

# PRELIMINARY DRAINAGE REPORT

FOR

## 7-Eleven Gas, C-Store & Car Wash Gun Club Road & 6<sup>th</sup> Parkway

**Original Submittal: February 16, 2020**

Owner/Developer/Applicant:

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Approved for one year from this date

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City Engineer

\_\_\_\_\_  
Date

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Water Department

\_\_\_\_\_  
Date

\_\_\_\_\_  
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## A. INTRODUCTION

### 1. Site Location

The proposed 7-Eleven Gas and C-Store project is located in Lot 1, Block 1 of The Cross Creek Subdivision Filing 1. The site is located in part of the Northwest Quarter of Section 7, Township 4 South, Range 65 West of the 6<sup>th</sup> Principal Meridian, City of Aurora, County of Arapahoe, State of Colorado. The site is bordered on the north by E. 2<sup>nd</sup> place, on the south by Tract A, a detention pond constructed as part of the underlying development, on the east by the Lot 2 of Block 1, and on the west by North Gun Club Road.



### 2. Proposed Development

The project site is Lot 1 of the Cross Creek Subdivision Filing 1. and is a 1.28 acre parcel. Lot 1 is currently zoned Mixed-Use Regional District (MU-R) and will remain as such for the proposed development.

The project site is currently undeveloped, covered with natural grasses and vegetation. The site in the existing condition has a high point on the site along the southern property line. The site generally drains to the northwest corner of the site, via sheet flow into the private drive where it collects in existing storm infrastructure. The proposed condition will mimic the existing condition in general and sheet flow to the northwest corner. Portions of flow are directed to an inlet at the southwest corner of the site. The remainder of the site will maintain historic conditions and discharge into the existing inlet at design point X, as referenced in the "Preliminary Drainage Report For Cross Creek Filing No. 4 Cross Creek Commercial" (hereafter referred to as the Master Drainage Study. Refer to the Appendix for excerpts of the report and existing drainage map. No wetlands or irrigation canals or ditches have been identified onsite.

According to the FEMA Flood Insurance Rate Map number 08005C0202L, effective date February 17, 2017, the site is currently located in Zone X which is outside of the 100-year

flood plain. A portion of the FIRM is included in Appendix A.

According to the Web Soil Survey provided by the USDA, the soils existing onsite are Bresser-Truckton sandy loams, which has low runoff class and well drained drainage class. Bresser-Truckton sandy loams are classified as hydrologic soil group B. A soil map by the Web Soil Survey is provided in Appendix A. For all runoff calculations, the site was considered to be Type B soils as it encompasses the entirety of the site.

Proposed construction will consist of a one-story, 4,000 GSF convenience store (c-store) building, gas station, 6-MPD fueling canopy, and car wash located on a 1.28 acres parcel within Lot 1 of the Cross Creek Subdivision Filing 1. The area disturbed will be 1.28 acres. In addition to the c-store, car wash and fueling canopy, drive aisles, parking, landscaping and utility services will also be constructed. Detention is provided downstream in an existing detention pond south of the site.

There are no requests for variance from the Storm Drainage and Technical Criteria Manual.

## **B. HISTORIC DRAINAGE**

### **1. Overall Basin Description**

The development was originally analyzed in the Preliminary Drainage Report For Cross Creek Filing No. 4 Cross Creek Commercial by JR Engineering, LLC, dated October 2020, herein referred to as the Master Drainage Study. Per this report, the project is located within sub-basin A3, which also includes the entire 1.28 acres of the project site for a total of a 2.61 acres basin. The Master Drainage Study assumed a developed percent impervious of 92.1% for sub-basin A3 with a minor flowrate of 5.87 CFS and major flowrate of 16.46 CFS. Runoff from sub-basin A3 is tributary to detention pond D-C, as identified in the Master Drainage Study, located southwest of the site. Refer to the existing drainage map in the appendix.

### **2. Drainage Patterns Through Property**

The existing grades are generally sloping at 2% towards the northwest corner of the site where it collects in an inlet at the southwest corner of the private drive and Gun Club Road and ultimately discharges to detention pond D-C.

