



INNOVATIVE DESIGN. **CLASSIC RESULTS.**

**FINAL DRAINAGE REPORT  
ADDENDUM NO. 2  
BENT GRASS RESIDENTIAL FILING NO. 1  
FOR  
BENT GRASS EAST COMMERCIAL  
FILING NO. 3**

Prepared for:

**LAND FIRST INC.**

1378 PROMONTORY BLUFF VIEW  
COLORADO SPRINGS, CO 80921  
Contact: Ron Waldthausen

Prepared by:

**CLASSIC CONSULTING**

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COLORADO SPRINGS, CO 80903  
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PCD File No. SP-20-010

Job no. 2177.64

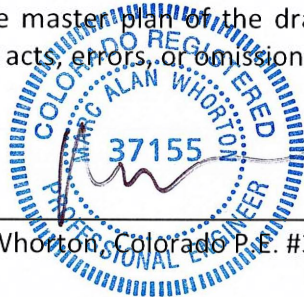


**FINAL DRAINAGE REPORT ADDENDUM NO. 2 BENT GRASS RESIDENTIAL FILING NO. 1  
FOR BENT GRASS EAST COMMERCIAL FILING NO. 3**

**DRAINAGE REPORT STATEMENT**

**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 County for drainage reports and said report is in conformity with the applicable 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.



\_\_\_\_\_  
Marc A. Whorton, Colorado P.E. #37155

5/10/2021

\_\_\_\_\_  
Date

**OWNER'S/DEVELOPER'S STATEMENT:**

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

Business Name: Land First Inc.

*Ronald Whorton*

Title: *President*

Address: 1378 Promontory Bluff View

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.

\_\_\_\_\_  
Jennifer Irvine, P.E.  
County Engineer, / ECM Administrator

**APPROVED**  
**Engineering Department**

11/02/2021 11:19:16 AM

*dsdnijkamp*

**EPC Planning & Community  
Development Department**

Conditions: **APPROVED**  
**Engineering Department**

04/21/2022 9:02:25 AM

*dsdnijkamp*

**EPC Planning & Community  
Development Department**

amended 4/21/22



**FINAL DRAINAGE REPORT ADDENDUM NO. 2 BENT GRASS RESIDENTIAL FILING NO. 1  
FOR BENT GRASS EAST COMMERCIAL FILING NO. 3**

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# **FINAL DRAINAGE REPORT ADDENDUM NO. 2 BENT GRASS RESIDENTIAL FILING NO. 1 FOR BENT GRASS EAST COMMERCIAL FILING NO. 3**

## **PURPOSE**

This portion of the Bent Grass East Commercial development was previously platted as Tract B within Bent Grass East Commercial Filing No. 2B. However, it was previously analyzed from a drainage standpoint and included in the Bent Grass Residential Filing No. 1 Final Drainage Report and latest Addendum filed in 2015. The previous drainage basins K, L and M1 encompass the proposed development and re-plat of Tract B. The purpose of this report is to confirm that the existing adjacent pond indeed accounted for this development and to better define the exact routing of the proposed storm sewer into the pond and associated concrete forebay design.

## **GENERAL DESCRIPTION**

Tract B, Bent Grass East Commercial Filing No. 2B contains a total area of 219,877 SF (5.05 AC.), located in the county of El Paso within Section 1, Township 13 South, Range 65 West of the Sixth Principal Meridian, El Paso County, Colorado. The site is bounded on the north by Bent Grass Meadows Dr., on the east by Meridian Park Dr., on the west Bent Grass Residential Filing No. 1 and to the south by the existing detention pond within Tract A of the Bent Grass East Commercial development.

The average soil condition reflects Hydrologic Group "A" (Columbine gravelly sandy loam), as determined by the "Soil Survey of El Paso County Area," prepared by the Soil Conservation Service. (See Appendix) For the purposes of the hydrologic calculations within this report, the soil type A was utilized.

## **EXISTING/DEVELOPED DRAINAGE CONDITIONS**

The entire proposed development area was previously overlot graded along with the adjacent developments. The revegetation consists of native grasses with slopes of 2%-4%. The entire property sheet flows in a southerly direction directly into the existing detention pond 2 just south of the property.





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



use and the hydrologic soil type in accordance with Table 6-6. The average rainfall intensity, by recurrence interval found in the Intensity-Duration-Frequency (IDF) curves in Figure 6-5. (See Appendix)

The City of Colorado Springs/El Paso County DCM requires the Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage ways, and implementing long-term source controls. The Four Step Process pertains to management of smaller, frequently occurring storm events, as opposed to larger storms for which drainage and flood control infrastructure are sized. Implementation of these four steps helps to achieve storm water permit requirements.

This site adheres to this **Four Step Process** as follows:

1. **Employ Runoff Reduction Practices:** Proposed urban commercial lot impervious areas (roof tops, parking lots, drive aisles, etc.) will to the extent possible, sheet flow across landscaped areas to slow runoff and increase time of concentration prior to being conveyed to the proposed private storm systems and stormwater quality facilities. This will minimize directly connected impervious areas within the project site.
2. **Stabilize Drainageways:** After developed flows utilize the runoff reduction practices through landscaped areas, developed flows will travel via curb and gutter and buried storm sewer systems. These collected flows are then routed directly to the existing stormwater quality facility adjacent to the site (Pond 2) that was originally constructed with Bent Grass Residential Filing No. 1.
3. **Provide Water Quality Capture Volume (WQCV):** Runoff from this development will be treated through capture and slow release of the WQCV in the existing stormwater quality facility (Pond 2).

4. **Consider need for Industrial and Commercial BMPs:** No industrial uses are proposed within this development. However, a site specific storm water quality and erosion control plan and narrative will be submitted along with the grading and erosion control plan. Details such as site specific sediment and erosion control construction BMP's as well as temporary and permanent BMP's will be detailed in this plan and narrative to protect receiving waters. BMP's will be constructed and maintained as the development has been graded and erosion control methods employed.

#### **FLOODPLAIN STATEMENT**

No portion of this site is located within a FEMA floodplain as determined by the Flood Insurance Rate Map (F.I.R.M.) Map Number 08041C0553G, with effective date of December, 7 2018. (See Appendix)

#### **DRAINAGE AND BRIDGE FEES**

This site lies entirely within the Falcon Drainage Basin boundaries.

The fees are calculated using the following impervious acreage method approved by El Paso County. Bent Grass East Commercial Filing No. 3 has a total area of 5.048 acres with a commercial land use designation.

The percent imperviousness for this subdivision is calculated as follows:

#### **Fees for Commercial Land Use**

(Per El Paso County Percent Impervious Chart: 95%)

5.048 Ac. x 95% = 4.796 **Impervious Ac.**

The following calculations are based on the ~~2020~~<sup>2021</sup> Falcon drainage/bridge fees:

**APPROVED**  
**Engineering Department**

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dsdnijkamp

**EPC Planning & Community  
Development Department**



**ESTIMATED FEES:**

**Bridge Fees**

\$ ~~4,232.00~~ x 4.796 Impervious Ac. = \$ ~~20,296.67~~  
4,380.00 \$ 21,006.48

**Drainage Fees**

\$ ~~30,807.00~~ x 4.796 Impervious Ac. = \$ ~~147,750.37~~  
31,885.00 \$152,920.46

Per the ECM 3.10.4.a, this development requests a reduction of drainage fees based on the on-site detention pond 2 that was constructed as a part of the Bent Grass Residential Filing No. 1 development. This facility within the Falcon Drainage Basin seems to meet the following criteria for this reduction:

1. *Allowed only where regional system is not yet in place – no downstream regional facility in place yet*
2. *The pond is less than 15 acre-feet in volume from the lowest outlet structure to the crest of the emergency spillway – The existing pond 2 has a volume of 2.32 ac.-ft.*
3. *The on-site pond is not part of the regional plan (for approval ponds that are part of the regional plan, developers are given 100% credit) – Pond 2 is not a part of the regional plan*
4. *The outlet of the pond must be designed to release at historic levels for all precipitation events from the 2 yr. storm to the 100 yr. storm. A smaller outlet may be required by the County if adequate downstream channel improvement are not in place to protect residents from the 2 yr. storm – Pond 2 was designed as a full spectrum facility*
5. *County approves design and construction – County approved the design and construction of Pond 2 along with the Bent Grass Residential Filing No. 1 development*
6. *Landowners assume responsibility for maintenance – Pond 2 is owned and maintained by the Bent Grass Metro. District*

Per Bent Grass East Commercial Filing No. 2 Final Drainage Report – Dated Aug. 2014

Construction of Detention Pond 2 (Full Spectrum on-site Facility) = \$75,000 \*  
50% credit was taken against drainage fees owed (See Appendix) = \$37,500 – 26,860.65  
Credit remaining within the Falcon Basin = \$10,639.35

*\*Developer to provide receipts for previous pond const. and apply for drainage reimbursement in order to receive credit.*

**TOTAL DRAINAGE FEES (after reduction):**

**Drainage Fees**

~~\$ 147,750.37~~ – 10,639.35 = ~~\$ 137,111.02~~\*  
\$152,920.46 = \$142,281.11\*

**SUMMARY**

The proposed grading plan, drainage patterns and quantities remain consistent with the previously approved final drainage report for Bent Grass Residential Filing No. 1 and associated addendum. The proposed development will not adversely impact surrounding properties.

