

DRAINAGE LETTER REPORT

For

BENT GRASS PLAZA

A replat of

LOT 1, 2, & 3, BENT GRASS EAST COMMERCIAL

Bent Grass Meadows Drive
Peyton, Colorado

November, 2023

PCD File No: PPR-2342

Prepared for:

Land First, LLC

1378 Promontory Bluff VW
Colorado Springs, CO 80921

Prepared by:

Drexel, Barrell & Co.

101 Sawatch St, Suite 100
Colorado Springs, CO 80903
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DRAINAGE LETTER REPORT
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1.0 CERTIFICATION STATEMENTS

Engineer's Statement

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the city/county for drainage reports and said report is in conformity with the master plan of the drainage basin. 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. Date
Katherine Varnum, P.E. #53459

Developer's Statement

I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

Authorized Signature Date
LAND FIRST, LLC
1378 Promontory Bluff VW
Colorado Springs, CO 80921

El Paso County

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

Joshua Palmer, P.E. Date
County Engineer / ECM Administrator

Conditions:

DRAINAGE LETTER REPORT
for
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2.0 PURPOSE

The purpose of this letter is to supplement the Final Drainage Report for Bent Grass East Commercial Filing No. 3 (approved November 2, 2021) with regards to the development Bent Grass Plaza, a replat of Lots 1, 2, & 3 Bent Grass East Commercial Filing No. 3, in order to establish that the development is in conformance with the approved drainage design.

Runoff patterns, drainage facilities and the ability to safely pass developed runoff to historic downstream facilities shall be presented.

3.0 GENERAL SITE DESCRIPTION

Location

Bent Grass Plaza, a replat of Lots 1, 2, & 3 of Bent Grass East Commercial is located in Peyton, El Paso County, Colorado, within the Southeast Quarter of Section 1, Township 13 South, Range 65 West of the 6th P.M. El Paso County, Colorado. The property is bounded to the north by Bent Grass Meadows Drive, to the east is Meridian Park Drive, Lot 4 and 5 to the south, and Bent Grass Residential Filing No. 1 lots to the west.

Proposed Development

The proposed development of Lot 1, 2, & 3 is the construction of a commercial center, with associated parking and landscaping. The proposed disturbed area consists of 1.86 acres. The property is proposed to be replatted as Bent Grass Plaza with two lots.

Soils

According to the Soil Survey of El Paso County Area, Colorado, prepared by the U.S. Department of Agriculture Soil Conservation Service, the site is underlain by the Columbine gravelly sandy loam (Soil No. 19), a hydrologic type A soils. See appendix for Soils map.

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 08041C0553G (December 7, 2018), no portion of the site lies within a designated floodplain.

4.0 DRAINAGE CRITERIA

The drainage analysis has been prepared in accordance with the current El Paso County Drainage Criteria Manual. Calculations were performed to determine runoff quantities during the 5-year and 100-year frequency storms for existing and developed conditions using the Rational Method as required for basins containing less than 100 acres.

5.0 EXISTING CONDITION

The existing condition is as described in the aforementioned approved Final Drainage Report for the Bent Grass East Commercial Filing No. 3 development, as part of Basins A, D, and E (see appendix for drainage report excerpts). Overlot grading has been completed and an access roadway, detention facility and utility infrastructure have been installed. The site generally follows a 3%-5% grade from north to south and currently drains directly to the south towards the existing water quality detention facility.

6.0 DEVELOPED CONDITION

The proposed development consists of a commercial center and associated parking and landscaping. The proposed grading and storm system will route flows to the south where they will enter the existing private 24" RCP storm sewer and be directed towards the existing water quality detention facility, Pond 2. Which was approved as part of Bent Grass East Commercial Filing No. 2 (SF1412).

Overlot grading will be completed at one time, however development of the site will take place in 2 phases. The first phase will include the eastern building, the proposed storm sewer, the site entrance and associated parking. Phase 2 will include the western building as well as all remaining parking and landscaping for the site. Timing of the phasing is not known at this time, but temporary diversion swales will be installed to ensure that runoff is adequately captured during construction, and after overlot grading of Phase 1.

Basin A covers 0.15-acres and represents the northern half of the westerly proposed building as well as the proposed sidewalk and swale to the north. Roof drains will lead runoff generated by the roof of the building, down and into the swale. Once there the runoff will be directed east, towards a proposed private Type C Area Inlet at **Design-Point 1** and discharge to the east via proposed private 18" RCP storm sewer.

Basin B covers 0.22-acres and represents the northern half of the easterly proposed building as well as the proposed sidewalk and swale to the north. Roof drains will lead runoff generated by the roof of the building, down and into the swale. Once there the runoff will be directed west towards a proposed private Type C Area Inlet at **Design-Point 2** and discharge to the west via proposed private 18" RCP storm sewer.

The table below lists the basins and design points along with their developed flow rates.

DEVELOPED				
BASIN	DP	Area (Ac.)	Q ₅ (CFS)	Q ₁₀₀ (CFS)
A	1	0.15	0.3	0.8
B	2	0.22	0.6	1.2
	3	0.37	0.9	2.0
C		0.12	0.5	0.9
	4	0.49	1.4	2.9
D	5	0.26	0.9	1.7
E	6	0.40	1.7	3.1
F		0.30	1.3	2.3
	7	1.45	5.2	9.9
G	8	0.05	0.1	0.2
H	9	0.11	0.5	0.9
I		0.04	0.0	0.2
J		0.24	1.1	2.0
	10	1.89	6.5	12.4
K	11	0.11	0.2	0.5
L	12	0.09	0.2	0.4

Design Point 3 is located at a proposed private 4' storm manhole where flows from DP1 and DP2 combine and discharge to the south via proposed private 18" RCP storm sewer.

Basin C represents the northern half of the central parking lot which separates the 2 proposed buildings. This 0.12-acres of parking area will direct its runoff to a low point at the southeast corner of the parking area, where it will be picked up by a proposed private 5' Type R inlet at **Design-Point 4**. Piped flows will continue to the southeast via proposed private 18" RCP storm sewer.

Basin D represents the southern half of the westerly proposed building, as well as a portion of parking lot directly south of the building. The building roof drains will output into the parking lot, and the 0.26-acre area will direct runoff towards a low point and a proposed private 5' Type R inlet at **Design-Point 5** at the southeast corner of the basin. Piped flows will continue to the east via proposed private 18" RCP storm sewer.

Basin E represents the south-easterly half of the eastern proposed building, as well as a portion of parking lot directly south of the building. The building roof drains will output into the parking lot, and the 0.40-acre area will direct runoff towards a low point and a proposed private 5' Type R inlet at **Design-Point 6** to the south of the basin. Piped flows will continue to the west via proposed private 18" RCP storm sewer.

Basin F represents the south-westerly half of the eastern proposed building, as well as a portion of parking lot directly south of the building. The building roof drains will output into the parking lot, and the 0.30-acre area will direct runoff towards a low point and a proposed private 5' Type R inlet at **Design-Point 7** to the south of the basin.

Design Point 7 is located at the proposed private 5' Type R curb inlet mentioned above where piped flows from DP4, DP5, DP6 and surface flow from Basin F combine and discharge to the south via proposed private 18" RCP storm sewer.

Basin G is 0.05-acres of landscaping and sidewalk located at the southwestern corner of the site. Runoff will sheet flow directly into the adjacent Bent Grass Market View at **Design Point 8** and continue to the east as curb and gutter flow ultimately reaching the existing inlet on Bent Grass Market View at Design Point 10.

Basin H covers 0.11-acres of the central drive aisle. Runoff will sheet flow directly into the adjacent Bent Grass Market View at **Design Point 9** and continue to the east as curb and gutter flow.

Basin I is 0.04-acres of landscaping and sidewalk located along the southern boundary of the site. Runoff will sheet flow directly into the adjacent Bent Grass Market View and continue to the west as curb and gutter flow towards the existing sump inlet at Design Point 10.

Basin J covers 0.24-acres of Bent Grass Market View along the west and south boundary of the site. Runoff currently travels to the south and west as curb and gutter flow towards the existing low point and private 5' Type R curb inlet at **Design Point 10**.

Design Point 10 is located at the existing private 5' Type R inlet mentioned above. Piped flows from DP7, DP8, DP9 and surface flows from Basins I and J combine at this point and discharge to the south via existing private 24" RCP storm sewer.

Developed flows at Design Point 10 ($Q_5=6.5$ cfs and $Q_{100}=12.4$ cfs) are higher than those anticipated by the previously approved report (see appendix for excerpts) ($Q_5=4.0$ cfs and $Q_{100}=8.0$ cfs). Analysis of the existing storm system that conveys the flows to the south has been completed and the piping determined to be adequately sized to accommodate the additional flows.

