MASTER DEVELOPMENT DRAINAGE PLAN/
PRELIMINARY & FINAL DRAINAGE REPORT

for

PIKES PEAK HEIGHTS

Development Plan

E. Pikes Peak Avenue
Colorado Springs, Colorado

July 25, 2019

Prepared for:

Pikes Peak Heights, LLC
c/o Schuck Communities, Inc.
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1.0 CERTIFICATION STATEMENTS

Engineer's Statement

This report and plan for the drainage design of Pikes Peak 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 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. 33797 Date
Tim D. McConnell, P.E. #33797 5-15-19

COLORADO REGISTERED TIM D. McCONNELL PROFESSIONAL ENGINEER

Developer's Statement

Pikes Peak Heights, LLC hereby certifies that the drainage facilities for Pikes Peak 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 Pikes Peak Heights guarantee that the final drainage design review will absolve Pikes Peak Heights, LLC and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

_____ 5-13-19

Authorized Signature — Date
Mike DeGrant
Agent
Schuck Communities, Inc.
Managers of Pikes Peak Heights, LLC.

City of Colorado Springs Statement

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

Jonathan B. Schuck 08/02/2019

For City Engineer — Date
Conditions:

MASTER DEVELOPMENT DRAINAGE PLAN/PRELIMINARY & FINAL DRAINAGE REPORT

for

PIKES PEAK HEIGHTS

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2.0 PURPOSE

The purpose of this Master Development Drainage Plan/Preliminary & Final Drainage Report is to identify the existing and proposed runoff patterns and drainage facilities required for Pikes Peak Heights, and to present the ability to safely pass developed runoff to historic downstream facilities.

3.0 GENERAL SITE DESCRIPTION

Location

Pikes Peak Heights is located in Section 13, Township 14S, Range 66 W of the 6th P.M., El Paso County, Colorado at the easterly dead end of Pikes Peak Avenue and immediately west of Sand Creek and the West Fork of Sand Creek.

The project is bounded on the north by Sand Creek West Tributary, on the west by Eastborough Subdivision, on the south and east by Sand Creek (main stem). This area has been studied as part of the *Sand Creek Drainage Basin Planning Study*, in 1996.

The Pikes Peak Heights property has not been studied previously, but reports from neighboring subdivisions: *Eastborough Subdivision No. 10 Drainage Report;* and *Lot 2 Towne East Centre Filing No.1* have both been reviewed in the preparation of this report.

Site Conditions

Pikes Peak Heights is approximately 67.5 acres in size and is proposed as a residential site. The development is proposed to consist of approximately 119 single-family residential units approximately 74 attached single-family residential units (a total of 193 platted lots), numerous open space tracts, roads and other improvements.

Soils

According to the Soil Survey of El Paso County Area, Colorado, prepared by the U.S. Department of Agriculture Soil Conservation Service, the majority of the site to be developed is underlain by the Blakeland loamy sand (Soil No. 8, Hydrologic Group A). A small portion of the southern end of the site to be developed is underlain by Blendon soils (Soil No. 10, Hydrologic Group B). Runoff coefficients corresponding to groups A and B were used for the purposes of the site drainage analysis. See appendix for Soils map.

For a number of years the site was used as a Clean Fill Site by City of Colorado Springs and Colorado Springs Utilities. The site was regularly inspected by the Colorado Department of Public Health and Environment (CDPHE), and mitigated at the time by an approved plan. Limits of the fill area have been established, and the proposed grading

design accounts for export of the remaining fill materials from the residential portion of the development.

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 08041CO753G (December 7, 2018). Portions of the site along the main stem of Sand Creek and the West Tributary of Sand Creek lie within a designated 100-year floodplain. These areas within the floodplain will be donated to the City of Colorado Springs for channel improvements, trails and other recreational amenities as developed by the Water Resources Engineering and the Parks, Recreation and Cultural Services Departments. No grading will take place within the floodplain as part of this development, and as such, no modification of the floodplain is anticipated.

4.0 DRAINAGE CRITERIA

The drainage analysis has been prepared in accordance with the current City of Colorado Springs 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.

In addition, Inlet Capacity Charts from the City of Colorado Springs Drainage Criteria Manual, and the following Urban Drainage and Flood Control District (UDFCD) provided spreadsheets, UD-BMP v.3.05 IRF and UD-Detention v3.07 were used for design of the detention facility and associated storm sewer infrastructure.

Hydraulic grade line calculations utilizing UD-Sewer 2009 1.4.0 are included in the appendix. Plan and profiles of the storm system depicting the HGL will be provided at the construction document stage.

5.0 EXISTING CONDITION

The existing site is undeveloped and covered primarily with native grasses, scattered shrubs and numerous trees. There are no existing structures on the property. A high-pressure gas line crosses the middle of the site, and overhead power lines are located along the western boundary. The northern third of the site slopes from southwest to northeast towards the West Fork of Sand Creek at approximately 1% to 25% grades. The southern two thirds of the site slopes from north to south towards the main stem of Sand Creek at approximately 1% to 25% grades See Existing Conditions Drainage Map in the appendix.

The central portion of the site was previously used by the City and private developers/contractors as dumping site for asphalt and concrete debris. The dump materials will be removed from the residential portion of the development site prior to development of the site.

Listed below are the existing conditions runoff rates for the 5-yr and 100-yr frequency storms:

BASIN	AREA (AC)	Q5 (cfs)	Q100 (cfs)
E1	31.10	8.7	67.8
E2	1.37	0.3	2.7
E3	2.46	0.6	4.9
E4	10.98	2.9	22.3
E5	21.59	6.6	51.4
OS-1	4.56	8.0	19.0
OS-2	1.01	2.9	6.2

DP	AREA (AC)	Q5 (cfs)	Q100 (cfs)
DP-1	31.10	8.7	67.8
DP-2	1.37	0.3	2.7
DP-3	2.46	0.6	4.9
DP-4	10.98	2.9	22.3
DP-5	21.59	6.6	51.4
DP-6	4.56	8.0	19.0
DP-7	1.01	2.9	6.2

Basin E1 covers 31.1 acres of open grassland and incorporates the majority of the southern 2/3 of the project site, with runoff ultimately reaching the main stem of Sand Creek, by way of overland and concentrated sheet flow. All of the flows from this basin are reflected as Design Point 1 (DP-1).

Basin E2 is located at the south end of the project site and covers 1.37 acres of open grassland. Runoff generated by this basin travels overland offsite to the south of the project site. The flows exiting the site from this basin are reflected as Design Point 2 (DP-2).

Basin E3 is located at the south end of the project site and covers 2.46 acres of open grassland. Runoff generated by this basin travels overland offsite to the south of the project site. The flows exiting the site from this basin are reflected as Design Point 3 (DP-3).

Basin E4 is located on the west side of the southern 2/3 of the project site and covers 10.98 acres of open grassland. Runoff generated by this basin travels overland offsite to the west of the project site. The flows exiting the site from this basin are reflected as Design Point 4 (DP-4).

Basin E5 covers 21.59 acres of open grassland and incorporates the northern 1/3 of the project site, with runoff ultimately reaching the west tributary of Sand Creek, by way of overland and concentrated sheet flow. All of the flows from this basin are reflected as Design Point 5 (DP-5).

Basin OS-1 is located offsite to the west of the project boundary and covers 4.56 acres of residential properties along Frost Drive. The flows from this basin culminate at two existing curb inlets that capture the flow, and direct it towards an open swale that discharges on to the Pikes Peak Heights property (DP-6).

Basin OS-2 is located offsite to the northwest of the project boundary and covers 1.01 acres of electrical substation with gravel surface. Runoff generated from this basin enters the project site as overland flow from the west. The flows entering the project site from Basin OS-1 are reflected as Design Point 7 (DP-7).

6.0 DEVELOPED CONDITION

Grading of the site for the developed condition was designed to minimize import/export for the site, while maintaining as much open usable area as possible. No offsite flows contribute to the on-site basins. See Proposed Drainage Conditions Map in the appendix.

Detention Pond #1 (North) is proposed to be privately owned and maintained by the Metropolitan District. All storm sewer infrastructure and Detention Pond #2 (South) are proposed to be publicly owned and maintained. All storm sewer shall be either RCP or HDPE.

Listed below are the developed runoff rates for the 5-yr and 100-yr frequency storms:

BASIN	AREA (AC)	Q5 (cfs)	Q100 (cfs)
A1	3.07	5.9	13.8
A2	3.17	6.1	14.3
A3	0.84	1.3	3.7
A4	0.98	0.9	3.3
B5	0.76	1.0	3.1
B6	3.64	6.5	15.2
B7	1.35	1.5	5.2
B8	4.59	8.1	19.0
B9	0.98	1.2	3.9
B10	1.23	0.9	4.2
OS-1	4.56	8.0	19.0
B11	0.72	1.5	3.4
B12	3.51	7.0	16.4
B13	5.78	10.2	23.9
B14	1.23	2.2	5.2
B15	0.86	0.3	2.5

DP	AREA (AC)	Q5 (cfs)	Q100 (cfs)
DP-1	3.07	5.9	13.8
DP-2	6.24	11.9	27.8
DP-3	7.08	13.0	30.8
DP-4	8.06	13.8	33.8
DP-5	0.76	1.0	3.1
DP-6	3.64	6.5	15.2
DP-7	5.75	8.6	22.0
DP-8	4.59	8.1	19.0
DP-9	11.32	17.6	43.8
DP-10	12.55	17.8	46.1
DP-11	4.56	8.0	19.0
DP-12	5.28	10.1	24.3
DP-13	8.79	17.0	40.0
DP-14	5.78	10.2	23.9
DP-15	15.80	27.6	64.9
DP-16	29.21	46.0	113.7

Drainage from individual lots will travel in side lot swales towards the street. Drainage from walkout/garden level lots will be collected in rear-lot swales and directed either via side – lot swales or directly out to the street.

A-group basins represent flows that are captured by the proposed privately owned and maintained Full Spectrum EDB (Pond 1) on the north end of the site.

Basin A1 covers 3.07 acres at the north end of the project site between Canyon Wren Lane and Meadowhawk Drive. Flows generated by this basin Q_5=5.9cfs and Q_{100}=13.7cfs travel as side lot/swale flow and ultimately via curb and gutter to the north and east.

Design Point 1 (DP1) is located at the northern end of the project site at the knuckle intersection at Petaltail Drive and Meadowhawk Drive and represents all flows generated by basin A1. A 10' Type R sump inlet is proposed at the low point to capture all flows at DP1.

Basin A2 covers 3.17 acres at the north end of Canyon Wren Lane and Petaltail Drive. Flows of Q_5=6.1cfs and Q_{100}=14.3cfs generated by this basin travel as side lot/swale flow and ultimately via curb and gutter towards a low point at the intersection of Canyon Wren Drive and Petailtail Drive.

Design Point 2 (DP2) is located across from DP1 at the knuckle intersection at Petaltail Drive and Meadowhawk Drive. DP2 covers all runoff generated by basin A2, a proposed 10' Type R inlet will capture all flows, combine with flows from Basin A1 (DP1) and discharge to the north by 24" storm pipe. Emergency overflow for this inlet will be to the north towards proposed Pond 1.

Basin A3 covers 0.84 acres at the north end of the project site along Petaltail Drive. Flows generated by this basin are Q_5=1.3cfs and Q_{100}=3.7cfs and travel overland to the north and by rear/side lot swale easterly towards DP3.

Design Point 3 (DP3) represents all runoff from Basin A3. DP3 is located at the rear of the northern-most lots on Petaltail Drive, adjacent to Pond 1. Flows generated by Basin A3 are captured by a proposed Type C area inlet, and then combine with runoff from Basins A1 (DP1) and A2 (DP2) and discharge towards Pond 1 by 30" storm pipe.

Basin A4 covers 0.98 acres of open space/detention pond at the northeast corner of the project site. Flows generated by this basin are Q_5=0.9cfs and Q_{100}=3.3cfs.

Design Point 4 (DP4) (Pond 1) is located at the bottom of the proposed Private Full Spectrum EDB in Basin A4. This design point reflects all of the flows from all "A" basins. The required minimum detention volume for Pond 1 has been calculated at 0.86 ac-ft, based on 8.06 acres of watershed at 58.1% imperviousness. The proposed 1.6 ac-ft basin will discharge via 18" storm pipe to the northeast into the Sand Creek West Tributary at or below historic rates. See further discussion below and appendix for calculations.

B-group basins represent flows that are captured by the proposed publicly owned and maintained Full Spectrum EDB (Pond 2) on the south end of the site.

Basin B5 covers 0.76 acres at the east end of the project site along Pondhawk Drive. Flows generated by this basin are Q_5=1.0cfs and Q_{100}=3.1cfs and travel overland to the east and by rear/side lot swale southerly towards DP5.

Design Point 5 (DP5) is located at the south end of Basin B5. Runoff is captured by a proposed Type C area inlet. The flows leave this inlet via a 12" storm pipe to the southwest.

Basin B6 covers 3.64 acres east of Meadowhawk Drive. Flows of Q_5=6.5cfs and Q_{100}=15.2cfs are generated by this basin and travel as side lot/swale flow and ultimately to the south via curb and gutter.

Design Point 6 (DP6) covers all runoff generated by basin B6 and is located at a proposed 10' Type R at-grade inlet at the knuckle intersection of Checkerspot Street and Meadowhawk Drive. The proposed inlet will capture all of the minor storm flows with some limited bypass flow (Q_5=0.0cfs and Q_{100}=2.4cfs) during the 100-year storm. The captured flows leave this inlet via an 18" storm pipe to the southeast.

Basin B7 covers 1.35 acres at the east end of the project site at the rear of lots located along Meadowhawk Drive and Darner Drive. Flows generated by this basin are Q_5=1.5cfs and Q_{100}=5.2cfs and travel rear/side lot and swale flow to the east and south.

Design Point 7 (DP7) is located southeast of DP6 in Basin B7. Runoff generated by basin B7 is captured by a proposed Type C area inlet at this location. Flows from basins B5 (DP5), B6 (DP6) and B7 combine at this point and discharge to the southwest by 24" storm pipe.

Basin B8 covers 4.59 acres between Meadowhawk Drive and Dragonfly Drive. Flows of Q_5=8.6cfs and Q_{100}=19.0cfs are generated by this basin and travel as side lot/swale flow and ultimately to the south via curb and gutter.

Design Point 8 (DP8) covers all runoff generated by basin B8 and is located at a proposed 15' Type R at-grade inlet at the knuckle intersection of Bluet Street and Dragonfly Drive. The proposed inlet will capture all of the minor storm flows with some limited bypass flow (Q_5=0.0cfs and Q_{100}=2.3cfs) during the 100-year storm. The flows leave this inlet via a 24" storm pipe to the southeast.

Basin B9 covers 0.98 acres along the eastern boundary of the project site at the rear of lots located along Checkerspot Street and Bluet Street. Flows generated by this basin are Q_5=1.2cfs and Q_{100}=3.9cfs and travel rear/side lot and swale flow to the east and south.

Design Point 9 (DP9) is located southeast of DP8 and in Basin B9. Runoff generated by basin B9 is captured by a proposed Type C area inlet at this location. Flows from basins B5 (DP5), B6 (DP6) and B7 (DP7), B8 (DP8) and B9 combine at this point and discharge to the southwest by 30" storm pipe.

Basin B10 covers 1.23 acres along the southeastern boundary of the project site at the rear of lots located along Bluet Street. Flows generated by this basin are Q_5=0.9cfs and Q_{100}=4.2cfs and travel rear/side lot and swale flow to the east and south.

Design Point 10 (DP10) is located southeast of DP9 in Basin B10. Runoff generated by basin B10 is captured by a proposed Type C area inlet at this location. Flows from basins B5 (DP5), B6 (DP6) and B7 (DP7), B8 (DP8), B9 (DP9) and B10 combine at this point and continue to discharge to the southwest by 30" storm pipe.

Basin OS-1 is located offsite to the west of the project boundary and covers 4.56 acres of residential properties along Frost Drive. The flows Q_5=8.0cfs and Q_{100}=19.0cfs from this

basin culminate at two existing curb inlets that capture the flow, and direct it towards an open swale that currently discharges on to the Pikes Peak Heights property (DP-11).

Basin B11 covers 0.72 acres along the western boundary of the project site at the rear of lots located along Canyon Wren Lane, south of Wilde Drive. Flows generated by this basin are Q_5=1.5cfs and Q_{100}=3.4cfs and travel rear/side lot to the west, a proposed 8' wide triangular swale along the rear of the lots will direct flows to the south towards Design Point DP12.

Design Point 12 (DP12) is located at the proposed flared end section at the far south end of Basin B11. A proposed 12" flared-end section captures all flows generated by basins OS-1 and B11. The flows leave this design point via a 24" storm pipe to the south.

Basin B12 covers 3.51 acres along the western boundary of the project site and covers lots located along Canyon Wren Lane, south of Pikes Peak Avenue. Flows generated by this basin are Q_5=7.0cfs and Q_{100}=16.4cfs and travel rear/side lot and swale flow to the west and curb and gutter flow to the south.

Design Point 13 (DP13) is located on the north side of the southernmost portion of Canyon Wren Drive and covers Basin B12 and DP12. A 15' Type R at-grade inlet is proposed at this location to capture all flows generated by basin B12.

Basin B13 covers 5.78 acres between Canyon Wren Lane and Dragonfly Drive. Flows of Q_5=10.2cfs and Q_{100}=23.9cfs are generated by this basin and travel as side lot/swale flow and ultimately to the south via curb and gutter.

Design Point 14 is located at the crosspan leaving Basin B13, at the intersection of Bluet Street and Canyon Wren Lane. Flows generated by Basin B13 travel to the south via curb and gutter towards DP15.

Basin B14 covers 1.23 acres west of Canyon Wren Lane. Flows of Q_5=2.2cfs and Q_{100}=5.2cfs are generated by this basin and travel as side lot/swale flow and ultimately to the south via curb and gutter.

Design Point 15 is located on the south side of the southernmost portion of Canyon Wren Drive and covers Basin B14, Basin B11 (DP12) and Basin 13 (DP14). Two 15' Type R at-grade inlets are proposed at this location to capture all flows generated by basins B13 and B14 and any bypass from the upstream inlets at DP6 and DP8.

Basin B15 covers 0.86 acres of open space/detention pond at the northeast corner of the project site. Flows generated by this basin are Q_5=0.3cfs and Q_{100}=2.5cfs.

Design Point 16 (DP16) (Pond 2) is located at the bottom of the proposed Public Full Spectrum EDB in Basin B15. This design point reflects all of the flows from all basins OS-1 and all "B" basins. The required minimum detention volume for Pond 2 has been calculated at 2.84 ac-ft, based on 29.22 acres of watershed at 52.9% imperviousness. The proposed 3.9 ac-ft basin will discharge via 24" storm pipe to the northeast into Sand Creek at or below historic rates. See further discussion below and appendix for calculations.

Inspection and maintenance of the facilities proposed for this project will be required on a regular basis to ensure effective operating condition. Repair or replacement may be necessary in the future.

Hydraulic grade line calculations are included in the appendix, and verify that all pipe sizes are appropriate for anticipated flows and velocities.

7.0 WATER QUALITY DETENTION FACILITIES

Water Quality Detention Facility No. 1 (North)

Water Quality/Detention Facility No. 1 (North) is proposed to be a private full-spectrum Extended Detention Basin (EDB). UD-Detention v3.07 and UD-BMP v.3.05 IRF calculations are provided in the appendix. Based on a watershed area of 8.06 acres, with an effective site imperviousness of 58.1%, the required pond volume for 100-yr detention is 0.86 acre-ft, the actual proposed pond volume is 1.55 acre-ft.

The forebay volume was calculated based on 3% of the WQCV volume. The forebay includes a dissipater as the flows enter, and a notch through which to exit to the trickle channel. In order to release the flows from the forebay at 2% of the peak 100-yr inflow, the forebay has a 3" wide notch. A 6' wide concrete trickle channel will run along the bottom of the pond from the forebay to the micropool. The micropool surface area is 41-sf and it has a depth of 2.5' with an additional 4" for surcharge volume.

The outlet structure will consist of a modified Type C outlet structure with an orifice plate and a grate on top. The orifice plate will have 2 – 1.35 sq. inch orifices to release the WQCV within 40 hours, and a third 1.35 sq-inch orifice above to ensure the EURV is released within 73 hours.

The elevation of the grate is set at 6167.84, which is below the 100-year detention volume elevation. The outlet pipe has been set as an 18" storm pipe, and will release the 100-year flow at 90% of the predeveloped 100-year runoff rate, in accordance with drainage criteria.

With these release rates the WQCV will drain in 40 hours, the EURV in 73 hours, and the 100-year storm volume in 89 hours. The pond drain time is acceptable and does not need to be increased with the use of a restrictor plate.

A 15' long spillway is located on the south side of the pond and is placed 1.6' below the crest of the pond to allow for 1' of freeboard above the spillway design flow depth. In the event that water overtops the spillway, it will discharge directly into Sand Creek West Tributary.

The flows leaving the pond via a public 18" storm pipe will discharge directly into the West Fork of Sand Creek at or below historic rates. A low tailwater basin is proposed at the outfall to protect against erosion and scour of the main channel. Sizing of the basin is based upon UDFCD criteria and verified utilizing the UD-Culvert v3.04 spreadsheet. See appendix for calculations. Further design details will be provided at the construction document stage.

Future improvements to the West Fork of Sand Creek channel are proposed adjacent to this Pikes Peak Heights Development, and have been considered as part of the outfall design. Timing of construction is unknown, but further coordination with the Colorado Springs Utilities will likely be necessary during installation.

Water Quality Detention Facility No. 2 (South)

Water Quality/Detention Facility No. 2 (South) is proposed to be a public full-spectrum Extended Detention Basin (EDB). UD-Detention v3.07 and UD-BMP v.3.05 IRF calculations are provided in the appendix. Based on a watershed area of 29.22 acres, with an effective site imperviousness of 52.9%, the required pond volume for 100-yr detention is 2.84 acre-ft, the actual proposed pond volume is 3.85 acre-ft.

The forebay volume was calculated based on 3% of the WQCV volume. Each forebay includes a dissipater as the flows enter, and a notch through which to exit to the trickle channel. In order to release the flows from the forebay at 2% of the peak 100-yr inflow, the north forebay has a 4" wide notch, and the south forebay a 6" notch. A 6' wide concrete trickle channel will run along the bottom of the pond from the forebays to the micropool. The micropool surface area is 41- sf and it has a depth of 2.5' with an additional 4" for surcharge volume.

The outlet structure will consist of a modified Type C outlet structure with an orifice plate and a grate on top. The orifice plate will have 3 – 3.88 sq. inch orifices to release the WQCV within 40 hours, and EURV within 70 hours.

The elevation of the grate is set at 6099.75, which is below the 100-year detention volume elevation. The outlet pipe has been set as a 24" storm pipe with restrictor plate set at 10" above the pipe invert, and will release the 100-year flow at 100% of the predeveloped 100-year runoff rate, in accordance with drainage criteria.

With these release rates the WQCV will drain in 40 hours, the EURV in 70 hours, and the 100-year storm volume in 76 hours.

A 50' long spillway is located on the south side of the pond and is placed 1.60' below the crest of the pond to allow for 1' of freeboard above the spillway design flow depth. In the event that water overtops the spillway, it will discharge directly into Sand Creek.

The flows leaving the pond via a public 24" storm pipe will discharge directly into Sand Creek at or below historic rates. A low tailwater basin is proposed at the outfall to protect against erosion and scour of the main channel. Sizing of the basin is based upon UDFCD criteria and verified utilizing the UD-Culvert v3.04 spreadsheet. See appendix for calculations. Further design details will be provided at the construction document stage.

Further expansion of the proposed detention facility in the future will be possible within Tract I of the Pikes Peak Heights development. Horizontally there is sufficient room to extend to the south and west by approximately 10 feet, and given the depth of the outfall into Sand Creek, it would be possible to lower the bottom elevation of the pond for additional storage volume.

Future improvements to the main Sand Creek channel are proposed upstream of this proposed outfall. Timing of construction is unknown, but further coordination with the City of Colorado Springs may be necessary during installation.

8.0 FOUR STEP PROCESS

This project conforms to the City of Colorado Springs Four Step Process. The process for this site 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 permanent Extended Detention Basin facilities designed per current City of Colorado Springs drainage criteria.

   In addition, a site specific Storm Water Quality and Erosion Control plan and narrative will be submitted and approved by City Engineering prior to any disturbance within the project area. Details such as potential pollutants, mitigation methods, site specific source control construction BMP's and permanent BMP's will be detailed in this plan and narrative to protect receiving waters.

3. ***Stabilize Drainage Ways*:** Stabilization of Sand Creek adjacent to the site is to be completed by the City of Colorado Springs and Colorado Springs Utilities. Project details and timeline at this point are unknown but are anticipated to be within the next few years. All runoff from the developed portion of the site will be detained and treated for water quality before being discharged into the adjacent drainage ways at historic rates.

4. ***Implement Site Specific and Other Source Control BMP's*:** The site is proposed as a residential development, and as such standard household source control will be utilized in order to minimize potential pollutants entering the storm system. Example source control measures consist of: garages for storage of household chemicals; and trash receptacles for individual households, and in common areas for pet waste.

9.0 GRADING & EROSION CONTROL PLAN

In accordance with the City of Colorado Springs Drainage Criteria Manual, an Erosion Control Plan was considered as part of this drainage analysis. However, the plan will be submitted as a stand-alone set of drawings at the construction document stage.