PREPARED BY:

**Classic Consulting Engineers & Surveyors, LLC**



Marc A. Whorton, P.E.  
Project Manager

mw/217764/Reports/217764FDR Addendum.doc



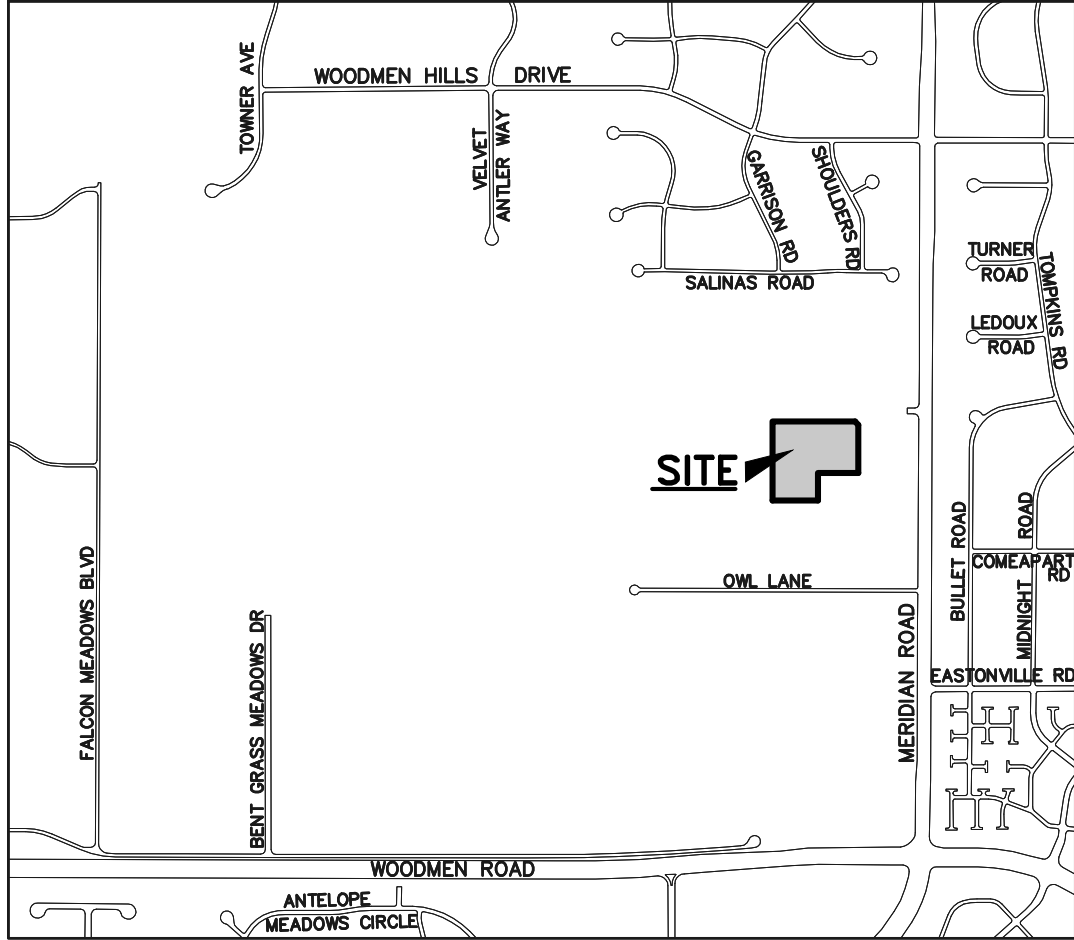


## REFERENCES

1. City of Colorado Springs/County of El Paso 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.
2. "Urban Storm Drainage Criteria Manual Volume 1, 2 & 3" Urban Drainage and Flood Control District, dated January 2016.
3. "Falcon Drainage Basin Planning Study - Update," by Matrix Design Group, dated August 2013.
4. "Preliminary Drainage Report for Bent Grass East Commercial – Phase 1 and Final Drainage Report for Bent Grass East Commercial Filing No. 1 – Lot 1", by Classic Consulting, dated May 2013
5. "Final Drainage Report for Bent Grass East Commercial Filing No. 2", by Classic Consulting, dated May 2014.
6. "Final Drainage Report for Bent Grass Residential Filing No. 1", by Classic Consulting, Sept. 2014.
7. "Final Drainage Report Addendum for Bent Grass Residential Filing No. 1", by Classic Consulting, August 2015.

## APPENDIX

## VICINITY MAP



**VICINITY MAP**

N.T.S.

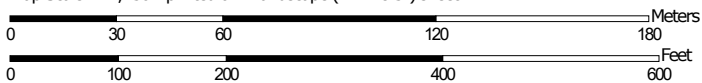
**SOILS MAP (S.C.S. SURVEY)**

Soil Map—El Paso County Area, Colorado



Soil Map may not be valid at this scale.

Map Scale: 1:2,130 if printed on A landscape (11" x 8.5") sheet.



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





## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil 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 18, Jun 5, 2020

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	22.5	100.0%
<b>Totals for Area of Interest</b>		<b>22.5</b>	<b>100.0%</b>

## 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, flood plains, fan terraces  
*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 capacity:* Very low (about 2.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 4e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* A  
*Ecological site:* R049XB215CO - Gravelly Foothill  
*Hydric soil rating:* No

#### Minor Components

##### Pleasant

*Percent of map unit:* 1 percent

*Landform:* Depressions  
*Hydric soil rating:* Yes

**Other soils**

*Percent of map unit:* 1 percent  
*Hydric soil rating:* No

**Fluvaquentic haplaquolls**

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

## Data Source Information

Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 18, Jun 5, 2020

**F.E.M.A MAP**

**NOTES TO USERS**

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

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

Coastal Base Flood Elevations shown on this map apply only to landward of 0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 15. The horizontal datum was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

NGS Information Services  
NOAA, NIMS12  
National Geodetic Survey  
SSMC-3 #9202  
1315 East-West Highway  
Silver Spring, MD 20910-3282

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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

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

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

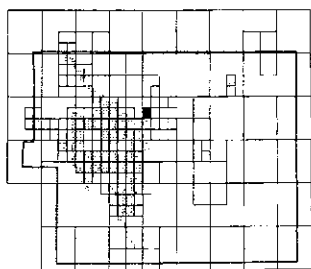
Contact FEMA Map Service Center (MSC) via the FEMA Map Information Exchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9520 and its website at <http://www.msc.fema.gov>.

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

Flooding Source	Vertical Datum Offset (ft)
...	...

REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION.