Per the Master Drainage study, sub-basin A3 is 2.61 acres and consists of undeveloped land but was modelled for future commercial use, with an assumed developed impervious value of 92.1%. The 2-Year and 100-year C values were determined to be 0.84 and 0.87, respectively; and anticipated 2-Year runoff flows of 5.87-cfs and 100-year runoff flows of 16.46-cfs. Flows from basin A3 are directed northwesterly via surface flows across the site and sheet flowing into the private access drive and a type r inlet at design point 1.1. Flow in the proposed condition will in general mimic historic conditions and drain to this inlet, identified as design point EX1 in the proposed drainage plan. Refer to excerpts and drainage plans in the Appendix for details.

### **3. Outfalls Downstream from Property**

Per the Master Drainage study, "All runoff from the portion of the site that is proposed to be developed will be directed to Detention Pond D-C. These flows will be detained/treated and piped across Gun Club Road. These flows will be conveyed west

and south in a pipe running parallel to Gun Club Road. The runoff will enter a channel that drains through the existing double 6'x8' box culvert crossing E-470. This crossing daylights to another existing channel and outfalls directly into Coal Creek.”

## **C. DESIGN CRITERIA**

### **1. Regulations**

Methods described in the MHFD Urban Storm Drainage Criteria Manual (USDCM) and in the City of Aurora Storm Drainage Design & Technical Criteria were used for the drainage design of the site. Minor and major storm elements have been analyzed for the 2- and 100-YR storms, respectively.

### **1. Hydrology**

The Rational method, and associated design procedures identified in Section 5 of the City of Aurora Storm Drainage Design & Technical Criteria have been utilized to evaluate the anticipated runoff of the site for the 2-yr and 100-yr storm events. The rational method can be described as below:

$Q = CIA$ , where

- Q = Storm runoff in cubic feet per second (cfs)
- C = Rainfall coefficients - ratio runoff to rainfall
- I = Rainfall intensity in inches per hour
- A = Drainage area in acres

Design rainfall is derived from one-hour rainfall depth (inches) from Figures RA-1 through RA-6 in USDCM, Volume 1, as referenced in section 5.22 of the Aurora Storm Criteria, and the NOAA 1-HR point precipitation values. The following one-hour rainfall depths were utilized for runoff calculations: 0.98 inches (2-yr), 2.67 inches (100-yr). Runoff coefficients were based on the type of proposed developed outlined in the USDCM. The 2-year and 100-year frequency runoff rates for historic and developed conditions are summarized in the Appendix.

### **2. Hydraulics**

Sizing of the storm sewer was analyzed using Flowmaster V8i. Inlet sizing was completed utilizing Urban Drainage and Flood Control District UD-Inlet\_v4.05 spreadsheet. The proposed onsite inlets will fully capture the 100-year storm events without exceeding 6-inches of ponding.

### **3. Water Quality Enhancement**

Water quality for the project site is provided by an existing detention pond located directly adjacent to the south of the site, identified as detention Pond D-C in the Master Drainage Study. The proposed condition provides less flow than the condition modelled in the Master Drainage Study, therefore the detention pond has sufficient capacity. Refer to the Master Drainage Study excerpts in the appendix for details.

## **D. DRAINAGE PLAN**

### **1. General Concept**

The proposed development will in general conform to the drainage patterns established within the Master Drainage Study. Flow will be directed to the northwest corner of the site and discharge into the existing storm infrastructure, and ultimately detention pond D-3. A constraint of this report is that the site improvement will not increase the runoff to the existing detention and water quality facilities. The adjacent developments will not be affected by the proposed condition.

## **2. Specific Details**

The proposed project site has been divided into the following sub-basins, shown on the included drainage map (See Appendix D).

### **Basin P1**

Basin P1 is 0.10 acres and consists of hardscape parking and sidewalk on the north side of the building. The impervious value for the basin is 100.00%. The 2-Year and 100-year runoff coefficients are 0.87 and 0.93, respectively. The runoff for the 2-Year and 100-year storm event are 0.29-cfs and 0.84-cfs, respectively. Runoff is conveyed via sheet flow to a Type R Inlet (Inlet P-1) where the developed runoff is fully captured at Design Point 1 and ultimately drains into the existing storm infrastructure, following historic drainage patterns.

