5.72	1.44	2.38	2.99	4.78
10yr width	51.59	76.24	106.97	137.2	59.52	87.01	119.91	186.25
10yr w/d	25	25	24	24	41	37	40	39
100yr depth	3.22	4.44	6.3	7.97	1.89	3.61	4.2	6.99
100yr width	77.78	107.51	154.41	193.71	75.16	136.9	170.75	275.93
100yr w/d	24	24	25	24	40	38	41	39
TW	92	120	168	200	84	144	188	284
Total depth	5	6	8	9	3	5	6	8
Slope	0.30%	0.30%	0.30%	0.30%	0.20%	0.20%	0.20%	0.20%



LEGEND

HEC-RAS CROSS SECTION	12345
SAND CREEK CENTERLINE	
FEMA EFFECTIVE FLOODWAY (12/07/2018)	
FEMA EFFECTIVE 100-YEAR FLOODPLAIN (12/07/2018)	
BOUNDARY BETWEEN SURVEYED CONTOURS AND LIDAR CONTOURS	
EXISTING MAJOR CONTOUR	
EXISTING MINOR CONTOUR	
PROPOSED MAJOR CONTOUR	
PROPOSED MINOR CONTOUR	

80 40 0 80 160

SCALE: 1"=80'

811 Know what's **below.** **Call** before you dig.

CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

CITY LAND USE REVIEW FILE NO.: CPC PUD 20-00054

PREPARED BY:

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CLIENT:

GOODWIN KNIGHT

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100% CONSTRUCTION PLANS

SAND CREEK DROP STRUCTURE

7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
75% SUBMITTAL	10-30-20
90% SUBMITTAL	10-21-21
100% SUBMITTAL	01-07-22