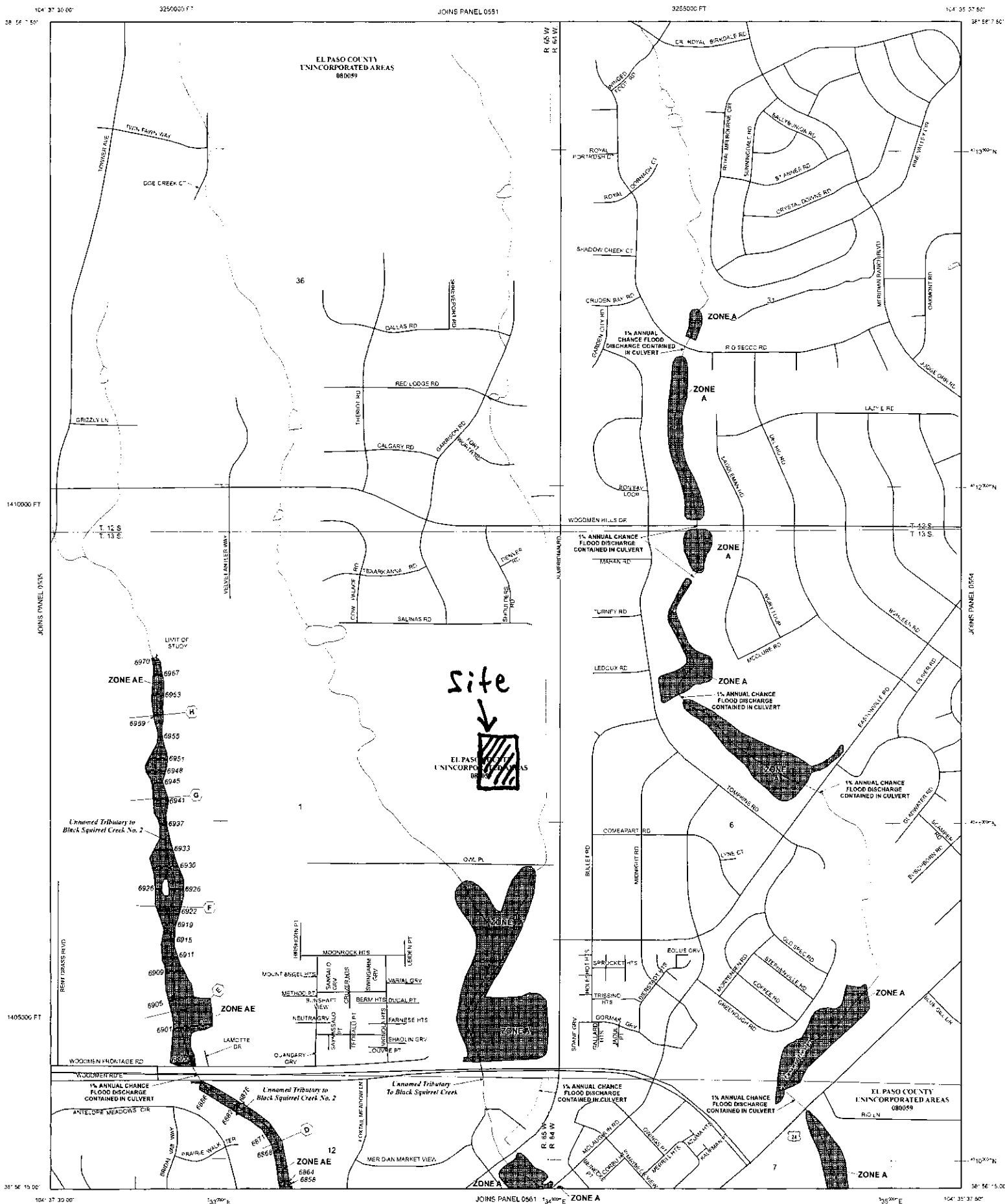
Panel Location Map



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

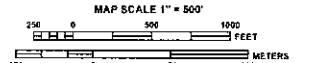


Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



**LEGEND**

- SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**
- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually areas of ponding). Base Flood Elevations determined.
- ZONE AR** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently determined to be obsolete. All areas that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE AP** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction. No Base Flood Elevations determined.
- ZONE AV** Coastal Flood zone with velocity hazard (wave action). No Base Flood Elevations determined.
- ZONE VE** Coastal Flood zone with velocity hazard (wave action). Base Flood Elevations determined.
- FLOODWAY AREAS IN ZONE AE**
- OTHER FLOOD AREAS**
- ZONE X** Areas of 0.2% annual chance flood, areas of 1% annual chance flood with average depths of less than 1 foot, or with discharge areas less than 1 square mile and areas protected by levees from 1% annual chance flood.
- OTHER AREAS**
- ZONE B** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazard is undetermined, see page 6.
- COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
- OTHERWISE PROTECTED AREAS (OPAs)**
- CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.
- Foodplain boundary
- Floodway boundary
- Zone D Boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different base flood elevations, flood depth or flood velocity
- Base Flood Elevation line and vertical elevation in feet
- Base Flood Elevation value where uniform zone elevation in feet
- Profile in feet
- Referenced to the North American Vertical Datum of 1988 (NAVD 88)
- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid ticks, zone 15
- 3000-foot grid ticks, Colorado State Plane coordinate system, north zone F152020E datum, Lambert Conformal Conic Projection
- Bench mark (see explanation in Notes to Users section of the FIS report)
- M15 River Mile
- MAP REPOSITORIES**
- Refer to Map Repository for on Map Index
- EFFECTIVE DATE OF COUNTY-WIDE FLOOD INSURANCE RATE MAP**
- MARCH 17, 1992
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL**
- DECEMBER 7, 2018 To update corporate limits to match Base Flood Elevations and Special Flood Hazard Areas in localities not shown; to add roads and road names and to incorporate the results of the Letters of Map Revision
- For information that is not on this map for countywide mapping, refer to the Community Map Index, Table A located in the Flood Insurance Study report for this jurisdiction.
- To determine if flood insurance is available in the community, contact your insurance agent or the National Flood Insurance Program at 1-800-438-6626.



**NATIONAL FLOOD INSURANCE PROGRAM**

**PANEL 0553G**

**FIRM**  
FLOOD INSURANCE RATE MAP  
EL PASO COUNTY,  
COLORADO  
AND INCORPORATED AREAS

PANEL 553 OF 1300  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

COUNTY	COMMUNITY	NUMBER	PANEL	SWITCH
EL PASO COUNTY	...	...	...	...

MAP NUMBER  
08041C0553G

MAP REVISED  
DECEMBER 7, 2018

Federal Emergency Management Agency



## CALCULATIONS

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	<b>0.99</b>	<b>1.01</b>	<b>1.16</b>
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	<b>0.27</b>	<b>0.28</b>	<b>0.32</b>
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	<b>1.43</b>	<b>1.47</b>	<b>1.68</b>
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	<b>0.67</b>	<b>0.69</b>	<b>0.77</b>
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	<b>0.05</b>	<b>0.07</b>	<b>0.14</b>
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	<b>0.32</b>	<b>0.37</b>	<b>0.56</b>

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

Table 6-7. Conveyance Coefficient,  $C_v$

Type of Land Surface	$C_v$
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)* $t_c = \frac{L}{180} + 10$	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

$$t_i = \frac{0.395(1.1 - C_s)\sqrt{L}}{S^{0.33}} \quad V = C_v S_w^{0.5} \quad T_c = L/V$$

\*For buried riprap, select  $C_v$  value based on type of vegetative cover.

**FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY**

BASIN	TOTAL AREA (AC)	WEIGHTED			OVERLAND				STREET / CHANNEL FLOW				Tc TOTAL (min)	INTENSITY			TOTAL FLOWS		
		CA(2)	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)		I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	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	7.03	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	7.99	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	7.0	3.72	4.67	7.83	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

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

**FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY**

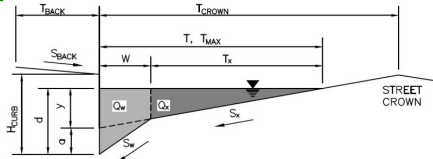
Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Outfall / Inlet Size
					I(5)	I(100)	Q(5)	Q(100)	
1	A	1.01	1.16	9.6	4.19	7.03	4	8	5' Type R Sump Inlet
2	B	0.28	0.32	6.6	4.76	7.99	1	3	5' Type R Sump Inlet
3	C, 70% K	1.73	2.07	12.7	3.77	6.34	7	13	24"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

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

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

Project:  
Inlet ID:

**BENT GRASS EAST COMMERCIAL FILING NO. 3**  
**DP1**



**Gutter Geometry (Enter data in the blue cells)**

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)  
  
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)

$T_{BACK} = 7.0$  ft  
 $S_{BACK} = 0.020$  ft/ft  
 $n_{BACK} = 0.020$

$H_{CURB} = 6.00$  inches  
 $T_{CROWN} = 14.0$  ft  
 $W = 2.00$  ft  
 $S_X = 0.020$  ft/ft  
 $S_W = 0.083$  ft/ft  
 $S_D = 0.000$  ft/ft  
 $n_{STREET} = 0.016$

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	
$T_{MAX} =$	14.0	14.0	ft
$d_{MAX} =$	6.0	12.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

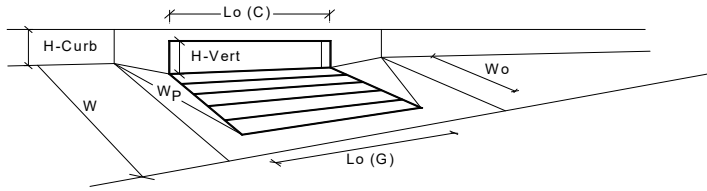
**MINOR STORM Allowable Capacity is based on Depth Criterion**  
**MAJOR STORM Allowable Capacity is based on Depth Criterion**

