
Drainage Compliance Letter

Kum & Go #2293

**Trails at Crowfoot Filing No. 9, 1st
Amendment
LOT 1
Parker, Colorado**

March 10, 2023

Prepared For:

Kum & Go LC

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SHAKE SHACK AT LOT 3, INTERQUEST FILING NO. 11

ENGINEER'S STATEMENT

This Drainage Conformance Letter for Lot 1 (Kum and Go #2293), of Tails at Crowfoot Filing No. 9, 1st Amendment, was prepared by me or under my direct supervision in accordance with the provisions of the Town of Parker Storm Drainage & Environmental Criteria Manual. I understand that the Town of Parker and its designated town authority do not and will not assume liability for drainage facilities designed by others.

Krysta Houtchens, PE

Colorado P.E. License No. 49550

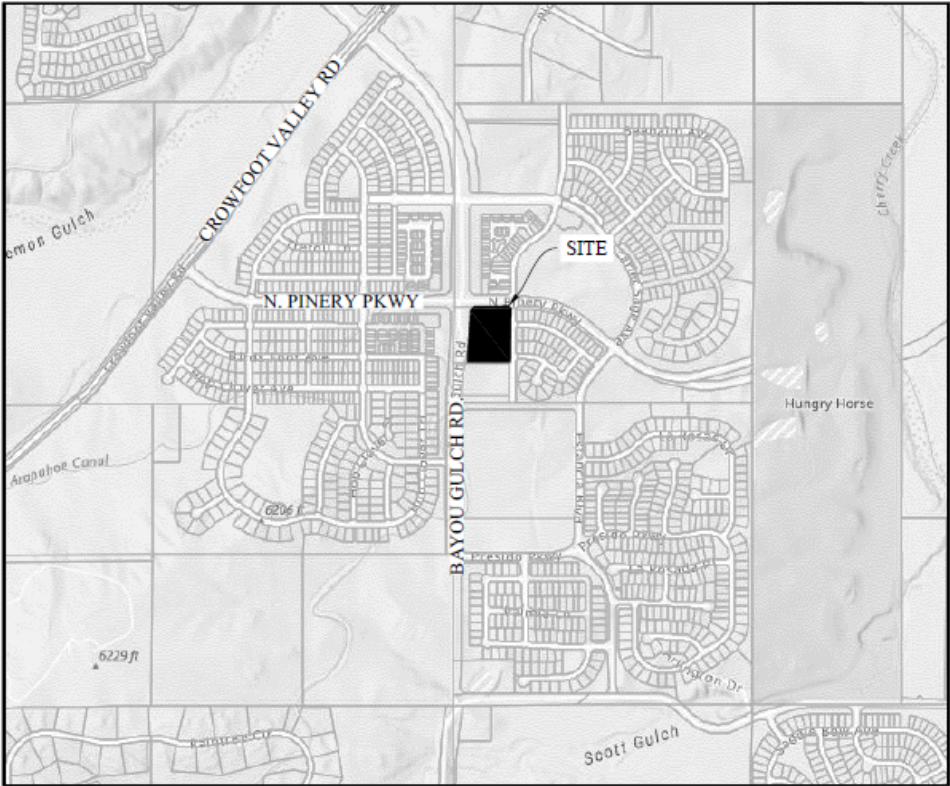
Seal and Date

Introduction

This Drainage Conformance Letter has been prepared for the Kum & Go Gas and Convenience Store #2293 located at Lot 1 of Tails at Crowfoot Filing No. 9, 1st A. The purposed of this letter is to show that the proposed development conforms to the Storm Drainage and Environmental Criteria Manual for the Town of Parker, and the *Trails at Crowfoot Final Drainage Report*, prepared by CVL Consultants, dated June 2018, herein referred to as “Master Drainage Report.”

Location

The project site is located at the southeast corner of Bayou Gulch Road and N. Pinery Parkway, which lies within the northeast ¼ of Section 9, Township 7 South, Range 66 West of the 6th Principal Meridian, Town of Parker, County of Douglas, State of Colorado. Lot 1 is bounded by N. Pinery Parkway to the north, Bayou Gulch to the west, Alpine Phlox to the east and vacant commercial property to the south. Refer to the Vicinity Map below for reference.



VICINITY MAP

Proposed Development

The proposed development includes a 3,968 sf Kum & Go Convenience Store with 8 MPD fueling canopy as well as associated drives, parking, sidewalk, landscaping and utilities. Detention for this proposed development is provided in the public Regional Detention Pond D, as referenced

in the approved “Trails at Crowfoot Final Drainage Report” by CVL Consultants dated June 2018, hereafter referred to as the “Master Drainage Report”.

The proposed Kum & Go is located within an existing 4.155-acre tract of commercially zoned vacant parcel. As part of this development the 4.155-acre tract will be subdivided into three lots (Lot 1, Lot 2 and Lot 3). The Kum & Go is proposed on Lot 1, which a proposed 1.43-acre parcel at the northwest corner of the existing Tract E. Proposed shared access drives are proposed as part of this development that are located partially on Lot 2 (0.66-acres) and Lot 3 (2.06-acres).

The proposed Lots 1, 2 and 3 lies within Basins F1, F10 & F11 of the “Master Drainage Report”. Per the “Master Drainage Report” the existing pond and surrounding storm infrastructure has been designed based on the below commercial values which results in an allowed imperviousness for the development of greater than 90%.

Basin	Area	Imperviousness	Q2	Q100
F1	1.71 acres	90.64%	4.59-cfs	13.55-cfs
F10	1.93 acres	92.20%	5.30-cfs	15.64-cfs
F11	1.50 acres	91.79%	4.07-cfs	12.03-cfs

In the developed condition, the proposed development has a combined impervious value of 83.11% including all site improvements, assumed 90% impervious for future commercial development on Lots 2 and 3 and shared private drives as well as portions of the Right-of-way as outlined in the “Master Drainage Report”. The proposed development improvements result is an impervious value (83.11%) significantly lower than the allowed impervious (90%), therefore there are no required improvements to the existing storm sewer infrastructure or regional facility. The future development of Lot 2 & 3 will be required to analyze overall imperviousness and confirm future development maintains the maximum allowed imperviousness. Proposed and existing storm sewer has been designed for the future developed condition of Lots 2 & 3.

The proposed development anticipates to utilize sheet runoff for a portion of the development as well as tie into the existing storm inlet located at the southwest corner of the intersection of Alpine Phlox & Pinery following historic drainage patterns as outlined in the “Master Drainage Report”.

Refer to the Appendix for basin maps and calculations.

Historic Drainage

The site is currently an undeveloped lot and consists of natural grasses and shrubs, with concrete sidewalks along the north and east perimeter of the site. The site naturally drains to the north & west and into the existing Alpine Phlox right-of-way on the east side of the property. Runoff is then captured by a series of existing inlets within the Alpine Phlox ROW. The existing inlets captures within Alpine Phlox will capture the 5-year and 100-year runoff and convey it to the

Regional Detention Pond D. Refer to the Master Drainage Report Plan in the appendix for more information.

Per the NRCS Soil Survey, the subsurface characteristics consist approximately 75% of Fondis Kutch associate soil which is defined as hydrologic soil group C and 25% of Renohill Sandy Loam, reddish variant which is classified as hydrologic soil group D. The soils have slow and very slow infiltration rates as defined for hydrological soil groups C & D. For the calculations within this report, hydrologic soil group C was used for runoff coefficients. Refer to the Appendix for the NRCS Soil Survey Map.

There are no recently reported cases of flooding within or around the development. The site is located within Zone "X", areas determined to be outside 0.2% annual chance floodplain, of the Flood Plain, as designated on the Flood Insurance Rate Map (FIRM) 08035C0183G, map last revised 03/16/2016. Refer to the Appendix for the FIRMette.

Existing Storm Water Basins & Drainage Patterns

Drainage patterns in the existing condition of the project site generally drain to the north & east and consist of Basins F1, F10 & F11 of the "Master Drainage Report". Flows from Basins F1, F10 and F11 are directed to the Alpine Phlox right-of-way where a series of existing inlets will capture the runoff and convey it to existing Pond D. The proposed condition is in compliance with the "Master Drainage Report" as outlined in the section above and will not have any negative impacts on the downstream system. Refer to the Appendix for excerpts of the "Master Drainage Report" and the Master Drainage Plan.

Developed Storm Water Conditions

The site in the proposed condition consists of eleven total basins (P-1, P-2, P-3, P-4, P-5, P-6, P-7, P-8, P-9, P-10, P-11) which direct flows to on-site inlets as well as off-site where they are capture within existing storm sewer infrastructure. The following is a description of the proposed drainage basins.

Basin P-1: Basin P-1 is 0.10 acres near the northwest corner of the site and consists of hardscape sidewalk as well as landscape for an impervious value of 14.4%. The 5-year and 100-year C values were determined to be 0.15 and 0.54, respectively; and anticipated 5-year runoff flows of 0.07 CFS and 100-year runoff flows of 0.50 CFS. Flows from Basin P-1 are directed towards an ADS 8" slotted drain in the landscaping that will fully capture the 100-year runoff. Captured runoff will conveyed from the slotted drain via proposed 8" PVC & 18" RCP storm infrastructure to an existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report".

Basin P-2: Basin P-2 is 0.09 acres and consists entirely of the Kum & Go Convenience Store roof for an impervious value of 90.0%. The 5-year and 100-year C values were determined to be 0.76 and 0.85, respectively; and anticipated 5-year runoff flows of 0.34 CFS and 100-year runoff flows

of 0.70 CFS. Flows from Basin P-2 are captured by roof drains and conveyed via proposed 8" PVC & 18" RCP storm infrastructure to an existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report".

Basin P-3: Basin P-3 is 0.14 acres and consists entirely of the Kum & Go fueling canopy roof for an impervious value of 90.0%. The 5-year and 100-year C values were determined to be 0.76 and 0.85, respectively; and anticipated 5-year runoff flows of 0.49 CFS and 100-year runoff flows of 1.03 CFS. Flows from Basin P-3 are captured by roof drains and conveyed via proposed 8" PVC & 18" RCP storm infrastructure towards STM MH-1 and ultimately to an existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report".

Basin P-4: Basin P-4 is 0.08 acres near the northwest corner of the site and consists of hardscape sidewalk, parking and drives for an impervious value of 91.0%. The 5-year and 100-year C values were determined to be 0.78 and 0.85, respectively; and anticipated 5-year runoff flows of 0.28 CFS and 100-year runoff flows of 0.57 CFS. Flows from Basin P-4 sheet flow across the parking and drives to proposed curb and gutter that conveys the runoff to a proposed Type 13 combination inlet (Inlet 1) at Design Point 3. Inlet 1 will capture 0.2 cfs and 0.4 cfs in the 5-year and 100-year storm events respectively and the remaining runoff will bypass and flow into the N. Pinery Parkway ROW. Captured runoff will be conveyed from the inlet via proposed 18" RCP storm infrastructure towards Inlet 2 and then to an existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report". Bypass runoff will be conveyed via existing curb and gutter within the ROW to the existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report".

Basin P-5: Basin P-5 is 0.49 acres near the southwest portion of the site and consists of hardscape sidewalk, parking and drives as well as landscaping for an impervious value of 68.0%. The 5-year and 100-year C values were determined to be 0.59 and 0.76, respectively; and anticipated 5-year runoff flows of 1.30 CFS and 100-year runoff flows of 3.13 CFS. Flows from Basin P-5 sheet flow across the parking and drives to proposed curb and gutter that conveys the runoff to a proposed 5' Type R inlet (Inlet 2) at Design Point 4. Inlet 2 will fully capture the 5-year and 100-year storm events. Captured runoff will be conveyed from the inlet via proposed 18" RCP storm infrastructure to an existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report".

Basin P-6: Basin P-6 is 0.15 acres near the northeast portion of the site and consists of hardscape sidewalk, parking and drives for an impervious value of 100%. The 5-year and 100-year C values were determined to be 0.85 and 0.89, respectively; and anticipated 5-year runoff flows of 0.60 CFS and 100-year runoff flows of 1.18 CFS. Flows from Basin P-6 sheet flow across the parking and drives to proposed curb and gutter that conveys the runoff to a proposed 5' Type R inlet

(Inlet 2) at Design Point 4. Inlet 2 will capture fully capture the 5-year and 100-year storm events. Captured runoff will be conveyed from the inlet via proposed 18" RCP storm infrastructure to an existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report".

Basin P-7: Basins P-7 is 0.69 acres located east of the proposed Kum & Go site and consists primarily of vacant commercial land with an assumed future developed impervious value of 90.0%. The 5-year and 100-year C values for the future developed site were determined to be 0.76 and 0.85, respectively; and anticipated 5-year runoff flows of 2.43 CFS and 100-year runoff flows of 5.07 CFS. Runoff from Basin P-7 in the interim undeveloped condition sheet flows off-site to the east where it is collected in existing storm infrastructure within the Alpine Phlox ROW. The proposed development includes an 18" RCP storm sewer along the northern boundary of Basin P-7. This pipe has been sized to convey the 5-year and 100-year future developed runoff from Basin P-7. At time of development runoff can be captured onsite and connected into the proposed 18" RCP storm sewer. Captured runoff will be conveyed via existing storm infrastructure to the existing detention Pond D per the "Master Drainage Report".

Basin P-8: Basins P-8 is 0.66 acres located south & east of the proposed Kum & Go site and consists primarily of vacant commercial land and a portion of the Alpine Phlox ROW with an assumed future developed impervious value of 90.0%. The 5-year and 100-year C values were determined to be 0.76 and 0.85, respectively; and anticipated 5-year runoff flows of 2.32 CFS and 100-year runoff flows of 4.86 CFS. Runoff from Basin P-8 sheet flow off-site to the east where it is collected in existing storm infrastructure within the Alpine Phlox ROW. At the time of development, runoff from Basin P-8 should be captured onsite and piped via proposed storm sewer to the existing inlet at Design Point 6. Captured runoff will be conveyed via existing storm infrastructure to the existing detention Pond D per the "Master Drainage Report".

Basin P-9: Basins P-9 is 1.03 acres located south and east of the proposed Kum & Go site and consists vacant commercial land, landscape, sidewalk, a portion of the private access road and a portion of the Alpine Phlox ROWs with an assumed future developed impervious value of 90.0%. The 5-year and 100-year C values were determined to be 0.76 and 0.85, respectively; and anticipated 5-year runoff flows of 3.61 CFS and 100-year runoff flows of 7.55 CFS. Runoff from Basin P-9 in the interim undeveloped condition sheet flows off-site to the north and east where it is collected in existing storm infrastructure within the Alpine Phlox ROW. The proposed development includes an 18" RCP storm sewer stub located at the northeast corner of Basin P-9 for future storm sewer connection. This pipe has been sized to convey the 5-year and 100-year future developed runoff from Basin P-9. At time of development runoff can be captured onsite and connected into the proposed 18" RCP storm sewer. Captured runoff will conveyed via existing storm infrastructure to the existing detention Pond D per the "Master Drainage Report".