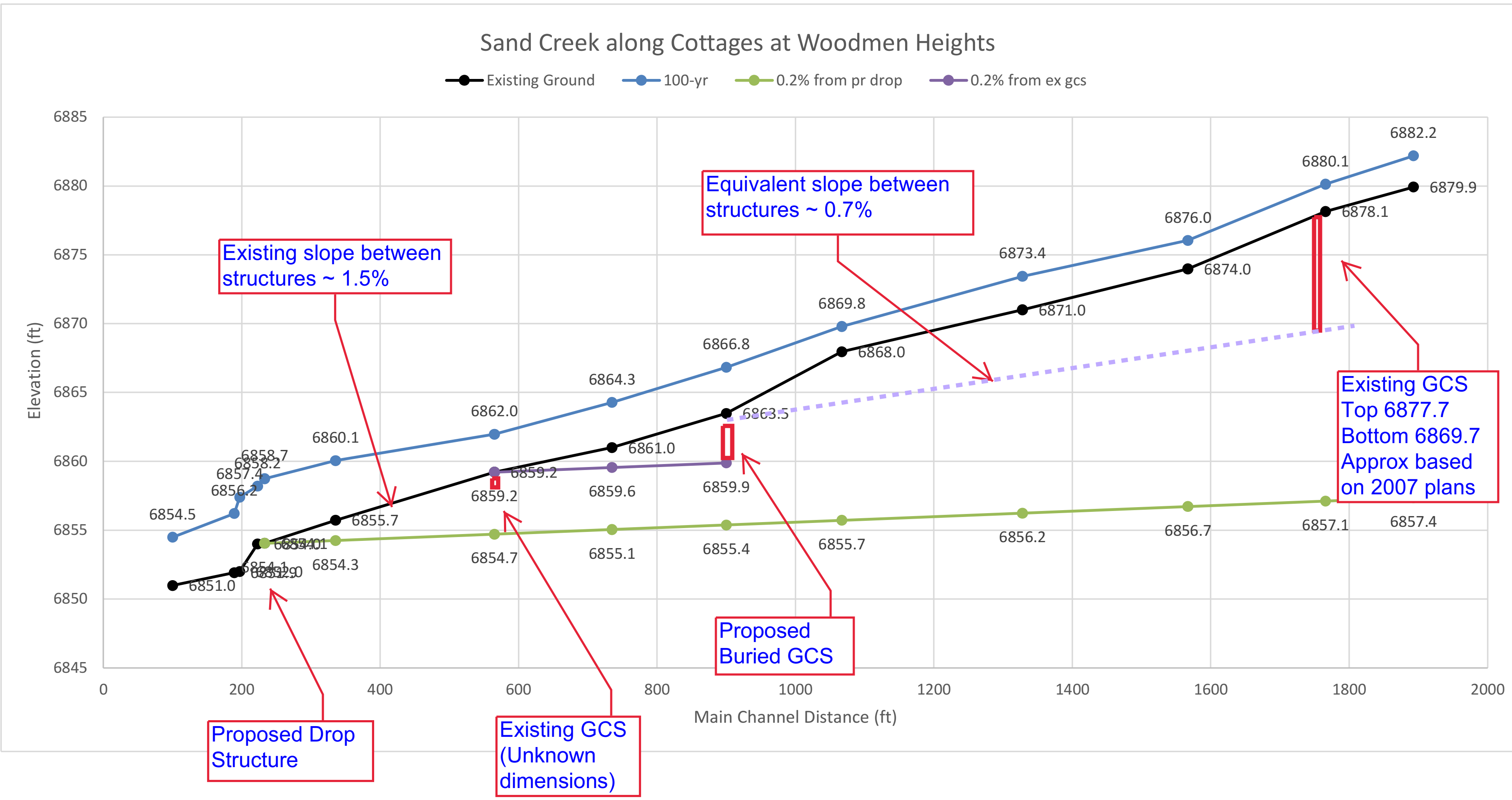
DESIGNED BY:	TDM
DRAWN BY:	SLG
CHECKED BY:	TDM
FILE NAME:	21369-00 SAND CREEK

DRAWING SCALE:
HORIZONTAL: 1" = 100"
VERTICAL: N/A

CHANNEL IMPROVEMENTS EXHIBIT

PROJECT NO. 21369-00CSCV

DRAWING NO.


Sand Creek along Cottages at Woodmen Heights
Existing Ground
100-yr
0.2% from pr drop
0.2% from ex gcs
Elevation (ft)
Main Channel Distance (ft)
6885
6880
6875
6870
6865
6860
6855
6850
6845
0
200
400
600
800
1000
1200
1400
1600
1800
2000
6882.2
6880.1
6879.9
6878.1
6876.0
6874.0
6873.4
6871.0
6869.8
6868.0
6866.8
6864.3
6863.5
6862.0
6861.0
6860.1
6859.2
6859.6
6859.9
6858.7
6858.2
6857.4
6856.2
6854.5
6855.7
6851.0
6854.1
6854.3
6854.7
6855.1
6855.4
6855.7
6856.2
6856.7
6857.1
6857.4
Existing slope between structures ~ 1.5%
Equivalent slope between structures ~ 0.7%
Existing GCS
Top 6877.7
Bottom 6869.7
Approx based on 2007 plans
Proposed Buried GCS
Proposed Drop Structure
Existing GCS (Unknown dimensions)

Michelle Iblings

From: Nicole Schanel <Nicole_Schanel@matrixdesigngroup.com>
Sent: Thursday, March 24, 2022 1:01 PM
To: Michelle Iblings; Tori Mack
Cc: Tim McConnell
Subject: RE: Sand Creek Improvements - USACE Permit
Attachments: Biostabilization Manual Draft 102916.pdf

Hi Michelle –

For this project, we can only speak to the wetlands that we located. The delineation was focused between cross sections 107 and 100 as shown in Drexel's RAS model. In these sections, the primary species included willows, grasses, and herbaceous species. The soils are Blakeland-Fluvaquentic Haplaquolls which have low cohesive properties.