Basin K covers 0.11-acres of landscaping and sidewalk along the northern boundary of the site. Runoff from this basin will discharge directly into Bent Grass Meadows Drive and continue to the east as curb and gutter flow. These flows will eventually be captured by the drainage swale running along the western edge of Meridian Road. Discharge of this area into the adjacent roadway was approved as part of the Final Drainage Report for the Bent Grass East Commercial Filing No. 3, as an exclusion (ECM 1.7.1.C.1.a). See appendix for highlighted section (Basin E) of the previously approved report.

Basin L covers 0.09-acres of landscaping and sidewalk along the eastern boundary of the site. Runoff from this basin will discharge directly into Meridian Park Drive and continue to the south as curb and gutter flow. Eventually being captured by an existing 5' Type R storm inlet before discharging into the existing detention pond by an existing 30" RCP storm sewer where flows are treated for Water Quality.

7.0 FOUR STEP PROCESS

This project conforms to the El Paso County 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 routed through onsite storm sewer to an existing detention basin to the south. This will allow for the runoff to be treated for water quality before discharging into the offsite storm system.
3. **Stabilize Drainage Ways:** No drainage ways exist within the project boundaries. Runoff will enter the storm sewer system, and be directed towards the existing detention basin to the south, this will allow for flow rate reduction and protection of downstream facilities.
4. **Implement Site Specific and Other Source Control BMP's:** Standard commercial source control will be utilized in order to minimize potential pollutants entering the storm system. Example source control measures consist of: indoor storage of chemicals; and trash receptacles in common areas.

8.0 DRAINAGE & BRIDGE FEES

Drainage and bridge fees are not required as the site has been previously platted.

9.0 SUMMARY

Development of Bent Grass Plaza, a replat of Lots 1, 2, & 3 of Bent Grass East Commercial Filing No. 3 will not adversely affect surrounding or downstream developments. Developed flows at Design Point 10 ($Q_5=6.5$ cfs and $Q_{100}=12.4$ cfs) are higher than those anticipated by the previously approved report ($Q_5=4.0$ cfs and $Q_{100}=8.0$ cfs), however analysis of the existing storm system that conveys the flows to the south has determined that the storm system adequately sized to accommodate the additional flows. Therefore, it is acceptable to state that the drainage design for Lots 1, 2, & 3 (Bent Grass Plaza replat) is in conformance with the Final Drainage Report from the original Bent Grass East Commercial Filing No. 3.

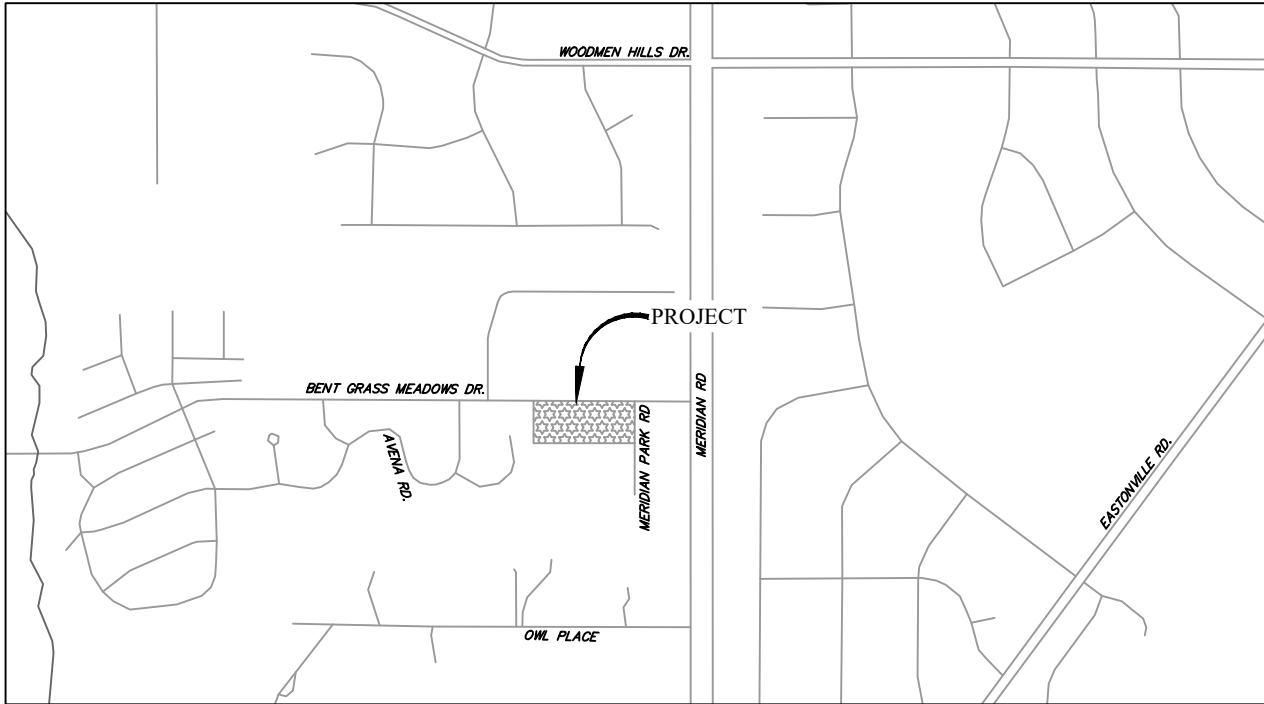
The downstream existing detention facility is functioning as intended and was designed to treat flows generated by this property.

10.0 REFERENCES

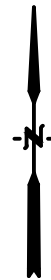
The sources of information used in the development of this study are listed below:

1. El Paso County Drainage Criteria Manual, 10-31-2018.
2. El Paso County Land Development Code, 5-25-2023.
3. Final Drainage Report for Bent Grass East Commercial Filing No. 3 (Classic Consulting) 11-02-2021. Amended 4-21-2022

Appendix



Vicinity Map
Not to scale



**BENT GRASS PLAZA
PEYTON, CO
VICINITY MAP**

Drexel, Barrell & Co.
Engineers • Surveyors

DATE:

DWG. NO.

JOB NO:

21814-00CSCV

VMAP

SHEET 1 OF 1


Custom Soil Resource Report Soil Map



Custom Soil Resource Report


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 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 2018

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	2.8	100.0%
Totals for Area of Interest		2.8	100.0%

Map Unit Descriptions

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

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

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

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

Custom Soil Resource Report

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

19—Columbine gravelly sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367p
Elevation: 6,500 to 7,300 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Columbine and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Columbine

Setting

Landform: Fans, fan terraces, flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 14 inches: gravelly sandy loam
C - 14 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well 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: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XY214CO - Gravelly Foothill
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquolls

Percent of map unit: 1 percent
Landform: Swales
Hydric soil rating: Yes

Custom Soil Resource Report

Other soils

Percent of map unit: 1 percent

Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent

Landform: Depressions

Hydric soil rating: Yes

National Flood Hazard Layer FIRMette



104°36'54"W 38°57'12"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

104°36'17"W 38°56'44"N

Basemap Imagery Source: USGS National Map 2023

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
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		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
		Coastal Transect Baseline
MAP PANELS		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 9/18/2023 at 5:23 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: Bent Grass Plaza
 PROJECT NO: 21814-00CSCV
 DESIGN BY: KGV
 REV. BY: TDM
 AGENCY: El Paso County
 REPORT TYPE: Final
 DATE: 10/10/2023



Drexel, Barrell & Co.

	C2*	C5*	C10*	C100*	% IMPERV
Roofs		0.73		0.81	90
Lawns/Landscaping		0.08		0.35	0
Drive and Walks		0.90		0.96	100

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

SUB-BASIN	SURFACE DESIGNATION		AREA ACRE	COMPOSITE RUNOFF COEFFICIENTS				% IMPERV
				C2	C5	C10	C100	
DEVELOPED								
A	Roofs		0.09		0.73		0.81	90
	Lawns/Landscaping		0.06		0.08		0.35	0
	Drive and Walks		0.00		0.90		0.96	100
A TOTAL	WEIGHTED AVERAGE		0.15		0.46		0.62	53
B	Roofs		0.15		0.73		0.81	90
	Lawns/Landscaping		0.07		0.08		0.35	0
	Drive and Walks		0.00		0.90		0.96	100
B TOTAL	WEIGHTED AVERAGE		0.22		0.52		0.66	62
C	Roofs		0.00		0.73		0.81	90
	Lawns/Landscaping		0.01		0.08		0.35	0
	Drive and Walks		0.11		0.90		0.96	100
C TOTAL	WEIGHTED AVERAGE		0.12		0.84		0.92	93
D	Roofs		0.09		0.73		0.81	90
	Lawns/Landscaping		0.05		0.08		0.35	0
	Drive and Walks		0.11		0.90		0.96	100
D TOTAL	WEIGHTED AVERAGE		0.26		0.67		0.78	76
E	Roofs		0.07		0.73		0.81	90
	Lawns/Landscaping		0.02		0.08		0.35	0
	Drive and Walks		0.31		0.90		0.96	100
E TOTAL	WEIGHTED AVERAGE		0.40		0.83		0.90	94
F	Roofs		0.10		0.73		0.81	90
	Lawns/Landscaping		0.01		0.08		0.35	0
	Drive and Walks		0.19		0.90		0.96	100
F TOTAL	WEIGHTED AVERAGE		0.30		0.82		0.89	94
G	Roofs				0.73		0.81	90
	Lawns/Landscaping		0.05		0.08		0.35	0
	Drive and Walks		0.01		0.90		0.96	100
G TOTAL	WEIGHTED AVERAGE		0.05		0.28		0.56	22

PROJECT INFORMATION

PROJECT: Bent Grass Plaza
 PROJECT NO: 21814-00CSCV
 DESIGN BY: KGV
 REV. BY: TDM
 AGENCY: El Paso County
 REPORT TYPE: Final
 DATE: 10/10/2023



Drexel, Barrell & Co.