10.0 DRAINAGE & BRIDGE FEES

Pikes Peak Heights is located within the Sand Creek Drainage Basin. The fees established for platting property within this basin as of January 1, 2019 are as follows:

Drainage Fee: $12,645 per acre
Bridge Fee: $761 per acre
Pond Land Fee: $1,070 per acre
Pond Facility Fee: $3,676 per acre
Surcharge: $1,333 per acre

Fees will be due prior to plat recording for individual filings within the Pikes Peak Heights development. Land donated to the City of Colorado Springs along Sand Creek and the West Tributary of Sand Creek will be exempt from drainage fees.

11.0 CONSTRUCTION COST ESTIMATE

Item	Qty	Unit	Unit Price	Cost
Public Non-Reimbursable				
3.72 ac-ft EDB	1	EA	$80,000.00	$80,000.00
Type C Inlet	3	EA	$5,000.00	$15,000.00
10' Type R Inlet	2	EA	$8,000.00	$16,000.00
15' Type R Inlet	5	EA	$12,000.00	$60,000.00
18" RCP	424	LF	$35.00	$14,840.00
24" RCP	608	LF	$45.00	$27,360.00
30" RCP	513	LF	$55.00	$28,215.00
36" RCP	85	LF	$75.00	$6,375.00
			Public facilities subtotal	*$247,790.00*
Private				
1.55 ac-ft EDB	1	EA	$50,000.00	$50,000.00
Type C Inlet	2	EA	$5,000.00	$10,000.00
Type 2 Storm MH	1	EA	$4,000.00	$4,000.00
12" RCP	543	LF	$25.00	$13,575.00
18" RCP	58	LF	$35.00	$2,030.00
30" RCP	29	LF	$55.00	$1,595.00
			Private facilities subtotal	*$81,200.00*
			Public & Private subtotal	*$328,990.00*
			10% Contingency	*$32,899.00*
			Cost Estimate Total	**$361,889.00**

12.0 SUMMARY

The findings of this report are in general conformance with the Sand Creek Drainage Basin Planning Study, and as such, all site runoff, storm drains and appurtenances proposed by the development of Pikes Peak Heights will not adversely affect the surrounding or downstream developments. The proposed drainage system will safely route developed flows to the proposed on-site full-spectrum water quality/detention facilities where flows will be released at or below historical rates.

13.0 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, May 2014 as amended.

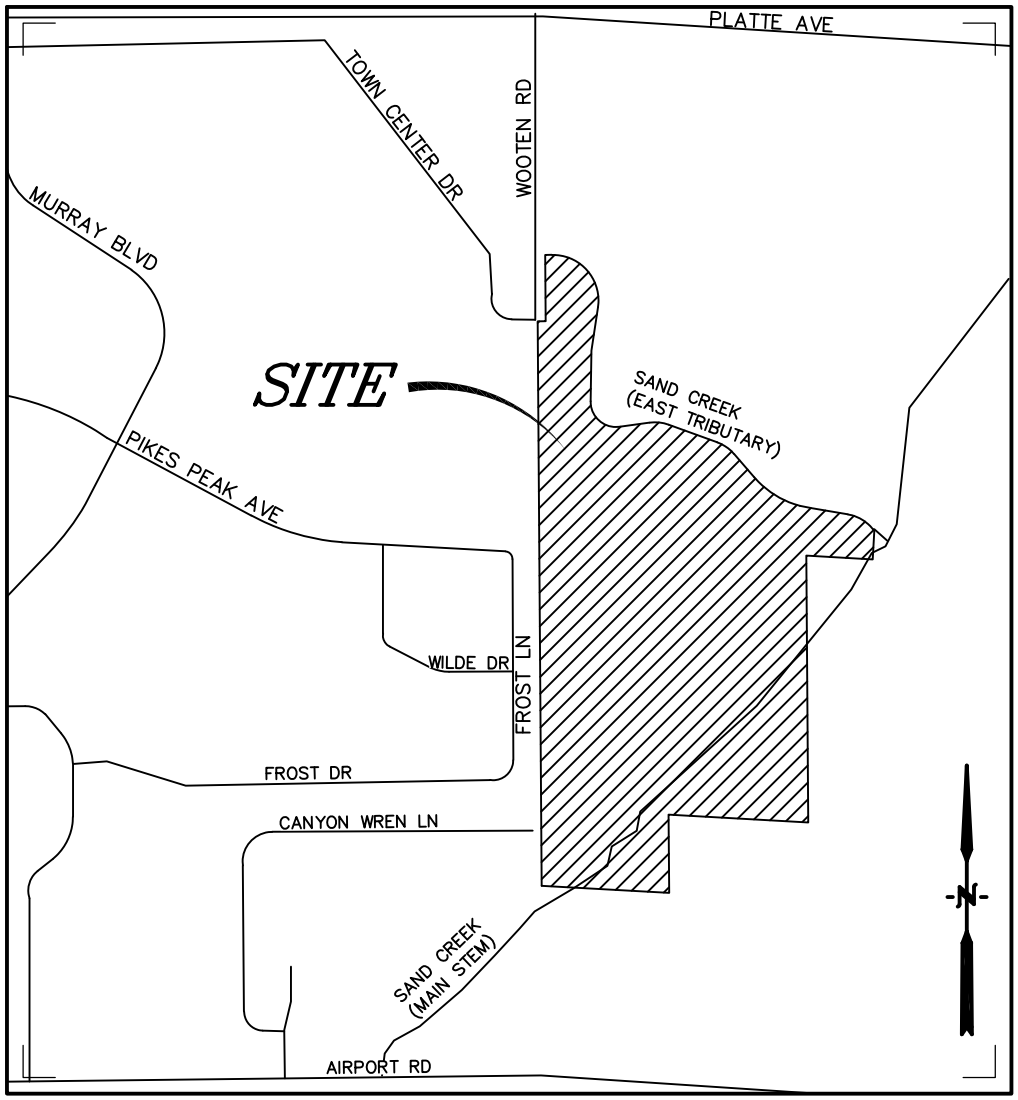
2. Urban Storm Drainage Criteria Manuals, Urban Drainage and Flood Control District. June 2001, Revised April 2008.

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

4. Eastborough Subdivision No. 10 Drainage Report, R. Keith Hook & Associates, Inc., October 26, 1970

5. Lot 2 Towne East Centre Filing No. 1 Final Drainage Report, WestWorks Engineering, June 2003.

APPENDIX



Vicinity Map

Not to scale

PIKES PEAK HEIGHTS
COLORADO SPRINGS, CO
VICINITY MAP

Drexel, Barrell & Co.
Engineers • Surveyors

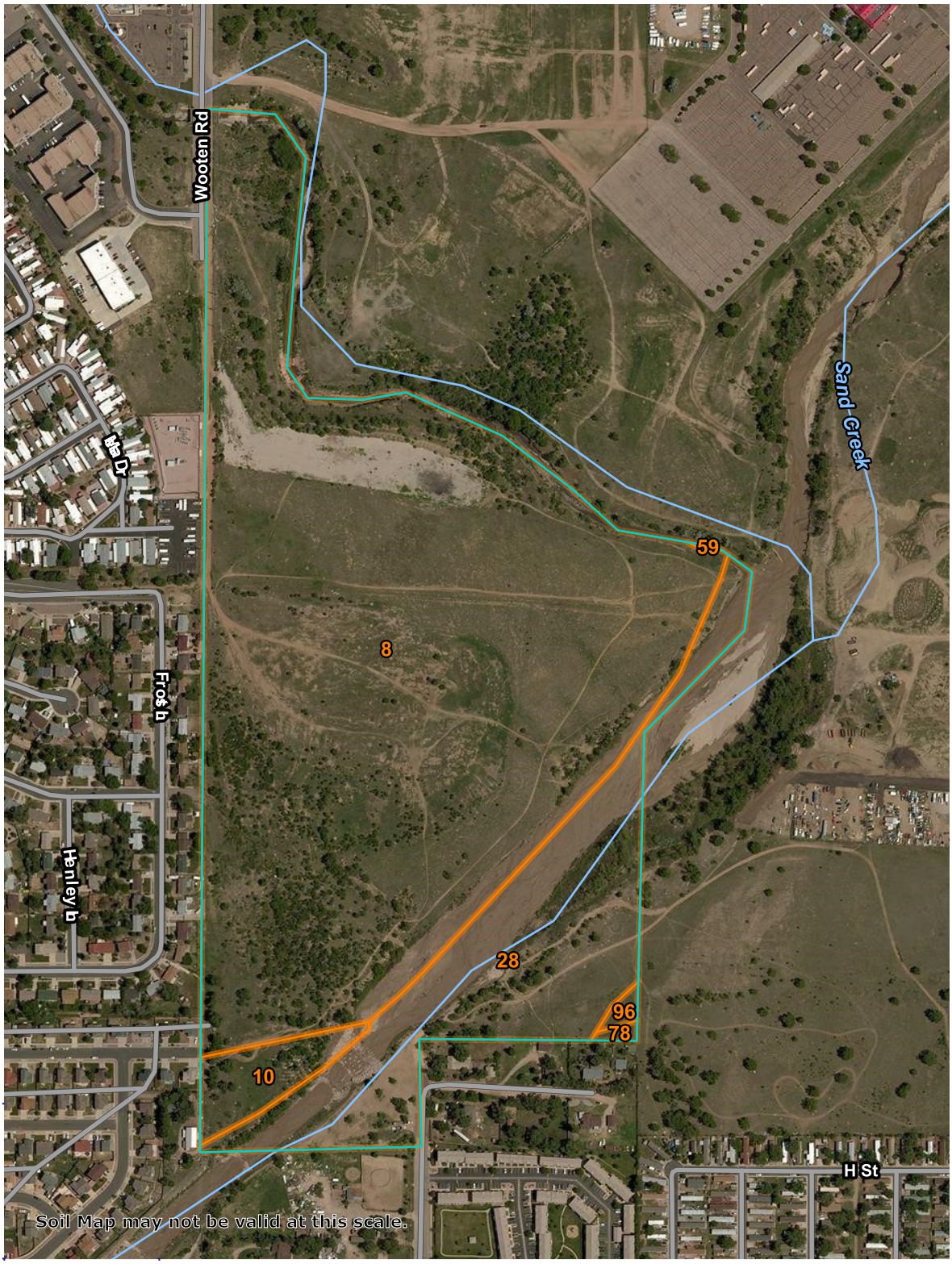
DATE:

JOB NO: 21150-01CSCV

DWG. NO. VMAP

SHEET 1 OF 1

104° 44' 27" W
104° 43' 50" W
38° 50' 14" N
38° 49' 37" N



Map Scale: 1:5,650 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Apr 15, 2011—Jun 17, 2014

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	55.1	78.4%
10	Blendon sandy loam, 0 to 3 percent slopes	1.9	2.7%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	12.9	18.4%
59	Nunn clay loam, 0 to 3 percent slopes	0.0	0.0%
78	Sampson loam, 0 to 3 percent slopes	0.1	0.2%
96	Truckton sandy loam, 0 to 3 percent slopes	0.2	0.3%
Totals for Area of Interest		**70.3**	**100.0%**

El Paso County Area, Colorado

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369v
Elevation: 4,600 to 5,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Blakeland

Setting

Landform: Hills, flats
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock and/or eolian deposits derived from sedimentary rock

Typical profile

A - 0 to 11 inches: loamy sand
AC - 11 to 27 inches: loamy sand
C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

10—Blendon sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3671
Elevation: 6,000 to 6,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Blendon

Setting

Landform: Terraces, alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

A - 0 to 10 inches: sandy loam
Bw - 10 to 36 inches: sandy loam
C - 36 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Available water storage in profile: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Sandy Foothill (R049BY210CO)

Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

28—Ellicott loamy coarse sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 3680
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Ellicott

Setting

Landform: Flood plains, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium

Typical profile

A - 0 to 4 inches: loamy coarse sand
C - 4 to 60 inches: stratified coarse sand to sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: Sandy Bottomland LRU's A & B (R069XY031CO)
Other vegetative classification: SANDY BOTTOMLAND (069AY031CO)
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquoll

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

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

59—Nunn clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3693
Elevation: 5,400 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Nunn

Setting

Landform: Fans, terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

A - 0 to 12 inches: clay loam
Bt - 12 to 26 inches: clay loam
BC - 26 to 30 inches: clay loam
Bk - 30 to 58 inches: sandy clay loam

C - 58 to 72 inches: clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C
Ecological site: Clayey Plains LRU's A & B (R069XY042CO)
Other vegetative classification: CLAYEY PLAINS (069AY042CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

78—Sampson loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 369s
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Sampson and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sampson

Setting

Landform: Depressions, alluvial fans, terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 15 inches: loam
Bt - 15 to 34 inches: clay loam
Bk - 34 to 60 inches: sandy clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: B
Ecological site: Loamy Foothill (R049BY202CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

96—Truckton sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 36bf
Elevation: 6,000 to 7,000 feet

Mean annual precipitation: 14 to 15 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

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

Description of Truckton

Setting

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

Typical profile

A - 0 to 8 inches: sandy loam
Bt - 8 to 24 inches: sandy loam
C - 24 to 60 inches: coarse sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

National Flood Hazard Layer FIRMette

FEMA

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 5/10/2019 at 4:25:33 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

PROJECT INFORMATION								
PROJECT:	Pikes Peak Heights							
PROJECT NO:	21150-01							
DESIGN BY:	SBN						Drexel, Barrell & Co.	
REV. BY:	TDM							
AGENCY:	City of Colorado Springs							
REPORT TYPE:	Final							
DATE:	6/10/2019							
Soil Type: A								
				C2*	C5*	C10*	C100*	% IMPERV
Pasture/Meadow					0.08		0.35	0
Gravel					0.59		0.70	80
Asphalt/Sidewalk					0.90		0.96	100
Residential (1/8 acre)					0.45		0.59	65
*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**	
E1	Pasture/Meadow		31.10		0.08		0.35	0
	Gravel		0.00		0.59		0.70	80
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	Residential (1/8 acre)		0.00		0.45		0.59	65
	WEIGHTED AVERAGE				0.08		0.35	0%
TOTAL E1			31.10					
E2	Pasture/Meadow		1.37		0.08		0.35	0
	Gravel		0.00		0.59		0.70	80
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	Residential (1/8 acre)		0.00		0.45		0.59	65
	WEIGHTED AVERAGE				0.08		0.35	0%
TOTAL E2			1.37					
E3	Pasture/Meadow		2.46		0.08		0.35	0
	Gravel		0.00		0.59		0.70	80
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	Residential (1/8 acre)		0.00		0.45		0.59	65
	WEIGHTED AVERAGE				0.08		0.35	0%
TOTAL E3			2.46					
E4	Pasture/Meadow		10.98		0.08		0.35	0
	Gravel		0.00		0.59		0.70	80
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	Residential (1/8 acre)		0.00		0.45		0.59	65
	WEIGHTED AVERAGE				0.08		0.35	0%
TOTAL E4			10.98					
E5	Pasture/Meadow		21.59		0.08		0.35	0
	Gravel		0.00		0.59		0.70	80
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	Residential (1/8 acre)		0.00		0.45		0.59	65
	WEIGHTED AVERAGE				0.08		0.35	0%
TOTAL E5			21.59					

OS-1	Pasture/Meadow		0.21		0.08		0.35	0
	Gravel		0.00		0.59		0.70	80
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	Residential (1/8 acre)		4.35		0.45		0.59	65
	WEIGHTED AVERAGE				0.43		0.58	62%
TOTAL OS-1			4.56					
OS-2	Pasture/Meadow		0.00		0.08		0.35	0
	Gravel		1.01		0.59		0.70	80
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	Residential (1/8 acre)		0.00		0.45		0.59	65
	WEIGHTED AVERAGE				0.59		0.70	80%
TOTAL OS-1			1.01					
TOTAL SITE			72.06		0.10		0.36	3.9%

PROJECT INFORMATION

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PROJECT NO:	21150-01
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	6/10/2019

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
E1	DP-1	0.08	0.35	31.10	100	4	4.0	12.0	1235	79	6.4	7.8	2.6	14.6	5	14.6
E2	DP-2	0.08	0.35	1.37	100	1.5	1.5	16.7	230	1.5	0.7	2.6	1.5	18.1	5	18.1
E3	DP-3	0.08	0.35	2.46	100	1.5	1.5	16.7	330	6	1.8	4.2	1.3	18.0	5	18.0
E4	DP-4	0.08	0.35	10.98	100	3	3.0	13.2	1635	84	5.1	7.0	3.9	17.1	5	17.1
E5	DP-5	0.08	0.35	21.59	100	7.5	7.5	9.7	1065	71.5	6.7	8.0	2.2	12.0	5	12.0
OS-1	DP-6	0.43	0.58	4.56	100	6	6.0	6.9	1230	37	3.0	5.9	3.5	10.3	5	10.3

PROJECT INFORMATION

PROJECT:	Pikes Peak Heights
PROJECT NO:	21150-01
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	6/10/2019

Drexel, Barrell & Co.

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

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

			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)	Calculated Pipe Dia	Used Pipe
E1	DP-1	31.10	0.08	14.6	2.49	3.50	8.7				
E2	DP-2	1.37	0.08	18.1	0.11	3.16	0.3				
E3	DP-3	2.46	0.08	18.0	0.20	3.18	0.6				
E4	DP-4	10.98	0.08	17.1	0.88	3.26	2.9				
E5	DP-5	21.59	0.08	12.0	1.73	3.82	6.6				
OS-1	DP-6	4.56	0.43	10.3	1.97	4.05	8.0				

PROJECT INFORMATION

PROJECT:	Pikes Peak Heights
PROJECT NO:	21150-01
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	6/10/2019

Drexel, Barrell & Co.

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

EXISTING RUNOFF 100 YR STORM P1= **2.67**

			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)	Calculated Pipe Dia	Used Pipe
E1	DP-1	31.10	0.35	14.6	10.89	6.23	67.8				
E2	DP-2	1.37	0.35	18.1	0.48	5.63	2.7				
E3	DP-3	2.46	0.35	18.0	0.86	5.66	4.9				
E4	DP-4	10.98	0.35	17.1	3.84	5.79	22.3				
E5	DP-5	21.59	0.35	12.0	7.56	6.80	51.4				
OS-1	DP-6	4.56	0.58	10.3	2.64	7.21	19.0				

PROJECT INFORMATION								
PROJECT:	Pikes Peak Heights							
PROJECT NO:	21150-01							
DESIGN BY:	SBN							Drexel, Barrell & Co.
REV. BY:	TDM							
AGENCY:	City of Colorado Springs							
REPORT TYPE:	Final							
DATE:	6/10/2019							
Soil Type: A								
				C2*	C5*	C10*	C100*	% IMPERV
Landscape/Lawn					0.08		0.35	0
Residential (1/8 acre)					0.45		0.59	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								
PROPOSED								
SUB-BASIN	SURFACE DESIGNATION		AREA	COMPOSITE RUNOFF COEFFICIENTS				% IMPERV
			ACRE	**C2**	**C5**	**C10**	**C100**	
A1	Landscape/Lawn		0.00		0.08		0.35	0
	Residential (1/8 acre)		3.07		0.45		0.59	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.45		0.59	65%
TOTAL A1			3.07					
A2	Landscape/Lawn		0.00		0.08		0.35	0
	Residential (1/8 acre)		3.17		0.45		0.59	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.45		0.59	65%
TOTAL A2			3.17					
A3	Landscape/Lawn		0.26		0.08		0.35	0
	Residential (1/8 acre)		0.58		0.45		0.59	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.34		0.52	45%
TOTAL A3			0.84					
A4	Landscape/Lawn		0.67		0.08		0.35	0
	Residential (1/8 acre)		0.31		0.45		0.59	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.20		0.43	21%
TOTAL A4			0.98					
TOTAL A BASINS			8.06		0.41		0.56	57.5%
OS-1	Landscape/Lawn		0.21		0.08		0.35	0
	Residential (1/8 acre)		4.35		0.45		0.59	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.43		0.58	62%
TOTAL B5			4.56					
B5	Landscape/Lawn		0.33		0.08		0.35	0
	Residential (1/8 acre)		0.43		0.45		0.59	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.29		0.49	37%
TOTAL B5			0.76					
B6	Landscape/Lawn		0.00		0.08		0.35	0
	Residential (1/8 acre)		3.64		0.45		0.59	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.45		0.59	65%
TOTAL B6			3.64					
B7	Landscape/Lawn		0.79		0.08		0.35	0
	Residential (1/8 acre)		0.56		0.45		0.59	65
	Asphalt/Sidewalk		0.00		0.90		0.96	100
	WEIGHTED AVERAGE				0.23		0.45	27%
TOTAL B7			1.35					

B8	Landscape/Lawn	0.00		0.08		0.35	0
	Residential (1/8 acre)	4.59		0.45		0.59	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.45		0.59	65%
TOTAL B8		4.59					
B9	Landscape/Lawn	0.53		0.08		0.35	0
	Residential (1/8 acre)	0.45		0.45		0.59	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.25		0.46	30%
TOTAL B9		0.98					
B10	Landscape/Lawn	1.01		0.08		0.35	0
	Residential (1/8 acre)	0.22		0.45		0.59	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.15		0.39	12%
TOTAL B10		1.23					
B11	Landscape/Lawn	0.00		0.08		0.35	0
	Residential (1/8 acre)	0.72		0.45		0.59	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.45		0.59	65%
TOTAL B11		0.72					
B12	Landscape/Lawn	0.00		0.08		0.35	0
	Residential (1/8 acre)	3.51		0.45		0.59	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.45		0.59	65%
TOTAL B12		3.51					
B13	Landscape/Lawn	0.00		0.08		0.35	0
	Residential (1/8 acre)	5.78		0.45		0.59	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.45		0.59	65%
TOTAL B13		5.78					
B14	Landscape/Lawn	0.00		0.08		0.35	0
	Residential (1/8 acre)	1.23		0.45		0.59	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.45		0.59	65%
TOTAL B14		1.23					
B15	Landscape/Lawn	0.86		0.08		0.35	0
	Residential (1/8 acre)	0.00		0.45		0.59	65
	Asphalt/Sidewalk	0.00		0.90		0.96	100
	WEIGHTED AVERAGE			0.08		0.35	0%
TOTAL B15		0.86					
TOTAL B BASINS		29.21		0.40		0.56	56.7%
TOTAL SITE		37.27		0.35		0.49	49.3%

PROJECT INFORMATION

PROJECT:	Pikes Peak Heights
PROJECT NO:	21150-01
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	6/10/2019

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
A1	DP-1	0.45	0.59	3.07	55	1	1.8	7.4	725	10	1.4	7.5	1.6					9.0	5	9.0
A2		0.45	0.59	3.17	100	7	7.0	6.4	885	10	1.1	6.1	2.4					8.8	5	8.8
	DP-2	0.45	0.59	6.24										35	1.0	4.8	0.1	9.1	5	9.1
A3		0.34	0.52	0.84	60	11	18.3	4.2	415	4	1.0	3.1	2.2					6.4	5	6.4
	DP-3	0.44	0.58	7.08										190	6.0	14.3	0.2	9.3	5	9.3
A4		0.20	0.43	0.98	100	11	11.0	7.6	95	5	5.3	7.1	0.2					7.8	5	7.8
	DP-4	0.41	0.56	8.06										75	6.5	14.9	0.1	9.4	5	9.4
B5	DP-5	0.29	0.49	0.76	90	14	15.6	5.8	340	19	5.6	7.3	0.8					6.5	5	6.5
B6	DP-6	0.45	0.59	3.64	100	2	2.0	9.6	810	30	3.7	11.3	1.2					10.8	5	10.8
B7		0.23	0.45	1.35	75	21	25.0	4.8	475	17	3.6	5.9	1.3					6.1	5	6.1
	DP-7	0.38	0.54	5.75										185	10.0	18.5	0.2	11.0	5	11.0
B8	DP-8	0.45	0.59	4.59	100	2	2.0	9.6	1035	45	4.3	12.0	1.4					11.1	5	11.1
B9		0.25	0.46	0.98	75	15	20.0	5.1	275	12	4.4	6.5	0.7					5.8	5	5.8
	DP-9	0.40	0.56	11.32										175	8.0	16.5	0.2	11.3	5	11.3
B10		0.15	0.39	1.23	60	12	20.0	5.1	390	18	4.6	6.7	1.0					6.1	5	6.1
	DP-10	0.37	0.54	12.55										385	4.0	9.7	0.7	11.9	5	11.9
OS-1	DP-11	0.43	0.58	4.56	100	6	6.0	6.9	1230	37	3.0	5.9	3.5					10.3	5	10.3
B11		0.45	0.59	0.72	45	1	2.2	6.2	678	46	6.8	8.1	1.4					7.6	5	7.6
	DP-12	0.44	0.59	5.28					185	4	2.2	4.8	0.6					8.3	5	8.3
B12		0.45	0.59	3.51	100	7	7.0	6.4	1430	87	6.1	14.5	1.6					8.0	5	8.0
	DP-13	0.44	0.58	8.79										50	1.0	8.4	0.1	8.4	5	8.4
B13	DP-14	0.45	0.59	5.78	100	2	2.0	9.6	1125	51	4.5	12.4	1.5					11.2	5	11.2
B14		0.45	0.59	1.23	100	2	2.0	9.6	530	31	5.8	14.1	0.6					10.3	5	10.3
	DP-15	0.45	0.59	15.80										35	1.0	8.4	0.1	11.2	5	11.2
B15		0.08	0.35	0.86	55	5	9.1	6.8	40	0.2	0.5	4.1	0.2					6.9	5	6.9
	DP-16	0.40	0.56	29.21										85	1.0	9.4	0.2	11.3	5	11.3

PROJECT INFORMATION

PROJECT:	Pikes Peak Heights
PROJECT NO:	21150-01
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	6/10/2019

Drexel, Barrell & Co.