I have attached the Living Streambanks Manual. We believe that the existing vegetation would fall into short or long native grasses which puts you into the 0.7-0.95 or 1.2-1.7 range, respectively; likely on the lower end due to the soil type. The willow brush does not seem to be present uniformly, rather in clumps, so this may not be appropriate to use as a primary classifier.

Summary:

Vegetation Type	Shear (lb/ft2)	Velocity (ft/s)
Short native grasses*	0.7-0.95	3-4
Long native grasses	1.2-1.7	4-6
Grass Mix, easily eroded soil, 0-5% slope		4
Willow brush (3-4 seasons old)	2.86	
Willow brush (immediately after construction)	0.41	

Please let me know if you have any questions.

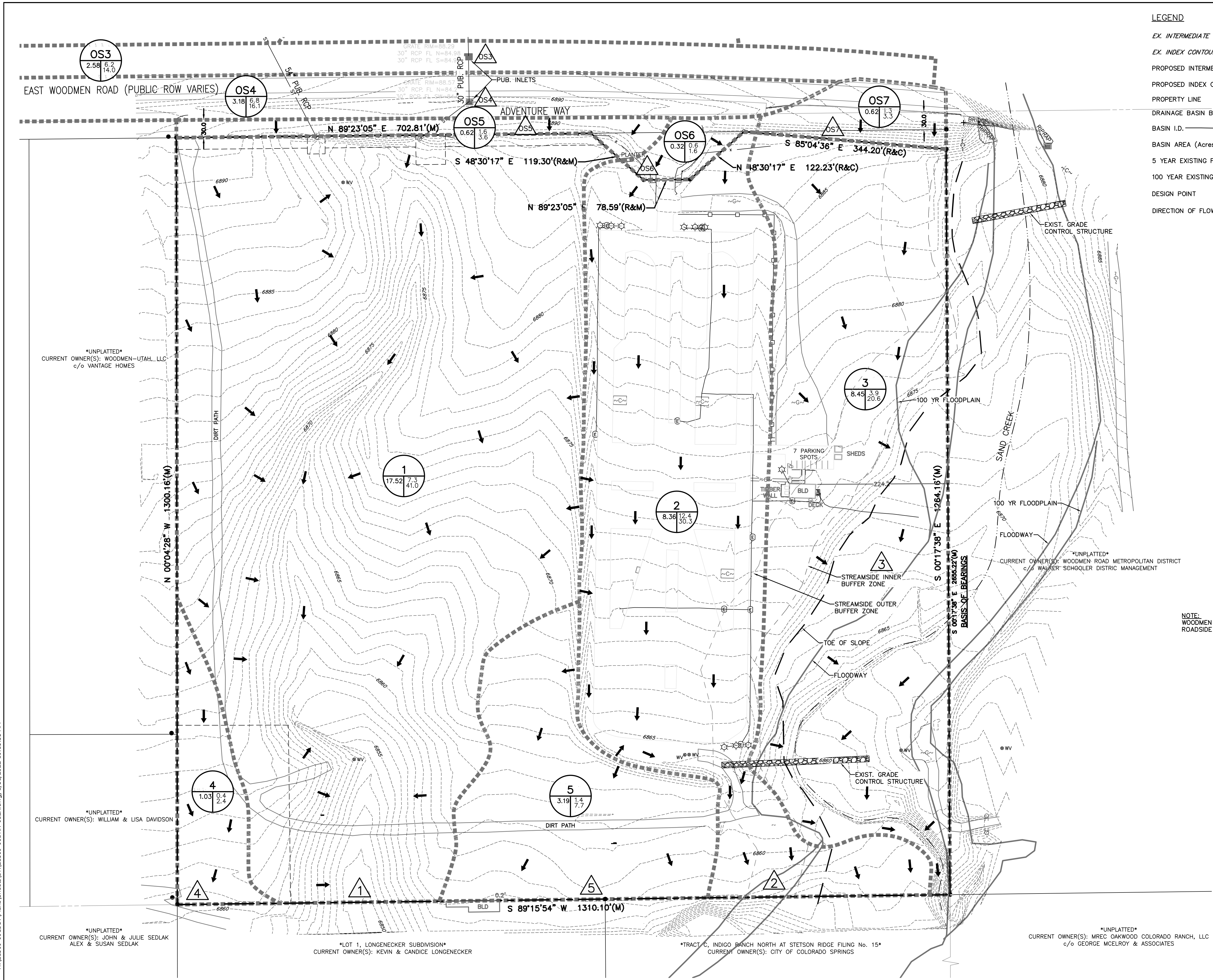
Thanks,

Matrix
Excellence by Design

Nicole Schanel, PE
Deputy Director, Civil South
Senior Project Manager
Matrix Design Group, Inc.
O 719.575.0100 | **C** 719.659.6141
nicole.schanel@matrixdesigngroup.com
2435 ResearchPkwy | Suite 300 | Colorado Springs, CO 80920
matrixdesigngroup.com

SAND CREEK DROP STRUCTURE & GRADE CONTROL
ENGINEER'S OPINION OF CONSTRUCTION COSTS
Drexel, Barrell & Co. - April 6, 2022

Item No.	CDOT No.	ITEM	UNIT	QUANTITY	PRICE	COST
1	201-00000	CLEARING AND GRUBBING	LS	1	$10,000	$10,000
2	202-01000	REMOVAL OF FENCE	LF	84	$30	$2,520
3	203-00000	UNCLASSIFIED EXCAVATION WITH OFFSITE DISPOSAL	CY	750	$150	$112,500