### **Basin P2**

Basin P2 is 0.56 acres and consists of parking and the private drive east of the convenience store, and landscaping. The impervious value for the basin is 86.00%. The 2-Year and 100-year runoff coefficients are 0.76 and 0.82, respectively. The runoff for the 2-Year and 100-year storm event are 1.41-cfs and 4.15-cfs, respectively. Runoff sheet flows across the site to the northwest corner at Design Point 2 where it discharges offsite and ultimately is collected in the existing Type R inlet at the northwest corner of Gun Club Road and the private access road, following historic drainage patterns.

### **Basin P3**

Basin P3 is 0.09 acres and consists entirely of the proposed convenience store. The impervious value for the basin is 96.00%. The 2-Year and 100-year runoff coefficients are 0.80 and 0.90, respectively. The runoff for the 2-Year and 100-year storm event are 0.24-cfs and 0.73-cfs, respectively. Runoff from the basin is collected in roof drains at Design point 3 and routed via proposed 4" PVC storm sewer to the east and north before ultimately connecting to existing storm infrastructure and following historic drainage patterns.

### **Basin P4**

Basin P4 is 0.07 acres and consists entirely of the fueling canopy. The impervious value for the basin is 96.00%. The 2-Year and 100-year runoff coefficients are 0.80 and 0.90, respectively. The runoff for the 2-Year and 100-year storm event are 0.19-cfs and 0.57-cfs, respectively. Runoff from the basin is collected in roof drains at Design point 3 and routed via proposed 4" PVC storm sewer to the northwest where it ultimately connects to existing storm infrastructure and follows historic drainage patterns

### **Basin P5**

Basin P5 is 0.17 acres and consists of the site access, car wash, and landscaping at the northeast corner of the site. The impervious value for the basin is 58.47%. The 2-Year and 100-year runoff coefficients are 0.53 and 0.60, respectively. The runoff for the 2-Year and 100-year storm event are 0.30-cfs and 0.92-cfs, respectively. Runoff from the basin is conveyed via sheet flow to the northeast access where it discharges offsite at Design Point 5, following historic conditions. Flows are ultimately collected in existing storm infrastructure at Design Point EX1.

### **Basin P6**

Basin P-6 is 0.10 acres and consists entirely of landscaping at the southern perimeter of the site. The impervious value for the basin is 2.00%. The 2-Year and 100-year runoff coefficients are 0.10 and 0.15, respectively. The runoff for the 2-Year and 100-year storm event are 0.03-cfs and 0.14-cfs, respectively. Runoff from the basin is conveyed via sheet flow at Design Point 6, directly into the existing detention pond D-C to the south.

### **Basin P7**

Basin P7 is 0.19 acres and consists of a portion of sidewalk and landscaping at the western side of the site. The impervious value for the basin is 12.32%. The 2-Year and 100-year runoff coefficients are 0.18 and 0.23, respectively. The runoff for the 2-Year and 100-year storm event are 0.11-cfs and 0.40-cfs, respectively. Runoff from the basin is conveyed via sheet flow to Gun Club Road at Design Point 7 where it is collected in a gutter and directed north where it ultimately discharges to the existing inlet, identified as Design Point EX1 in the drainage plan.

## **3. Detention Pond Design**

Detention for this site was previously provided in the existing detention pond D-3 as identified in the Master Drainage Study. The detention pond was originally sized to include flows from the proposed site within basin A3 in the Master Drainage Study. Basin A3 in the existing condition was 92.1%. Basin A3 in the proposed condition, including the 67.19% from the proposed development of Lot 1, is 79.4%, or 12.7% less than existing. Therefore, the existing detention pond D-3 has sufficient capacity for the developed condition and does not need any modifications from existing condition.

## **E. DRAINAGE PLAN**

### **1. Compliance with Standards**

All facilities designed for this project have been designed to meet the requirements of City of Aurora Storm Drainage Design and Technical Criteria Manual, and the Mile High Flood Control District, and the aforementioned Master Drainage Study.

### **2. Variances**

No variances are requested.