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

PROPOSED RUNOFF 5 YR STORM P1= **1.50**

			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)	Calculated Pipe Dia	Used Pipe
A1	DP-1	3.07	0.45	9.0	1.38	4.27	5.9				
A2		3.17	0.45	8.8	1.43	4.31	6.1				
	DP-2	6.24	0.45	9.1	2.81	4.24	11.9				
A3		0.84	0.34	6.4	0.28	4.76	1.3				
	DP-3	7.08	0.44	9.3	3.09	4.21	13.0				
A4		0.98	0.20	7.8	0.19	4.48	0.9				
	DP-4	8.06	0.41	9.4	3.28	4.19	13.8				
B5	DP-5	0.76	0.29	6.5	0.22	4.74	1.0				
B6	DP-6	3.64	0.45	10.8	1.64	3.97	6.5				
B7		1.35	0.23	6.1	0.32	4.83	1.5				
	DP-7	5.75	0.38	11.0	2.17	3.95	8.6				
B8	DP-8	4.59	0.45	11.1	2.07	3.94	8.1				
B9		0.98	0.25	5.8	0.24	4.91	1.2				
	DP-9	11.32	0.40	11.3	4.48	3.92	17.6				
B10		1.23	0.15	6.1	0.18	4.84	0.9				
	DP-10	12.55	0.37	11.9	4.66	3.83	17.8				
OS-1	DP-11	4.56	0.43	10.3	1.97	4.05	8.0				
B11		0.72	0.45	7.6	0.32	4.51	1.5				
	DP-12	5.28	0.44	8.3	2.30	4.39	10.1				
B12		3.51	0.45	8.0	1.58	4.44	7.0				
	DP-13	8.79	0.44	8.4	3.88	4.37	17.0				
B13	DP-14	5.78	0.45	11.2	2.60	3.93	10.2				
B14		1.23	0.45	10.3	0.55	4.06	2.2				
	DP-15	15.80	0.45	11.2	7.03	3.93	27.6				
B15		0.86	0.08	6.9	0.07	4.65	0.3				
	DP-16	29.21	0.40	11.3	11.76	3.91	46.0				

PROJECT INFORMATION

PROJECT:	Pikes Peak Heights
PROJECT NO:	21150-01
DESIGN BY:	SBN
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	6/10/2019

Drexel, Barrell & Co.

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

PROPOSED RUNOFF 100 YR STORM P1= **2.67**

			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)	Calculated Pipe Dia (ft)	Used Pipe (in)
A1	DP-1	3.07	0.59	9.0	1.81	7.59	13.8				
A2		3.17	0.59	8.8	1.87	7.67	14.3				
	DP-2	6.24	0.59	9.1	3.68	7.56	27.8				
A3		0.84	0.52	6.4	0.43	8.48	3.7				
	DP-3	7.08	0.58	9.3	4.11	7.49	30.8				
A4		0.98	0.43	7.8	0.42	7.97	3.3				
	DP-4	8.06	0.56	9.4	4.53	7.47	33.8				
B5	DP-5	0.76	0.49	6.5	0.37	8.44	3.1				
B6	DP-6	3.64	0.59	10.8	2.15	7.08	15.2				
B7		1.35	0.45	6.1	0.61	8.59	5.2				
	DP-7	5.75	0.54	11.0	3.12	7.03	22.0				
B8	DP-8	4.59	0.59	11.1	2.71	7.01	19.0				
B9		0.98	0.46	5.8	0.45	8.74	3.9				
	DP-9	11.32	0.56	11.3	6.28	6.97	43.8				
B10		1.23	0.39	6.1	0.48	8.62	4.2				
	DP-10	12.55	0.54	11.9	6.77	6.81	46.1				
OS-1	DP-11	4.56	0.58	10.3	2.64	7.21	19.0				
B11		0.72	0.59	7.6	0.42	8.03	3.4				
	DP-12	5.28	0.59	8.3	3.12	7.82	24.3				
B12		3.51	0.59	8.0	2.07	7.91	16.4				
	DP-13	8.79	0.58	8.4	5.14	7.78	40.0				
B13	DP-14	5.78	0.59	11.2	3.41	7.00	23.9				
B14		1.23	0.59	10.3	0.73	7.23	5.2				
	DP-15	15.80	0.59	11.2	9.27	7.00	64.9				
B15		0.86	0.35	6.9	0.30	8.28	2.5				
	DP-16	29.21	0.56	11.3	16.34	6.96	113.7				

PROJECT INFORMATION

Drexel, Barrell & Co.

PROJECT:	Pikes Peak Hts
PROJECT NO:	21150-01
DESIGN BY:	KGV
REV. BY:	TDM
AGENCY:	Colorado Springs
REPORT TYPE:	Final
DATE:	7/25/2019

TRIANGULAR SWALE DESIGN - DESIGN POINT 12

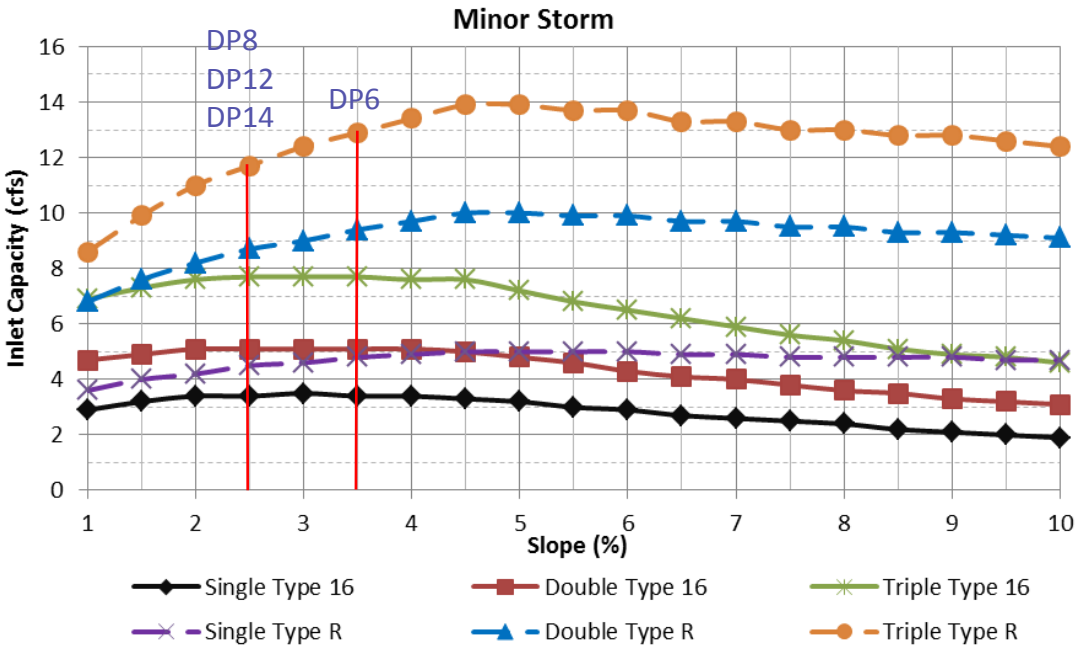
Bottom Width (b)	0	ft
Depth (d)	1.33	ft
Side slopes (z:1)	3	ft
Roughness Mannings	0.035	
Full Capacity		
Area	5.31	sf
Wetted Perimeter	8.41	ft
Hydraulic Radius	0.63	ft
Top Width	7.98	ft

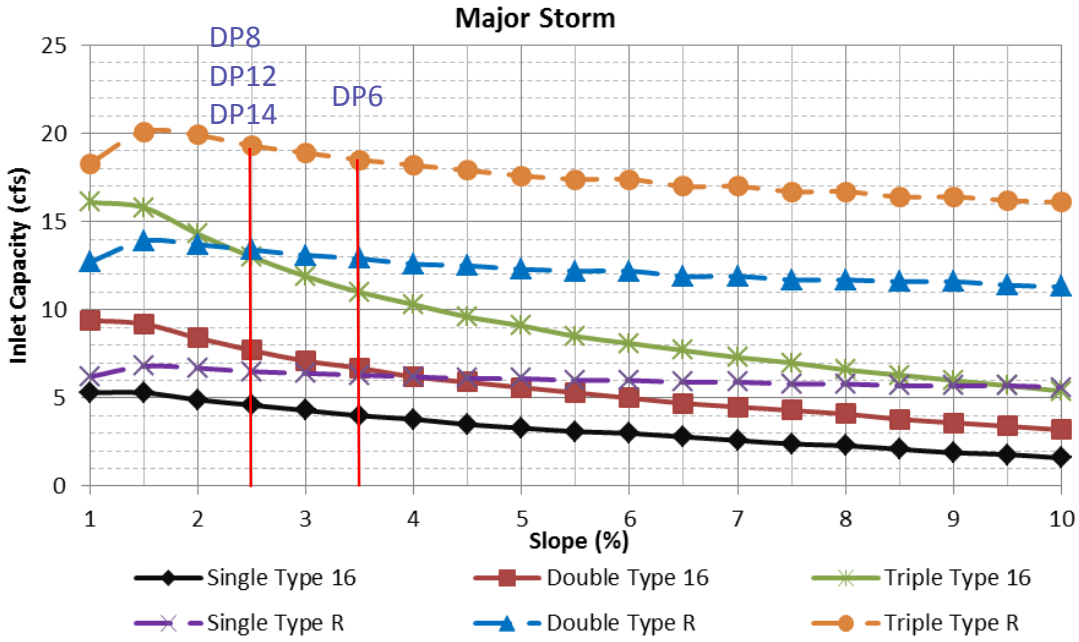
DESIGN POINT 12

Slope %	*Capacity (cfs)*	*Flow (cfs)*	*Velocity (fps)*	*Depth (ft)*	*Area (sf)*	*W. Perim (ft)*	*Freeboard (ft)*
5.2	37.84	24.30	6.34	1.13	3.83	7.15	0.20

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

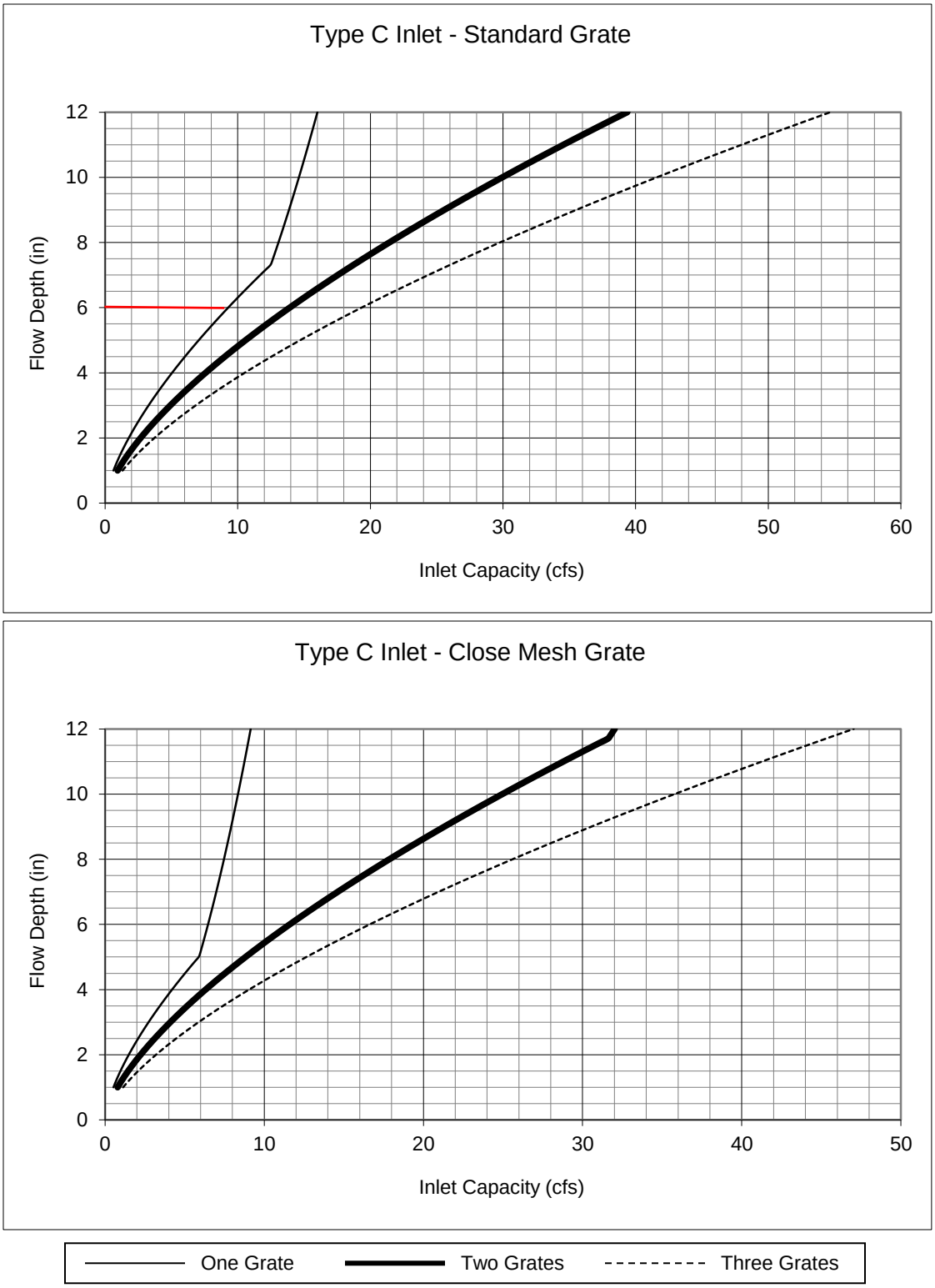
Street Section Data: Street Width Flowline to Flowline = 32'
Type of Curb and Gutter = 6" vertical





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



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

Pikes Peak Heights
At-grade Type R Inlets

Location	Inlet #	Basin/DP	Q5 (cfs)	Q100 (cfs)	Street grade %	Pro. Inlet Type	Q5 capture (cfs)	Q5 bypass (cfs)	Q5 % capture	Q100 capture (cfs)	Q100 bypass (cfs)	Q100 % capture
DP6	1	DP6	6.5	15.2	3.7%	10' Type R (AG)	*9.5*	0.0	100%	*12.8*	2.4	84%
		DP8	8.1	19.0								
		#1 Bypass	0.0	2.4								
DP8	2		8.1	21.4	2.4%	15' Type R (AG)	*11.8*	0.0	100%	*19.1*	2.3	80%
DP12	3	B12	7.0	16.4		15' Type R (AG)	*11.8*	0.0	100%	*19.1*	0.0	100%
		B13	10.2	23.9								
		B14	2.2	5.2								
		#2 Bypass	0.0	2.3								
DP14A	4		12.5	31.4	2.6%	15' Type R (AG)	*11.8*	0.7	100%	*19.1*	12.3	57%
DP14B	5	*#4 Bypass*	0.7	12.3	2.6%	15' Type R (AG)	*11.8*	0.0	0%	*19.1*	0.0	100%

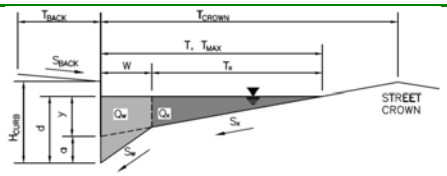
Version 4.05 Released March 2017

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

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

Project: Pikes Peak Heights

Inlet ID: DP1



Gutter Geometry (Enter data in the blue cells)

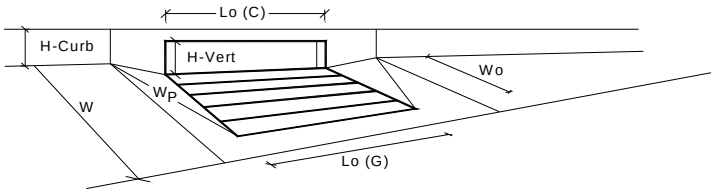
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.1	7.8	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	7.8	inches
Curb Opening Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.48	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.57	0.74	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**8.3**	**15.5**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	5.9	13.7	cfs

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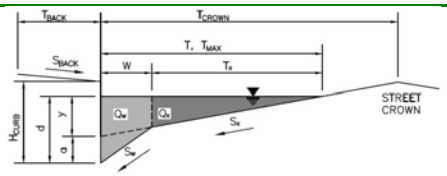
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: Pikes Peak Heights

Inlet ID: DP2



Gutter Geometry (Enter data in the blue cells)

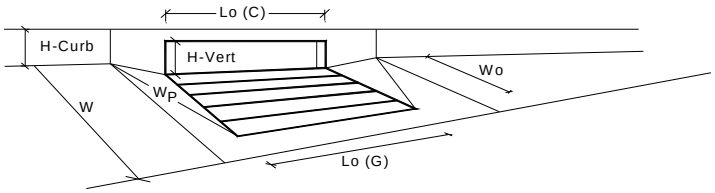
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.1	7.8	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

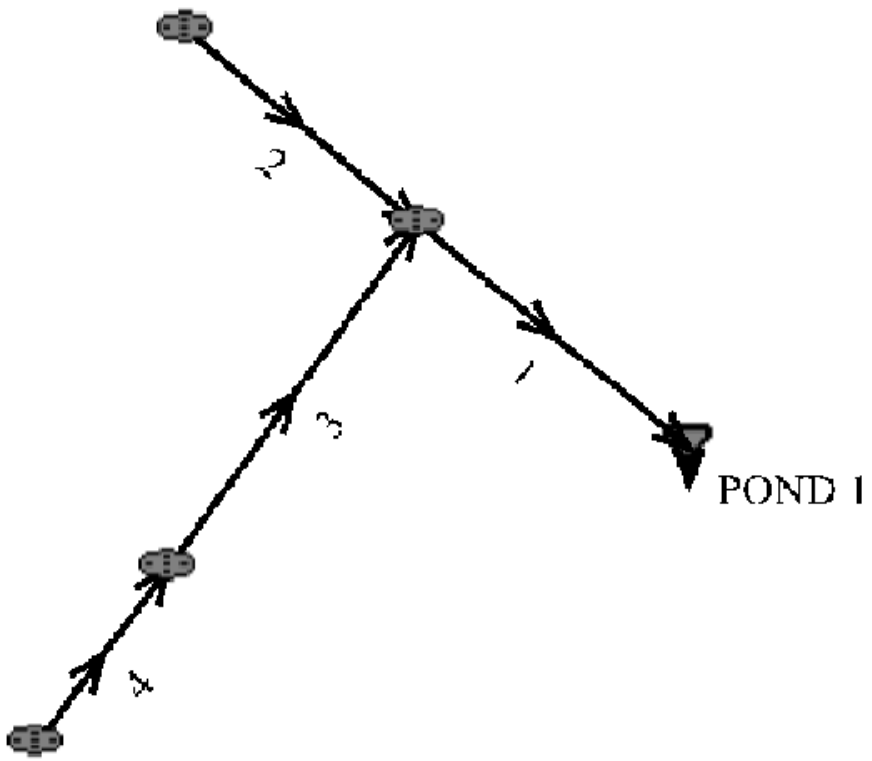
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	7.8	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	0.33	0.48	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.57	0.74	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	0.93	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	N/A	N/A	
			MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		**Q_a =**	**8.3**	**15.5**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK\ REQUIRED}$ =	6.1	14.3	cfs


2
1
3
4
POND 1

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 1/2/2019 1:41:19 PM	# UDSewer Results Summary **Project Title:** New UDSEWER System Module **Project Description:** Default system

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

One Hour Depth (in): 1.50
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6164.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	**Ground Elevation (ft)**	**Total Known Flow (cfs)**	**Local Contribution (cfs)**	**Drainage Area (Ac.)**	**Runoff Coefficient**	**5yr Coefficient**	**Overland Length (ft)**	**Overland Slope (%)**	**Gutter Length (ft)**	**Gutter Velocity (fps)**
POND 1	6164.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	6169.80	12.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3	6174.35	11.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	6174.92	5.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	6168.37	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
POND 1	0.00	0.00	0.00	0.00	0.00	1.87	6.89	0.19	12.90	
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.90	Surface Water Present (Downstream)
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.90	
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.90	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
1	29.88	6163.51	1.1	6163.84	0.015	0.00	0.00	CIRCULAR	30.00 in	30.00 in
3	87.59	6163.82	7.1	6170.04	0.015	0.05	0.00	CIRCULAR	24.00 in	24.00 in
4	49.57	6170.52	2.2	6171.61	0.015	0.05	0.00	CIRCULAR	24.00 in	24.00 in
2	58.17	6163.86	1.1	6164.50	0.015	0.15	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
1	37.38	7.62	14.48	5.50	12.16	6.91	1.40	Supercritical	12.90	0.00	
3	52.38	16.67	14.87	5.82	7.78	13.49	3.46	Supercritical	11.90	0.00	
4	29.16	9.28	10.30	4.58	7.32	7.27	1.93	Supercritical	5.90	0.00	
2	9.57	5.42	5.12	3.14	4.48	3.79	1.30	Supercritical Jump	1.30	13.79	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
1	12.90	CIRCULAR	30.00 in	30.00 in	21.00 in	21.00 in	30.00 in	30.00 in	4.91	
3	11.90	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
4	5.90	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
2	1.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6164.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
1	6163.51	6163.84	0.00	0.00	6164.52	6165.05	6165.27	0.25	6165.52
3	6163.82	6170.04	0.01	0.00	6165.06	6171.28	6167.30	4.51	6171.81
4	6170.52	6171.61	0.00	0.00	6171.28	6172.47	6171.95	0.84	6172.79
2	6163.86	6164.50	0.00	0.00	6165.51	6165.51	6165.52	0.01	6165.53

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

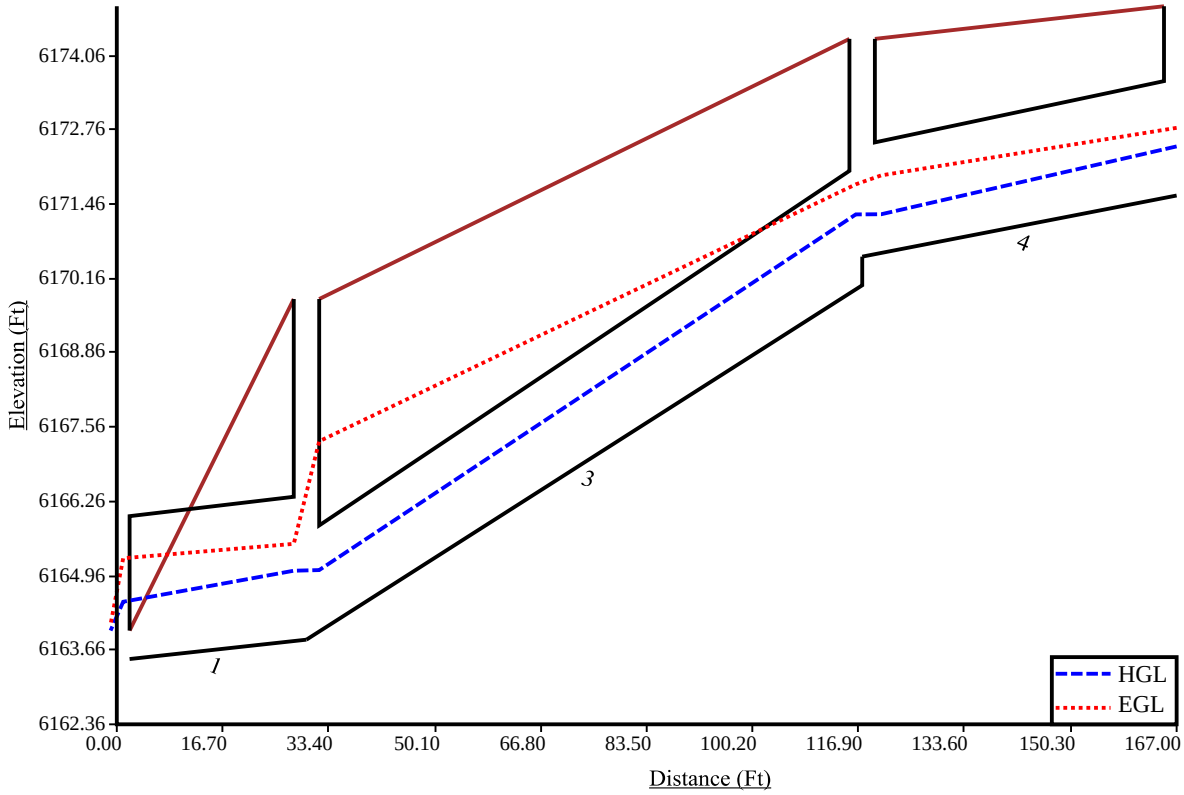
					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
1	29.88	3.50	6.00	6.08	0.00	1.28	0.00	10.42	6.75	3.17	29.64	Sewer Too Shallow
3	87.59	3.00	4.00	5.50	10.96	6.56	3.73	7.62	4.89	2.06	116.10	

4	49.57	3.00	4.00	5.50	6.66	4.41	1.58	5.62	3.89	1.06	42.25	Sewer Too Shallow
2	58.17	2.50	4.00	4.92	11.38	6.48	4.23	7.24	4.41	2.16	70.40	

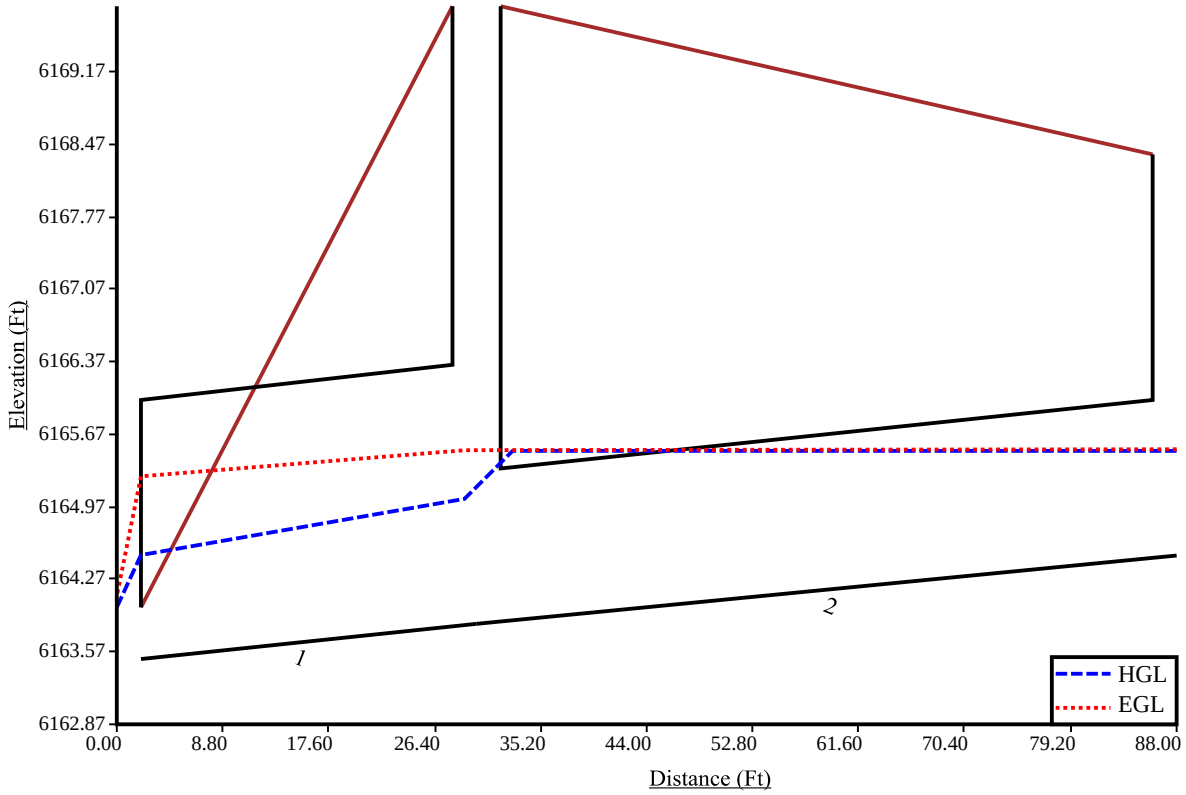
Total earth volume for sewer trenches = 258 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
    - Four inches for pipes less than 33 inches.
    - Six inches for pipes less than 60 inches.
    - Eight inches for all larger sizes.