4	203-00010	UNCLASSIFIED EXCAVATION (COMPLETE IN PLACE)	CY	300	$100	$30,000
5	203-01597	POTHOLING	HR	8	$500	$4,000
6	206-00510	8" TYPE II GRANULAR BEDDING (CDOT FILTER MATERIAL CLASS A)	CY	78	$100	$7,800
7	207-00205	TOPSOIL	CY	62	$100	$6,200
8	207-00310	STOCKPILE WETLAND TOPSOIL	CY	40	$150	$6,000
9	208-00012	SEDIMENT CONTROL LOG (9 INCH)	LF	350	$20	$7,000
10	208-00045	CONCRETE WASHOUT STRUCTURE	EA	1	$3,500	$3,500
11	208-00400	WATER CONTROL	LS	1	$40,000	$40,000
12	212-00006	SEEDING (NATIVE UPLANDS SEED MIX)	ACRE	0.11	$7,000	$770
13	213-00011	MULCHING (HYDRAULIC)	ACRE	0.11	$7,000	$770
14	216-00037	SOIL RETENTION BLANKET (COCONUT)	SY	208	$10	$2,080
15	506-00030	GROUTED BOULDERS (B24)	CY	153	$500	$76,500
16	506-00412	SOIL RIPRAP (VH, D50=12")	CY	232	$300	$69,600
17	521-00000	CUTOFF WALL (CONCRETE/GROUT IN TRENCH)	CY	60	$1,500	$90,000
18	620-00020	SANITATION FACILITY	EA	1	$3,500	$3,500
19	626-00000	MOBILIZATION	LS	1	$50,000	$50,000
		SUBTOTAL				**$522,740**
		CONTINGENCY	**10%**			**$52,274**
		TOTAL				**$575,014**



LEGEND

- EX. INTERMEDIATE CONTOUR
- EX. INDEX CONTOUR (6805)
- PROPOSED INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR (6850)
- PROPERTY LINE
- DRAINAGE BASIN BOUNDARY
- BASIN I.D.
- BASIN AREA (Acres)
- 5 YEAR EXISTING FLOW (CFS)
- 100 YEAR EXISTING FLOW (CFS)
- DESIGN POINT
- DIRECTION OF FLOW