Basin P-10: Basins P-10 is 0.91 acres located south and east of the proposed Kum & Go site and consists vacant commercial land, landscape, sidewalk and a portion of the N. Pinery Parkway and Alpine Phlox ROWs for an impervious value of 69.8%. The 5-year and 100-year C values were determined to be 0.60 and 0.77, respectively; and anticipated 5-year runoff flows of 2.39 CFS and

100-year runoff flows of 5.68 CFS. Runoff from Basin P-10 sheet flow off-site to the north and east where it is collected in proposed curb and gutter that conveys the runoff to a proposed on-grade 10' Type R inlet (Inlet 3) at Design Point 7. Inlet 3 will capture fully capture the 5-year and 84% of the 100-year storm events with approximately 1.2 cfs bypassing the inlet. Captured runoff will be conveyed from the inlet via proposed 18" RCP storm infrastructure an existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report". Bypass runoff will be conveyed via existing curb and gutter within the ROW to the existing inlet located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report".

Basin P-11: Basins P-11 is 1.49 acres located north of the proposed Kum & Go site and consists vacant commercial land, landscape, sidewalk and a portion of the N. Pinery Parkway and Alpine Phlox ROWs for an impervious value of 86.9%. The 5-year and 100-year C values were determined to be 0.74 and 0.84, respectively; and anticipated 5-year runoff flows of 5.23CFS and 100-year runoff flows of 11.02 CFS. Runoff from Basin P-11 sheet flow off-site to the north and east where it discharges offsite and is collected in existing curb and gutter that conveys the runoff to an existing storm inlet at Design Point 8, located east of the project site within the Alpine Phlox ROW that will ultimately convey the runoff to the existing detention Pond D per the "Master Drainage Report".

Refer to the Appendix for excerpts of the "Master Drainage Report" and the Proposed Drainage Plan.

Conclusions & Recommendations

In the proposed condition the site drainage is in conformance and follows the historic drainage patterns as outlined in the "Master Drainage Report". The proposed improvements within three proposed lots making up the existing Tract E result in an impervious value of 83.11%, which is significantly less than the approximately 90% allowed impervious values as outlined in the "Master Drainage Report". Therefore, the proposed development has addressed will not adversely affect the downstream storm infrastructure and will require no changes or additions to the existing storm sewer infrastructure and water quality and detention facility. It is requested that the City accept this letter of drainage compliance.

APPENDIX

- APPENDIX A
 - FEMA Firmette
 - NRCS Soil Survey
- APPENDIX B
 - Hydrology Calculations
- APPENDIX C
 - Hydraulic Calculations
- APPENDIX D
 - Master Drainage Report
 - Excerpts
 - Existing Drainage Map
- APPENDIX E
 - Developed Drainage Map

APPENDIX A
FIRM, Soil Survey

National Flood Hazard Layer FIRMette



104°47'17"W 39°27'50"N



Legend

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

- | | | |
|------------------------------------|--|--|
| SPECIAL FLOOD HAZARD AREAS | | Without Base Flood Elevation (BFE)
<i>Zone A, V, A99</i> |
| | | With BFE or Depth <i>Zone AE, AO, AH, VE, AR</i> |
| | | 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 <i>Zone X</i> |
| | | Future Conditions 1% Annual Chance Flood Hazard <i>Zone X</i> |
| | | Area with Reduced Flood Risk due to Levee. See Notes. <i>Zone X</i> |
| | | Area with Flood Risk due to Levee <i>Zone D</i> |
| OTHER AREAS | | NO SCREEN Area of Minimal Flood Hazard <i>Zone X</i> |
| | | Effective LOMRs |
| GENERAL STRUCTURES | | Area of Undetermined Flood Hazard <i>Zone D</i> |
| | | Channel, Culvert, or Storm Sewer |
| | | Levee, Dike, or Floodwall |
| OTHER FEATURES | | 20.2 Cross Sections with 1% Annual Chance Water Surface Elevation |
| | | 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation |
| | | Coastal Transect |
| | | Base Flood Elevation Line (BFE) |
| | | Limit of Study |
| | | Jurisdiction Boundary |
| MAP PANELS | | Coastal Transect Baseline |
| | | Profile Baseline |
| | | Hydrographic Feature |
| | | Digital Data Available |
| | | No Digital Data Available |
| | | Unmapped |



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

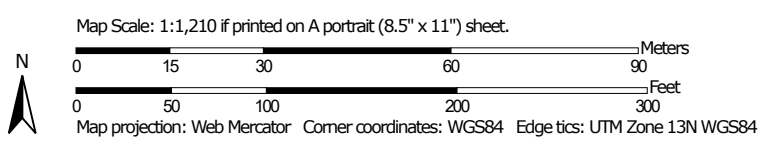
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **9/13/2022 at 6:37 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded 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.

Hydrologic Soil Group—Castle Rock Area, Colorado




Soil Map may not be valid at this scale.



MAP LEGEND

Area of Interest (AOI)









 Area of Interest (AOI)

Soils

Soil Rating Polygons





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

Soil Rating Lines


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

Soil Rating Points






 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Castle Rock Area, Colorado
 Survey Area Data: Version 14, Aug 31, 2021

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Fu	Fondis-Kutch association	C	5.7	74.9%
RoE	Renohill sandy loam, reddish variant, 5 to 20 percent slopes	D	1.9	25.1%
Totals for Area of Interest			7.5	100.0%

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX B
Hydrology Calculations

DEVELOPED CONDITION

Runoff Coefficients

Project: Kum & Go 2293 - SEC Bayou Gulch & N. Pinery Parkway - Parker, CO
 Section:

Created by: KMH Date: 2/26/2023
 Checked by: KMH Date: 2/26/2023

Sub-Basin Data			Composite C					Sub Area (Roof)					Sub Area (Drives/Walks)					Sub Area (Landscape)									
Basin ID	Description	Area	C ₂	C ₅	C ₁₀	C ₁₀₀	(%)	C ₂	C ₅	C ₁₀	C ₁₀₀	(%)	(ac)	C ₂	C ₅	C ₁₀	C ₁₀₀	(%)	(ac)	C ₂	C ₅	C ₁₀	C ₁₀₀	(%)	(ac)		
Developed Onsite																											
P-1	Landscaping & Walks	0.10	0.11	0.15	0.24	0.54	14.4	0.74	0.76	0.79	0.85	90	0.00	0.83	0.85	0.87	0.89	100	0.01	0.01	0.05	0.15	0.49	2	0.09		
P-2	Building	0.09	0.74	0.76	0.79	0.85	90.0	0.74	0.76	0.79	0.85	90	0.09	0.83	0.85	0.87	0.89	100	0.00	0.01	0.05	0.15	0.49	2	0.00		
P-3	Canopy	0.14	0.74	0.76	0.79	0.85	90.0	0.74	0.76	0.79	0.85	90	0.14	0.83	0.85	0.87	0.89	100	0.00	0.01	0.05	0.15	0.49	2	0.00		
P-4	Parking/Drives, Walks & Landscaping	0.08	0.75	0.78	0.80	0.85	91.0	0.74	0.76	0.79	0.85	90	0.00	0.83	0.85	0.87	0.89	100	0.07	0.01	0.05	0.15	0.49	2	0.01		
P-5	Private Drive, Walks & Landscaping	0.49	0.56	0.59	0.63	0.76	68.0	0.74	0.76	0.79	0.85	90	0.00	0.83	0.85	0.87	0.89	100	0.33	0.01	0.05	0.15	0.49	2	0.16		
P-6	Private Drive, Walks & Landscaping	0.15	0.83	0.85	0.87	0.89	100.0	0.74	0.76	0.79	0.85	90	0.00	0.83	0.85	0.87	0.89	100	0.15	0.01	0.05	0.15	0.49	2	0.00		
P-7	Vacant commercial property	0.69	0.74	0.76	0.79	0.85	90.0	ASSUME 90% IMPERVIOUS (PER MASTER STUDY)																			
P-8	Vacant commercial property	0.66	0.74	0.76	0.79	0.85	90.0	ASSUME 90% IMPERVIOUS (PER MASTER STUDY)																			
P-9	Vacant commercial property	1.03	0.74	0.76	0.79	0.85	90.0	ASSUME 90% IMPERVIOUS (PER MASTER STUDY)																			
P-10	Private Drive, Walks & Landscaping	0.91	0.58	0.60	0.65	0.77	69.8	0.74	0.76	0.79	0.85	90	0.00	0.83	0.85	0.87	0.89	100	0.63	0.01	0.05	0.15	0.49	2	0.28		
P-11	Private Drive, ROW, Walks & Landscaping	1.49	0.72	0.74	0.77	0.84	86.9	0.74	0.76	0.79	0.85	90	0.00	0.83	0.85	0.87	0.89	100	1.29	0.01	0.05	0.15	0.49	2	0.20		
Composite	Developed Site Composite	5.84	0.69	0.71	0.74	0.82	83.11						0.23						2.49						0.74		

DEVELOPED CONDITIONS

Time of Concentration

Project: Kum & Go 2293 - SEC Bayou Gulch & N. Pinery Parkway - Parker, CO
 Section: _____

Created by: KMH Date: 2/26/2023
 Checked by: KMH Date: 2/26/2023

Urban TOC_{min} = 5 min
 Rural TOC_{min} = 10 min

Basin ID	SUB-BASIN DATA			INITIAL/OVERLAND FLOW (t _o)			TRAVEL TIME (t _t)					Tc CHECK (Urbanized basins)				FINAL Tc (min)			
	Description	C _s	Area (ac)	Length (ft)	Slope (ft/ft)	t _o (min)	Length (ft)	S _w (ft/ft)	Code	Description	Convey Coef (C _c)	Velocity (ft/s)	Time (min)	t _c = t _t + t _o (min)	(Yes /No)		Length (ft)	T _c max (min)	Tc _{max} > t _c
P-1	Landscaping & Walks	0.15	0.10	28	0.25	3.13	10	0.01	5	Grassed waterway	15.00	1.50	0.11	3.24	YES	38.00	10.21	Regional Tc	5.00
P-2	Building	0.76	0.09	45	0.02	3.39	0	0.01	6	Paved areas and shallow paved swales	20.00	1.79	0.00	3.39	YES	45.00	10.25	Regional Tc	5.00
P-3	Canopy	0.76	0.14	50	0.02	3.80	0	0.01	6	Paved areas and shallow paved swales	20.00	1.41	0.00	3.80	YES	50.00	10.28	Regional Tc	5.00
P-4	Parking/Drives, Walks & Landscaping	0.78	0.08	42	0.04	2.39	89	0.04	6	Paved areas and shallow paved swales	20.00	4.00	0.37	2.76	YES	131.00	10.73	Regional Tc	5.00
P-5	Private Drive, Walks & Landscaping	0.59	0.49	143	0.10	5.16	87	0.01	6	Paved areas and shallow paved swales	20.00	2.00	0.73	5.89	YES	230.00	11.28	Regional Tc	5.89
P-6	Private Drive, Walks & Landscaping	0.85	0.15	47	0.02	2.46	133	0.02	6	Paved areas and shallow paved swales	20.00	2.83	0.78	3.25	YES	180.00	11.00	Regional Tc	5.00
P-7	Vacant commercial property	0.76	0.69	80	0.02	4.37	150	0.02	6	Paved areas and shallow paved swales	20.00	2.83	0.88	5.25	YES	230.00	11.28	Regional Tc	5.25
P-8	Vacant commercial property	0.76	0.66	80	0.02	4.37	180	0.02	6	Paved areas and shallow paved swales	20.00	2.83	1.06	5.43	YES	260.00	11.44	Regional Tc	5.43
P-9	Vacant commercial property	0.76	1.03	80	0.02	4.37	180	0.02	6	Paved areas and shallow paved swales	20.00	2.83	1.06	5.43	YES	260.00	11.44	Regional Tc	5.43
P-10	Private Drive, Walks & Landscaping	0.60	0.91	110	0.07	4.95	420	0.04	6	Paved areas and shallow paved swales	20.00	4.00	1.75	6.70	YES	530.00	12.94	Regional Tc	6.70
P-11	Private Drive,ROW, Walks & Landscaping	0.74	1.49	50	0.03	3.37	356	0.04	6	Paved areas and shallow paved swales	20.00	4.00	1.48	4.85	YES	406.00	12.26	Regional Tc	5.00

Notes:

t_t = (0.395*(1.1-C_s)*(L^0.5))/(S^0.33), from UDFCD Eqn 6-3

Velocity from V = C_s*S_w^{0.5}, from UDFCD Eqn 6-4, C_c from Table 6-2(See Sheet Design Info)

t_o = L/60V

t_c max = 10+L/180

Final Tc > 10 min for nonurban watersheds

UDFCD Table 6-2. NRCS Conveyance factors, K

Code	Type of Land Surface	Conveyance Factor, K
1	Heavy meadow	2.5
2	Tillage/field	5
3	Short pasture and lawns	7
4	Nearly bare ground	10
5	Grassed waterway	15
6	Paved areas and shallow paved swales	20

DEVELOPED CONDITIONS

Storm Drainage System Design (Rational Method Procedure)

Project: Kum & Go 2293 - SEC Bayou Gulch & N. Pinery Parkway - Parker, CO
 Section: _____

Created by: KMH
 Checked by: KMH
 2/26/2023
 2/26/2023

5 YEAR MINOR STORM

Design Storm: 5-yr P = 1.39 in

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS	
		AREA DESIGN (name)	AREA (AC)	RUNOFF COEFF (5 Yr)	t _c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t _c (MIN)	SUM (C* A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (in)	LENGTH (FT)	VELOCITY (FPS)	t _c (MIN)		
DP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	Developed																					
	P-1	Landscaping & Walks	P-1	0.10	0.15	5.00	0.02	4.71	0.07													Slotted Drain
	P-2	Building	P-2	0.09	0.76	5.00	0.07	4.71	0.34													Roof Drain
1	P-1 & P-2			0.20						5.00	0.09	4.71	0.41									
	P-3	Canopy	P-3	0.14	0.76	5.00	0.10	4.71	0.49													Roof Drain
2	DP1 & P-3			0.34						5.00	0.19	4.71	0.90									STM MH-1
	P-4	Parking/Drives, Walks & Landscaping	P-4	0.08	0.78	5.00	0.06	4.71	0.28													Inlet 1
3	DP2 & P-4			0.41						5.00	0.25	4.71	1.18									
	P-5	Private Drive, Walks & Landscaping	P-5	0.49	0.59	5.89	0.29	4.51	1.30													
	P-6	Private Drive, Walks & Landscaping	P-6	0.15	0.85	5.00	0.13	4.71	0.60													
4	P-5 & P-6			0.64						5.89	0.42	4.51	1.87									Inlet 2
	P-7	Vacant commercial property	P-7	0.69	0.76	5.25	0.52	4.65	2.43													
5	P-7, DP3 & DP4			1.74						5.89	1.19	4.51	5.35									DPS
	P-8	Vacant commercial property	P-8	0.66	0.76	5.43	0.50	4.61	2.32													Existing Inlet
	P-9	Vacant commercial property	P-9	1.03	0.76	5.43	0.78	4.61	3.61													18" STM Stub
	P-10	Private Drive, Walks & Landscaping	P-10	0.91	0.60	6.70	0.55	4.33	2.39													Inlet 3
7	P-9 + P-10			1.94						6.70	1.33	4.33	5.79									
	P-11	Private Drive, ROW, Walks & Landscaping	P-11	1.49	0.74	5.00	1.11	4.71	5.23													
8	DP5 & P-11			3.23						5.89	2.30	4.51	10.35									Existing Inlet

DEVELOPED CONDITIONS

Storm Drainage System Design (Rational Method Procedure)

Project: Kum & Go 2293 - SEC Bayou Gulch & N. Pinery Parkway - Parker, CO
 Section: _____