	C2*	C5*	C10*	C100*	% IMPERV
Roofs		0.73		0.81	90
Lawns/Landscaping		0.08		0.35	0
Drive and Walks		0.90		0.96	100

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

H	Roofs		0.01		0.73		0.81	90
	Lawns/Landscaping		0.00		0.08		0.35	0
	Drive and Walks		0.10		0.90		0.96	100
H TOTAL	WEIGHTED AVERAGE		0.11		0.89		0.95	99
I	Roofs		0.01		0.73		0.81	90
	Lawns/Landscaping		0.03		0.08		0.35	0
	Drive and Walks		0.00		0.90		0.96	100
I TOTAL	WEIGHTED AVERAGE		0.04		0.23		0.46	21
J	Roofs		0.00		0.73		0.81	90
	Lawns/Landscaping		0.00		0.08		0.35	0
	Drive and Walks		0.24		0.90		0.96	100
J TOTAL	WEIGHTED AVERAGE		0.24		0.90		0.96	100
K	Roofs		0.00		0.73		0.81	90
	Lawns/Landscaping		0.07		0.08		0.35	0
	Drive and Walks		0.04		0.90		0.96	100
K TOTAL	WEIGHTED AVERAGE		0.11		0.38		0.57	36
L	Roofs		0.00		0.73		0.81	90
	Lawns/Landscaping		0.05		0.08		0.35	0
	Drive and Walks		0.04		0.90		0.96	100
L TOTAL	WEIGHTED AVERAGE		0.09		0.44		0.62	44

PROJECT INFORMATION

PROJECT: Bent Grass Plaza
 PROJECT NO: 21814-00CSCV
 DESIGN BY: KGV
 REV. BY: TDM
 AGENCY: El Paso County
 REPORT TYPE: Final
 DATE: 10/10/2023



Drexel, Barrell & Co.

RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF

DEVELOPED TIME OF CONCENTRATION STANDARD FORM SF-2

SUB-BASIN DATA					CA		INITIAL/OVERLAND TIME (t _i)			TRAVEL TIME (t _t)				TIME OF CONC. t _c		FINAL t _c
BASIN	DESIGN PT.	C _s	C ₁₀₀	AREA	5	100	LENGTH	SLOPE	t _i	LENGTH	SLOPE	VEL.	t _t	COMP.	MINIMUM	
				Ac			Ft	%	Min	Ft	%	FPS	Min	t _c	t _c	Min
DEVELOPED																
A	1	0.46	0.62	0.15	0.07	0.09	50	10.0	3.9	135	0.5	3.0	0.8	4.7	5.0	5.0
B	2	0.52	0.66	0.22	0.12	0.15	50	4.5	4.6	160	0.5	3.0	0.9	5.5	5.0	5.5
DP1+DP2	3	0.50	0.65	0.37	0.19	0.24	From DP2			25	1.0	11.3	0.0	5.5	5.0	5.5
C		0.84	0.92	0.12	0.10	0.11	25	1.0	2.4	60	2.0	5.3	0.2	2.6	5.0	5.0
DP3+C	4	0.58	0.71	0.49	0.29	0.35	From DP3			90	1.0	11.3	0.1	5.7	5.0	5.7
D	5	0.67	0.78	0.26	0.17	0.20	50	10.0	2.7	170	2.0	5.3	0.5	3.2	5.0	5.0
E	6	0.83	0.90	0.40	0.33	0.36	50	2.0	2.8	120	1.6	4.2	0.5	3.3	5.0	5.0
F		0.82	0.89	0.30	0.25	0.27	50	2.0	2.9	170	3.0	6.3	0.4	3.4	5.0	5.0
DP4+DP5+DP6+F	7	0.72	0.81	1.45	1.04	1.18	From DP6			180	1.0	11.3	0.3	5.3	5.0	5.3
G	8	0.28	0.56	0.05	0.01	0.03	25	2.0	6.1	15	2.0	5.3	0.0	6.2	5.0	6.2
H	9	0.89	0.95	0.11	0.10	0.10	20	2.0	1.4	60	4.0	6.8	0.1	1.6	5.0	5.0
I		0.23	0.46	0.04	0.01	0.02	25	2.0	6.5	15	2.0	5.3	0.0	6.5	5.0	6.5
J		0.90	0.96	0.24	0.21	0.23	25	2.0	1.5	365	1.0	3.8	1.6	3.1	5.0	5.0
DP7+DP8+DP9+I+J	10	0.73	0.83	1.89	1.37	1.56	From DP8			75	1.0	3.8	0.3	6.5	5.0	6.5
K	11	0.38	0.57	0.11	0.04	0.06	25	2.0	5.4	25	2.0	5.3	0.1	5.4	5.0	5.4
L	12	0.44	0.62	0.09	0.04	0.06	45	2.0	6.5	25	2.0	5.3	0.1	6.6	5.0	6.6

PROJECT INFORMATION

PROJECT: Bent Grass Plaza
 PROJECT NO: 21814-00CSCV
 DESIGN BY: KGV
 REV. BY: TDM
 AGENCY: El Paso County
 REPORT TYPE: Final
 DATE: 10/10/2023

**RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF****DEVELOPED****RUNOFF****5 YR STORM****P1=****1.50**

BASIN (S)	DIRECT RUNOFF						
	DESIGN POINT	AREA (AC)	RUNOFF COEFF	t _c (MIN)	C * A	I (IN/HR)	Q (CFS)
DEVELOPED							
A	1	0.15	0.46	5.0	0.07	5.09	0.3
B	2	0.22	0.52	5.5	0.12	4.96	0.6
DP1+DP2	3	0.37	0.50	5.5	0.19	4.95	0.9
C		0.12	0.84	5.0	0.10	5.09	0.5
DP3+C	4	0.49	0.58	5.7	0.29	4.91	1.4
D	5	0.26	0.67	5.0	0.17	5.09	0.9
E	6	0.40	0.83	5.0	0.33	5.09	1.7
F		0.30	0.82	5.0	0.25	5.09	1.3
DP4+DP5+DP6+F	7	1.45	0.72	5.3	1.04	5.02	5.2
G	8	0.05	0.28	6.2	0.01	4.80	0.1
H	9	0.11	0.89	5.0	0.10	5.09	0.5
I		0.04	0.23	6.5	0.01	4.72	0.0
J		0.24	0.90	5.0	0.21	5.09	1.1
DP7+DP8+DP9+I+J	10	1.89	0.73	6.5	1.37	4.72	6.5
K	11	0.11	0.38	5.4	0.04	4.97	0.2
L	12	0.09	0.44	6.6	0.04	4.69	0.2

PROJECT INFORMATION

PROJECT: Bent Grass Plaza
 PROJECT NO: 21814-00CSCV
 DESIGN BY: KGV
 REV. BY: TDM
 AGENCY: El Paso County
 REPORT TYPE: Final
 DATE: 10/10/2023