BASIN	AREA (AC)	% IMPERV	Q5 (cfs)	Q100 (cfs)
OS1	16.80	65%	4.7	22.0
OS2	2.69	27%	3.7	11.0
OS3	2.58	55%	6.2	14.0
OS4	3.18	48%	6.8	16.1
OS5	0.62	55%	1.6	3.6
OS6	0.32	41%	0.6	1.6
OS7	0.62	37%	1.3	3.3
1	17.52	0%	7.3	41.0
2	8.36	44%	12.4	30.3
3	8.45	1%	3.9	20.6
4	1.03	0%	0.4	2.4
5	3.19	0%	1.4	7.7

DP	AREA (AC)	Q5 (cfs)	Q100 (cfs)
OS1	16.80	4.7	22.0
OS2	2.69	3.7	11.0
OS3	5.27	9.3	23.5
OS4	8.45	15.5	38.2
OS5	0.62	1.6	3.6
OS6	0.32	0.6	1.6
OS7	0.62	1.3	3.3
1	43.39	33.7	96.8
2	8.68	10.5	25.7
3	9.07	4.0	19.6
4	1.03	0.4	2.4
5	3.19	1.4	7.7

NOTE:
WOODMEN ROAD AND ADVENTURE WAY ARE ASPHALT WITH ROADSIDE DITCHES AND DO NOT HAVE CURB & GUTTER

PREPARED BY:

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CONTACT: TIM D. McCONNELL, P.E.
(719)260-0887
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CLIENT:

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CIVIL CONSTRUCTION PLANS

COTTAGES @ WOODMEN HEIGHTS

7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
INITIAL ISSUE	02-26-20
LATEST ISSUE	1-31-22