Created by: KMH
 Checked by: KMH
 2/26/2023
 2/26/2023

100 YEAR MAJOR STORM

Design Storm: 100-yr P = 2.60 in

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME		REMARKS		
		AREA DESIGN (name)	AREA (AC)	RUNOFF COEFF (100 Yr)	t _c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t _c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (in)	LENGTH (FT)	VELOCITY (FPS)		t _c (MIN)	
DP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Developed																						
	P-1	Landscaping & Walks	P-1	0.10	0.54	5.00	0.06	8.82	0.50													Slotted Drain
	P-2	Building	P-2	0.09	0.85	5.00	0.08	8.82	0.70													Roof Drain
1	P-1 & P-2			0.20						5.00	0.14	8.82	1.20									
	P-3	Canopy	P-3	0.14	0.85	5.00	0.12	8.82	1.03													Roof Drain
2	DP1 & P-3			0.34						5.00	0.25	8.82	2.23									STM MH-1
	P-4	Parking/Drives, Walks & Landscaping	P-4	0.08	0.85	5.00	0.06	8.82	0.57													Inlet 1
3	DP2 & P-4			0.41						5.00	0.32	8.82	2.80									
	P-5	Private Drive, Walks & Landscaping	P-5	0.49	0.76	5.89	0.37	8.43	3.13													
	P-6	Private Drive, Walks & Landscaping	P-6	0.15	0.89	5.00	0.13	8.82	1.18													
4	P-5 & P-6			0.64						5.89	0.51	8.43	4.26									Inlet 2
	P-7	Vacant commercial property	P-7	0.69	0.85	5.25	0.58	8.70	5.07													
5	P-7, DP3 & DP4			1.74						5.89	1.41	8.43	11.85									DP5
6	P-8	Vacant commercial property	P-8	0.66	0.85	5.43	0.56	8.63	4.86													Existing Inlet
	P-9	Vacant commercial property	P-9	1.03	0.85	5.43	0.88	8.63	7.55													
	P-10	Private Drive, Walks & Landscaping	P-10	0.91	0.77	6.70	0.70	8.11	5.68													18" STM Stub
7	P-9 + P-10			1.94						6.70	1.58	8.11	12.78									Inlet 3
	P-11	Private Drive, ROW, Walks & Landscaping	P-11	1.49	0.84	5.00	1.25	8.82	11.02													
8	DP5 & P-11			3.23						5.89	2.66	8.43	22.38									Existing Inlet

- (1) Enter the Basin Name from C Value Sheet
- (2) Basin Description linked to C-Value Sheet
- (3) Enter the Basin Name from C-Value Sheet
- (4) Basin Area linked to C-Value Sheet
- (5) Composite C linked to C-Value Sheet
- (6) Time of Concentration linked to C-Value Sheet

- (7) =Column 4 x Column 5
- (8) =28.5*P/(10+Column 6)^0.786
- (9) =Column 7 x Column 8
- (10) =Column 6 x Column 21
- (11) Add the Basin Areas (7) to get the combined basin AC
- (12) =28.5*P/(10+Column 10)^0.786

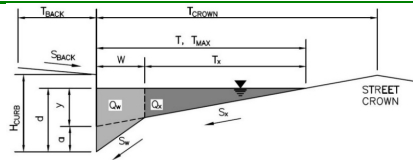
- (13) Sum of Qs
- (14) Additional Street Overland Flow
- (15) Additional Street Overland Flow
- (16) Additional Pipe Flow
- (17) Additional Pipe Flow
- (18) Additional Pipe Flow

- (19) Additional Flow Length
- (20) Overland Velocity
- (21) =Column 16 / Column 20 / 60

APPENDIX C
Hydraulic Calculations

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)
 (Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

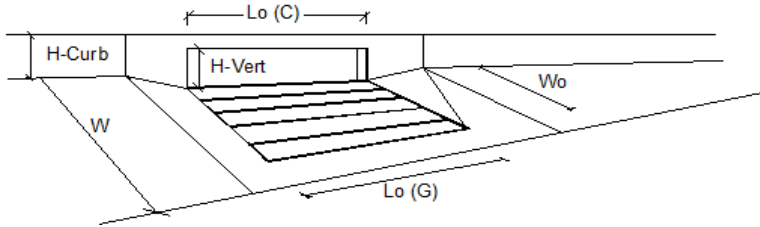
Project: **Kum & Go 2293 - Pinery & Bayou Gulch**
 Inlet ID: **INLET 1**



Gutter Geometry:	
Maximum Allowable Width for Spread Behind Curb	$T_{BACK} = 0.5$ 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	$T_{CROWN} = 30.0$ 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	$S_0 = 0.040$ ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	$n_{STREET} = 0.013$
Max. Allowable Spread for Minor & Major Storm	$T_{MAX} = \begin{matrix} \text{Minor Storm} & \text{Major Storm} \\ 30.0 & 30.0 \end{matrix}$ ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	$d_{MAX} = \begin{matrix} \text{Minor Storm} & \text{Major Storm} \\ 6.0 & 6.0 \end{matrix}$ inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)	<input type="checkbox"/> <input type="checkbox"/>
MINOR STORM Allowable Capacity is based on Depth Criterion	$Q_{allow} = \begin{matrix} \text{Minor Storm} & \text{Major Storm} \\ 20.0 & 20.0 \end{matrix}$ cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	
<p>Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'</p> <p>Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'</p>	

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



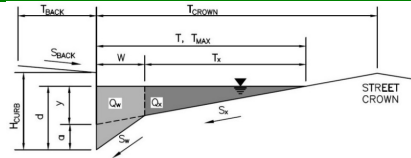
Design Information (Input)	MINOR		MAJOR	
Type of Inlet	CDOT/Denver 13 Combination			
Local Depression (additional to continuous gutter depression 'a')	$a_{LOCAL} =$	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	$L_o =$	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	$W_o =$	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	$C_r-G =$	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	$C_r-C =$	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity				
Total Inlet Interception Capacity	$Q =$	0.2	0.4	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	$Q_o =$	0.1	0.2	cfs
Capture Percentage = $Q_o/Q_o =$	$C\% =$	75	73	%

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

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

Project: Kum & Go 2293 - Pinery & Bayou Gulch

Inlet ID: INLET 2



Gutter Geometry:

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

T _{BACK} =	0.5	ft
S _{BACK} =	0.020	ft/ft
n _{BACK} =	0.020	

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

H _{CURB} =	6.00	inches
T _{CROWN} =	30.0	ft
W =	1.00	ft
S _x =	0.020	ft/ft
S _w =	0.083	ft/ft
S _o =	0.000	ft/ft
n _{STREET} =	0.013	

Max. Allowable Spread for Minor & Major Storm
 Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
 Check boxes are not applicable in SUMP conditions

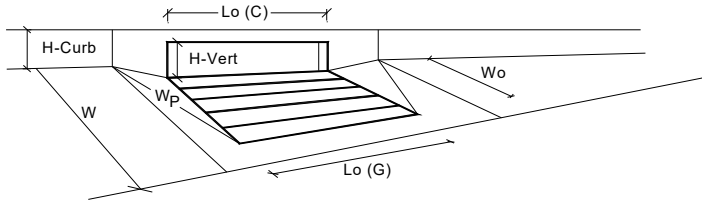
	Minor Storm	Major Storm	
T _{MAX} =	24.0	24.0	ft
d _{MAX} =	5.0	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

[MINOR STORM Allowable Capacity is based on Depth Criterion](#)
[MAJOR STORM Allowable Capacity is based on Depth Criterion](#)

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

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



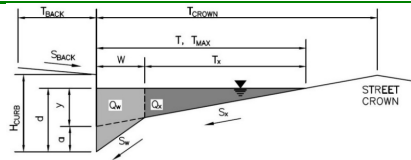
Design Information (Input)		<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>MINOR</th> <th>MAJOR</th> <th></th> </tr> </thead> <tbody> <tr> <td>Type =</td> <td>CDOT Type R Curb Opening</td> <td></td> <td></td> </tr> <tr> <td>a_{local} =</td> <td>3.00</td> <td>3.00</td> <td>inches</td> </tr> <tr> <td>No =</td> <td>1</td> <td>1</td> <td></td> </tr> <tr> <td>Ponding Depth =</td> <td>5.0</td> <td>6.0</td> <td>inches</td> </tr> <tr> <td></td> <td style="text-align: center;">MINOR</td> <td style="text-align: center;">MAJOR</td> <td><input type="checkbox"/> Override Depths</td> </tr> <tr> <td>L_o (G) =</td> <td>N/A</td> <td>N/A</td> <td>feet</td> </tr> <tr> <td>W_o =</td> <td>N/A</td> <td>N/A</td> <td>feet</td> </tr> <tr> <td>A_{ratio} =</td> <td>N/A</td> <td>N/A</td> <td></td> </tr> <tr> <td>C_f (G) =</td> <td>N/A</td> <td>N/A</td> <td></td> </tr> <tr> <td>C_w (G) =</td> <td>N/A</td> <td>N/A</td> <td></td> </tr> <tr> <td>C_o (G) =</td> <td>N/A</td> <td>N/A</td> <td></td> </tr> <tr> <td></td> <td style="text-align: center;">MINOR</td> <td style="text-align: center;">MAJOR</td> <td></td> </tr> <tr> <td>L_o (C) =</td> <td>5.00</td> <td>5.00</td> <td>feet</td> </tr> <tr> <td>H_{vert} =</td> <td>6.00</td> <td>6.00</td> <td>inches</td> </tr> <tr> <td>H_{throat} =</td> <td>6.00</td> <td>6.00</td> <td>inches</td> </tr> <tr> <td>Theta =</td> <td>63.40</td> <td>63.40</td> <td>degrees</td> </tr> <tr> <td>W_p =</td> <td>1.00</td> <td>1.00</td> <td>feet</td> </tr> <tr> <td>C_f (C) =</td> <td>0.10</td> <td>0.10</td> <td></td> </tr> <tr> <td>C_w (C) =</td> <td>3.60</td> <td>3.60</td> <td></td> </tr> <tr> <td>C_o (C) =</td> <td>0.67</td> <td>0.67</td> <td></td> </tr> <tr> <td></td> <td style="text-align: center;">MINOR</td> <td style="text-align: center;">MAJOR</td> <td></td> </tr> <tr> <td>d_{Grate} =</td> <td>N/A</td> <td>N/A</td> <td>ft</td> </tr> <tr> <td>d_{Curb} =</td> <td>0.33</td> <td>0.42</td> <td>ft</td> </tr> <tr> <td>$RF_{Combination}$ =</td> <td>0.64</td> <td>0.77</td> <td></td> </tr> <tr> <td>RF_{Curb} =</td> <td>1.00</td> <td>1.00</td> <td></td> </tr> <tr> <td>RF_{Grate} =</td> <td>N/A</td> <td>N/A</td> <td></td> </tr> <tr> <td></td> <td style="text-align: center;">MINOR</td> <td style="text-align: center;">MAJOR</td> <td></td> </tr> <tr> <td>Q_a =</td> <td>4.2</td> <td>5.9</td> <td>cfs</td> </tr> <tr> <td>$Q_{PEAK REQUIRED}$ =</td> <td>1.9</td> <td>4.3</td> <td>cfs</td> </tr> </tbody> </table>			MINOR	MAJOR		Type =	CDOT Type R Curb Opening			a_{local} =	3.00	3.00	inches	No =	1	1		Ponding Depth =	5.0	6.0	inches		MINOR	MAJOR	<input type="checkbox"/> Override Depths	L_o (G) =	N/A	N/A	feet	W_o =	N/A	N/A	feet	A_{ratio} =	N/A	N/A		C_f (G) =	N/A	N/A		C_w (G) =	N/A	N/A		C_o (G) =	N/A	N/A			MINOR	MAJOR		L_o (C) =	5.00	5.00	feet	H_{vert} =	6.00	6.00	inches	H_{throat} =	6.00	6.00	inches	Theta =	63.40	63.40	degrees	W_p =	1.00	1.00	feet	C_f (C) =	0.10	0.10		C_w (C) =	3.60	3.60		C_o (C) =	0.67	0.67			MINOR	MAJOR		d_{Grate} =	N/A	N/A	ft	d_{Curb} =	0.33	0.42	ft	$RF_{Combination}$ =	0.64	0.77		RF_{Curb} =	1.00	1.00		RF_{Grate} =	N/A	N/A			MINOR	MAJOR		Q_a =	4.2	5.9	cfs	$Q_{PEAK REQUIRED}$ =	1.9	4.3	cfs
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H_{vert} =	6.00	6.00	inches																																																																																																																								
H_{throat} =	6.00	6.00	inches																																																																																																																								
Theta =	63.40	63.40	degrees																																																																																																																								
W_p =	1.00	1.00	feet																																																																																																																								
C_f (C) =	0.10	0.10																																																																																																																									
C_w (C) =	3.60	3.60																																																																																																																									
C_o (C) =	0.67	0.67																																																																																																																									
	MINOR	MAJOR																																																																																																																									
d_{Grate} =	N/A	N/A	ft																																																																																																																								
d_{Curb} =	0.33	0.42	ft																																																																																																																								
$RF_{Combination}$ =	0.64	0.77																																																																																																																									
RF_{Curb} =	1.00	1.00																																																																																																																									
RF_{Grate} =	N/A	N/A																																																																																																																									
	MINOR	MAJOR																																																																																																																									
Q_a =	4.2	5.9	cfs																																																																																																																								
$Q_{PEAK REQUIRED}$ =	1.9	4.3	cfs																																																																																																																								
Type of Inlet	CDOT Type R Curb Opening																																																																																																																										
Local Depression (additional to continuous gutter depression 'a' from above)																																																																																																																											
Number of Unit Inlets (Grate or Curb Opening)																																																																																																																											
Water Depth at Flowline (outside of local depression)																																																																																																																											
Grate Information																																																																																																																											
Length of a Unit Grate																																																																																																																											
Width of a Unit Grate																																																																																																																											
Area Opening Ratio for a Grate (typical values 0.15-0.90)																																																																																																																											
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)																																																																																																																											
Grate Weir Coefficient (typical value 2.15 - 3.60)																																																																																																																											
Grate Orifice Coefficient (typical value 0.60 - 0.80)																																																																																																																											
Curb Opening Information																																																																																																																											
Length of a Unit Curb Opening																																																																																																																											
Height of Vertical Curb Opening in Inches																																																																																																																											
Height of Curb Orifice Throat in Inches																																																																																																																											
Angle of Throat (see USDCM Figure ST-5)																																																																																																																											
Side Width for Depression Pan (typically the gutter width of 2 feet)																																																																																																																											
Clogging Factor for a Single Curb Opening (typical value 0.10)																																																																																																																											
Curb Opening Weir Coefficient (typical value 2.3-3.7)																																																																																																																											
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)																																																																																																																											
Low Head Performance Reduction (Calculated)																																																																																																																											
Depth for Grate Midwidth																																																																																																																											
Depth for Curb Opening Weir Equation																																																																																																																											
Combination Inlet Performance Reduction Factor for Long Inlets																																																																																																																											
Curb Opening Performance Reduction Factor for Long Inlets																																																																																																																											
Grated Inlet Performance Reduction Factor for Long Inlets																																																																																																																											
Total Inlet Interception Capacity (assumes clogged condition)																																																																																																																											
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)																																																																																																																											

Warning 5: The width of unit is greater than the gutter width.