STM-N


6174.06
6172.76
6171.46
6170.16
6168.86
6167.56
6166.26
6164.96
6163.66
6162.36
Elevation (Ft)
0.00
16.70
33.40
50.10
66.80
83.50
100.20
116.90
133.60
150.30
167.00
Distance (Ft)
1
3
4
HGL
EGL

N2


6169.17
6168.47
6167.77
6167.07
6166.37
6165.67
6164.97
6164.27
6163.57
6162.87
Elevation (Ft)
0.00
8.80
17.60
26.40
35.20
44.00
52.80
61.60
70.40
79.20
88.00
Distance (Ft)
1
2
HGL
EGL

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 1/2/2019 1:43:10 PM	# UDSewer Results Summary **Project Title:** New UDSEWER System Module **Project Description:** Default system

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in): 2.52
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6164.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	**Ground Elevation (ft)**	**Total Known Flow (cfs)**	**Local Contribution (cfs)**	**Drainage Area (Ac.)**	**Runoff Coefficient**	**5yr Coefficient**	**Overland Length (ft)**	**Overland Slope (%)**	**Gutter Length (ft)**	**Gutter Velocity (fps)**
POND 1	6164.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	6169.80	30.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3	6174.35	27.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	6174.92	13.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	6168.37	3.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
POND 1	0.00	0.00	0.00	0.00	0.00	2.63	11.68	0.08	30.70	
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.70	Surface Water Present (Downstream)
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.70	
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.70	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
1	29.88	6163.51	1.1	6163.84	0.015	0.00	0.00	CIRCULAR	30.00 in	30.00 in
3	87.59	6163.82	7.1	6170.04	0.015	0.05	0.00	CIRCULAR	24.00 in	24.00 in
4	49.57	6170.52	2.2	6171.61	0.015	0.05	0.00	CIRCULAR	24.00 in	24.00 in
2	58.17	6163.86	1.1	6164.50	0.015	0.15	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
1	37.38	7.62	22.66	7.72	20.69	8.50	1.20	Supercritical	30.70	0.00	
3	52.38	16.67	21.87	9.22	12.41	16.91	3.29	Supercritical	27.70	0.00	
4	29.16	9.28	15.99	6.16	11.57	9.14	1.86	Supercritical Jump	13.70	22.31	
2	9.57	5.42	8.82	4.30	7.77	5.07	1.27	Pressurized	3.70	58.17	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
1	30.70	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
3	27.70	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
4	13.70	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
2	3.70	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6164.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
1	6163.51	6163.84	0.00	0.00	6165.24	6165.73	6166.36	0.30	6166.65
3	6163.82	6170.04	0.06	0.00	6165.79	6171.86	6169.29	3.89	6173.18
4	6170.52	6171.61	0.01	0.00	6172.90	6172.94	6173.20	0.33	6173.53
2	6163.86	6164.50	0.01	0.00	6166.60	6166.69	6166.66	0.10	6166.76

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

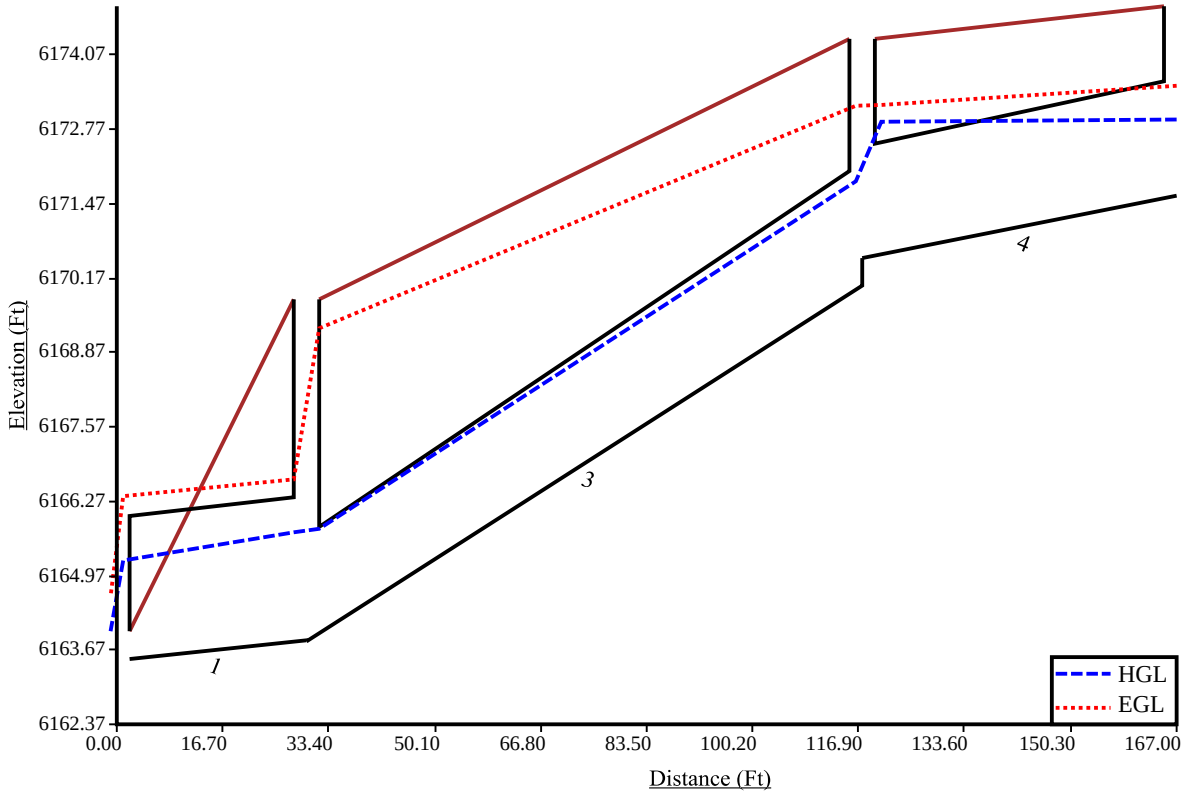
					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
1	29.88	3.50	6.00	6.08	0.00	1.28	0.00	10.42	6.75	3.17	29.64	Sewer Too Shallow
3	87.59	3.00	4.00	5.50	10.96	6.56	3.73	7.62	4.89	2.06	116.10	

4	49.57	3.00	4.00	5.50	6.66	4.41	1.58	5.62	3.89	1.06	42.25	Sewer Too Shallow
2	58.17	2.50	4.00	4.92	11.38	6.48	4.23	7.24	4.41	2.16	70.40	

Total earth volume for sewer trenches = 258 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
    - Four inches for pipes less than 33 inches.
    - Six inches for pipes less than 60 inches.
    - Eight inches for all larger sizes.

STM-N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33.40
50.10
66.80
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133.60
150.30
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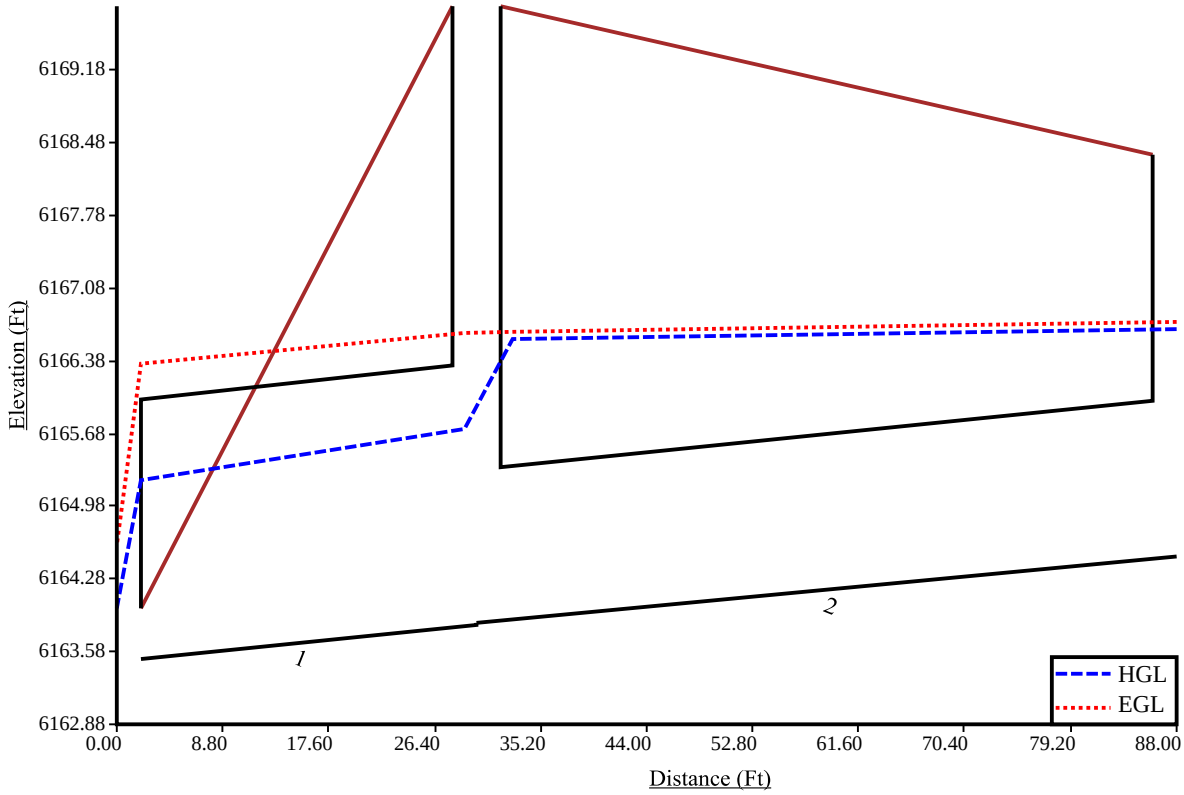
3
4
HGL
EGL

N2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Distance (Ft)
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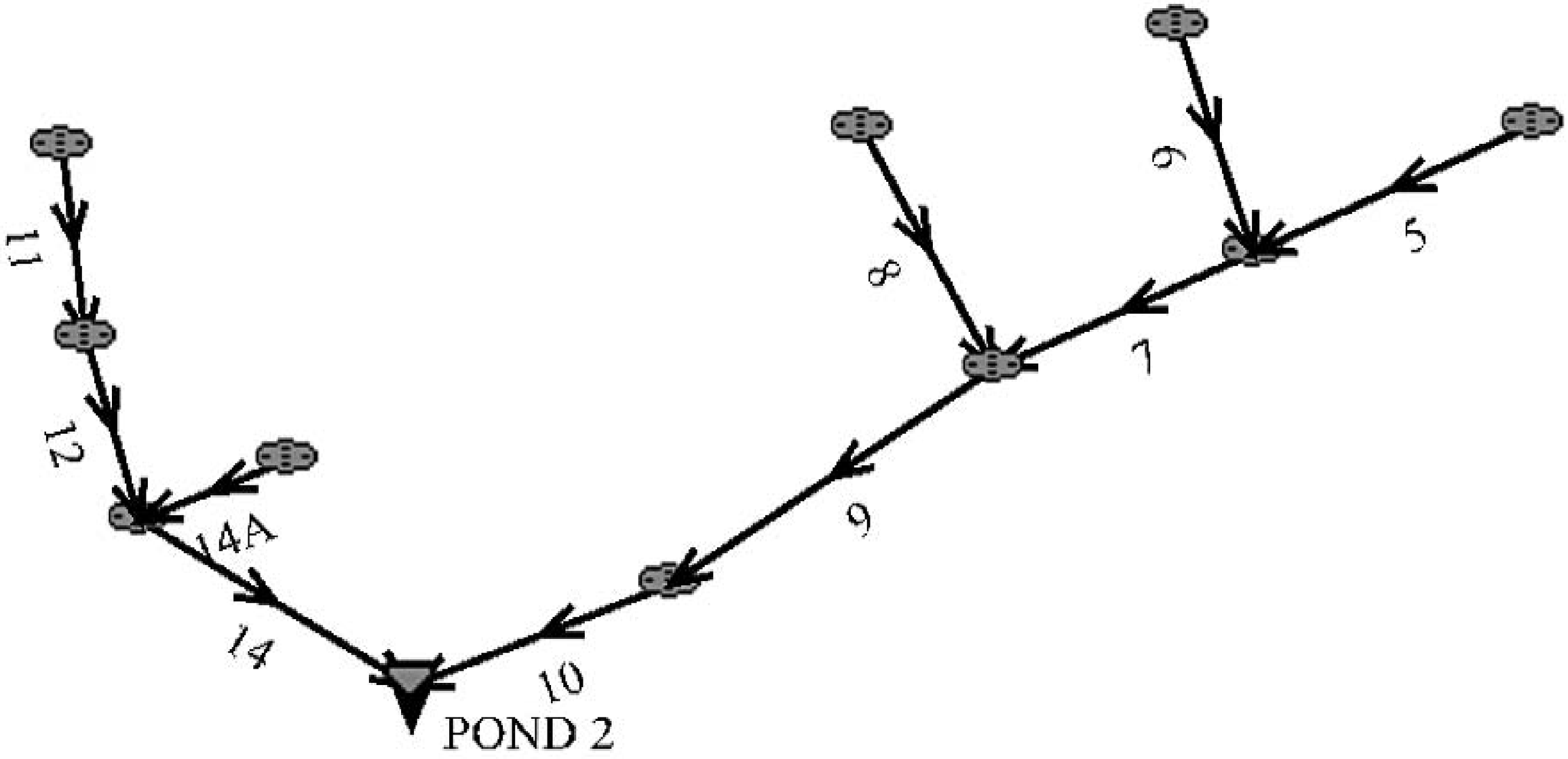
2
HGL
EGL


11
12
14A
14
10
POND 2
9
7
8
6
5

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 6/10/2019 12:53:24 PM	# UDSewer Results Summary **Project Title:** New UDSEWER System Module **Project Description:** Default system

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

One Hour Depth (in): 1.50
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 12.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6094.50

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	**Ground Elevation (ft)**	**Total Known Flow (cfs)**	**Local Contribution (cfs)**	**Drainage Area (Ac.)**	**Runoff Coefficient**	**5yr Coefficient**	**Overland Length (ft)**	**Overland Slope (%)**	**Gutter Length (ft)**	**Gutter Velocity (fps)**
POND 2	6094.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	6109.10	25.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

9	6127.81	25.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	6133.11	12.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	6150.64	9.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6152.52	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	6137.22	11.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	6100.41	27.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14A	6100.90	11.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	6100.41	17.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	6102.00	10.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	**Overland Time (min)**	**Gutter Time (min)**	**Basin Tc (min)**	**Intensity (in/hr)**	**Local Contrib (cfs)**	**Coeff. Area**	**Intensity (in/hr)**	**Manhole Tc (min)**	**Peak Flow (cfs)**	**Comment**
POND 2	0.00	0.00	0.00	0.00	0.00	7.86	6.81	0.36	53.50	Surface Water Present (Upstream)
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.90	Surface Water Present (Downstream)
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.10	
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.10	
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.50	
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.80	
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.60	Surface Water Present (Downstream)
14A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.80	
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.00	
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.10	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	**Sewer Length (ft)**	**Downstream Invert (ft)**	**Slope (%)**	**Upstream Invert (ft)**	**Mannings n**	**Bend Loss**	**Lateral Loss**	**Cross Section**	**Rise (ft or in)**	**Span (ft or in)**
10	114.05	6095.54	4.0	6100.10	0.013	0.00	0.00	CIRCULAR	30.00 in	30.00 in
9	367.53	6100.09	4.6	6117.00	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
7	286.78	6117.61	3.1	6126.50	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
6	120.54	6127.98	10.5	6140.64	0.013	1.00	0.00	CIRCULAR	18.00 in	18.00 in
5	543.71	6127.07	4.1	6149.36	0.013	0.05	0.00	CIRCULAR	12.00 in	12.00 in
8	108.98	6119.05	7.5	6127.22	0.013	1.00	0.00	CIRCULAR	18.00 in	18.00 in
14	84.50	6094.51	1.0	6095.35	0.013	0.00	0.00	CIRCULAR	36.00 in	36.00 in

14A	43.79	6096.34	1.0	6096.78	0.013	1.00	0.00	CIRCULAR	24.00 in	24.00 in
12	32.05	6095.85	1.0	6096.17	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
11	20.38	6097.15	6.6	6098.50	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in

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Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
10	82.26	16.76	20.81	7.13	11.56	14.84	3.09	Supercritical	25.90	0.00	
9	88.21	17.97	20.48	7.03	10.95	15.48	3.32	Supercritical	25.10	0.00	
7	39.94	12.71	15.00	5.86	9.06	11.14	2.62	Supercritical	12.10	0.00	
6	34.13	19.31	14.29	6.32	6.49	16.54	4.62	Supercritical	9.50	0.00	
5	7.23	9.21	5.04	3.20	3.01	6.47	2.70	Supercritical Jump	1.00	4.75	
8	28.84	16.32	15.67	7.23	8.02	15.50	3.82	Supercritical	11.80	0.00	
14	66.88	9.46	20.38	6.69	16.12	9.01	1.57	Supercritical	27.60	0.00	
14A	22.68	7.22	14.80	5.80	12.28	7.29	1.43	Supercritical	11.80	0.00	
12	41.13	8.38	16.73	6.04	13.44	7.98	1.52	Supercritical	17.00	0.00	
11	58.38	18.58	13.65	5.48	6.76	13.92	3.86	Supercritical	10.10	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
10	25.90	CIRCULAR	30.00 in	30.00 in	21.00 in	21.00 in	30.00 in	30.00 in	4.91	
9	25.10	CIRCULAR	30.00 in	30.00 in	21.00 in	21.00 in	30.00 in	30.00 in	4.91	
7	12.10	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
6	9.50	CIRCULAR	18.00 in	18.00 in	12.00 in	12.00 in	18.00 in	18.00 in	1.77	
5	1.00	CIRCULAR	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	0.79	
8	11.80	CIRCULAR	18.00 in	18.00 in	15.00 in	15.00 in	18.00 in	18.00 in	1.77	
14	27.60	CIRCULAR	36.00 in	36.00 in	27.00 in	27.00 in	36.00 in	36.00 in	7.07	
14A	11.80	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
12	17.00	CIRCULAR	30.00 in	30.00 in	24.00 in	24.00 in	30.00 in	30.00 in	4.91	
11	10.10	CIRCULAR	24.00 in	24.00 in	15.00 in	15.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.

- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6094.50

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
10	6095.54	6100.10	0.00	0.00	6096.50	6101.83	6099.92	2.70	6102.62
9	6100.09	6117.00	0.02	0.00	6101.85	6118.71	6104.73	14.75	6119.47
7	6117.61	6126.50	0.01	0.00	6118.72	6127.75	6120.29	7.99	6128.28
6	6127.98	6140.64	0.45	0.00	6128.52	6141.83	6132.77	9.68	6142.45
5	6127.07	6149.36	0.00	0.00	6128.26	6149.78	6128.28	21.65	6149.94
8	6119.05	6127.22	0.69	0.00	6119.71	6128.53	6123.45	5.89	6129.34
14	6094.51	6095.35	0.00	0.00	6095.85	6097.05	6097.11	0.63	6097.74
14A	6096.34	6096.78	0.22	0.00	6097.37	6098.01	6098.19	0.34	6098.54
12	6095.85	6096.17	0.01	0.00	6097.06	6097.56	6097.96	0.17	6098.13
11	6097.15	6098.50	0.01	0.00	6097.71	6100.56	6100.72	0.00	6100.72

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

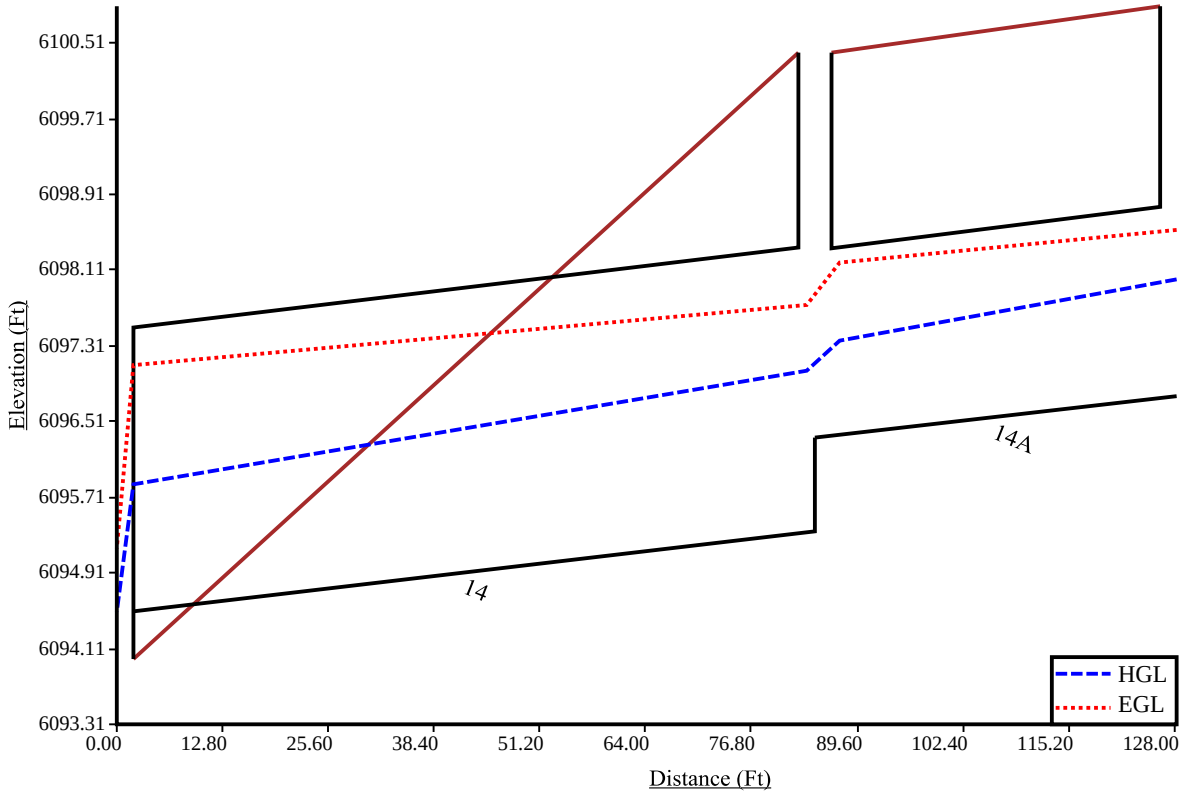
					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
10	114.05	3.50	6.00	6.08	0.00	0.00	0.00	16.50	9.79	6.21	183.10	Sewer Too Shallow
9	367.53	3.50	6.00	6.08	16.51	9.80	6.21	20.12	11.60	8.02	1406.36	
7	286.78	3.00	4.00	5.50	19.40	10.78	7.95	12.22	7.19	4.36	841.58	
6	120.54	2.50	4.00	4.92	9.75	5.67	3.42	19.50	10.54	8.29	309.65	
5	543.71	2.00	4.00	4.33	12.08	6.54	4.88	6.32	3.66	1.99	606.29	Sewer Too Shallow
8	108.98	2.50	4.00	4.92	17.03	9.31	7.06	19.50	10.54	8.29	378.23	
14	84.50	4.00	6.00	6.67	0.00	0.33	0.00	8.12	5.89	1.73	65.73	Sewer Too Shallow

14A	43.79	3.00	4.00	5.50	7.14	4.65	1.82	7.24	4.70	1.87	42.88	Sewer Too Shallow
12	32.05	3.50	6.00	6.08	7.62	5.35	1.77	6.98	5.03	1.45	37.96	Sewer Too Shallow
11	20.38	3.00	4.00	5.50	5.52	3.84	1.01	6.00	4.08	1.25	16.48	Sewer Too Shallow

Total earth volume for sewer trenches = 3888 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

2-14a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102.40
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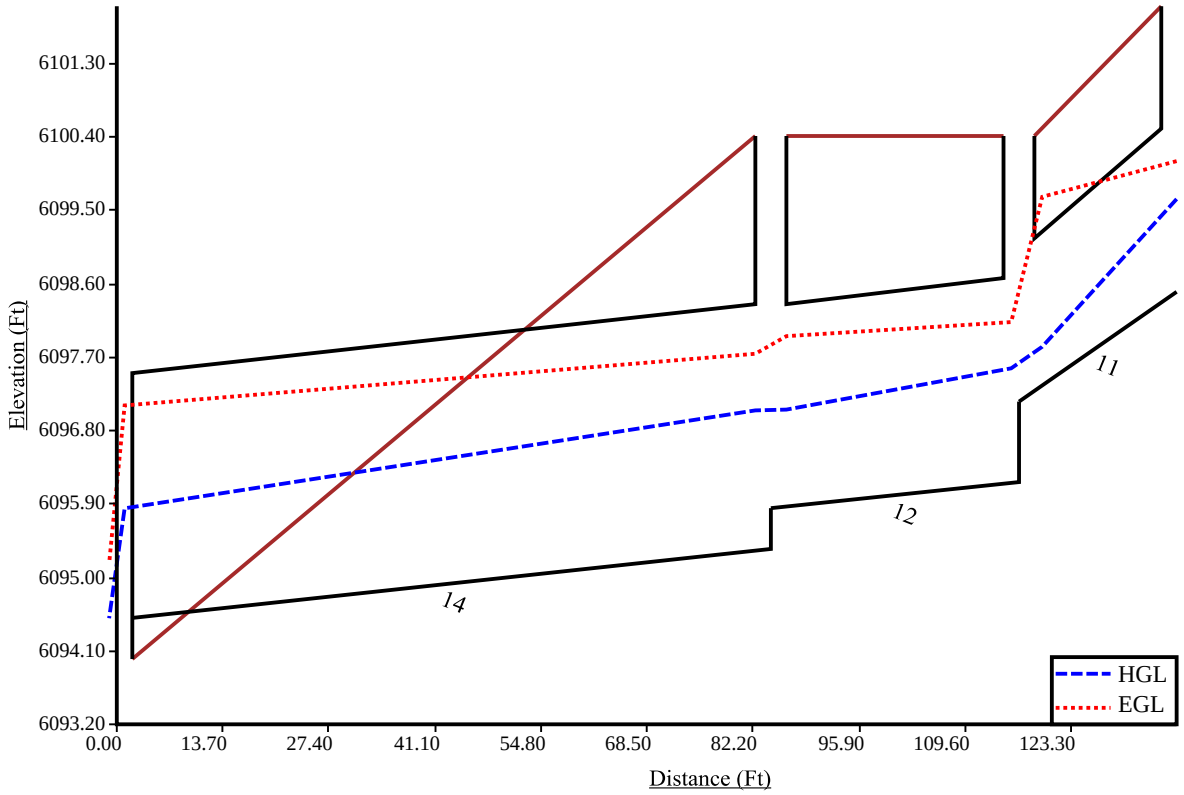
Distance (Ft)
14
14A
HGL
EGL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27.40
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82.20
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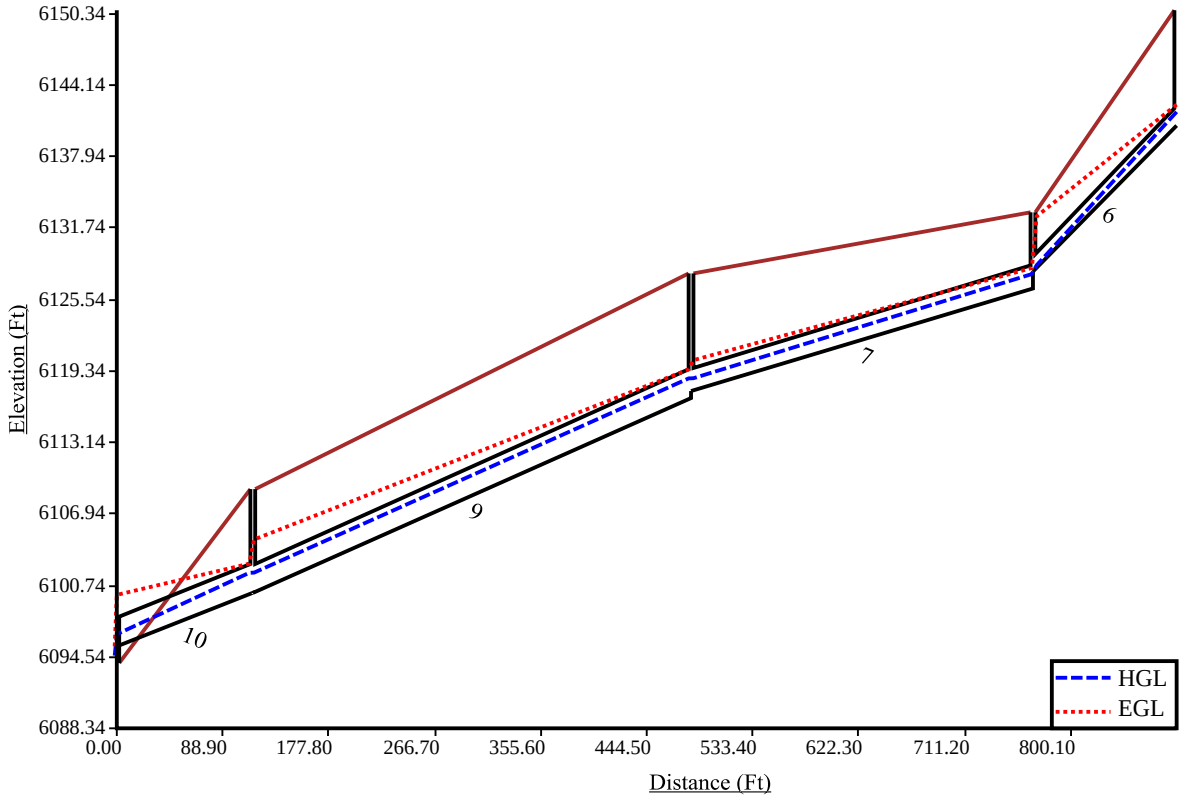
Distance (Ft)
HGL
EGL
l1
l2
l4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Elevation (Ft)
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EGL
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7
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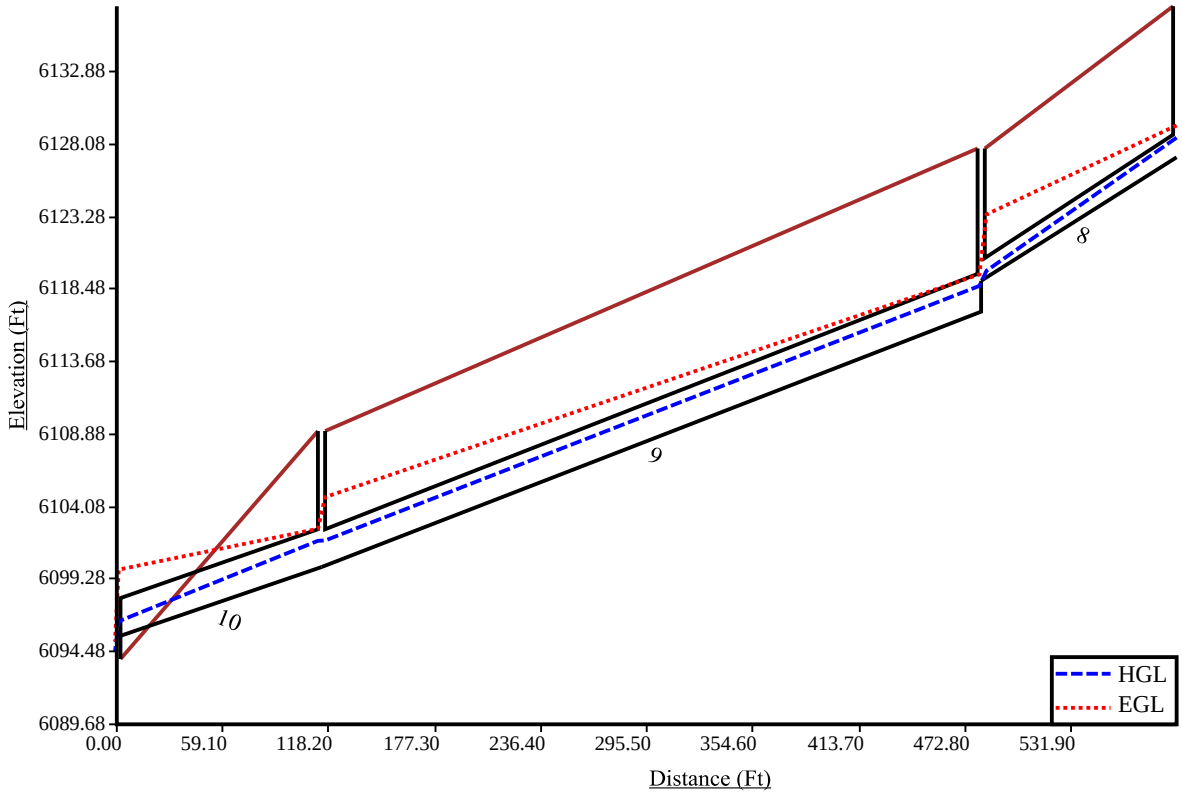
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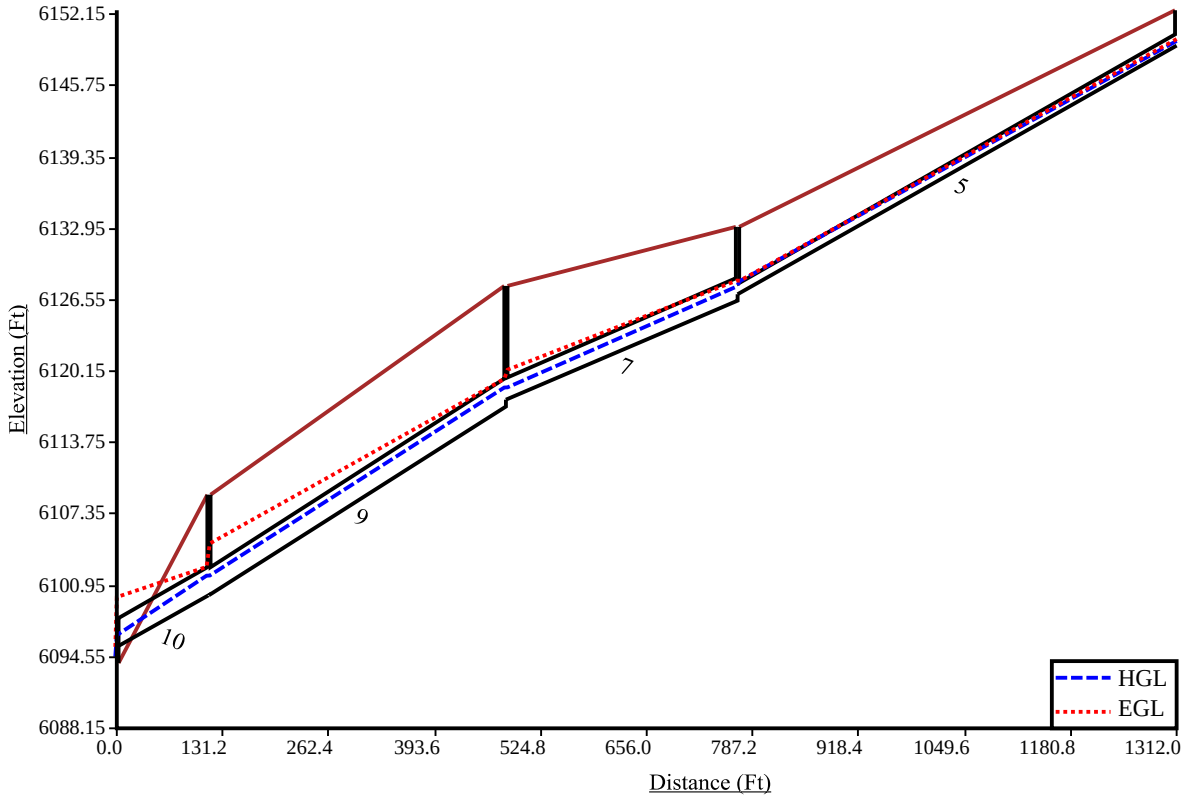
pond2-5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Elevation (Ft)
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787.2
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Distance (Ft)
10
9
7
5
HGL
EGL

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 6/10/2019 12:51:05 PM	# UDSewer Results Summary **Project Title:** New UDSEWER System Module **Project Description:** Default system

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in): 2.52
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 12.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6094.50

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	**Ground Elevation (ft)**	**Total Known Flow (cfs)**	**Local Contribution (cfs)**	**Drainage Area (Ac.)**	**Runoff Coefficient**	**5yr Coefficient**	**Overland Length (ft)**	**Overland Slope (%)**	**Gutter Length (ft)**	**Gutter Velocity (fps)**
POND 2	6094.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	6109.10	48.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

9	6127.81	44.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	6133.11	21.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	6150.64	12.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6152.52	3.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	6137.22	19.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	6100.41	64.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14A	6100.90	19.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	6100.41	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	6102.00	24.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	**Overland Time (min)**	**Gutter Time (min)**	**Basin Tc (min)**	**Intensity (in/hr)**	**Local Contrib (cfs)**	**Coeff. Area**	**Intensity (in/hr)**	**Manhole Tc (min)**	**Peak Flow (cfs)**	**Comment**
POND 2	0.00	0.00	0.00	0.00	0.00	9.78	11.58	0.19	113.20	Surface Water Present (Upstream)
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.30	Surface Water Present (Downstream)
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.20	
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.10	
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.80	
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.10	
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.90	Surface Water Present (Downstream)
14A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.10	
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00	
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.30	Surface Water Present (Upstream)

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	**Sewer Length (ft)**	**Downstream Invert (ft)**	**Slope (%)**	**Upstream Invert (ft)**	**Mannings n**	**Bend Loss**	**Lateral Loss**	**Cross Section**	**Rise (ft or in)**	**Span (ft or in)**
10	114.05	6095.54	4.0	6100.10	0.013	0.00	0.00	CIRCULAR	30.00 in	30.00 in
9	367.53	6100.09	4.6	6117.00	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
7	286.78	6117.61	3.1	6126.50	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
6	120.54	6127.98	10.5	6140.64	0.013	1.00	0.00	CIRCULAR	18.00 in	18.00 in
5	543.71	6127.07	4.1	6149.36	0.013	0.05	0.00	CIRCULAR	12.00 in	12.00 in
8	108.98	6119.05	7.5	6127.22	0.013	1.00	0.00	CIRCULAR	18.00 in	18.00 in

14	84.50	6094.51	1.0	6095.35	0.013	0.00	0.00	CIRCULAR	36.00 in	36.00 in
14A	43.79	6096.34	1.0	6096.78	0.013	1.00	0.00	CIRCULAR	24.00 in	24.00 in
12	32.05	6095.85	1.0	6096.17	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
11	20.38	6097.15	6.6	6098.50	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in

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Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
10	82.26	16.76	27.32	10.29	16.53	17.43	2.91	Supercritical	48.30	0.00	
9	88.21	17.97	26.54	9.62	15.02	17.98	3.20	Supercritical	44.20	0.00	
7	39.94	12.71	19.74	7.63	12.40	12.89	2.51	Supercritical	21.10	0.00	
6	34.13	19.31	16.13	7.67	7.64	17.93	4.55	Supercritical	12.80	0.00	
5	7.23	9.21	9.05	4.88	5.49	8.86	2.63	Supercritical Jump	3.10	22.46	
8	28.84	16.32	17.53	10.88	10.70	17.45	3.57	Supercritical Jump	19.10	11.37	
14	66.88	9.46	31.00	10.02	28.59	10.78	1.21	Supercritical	64.90	0.00	
14A	22.68	7.22	18.86	7.21	16.87	8.09	1.25	Pressurized	19.10	43.79	
12	41.13	8.38	25.55	8.98	23.88	9.55	1.17	Pressurized	40.00	32.05	
11	58.38	18.58	20.92	8.36	10.80	17.73	3.77	Supercritical	24.30	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
10	48.30	CIRCULAR	30.00 in	30.00 in	27.00 in	27.00 in	30.00 in	30.00 in	4.91	
9	44.20	CIRCULAR	30.00 in	30.00 in	24.00 in	24.00 in	30.00 in	30.00 in	4.91	
7	21.10	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
6	12.80	CIRCULAR	18.00 in	18.00 in	15.00 in	15.00 in	18.00 in	18.00 in	1.77	
5	3.10	CIRCULAR	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	0.79	
8	19.10	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
14	64.90	CIRCULAR	36.00 in	36.00 in	36.00 in	36.00 in	36.00 in	36.00 in	7.07	
14A	19.10	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
12	40.00	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
11	24.30	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6094.50

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
10	6095.54	6100.10	0.00	0.00	6096.92	6102.38	6101.63	2.39	6104.02
9	6100.09	6117.00	0.06	0.00	6102.44	6119.21	6106.36	14.28	6120.65
7	6117.61	6126.50	0.04	0.00	6119.25	6128.14	6121.22	7.83	6129.05
6	6127.98	6140.64	0.81	0.00	6128.96	6141.98	6133.61	9.28	6142.90
5	6127.07	6149.36	0.01	0.00	6128.82	6150.11	6129.06	21.42	6150.48
8	6119.05	6127.22	1.81	0.00	6121.03	6128.68	6122.84	7.68	6130.52
14	6094.51	6095.35	0.00	0.00	6096.89	6097.93	6098.69	0.80	6099.49
14A	6096.34	6096.78	0.57	0.00	6099.49	6099.80	6100.07	0.31	6100.38
12	6095.85	6096.17	0.05	0.00	6098.51	6098.82	6099.55	0.30	6099.85
11	6097.15	6098.50	0.05	0.00	6098.86	6102.00	6102.93	0.00	6102.93

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

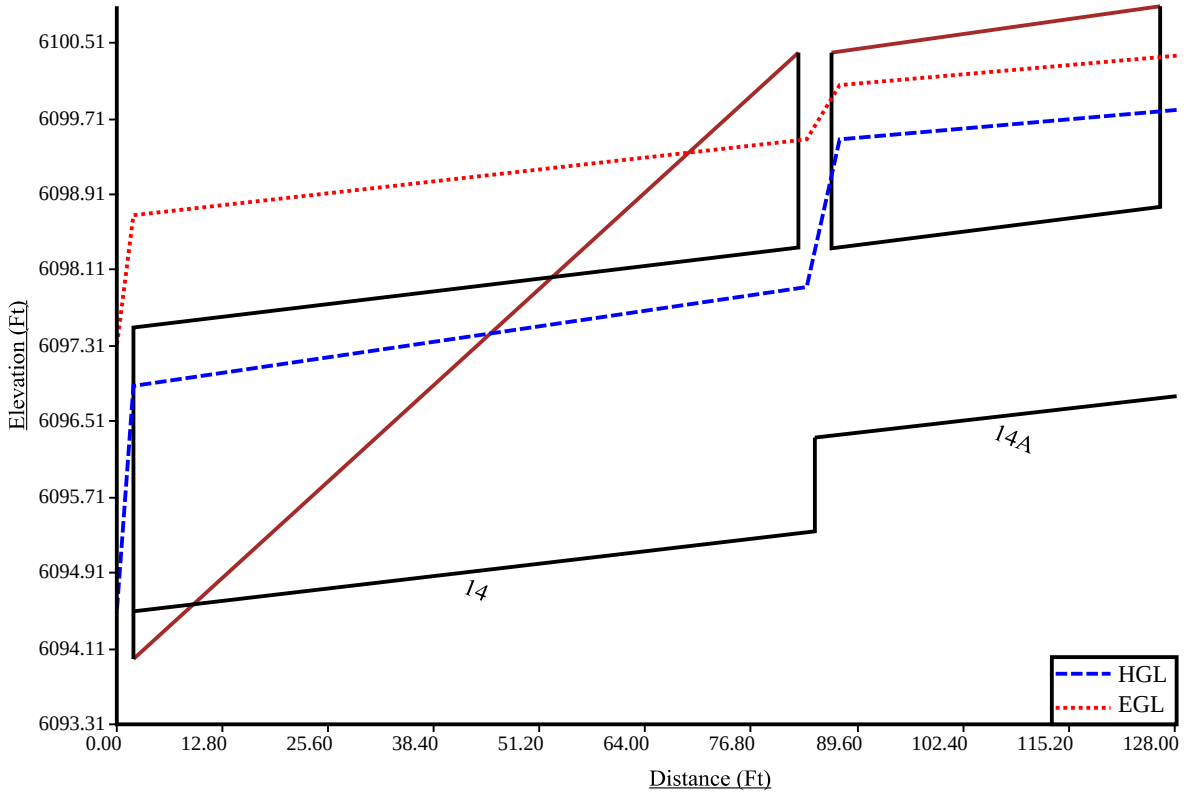
					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
10	114.05	3.50	6.00	6.08	0.00	0.00	0.00	16.50	9.79	6.21	183.10	Sewer Too Shallow
9	367.53	3.50	6.00	6.08	16.51	9.80	6.21	20.12	11.60	8.02	1406.36	
7	286.78	3.00	4.00	5.50	19.40	10.78	7.95	12.22	7.19	4.36	841.58	
6	120.54	2.50	4.00	4.92	9.75	5.67	3.42	19.50	10.54	8.29	309.65	
5	543.71	2.00	4.00	4.33	12.08	6.54	4.88	6.32	3.66	1.99	606.29	Sewer Too Shallow
8	108.98	2.50	4.00	4.92	17.03	9.31	7.06	19.50	10.54	8.29	378.23	

14	84.50	4.00	6.00	6.67	0.00	0.33	0.00	8.12	5.89	1.73	65.73	Sewer Too Shallow
14A	43.79	3.00	4.00	5.50	7.14	4.65	1.82	7.24	4.70	1.87	42.88	Sewer Too Shallow
12	32.05	3.50	6.00	6.08	7.62	5.35	1.77	6.98	5.03	1.45	37.96	Sewer Too Shallow
11	20.38	3.00	4.00	5.50	5.52	3.84	1.01	6.00	4.08	1.25	16.48	Sewer Too Shallow

Total earth volume for sewer trenches = 3888 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
    - Four inches for pipes less than 33 inches.
    - Six inches for pipes less than 60 inches.
    - Eight inches for all larger sizes.