$Q_{allow} =$ 

Minor Storm	Major Storm	
SUMP	SUMP	cfs

## INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	MINOR	MAJOR	
Type of Inlet	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)			
Number of Unit Inlets (Grate or Curb Opening)	1	1	
Water Depth at Flowline (outside of local depression)	6.0	12.0	inches
<b>Grate Information</b>	MINOR	MAJOR	<input checked="" type="checkbox"/> Override Depths
Length of a Unit Grate	N/A	N/A	feet
Width of a Unit Grate	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	N/A	N/A	
<b>Curb Opening Information</b>	MINOR	MAJOR	
Length of a Unit Curb Opening	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	0.67	0.67	
<b>Low Head Performance Reduction (Calculated)</b>	MINOR	MAJOR	
Depth for Grate Midwidth	N/A	N/A	ft
Depth for Curb Opening Weir Equation	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	N/A	N/A	
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>	MINOR	MAJOR	
<b>Q<sub>a</sub></b>	<b>5.4</b>	<b>12.3</b>	cfs
Q <sub>PEAK REQUIRED</sub>	4.0	8.0	cfs

Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)



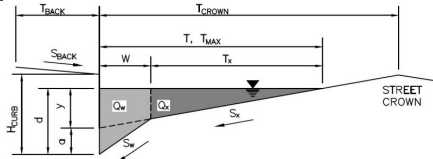
**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

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

Project:  
Inlet ID:

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

**DP2**



**Gutter Geometry (Enter data in the blue cells)**

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)  
 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)

$T_{BACK} = 7.0$  ft  
 $S_{BACK} = 0.020$  ft/ft  
 $n_{BACK} = 0.020$

$H_{CURB} = 6.00$  inches  
 $T_{CROWN} = 14.0$  ft  
 $W = 2.00$  ft  
 $S_x = 0.020$  ft/ft  
 $S_w = 0.083$  ft/ft  
 $S_D = 0.000$  ft/ft  
 $n_{STREET} = 0.016$

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	
$T_{MAX} =$	14.0	14.0	ft
$d_{MAX} =$	6.0	12.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

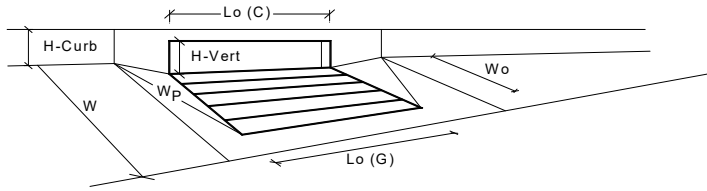
**MINOR STORM Allowable Capacity is based on Depth Criterion**  
**MAJOR STORM Allowable Capacity is based on Depth Criterion**

$Q_{allow} =$ 

Minor Storm	Major Storm	
SUMP	SUMP	cfs

## INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



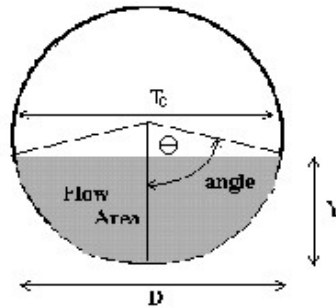
Design Information (Input)	MINOR	MAJOR	
Type of Inlet	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)			
Number of Unit Inlets (Grate or Curb Opening)			
Water Depth at Flowline (outside of local depression)			
<b>Grate Information</b>	MINOR	MAJOR	
Length of a Unit Grate	L <sub>g</sub> (G) =	N/A	feet
Width of a Unit Grate	W <sub>o</sub> =	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A <sub>ratio</sub> =	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C <sub>f</sub> (G) =	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C <sub>w</sub> (G) =	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C <sub>o</sub> (G) =	N/A	
<b>Curb Opening Information</b>	MINOR	MAJOR	
Length of a Unit Curb Opening	L <sub>c</sub> (C) =	5.00	feet
Height of Vertical Curb Opening in Inches	H <sub>vert</sub> =	6.00	inches
Height of Curb Orifice Throat in Inches	H <sub>throat</sub> =	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W <sub>p</sub> =	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C <sub>f</sub> (C) =	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C <sub>w</sub> (C) =	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C <sub>o</sub> (C) =	0.67	
<b>Low Head Performance Reduction (Calculated)</b>	MINOR	MAJOR	
Depth for Grate Midwidth	d <sub>grate</sub> =	N/A	ft
Depth for Curb Opening Weir Equation	d <sub>curb</sub> =	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets	RF <sub>Combination</sub> =	0.77	
Curb Opening Performance Reduction Factor for Long Inlets	RF <sub>Curb</sub> =	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF <sub>Grate</sub> =	N/A	
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>	MINOR	MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	Q <sub>a</sub> =	5.4	cfs
	Q <sub>PEAK REQUIRED</sub> =	1.0	cfs

# 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)**



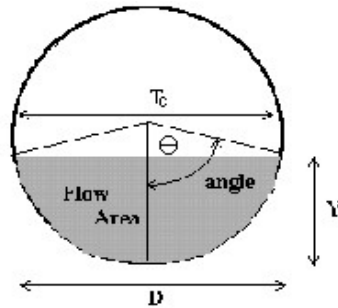
<u>Design Information (Input)</u>			
Pipe Invert Slope	So = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">0.0100</td><td style="width: 50px;">ft/ft</td></tr></table>	0.0100	ft/ft
0.0100	ft/ft		
Pipe Manning's n-value	n = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">0.0130</td><td></td></tr></table>	0.0130	
0.0130			
Pipe Diameter	D = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">24.00</td><td style="width: 50px;">inches</td></tr></table>	24.00	inches
24.00	inches		
Design discharge	Q = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">8.00</td><td style="width: 50px;">cfs</td></tr></table>	8.00	cfs
8.00	cfs		
<u>Full-Flow Capacity (Calculated)</u>			
Full-flow area	Af = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">3.14</td><td style="width: 50px;">sq ft</td></tr></table>	3.14	sq ft
3.14	sq ft		
Full-flow wetted perimeter	Pf = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">6.28</td><td></td></tr></table>	6.28	
6.28			
Half Central Angle	Theta = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">3.14</td><td style="width: 50px;">radians</td></tr></table>	3.14	radians
3.14	radians		
Full-flow capacity	Qf = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">22.68</td><td style="width: 50px;">cfs</td></tr></table>	22.68	cfs
22.68	cfs		
<u>Calculation of Normal Flow Condition</u>			
Half Central Angle ( $0 < \theta < 3.14$ )	Theta = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">1.39</td><td style="width: 50px;">radians</td></tr></table>	1.39	radians
1.39	radians		
Flow area	An = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">1.21</td><td style="width: 50px;">sq ft</td></tr></table>	1.21	sq ft
1.21	sq ft		
Top width	Tn = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">1.97</td><td></td></tr></table>	1.97	
1.97			
Wetted perimeter	Pn = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">2.78</td><td style="width: 50px;">ft</td></tr></table>	2.78	ft
2.78	ft		
Flow depth	Yn = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">0.82</td><td style="width: 50px;">ft</td></tr></table>	0.82	ft
0.82	ft		
Flow velocity	Vn = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">6.59</td><td style="width: 50px;">fps</td></tr></table>	6.59	fps
6.59	fps		
Discharge	Qn = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">8.00</td><td style="width: 50px;">cfs</td></tr></table>	8.00	cfs
8.00	cfs		
Percent of Full Flow	Flow = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">35.3%</td><td style="width: 50px;">of full flow</td></tr></table>	35.3%	of full flow
35.3%	of full flow		
Normal Depth Froude Number	Fr <sub>n</sub> = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">1.48</td><td style="width: 50px;">supercritical</td></tr></table>	1.48	supercritical
1.48	supercritical		
<u>Calculation of Critical Flow Condition</u>			
Half Central Angle ( $0 < \theta_c < 3.14$ )	Theta-c = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">1.58</td><td style="width: 50px;">radians</td></tr></table>	1.58	radians
1.58	radians		
Critical flow area	Ac = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">1.58</td><td style="width: 50px;">sq ft</td></tr></table>	1.58	sq ft
1.58	sq ft		
Critical top width	Tc = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">2.00</td><td style="width: 50px;">ft</td></tr></table>	2.00	ft
2.00	ft		
Critical flow depth	Yc = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">1.01</td><td style="width: 50px;">ft</td></tr></table>	1.01	ft
1.01	ft		
Critical flow velocity	Vc = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">5.05</td><td style="width: 50px;">fps</td></tr></table>	5.05	fps
5.05	fps		
Critical Depth Froude Number	Fr <sub>c</sub> = <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="width: 50px; text-align: center;">1.00</td><td></td></tr></table>	1.00	
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)**