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

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

Project: Kum & Go 2293 - Pinery & Bayou Gulch
Inlet ID: INLET 3



Gutter Geometry:

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

T _{BACK} =	2.0	ft
S _{BACK} =	0.020	ft/ft
n _{BACK} =	0.020	

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

H _{CURB} =	6.00	inches
T _{CROWN} =	35.0	ft
W =	2.00	ft
S _X =	0.028	ft/ft
S _W =	0.083	ft/ft
S ₀ =	0.038	ft/ft
n _{STREET} =	0.015	

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

	Minor Storm	Major Storm	
T _{MAX} =	35.0	35.0	ft
d _{MAX} =	6.0	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

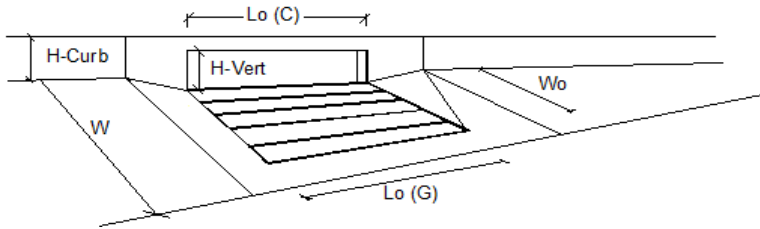
MINOR STORM Allowable Capacity is based on Depth Criterion
 MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
Q _{allow} =	14.2	14.2	cfs

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

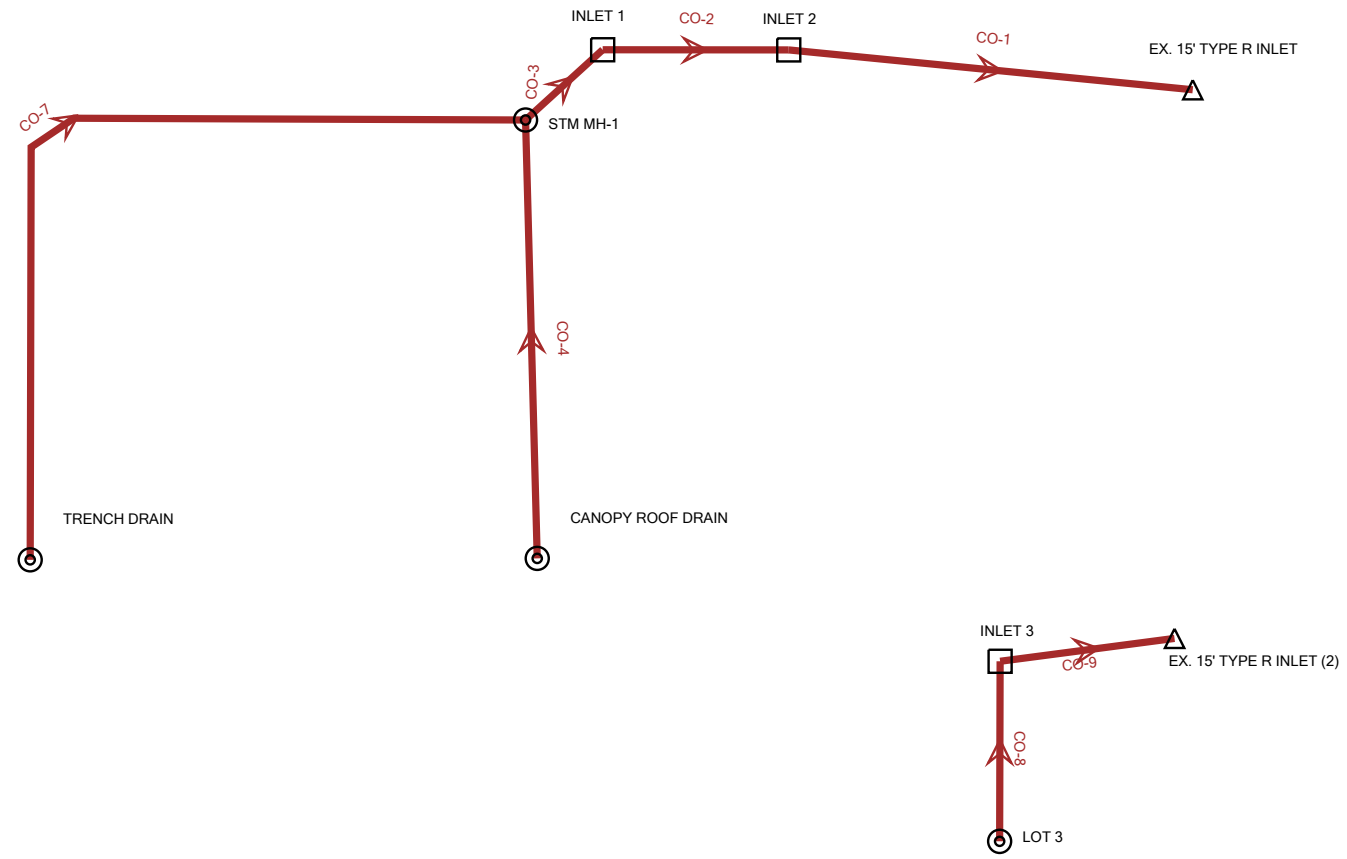
INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



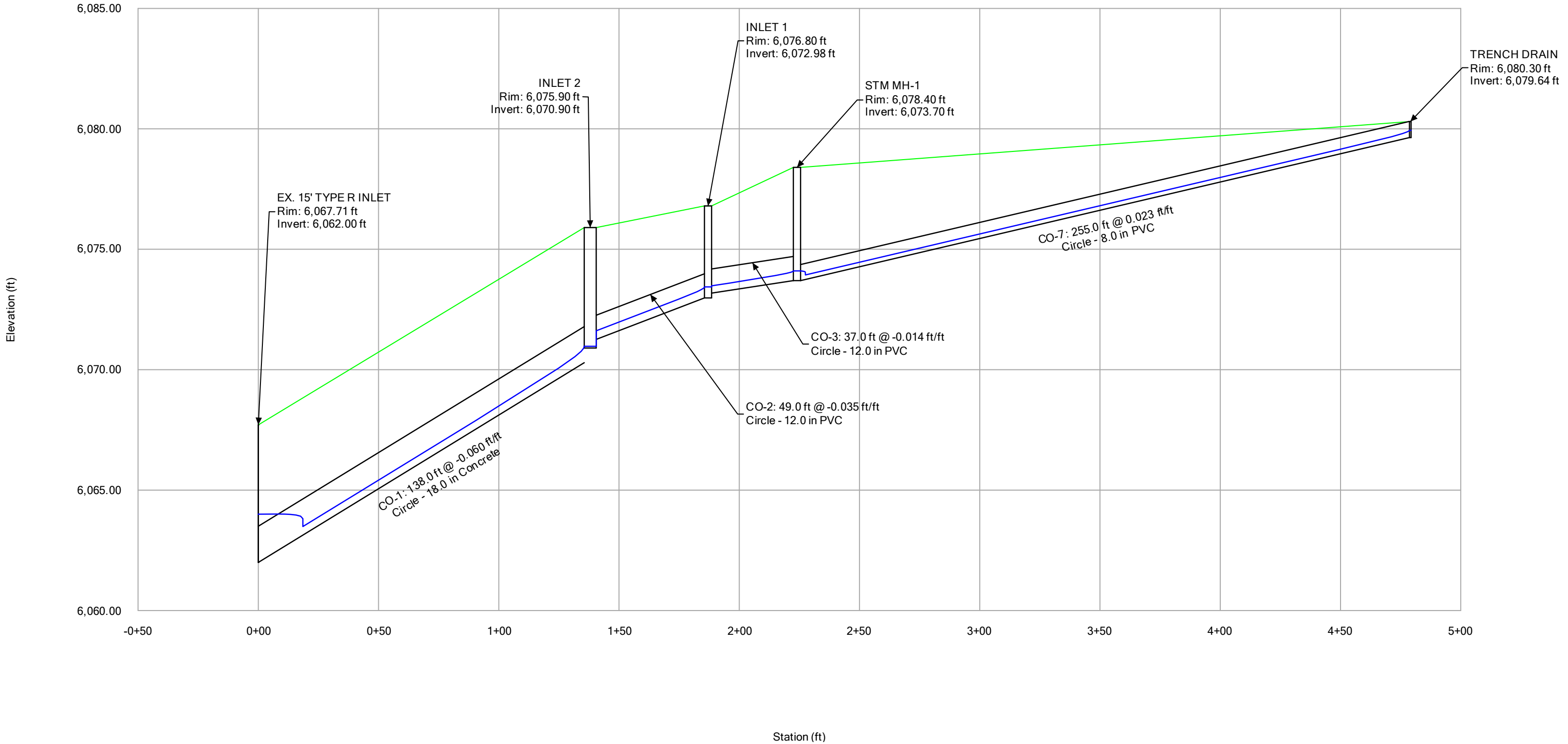
Design Information (Input)	MINOR	MAJOR	
Type of Inlet	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity			
Total Inlet Interception Capacity	3.6	6.3	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	0.0	1.2	cfs
Capture Percentage = Q_i/Q_o =	100	84	%

STORMCAD MODEL

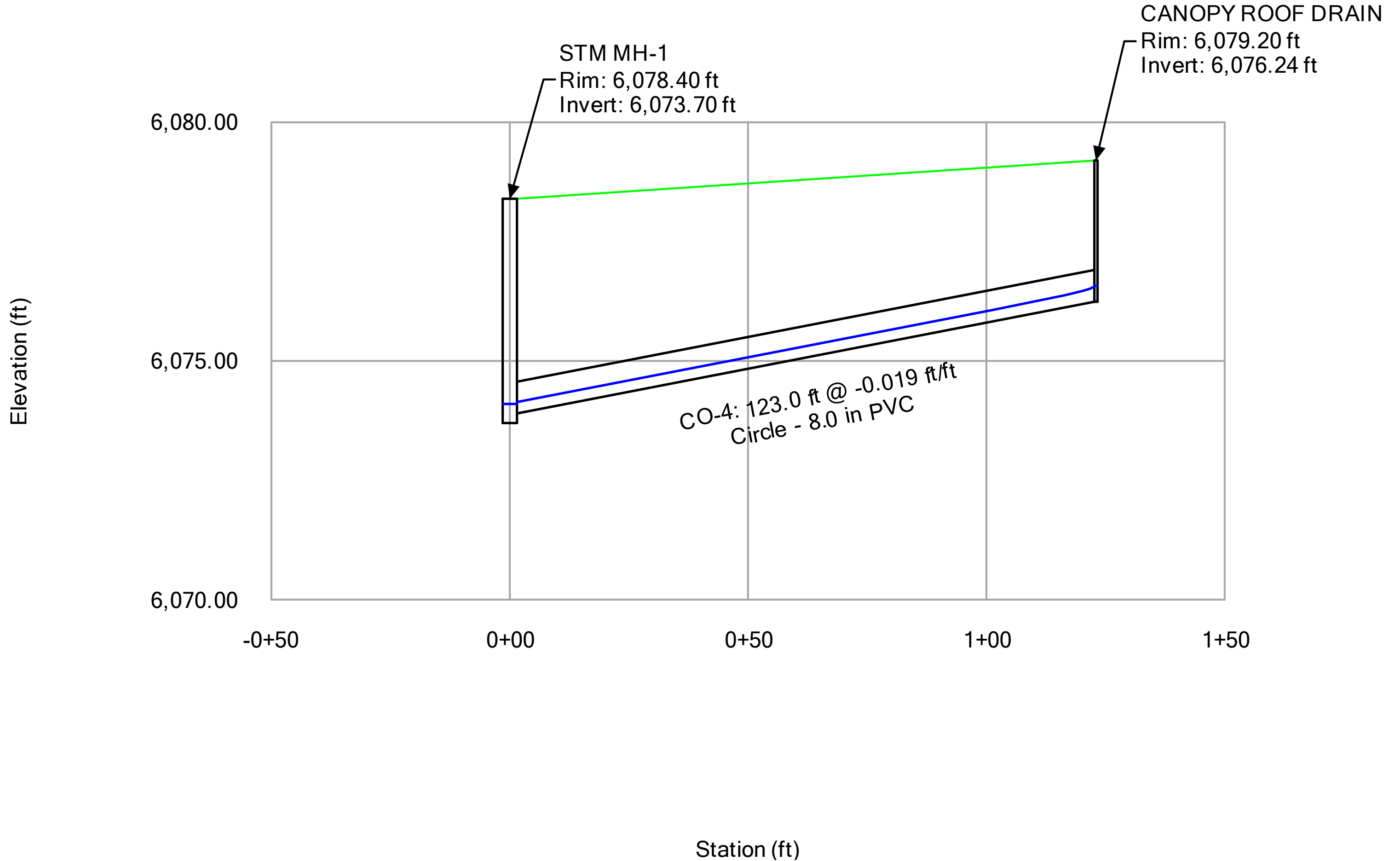


Profile Report

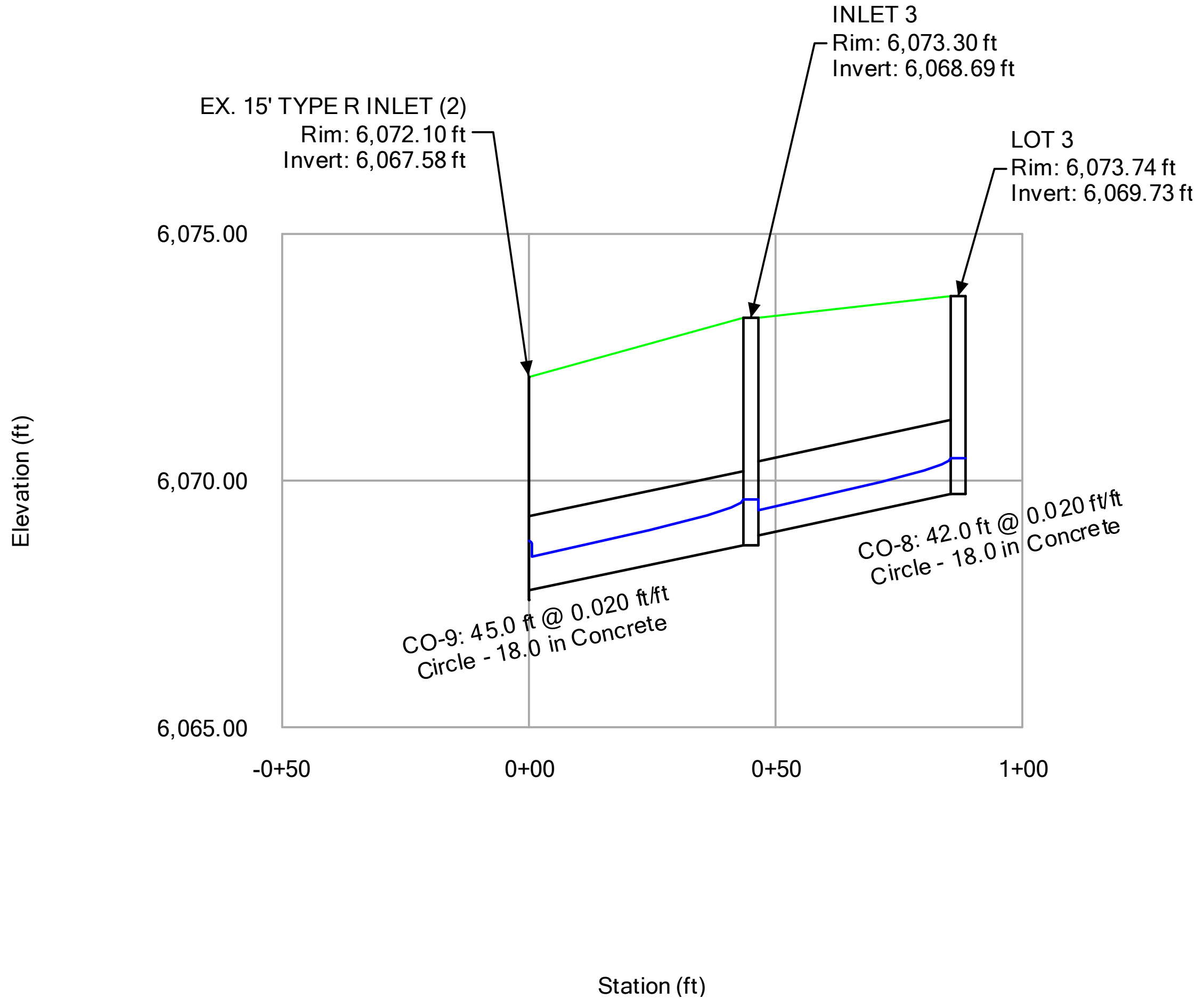
Engineering Profile - Profile - 1 (2293_Parker_Storm CAD.stsw)