**RATIONAL METHOD CALCULATIONS FOR STORM WATER RUNOFF****DEVELOPED****RUNOFF****100 YR STORM****P1=****2.52**

BASIN (S)	DIRECT RUNOFF						
	DESIGN POINT	AREA (AC)	RUNOFF COEFF	t _c (MIN)	C * A	I (IN/HR)	Q (CFS)
DEVELOPED							
A	1	0.15	0.62	5.0	0.09	8.55	0.8
B	2	0.22	0.66	5.5	0.15	8.33	1.2
DP1+DP2	3	0.37	0.65	5.5	0.24	8.31	2.0
C		0.12	0.92	5.0	0.11	8.55	0.9
DP3+C	4	0.49	0.71	5.7	0.35	8.26	2.9
D	5	0.26	0.78	5.0	0.20	8.55	1.7
E	6	0.40	0.90	5.0	0.36	8.55	3.1
F		0.30	0.89	5.0	0.27	8.55	2.3
DP4+DP5+DP6+F	7	1.45	0.81	5.3	1.18	8.43	9.9
G	8	0.05	0.56	6.2	0.03	8.06	0.2
H	9	0.11	0.95	5.0	0.10	8.55	0.9
I		0.04	0.46	6.5	0.02	7.93	0.2
J		0.24	0.96	5.0	0.23	8.55	2.0
DP7+DP8+DP9+I+J	10	1.89	0.83	6.5	1.56	7.94	12.4
K	11	0.11	0.57	5.4	0.06	8.36	0.5
L	12	0.09	0.62	6.6	0.06	7.88	0.4

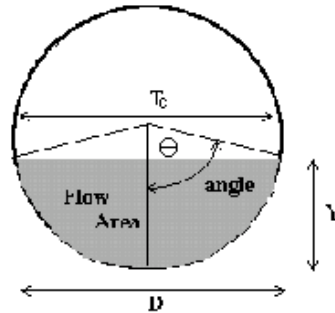
CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS PLAZA - UPDATED**

Pipe ID: **24" RCP (DP-1)**

UPDATED WITH REVISED
FLOW RATES. REFERENCE
ORIGINAL CALCULATIONS
LATER IN THIS REPORT



Design Information (Input)

Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	12.40	cfs

Full-Flow Capacity (Calculated)

Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	22.68	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \text{Theta} < 3.14$)	Theta =	1.63	radians
Flow area	An =	1.68	sq ft
Top width	Tn =	2.00	ft
Wetted perimeter	Pn =	3.25	ft
Flow depth	Yn =	1.05	ft
Flow velocity	Vn =	7.38	fps
Discharge	Qn =	12.40	cfs
Percent of Full Flow	Flow =	54.7%	of full flow
Normal Depth Froude Number	Fr _n =	1.42	supercritical

Calculation of Critical Flow Condition

Half Central Angle ($0 < \text{Theta-c} < 3.14$)	Theta-c =	1.84	radians
Critical flow area	Ac =	2.10	sq ft
Critical top width	Tc =	1.93	ft
Critical flow depth	Yc =	1.27	ft
Critical flow velocity	Vc =	5.92	fps
Critical Depth Froude Number	Fr _c =	1.00	

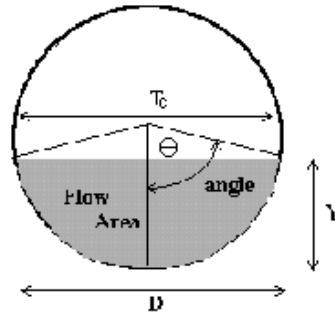
CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS PLAZA - UPDATED**

Pipe ID: **24" RCP (DP-1 & DP-2)**

UPDATED WITH REVISED
FLOW RATES. REFERENCE
ORIGINAL CALCULATIONS
LATER IN THIS REPORT



Design Information (Input)

Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	14.40	cfs

Full-Flow Capacity (Calculated)

Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	22.68	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \text{Theta} < 3.14$)	Theta =	1.73	radians
Flow area	An =	1.88	sq ft
Top width	Tn =	1.98	ft
Wetted perimeter	Pn =	3.46	ft
Flow depth	Yn =	1.16	ft
Flow velocity	Vn =	7.65	fps
Discharge	Qn =	14.40	cfs
Percent of Full Flow	Flow =	63.5%	of full flow
Normal Depth Froude Number	Fr _n =	1.38	supercritical

Calculation of Critical Flow Condition

Half Central Angle ($0 < \text{Theta-c} < 3.14$)	Theta-c =	1.95	radians
Critical flow area	Ac =	2.29	sq ft
Critical top width	Tc =	1.86	ft
Critical flow depth	Yc =	1.37	ft
Critical flow velocity	Vc =	6.29	fps
Critical Depth Froude Number	Fr _c =	1.00	

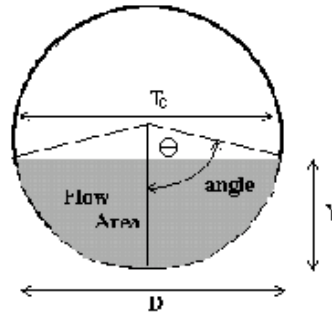
CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS PLAZA - UPDATED**

Pipe ID: **24" RCP (DP-3)**

UPDATED WITH REVISED
FLOW RATES. REFERENCE
ORIGINAL CALCULATIONS
LATER IN THIS REPORT



Design Information (Input)

Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	17.40	cfs

Full-Flow Capacity (Calculated)

Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	22.68	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \theta < 3.14$)	Theta =	1.89	radians
Flow area	An =	2.19	sq ft
Top width	Tn =	1.90	ft
Wetted perimeter	Pn =	3.78	ft
Flow depth	Yn =	1.31	ft
Flow velocity	Vn =	7.96	fps
Discharge	Qn =	17.40	cfs
Percent of Full Flow	Flow =	76.7%	of full flow
Normal Depth Froude Number	Fr _n =	1.31	supercritical

Calculation of Critical Flow Condition

Half Central Angle ($0 < \theta_c < 3.14$)	Theta-c =	2.10	radians
Critical flow area	Ac =	2.53	sq ft
Critical top width	Tc =	1.73	ft
Critical flow depth	Yc =	1.50	ft
Critical flow velocity	Vc =	6.87	fps
Critical Depth Froude Number	Fr _c =	1.00	

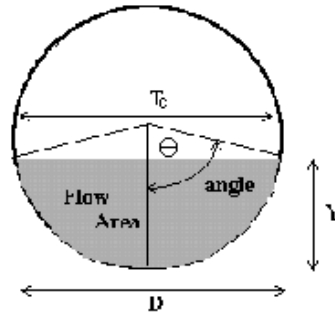
CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS PLAZA - UPDATED**

Pipe ID: **30" RCP (DP-4)**

UPDATED WITH REVISED
FLOW RATES. REFERENCE
ORIGINAL CALCULATIONS
LATER IN THIS REPORT



Design Information (Input)

Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	30.00	inches
Design discharge	Q =	26.40	cfs

Full-Flow Capacity (Calculated)

Full-flow area	Af =	4.91	sq ft
Full-flow wetted perimeter	Pf =	7.85	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	41.13	cfs