### **3. Summary of Concept**

Runoff from the project site is by a proposed onsite storm system which follow historic drainage patterns and connects to an existing underground storm sewer system that

releases the runoff into the existing sub-regional detention and water quality facility. The proposed development complies with the existing drainage report and therefore no modifications to the existing storm system or pond are required. The existing detention pond releases at historic rates and the existing storm system will not be affected. Downstream impacts will be mitigated by the collection and conveyance of storm runoff. The proposed development is not anticipated to have any adverse effects to downstream facilities.

## F. References

### 1. Reports/Resources

- *Preliminary Drainage Report for Cross Creek Filing No. 4 Cross Creek Commercial*, dated October 2020 by JR Engineering, LLC
- National Flood Insurance Program Flood Insurance Rate Map (FIRM) Number 08005C0202L, revised February 17, 2017
- USDA National Resources Conservation Service Web Soil Survey

Excerpts from these reports are provided in Appendix A

#### a. Criteria Manuals

- *Storm Drainage Design & Technical Criteria*, October 2011.
- *Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual*, Dated March 2017.

## Appendix A – Reference Materials

**Preliminary Drainage Report  
For  
Cross Creek Filing No. 4  
Cross Creek Commercial**

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APPROVED FOR ONE YEAR FROM THIS DATE	
City Engineer	Date
Aurora Water Department	Date

July 21, 2020  
Revised: October 30, 2020

## **A. INTRODUCTION**

### **1. Location**

The site is bounded to the west by N. Gun Club Road, to the north by E. 5<sup>th</sup> Ave, to the south by E. 6<sup>th</sup> Parkway, and to the northeast by the Cross Creek Community Clubhouse. The site is approximately 31.91 acres. The Cross Creek Commercial site is within the City of Aurora, Arapahoe County, Colorado, adjacent to and just east of E-470 and south of I-70.

The site is located in the northwest quarter of Section 7, Township 6 South, Range 65 West of the 6<sup>th</sup> Principal Meridian. A Preliminary Plat for this filing has been submitted concurrently with this report.

A vicinity map is provided in the Appendix.

### **2. Proposed Development**

Cross Creek Commercial is currently undeveloped, covered with native grass and sparsely distributed brush. The site's topography slopes from east to west with shallow grades, which are between 0.5 and 2 percent. The existing drainage pattern will generally remain to the greatest extent possible in the proposed condition. Existing detention pond D-C lies in the southwest corner of the site.

The site will consist of two proposed roads two commercial pads for development, and a tract existing detention pond D-C, which all together total approximately 5.12 acres. The remaining 26.79 acres will be future development.

Basins tributary to Pond D-C have been analyzed in detail with this report, and include the proposed 5.12 acres that is proposed to be developed, four offsite basins south of the site that are tributary to pond D-C, and Basins A-1 and A-2 that are future development. Total area tributary to Pond D-C is 25.71 acres.

Existing detention pond D-MF lies north of the site. No basins tributary to pond D-MF are proposed to develop at this time and therefore existing pond D-MF is proposed to remain in its existing historic conditions and is not part of this analysis.

Drainage for this site has been previously analyzed in the previously-approved "Cross Creek Subdivision Master Drainage Study," by High Country Engineering, Inc. revised December 10, 2002 and "Addendum I to the Final Drainage Report Cross Creek Metropolitan District" by High Country Engineering, Inc. revised October 23, 2003. These previous reports analyzed the drainage characteristics of this site and calculated the required detention and water quality control volumes (WQCV) for detention pond D-C.

storm sewer inlets.

Basin D-C (1.31 acres, 81.7% impervious) is the existing detention pond D-C. 100% impervious was assumed for the detention pond area. Runoff from this basin will sheetflow directly into detention pond D-C. Detention pond details for pond D-C are discussed in detail below.

All sump inlets have been designed to overflow into adjacent rights of way prior to inundating adjacent properties, should the inlets become clogged.

There are no known unusual drainage issues or problems associated with this development. It is anticipated that the site will be constructed in a single phase.

### **3. Detention Pond Design**

Storm water flood detention and storm water quality management for this development will be provided within detention Pond D-C, which is located in the southwest corner of the site. Sediment and erosion control, Best Management Practices, as presented in the Urban Storm Drainage Criteria Manual, Volume III, will be implemented.