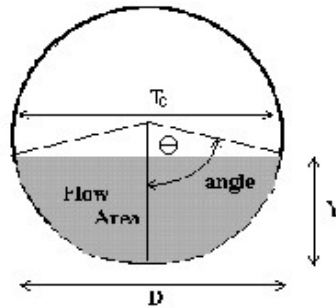
Design Information (Input)	
Pipe Invert Slope	So = 0.0100 ft/ft
Pipe Manning's n-value	n = 0.0130
Pipe Diameter	D = 24.00 inches
Design discharge	Q = 10.00 cfs
Full-Flow Capacity (Calculated)	
Full-flow area	Af = 3.14 sq ft
Full-flow wetted perimeter	Pf = 6.28 ft
Half Central Angle	Theta = 3.14 radians
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 <sub>n</sub> = 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 <sub>c</sub> = 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)**



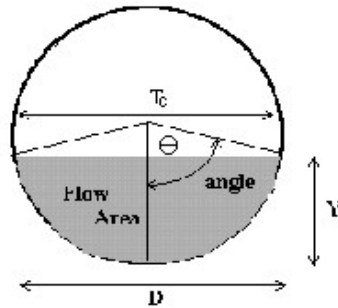
<u>Design Information (Input)</u>			
Pipe Invert Slope	So = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">0.0100</td><td style="text-align: left;">ft/ft</td></tr></table>	0.0100	ft/ft
0.0100	ft/ft		
Pipe Manning's n-value	n = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">0.0130</td><td></td></tr></table>	0.0130	
0.0130			
Pipe Diameter	D = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">24.00</td><td style="text-align: left;">inches</td></tr></table>	24.00	inches
24.00	inches		
Design discharge	Q = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">13.00</td><td style="text-align: left;">cfs</td></tr></table>	13.00	cfs
13.00	cfs		
<u>Full-Flow Capacity (Calculated)</u>			
Full-flow area	Af = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">3.14</td><td style="text-align: left;">sq ft</td></tr></table>	3.14	sq ft
3.14	sq ft		
Full-flow wetted perimeter	Pf = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">6.28</td><td></td></tr></table>	6.28	
6.28			
Half Central Angle	Theta = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">3.14</td><td style="text-align: left;">radians</td></tr></table>	3.14	radians
3.14	radians		
Full-flow capacity	Qf = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">22.68</td><td style="text-align: left;">cfs</td></tr></table>	22.68	cfs
22.68	cfs		
<u>Calculation of Normal Flow Condition</u>			
Half Central Angle ( $0 < \theta < 3.14$ )	Theta = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.66</td><td style="text-align: left;">radians</td></tr></table>	1.66	radians
1.66	radians		
Flow area	An = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.74</td><td style="text-align: left;">sq ft</td></tr></table>	1.74	sq ft
1.74	sq ft		
Top width	Tn = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.99</td><td></td></tr></table>	1.99	
1.99			
Wetted perimeter	Pn = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">3.31</td><td style="text-align: left;">ft</td></tr></table>	3.31	ft
3.31	ft		
Flow depth	Yn = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.09</td><td style="text-align: left;">ft</td></tr></table>	1.09	ft
1.09	ft		
Flow velocity	Vn = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">7.47</td><td style="text-align: left;">fps</td></tr></table>	7.47	fps
7.47	fps		
Discharge	Qn = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">13.00</td><td style="text-align: left;">cfs</td></tr></table>	13.00	cfs
13.00	cfs		
Percent of Full Flow	Flow = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">57.3%</td><td style="text-align: left;">of full flow</td></tr></table>	57.3%	of full flow
57.3%	of full flow		
Normal Depth Froude Number	Fr <sub>n</sub> = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.41</td><td style="text-align: left;">supercritical</td></tr></table>	1.41	supercritical
1.41	supercritical		
<u>Calculation of Critical Flow Condition</u>			
Half Central Angle ( $0 < \theta_c < 3.14$ )	Theta-c = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.87</td><td style="text-align: left;">radians</td></tr></table>	1.87	radians
1.87	radians		
Critical flow area	Ac = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">2.16</td><td style="text-align: left;">sq ft</td></tr></table>	2.16	sq ft
2.16	sq ft		
Critical top width	Tc = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.91</td><td style="text-align: left;">ft</td></tr></table>	1.91	ft
1.91	ft		
Critical flow depth	Yc = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.30</td><td style="text-align: left;">ft</td></tr></table>	1.30	ft
1.30	ft		
Critical flow velocity	Vc = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">6.03</td><td style="text-align: left;">fps</td></tr></table>	6.03	fps
6.03	fps		
Critical Depth Froude Number	Fr <sub>c</sub> = <table border="1" style="display: inline-table; border-collapse: collapse;"><tr><td style="text-align: center;">1.00</td><td></td></tr></table>	1.00	
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)**



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 = 22.00 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 ( $0 < \theta < 3.14$ )	Theta = 1.61 radians
Flow area	An = 2.58 sq ft
Top width	Tn = 2.50 ft
Wetted perimeter	Pn = 4.03 ft
Flow depth	Yn = 1.30 ft
Flow velocity	Vn = 8.52 fps
Discharge	Qn = 22.00 cfs
Percent of Full Flow	Flow = 53.5% of full flow
Normal Depth Froude Number	Fr <sub>n</sub> = 1.48 supercritical
Calculation of Critical Flow Condition	
Half Central Angle ( $0 < \theta_c < 3.14$ )	Theta-c = 1.85 radians
Critical flow area	Ac = 3.31 sq ft
Critical top width	Tc = 2.40 ft
Critical flow depth	Yc = 1.59 ft
Critical flow velocity	Vc = 6.66 fps
Critical Depth Froude Number	Fr <sub>c</sub> = 1.00

**Design Procedure Form: Extended Detention Basin (EDB)**

UD-BMP (Version 3.07, March 2018)

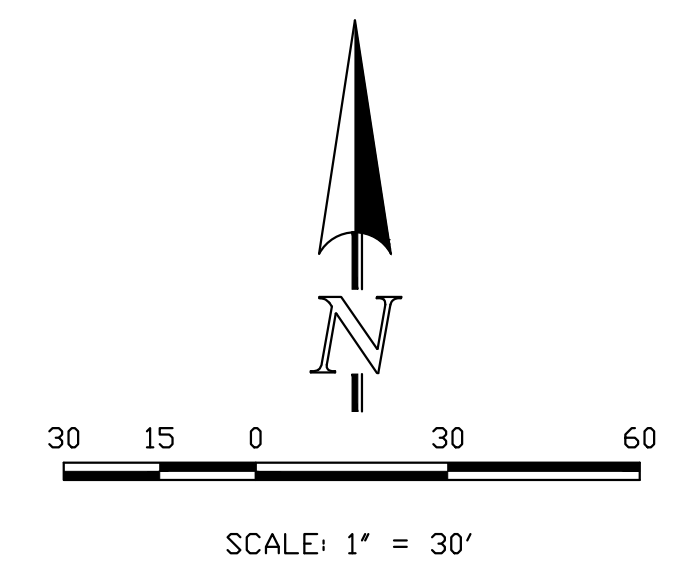
Sheet 1 of 3

**Designer:** Marc A. Whorton, P.E.  
**Company:** Classic Consulting  
**Date:** November 4, 2020  
**Project:** Bent Grass East Commercial Filing No. 3  
**Location:** Exist. Pond - Proposed Forebay for Commercial Development