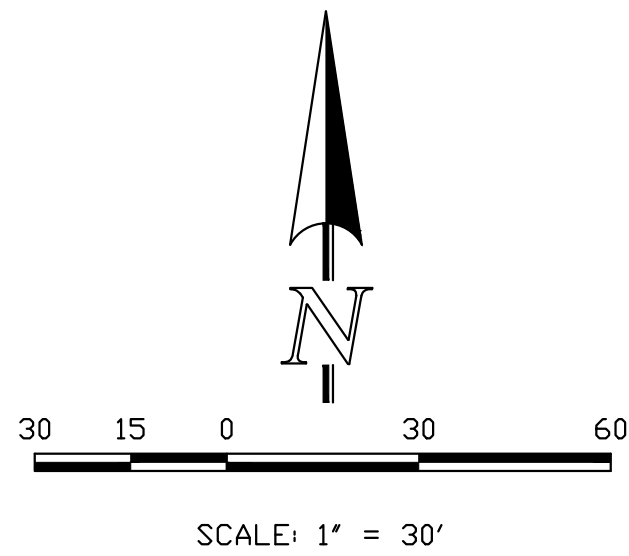
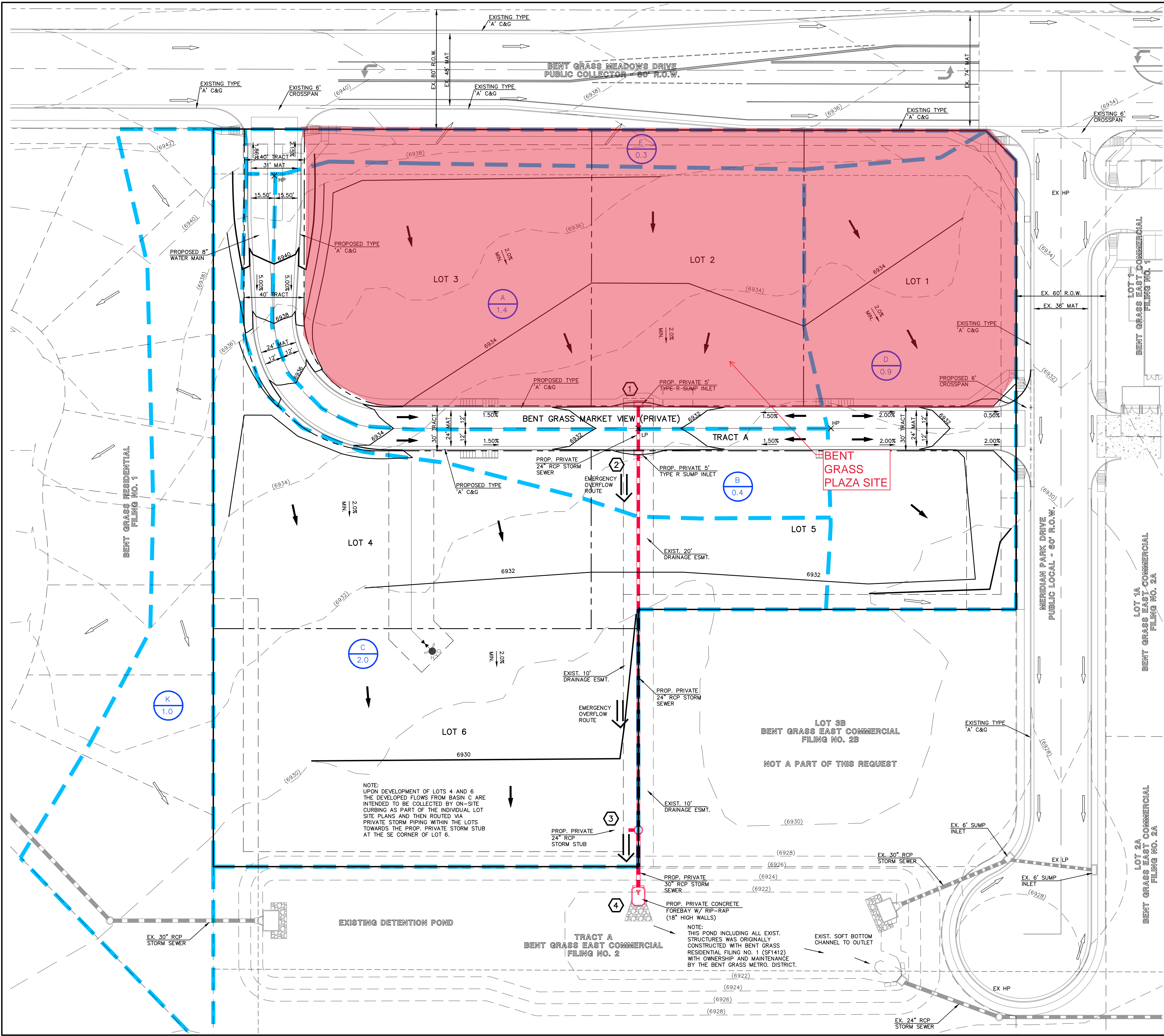
Calculation of Normal Flow Condition

Half Central Angle ($0 < \text{Theta} < 3.14$)	Theta =	1.74	radians
Flow area	An =	2.97	sq ft
Top width	Tn =	2.47	ft
Wetted perimeter	Pn =	4.34	ft
Flow depth	Yn =	1.46	ft
Flow velocity	Vn =	8.89	fps
Discharge	Qn =	26.40	cfs
Percent of Full Flow	Flow =	64.2%	of full flow
Normal Depth Froude Number	Fr _n =	1.43	supercritical

Calculation of Critical Flow Condition

Half Central Angle ($0 < \text{Theta-c} < 3.14$)	Theta-c =	1.98	radians
Critical flow area	Ac =	3.67	sq ft
Critical top width	Tc =	2.29	ft
Critical flow depth	Yc =	1.75	ft
Critical flow velocity	Vc =	7.19	fps
Critical Depth Froude Number	Fr _c =	1.00	

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LEGEND	
DESCRIPTION	SYMBOL
PROPOSED CONTOUR-10	
PROPOSED CONTOUR-2	
EXISTING CONTOUR-10	
EXISTING CONTOUR-2	
PROPERTY LINE	
BOUNDARY LINE	
PROPOSED PRIVATE STORM SEWER	
PROPOSED PRIVATE STORM INLET	
EXISTING STORM SEWER	
EXISTING STORM INLET	
EXISTING FLOW DIRECTION	
PROPOSED FLOW	
HIGH POINT	
LOW POINT	
OVERFLOW ROUTE	
BASIN IDENTIFIER	
AREA IN ACRES	
DESIGN POINT	
DRAINAGE BASIN	

FINAL DRAINAGE REPORT - BASIN RUNOFF SUMMARY																			
BASIN	TOTAL AREA (AC)	WEIGHTED			OVERLAND			STREET / CHANNEL FLOW			TOTAL			INTENSITY			TOTAL FLOWS		
		CA(2)	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (ft/s)	Tc (min)	TOTAL	I(2)	I(5)	I(100)	Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
A	1.4	0.99	1.01	1.16	0.08	30	2	5.4	250	2.0%	1.0	4.2	9.6	3.34	4.19	7.93	3	4	8
B	0.4	0.27	0.28	0.32	0.08	10	0.2	4.6	100	1.5%	0.9	1.9	6.6	3.79	4.76	7.95	1	1	3
C	2.0	1.43	1.47	1.68	0.08	30	1.5	5.9	400	2.0%	1.0	6.7	12.7	3.01	3.77	6.34	4	6	11
D	0.9	0.67	0.69	0.77	0.08	10	0.2	4.6	200	2.0%	1.4	2.4	7.6	3.72	4.67	7.93	2	3	6
E	0.3	0.05	0.07	0.14	0.08	25	0.5	7.3					7.3	3.67	4.60	7.72	0.2	0.3	1.0
K	1.0	0.32	0.37	0.56	0.08	65	3	9.0					9.0	3.43	4.29	7.21	1	2	4

FINAL DRAINAGE REPORT - SURFACE ROUTING SUMMARY									
Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity				Outfall / Inlet Size
					I(5)	I(100)	Q(5)	Q(100)	
1	A	1.01	1.16	9.6	4.19	7.03	4	8	5" Type R Sump Inlet
2	B	0.28	0.32	6.6	4.76	7.99	1	3	5" Type R Sump Inlet
3	C, 70% K	1.73	2.07	12.7	3.77	6.34	7	13	24" RCP Sub
4	A, B, C, 70% K	3.02	3.55	12.8	3.76	6.32	11	22	Concrete Forebay



BENT GRASS EAST
COMMERCIAL FILING NO. 3
DEVELOPED DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE	10-27-20
DRAWN BY	MAW	(H) 1" = 30'	SHEET	1 OF 1
CHECKED BY		(V) 1" = N/A	JOB NO.	2177.64

619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719) 785-0790
(719) 785-0799 (Fax)



The proposed development plans to construct a private roadway in order to provide vehicular access to the 6 lots. This private road will connect to both Bent Grass Meadows Dr. to the north and Meridian Park Dr. to the east. High points are planned at each of these two connection points with a low point near the middle of the property. (See Developed Drainage Map in Appendix)

Design Point 1 ($Q_5 = 4$ cfs and $Q_{100} = 8$ cfs) represents developed flows from Basin A (lots 2 and 3 and north half of the private road). These flows will be routed towards Design Point 1 where a private 5' Type R Sump Inlet will completely collect both the 5 and 100 yr. developed flows.

Design Point 2 ($Q_5 = 1$ cfs and $Q_{100} = 3$ cfs) represents developed flows from Basin B (portion of lots 4 and 5 and south half of the private road). These flows will be routed towards Design Point 2 where a private 5' Type R Sump Inlet will completely collect both the 5 and 100 yr. developed flows.

Design Point 3 ($Q_5 = 7$ cfs and $Q_{100} = 13$ cfs) represents developed flows from Basin C (lots 4 and 6) and a portion of off-site Basin K (existing residential development to the west). These flows will be routed towards Design Point 3 where a private 24" RCP storm stub will collect both the 5 and 100 yr. developed flows. The individual site plans for each of these lots will show how curb and gutter will collect these developed flows and route them towards the provided 24" RCP private storm stub. These flows remain consistent with Basins L ($Q_5 = 18$ cfs and $Q_{100} = 35$ cfs) and K ($Q_5 = 2$ cfs and $Q_{100} = 4$ cfs) from the previous report. (See Appendix)

Design Point 4 ($Q_5 = 11$ cfs and $Q_{100} = 22$ cfs) represents the total developed flows that will enter the existing pond at this location (Basins A, B, C and a portion of Basin K). A concrete forebay is proposed within the existing pond at this location with the following criteria:
(See Appendix)

Per UD-BMP Spreadsheet – **Concrete Forebay sizing**

0.003 Ac-ft. or 131 SF min. Forebay with 12” high walls OR **88 SF min. with 18” high walls**

4.5” wide notch at end of forebay

Basin E ($Q_5 = 0.3$ cfs and $Q_{100} = 1.0$ cfs) represents developed flows from Basin E (landscape/setback area within lots 1, 2 and 3) that will continue to sheet flow in a northeasterly direction and directly into Bent Grass Meadows Dr. This minor developed flow was accounted for and remains consistent with the previously approved report. Also, per ECM I.7.1.C.1.a this basin of 0.3 ac. is not practical to be captured and will not drain towards the downstream control measures.