Detention Pond D-C was previously analyzed in the previously-approved “Addendum I to the Final Drainage Report, Cross Creek Metropolitan District”, prepared by High Country Engineering, Inc., revised October 23, 2003. The previously-approved report assumed this site in its entirety would be commercial development. However, the current zoning for the site restricts the east portion of the site to residential, resulting in a decrease in impervious area for the area tributary to pond D-C. As a result, the required detention pond volume for pond D-C can be reduced.

The site lies with the Buckley AFB buffer zone for ponds. Detention Pond D-C is an extended detention basin in the historic condition and water quality is provided. The pond has been re-analyzed to provide a 24 hour drain time for the WQCV event, 36 hour drain time for the EURV event, and the full pond will drain within 48 hours. The pond is proposed to remain to the greatest extent possible (the pond depth, outlet structure, and south and west sides are proposed to remain, and the north and east sides are proposed to be re-graded to accommodate the proposed development). The existing outlet structure will be retrofitted with new orifice plates to provide the WQCV, EURV, and full pond drain times stated above.

In accordance with City of Aurora standards, the total pond volume is designed to detain the 100-year stormwater event plus 50% of the EURV stormwater events. An additional 1.9ft of freeboard has been provided between the top of the 100-yr water surface elevation and the overflow weir. The top of the 100-yr water surface elevation is at 5559.10 and the proposed overflow weir is at an elevation of 5561.00 and overflows to the south to E 6<sup>th</sup> Pkwy. Although City criteria requires only 1.0 foot of freeboard above the 100 year water surface elevation, the overflow weir will be installed at an elevation of 5561.00 (one foot higher than required) due

to the existing grade and sidewalk surrounding the pond being at an elevation of approximately 5560.50 adjacent to the overflow weir. The emergency spillway will be designed to current City of Aurora standards.

This site has been rezoned to R-2 since the approval of the 2003 Master Drainage Study. The re-zone restricts the east portion of the site to residential, which results in a decrease in percent impervious for the site from the percent impervious values assumed in the previously-approved Master Drainage Study. The previously-approved report assumed commercial development (95% impervious per current criteria) for the entire 31.91 acre site, whereas in the proposed condition, the west portion of the site is now anticipated to be commercial or multi-family (95% impervious) and the east portion of the site is now anticipated to be single family duplex (60% impervious). Because of the change in zoning the percent impervious value for the tributary area to pond D-C is reduced from 88.3% to 84.3%. This decrease in impervious area results in a decrease in required pond volume. Additional offsite basins within Gun Club Road, 6<sup>th</sup> Parkway, and the residential development south of the site are tributary to pond D-C as further described below and depicted in the historic drainage plans provided in the Appendix.

A summary of the historic basins tributary to pond D-C per the previously-approved “Addendum I to the Final Drainage Report, Cross Creek Metropolitan District” as well as a summary of the basins tributary to pond D-C in the proposed conditions are as follows:

***Per Previously-approved report:***

<b><u>Pond D-C</u></b>		
<u>Basin Designation</u>	<u>Basin Area (acres)</u>	<u>Percent Impervious</u>
D4.1	3.8	88.3%
D4.2	2.6	88.3%
<b>D9S</b>	<b>11.1</b>	<b>88.3%</b>
D10.1	1.4	88.3%
D10.2	6.9	88.3%
<b>Total to Pond D-C</b>	<b>25.8</b>	<b>88.3%</b>

**Per Previously-approved report:**

*Pond D-C Required 100-Yr Volume: 3.96 acre-feet*  
*Pond D-C Required WQCV Volume: 1.02 acre-feet*  
*Total Req'd Pond D-C Volume (100yr+WQCV): 4.97 acre-feet*

**Note: Onsite Basins highlighted in Yellow**

**Proposed Development:**

**Pond D-C**

<u>Basin Designation</u>	<u>Basin Area (acres)</u>	<u>Percent Impervious</u>
D4.1	3.8	88.3%
D4.2	2.6	88.3%
A1	4.14	60.7%
A2	2.74	92.9%
A3	2.61	92.1%
B1	0.10	79.1%
B2	0.11	79.1%
D-C	1.31	81.7%
D10.1	1.4	88.3%
D10.2	6.9	88.3%
<b>Total to Pond D-C</b>	<b>25.71</b>	<b>84.3%</b>