DESIGNED BY:	SBN
DRAWN BY:	SBN
CHECKED BY:	TDM
FILE NAME:	21369-00DRN-01EX

DRAWING SCALE:
HORIZONTAL: 1" = 80'
VERTICAL: N/A

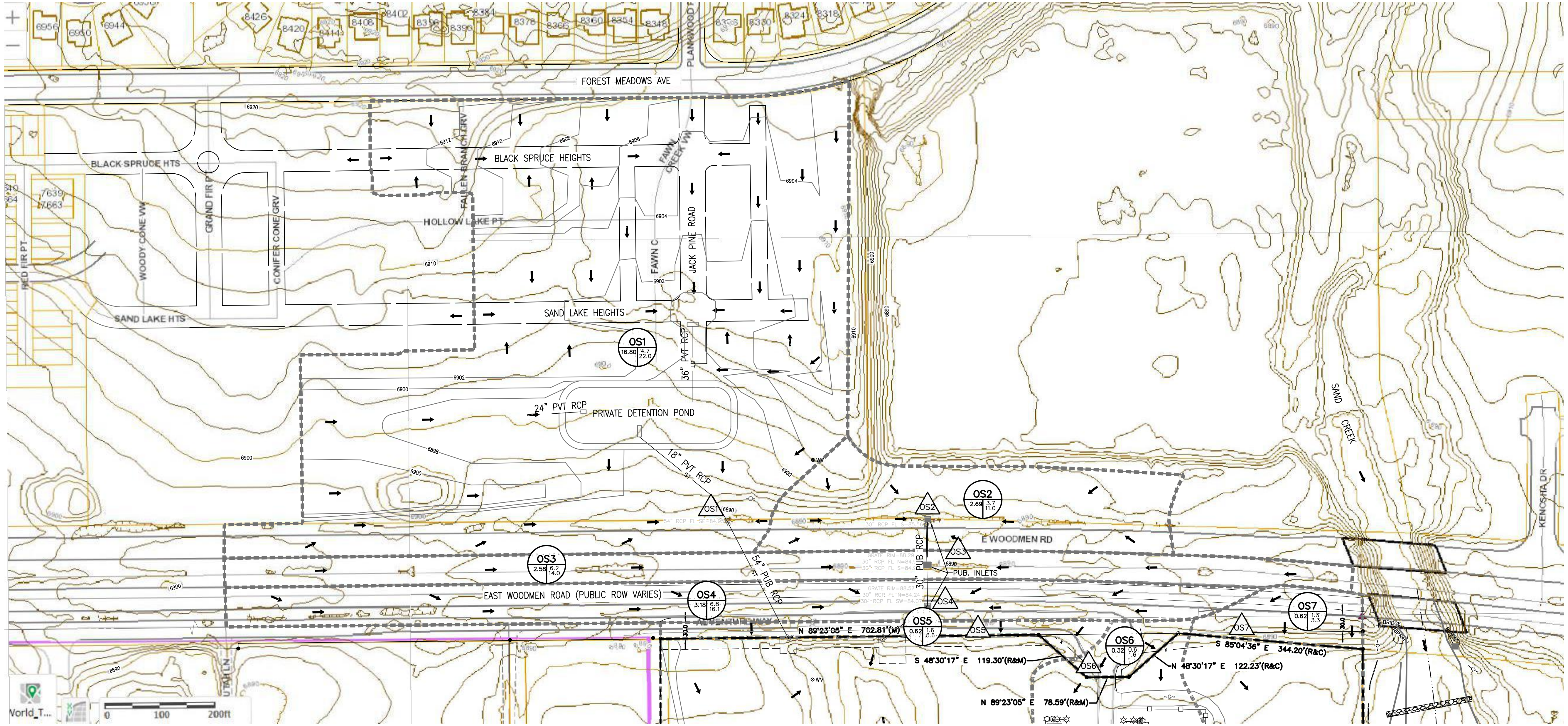
EXISTING CONDITIONS DRAINAGE PLAN

PROJECT NO. 21369-00CSCV
DRAWING NO.

DR-1

SHEET: 1 OF 3

H:\21369-00CSCV\Plans\Sheets\DR\21369-00DRN-01EX.dwg, 1/31/2022 10:15:33 AM



NOTE:
WOODMEN ROAD AND ADVENTURE WAY ARE ASPHALT WITH ROADSIDE DITCHES AND DO NOT HAVE CURB & GUTTER

LEGEND

- EX. INTERMEDIATE CONTOUR
- EX. INDEX CONTOUR — 6805
- PROPOSED INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR — 6850
- PROPERTY LINE
- DRAINAGE BASIN BOUNDARY
- BASIN I.D. — 1
- BASIN AREA (Acres) — 0.42
- 5 YEAR EXISTING FLOW (CFS) — 1.2
- 100 YEAR EXISTING FLOW (CFS) — 2.6
- DESIGN POINT — 1
- DIRECTION OF FLOW — ←

N

100 50 0 100 200
SCALE: 1"=100'

Know what's **below.** **Call** before you dig.
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

H:\21369-00CSCV\Plans\Sheets\DR\21369-00DRN-02OFF.dwg, 1/10/2022 12:51:21 PM

PREPARED BY:

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CIVIL CONSTRUCTION PLANS
COTTAGES @ WOODMEN HEIGHTS
7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