Profile Report
Engineering Profile - Profile - 2 (2293_Parker_Storm CAD.stsw)



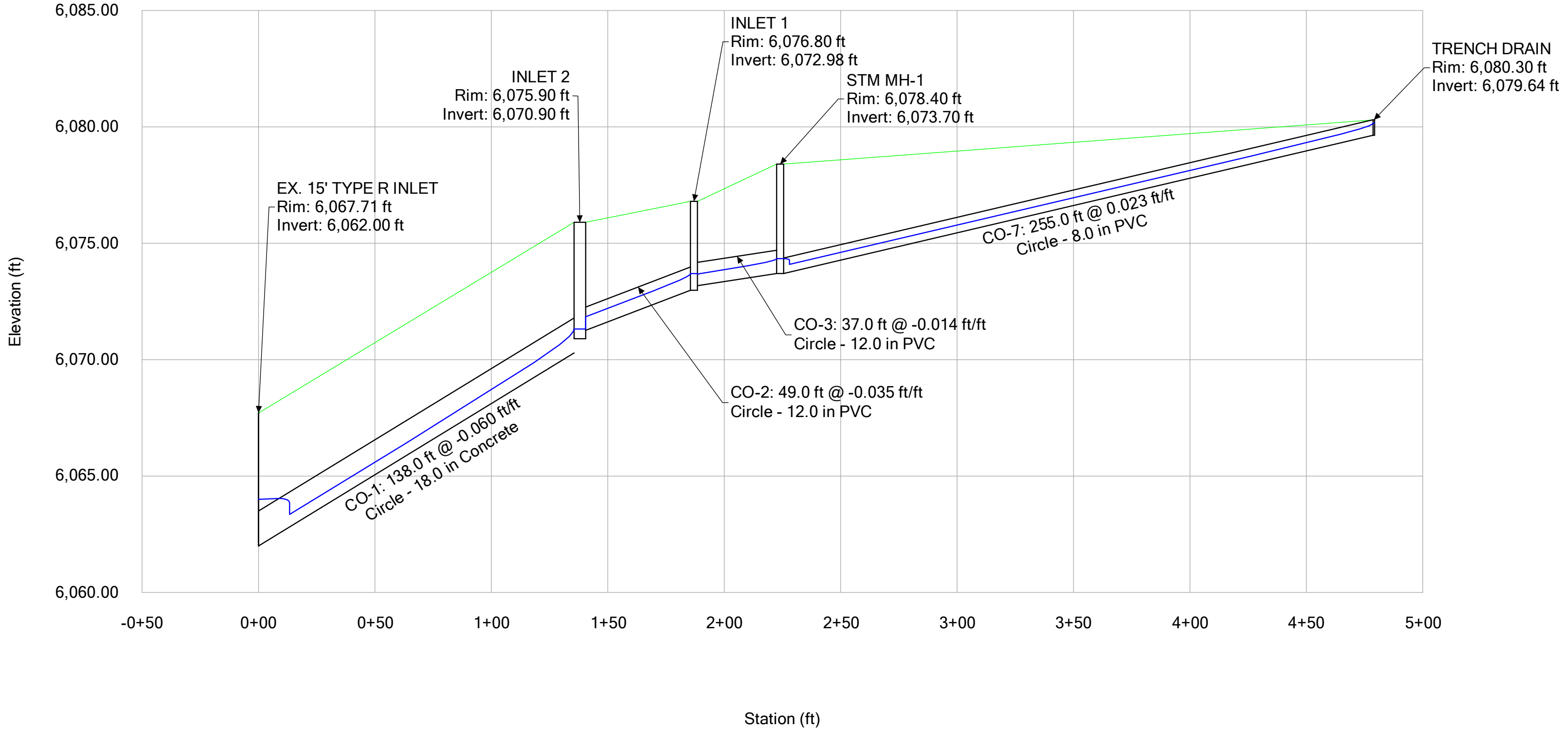
Profile Report
Engineering Profile - Profile - 3 (2293_Parker_Storm CAD.stsw)



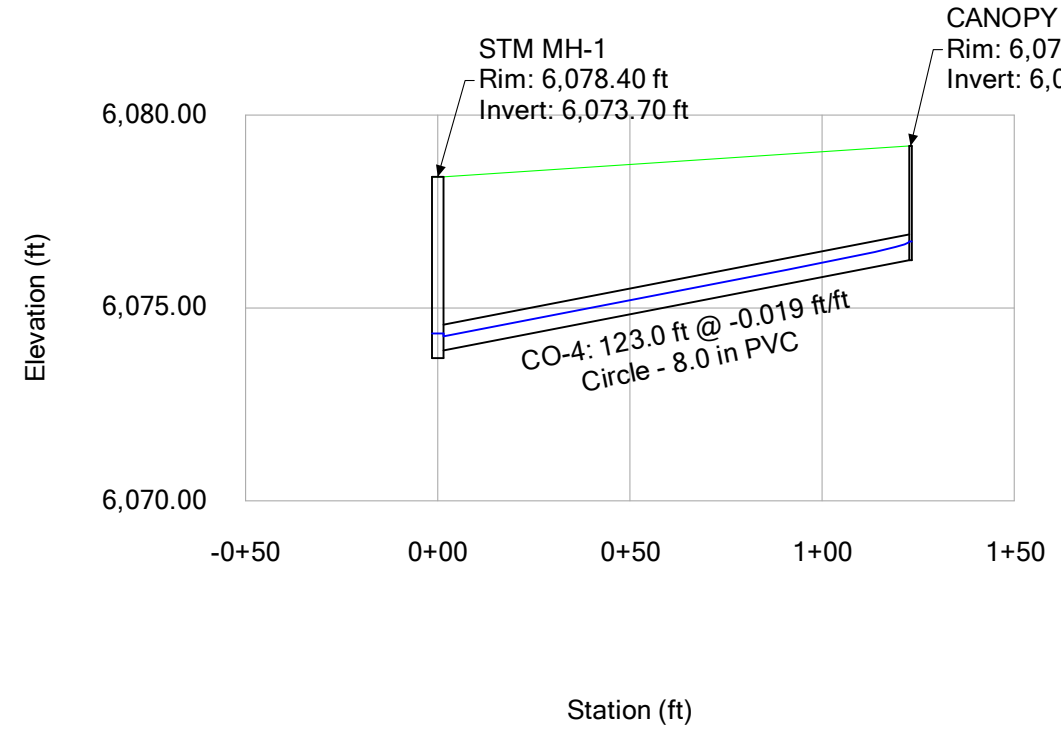
5-YR STORM EVENT

Label	-Node- Upstream Downstream	Diameter (in)	Slope (Calculated) (ft/ft)	Flow (cfs)	Length (User Defined) (ft)	Velocity (ft/s)	-EGL- Upstream Downstream (ft)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Invert- Upstream Downstream (ft)	Section Discharge Capacity (cfs)	Capacity (Design) (cfs)
CO-1	EX. 15' TYPE R INLET	18	-0.06	3.19	138	9.91	(N/A)	6067.71	6070.97	6062	3.19	25.74
	INLET 2						6071.31	6075.9	6064	6070.9	25.74	
CO-2	INLET 2	12	-0.035	1.18	49	4.7	6071.23	6075.9	6073.44	6070.9	1.18	4.34
	INLET 1						6073.76	6076.8	6071.62	6072.98	4.34	
CO-3	INLET 1	12	-0.014	0.91	37	4.54	6073.61	6076.8	6074.1	6072.98	0.91	4.58
	STM MH-1						6074.15	6078.4	6073.48	6073.7	4.58	
CO-4	STM MH-1	8	-0.019	0.5	123	4.42	6074.25	6078.4	6076.57	6073.7	0.5	1.81
	CANOPY ROOF DRAIN						6076.7	6079.2	6074.14	6076.24	1.81	
CO-7	TRENCH DRAIN	8	0.023	0.41	255	5.13	6080.05	6080.3	6079.94	6079.64	0.41	2.4
	STM MH-1						6074.15	6078.4	6074.1	6073.7	2.4	
CO-8	LOT 3	18	0.02	3.61	42	6.93	6070.74	6073.74	6070.46	6069.73	3.61	14.85
	INLET 3						6069.9	6073.3	6069.62	6068.69	14.85	
CO-9	INLET 3	18	0.02	5.79	45	7.91	6070.01	6073.3	6069.62	6068.69	5.79	14.94
	EX. 15' TYPE R INLET (2)						(N/A)	6072.1	6068.78	6067.58	14.94	

Profile Report
Engineering Profile - Profile - 1 (2293_Parker_Storm CAD.stsw)

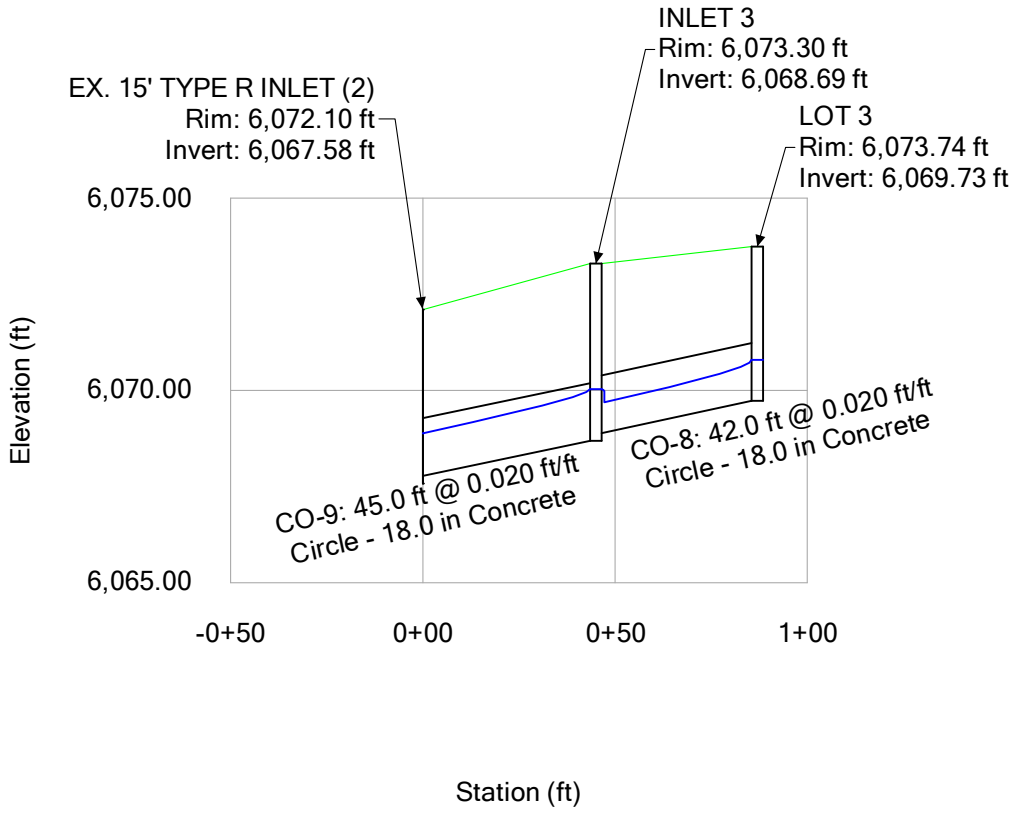


Profile Report
Engineering Profile - Profile - 2 (2293_Parker_Storm CAD.stsw)



Profile Report

Engineering Profile - Profile - 3 (2293_Parker_Storm CAD.stsw)



100-YEAR STORM EVENT

Label	-Node- Upstream Downstream	Diameter (in)	Slope (Calculated) (ft/ft)	Flow (cfs)	Length (User Defined) (ft)	Velocity (ft/s)	-EGL- Upstream Downstream (ft)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Invert- Upstream Downstream (ft)	Section Discharge Capacity (cfs)	Capacity (Design) (cfs)
CO-1	EX. 15' TYPE R INLET	18	-0.06	7.06	138	12.42	(N/A)	6067.71	6071.32	6062	7.06	25.74
	INLET 2						6071.85	6075.9	6064	6070.9	25.74	
CO-2	INLET 2	12	-0.035	2.8	49	5.87	6071.78	6075.9	6073.7	6070.9	2.8	4.34
	INLET 1						6074.21	6076.8	6071.84	6072.98	4.34	
CO-3	INLET 1	12	-0.014	2.23	37	5.79	6074.03	6076.8	6074.34	6072.98	2.23	4.58
	STM MH-1						6074.78	6078.4	6073.68	6073.7	4.58	
CO-4	STM MH-1	8	-0.019	1.03	123	5.34	6074.61	6078.4	6076.72	6073.7	1.03	1.81
	CANOPY ROOF DRAIN						6076.95	6079.2	6074.26	6076.24	1.81	
CO-7	TRENCH DRAIN	8	0.023	1.2	255	6.87	6080.42	6080.3	6080.16	6079.64	1.2	2.4
	STM MH-1						6074.78	6078.4	6074.34	6073.7	2.4	
CO-8	LOT 3	18	0.02	7.55	42	8.44	6071.29	6073.74	6070.79	6069.73	7.55	14.85
	INLET 3						6070.46	6073.3	6070.03	6068.69	14.85	
CO-9	INLET 3	18	0.02	12.78	45	9.5	6070.94	6073.3	6070.03	6068.69	12.78	14.94
	EX. 15' TYPE R INLET (2)						(N/A)	6072.1	6068.88	6067.58	14.94	

APPENDIX D
Master Drainage Report & Amendment Excerpts



10333 E Dry Creek Road, Ste 240
Englewood, Colorado 80112
www.cvlci.com

720.482.9526

TRAILS AT CROWFOOT FINAL DRAINAGE REPORT

Prepared for:
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Englewood, CO 80112
Phone (303) -440-9111
Contact: Chris Elliott

Prepared by:
CVL Consultants of Colorado, Inc.
10333 E. Dry Creek Road, Suite 240
Englewood, CO 80112
Phone (720) 482-9526
Contact: Mark Scheurer, P.E.

CVL PROJECT NO. 8130283701

June 2018
May 2018 (Revised)
February 2018 (Revised)
October 2017 (Revised)

TRAILS AT CROWFOOT
Town of Parker, Colorado



*This report for the Final design of **Trails at Crowfoot** was prepared by me or under my direct supervision in accordance with the provisions of the Town of Parker Storm Drainage and Enviromental Criteria Manual. I understand that the Town of Parker and its designated town authority do not and will not assume liability for drainage facilities designed by other.*

A handwritten signature in blue ink, appearing to read "Mark Scheurer".