<p>1. Basin Storage Volume</p> <p>A) Effective Imperviousness of Tributary Area, <math>I_a</math></p> <p>B) Tributary Area's Imperviousness Ratio (<math>i = I_a / 100</math>)</p> <p>C) Contributing Watershed Area</p> <p>D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm</p> <p>E) Design Concept (Select EURV when also designing for flood control)</p> <p>F) Design Volume (WQCV) Based on 40-hour Drain Time (<math>V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)</math>)</p> <p>G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume (<math>V_{WQCV\ OTHER} = (d_s * V_{DESIGN} / 0.43)</math>)</p> <p>H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)</p> <p>I) NRCS Hydrologic Soil Groups of Tributary Watershed              i) Percentage of Watershed consisting of Type A Soils              ii) Percentage of Watershed consisting of Type B Soils              iii) Percentage of Watershed consisting of Type C/D Soils</p> <p>J) Excess Urban Runoff Volume (EURV) Design Volume              For HSG A: <math>EURV_A = 1.68 * i^{1.28}</math>              For HSG B: <math>EURV_B = 1.36 * i^{1.08}</math>              For HSG C/D: <math>EURV_{C/D} = 1.20 * i^{1.08}</math></p> <p>K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)</p>	<p><math>I_a = </math> <input type="text" value="90.0"/> %</p> <p><math>i = </math> <input type="text" value="0.900"/></p> <p>Area = <input type="text" value="4.500"/> ac</p> <p><math>d_s = </math> <input type="text" value="0.42"/> in</p> <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <p>Choose One</p> <p><input type="radio"/> Water Quality Capture Volume (WQCV)</p> <p><input checked="" type="radio"/> Excess Urban Runoff Volume (EURV)</p> </div> <p><math>V_{DESIGN} = </math> <input type="text"/> ac-ft</p> <p><math>V_{DESIGN\ OTHER} = </math> <input type="text" value="0.147"/> ac-ft</p> <p><math>V_{DESIGN\ USER} = </math> <input type="text"/> ac-ft</p> <p>HSG <sub>A</sub> = <input type="text" value="0"/> %              HSG <sub>B</sub> = <input type="text" value="100"/> %              HSG <sub>C/D</sub> = <input type="text" value="0"/> %</p> <p><math>EURV_{DESIGN} = </math> <input type="text" value="0.455"/> ac-ft</p> <p><math>EURV_{DESIGN\ USER} = </math> <input type="text"/> ac-ft</p>
<p>2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)</p>	<p>L : W = <input type="text" value="2.0"/> : 1</p>
<p>3. Basin Side Slopes</p> <p>A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)</p>	<p>Z = <input type="text" value="4.00"/> ft / ft</p>
<p>4. Inlet</p> <p>A) Describe means of providing energy dissipation at concentrated inflow locations:</p>	<p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>
<p>5. Forebay</p> <p>A) Minimum Forebay Volume (<math>V_{MIN} = </math> <input type="text" value="2%"/> of the WQCV)</p> <p>B) Actual Forebay Volume</p> <p>C) Forebay Depth (<math>D_F = </math> <input type="text" value="18"/> inch maximum)</p> <p>D) Forebay Discharge</p> <p>i) Undetained 100-year Peak Discharge</p> <p>ii) Forebay Discharge Design Flow (<math>Q_F = 0.02 * Q_{100}</math>)</p> <p>E) Forebay Discharge Design</p> <p>F) Discharge Pipe Size (minimum 8-inches)</p> <p>G) Rectangular Notch Width</p>	<p><math>V_{MIN} = </math> <input type="text" value="0.003"/> ac-ft</p> <p><math>V_F = </math> <input type="text" value="0.003"/> ac-ft</p> <p><math>D_F = </math> <input type="text" value="18.0"/> in</p> <p><math>Q_{100} = </math> <input type="text" value="22.00"/> cfs</p> <p><math>Q_F = </math> <input type="text" value="0.44"/> cfs</p> <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <p>Choose One</p> <p><input type="radio"/> Berm With Pipe</p> <p><input checked="" type="radio"/> Wall with Rect. Notch</p> <p><input type="radio"/> Wall with V-Notch Weir</p> </div> <p>Calculated <math>D_P = </math> <input type="text"/> in</p> <p>Calculated <math>W_N = </math> <input type="text" value="4.5"/> in</p> <p style="color: blue; font-size: small;">Flow too small for berm w/ pipe</p>

**DEVELOPED DRAINAGE MAP**





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	

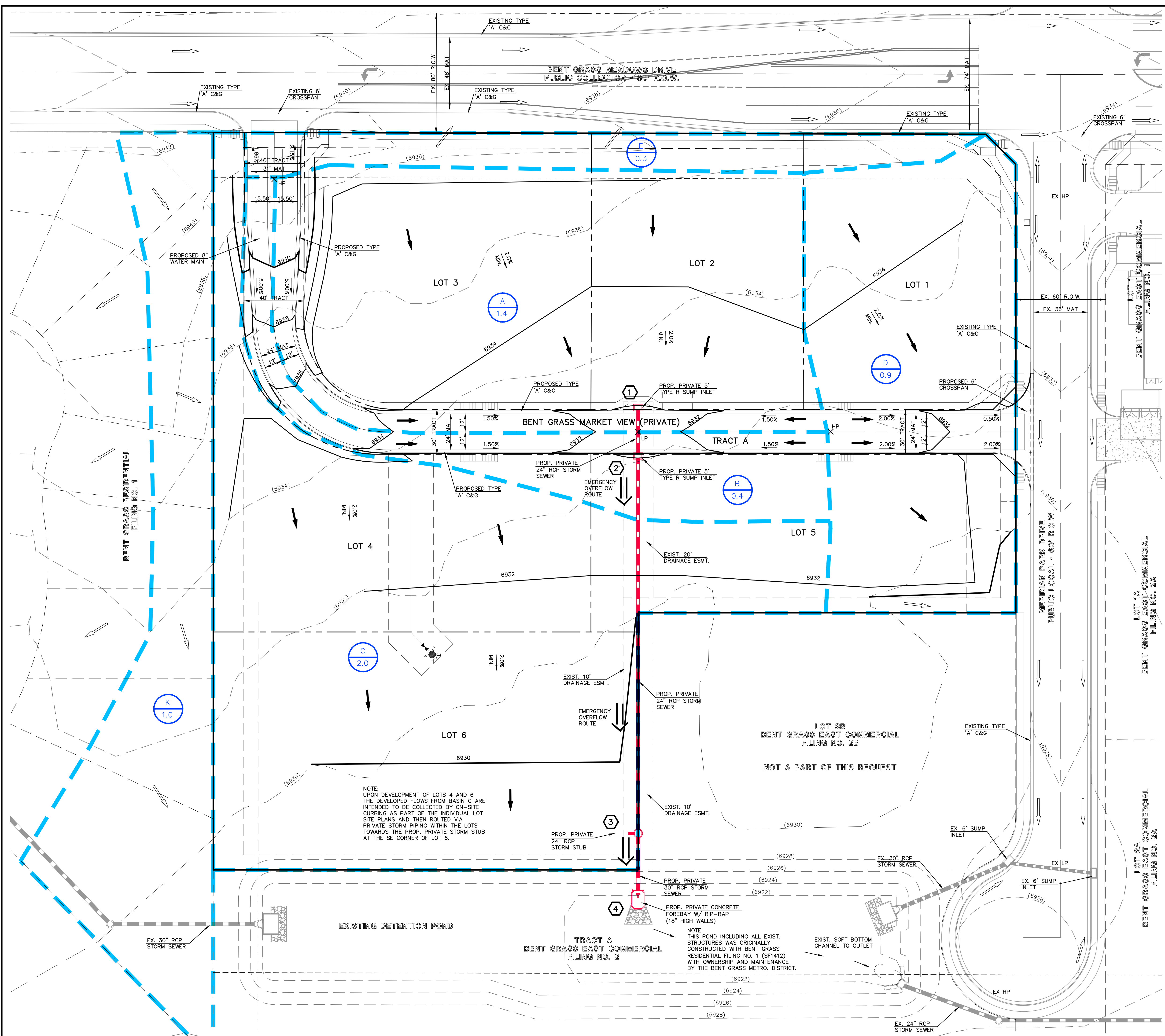
BASIN	TOTAL AREA (AC)	WEIGHTED				OVERLAND				STREET / CHANNEL FLOW				INTENSITY				TOTAL FLOWS			
		CA(2)	CA(5)	CA(100)	CA(1000)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (ft/s)	Tc (min)	I(2)	I(5)	I(100)	Q(2)	Q(5)	Q(100)	Q(1000)	
A	1.4	0.99	1.01	1.16	1.16	0.08	30	2	5.4	200	2.0%	1.0	4.2	9.6	3.34	4.19	7.03	3	4	8	
B	0.4	0.27	0.28	0.32	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	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	0.77	0.08	10	0.2	4.6	200	2.0%	1.4	2.4	7.0	3.72	4.67	7.83	2	3	6	
E	0.3	0.05	0.07	0.14	0.14	0.08	25	0.5	7.3					7.3	3.67	4.60	7.73	0.2	0.3	1.0	
K	1.0	0.32	0.37	0.56	0.56	0.08	65	3	9.0					9.0	3.43	4.29	7.21	1	2	4	

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity				Flow	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	7.95	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	