2-14a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6097.31
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6095.71
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6094.11
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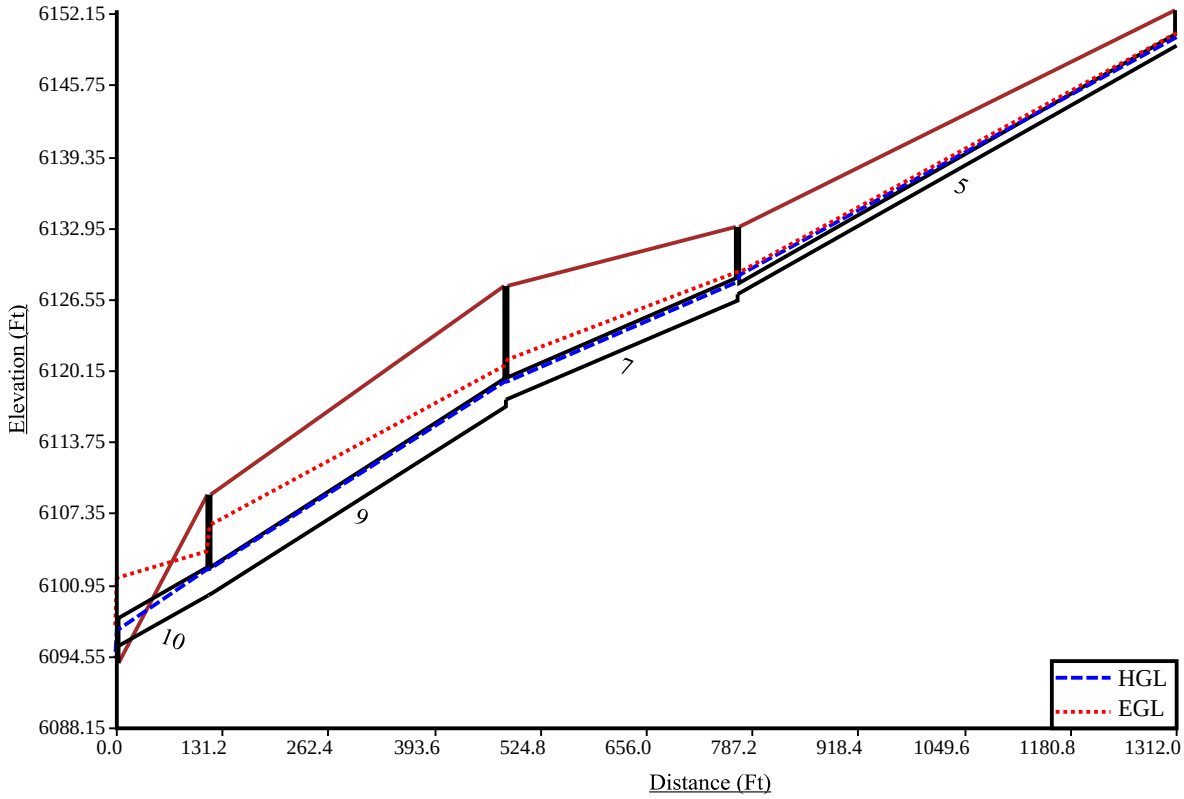
Elevation (Ft)
0.00
12.80
25.60
38.40
51.20
64.00
76.80
89.60
102.40
115.20
128.00
Distance (Ft)
14
14A
HGL
EGL

pond2-5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Elevation (Ft)
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131.2
262.4
393.6
524.8
656.0
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918.4
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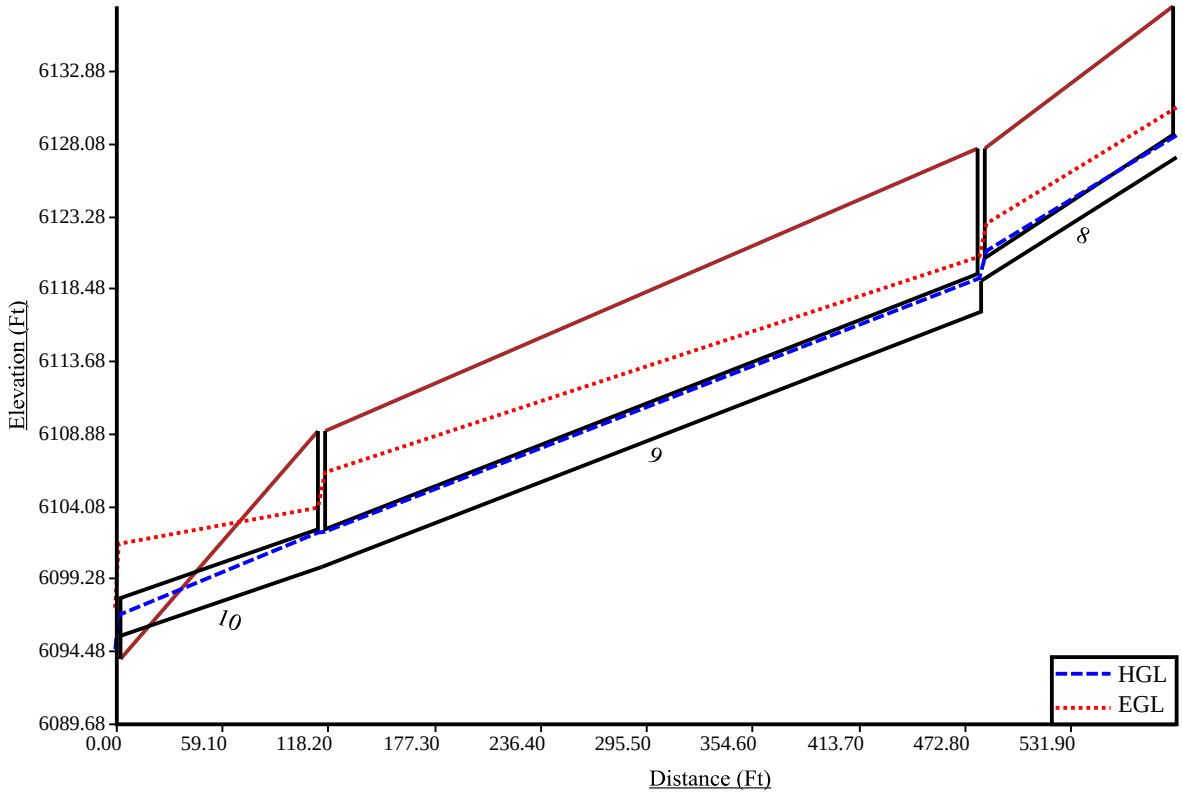
Distance (Ft)
5
7
9
10
HGL
EGL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Elevation (Ft)
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59.10
118.20
177.30
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354.60
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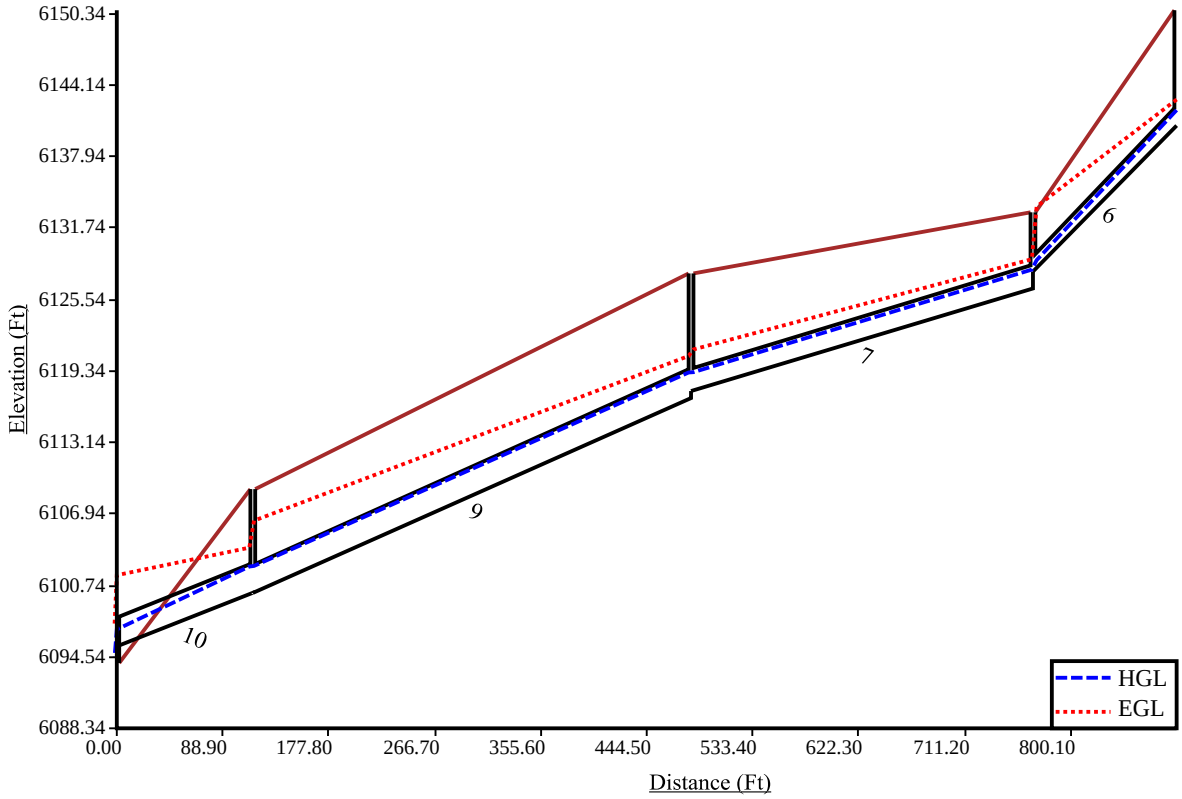
Distance (Ft)
10
9
8
HGL
EGL

2-6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Elevation (Ft)
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88.90
177.80
266.70
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533.40
622.30
711.20
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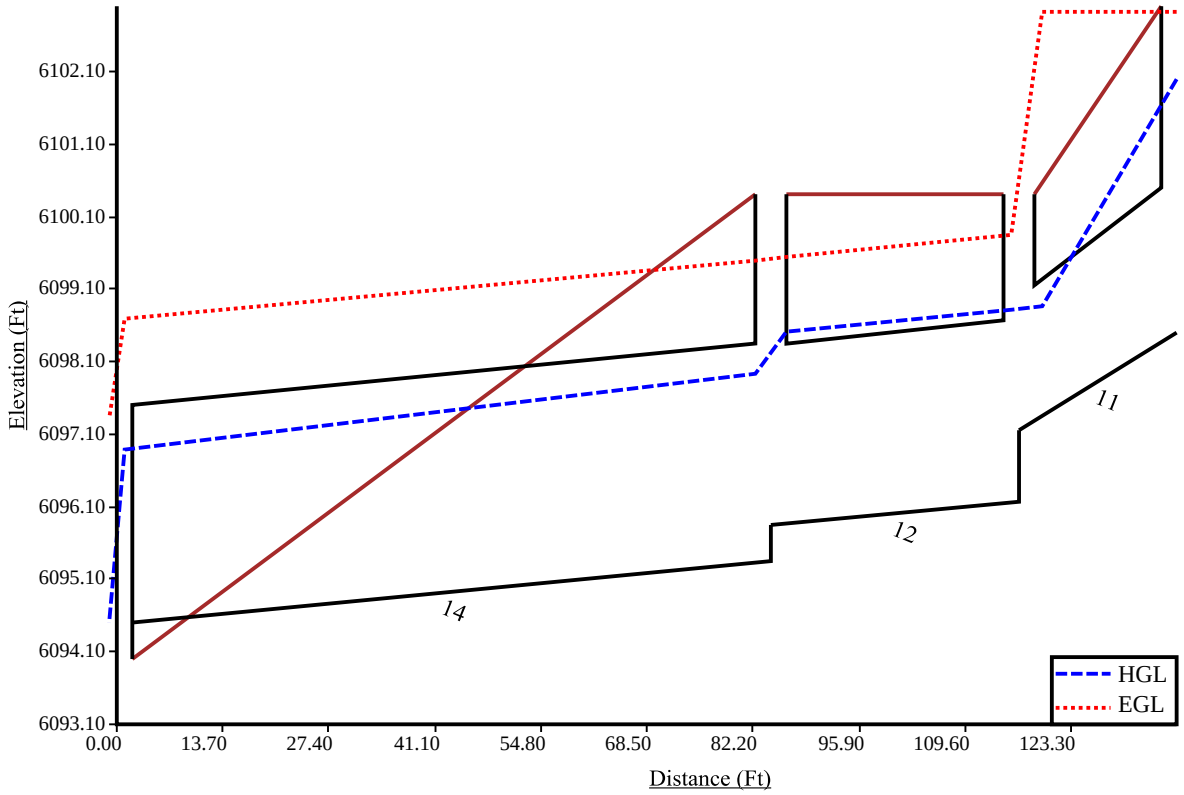
Distance (Ft)
HGL
EGL
6
7
9
10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27.40
41.10
54.80
68.50
82.20
95.90
109.60
123.30
Distance (Ft)
HGL
EGL
l1
l2
l4

PROJECT INFORMATION

PROJECT:	Pikes Peak Heights
PROJECT NO:	21150-01
DESIGN BY:	KGV
REV. BY:	TDM
AGENCY:	City of Colorado Springs
REPORT TYPE:	Final
DATE:	7/25/2019

Drexel, Barrell & Co.

IRF CALCULATIONS PER BASIN FOR INPUT INTO UDFCD WORKSHEET

SUB-BASIN					Linked to Ratios	
BASIN	AREA	ACREAGE	DCIA	UIA	RPA	SPA
A1	Landscape/Lawn	0.00				
DUP	Residential (1/8 acre)	3.07	0.88	1.23	0.22	0.74
	Asphalt/Sidewalk	0.00				
A2	Landscape/Lawn	0.00				
DUP	Residential (1/8 acre)	3.17	0.91	1.27	0.23	0.76
	Asphalt/Sidewalk	0.00				
A3	Landscape/Lawn	0.26			0.26	
SF	Residential (1/8 acre)	0.58	0.14	0.22	0.07	0.15
	Asphalt/Sidewalk	0.00				
A4	Landscape/Lawn	0.67			0.67	
SF	Residential (1/8 acre)	0.31	0.08	0.12	0.04	0.08
	Asphalt/Sidewalk	0.00				
B5	Landscape/Lawn	0.33			0.33	
SF	Residential (1/8 acre)	0.43	0.11	0.17	0.05	0.11
	Asphalt/Sidewalk	0.00				
B6	Landscape/Lawn	0.00				
SF	Residential (1/8 acre)	3.64	0.89	1.40	0.42	0.93
	Asphalt/Sidewalk	0.00				
B7	Landscape/Lawn	0.79			0.79	
SF	Residential (1/8 acre)	0.56	0.14	0.22	0.06	0.14
	Asphalt/Sidewalk	0.00				
B8	Landscape/Lawn	0.00				
SF	Residential (1/8 acre)	2.30	0.56	0.88	0.26	0.59
DUP	Residential (1/8 acre)	2.30	0.66	0.92	0.17	0.55
	Asphalt/Sidewalk	0.00				
B9	Landscape/Lawn	0.53			0.53	
SF	Residential (1/8 acre)	0.45	0.11	0.17	0.05	0.12
	Asphalt/Sidewalk	0.00				
B10	Landscape/Lawn	1.01			1.01	
SF	Residential (1/8 acre)	0.22	0.05	0.08	0.03	0.06
	Asphalt/Sidewalk	0.00				
B11	Landscape/Lawn	0.00				
SF	Residential (1/8 acre)	0.72	0.18	0.28	0.08	0.18
	Asphalt/Sidewalk	0.00				
B12	Landscape/Lawn	0.00				
SF	Residential (1/8 acre)	3.51	0.86	1.35	0.40	0.90
	Asphalt/Sidewalk	0.00				
B13	Landscape/Lawn	0.00				
SF	Residential (1/8 acre)	2.89	0.71	1.11	0.33	0.74
DUP	Residential (1/8 acre)	2.89	0.83	1.16	0.21	0.69
	Asphalt/Sidewalk	0.00				
B14	Landscape/Lawn	0.00				
SF	Residential (1/8 acre)	1.23	0.30	0.47	0.14	0.31
	Asphalt/Sidewalk	0.00				
B15	Landscape/Lawn	0.86			0.86	
	Residential (1/8 acre)	0.00				
	Asphalt/Sidewalk	0.00				
OS-1	Landscape/Lawn	0.21			0.63	
	Residential (1/8 acre)	4.35	1.64	0.71		1.58
	Asphalt/Sidewalk	0.00				

INPUT LOT DATA

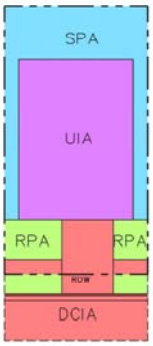
SINGLE FAMILY RATIOS

	SF	Ratio	
DCIA	1530	24%	Directly Connected Impervious Area
UIA	2400	38%	Unconnected Impervious Area
RPA	720	12%	Receiving Pervious Area
SPA	1600	26%	Separate Pervious Area
TOTAL	6250	100%	

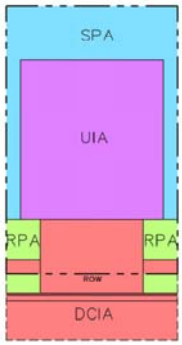
INPUT LOT DATA

DUPLEX RATIOS

	SF	Ratio	
DCIA	2160	29%	Directly Connected Impervious Area
UIA	3000	40%	Unconnected Impervious Area
RPA	540	7%	Receiving Pervious Area
SPA	1800	24%	Separate Pervious Area
TOTAL	7500	100%	



SINGLE FAMILY
TYPICAL LOT



DUPLEX
TYPICAL LOT

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: KGV
Company: DB&CO
Date: October 25, 2018
Project: PIKES PEAK HEIGHTS - POND 1 (NORTH)
Location: COLORADO SPRINGS

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	A1	A2	A3	A4										
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand										
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	3.070	3.170	0.840	0.980										
Directly Connected Impervious Area (DCIA, acres)	0.880	0.910	0.140	0.070										
Unconnected Impervious Area (UIA, acres)	1.230	1.270	0.220	0.120										
Receiving Pervious Area (RPA, acres)	0.220	0.230	0.330	0.710										
Separate Pervious Area (SPA, acres)	0.740	0.760	0.150	0.080										
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C	C	V										

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	3.070	3.170	0.840	0.980										
Directly Connected Impervious Area (DCIA, %)	28.7%	28.7%	16.7%	7.1%										
Unconnected Impervious Area (UIA, %)	40.1%	40.1%	26.2%	12.2%										
Receiving Pervious Area (RPA, %)	7.2%	7.3%	39.3%	72.4%										
Separate Pervious Area (SPA, %)	24.1%	24.0%	17.9%	8.2%										
A_R (RPA / UIA)	0.179	0.181	1.500	5.917										
I_a Check	0.850	0.850	0.400	0.140										
f / I for WQCV Event:	3.6	3.6	3.6	3.6										
f / I for 10-Year Event:	0.5	0.5	0.5	0.5										
f / I for 100-Year Event:	0.4	0.4	0.4	0.4										
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.83	0.83	0.55	0.00										
IRF for 10-Year Event:	0.96	0.96	0.88	0.53										
IRF for 100-Year Event:	0.97	0.97	0.90	0.55										
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	68.7%	68.8%	42.9%	19.4%										
Effective Imperviousness for WQCV Event:	61.9%	62.0%	31.0%	7.1%										
Effective Imperviousness for 10-Year Event:	67.0%	67.1%	39.6%	13.6%										
Effective Imperviousness for 100-Year Event:	67.5%	67.5%	40.2%	13.9%										
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	9.9%	9.9%	17.4%	N/A	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:	2.5%	2.6%	8.1%	33.3%	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:	1.7%	1.8%	6.4%	31.3%	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:	**60.0%**
Total Site Effective Imperviousness for WQCV Event:	**52.1%**
Total Site Effective Imperviousness for 10-Year Event:	**57.7%**
Total Site Effective Imperviousness for 100-Year Event:	**58.1%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

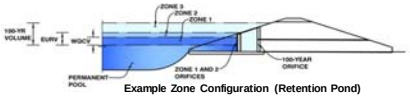
* Use Green-Ampt average infiltration rate values from Table 3-3.
** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: PIKES PEAK HEIGHTS

Basin ID: POND 1 (NORTH)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB		
Watershed Area =	8.06	acres	
Watershed Length =	850	ft	
Watershed Slope =	0.050	ft/ft	
Watershed Imperviousness =	58.10%	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	
Desired WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.154	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	0.563	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	0.386	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.505	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.618	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	0.758	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.921	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.112	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.76 in.) =	1.854	acre-feet	3.76 inches
Approximate 2-yr Detention Volume =	0.365	acre-feet	
Approximate 5-yr Detention Volume =	0.478	acre-feet	
Approximate 10-yr Detention Volume =	0.579	acre-feet	
Approximate 25-yr Detention Volume =	0.702	acre-feet	
Approximate 50-yr Detention Volume =	0.777	acre-feet	
Approximate 100-yr Detention Volume =	0.862	acre-feet	

Stage-Storage Calculation

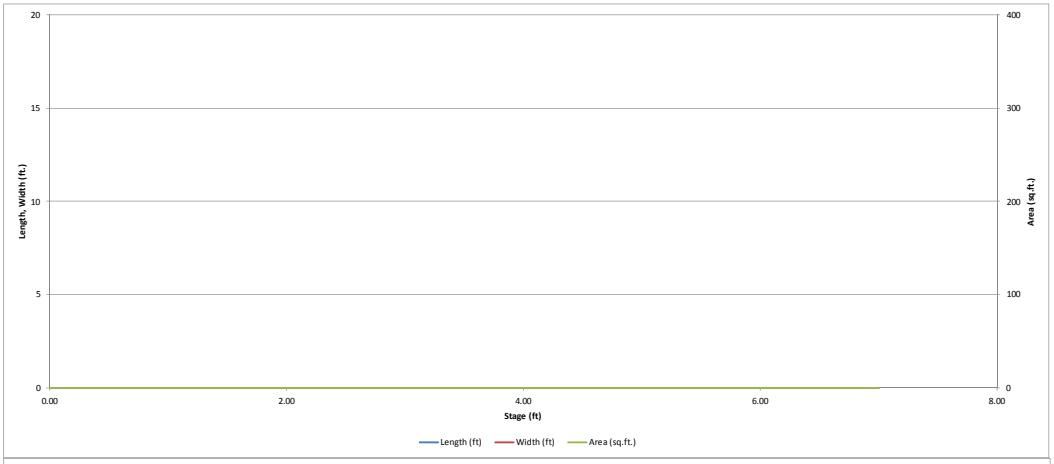
Zone 1 Volume (WQCV) =	0.154	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.409	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.298	acre-feet
Total Detention Basin Volume =	0.862	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (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

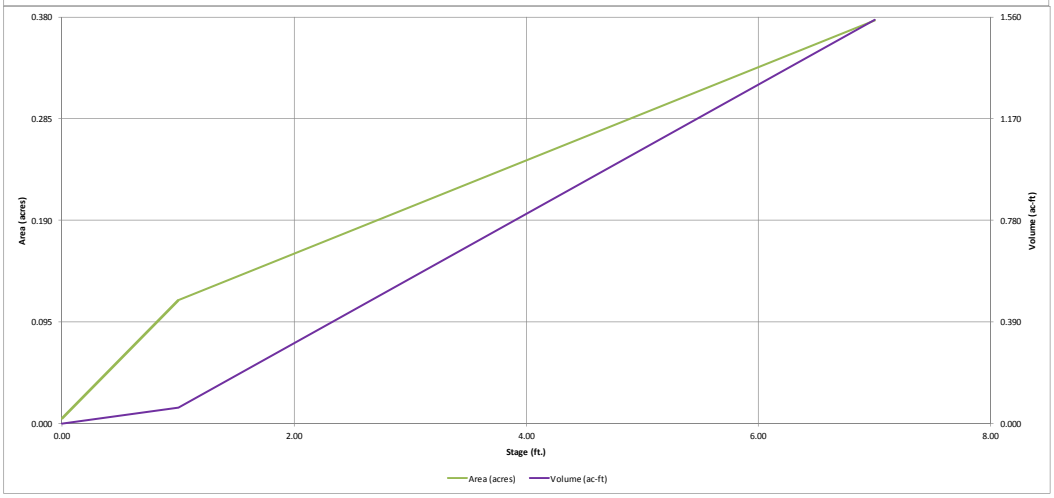
Depth Increment = ft

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	--	--	--	200	0.005		
6164	--	1.00	--	--	--	5,038	0.116	2,635	0.060
6169.84	--	7.00	--	--	--	16,412	0.377	67,441	1.548

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



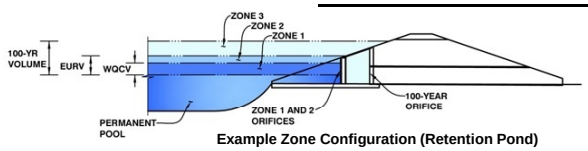


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Pikes Peak Heights - Pond 1 North

Basin ID:



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.70	0.154	Orifice Plate
Zone 2 (EURV)	3.81	0.409	Orifice Plate
Zone 3 (100-year)	4.94	0.298	Weir&Pipe (Circular)
		0.862	Total

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

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	9.375E-03	ft^2
Depth at top of Zone using Orifice Plate =	3.81	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	15.24	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.35	sq. inches (diameter = 1-5/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.30	2.60					
Orifice Area (sq. inches)	1.35	1.35	1.35					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.00	N/A	feet
Overflow Weir Front Edge Length =	3.91	N/A	feet	Over Flow Weir Slope Length =	3.91	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	6.06	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	3.91	N/A	feet	Overflow Grate Open Area w/o Debris =	10.70	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	5.35	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Circular	Not Selected			Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	2.83	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A	ft^2
Circular Orifice Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.40	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.55	feet
Spillway Crest Length =	15.00	feet	Stage at Top of Freeboard =	6.95	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.37	acres
Freeboard above Max Water Surface =	1.00	feet			