Signature

48988

Colorado P.E. License No.

June 18,2018

Seal and Date



POND C	
Description	
Drainage Area (ACRES)	101.09
Percent Impervious (%)	44.49
WQCV Volume (AC-FT)	1.495
EURV Volume (including WQCV) (AC-FT)	4.262
EURV water surface (FT)	5975.55
100-YR Volume (including EURV) (AC-FT)	8.444
100-YR water surface (FT)	5977.94
Emergency Spillway Elevation (FT)	5978.15
100-YR Peak Inflow (CFS)	204.8
100-YR Peak Outflow (CFS)	106.5
100-YR Peak Allowable (CFS)	111.36

Pond C complies with CRS 37-92-602(8). The UD-Detention worksheet is included in the appendix.

Pond D is a maintenance eligible regional facility with a drainage area of 50.2 acres. The weighted average imperviousness for the area is 55.4%. The pond provides full spectrum detention per UDFCD requirements. The UD-Detention spreadsheet was utilized to determine the WQCV and EURV. The CUHP/SWMM with calculated allowable release rates was utilized to determine the 100-year volume. The outlet discharges to Cherry Creek and will comply with Cherry Creek Reservoir Control Regulations. The overflow for Pond D conveys the peak inflow of 97.3 cfs and discharges west to Cherry Creek.

The table below summarizes the major basins and percent impervious from the CUHP/SWMM analysis used in the pond design.

POND D SWMM BASINS			
Design Point	AREA	% IMP.	WEIGHTED
ID	AC	%	%
D-1	20.7	48	20
F-1	29.5	55	32
TOTAL	50.2	-	52

The table on the following page summarizes the Pond D design. Calculations for the design of Pond D are included in the appendix. The Pond D detailed design is shown in the construction drawings.

POND D	
Description	
Drainage Area (ACRES)	50.18
Percent Impervious (%)	51.42
WQCV Volume (AC-FT)	0.805
EURV Volume (including WQCV) (AC-FT)	2.447
EURV water surface (FT)	5991.2
100-YR Volume (including EURV) (AC-FT)	4.475
100-YR water surface (FT)	5993.16
Emergency Spillway Elevation (FT)	5993.48
100-YR Peak Inflow (CFS)	97.3
100-YR Peak Outflow (CFS)	52.2
100-YR Peak Allowable (CFS)	55.28

Pond D complies with CRS 37-92-602(8). The UD-Detention worksheet is included in the appendix.

The minor sub-basins are described in detail as follows. These basins were delineated for the Rational Method analysis used in the street capacity, inlet, and stormsewer design.

Sub-basin A1 primarily consists of the lots along Red Cosmos Terr. Surface runoff generally drains to the curb and gutter, which continues northerly to the on-grade inlet at Design Point 1A where it is piped to DP 1. 100-year storm street flows to sump inlet DP 1B. Emergency flow from DP 1B will overland to Crowfoot Gulch.

Sub-basin A2 primarily consists of the lots along Rose Mallow Street. Surface runoff generally drains to the curb and gutter to sump inlet at Design Point 1B where it is piped Crowfoot Gulch via swale. Emergency flow from DP 1B will overland to Crowfoot Gulch.

Sub-basin A3 primarily consists of the lots along Rose Mallow Street. Surface runoff generally drains to the curb and gutter to sump inlet at Design Point 1C where it is piped Crowfoot Gulch via swale. Emergency flow from DP 1C will overland to Crowfoot Gulch.

Sub-basin A4 primarily consists of the lots along Wild Lupine Street and Shasta Daisy Street. Surface runoff generally drains to the curb and gutter to sump inlet at Design Point 1D where it is piped Crowfoot Gulch via swale. Emergency flow from DP 1D will overland to Crowfoot Gulch.

Sub-basin A5 primarily consists of the lots along Shasta Daisy Street and Scarlet Sage Ave. Surface runoff generally drains to the curb and gutter to sump inlet at Design Point 1E where it is piped Crowfoot Gulch via swale. Emergency flow from DP 1E will overland to Crowfoot Gulch.

Sub-basin A6 primarily consists of the lots along Scarlet Sage Ln. Surface runoff generally drains to the curb and gutter, which continues westerly to the on-grade inlet at Design Point

Sub-basin F1 is located along Alpine Phlox Street and N. Pinery Parkway. Surface runoff generally drains to on-grade inlet at Design Point 6A. 100 Year discharge from 6A street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F2 is located along Alpine Phlox Street. Surface runoff generally drains to on-grade inlet at Design Point 6B. 100 Year discharge from 6B street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F3 is located along Scarlet Sage Ave and Sky Pilot Ave. Surface runoff generally drains to on-grade inlet at Design Point 6C. 100 Year discharge from 6C street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F4 primarily consists of lots located along Sky Pilot Ave. Surface runoff generally drains to Design Point 6D. 2 Year discharge from 6D street flows Design Point 6C. 100 Year discharge from 6D street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F5 primarily consists of lots located along N. Pinery Parkway. Surface runoff generally drains to on-grade inlet at Design Point 6E. 100 Year discharge from 6E street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F6 primarily consists of lots located along Beebalm Way. Surface runoff generally drains to sump inlet at Design Point 6F. Emergency flow from DP 6F overland flows to Pond C.

Sub-basin F7 is located along N. Pinery Parkway. Surface runoff generally drains to sump inlet at Design Point 6G. Emergency flow from DP 6G overland flows to Pond D.

Sub-basin F8 primarily consists of lots located along Beebalm Way. Surface runoff generally drains to sump inlet at Design Point 6H. Emergency flow from DP 6H overland flows to Pond C.

Sub-basin F9 is located along street E and N. Pinery Parkway. Surface runoff generally drains to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F10 is located along Alpine Phlox Street. Surface runoff generally drains to on-grade inlet at Design Point 6J. 100 Year discharge from 6J street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F11 is located along Alpine Phlox Street. Surface runoff generally drains to on-grade inlet at Design Point 6K. 100 Year discharge from 6K street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F12 is located along Alpine Phlox Street. Surface runoff generally drains to on-grade inlet at Design Point 6L. 100 Year discharge from 6L street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Sub-basin F13 primarily consists of lots located along Sky Pilot Lane. Surface runoff generally drains to Design Point 6M. 2 Year discharge from 6M street flows Design Point 6C. 100 Year discharge from 6M street flows to sump inlet at Design Point 6I. Emergency flow from DP 6I overland flows to Pond D.

Note:						
1) 0% slope indicates sump inlet.						
DIRECT FLOW						
BASIN ID	AREA	Imperviousness	Q2	Q100	Street Type	Slope
	(AC)	%	(CFS)	(CFS)		%
F1	1.71	90.64	4.59	13.55	Local	2.50
F2	1.77	93.50	4.96	14.53	Local	2.50
F3	3.60	19.77	1.47	12.47	Local	1.00
F4	3.79	53.06	4.56	18.47	Local	4.00
F5	4.58	46.86	4.46	19.66	Res. Blvd	4.00
F6	4.93	38.37	3.70	18.75	Local	0.00
F7	4.51	18.05	1.68	15.41	Res. Blvd	0.00
F8	7.93	34.99	5.57	30.18	Local	0.00
F9	1.28	66.27	1.75	6.18	Res. Blvd	0.00
F10	1.93	92.20	5.30	15.64	Local	2.50
F11	1.50	91.79	4.07	12.03	Local	2.50
F12	1.22	93.17	3.39	9.95	Local	2.50
F13	3.58	52.91	4.36	17.70	Local	4.00

Sub-basin OS10 is located in the South west of the site. Surface runoff will overland flow to DP 34. Flow from DP 34 is conveyed to the Crowfoot Gulch via DP A.

DIRECT FLOW						
BASIN ID	AREA	Imperviousness	Q2	Q100	Street Type	Slope
	(AC)	%	(CFS)	(CFS)		%
OS 10	5.37	2.00	0.30	16.40	N/A	5.00

Sub-basin OS 1 is located south west of the site. Surface runoff overland flows to Design Point A. Flow from DP A and is conveyed via pipe into the Crowfoot Gulch. This point was evaluated in the SWMM model. The Q100 peak flow for OS 1 is 19 cfs.

Sub-basin OS 2 is located south west of the site. . Surface runoff overland flows to the Crowfoot Gulch. This point was evaluated in the SWMM model. The Q100 peak flow for OS 2 is 9.06 cfs.

Sub-basin OS 8 is located south west of the site. . Surface runoff overland flows to the Crowfoot Gulch. This point was evaluated in the SWMM model. The Q100 peak flow for OS 8 is 8.04 cfs.

F1

Total Area		1.73 acres			Composite Calculations				
Land Use	Imp.	C ₂	C ₅	C ₁₀₀	Area	Imp%	C ₂	C ₅	C ₁₀₀
Residential (Single Family)	45%	0.40	0.43	0.69	0.00	0.0	0.00	0.00	0.00
Business	95%	0.85	0.88	0.94	1.42	77.9	0.70	0.72	0.77
Residential (Multi Family)	75%	0.67	0.70	0.84	0.00	0.0	0.00	0.00	0.00
ROW	77%	0.68	0.72	0.84	0.29	12.7	0.11	0.12	0.14
Open Space / Lawns	2%	0.02	0.05	0.49	0.00	0.0	0.00	0.00	0.00
TOTAL					1.71	90.6	0.81	0.84	0.91

F2

Total Area		1.77 acres			Composite Calculations				
Land Use	Imp.	C ₂	C ₅	C ₁₀₀	Area	Imp%	C ₂	C ₅	C ₁₀₀
Residential (Single Family)	45%	0.40	0.43	0.69	0.00	0.0	0.00	0.00	0.00
Business	95%	0.85	0.88	0.94	1.65	88.3	0.79	0.82	0.87
Residential (Multi Family)	75%	0.67	0.70	0.84	0.00	0.0	0.00	0.00	0.00
ROW	74%	0.66	0.69	0.83	0.12	5.2	0.05	0.05	0.06
Open Space / Lawns	2%	0.02	0.05	0.49	0.00	0.0	0.00	0.00	0.00
TOTAL					1.77	93.5	0.84	0.87	0.93

F3

Total Area		3.60 acres			Composite Calculations				
Land Use	Imp.	C ₂	C ₅	C ₁₀₀	Area	Imp%	C ₂	C ₅	C ₁₀₀
Residential (Single Family)	45%	0.40	0.43	0.69	0.00	0.0	0.00	0.00	0.00
Business	95%	0.85	0.88	0.94	0.00	0.0	0.00	0.00	0.00
Residential (Multi Family)	75%	0.67	0.70	0.84	0.00	0.0	0.00	0.00	0.00
ROW	74%	0.66	0.69	0.83	0.89	18.3	0.16	0.17	0.21
Open Space / Lawns	2%	0.02	0.05	0.49	2.70	1.5	0.02	0.03	0.37
TOTAL					3.60	19.8	0.18	0.20	0.57

F4

Total Area		3.79 acres			Composite Calculations				
Land Use	Imp.	C ₂	C ₅	C ₁₀₀	Area	Imp%	C ₂	C ₅	C ₁₀₀
Residential (Single Family)	45%	0.40	0.43	0.69	2.57	30.6	0.27	0.29	0.47
Business	95%	0.85	0.88	0.94	0.00	0.0	0.00	0.00	0.00
Residential (Multi Family)	75%	0.67	0.70	0.84	0.00	0.0	0.00	0.00	0.00
ROW	74%	0.66	0.69	0.83	1.15	22.4	0.20	0.21	0.25
Open Space / Lawns	2%	0.02	0.05	0.49	0.06	0.0	0.00	0.00	0.01
TOTAL					3.79	53.1	0.47	0.50	0.73

F5

Total Area		4.58 acres			Composite Calculations				
Land Use	Imp.	C ₂	C ₅	C ₁₀₀	Area	Imp%	C ₂	C ₅	C ₁₀₀
Residential (Single Family)	45%	0.40	0.43	0.69	2.18	21.4	0.19	0.20	0.33
Business	95%	0.85	0.88	0.94	0.00	0.0	0.00	0.00	0.00
Residential (Multi Family)	75%	0.67	0.70	0.84	0.00	0.0	0.00	0.00	0.00
ROW	77%	0.68	0.72	0.84	1.49	25.1	0.22	0.23	0.27
Open Space / Lawns	2%	0.02	0.05	0.49	0.90	0.4	0.00	0.01	0.10
TOTAL					4.58	46.9	0.42	0.45	0.70

F10

Total Area

1.93 acres

Composite Calculations

Land Use	Imp.	C ₂	C ₅	C ₁₀₀	Area	Imp%	C ₂	C ₅	C ₁₀₀
Residential (Single Family)	45%	0.40	0.43	0.69	0.00	0.0	0.00	0.00	0.00
Business	95%	0.85	0.88	0.94	1.61	79.2	0.71	0.73	0.78
Residential (Multi Family)	75%	0.67	0.70	0.84	0.00	0.0	0.00	0.00	0.00
ROW	77%	0.68	0.72	0.84	0.33	12.9	0.12	0.12	0.14
Open Space / Lawns	2%	0.02	0.05	0.49	0.00	0.0	0.00	0.00	0.00
TOTAL					1.93	92.2	0.82	0.85	0.93

F11

Total Area

1.50 acres

Composite Calculations

Land Use	Imp.	C ₂	C ₅	C ₁₀₀	Area	Imp%	C ₂	C ₅	C ₁₀₀
Residential (Single Family)	45%	0.40	0.43	0.69	0.00	0.0	0.00	0.00	0.00
Business	95%	0.85	0.88	0.94	1.24	78.3	0.70	0.73	0.78
Residential (Multi Family)	75%	0.67	0.70	0.84	0.00	0.0	0.00	0.00	0.00
ROW	77%	0.68	0.72	0.84	0.26	13.5	0.12	0.13	0.15
Open Space / Lawns	2%	0.02	0.05	0.49	0.00	0.0	0.00	0.00	0.00
TOTAL					1.50	91.8	0.82	0.85	0.92

F12

Total Area

1.22 acres

Composite Calculations

Land Use	Imp.	C ₂	C ₅	C ₁₀₀	Area	Imp%	C ₂	C ₅	C ₁₀₀
Residential (Single Family)	45%	0.40	0.43	0.69	0.00	0.0	0.00	0.00	0.00
Business	95%	0.85	0.88	0.94	1.11	86.9	0.78	0.80	0.86
Residential (Multi Family)	75%	0.67	0.70	0.84	0.00	0.0	0.00	0.00	0.00
ROW	74%	0.66	0.69	0.83	0.10	6.3	0.06	0.06	0.07
Open Space / Lawns	2%	0.02	0.05	0.49	0.00	0.0	0.00	0.00	0.00
TOTAL					1.22	93.2	0.83	0.86	0.93

STANDARD FORM SF-2 TIME OF CONCENTRATION

Subdivision: Trails at Crowfoot

Project Name: Trails at Crowfoot
 Project No. 254103
 Calculated By: MRS
 Date: 1/31/2018