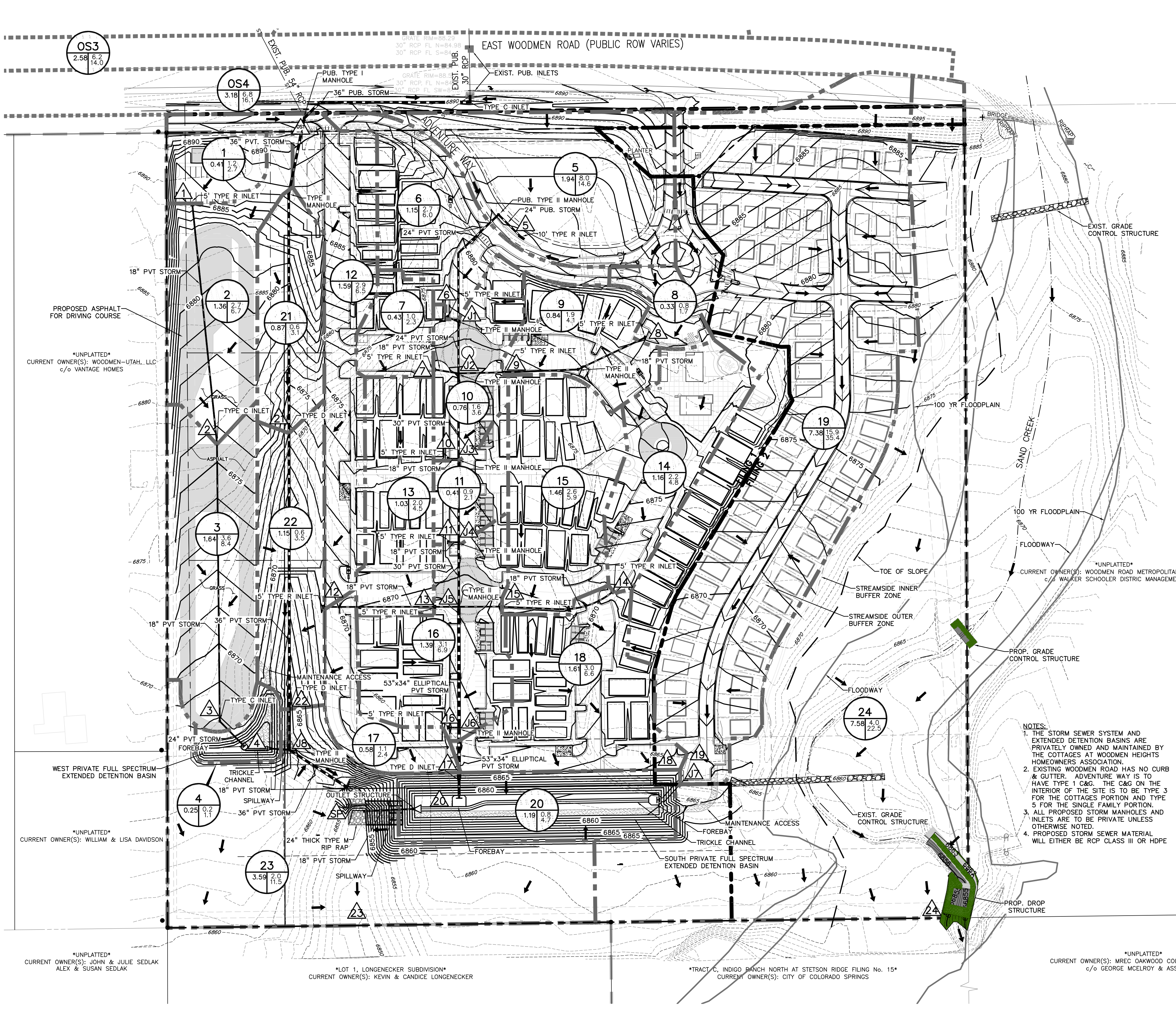
ISSUE	DATE
INITIAL ISSUE	02-26-20
LATEST ISSUE	1-10-22

DESIGNED BY:	TDM
DRAWN BY:	SLG
CHECKED BY:	TDM
FILE NAME:	21369-00DRN-02OF

DRAWING SCALE:
HORIZONTAL: 1" = 80"
VERTICAL: N/A

EXIST. OFF-SITE CONDITIONS DRAINAGE PLAN

PROJECT NO. 21369-00CSCV
DRAWING NO.
DR-2



LEGEND

- EX. INTERMEDIATE CONTOUR
- EX. INDEX CONTOUR — 6805
- PROPOSED INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR — 6850
- PROPERTY LINE
- DRAINAGE BASIN BOUNDARY
- BASIN I.D.
- BASIN AREA (Acres)
- 5 YEAR EXISTING FLOW (CFS)
- 100 YEAR EXISTING FLOW (CFS)
- DESIGN POINT
- DIRECTION OF FLOW
- PHASE BOUNDARY