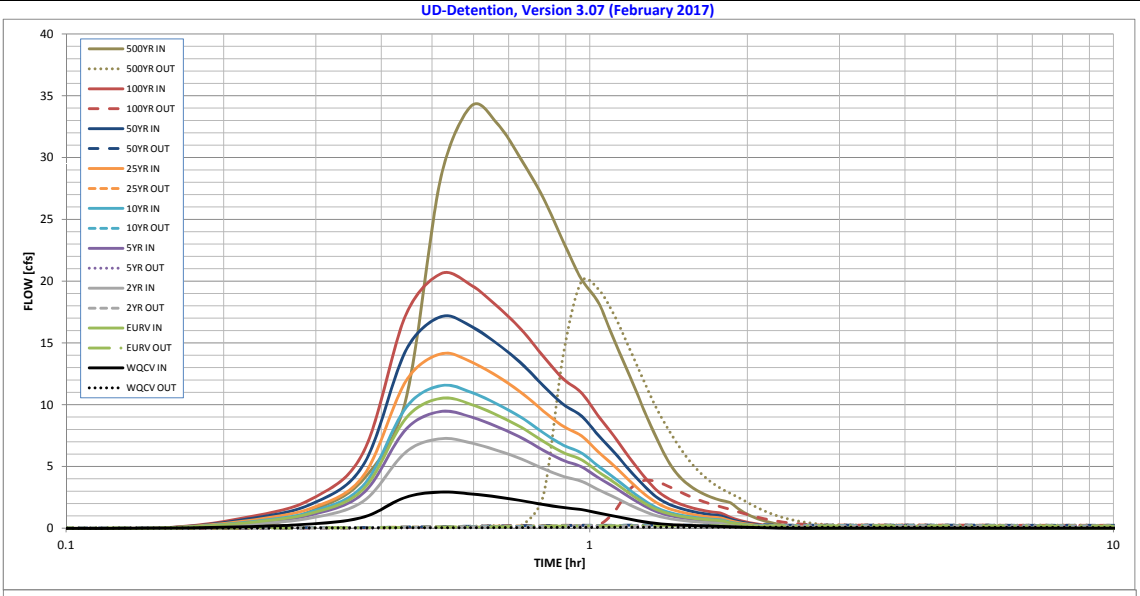
Calculated Parameters for Spillway

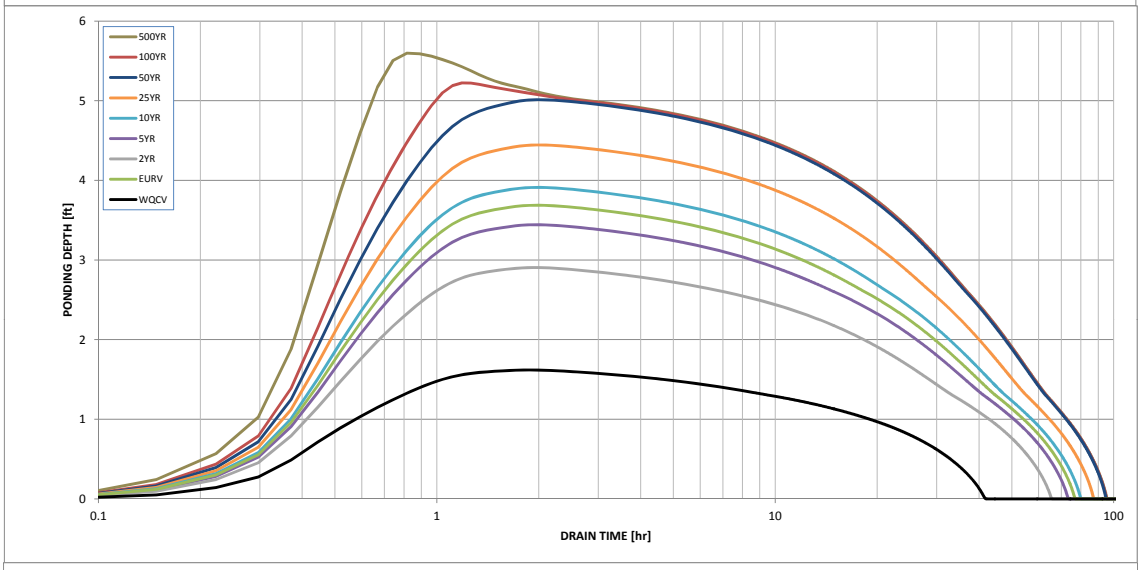
Routed Hydrograph Results

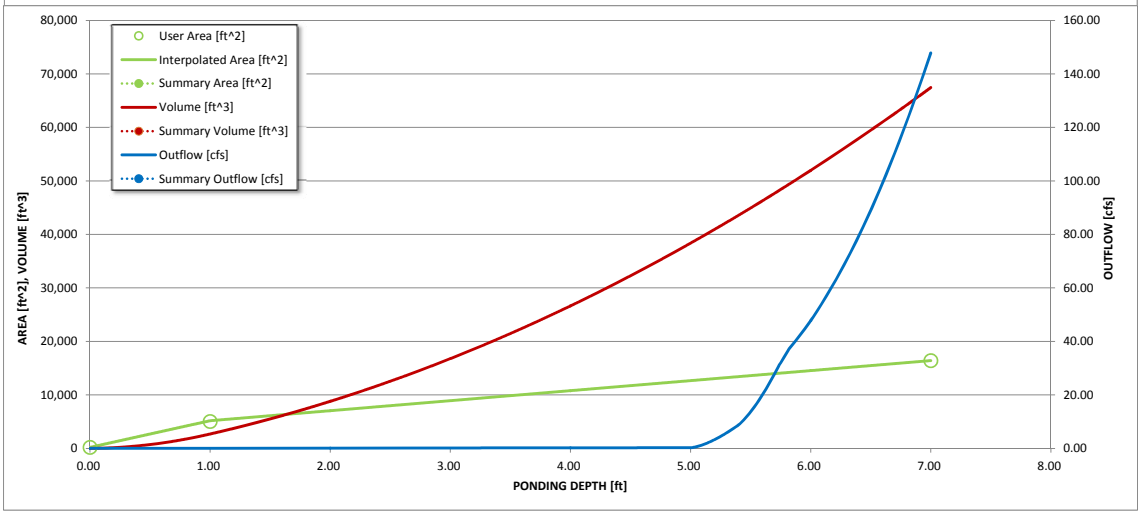
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.76
Calculated Runoff Volume (acre-ft) =	0.154	0.563	0.386	0.505	0.618	0.758	0.921	1.112	1.854
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.154	0.563	0.386	0.505	0.618	0.758	0.920	1.110	1.854
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.01	0.03	0.22	0.54	1.45
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.3	1.8	4.4	11.7
Peak Inflow Q (cfs) =	2.9	10.5	7.2	9.4	11.5	14.1	17.1	20.6	34.2
Peak Outflow Q (cfs) =	0.1	0.2	0.2	0.2	0.2	0.2	0.3	3.8	20.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.1	2.0	0.9	0.2	0.9	1.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.3	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	68	59	65	71	76	82	81	75
Time to Drain 99% of Inflow Volume (hours) =	**40**	73	62	70	76	82	89	89	86
Maximum Ponding Depth (ft) =	1.62	3.69	2.90	3.44	3.91	4.44	5.01	5.22	5.60
Area at Maximum Ponding Depth (acres) =	0.14	0.23	0.20	0.22	0.24	0.27	0.29	0.30	0.32
Maximum Volume Stored (acre-ft) =	0.142	0.534	0.365	0.479	0.589	0.725	0.884	0.946	1.060

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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: _____

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
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]
4.45 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:04:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:08:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:13:21	0.13	0.47	0.32	0.42	0.51	0.62	0.75	0.90	1.47
1.123	0:17:48	0.35	1.26	0.87	1.13	1.38	1.68	2.03	2.44	4.02
	0:22:15	0.91	3.23	2.23	2.90	3.54	4.32	5.22	6.27	10.31
	0:26:42	2.51	8.87	6.14	7.98	9.72	11.86	14.34	17.21	28.31
	0:31:09	2.92	10.51	7.24	9.44	11.53	14.11	17.11	20.59	34.16
	0:35:36	2.78	10.03	6.90	9.00	11.00	13.47	16.34	19.68	32.70
	0:40:03	2.52	9.13	6.28	8.19	10.02	12.27	14.88	17.92	29.76
	0:44:30	2.24	8.15	5.59	7.31	8.95	10.96	13.31	16.04	26.72
	0:48:57	1.91	7.03	4.81	6.30	7.72	9.48	11.52	13.90	23.21
	0:53:24	1.67	6.13	4.20	5.49	6.73	8.25	10.03	12.09	20.16
	0:57:51	1.51	5.55	3.80	4.98	6.10	7.48	9.09	10.96	18.28
	1:02:18	1.23	4.57	3.12	4.10	5.03	6.18	7.52	9.09	15.24
	1:06:45	0.99	3.73	2.54	3.34	4.10	5.05	6.16	7.46	12.56
	1:11:12	0.74	2.87	1.94	2.56	3.16	3.90	4.77	5.80	9.84
	1:15:39	0.54	2.13	1.43	1.90	2.35	2.91	3.58	4.36	7.49
	1:20:06	0.40	1.55	1.04	1.38	1.70	2.11	2.58	3.17	5.50
	1:24:33	0.31	1.20	0.81	1.07	1.32	1.63	1.99	2.43	4.18
	1:29:00	0.26	0.99	0.67	0.88	1.09	1.34	1.64	1.99	3.40
	1:33:27	0.22	0.84	0.57	0.75	0.92	1.14	1.39	1.69	2.87
	1:37:54	0.19	0.74	0.50	0.66	0.81	1.00	1.22	1.48	2.51
	1:42:21	0.18	0.66	0.45	0.59	0.73	0.90	1.10	1.33	2.25
	1:46:48	0.16	0.61	0.42	0.55	0.67	0.83	1.01	1.22	2.07
	1:51:15	0.12	0.45	0.31	0.40	0.49	0.61	0.74	0.90	1.53
	1:55:42	0.09	0.33	0.22	0.29	0.36	0.45	0.54	0.66	1.11
	2:00:09	0.06	0.24	0.16	0.22	0.27	0.33	0.40	0.48	0.82
	2:04:36	0.05	0.18	0.12	0.16	0.20	0.24	0.29	0.36	0.61
	2:09:03	0.03	0.13	0.09	0.11	0.14	0.17	0.21	0.26	0.44
	2:13:30	0.02	0.09	0.06	0.08	0.10	0.12	0.15	0.18	0.31
	2:17:57	0.02	0.06	0.04	0.06	0.07	0.09	0.11	0.13	0.23
	2:22:24	0.01	0.04	0.03	0.04	0.05	0.06	0.07	0.09	0.16
	2:26:51	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.10
	2:31:18	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.05
	2:35:45	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
	2:40:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:44:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:49:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:53:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:58:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:02:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:06:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:11:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:24:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:29:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:33:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:38:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:42:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:46:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:51:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:04:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:09:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:13:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:18:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:22:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:27:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:31:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:44:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:49:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:53:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:58:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:02:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:07:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:11:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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: KGV
Company: DB&CO
Date: July 25, 2019
Project: PIKES PEAK HEIGHTS - POND 2 (SOUTH)
Location: COLORADO SPRINGS

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	OS-1		
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Loam		
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.760	3.640	1.350	4.600	0.980	1.230	0.720	3.510	5.780	1.230	0.860	4.560		
Directly Connected Impervious Area (DCIA, acres)	0.100	0.890	0.140	1.220	0.110	0.050	0.180	0.860	1.540	0.300	0.000	1.640		
Unconnected Impervious Area (UIA, acres)	0.170	1.400	0.220	1.800	0.170	0.080	0.280	1.350	2.270	0.470	0.000	0.710		
Receiving Pervious Area (RPA, acres)	0.380	0.420	0.850	0.440	0.580	1.040	0.080	0.400	0.540	0.150	0.860	0.630		
Separate Pervious Area (SPA, acres)	0.110	0.930	0.140	1.140	0.120	0.060	0.180	0.900	1.430	0.310	0.000	1.580		
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C	C	C	C	C	C	C	C	C	V	C		

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.760	3.640	1.350	4.600	0.980	1.230	0.720	3.510	5.780	1.230	0.860	4.560		
Directly Connected Impervious Area (DCIA, %)	13.2%	24.5%	10.4%	26.5%	11.2%	4.1%	25.0%	24.5%	26.6%	24.4%	0.0%	36.0%		
Unconnected Impervious Area (UIA, %)	22.4%	38.5%	16.3%	39.1%	17.3%	6.5%	38.9%	38.5%	39.3%	38.2%	0.0%	15.6%		
Receiving Pervious Area (RPA, %)	50.0%	11.5%	63.0%	9.6%	59.2%	84.6%	11.1%	11.4%	9.3%	12.2%	100.0%	13.8%		
Separate Pervious Area (SPA, %)	14.5%	25.5%	10.4%	24.8%	12.2%	4.9%	25.0%	25.6%	24.7%	25.2%	0.0%	34.6%		
A_R (RPA / UIA)	2.235	0.300	3.864	0.244	3.412	13.000	0.286	0.296	0.238	0.319	0.000	0.887		
I_a Check	0.310	0.770	0.210	0.800	0.230	0.070	0.780	0.770	0.810	0.760	1.000	0.530		
f / I for WQCV Event:	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	2.0	2.0		
f / I for 10-Year Event:	0.5	0.5	0.5	0.5	0.5	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	0.4	0.4	0.4	0.3	0.3		
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.50	0.76	0.44	0.78	0.45	0.15	0.77	0.76	0.78	0.75	0.00	0.63		
IRF for 10-Year Event:	0.86	0.94	0.84	0.94	0.85	0.29	0.94	0.94	0.95	0.94	1.00	0.90		
IRF for 100-Year Event:	0.88	0.95	0.87	0.96	0.87	0.30	0.96	0.95	0.96	0.95	1.00	0.94		
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	35.5%	62.9%	26.7%	65.7%	28.6%	10.6%	63.9%	63.0%	65.9%	62.6%	0.0%	51.5%		
Effective Imperviousness for WQCV Event:	24.3%	53.7%	17.6%	56.9%	19.1%	5.0%	54.8%	53.7%	57.5%	53.2%	0.0%	45.8%		
Effective Imperviousness for 10-Year Event:	32.4%	60.5%	24.1%	63.4%	25.9%	6.0%	61.6%	60.6%	63.8%	60.2%	0.0%	50.0%		
Effective Imperviousness for 100-Year Event:	32.9%	61.1%	24.5%	64.0%	26.3%	6.0%	62.2%	61.2%	64.3%	60.8%	0.0%	50.5%		
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	21.1%	12.1%	25.2%	11.9%	23.9%	48.1%	12.1%	12.1%	11.6%	12.2%	N/A	7.4%	N/A	N/A
10-Year Event CREDIT**: Reduce Detention By:	9.3%	3.9%	10.5%	3.5%	10.1%	53.9%	3.8%	3.9%	3.3%	4.0%	N/A	3.2%	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	7.5%	2.7%	8.6%	2.4%	8.3%	52.9%	2.6%	2.7%	2.3%	2.8%	N/A	1.9%	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**54.6%**
Total Site Effective Imperviousness for WQCV Event:	**46.5%**
Total Site Effective Imperviousness for 10-Year Event:	**52.4%**
Total Site Effective Imperviousness for 100-Year Event:	**52.9%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

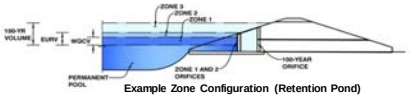
* Use Green-Ampt average infiltration rate values from Table 3-3.
** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: PIKES PEAK HEIGHTS

Basin ID: POND 2 (SOUTH)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB		
Watershed Area =	29.22	acres	
Watershed Length =	1,400	ft	
Watershed Slope =	0.050	ft/ft	
Watershed Imperviousness =	52.90%	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	
Desired WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.522	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	1.811	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	1.237	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.624	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.995	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	2.471	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.053	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.736	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.76 in.) =	6.356	acre-feet	3.76 inches
Approximate 2-yr Detention Volume =	1.167	acre-feet	
Approximate 5-yr Detention Volume =	1.534	acre-feet	
Approximate 10-yr Detention Volume =	1.867	acre-feet	
Approximate 25-yr Detention Volume =	2.276	acre-feet	
Approximate 50-yr Detention Volume =	2.533	acre-feet	
Approximate 100-yr Detention Volume =	2.836	acre-feet	

Stage-Storage Calculation

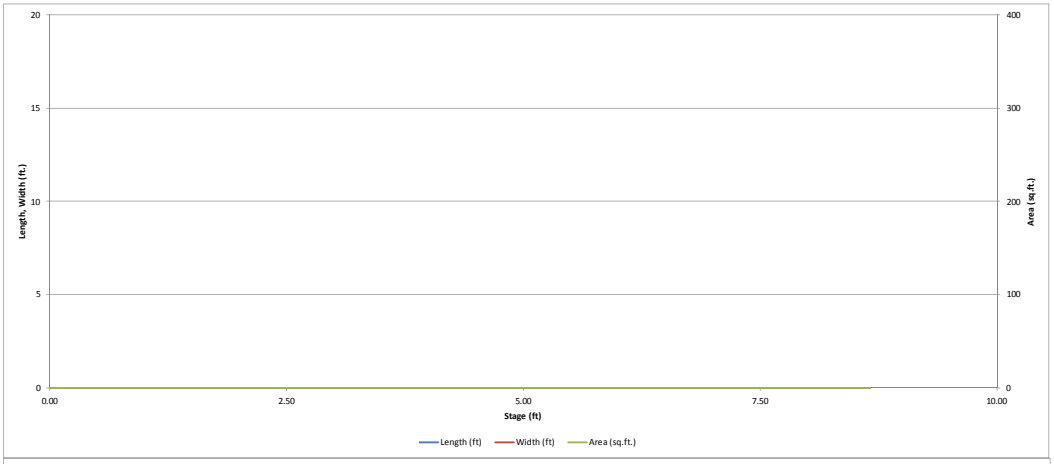
Zone 1 Volume (WQCV) =	0.522	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.289	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.025	acre-feet
Total Detention Basin Volume =	2.836	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (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

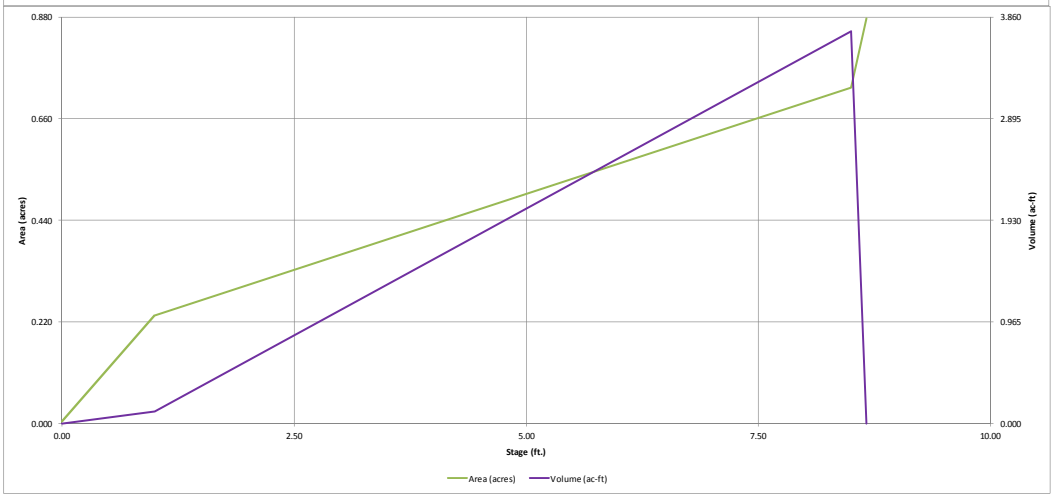
Depth Increment = ft

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	--	--	--	200	0.005		
6094.5	--	1.00	--	--	--	10,199	0.234	5,098	0.117
6102	--	8.50	--	--	--	31,667	0.727	162,197	3.724
6102.35	--	8.85	--	--	--	38,219	0.877		

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



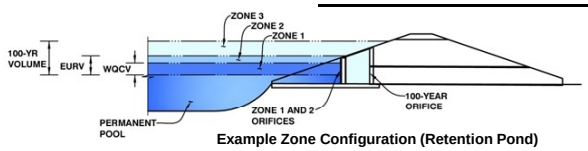


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Pikes Peak Heights

Basin ID: Pond 2 South



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.44	0.522	Orifice Plate
Zone 2 (EURV)	5.45	1.289	Orifice Plate
Zone 3 (100-year)	7.21	1.025	Weir&Pipe (Restrict)
		2.836	Total

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

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.694E-02	ft^2
Depth at top of Zone using Orifice Plate =	5.45	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	21.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	3.88	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.82	3.63					
Orifice Area (sq. inches)	3.88	3.88	3.88					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.25	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	6.25	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Over Flow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	9.04	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.20	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	5.60	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.83	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.24	N/A	ft^2
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	0.48	N/A	feet
Restrictor Plate Height Above Pipe Invert =	10.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.40	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.21	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.61	feet
Spillway Crest Length =	50.00	feet	Stage at Top of Freeboard =	8.82	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.00	acres
Freeboard above Max Water Surface =	1.00	feet			

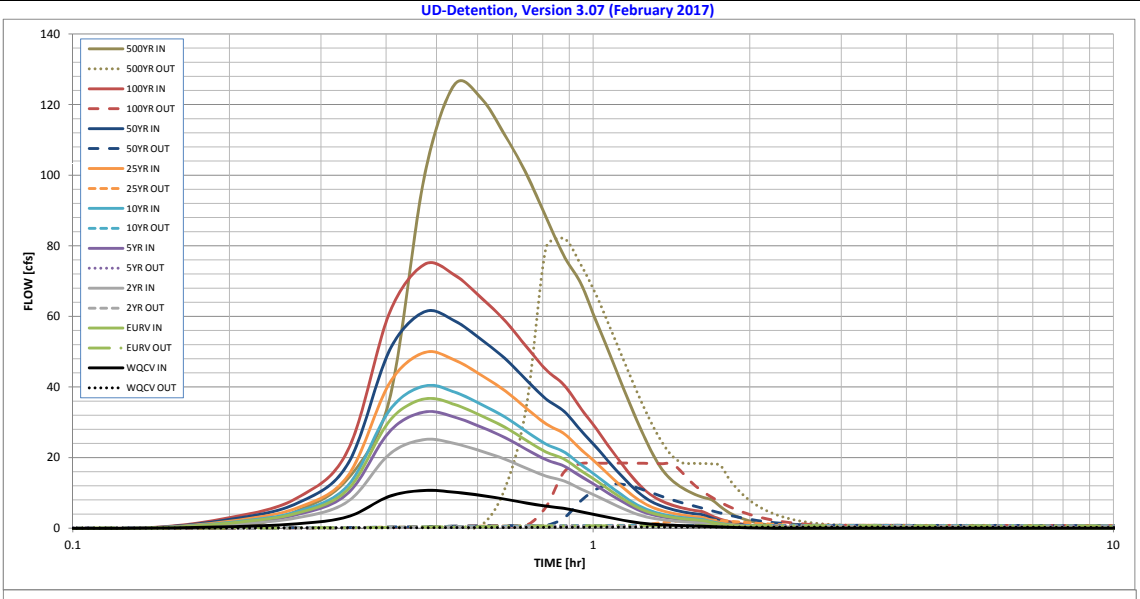
Calculated Parameters for Spillway

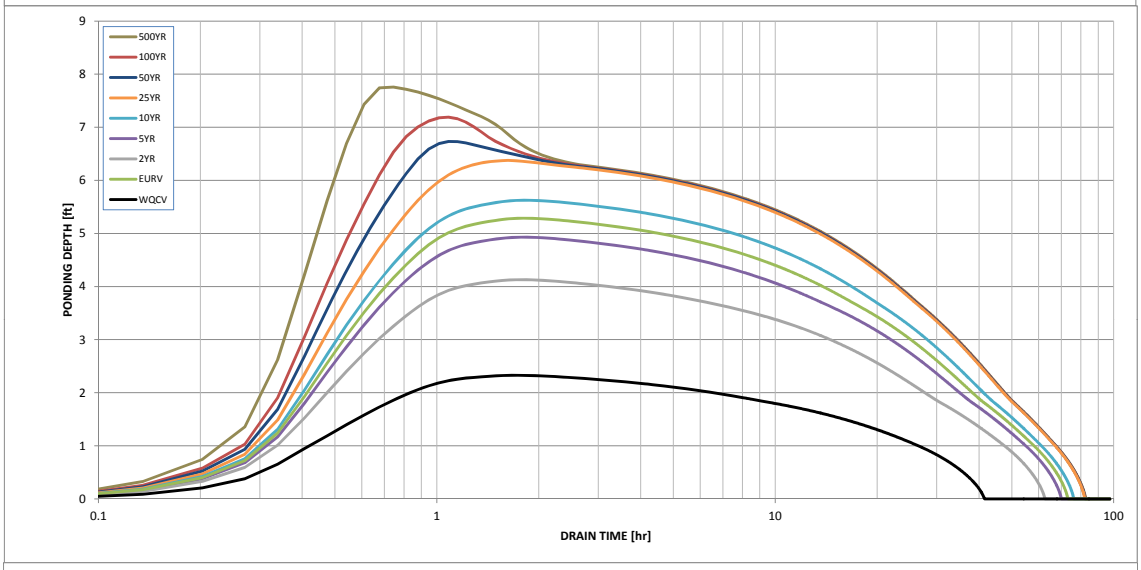
Routed Hydrograph Results

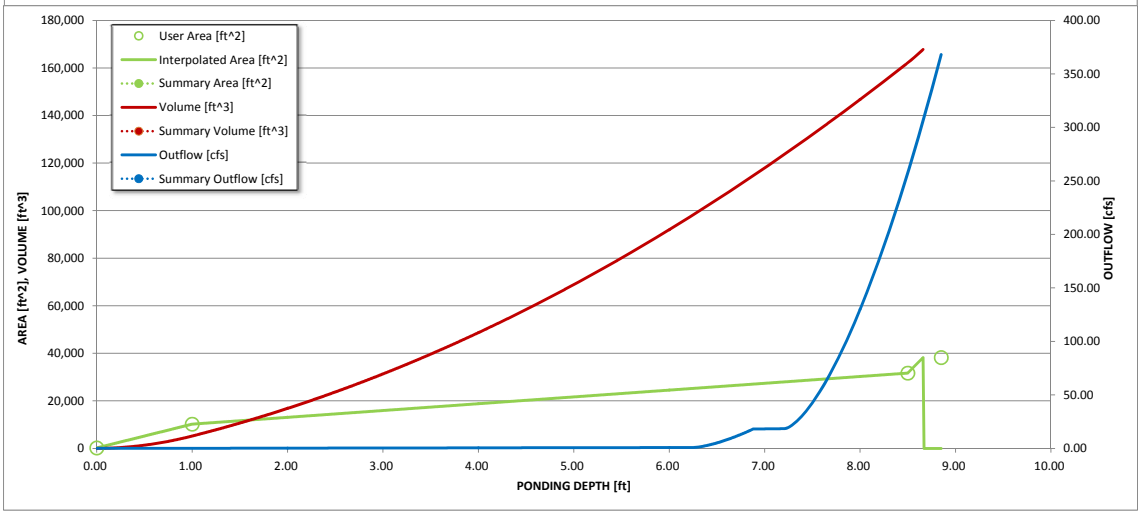
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.76
Calculated Runoff Volume (acre-ft) =	0.522	1.811	1.237	1.624	1.995	2.471	3.053	3.736	6.356
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.521	1.811	1.237	1.625	1.995	2.472	3.054	3.737	6.355
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.02	0.04	0.25	0.61	1.63
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.2	0.5	1.0	7.4	18.0	47.6
Peak Inflow Q (cfs) =	10.7	36.6	25.1	32.9	40.3	49.7	61.3	74.7	125.6
Peak Outflow Q (cfs) =	0.3	0.7	0.6	0.7	0.7	2.4	12.4	18.4	82.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.4	1.7	2.3	1.7	1.0	1.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	1.0	1.6	1.6
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	65	56	62	67	72	70	68	61
Time to Drain 99% of Inflow Volume (hours) =	**40**	70	60	67	72	78	77	76	73
Maximum Ponding Depth (ft) =	2.33	5.29	4.13	4.93	5.63	6.38	6.73	7.19	7.76
Area at Maximum Ponding Depth (acres) =	0.32	0.52	0.44	0.49	0.54	0.59	0.61	0.64	0.68
Maximum Volume Stored (acre-ft) =	0.486	1.723	1.170	1.547	1.902	2.324	2.540	2.821	3.197