SUB-BASIN DATA			INITIAL/OVERLAND (T _i)			TRAVEL TIME (T _i)				T _c CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (AC)	C ₅	L (FT)	S (%)	T _i (MIN)	L (FT)	S (%)	VEL. (FPS)	T _i (MIN)	COMP. T _c (MIN)	TOTAL LENGTH(FT)	MIN. T _c (MIN)	T _c (MIN)
F1	1.71	0.84	50	1.0	3.3	400	3.0	3.5	1.9	5.2	450.0	12.5	5.2
F2	1.77	0.87	50	1.0	3.0	510	4.3	4.1	2.0	5.0	560.0	13.1	5.0
F3	3.60	0.20	50	1.0	11.4	717	1.3	2.2	5.5	16.9	767.0	14.3	14.3
F4	3.79	0.50	50	1.0	7.6	850	3.8	3.8	3.7	11.3	900.0	15.0	11.3
F5	4.58	0.45	50	1.0	8.3	719	1.3	2.2	5.5	13.8	769.0	14.3	13.8
F6	4.93	0.37	50	1.0	9.3	1234	2.6	3.2	6.5	15.8	1284.0	17.1	15.8
F7	4.51	0.19	50	1.0	11.6	721	1.2	2.2	5.5	17.1	771.0	14.3	14.3
F8	7.93	0.34	50	1.0	9.7	1070	2.8	3.3	5.3	15.0	1120.0	16.2	15.0
F9	1.28	0.62	50	1.0	6.1	1708	3.2	3.6	8.0	14.0	1758.0	19.8	14.0
F10	1.93	0.85	50	1.0	3.1	520	4.4	4.2	2.1	5.2	570.0	13.2	5.2
F11	1.50	0.85	50	1.0	3.2	520	4.0	4.0	2.2	5.3	570.0	13.2	5.3
F12	1.22	0.86	50	1.0	3.0	510	4.3	4.1	2.0	5.1	560.0	13.1	5.1
F13	3.58	0.50	50	1.0	7.6	850	4.7	4.3	3.3	10.9	900.0	15.0	10.9
OS1	56.02	0.05	300	3.1	22.7	2240	5.5	4.7	8.0	30.6	2540.0	24.1	24.1
OS2	10.95	0.05	300	1.2	30.8	1334	1.2	2.2	10.1	40.9	1634.0	19.1	19.1
OS3	5.32	0.05	300	2.9	23.2	1037	2.9	3.3	5.2	28.4	1337.0	17.4	17.4
OS4	2.22	0.05	300	3.5	21.7	730	3.5	3.7	3.3	24.9	1030.0	15.7	15.7
OS10	5.37	0.05	300	4.2	20.4	305	4.2	4.1	1.2	21.6	605.0	13.4	13.4

NOTES:

$$T_i = (1.8 * (1.1 - C_5) * (L)^{0.5}) / (S^{0.33})$$

$$T_i = L / 60V \text{ (Velocity From Fig. 3-2)}$$

$$T_c \text{ Check} = 10 + L / 180$$

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision Trails at Crowfoot

Project Name: Trails at Crowfoot
Project No. 254103
Calculated By: MRS
Date: 4/9/2018

Design Storm 100 Yr
100-Year P1 = 2.6 in.

COMBINED BASINS	DIRECT RUNOFF								TOTAL RUNOFF					STREET		PIPE			TRAVEL TIME			REMARKS			
	Design Point	Area Design.	Area (Ac)	Runoff Coeff.	Tc (min)	C _a (Ac)	i (in/hr)	Q (cfs)	Inlet Type	Q (intercept)	Q (carry-on)	Tc (min)	C _a (Ac)	i (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)		Velocity (fps)	Tc (min)	
F12	6L	F12	1.22	0.93	5.1	1.13	8.8	9.9				5.1	1.13	8.8	9.9										
F2	6B	F2	1.77	0.93	5.0	1.65	8.8	14.5				5.5	2.78	8.6	23.9	1.0	9.9				50.0	2.00	0.4	Street Flow to 6B	
F2,11,12	6K	F11	1.50	0.92	5.3	1.39	8.7	12.0				6.6	4.17	8.2	34.0	1.0	23.9				130.0	2.00	1.1	Street Flow to 6K	
F2,10,11,12	6J	F10	1.93	0.93	5.2	1.79	8.7	15.6				7.4	5.96	7.9	46.8	1.0	34.0				100.0	2.00	0.8	Street Flow to 6J	
F1,2,10,11,12	6A	F1	1.71	0.91	5.2	1.55	8.7	13.5				8.2	7.51	7.6	56.9	1.0	46.8				100.0	2.00	0.8	Street Flow to 6A	
F1,2,10,11,12	16											8.9	7.51	7.4	55.3	1.0	56.9				80.0	2.00	0.7	Street Flow to DP 16	
F4	6D	F4	3.79	0.73	11.3	2.76	6.7	18.5				11.3	2.76	6.7	18.5	1.0	18.5				1025.0	2.00	8.5	Street Flow to 6E	
F4,13	6M	F13	3.58	0.73	10.9	2.60	6.8	17.7				11.7	5.36	6.6	35.4	1.0	35.4				50.0	2.00	0.4	Street Flow to 6M	
F3,4,13	6C	F3	3.60	0.57	14.3	2.06	6.0	12.5				14.3	7.42	6.0	44.9	1.0	44.9				200.0	2.00	1.7	Street Flow to DP 17	
F1,2,5,10,11,12	6E	F5	4.58	0.70	13.8	3.20	6.1	19.7				17.4	10.72	5.5	58.8	1.0	58.8				100.0	2.00	0.8	Street Flow to DP 17	
F1,2,3,4,5,10,11,12,13	17											18.3	18.14	5.4	97.2	5.0	97.2				952.0	4.47	3.5	Street Flow to 6fa	
F1,2,3,4,5,10,11,12,13	6la											18.3	14.65	5.4	78.5	3.0	18.72				270.0	3.46	1.3	Street Flow to 6l & 6G	
F7	6G	F7	4.51	0.57	14.3	2.55	6.0	15.4	1 @ 10" Type R Sump Inlet	22.2	0.0	19.6	4.30	5.2	22.2			78.5	0.50	48.00	100.0	9.10	0.2	Piped to Pond D	
F1,2,3,4,5,9,10,11,12,13	6l	F9	1.28	0.79	14.0	1.02	6.1	6.2	1 @ 10" Type R Sump Inlet	15.5	0.0	19.7	7.06	5.2	36.4			22.2	0.50	36.00	50.0	9.10	0.1	Piped to 6l	
E13	5M	E13	4.45	0.62	14.2	2.76	6.0	16.7				14.2	2.76	6.0	16.7			36.4	0.50	36.00	100.0	9.10	0.2	Piped to Pond D	
E17	5Q	E17	1.55	0.83	10.7	1.28	6.8	8.8				14.8	4.04	5.9	24.0	1.0	16.7				70.0	2.00	0.6	Street Flow to 5Q	
F8	6H	F8	7.93	0.64	15.0	5.11	5.9	30.2	1 @ 15" Type R Sump Inlet	42.1	9.0	16.8	9.15	5.6	51.1			24.0	0.50	30.00	780.0	6.60	2.0	Piped/Overland Flow to 6H	
F6	6F	F6	4.93	0.66	15.8	3.25	5.8	18.7	1 @ 10" Type R Sump Inlet	27.8	0.0	16.9	12.40	5.6	69.2			42.1	0.50	36.00	30.0	7.60	0.1	Piped to 6F	
																		69.2	0.50	42.00	102.0	8.40	0.2	Piped to Pond C	

Note:
1) 0% slope indicates sump inlet.

DIRECT FLOW						
BASIN ID	AREA (AC)	Imperviousness %	Q2 (CFS)	Q100 (CFS)	Street Type	Slope %
A1	4.11	43.77	3.84	17.73	Local	2.00
A2	1.84	52.16	2.22	9.10	Local	0.00
A3	3.23	48.80	3.16	13.54	Local	0.00
A4	4.07	34.03	2.78	15.39	Local	0.00
A5	2.04	49.08	2.27	9.70	Local	0.00
A6	4.96	35.28	3.58	19.32	Local	1.50
A7	3.96	50.41	4.44	18.62	Local	4.00
A8	2.86	52.68	3.45	14.07	Local	0.00
A9	3.44	50.33	3.75	15.73	Arterial	2.00
A10	0.72	61.44	1.12	4.14	Arterial	0.00
A11	2.39	53.79	2.92	11.75	Local	2.00
A12	2.96	48.02	3.22	13.95	Local	1.50
A13	5.13	47.44	5.03	21.94	Local	5.00
A14	1.43	54.86	1.94	7.68	Local	0.00
A15	7.15	26.55	3.58	23.96	Arterial	0.00
A16	0.75	76.70	1.39	4.52	Local	2.00
A17	3.76	52.91	4.19	17.02	Local	2.00
A18	2.54	52.67	2.95	11.99	Local	2.00
A19	2.09	51.95	2.51	10.32	Local	4.00
A20	2.04	49.09	2.28	9.72	Local	2.00
A21	3.02	52.59	3.69	15.04	Local	1.50
A22	3.07	74.76	6.17	20.24	Local	2.50

Note:
1) 0% slope indicates sump inlet.

DIRECT FLOW						
BASIN ID	AREA (AC)	Imperviousness %	Q2 (CFS)	Q100 (CFS)	Street Type	Slope %
B1	21.00	23.33	8.48	62.92	Local	7.00
B2	3.13	51.76	3.62	15.75	Local	3.00
B3	4.92	50.31	5.58	23.45	Local	3.00
B4	2.51	58.47	3.16	12.02	Local	5.00
B5	3.19	53.20	3.68	15.72	Local	6.00
B6	3.19	53.20	3.68	15.72	Local	6.00
B7	5.76	49.66	5.79	24.54	Local	6.00
B8	4.93	46.94	4.95	21.81	Res. Blvd	0.00
B9	2.81	49.17	2.94	12.55	Local	0.00
B10	0.65	76.70	1.28	4.14	Res. Blvd	0.00
B11	0.84	76.70	1.59	5.15	Res. Blvd	0.00
B12	3.30	75.52	6.18	20.16	Local	3.00
B13	3.19	53.20	3.88	15.72	Local	2.00
B14	3.19	53.20	3.88	15.72	Local	2.00
B15	2.01	53.11	2.50	10.13	Local	1.00

Note:
1) 0% slope indicates sump inlet.

DIRECT FLOW						
BASIN ID	AREA (AC)	Imperviousness %	Q2 (CFS)	Q100 (CFS)	Street Type	Slope %
C1	10.07	45.10	8.72	39.44	Local	0.00
D1	5.94	42.41	5.34	25.23	Local	0.00
D2	5.33	46.14	5.58	24.83	Local	5.00
D3	3.66	43.82	3.28	15.11	Local	5.00
D4	2.91	42.33	2.45	11.57	Local	3.00
D5	6.97	33.88	4.29	23.81	Arterial	0.00
D6	2.57	42.99	2.30	10.74	Arterial	6.00
D7	2.58	42.09	2.48	11.76	Local	4.00
D8	0.85	51.73	1.06	4.38	Local	5.00
D9	3.90	49.27	4.06	17.30	Arterial	0.00
D10	4.80	50.52	5.60	23.45	Local	0.00
D11	3.29	84.30	6.19	19.00	Arterial	0.00
D12	1.13	84.30	2.13	6.53	Arterial	1.50

Note:
1) 0% slope indicates sump inlet.

DIRECT FLOW						
BASIN ID	AREA (AC)	Imperviousness %	Q2 (CFS)	Q100 (CFS)	Street Type	Slope %
E1	4.04	52.65	4.95	20.19	Local	2.70
E2	5.27	52.02	4.71	19.36	Local	0.00
E3	4.77	52.31	5.64	23.07	Local	3.00
E4	3.20	52.07	3.78	14.69	Local	4.00
E5	2.76	53.77	3.09	12.43	Local	0.00
E6	2.63	53.59	3.06	12.34	Local	1.00
E7	2.77	51.99	3.21	13.17	Local	0.00
E8	2.68	53.33	3.13	12.64	Local	2.00
E9	4.84	39.52	3.92	19.46	Local	2.00
E10	0.70	56.03	0.85	3.31	Local	1.00
E11	3.99	30.00	2.48	14.96	Local	1.00
E12	3.28	30.00	2.04	12.33	Local	6.00
E13	4.45	30.00	2.76	16.67	Local	1.00
E14	9.14	44.35	8.62	39.37	Local	0.00
E15	1.89	51.97	2.08	8.55	Local	2.00
E16	1.57	73.60	2.98	8.99	Local	6.00
E17	1.55	73.60	2.64	8.78	Local	1.00
E18	2.72	52.96	3.45	14.00	Local	1.50
E19	2.91	53.40	3.58	14.46	Local	1.20
E20	2.75	53.49	3.12	12.57	Local	2.00
E21	2.05	54.72	2.56	10.18	Local	2.00
E22	4.41	53.09	5.39	21.86	Local	2.70
E23	4.11	51.69	4.81	19.86	Local	2.70
E24	4.23	30.00	2.63	15.87	Local	2.00
E25	2.78	35.90	2.16	11.51	Local	2.00

Note:
1) 0% slope indicates sump inlet.

DIRECT FLOW						
BASIN ID	AREA (AC)	Imperviousness %	Q2 (CFS)	Q100 (CFS)	Street Type	Slope %
F1	1.71	90.64	4.59	13.55	Local	2.50
F2	1.77	93.50	4.96	14.53	Local	2.50
F3	3.60	19.77	1.47	12.47	Local	1.00
F4	3.79	53.06	4.56	18.47	Local	4.00
F5	4.58	46.86	4.46	19.66	Res. Blvd	4.00
F6	4.93	38.37	3.70	18.75	Local	0.00
F7	4.51	18.05	1.68	15.41	Res. Blvd	0.00
F8	7.93	34.99	5.57	30.18	Local	0.00
F9	1.28	66.27	1.75	6.18	Res. Blvd	0.00
F10	1.93	92.20	5.30	15.64	Local	2.50
F11	1.50	91.79	4.07	12.03	Local	2.50
F12	1.22	93.17	3.39	9.95	Local	2.50
F13	3.58	52.91	4.36	17.70	Local	4.00

CUMULATIVE FLOW			
Design Point	Q2 (CFS)	Q100 (CFS)	
1A	3.84	17.73	
1B	5.04	60.61	
1C	18.94	72.95	
1D	22.01	88.25	
1E	4.69	74.09	
1F	9.74	45.15	
1G	4.44	61.21	
1H	24.90	99.54	
1I	3.75	15.73	
1J	7.60	40.45	
1K	2.92	11.75	
1L	3.22	13.95	
1M	9.77	37.49	
1N	11.20	49.77	
1O	3.58	23.96	
1P	5.05	21.53	
1Q	6.90	27.93	
1R	2.95	11.99	
1S	2.51	10.32	
1T	6.64	44.92	
1U	6.71	27.72	
1	11.54	45.92	
2	15.83	42.02	
3	15.88	(Not Relavant for 100 year)	
4	19.35	41.99	

CUMULATIVE FLOW			
Design Point	Q2 (CFS)	Q100 (CFS)	
2A	13.11	74.41	
2B	6.15	15.75	
2C	5.58	33.21	
2D	13.83	60.55	
2E	3.88	76.36	
2F	3.88	29.09	
2G	5.79	24.54	
2H	4.95	21.81	
2I	19.60	35.69	
2J	26.73	169.56	
2K	27.76	172.83	
2L	10.97	50.07	
2M	3.88	15.72	
2N	3.88	15.72	
2O	2.50	10.13	
5	18.73	76.25	
6	7.44	(Not Relavant for 100 year)	
7	7.40	(Not Relavant for 100 year)	
9	19.80	84.75	
10	32.55	84.62	