BASIN	AREA (AC)	% IMPERV	Q5 (cfs)	Q100 (cfs)
1	0.41	56%	1.2	2.7
2	1.36	44%	2.7	6.7
3	1.64	51%	3.6	8.4
4	0.25	0%	0.2	1.1
5	1.94	95%	8.0	14.6
6	1.15	65%	2.7	6.0
7	0.43	65%	1.0	2.3
8	0.31	65%	0.8	1.7
9	0.84	65%	1.9	4.1
10	0.76	65%	1.6	3.6
11	0.41	65%	0.9	2.1
12	1.59	65%	2.9	6.5
13	1.03	65%	2.0	4.5
14	1.16	65%	2.2	4.8
15	1.46	65%	2.6	5.9
16	1.39	65%	3.1	6.9
17	0.58	65%	1.1	2.4
18	1.61	65%	3.0	6.6
19	7.38	65%	15.9	35.4
20	1.19	0%	0.8	4.7
21	0.87	0%	0.6	3.1
22	1.15	0%	0.6	3.5
23	3.59	0%	2.0	11.5
24	7.58	0%	4.0	22.5

DP	AREA (AC)	Q5 (cfs)	Q100 (cfs)
1	0.41	1.2	2.7
2	1.77	3.7	8.9
3	3.41	7.2	17.1
4	3.66	7.4	17.9
5	1.94	8.0	14.6
6	1.15	2.7	6.0
J1	3.09	10.1	19.5
7	0.43	1.0	2.3
8	0.31	0.8	1.7
9	1.15	2.5	5.7
J2	4.67	13.0	26.2
10	0.76	1.6	3.6
J3	5.43	14.3	29.1
11	0.41	0.9	2.1
J4	5.84	15.0	30.6
12	1.59	2.9	6.5
13	2.62	4.7	10.5
14	1.16	2.2	4.8
15	2.62	4.8	10.6
J5	11.08	22.0	46.8
16	1.39	3.1	6.9
J6	12.47	24.1	51.5
17	13.05	25.0	53.6
18	1.61	3.0	6.6
19	7.38	15.9	35.4
J7	8.99	16.6	36.9
20	23.23	41.4	92.1
SP		0.6	16.9
OS1-4	25.25	20.2	60.2
21	26.12	20.8	63.3
22	27.27	21.4	66.8
J8	30.93	21.4	69.3
23	57.75	24.1	97.7
24	7.58	4.0	22.5

NOTES:
1. THE STORM SEWER SYSTEM AND EXTENDED DETENTION BASINS ARE PRIVATELY OWNED AND MAINTAINED BY THE COTTAGES AT WOODMEN HEIGHTS HOMEOWNERS ASSOCIATION.
2. EXISTING WOODMEN ROAD HAS NO CURB & GUTTER. ADVENTURE WAY IS TO HAVE TYPE 1 C&G. THE C&G ON THE INTERIOR OF THE SITE IS TO BE TYPE 3 FOR THE COTTAGES PORTION AND TYPE 5 FOR THE SINGLE FAMILY PORTION.
3. ALL PROPOSED STORM MANHOLES AND INLETS ARE TO BE PRIVATE UNLESS OTHERWISE NOTED.
4. PROPOSED STORM SEWER MATERIAL WILL EITHER BE RCP CLASS III OR HDPE

80 40 0 80 160

SCALE: 1"=80'

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CIVIL CONSTRUCTION PLANS

COTTAGES @ WOODMEN HEIGHTS

7725 ADVENTURE WAY
COLORADO SPRINGS, COLORADO

ISSUE	DATE
INITIAL ISSUE	02-26-20
LATEST ISSUE	4-26-22

DESIGNED BY:	SBN
DRAWN BY:	SBN
CHECKED BY:	TDM
FILE NAME:	21369-00DRN-03

DRAWING SCALE:
HORIZONTAL: 1" = 80'
VERTICAL: N/A

PROPOSED CONDITIONS DRAINAGE PLAN

PROJECT NO. 21369-00CSCV
DRAWING NO.

DR-3