Basin D ($Q_5 = 3$ cfs and $Q_{100} = 6$ cfs) represents developed flows from Basin D (lots 1 and a portion of 5 and a portion of the private road). These flows will continue to sheet flow directly into Meridian Park Dr. They then travel as curb and gutter flows to the existing sump inlet within the cul-de-sac and then directly into the existing pond. These flows were accounted for in the previously approved drainage report and remain consistent with Basin M1 ($Q_5 = 6$ cfs and $Q_{100} = 11$ cfs) from the previous report. (See Appendix)

DRAINAGE CRITERIA

Hydrologic calculations were performed using the City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014 along with the El Paso County Engineering Criteria Manual, updated October 2020. Individual on-site developed basin design used for detention/SWQ basin sizing, inlet sizing and storm system routing was calculated using the Rational Method. Runoff Coefficients are based on the imperviousness of the particular land

JOB NAME: BENT GRASS EAST COMMERCIAL FILING NO. 3
 JOB NUMBER: 2177.64
 DATE: 11/04/20
 CALCULATED BY: MAW

FINAL DRAINAGE REPORT ~ BASIN RUNOFF COEFFICIENT SUMMARY

BASIN	TOTAL AREA (AC)	IMPERVIOUS AREA / STREETS				LANDSCAPE/UNDEVELOPED AREAS				WEIGHTED			WEIGHTED CA		
		AREA (AC)	C(2)	C(5)	C(100)	AREA (AC)	C(2)	C(5)	C(100)	C(2)	C(5)	C(100)	CA(2)	CA(5)	CA(100)
A	1.4	1.10	0.89	0.90	0.96	0.30	0.02	0.08	0.35	0.70	0.72	0.83	0.99	1.01	1.16
B	0.4	0.30	0.89	0.90	0.96	0.10	0.02	0.08	0.35	0.67	0.70	0.81	0.27	0.28	0.32
C	2.0	1.60	0.89	0.90	0.96	0.40	0.02	0.08	0.35	0.72	0.74	0.84	1.43	1.47	1.68
D	0.9	0.75	0.89	0.90	0.96	0.15	0.02	0.08	0.35	0.75	0.76	0.86	0.67	0.69	0.77
E	0.3	0.05	0.89	0.90	0.96	0.25	0.02	0.08	0.35	0.17	0.22	0.45	0.05	0.07	0.14
K	1.0	0.35	0.89	0.90	0.96	0.65	0.02	0.08	0.35	0.32	0.37	0.56	0.32	0.37	0.56

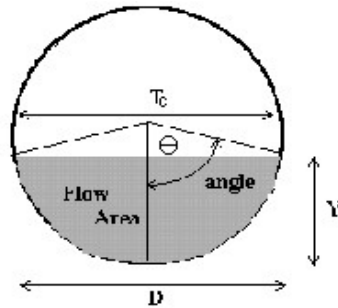
CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS EAST COMMERCIAL FILING NO. 3**

Pipe ID: **24" RCP (DP-1)**

ORIGINAL CALCULATIONS



Design Information (Input)

Pipe Invert Slope	$S_o =$	0.0100	ft/ft
Pipe Manning's n-value	$n =$	0.0130	
Pipe Diameter	$D =$	24.00	inches
Design discharge	$Q =$	8.00	cfs

Full-Flow Capacity (Calculated)

Full-flow area	$A_f =$	3.14	sq ft
Full-flow wetted perimeter	$P_f =$	6.28	ft
Half Central Angle	$\theta =$	3.14	radians
Full-flow capacity	$Q_f =$	22.68	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \theta < 3.14$)	$\theta =$	1.39	radians
Flow area	$A_n =$	1.21	sq ft
Top width	$T_n =$	1.97	ft
Wetted perimeter	$P_n =$	2.78	ft
Flow depth	$Y_n =$	0.82	ft
Flow velocity	$V_n =$	6.59	fps
Discharge	$Q_n =$	8.00	cfs
Percent of Full Flow	$\text{Flow} =$	35.3%	of full flow
Normal Depth Froude Number	$Fr_n =$	1.48	supercritical

Calculation of Critical Flow Condition

Half Central Angle ($0 < \theta_c < 3.14$)	$\theta_c =$	1.58	radians
Critical flow area	$A_c =$	1.58	sq ft
Critical top width	$T_c =$	2.00	ft
Critical flow depth	$Y_c =$	1.01	ft
Critical flow velocity	$V_c =$	5.05	fps
Critical Depth Froude Number	$Fr_c =$	1.00	

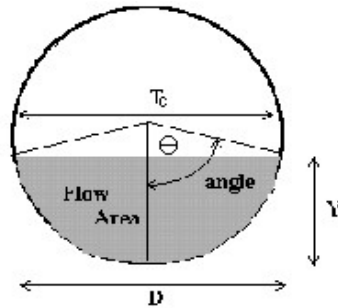
CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS EAST COMMERCIAL FILING NO. 3**

Pipe ID: **24" RCP (DP-1 & DP-2)**

ORIGINAL CALCULATIONS



Design Information (Input)

Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	10.00	cfs

Full-Flow Capacity (Calculated)

Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	22.68	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \theta < 3.14$)	Theta =	1.50	radians
Flow area	An =	1.43	sq ft
Top width	Tn =	2.00	ft
Wetted perimeter	Pn =	3.00	ft
Flow depth	Yn =	0.93	ft
Flow velocity	Vn =	6.99	fps
Discharge	Qn =	10.00	cfs
Percent of Full Flow	Flow =	44.1%	of full flow
Normal Depth Froude Number	Fr _n =	1.46	supercritical

Calculation of Critical Flow Condition

Half Central Angle ($0 < \theta_c < 3.14$)	Theta-c =	1.70	radians
Critical flow area	Ac =	1.83	sq ft
Critical top width	Tc =	1.98	ft
Critical flow depth	Yc =	1.13	ft
Critical flow velocity	Vc =	5.46	fps
Critical Depth Froude Number	Fr _c =	1.00	

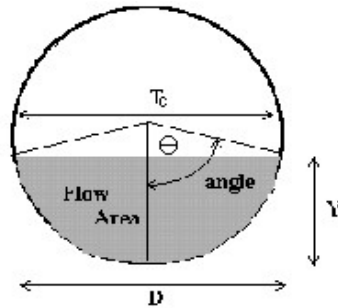
CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS EAST COMMERCIAL FILING NO. 3**

Pipe ID: **24" RCP (DP-3)**

ORIGINAL CALCULATIONS



Design Information (Input)	
Pipe Invert Slope	$S_o = 0.0100$ ft/ft
Pipe Manning's n-value	$n = 0.0130$
Pipe Diameter	$D = 24.00$ inches
Design discharge	$Q = 13.00$ cfs
Full-Flow Capacity (Calculated)	
Full-flow area	$A_f = 3.14$ sq ft
Full-flow wetted perimeter	$P_f = 6.28$ ft
Half Central Angle	$\theta = 3.14$ radians
Full-flow capacity	$Q_f = 22.68$ cfs
Calculation of Normal Flow Condition	
Half Central Angle ($0 < \theta < 3.14$)	$\theta = 1.66$ radians
Flow area	$A_n = 1.74$ sq ft
Top width	$T_n = 1.99$ ft
Wetted perimeter	$P_n = 3.31$ ft
Flow depth	$Y_n = 1.09$ ft
Flow velocity	$V_n = 7.47$ fps
Discharge	$Q_n = 13.00$ cfs
Percent of Full Flow	$\text{Flow} = 57.3\%$ of full flow
Normal Depth Froude Number	$Fr_n = 1.41$ supercritical
Calculation of Critical Flow Condition	
Half Central Angle ($0 < \theta_c < 3.14$)	$\theta_c = 1.87$ radians
Critical flow area	$A_c = 2.16$ sq ft
Critical top width	$T_c = 1.91$ ft
Critical flow depth	$Y_c = 1.30$ ft
Critical flow velocity	$V_c = 6.03$ fps
Critical Depth Froude Number	$Fr_c = 1.00$

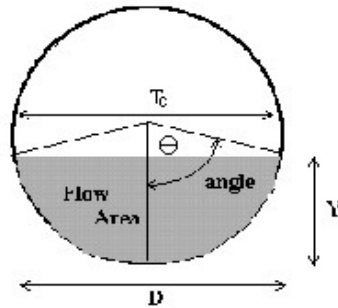
CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **BENT GRASS EAST COMMERCIAL FILING NO. 3**