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

**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



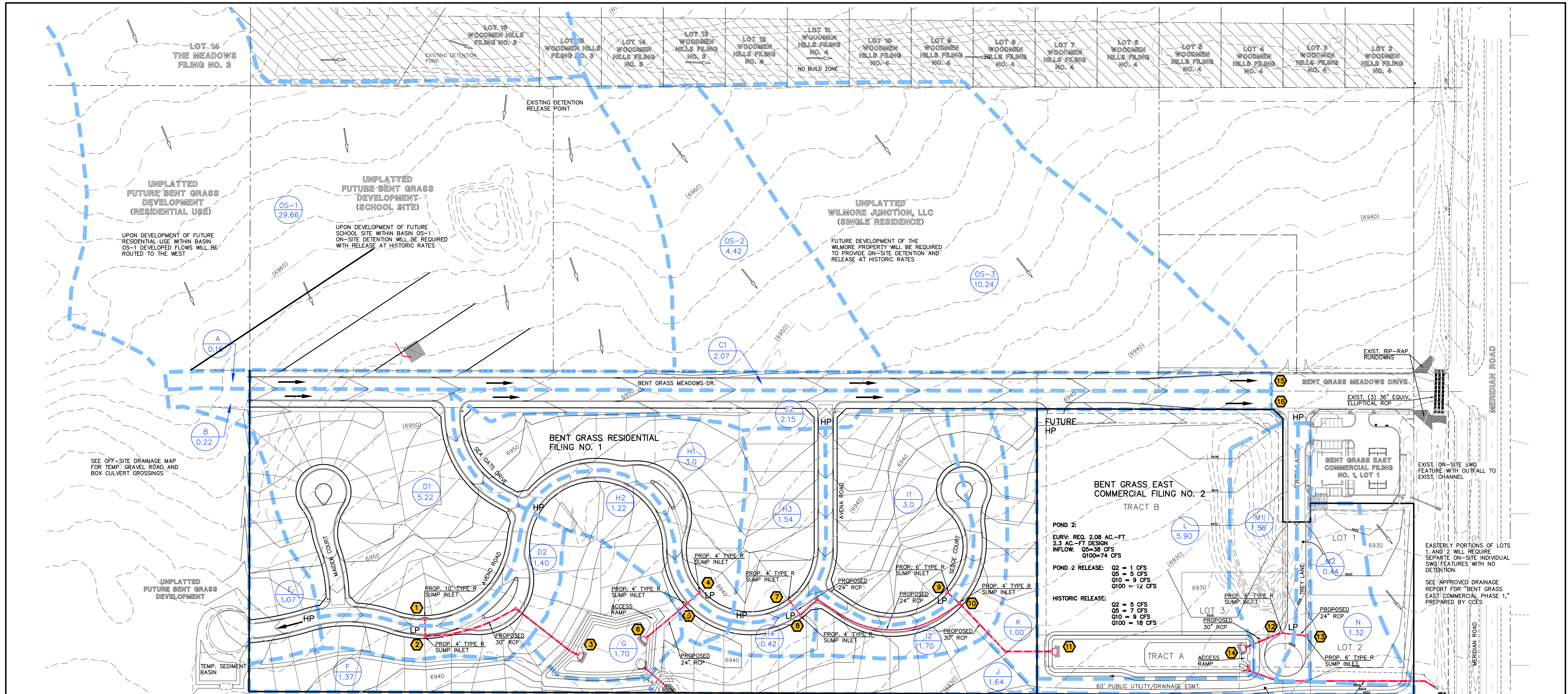
NOTE:  
UPON DEVELOPMENT OF LOTS 4 AND 6  
THE DEVELOPED FLOWS FROM BASIN C ARE  
INTENDED TO BE COLLECTED BY ON-SITE  
CURBING AS PART OF THE INDIVIDUAL LOT  
SITE PLANS AND THEN ROUTED VIA  
PRIVATE STORM PIPING WITHIN THE LOTS  
TOWARDS THE PROP. PRIVATE STORM STUB  
AT THE SE CORNER OF LOT 6.

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.

N:\217764\RCP\01\SYFOR\_A\drainum\217764.dwg, 5/6/2021, 11:24:04 AM, 1:1

**PREVIOUS DRAINAGE MAP  
(BENT GRASS RESIDENTIAL FILING NO. 1)**





DEVELOPED SHEET FLOW RELEASE:  
 Q5=3 CFS  
 Q100=6 CFS  
 HISTORIC RELEASE:  
 Q5=23 CFS  
 Q100=43 CFS

LOT 1:  
 EURY. REQ. 1.14 AC.-FT  
 1.53 AC.-FT DESIGN  
 INFLOW: Q5 = 22 CFS  
 Q100 = 46 CFS  
 POND 1 RELEASE: Q2 = 0.3 CFS  
 Q5 = 0.4 CFS  
 Q10 = 0.5 CFS  
 Q100 = 6.8 CFS

DEVELOPED SHEET FLOW RELEASE:  
 Q5=3 CFS  
 Q100=7 CFS  
 HISTORIC RELEASE:  
 Q5=7 CFS  
 Q100=16 CFS

LOT 2:  
 EURY. REQ. 2.08 AC.-FT  
 2.3 AC.-FT DESIGN  
 INFLOW: Q5=38 CFS  
 Q100=74 CFS  
 POND 2 RELEASE: Q2 = 1 CFS  
 Q5 = 5 CFS  
 Q10 = 9 CFS  
 Q100 = 12 CFS  
 HISTORIC RELEASE: Q2 = 5 CFS  
 Q5 = 7 CFS  
 Q10 = 9 CFS  
 Q100 = 18 CFS

TOTAL DEVELOPED RELEASE:  
 Q5 = 19 CFS  
 Q100 = 44 CFS

FINAL DRAINAGE REPORT - BASIN RUNOFF SUMMARY																							
BASIN	WEIGHTED CA(5)	CA(100)	OVERLAND			STREET / CHANNEL FLOW			Tc	TOTAL	INTENSITY												
			Length (ft)	Height (ft)	Vc (ft)	Length (ft)	Velocity (ft/s)	Tc (min)			(2)	(5)	(10)	(15)	(20)	(25)	(30)	(35)	(40)	(45)	(50)		
A	0.12	0.13	0.25						5.0	3.71	5.10	5.96	7.66	8.68	9.07	0.4	0.6	0.7	1.0	1.1	1.2		
B	0.13	0.15	0.25						5.0	3.71	5.10	5.96	7.66	8.68	9.07	0.5	0.7	0.8	1.1	1.3	1.4		
C1	1.56	1.68	0.25	12	0.24	4.4	2100	1.0%	3.5	10.9	14.4	2.96	3.83	4.12	5.29	6.00	6.27	4	5	6	9	10	11
C2	1.64	1.77	0.25	12	0.24	4.4	2100	1.0%	3.5	10.9	14.4	2.96	3.83	4.12	5.29	6.00	6.27	4	5	6	9	10	11
D1	2.87	3.26	0.25	100	2	12.6	508	1.5%	4.3	1.9	14.6	3.55	3.51	4.09	5.26	5.96	6.23	7	10	12	18	20	21
D2	0.77	0.91	0.25	50	1	6.3	400	1.0%	3.5	1.9	10.8	2.89	3.07	4.04	5.96	6.76	7.07	2	3	4	5	6	8
E	0.69	0.79	0.25	100	2	12.6	120	2.0%	4.9	0.4	13.0	2.68	3.88	4.30	5.52	6.26	6.55	2	3	4	4	4	5
F	0.65	0.75	0.25	60	7	6.9				6.9	3.36	4.65	5.43	6.96	7.91	8.27	2	3	3	5	6	6	
G	0.68	0.85	0.25	240	7	17.3				17.3	2.35	3.24	3.78	4.86	5.51	5.75	2	3	3	4	5	5	
H1	1.65	1.95	0.25	100	2	12.6	600	1.5%	4.3	2.3	15.0	2.52	3.46	4.04	5.20	5.89	6.16	4	6	7	10	11	12
H2	0.67	0.79	0.25	100	2	12.6	150	1.5%	4.3	0.6	13.2	2.66	3.66	4.27	5.49	6.22	6.51	2	2	3	4	4	5
H3	0.85	1.00	0.25	100	2	12.6	300	2.0%	4.9	1.2	13.8	2.61	3.69	4.19	5.39	6.11	6.38	2	3	4	5	6	8
H4	0.23	0.27	0.25	50	1	6.3	150	2.0%	4.9	3.4	3.05	4.19	4.89	6.29	7.12	7.45	0.7	1.0	1.1	1.7	1.9	2.8	
I1	1.65	1.95	0.25	100	2	12.6	600	1.5%	4.3	1.9	10.8	2.89	3.96	4.65	5.97	6.77	7.08	5	7	8	12	13	14
I2	0.94	1.11	0.25	50	1	6.3	300	2.0%	4.9	1.0	10.0	2.89	4.11	4.78	6.06	6.99	7.31	3	4	4	7	8	8
J	0.66	0.80	0.25	75	4	7.9				7.9	3.21	4.46	5.20	6.65	7.58	7.93	2	3	3	6	7	7	
K	0.40	0.55	0.25	65	3	7.7				7.7	3.37	4.49	5.24	6.74	7.64	7.99	1	2	2	4	4	4	
L	4.00	4.93	0.25	30	0.6	6.9	800	1.0%	3.5	3.8	10.7	2.50	3.99	4.66	5.96	6.78	7.10	13	18	21	29	33	35
M1	1.33	1.40	0.25	30	0.6	6.9	300	1.0%	3.5	1.4	8.4	3.18	4.38	5.11	6.57	7.44	7.78	4	6	7	9	10	11
M2	0.37	0.40	0.25	30	0.6	6.9	300	1.0%	3.5	5.0	3.71	5.10	5.96	7.66	8.68	9.07	1.4	1.9	2.2	3.0	3.4	3.6	
N	1.12	1.19	0.25	20	0.4	5.7	300	2.0%	4.9	1.1	6.8	3.41	4.69	5.47	7.04	7.97	8.34	4	5	6	8	9	10
O	0.15	0.20	0.25	60	5	6.1				6.1	3.51	4.83	5.64	7.25	8.22	8.59	0.5	0.7	0.8	1.5	1.7	1.7	