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
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]
4.06 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:04:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:08:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:12:11	0.48	1.58	1.09	1.42	1.73	2.12	2.59	3.13	4.98
1.232	0:16:14	1.28	4.30	2.97	3.87	4.73	5.82	7.14	8.65	14.14
	0:20:18	3.29	11.05	7.63	9.95	12.14	14.94	18.32	22.22	36.30
	0:24:22	9.03	30.35	20.95	27.31	33.33	41.00	50.27	60.93	99.41
	0:28:25	10.69	36.59	25.11	32.87	40.26	49.73	61.25	74.71	125.60
	0:32:29	10.19	35.03	24.01	31.46	38.56	47.66	58.76	71.79	121.84
	0:36:32	9.28	31.89	21.85	28.63	35.09	43.38	53.47	65.33	111.36
	0:40:36	8.28	28.62	19.58	25.69	31.51	38.99	48.11	58.84	100.40
	0:44:40	7.14	24.86	16.97	22.30	27.39	33.96	41.98	51.44	88.10
	0:48:43	6.22	21.59	14.76	19.38	23.80	29.55	36.59	44.88	77.05
	0:52:47	5.64	19.58	13.38	17.57	21.58	26.76	33.09	40.54	69.32
	0:56:50	4.64	16.32	11.11	14.63	17.99	22.34	27.66	33.95	58.41
	1:00:54	3.78	13.45	9.13	12.04	14.84	18.45	22.88	28.11	48.50
	1:04:58	2.90	10.53	7.10	9.41	11.63	14.51	18.05	22.24	38.69
	1:09:01	2.15	8.01	5.36	7.14	8.87	11.11	13.87	17.15	30.05
	1:13:05	1.56	5.88	3.90	5.23	6.52	8.21	10.30	12.78	22.61
	1:17:08	1.21	4.47	2.99	3.99	4.95	6.21	7.76	9.60	16.84
	1:21:12	1.00	3.64	2.45	3.25	4.03	5.03	6.27	7.73	13.45
	1:25:16	0.85	3.08	2.07	2.75	3.40	4.25	5.28	6.51	11.30
	1:29:19	0.75	2.69	1.81	2.40	2.97	3.71	4.61	5.67	9.80
	1:33:23	0.67	2.41	1.63	2.16	2.66	3.32	4.12	5.07	8.75
	1:37:26	0.62	2.22	1.50	1.98	2.45	3.05	3.78	4.65	8.00
	1:41:30	0.45	1.63	1.10	1.46	1.81	2.25	2.80	3.46	6.04
	1:45:34	0.33	1.19	0.81	1.07	1.31	1.64	2.03	2.50	4.36
	1:49:37	0.24	0.88	0.59	0.78	0.97	1.21	1.50	1.85	3.23
	1:53:41	0.18	0.65	0.44	0.58	0.72	0.90	1.12	1.38	2.40
	1:57:44	0.13	0.47	0.32	0.42	0.52	0.65	0.81	1.01	1.77
	2:01:48	0.09	0.33	0.22	0.30	0.37	0.47	0.58	0.72	1.27
	2:05:52	0.06	0.24	0.16	0.22	0.27	0.34	0.42	0.52	0.92
	2:09:55	0.04	0.17	0.11	0.15	0.18	0.23	0.29	0.37	0.65
	2:13:59	0.02	0.10	0.07	0.09	0.12	0.15	0.19	0.23	0.43
	2:18:02	0.01	0.06	0.03	0.05	0.06	0.08	0.10	0.13	0.25
	2:22:06	0.00	0.02	0.01	0.02	0.03	0.03	0.05	0.06	0.12
	2:26:10	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04
	2:30:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:34:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:38:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:42:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:46:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:54:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:58:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:02:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:06:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:14:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:18:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:23:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:27:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:31:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:39:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:43:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:47:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:51:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:59:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:03:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:07:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:11:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:19:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:23:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:27:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:32:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:36:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:44:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:48:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:52:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

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

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

Pond 1 (North)

FOREBAY VOLUME

Req'd V=3% x WQCV

WQCV=	0.154	ac-ft
V=	0.0046	ac-ft
Actual V	0.0056	ac-ft

FOREBAY RELEASE NOTCH WIDTH

$Q=CLH^{3/2}$

Q_{100}=	30.7	cfs
2% of Q=	0.61	cfs
C=	2.6	
H (height of forebay wall)=	1	ft
L=	3	in

Pond 2 (South)

FOREBAY 1 VOLUME

Req'd V=3% x WQCV

WQCV=	0.522	ac-ft
V/2 (two forebays)=	0.0078	ac-ft
Actual V	0.0080	ac-ft

FOREBAY 1 RELEASE NOTCH WIDTH

$Q=CLH^{3/2}$

Q_{100}=	48.3	cfs
2% of Q=	0.97	cfs
C=	2.6	
H (height of forebay wall)=	1	ft
L=	4	in

Pond 2 (South)

FOREBAY 2 VOLUME

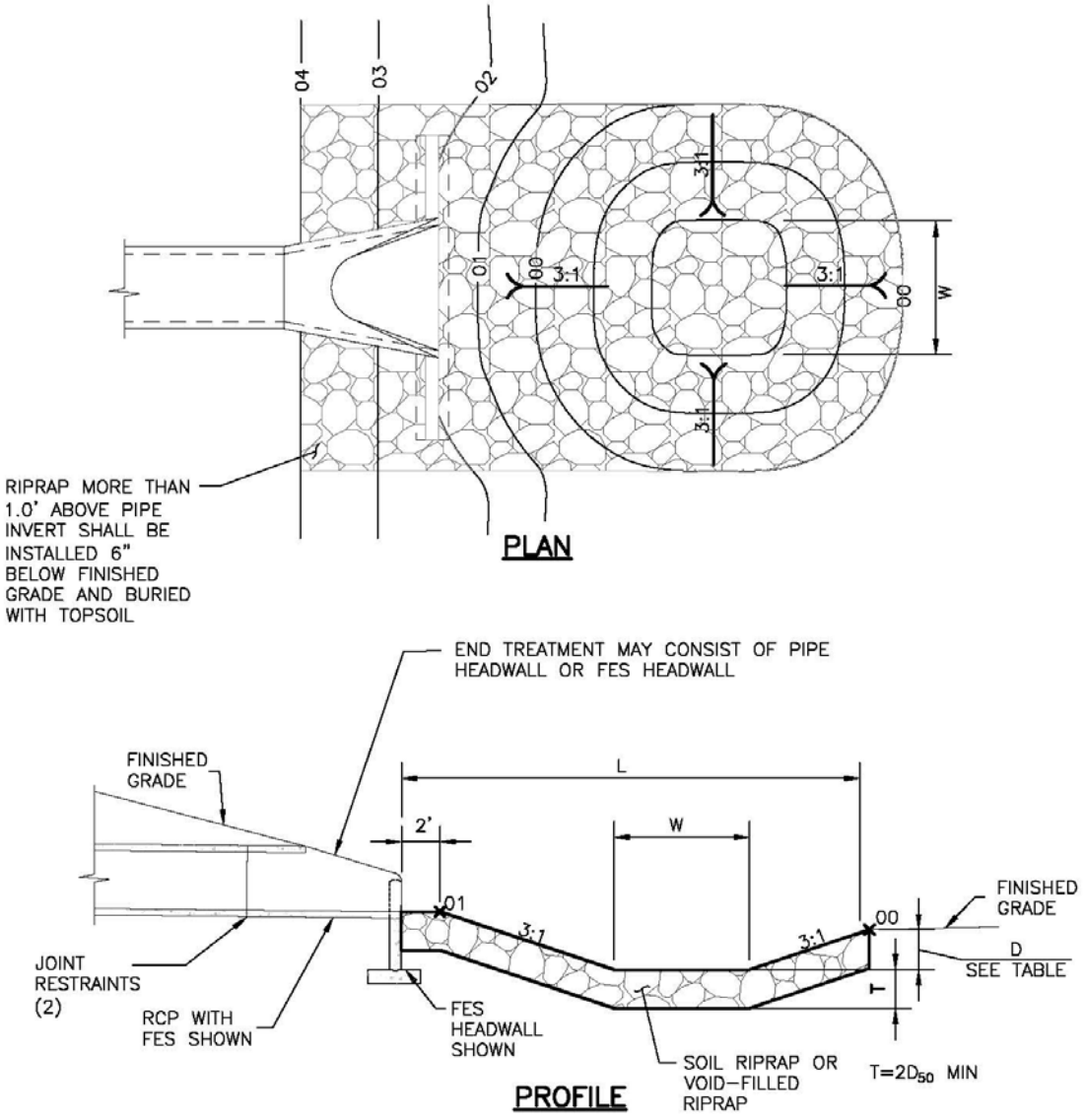
Req'd V=3% x WQCV

WQCV=	0.522	ac-ft
V/2 (two forebays)=	0.0078	ac-ft
Actual V	0.0080	ac-ft

FOREBAY 2 RELEASE NOTCH WIDTH

$Q=CLH^{3/2}$

Q_{100}=	64.9	cfs
2% of Q=	1.30	cfs
C=	2.6	
H (height of forebay wall)=	1	ft
L=	6	in



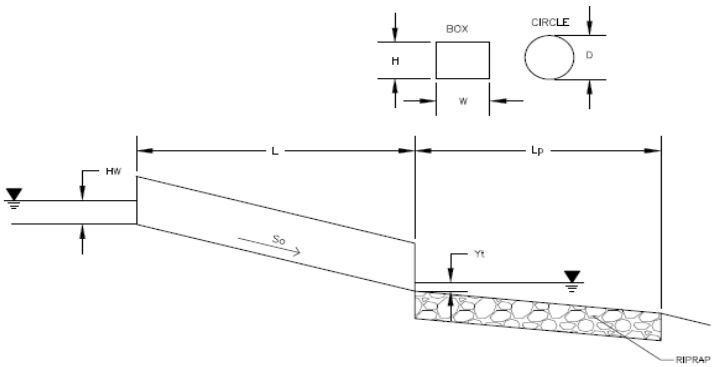
PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

Figure 9-37. Low tailwater riprap basin

Determination of Culvert Headwater and Outlet Protection

Project: Pikes Peak Heights
Basin ID: Pond 1 North Outfall



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

Supercritical Flow! Using Da to calculate protection type

Design Information (Input):

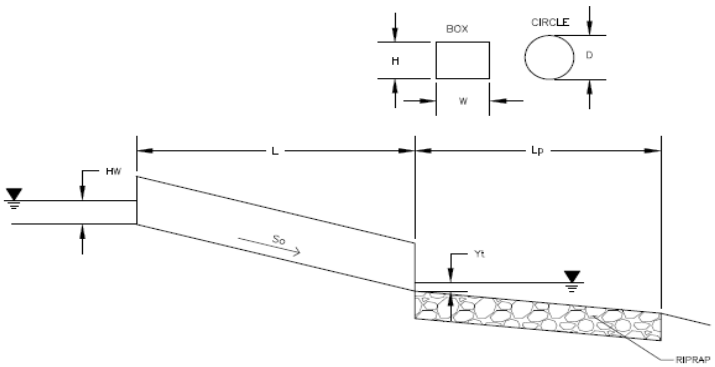
	Design Discharge	Q =	3.8	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (Choose from pull-down list)		Square End with Headwall	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	6161.8	ft
	Outlet Elevation **OR** Slope	Elev OUT =	6130	ft
	Culvert Length	L =	193	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

	Tailwater Surface Height	Y_t =	0.60	ft
	Flow Area at Max Channel Velocity	A_t =	0.76	ft^2
	Culvert Cross Sectional Area Available	A =	1.77	ft^2
	Entrance Loss Coefficient	k_e =	0.50	
	Friction Loss Coefficient	k_f =	2.98	
	Sum of All Losses Coefficients	k_s =	4.48	ft
	Culvert Normal Depth	Y_n =	0.29	ft
	Culvert Critical Depth	Y_c =	0.75	ft
	Tailwater Depth for Design	d =	1.12	ft
	Adjusted Diameter **OR** Adjusted Rise	D_a =	0.90	ft
	Expansion Factor	1/(2*tan(Θ)) =	6.70	
	Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.38	$ft^{0.5}/s$
	Froude Number	Fr =	6.19	**Supercritical!**
	Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.67	
	Inlet Control Headwater	HW_I =	0.97	ft
	Outlet Control Headwater	HW_O =	-30.36	
	Design Headwater Elevation	**HW =**	**6,162.77**	**ft**
	Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.65**	
	Minimum Theoretical Riprap Size	d_{50} =	2	in
	Nominal Riprap Size	d_{50} =	6	in
	UDFCD Riprap Type	**Type =**	**VL**	
	Length of Protection	**L_p =**	**5**	**ft**
	Width of Protection	**T =**	**3**	**ft**

Determination of Culvert Headwater and Outlet Protection

Project: Pikes Peak Heights
Basin ID: Pond 2 South Outfall



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

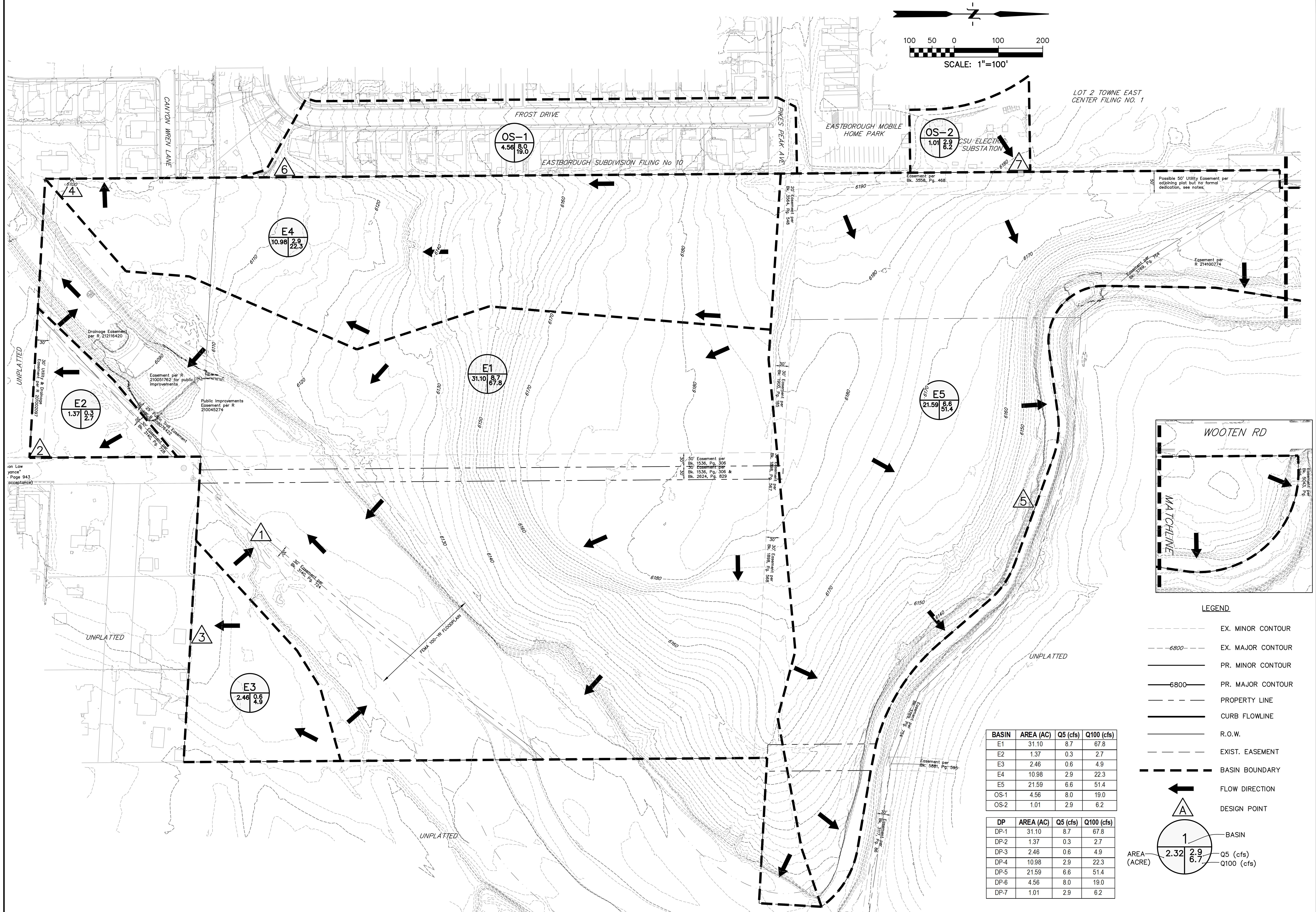
Supercritical Flow! Using Da to calculate protection type

Design Information (Input):

Design Discharge	Q =	14.7	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)		Square End with Headwall	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	6093.85	ft
Outlet Elevation **OR** Slope	Elev OUT =	6086	ft
Culvert Length	L =	118	ft
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	2.94	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.24	
Sum of All Losses Coefficients	k_s =	2.74	ft
Culvert Normal Depth	Y_n =	0.66	ft
Culvert Critical Depth	Y_c =	1.38	ft
Tailwater Depth for Design	d =	1.69	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.33	ft
Expansion Factor	1/(2*tan(Θ)) =	6.67	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.60	$ft^{0.5}/s$
Froude Number	Fr =	4.19	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.60	
Inlet Control Headwater	HW_I =	2.16	ft
Outlet Control Headwater	HW_O =	-5.23	
Design Headwater Elevation	**HW =**	**6,096.01**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.08**	
Minimum Theoretical Riprap Size	d_{50} =	5	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**12**	**ft**
Width of Protection	**T =**	**4**	**ft**



BASIN	AREA (AC)	Q5 (cfs)	Q100 (cfs)
E1	31.10	8.7	67.8
E2	1.37	0.3	2.7
E3	2.46	0.6	4.9
E4	10.98	2.9	22.3
E5	21.59	6.6	51.4
OS-1	4.56	8.0	19.0
OS-2	1.01	2.9	6.2

DP	AREA (AC)	Q5 (cfs)	Q100 (cfs)
DP-1	31.10	8.7	67.8
DP-2	1.37	0.3	2.7
DP-3	2.46	0.6	4.9
DP-4	10.98	2.9	22.3
DP-5	21.59	6.6	51.4
DP-6	4.56	8.0	19.0
DP-7	1.01	2.9	6.2

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 • GREELY

CLIENT:

PIKES PEAK HEIGHTS LLC.
SCHUCK COMMUNITIES
CO/SCHUCK COMMUNITIES, INC.
2 N. CASCADE AVE. #1250
COLORADO SPRINGS CO, 80903
(719)-633-4500
CONTACT: DENNIS MINCHOW, PM
dam@schuckcommunities.com

DRAINAGE PLAN FOR

PIKES PEAK HEIGHTS

COLORADO SPRINGS, COLORADO

ISSUE	DATE
INITIAL ISSUE	6-19-18
RESUBMITTAL	7-25-19

DESIGNED BY:	SBN
DRAWN BY:	SBN
CHECKED BY:	TDM
FILE NAME:	21150-01DR MAP

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF DREXEL, BARRELL & CO.

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

EXISTING DRAINAGE PLAN

PROJECT NO. 21102-02CSCV

DRAWING NO.

EX1

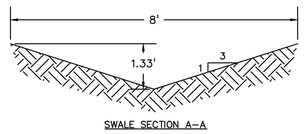
SHEET: 1 OF 2

80 40 0 80 160

SCALE: 1"=80'

NOTES

1. ALL STORM SEWER PIPING TO BE RCP OR HDPE.
2. DETENTION POND #2 (SOUTH) AND ALL STORM SEWER TO BE PUBLICLY OWNED AND MAINTAINED
3. DETENTION POND #1 (NORTH) AND ASSOCIATED STORM SEWER TO BE PRIVATELY OWNED AND MAINTAINED BY THE METROPOLITAN DISTRICT.
2. ALL CURB & GUTTER TO BE CITY OF COLORADO SPRINGS TYPE 5 WITH TRANSITION TO VERTICAL TYPE 3 AT CURB RETURNS AND INLETS UNLESS NOTED OTHERWISE.



SWALE SECTION A–A

BASIN	AREA (AC)	Q5 (cfs)	Q100 (cfs)
A1	3.07	5.9	13.8
A2	3.17	6.1	14.3
A3	0.84	1.3	3.7
A4	0.98	0.9	3.3
B5	0.76	1.0	3.1
B6	3.64	6.5	15.2
B7	1.35	1.5	5.2
B8	4.59	8.1	19.0
B9	0.98	1.2	3.9
B10	1.23	0.9	4.2
OS-1	4.56	8.0	19.0
B11	0.72	1.5	3.4
B12	3.51	7.0	16.4
B13	5.78	10.2	23.9
B14	1.23	2.2	5.2
B15	0.86	0.3	2.5

DP	AREA (AC)	Q5 (cfs)	Q100 (cfs)
DP-1	3.07	5.9	13.8
DP-2	6.24	11.9	27.8
DP-3	7.08	13.0	30.8
DP-4	8.06	13.8	33.8
DP-5	0.76	1.0	3.1
DP-6	3.64	6.5	15.2
DP-7	5.75	8.6	22.0
DP-8	4.59	8.1	19.0
DP-9	11.32	17.6	43.8
DP-10	12.55	17.8	46.1
DP-11	4.56	8.0	19.0
DP-12	5.28	10.1	24.3
DP-13	8.79	17.0	40.0
DP-14	5.78	10.2	23.9
DP-15	15.80	27.6	64.9
DP-16	29.21	46.0	113.7

LEGEND

- EX. MINOR CONTOUR
- 6800 EX. MAJOR CONTOUR
- PR. MINOR CONTOUR
- 6800 PR. MAJOR CONTOUR
- PROPERTY LINE
- CURB FLOWLINE
- R.O.W.
- EXIST. EASEMENT
- BASIN BOUNDARY
- FLOW DIRECTION
- A DESIGN POINT
- 1 BASIN, 2.32 AREA (ACRE), 2.9 Q5 (cfs), 6.7 Q100 (cfs)

PREPARED BY:

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CONTACT: DENNIS MINCHOW, PM
dom@schuckcommunities.com

DRAINAGE PLAN FOR
PIKES PEAK HEIGHTS
COLORADO SPRINGS, COLORADO

ISSUE	DATE
INITIAL ISSUE	6-19-18
RESUBMITTAL	7-25-19

DESIGNED BY:	SBN
DRAWN BY:	SBN
CHECKED BY:	TDM
FILE NAME:	21150-01DR MAP

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF DREXEL, BARRELL & CO.

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

PROPOSED CONDITIONS DRAINAGE PLAN

PROJECT NO. 21102-02CSCV

DRAWING NO.

PR1

SHEET: 2 OF 2