Pipe ID: **30" RCP (DP-4)**

ORIGINAL CALCULATIONS



Design Information (Input)

Pipe Invert Slope	$S_o =$	0.0100	ft/ft
Pipe Manning's n-value	$n =$	0.0130	
Pipe Diameter	$D =$	30.00	inches
Design discharge	$Q =$	22.00	cfs

Full-Flow Capacity (Calculated)

Full-flow area	$A_f =$	4.91	sq ft
Full-flow wetted perimeter	$P_f =$	7.85	ft
Half Central Angle	$\theta =$	3.14	radians
Full-flow capacity	$Q_f =$	41.13	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \theta < 3.14$)	$\theta =$	1.61	radians
Flow area	$A_n =$	2.58	sq ft
Top width	$T_n =$	2.50	ft
Wetted perimeter	$P_n =$	4.03	ft
Flow depth	$Y_n =$	1.30	ft
Flow velocity	$V_n =$	8.52	fps
Discharge	$Q_n =$	22.00	cfs
Percent of Full Flow	$\text{Flow} =$	53.5%	of full flow
Normal Depth Froude Number	$Fr_n =$	1.48	supercritical

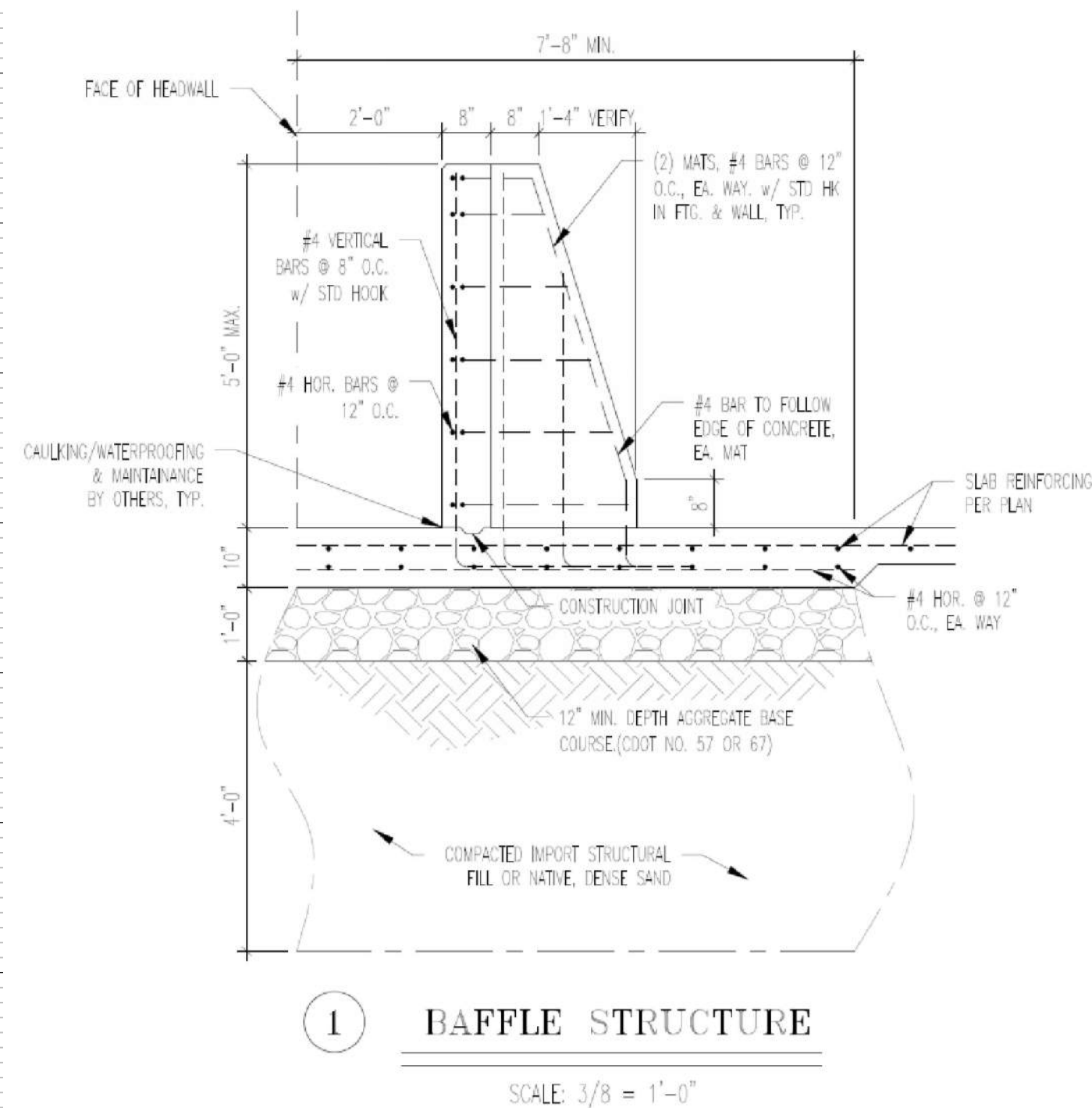
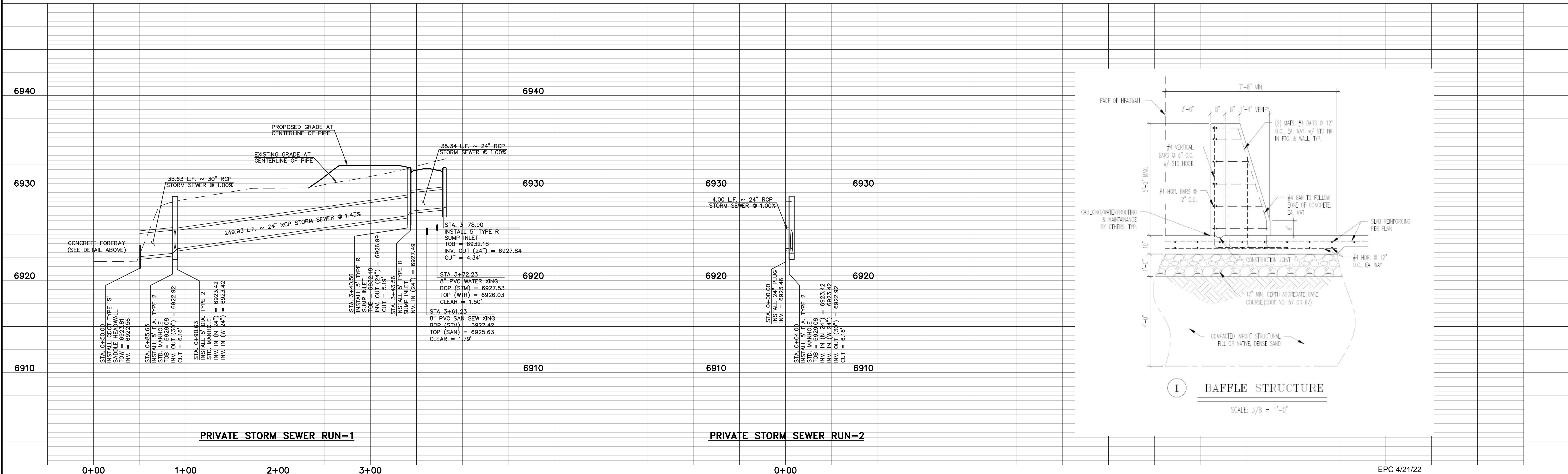
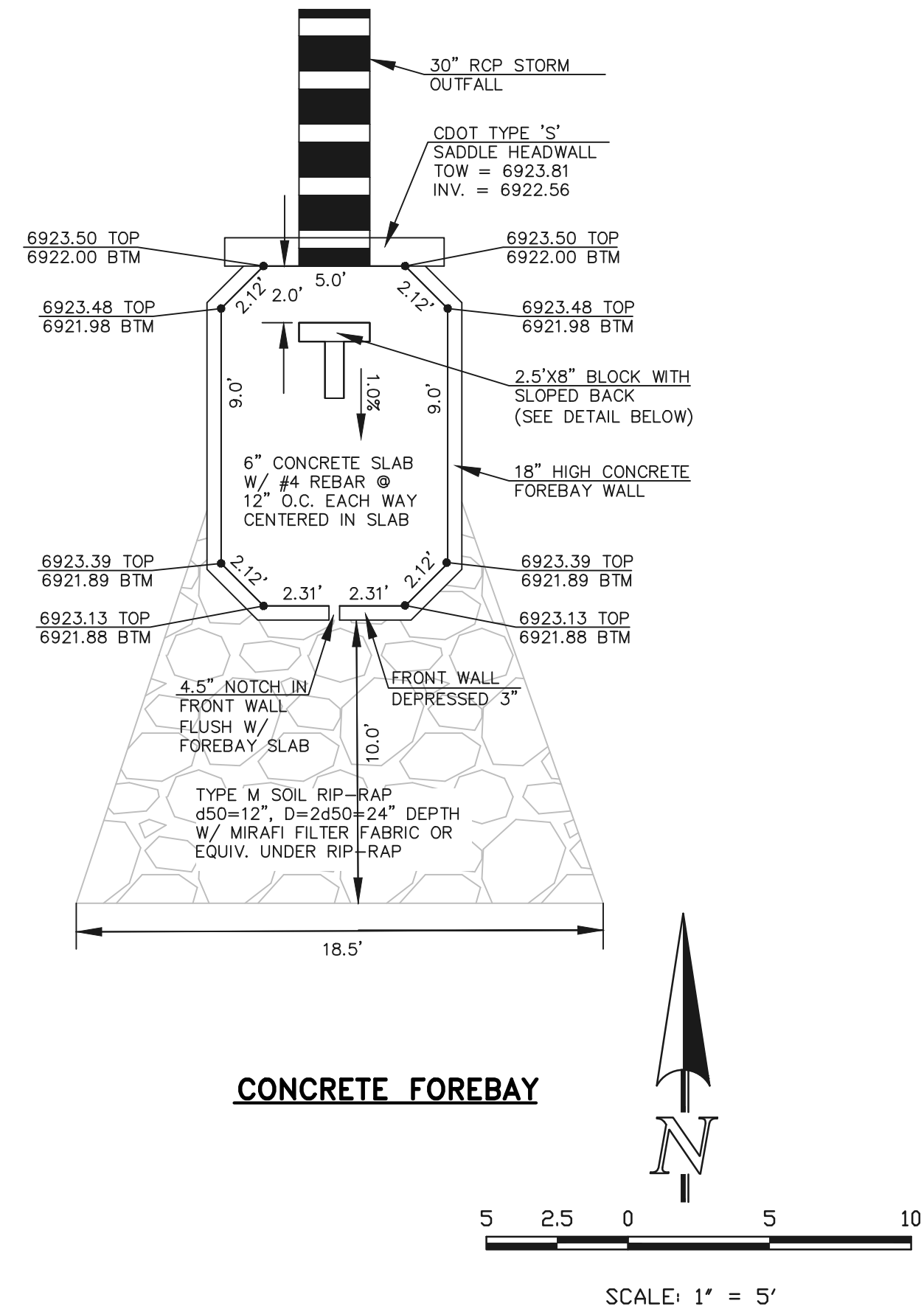
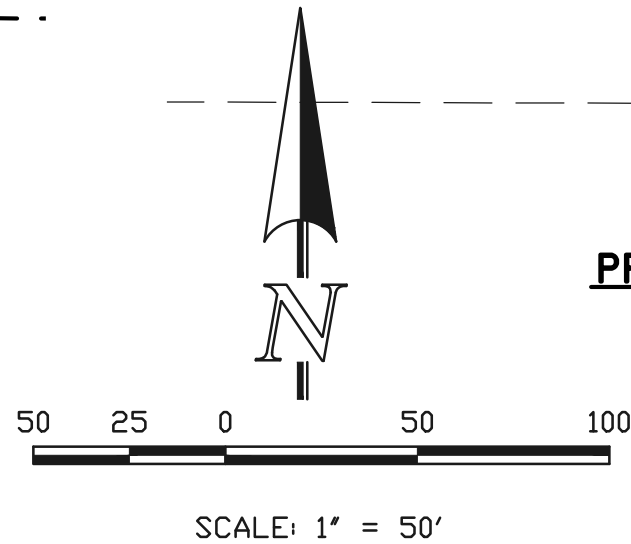
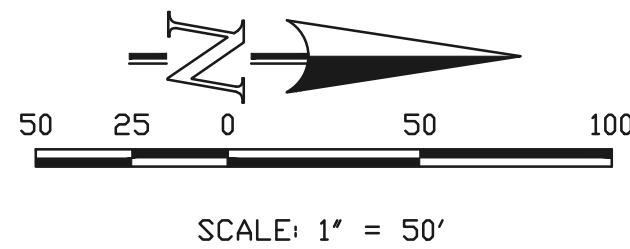
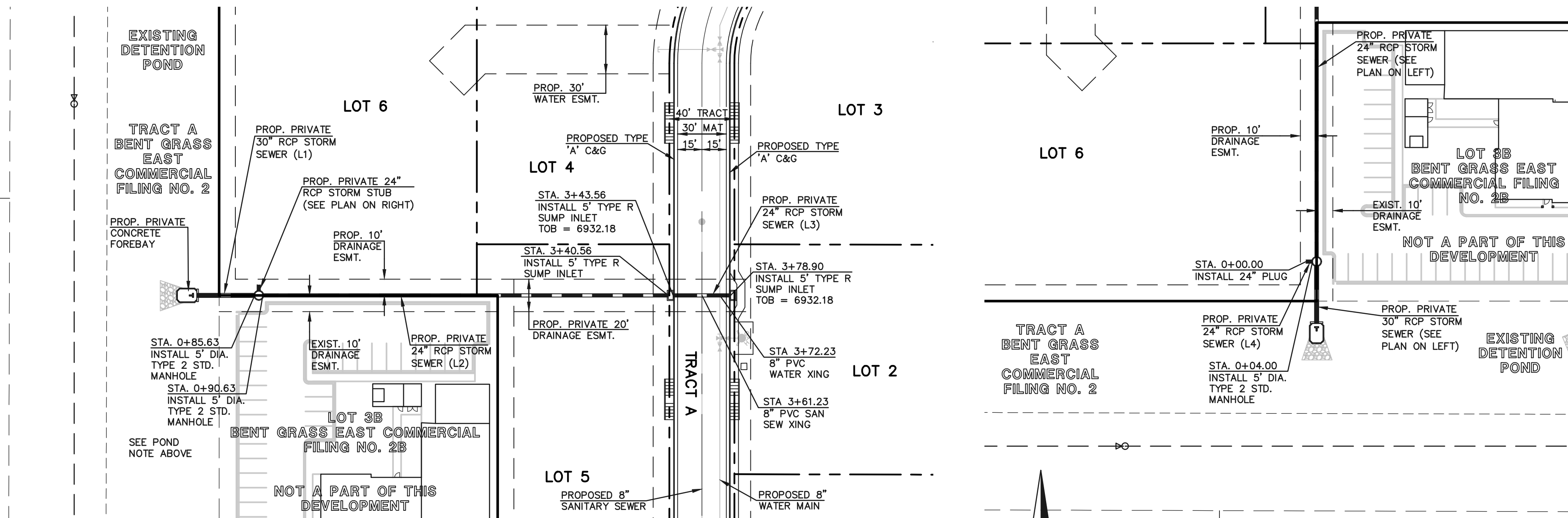
Calculation of Critical Flow Condition