CUMULATIVE FLOW			
Design Point	Q2 (CFS)	Q100 (CFS)	
3A	8.95	54.35	

CUMULATIVE FLOW			
Design Point	Q2 (CFS)	Q100 (CFS)	
4A	18.01	80.94	
4B	5.58	24.83	
4C	3.28	15.11	
4D	5.63	26.26	
4E	8.32	42.18	
4F	5.19	24.34	
4G	2.48	11.76	
4H	1.06	4.38	
4I	4.06	17.30	
4J	10.66	45.70	
4K	6.19	19.00	
4L	2.94	10.02	
11	12.69	56.80	
12	11.38	55.22	
13	15.66	68.43	

CUMULATIVE FLOW			
Design Point	Q2 (CFS)	Q100 (CFS)	
14	32.04	124.18	
15	36.95	142.09	
5A	14.28	56.31	
5B	9.56	77.69	
5C	18.85	70.87	
5D	21.89	79.97	
5E	23.45	83.44	
5F	3.06	12.34	
5G	6.16	142.25	
5H	29.48	81.28	
5I	3.92	19.46	
5J	0.85	3.31	
5K	2.48	14.96	
5L	4.60	27.74	
5M	2.76	16.67	
5N	10.74	49.99	
5O	2.08	8.55	
5P	19.53	49.94	
5Q	5.06	23.96	
5R	4.86	14.00	
5S	24.94	67.90	
5T	3.12	12.57	
5U	2.56	10.18	
5V	9.85	39.52	
5W	4.81	19.86	
5X	2.63	15.87	
5Y	2.16	11.51	

CUMULATIVE FLOW			
Design Point	Q2 (CFS)	Q100 (CFS)	
6A	21.41	56.86	
6B	8.28	23.93	
6C	9.45	44.87	
6D	4.56	18.47	
6E	29.25	58.80	
6F	13.68	59.19	
6G	3.39	22.24	
6H	10.08	42.10	
6I	1.75	36.44	
6Ia	-	78.50	
6J	17.19	46.79	
6K	12.18	34.01	
6L	3.39	9.95	
6M	8.80	35.37	
16	27.15	55.27	
17	36.01	97.22	

CHANNEL DESIGN POINT SUMMARY			
Design Point	Q5 (CFS)	Q100 (CFS)	
A	25.55	76.45	
B	49.11	150.81	
C	58.29	188.03	
D	73.01	240.76	
E	83.23	280.45	

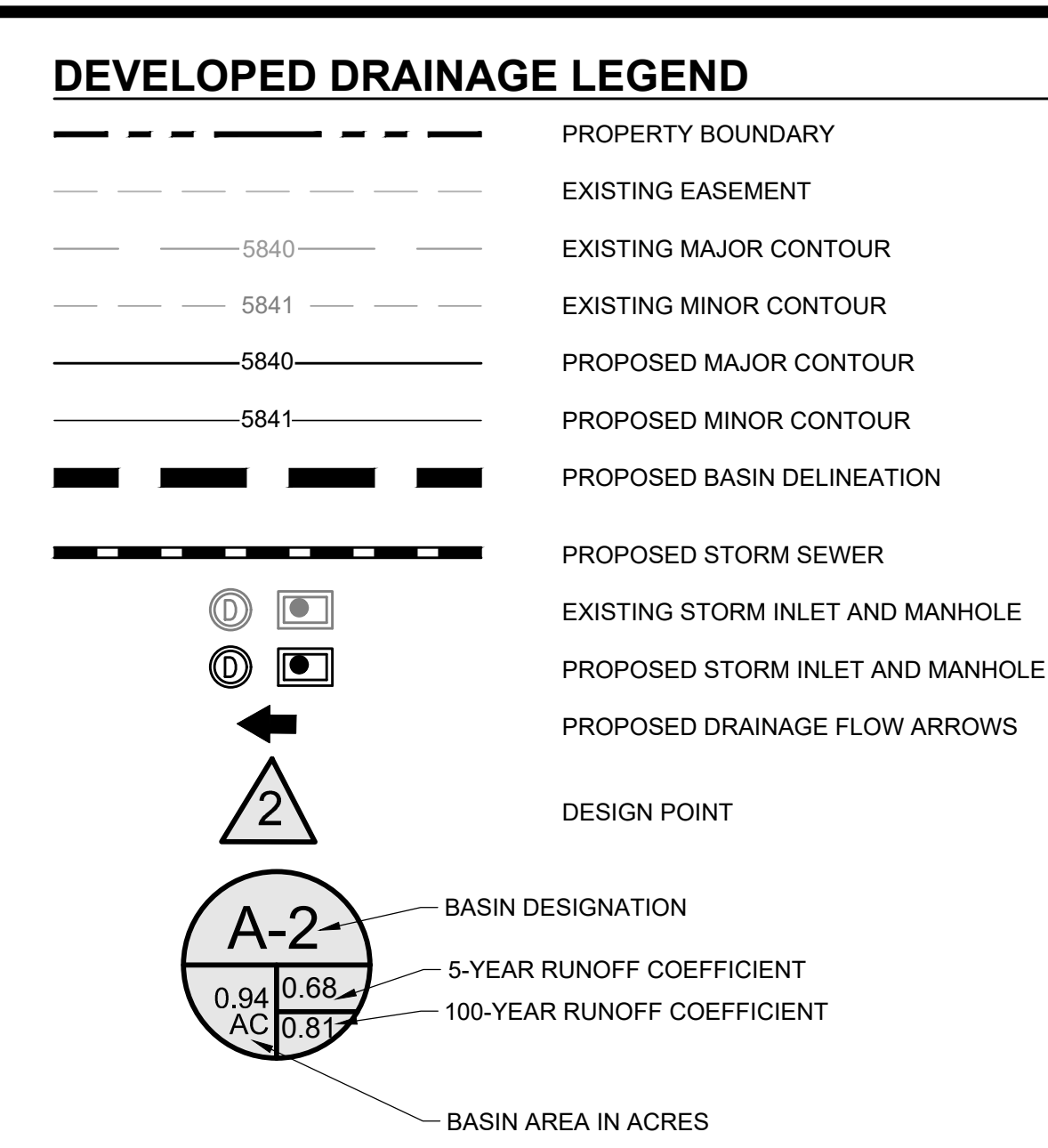
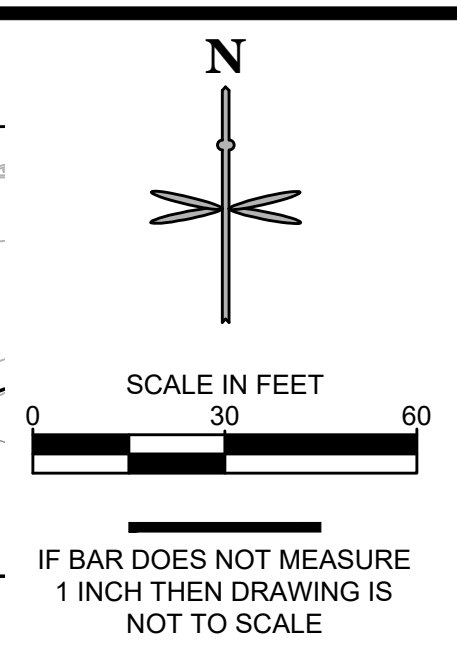
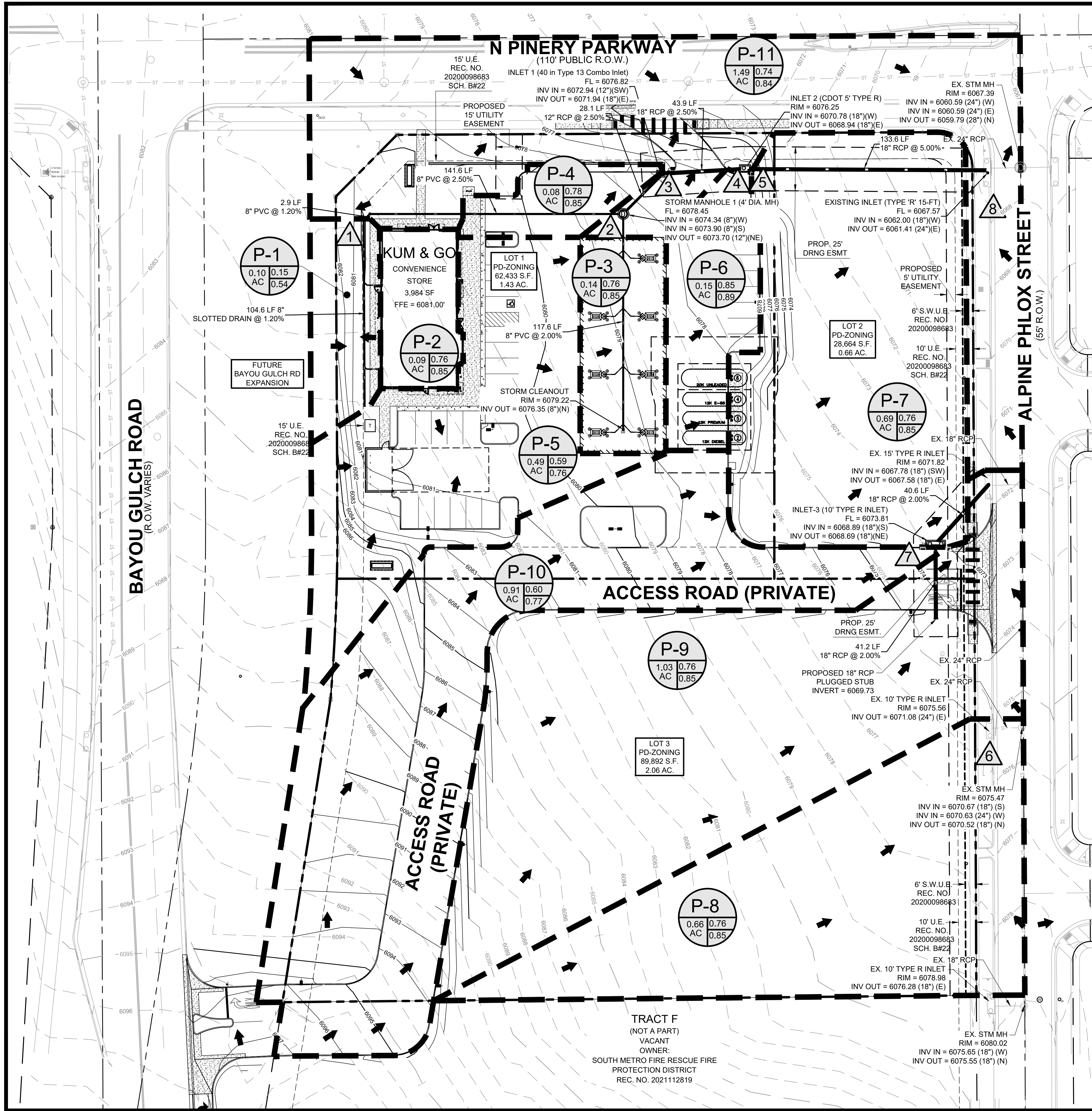
NOTE: Flows are from SWMM analysis. See drainage report for more details.

SWMM BASIN SUMMARY			
Design Point	Q5 (CFS)	Q100 (CFS)	
A-1	11.86	32.59	
A-2	19.60	53.08	
A-3	7.60	21.76	
A-4	5.01	16.11	
B-1	20.87	66.84	
B-2	26.81	74.30	
C-1	14.00	39.86	
OS-1	1.82	9.80	
OS-2	1.62	8.90	
OS-3	1.02	5.59	
OS-4	0.31	1.87	
OS-5	1.55	7.82	

POND A	
Description	
Drainage Area (FT)	174.49
Percent Imperviousness (%)	37.55
WQCV (AC-FT)	2.314
EURV Volume (including WQVC) (AC-FT)	6.12
EURV Water Surface (FT)	5995.39
100-YR Volume (including EURV) (AC-FT)	11.29
100-yr water surface elevation (FT)	5997.19
Emergency Spillway Crest Elevation (FT)	5997.19
100-year Peak Inflow (CFS)	278.84
100-year Peak Outflow (CFS)	197.00
100-year Peak Allowable (CFS)	204.47

POND B	
Description	
Drainage Area (FT)	23.2
Percent Imperviousness (%)	47.36
WQCV (AC-FT)	0.36
EURV Volume (including WQVC) (AC-FT)	1.05
EURV Water Surface (FT)	6092.88
100-YR Volume (including EURV) (AC-FT)	1.83
100-yr water surface elevation (FT)</	

APPENDIX E
Developed Drainage Map



DEVELOPED RUNOFF SUMMARY TABLE

DESIGN POINT	TRIBUTARY BASIN	TRIBUTARY AREA (AC)	COEFFICIENT		TOTAL RUNOFF	
			C5	C100	Q5 (CFS)	Q100 (CFS)
1	P-1	0.10	0.15	0.54	0.07	0.50
	P-2	0.09	0.76	0.85	0.34	0.70
	P-3	0.14	0.76	0.85	0.49	1.03
2	DP1 & P-3	0.34			0.90	2.23
	P-4	0.08	0.78	0.85	0.28	0.57
3	DP2 & P-4	0.41			1.18	2.80
	P-5	0.49	0.59	0.76	1.30	3.13
	P-6	0.15	0.85	0.89	0.60	1.18
4	P-5 & P-6	0.64			1.87	4.26
	P-7	0.69	0.76	0.85	2.43	5.07
5	P-7, DP3 & DP4	1.74			5.35	11.85
6	P-8	0.66	0.76	0.85	2.32	4.86
	P-9	1.03	0.76	0.85	3.61	7.55
7	P-10	0.91	0.60	0.77	2.39	5.68
	P-9 + P-10	1.94			5.79	12.78
8	P-11	1.49	0.74	0.84	5.23	11.02
	DP5 & P-11	3.23			10.35	22.38

BENCHMARK:
 ELEVATIONS ARE BASED UPON A POST-PROCESSED STATIC GNSS CONNECTION MADE TO DOUGLAS COUNTY GIS POINT 1.051038 BEING A FOUND 3.25" ALLOY CAP STAMPED "DOUGLAS COUNTY - 1.051038 - SECONDARY CONTROL MONUMENT" UTILIZING GEOID 18 TO MODEL THE ELLIPSOID SEPARATION AND HAVING A PUBLISHED ELEVATION OF 6053.87 FEET (NAVD 88). SITE BENCHMARK: FWS CONTROL POINT 501 BEING A PUBLISHED ELEVATION OF 6053.87 FEET (NAVD 88). WITH A 2" ALLOY CAP STAMPED "FWS CONTROL POINT" LOCATED APPROXIMATELY 144.5' SOUTH OF THE INTERSECTION OF THE CENTER LINES OF NORTH PINERY PARKWAY AND ALPINE PHLOX STREET AND 23' WEST OF THE CENTER-LINE OF ALPINE PHLOX STREET HAVING AN ESTABLISHED ELEVATION OF 6069.33' NAVD 88

CALL 811 SEVENTY-TWO HOURS PRIOR TO DIGGING, GRADING OR EXCAVATING FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

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 P: 888-458-6646

2293 - PARKER, COLORADO
 BAYOU GULCH RD AND PINERY PKWY
 DEVELOPED DRAINAGE MAP

KG PROJECT TEAM:
 RDM:
 SDM:
 CPM:

REVISION DESCRIPTION	DATE

DATE: 03-10-2023
 SHEET NUMBER: D1.0
 1 OF 1