**LEGEND**

- EXISTING GROUND CONTOUR: 5910
- PROPOSED FINISHED CONTOUR: 5910
- SUBDIVISION BOUNDARY: ---
- LOT LINE: ---
- PROPOSED BASIN BOUNDARY: ---
- DIRECTION OF DRAINAGE: →
- EXISTING STORM SEWER: ---
- EXISTING STORM INLET: □
- PROPOSED STORM SEWER: ---
- PROPOSED STORM INLET: □
- LOW POINT/HIGH POINT: LP/HP
- BASIN IDENTIFIER: D
- AREA IN ACRES: 1.41
- DESIGN POINT: 1

FINAL DRAINAGE REPORT - SURFACE ROUTING SUMMARY											
Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity			Flow		Facility Size	
					(5)	(100)	Q(5)	Q(100)			
1	B & D1	300	354	145	3.51	6.25	11	22	10" TYPE R SUMP INLET		
2	D2	0.77	0.91	10.8	3.97	7.07	3	6	4" TYPE R SUMP INLET		
3	DP 1, DP 2 & G (Westerly Flow into Pond 1)	4.45	5.30	17.3	3.24	6.74	14	31	30" RCP		
4	H1	1.65	1.95	15.0	3.46	6.16	6	12	4" TYPE R SUMP INLET		
5	H2	0.67	0.79	13.2	3.46	6.51	2	5	4" TYPE R SUMP INLET		
6	DP 4, DP 5 (Easterly Flow into Pond 1)	2.32	2.74	16.0	3.24	6.84	8	16	24" RCP		
	Total Flow into Pond 1	6.78	8.05	17.3	3.24	6.74	22	46	18 AC.-FT POND 1		
7	H3	0.85	1.00	13.8	3.19	6.36	3	6	4" TYPE R SUMP INLET		
8	H4	0.23	0.27	9.4	4.19	7.45	1	2	4" TYPE R SUMP INLET		
9	I1	1.65	1.95	10.8	3.46	7.48	7	14	6" TYPE R SUMP INLET		
10	I2	0.94	1.11	10.0	4.11	7.31	4	8	4" TYPE R SUMP INLET		
11	DP 7, DP 10 (Westerly Flow into Pond 2)	3.66	4.33	16.9	3.27	6.82	12	25	30" RCP		
12	M1	1.33	1.40	8.4	4.38	7.76	6	11	4" TYPE R SUMP INLET		
13	M2 & N	1.50	1.58	6.8	4.49	8.34	7	13	4" TYPE R SUMP INLET		
14	DP 12 & DP 13 (Easterly Flow into Pond 2)	2.82	2.99	8.9	4.29	7.43	12	23	30" RCP		
	Total Flow into Pond 2 (incl. Basins K & L)	11.48	12.79	16.9	3.27	6.82	38	74	20 AC.-FT POND 2		
15	OS-1, OS-2, OS-3, C1 & EXIST LOT 15 POND RELEASE	SCS MODEL					6	19			
16	C2	1.64	1.77	14.4	3.53	6.27	6	11			
17	DP 15 and 16, Basin O, East P 11 & Pond 2 Release	SCS MODEL					19	44			

SCALE: 1" = 100'

**CLASSIC CONSULTING ENGINEERS & SURVEYORS**

6385 Corporate Drive, Suite 101  
 Colorado Springs, Colorado 80919

(719) 785-0790  
 (719) 785-0799 (Fax)

**BENT GRASS RESIDENTIAL FILING NO. 1**

FINAL DRAINAGE REPORT  
 DEVELOPED CONDITIONS MAP

DESIGNED BY: MAW    SCALE: (H) 1" = 100'    DATE: 09-03-14

DRAWN BY: MAW    SHEET: 1 OF 1

CHECKED BY: (V) 1" = N/A    JOB NO.: 2430.00

N:\243000\DRAWINGS\DEVELOPMENT\243000\_FDR\_Map.dwg, 4/28/2016 11:45:45 AM, 1:1,03671





Innovative Design. Classic Results.

SP149

**FINAL DRAINAGE REPORT  
FOR  
BENT GRASS EAST COMMERCIAL FILING NO. 2**

**MAY 2014  
REVISED JULY 2014**

*RETURN TO  
ENGINEERING  
LIBRARY*

Prepared for:

**LAND FIRST, INC.  
154 DEL ORO CIRCLE  
COLORADO SPRINGS, CO 80919  
Contact: Ron Waldthasuen**

Prepared by:

**CLASSIC CONSULTING ENGINEERS & SURVEYORS, LLC  
6385 CORPORATE DRIVE, SUITE 101  
COLORADO SPRINGS, CO 80919  
(719) 785-0790**

RECEIVED      VERSION  
AUG 20 2014      2

Job no. 2177.53

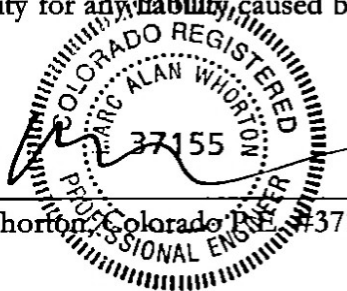


**FINAL DRAINAGE REPORT  
FOR BENT GRASS EAST COMMERCIAL FILING NO. 2**

**DRAINAGE REPORT STATEMENT**

**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 Drainage Criteria Manual for the City of Colorado Springs and El Paso County. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.



\_\_\_\_\_  
Marc A. Whorton, Colorado P.E. #37155

6/20/14  
\_\_\_\_\_  
Date

**DEVELOPER'S STATEMENT:**

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

Business Name: Land First, Inc.

[Signature]

Title: Pres.

Address: 154 Del Oro Circle

Colorado Springs, CO 80919

**EL PASO COUNTY:**

Filed in accordance with Section 51.1 of the El Paso Land Development Code, as amended.

[Signature]

For El Paso County Engineer/Director

8-24-14  
\_\_\_\_\_  
Date

Conditions:



The following calculations are based on the 2014 drainage/bridge fees:

**Bridge Fees**

$$\$3,115 \times 3.31 \text{ Impervious Ac.} = \underline{\$ 10,310.65}$$

**Drainage Fees**

$$\$8,115 \times 3.31 \text{ Impervious Ac.} = \underline{\$ 26,860.65}$$

**Fee Reduction (50% reasonable const. costs for detention facility)**

$$\text{Detention Pond 2 (Full Spectrum on-site facility)} \quad \$75,000 \times 50\% = \$37,500.00$$

(See FAE for Pond estimate)

$$\text{Drainage Fee Total} \quad \$26,860.65 - \$37,500.00 = \underline{\text{N/A}}$$

$$\text{Bridge Fee Total} \quad \underline{\$10,310.65}$$

**SUMMARY**

All detention facilities have been designed to release at or below historic rates. The proposed development will not adversely impact surrounding developments.

PREPARED BY:

**Classic Consulting Engineers & Surveyors, LLC**

Marc A. Whorton, P.E.  
Project Manager

mw/217753/Reports/217753FDR.doc