Half Central Angle ($0 < \theta_c < 3.14$)	$\theta_c =$	1.85	radians
Critical flow area	$A_c =$	3.31	sq ft
Critical top width	$T_c =$	2.40	ft
Critical flow depth	$Y_c =$	1.59	ft
Critical flow velocity	$V_c =$	6.66	fps
Critical Depth Froude Number	$Fr_c =$	1.00	

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POND NOTE:
THIS POND, INCLUDING ALL EXIST. STRUCTURES WAS ORIGINALLY
CONSTRUCTED WITH BENT GRASS RESIDENTIAL FILING NO. 1 (SF1412) WITH
OWNERSHIP AND MAINTENANCE BY THE BENT GRASS METRO. DISTRICT.

STORM SEWER LINE TABLE		
LINE	LENGTH	BEARING
L1	35.63'	N00°00'03"E
L2	249.93'	N00°00'03"E
L3	35.34'	N00°00'03"E
L4	4.00'	N89°59'57"W



48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE
SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR
SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING
UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL
BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH
MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND
PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE
1	REVISED PER COUNTY COMMENTS	11-30-21
2	REVISED PER COUNTY COMMENTS	2-16-22

REVIEW:
PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF
CLASSIC CONSULTING, INC. A PROFESSIONAL SURVEYORS, LLC

MARC A. WHORTON, COLORADO PROFESSIONAL ENGINEER #37155
4/4/2022
DATE

CLASSIC CONSULTING
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719) 785-0790
(719) 785-0799 (Fax)

BENT GRASS EAST COMMERCIAL
FILING NO. 3
PRIVATE STORM SEWER PLAN

DESIGNED BY	PRA	SCALE	DATE	04-21-21
DRAWN BY	PRA	(H) 1" = 50'	SHEET	7 OF 10
CHECKED BY	(V) 1" = 5'	JOB NO.	2177.64	