In the Proposed Condition:

Amended Pond D-C Required 100-Yr Volume: 3.62 acre-feet

Amended Pond D-C Required WQCV (1.2WQCV): 0.826 acre-feet

Amended Total Req'd Pond D-C Volume (100yr+0.5EURV): 4.85 acre-feet

**Note: Onsite Basins highlighted in Yellow**

Pond Volume Summary – Detention Pond D-C

	Required Volume Per Previous Master Study	Required Volume Per This Report	Provided Pond Volume
Apron Invert (Pond Bottom)	5548.41 ft	5548.41 ft	5548.41 ft
WQCV	1.02 ac-ft	0.826 ac-ft (1.2WQCV)	0.839 ac-ft
WQCV WSEL	5552.16 ft	--	5552.90 ft
EURV/10-yr Volume	3.11 acre-ft (10-yr)	2.14 ac-ft (EURV)	2.46 ac-ft (EURV)
EURV/10-yr WSEL	5555.56 ft	--	5556.00 ft
100-yr Volume	3.96 ac-ft	3.62 ac-ft	--
100-yr + WQCV	4.97 ac-ft	--	--
100-yr + WQCV WSEL	5557.88 ft	--	--
100+0.5EURV Volume	--	4.85 ac-ft	4.90 ac-ft
100-yr + 0.5EURV WSEL	--	--	5559.10 ft
Top of Spillway Elevation	5560.41 ft	5561.00 ft	5561.00 ft
Top of Berm Elevation	N/A	5562.50 ft	5562.50 ft

# COMPOSITE % IMPERVIOUS CALCULATIONS

Subdivision: Cross Creek  
 Location: Aurora

Project Name: Cross Creek Commercial  
 Project No.: 15879.20  
 Calculated By: GGM  
 Checked By: JGS  
 Date: 7/9/20

### ONSITE BASINS

Basin ID	Total Area (ac)	Paving, Drives, Walks, Ponds		Landscaping		Use (Commercial, Residential)		Basins Total Weighted % Imp.			
		% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.				
A1	4.14	100%	0.090	2.2%	5%	0.011	0.0%	60%	4.04	58.5%	60.7%
A2	2.74	100%	0.300	10.9%	5%	0.081	0.1%	95%	2.36	81.8%	92.9%
A3	2.61	100%	0.350	13.4%	5%	0.102	0.2%	95%	2.16	78.5%	92.1%
TOTAL A	9.49										78.7%
B1	0.10	100%	0.078	78.0%	5%	0.022	1.1%	95%	0.000	0.0%	79.1%
B2	0.11	100%	0.086	78.0%	5%	0.024	1.1%	95%	0.000	0.0%	79.1%
TOTAL B	0.21										79.1%
D-C	1.31	100%	1.058	80.7%	5%	0.252	1.0%	95%	0.000	0.0%	81.7%
TOTAL D-C	1.31										81.7%
TOTAL ONSITE	11.01										79.0%

### OFFSITE BASINS

D4.1	3.80	100%	0.000	0.0%	5%	0.000	0.0%	88%	3.800	88.3%	88.3%
D4.2	2.60	100%	0.000	0.0%	5%	0.000	0.0%	88%	2.600	88.3%	88.3%
TOTAL D4	6.40										88.3%
D10.1	1.40	100%	0.000	0.0%	5%	0.000	0.0%	88%	1.400	88.3%	88.3%
D10.2	6.90	100%	0.000	0.0%	5%	0.000	0.0%	88%	6.900	88.3%	88.3%
TOTAL D10	8.30										88.3%
TOTAL OFFSITE	14.70										88.3%

TOTAL TO DETENTION POND D-C	25.71										84.3%
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Per Table 1. City of Aurora Storm Drainage and Technical Criteria Manual:

- Paving, Drives, Walks: 100% impervious
- Undeveloped Areas (Lawns): 5% impervious
- Commercial Areas: 95% impervious
- Multi-Unit Residential (Detached): 60% impervious
- Apartments: 80% impervious

COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: Cross Creek  
 Location: Aurora

Project Name: Cross Creek Commercial  
 Project No.: 15879/20  
 Calculated By: CGM  
 Checked By: JGS  
 Date: 7/9/20

Basin ID	Total Area (ac)	Paved Roads/Walks/Walls		Landscaping		Use (Commercial, Residential)		Basins Total Weighted C <sub>2</sub>		
		C <sub>2</sub>	Area (ac)	Weighted C <sub>2</sub>	C <sub>2</sub>	Area (ac)	Weighted C <sub>2</sub>			
<b>ONSITE BASINS</b>										
A1	4.140	0.87	0.09	0.02	0.18	0.01	0.45	4.04	0.44	0.46
A2	2.740	0.87	0.30	0.10	0.18	0.08	0.01	0.87	2.36	0.85
A3	2.610	0.87	0.35	0.12	0.18	0.10	0.01	0.87	2.16	0.84
TOTAL A	9.490									0.68
B1	0.100	0.87	0.08	0.68	0.18	0.02	0.04	0.87	0.00	0.72
B2	0.110	0.87	0.09	0.68	0.18	0.02	0.04	0.87	0.00	0.72
TOTAL B	0.210									0.72
D-C	1.310	0.87	1.06	0.70	0.18	0.25	0.03	0.87	0.00	0.74
TOTAL D-C	1.310									0.74
TOTAL ONSITE	11.010									0.69

OFFSITE BASINS	
D4-1	3.80
D4-2	2.60
TOTAL D4	6.40
D10-1	1.40
D10-2	6.90
TOTAL D10	8.30

\*Note: 2-yr and 100-yr C Values of 0.87 and 0.89 for offsite basins are from previously-approved drainage report

**TABLE 1**  
**RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS**

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY		
		2	5	10
Business:				
Commercial Areas	95	87	88	89
Neighborhood Areas	85	60	65	70
Residential:				
Single-Family (**)	40	45	50	60
Main Unit (detached)	60	45	60	70
Main Unit (attached)	75	60	65	80
1/2-Acre Lot or Larger	(*)	30	35	40
Apartments	80	65	70	80
Industrial:				
Light Industrial	80	71	71	76
Heavy Areas	90	80	80	85
Parks, Cemeteries	5	10	10	35
Playgrounds	10	15	25	35
Schools	50	45	50	60
Railroad Yard Areas:				
Undeveloped Areas:	15	40	45	50
Historic Flow Analysis, Greenbelt, Agricultural	2			
Off-Site Flow Analysis (when land use not defined)	45	43	47	55

(See "Lamas")

**TABLE 1 (continued)**  
**RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS**

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY		
		2	5	10
Streets:				
Paved	100	87	88	90
Gravel	40	15	25	35
Concrete Drive and Walks:				
Roofs:	96	87	87	88
Lamas, Single Soil (A and B Soils):	2	80	85	90
2-7% Slope		06	06	08
>7% Slope		10	11	11
Lamas, Clay Soil (C and D Soils):	5	15	16	18
2% Slope		13	14	15
2-7% Slope		18	19	20
>7% Slope		25	27	30

NOTE: These Rational Formula coefficients may not be valid for large basins

(\*)See Figures EO-1 through EO-5 of USDCM Volume 1 for percent impervious.

(\*\*)Up to 5 units per acre. Single-family with more than 5 units per acre, use values for multi-unit/detached

**COMPOSITE RUNOFF COEFFICIENT CALCULATIONS**

Subdivision: Cross Creek  
Location: Aurora

Project Name: Cross Creek Commercial  
Project No.: 15879/20  
Calculated By: CGM  
Checked By: JGS  
Date: 7/9/20

Basin ID	Total Area (ac)	Paved Roads/Walks/Walls		Landscaping		Use (Commercial, Residential)		Basins Total Weighted C <sub>s</sub>		
		C <sub>s</sub>	Area (ac)	Weighted C <sub>s</sub>	C <sub>s</sub>	Area (ac)	Weighted C <sub>s</sub>			
<b>ONSITE BASINS</b>										
A1	4.140	0.88	0.09	0.02	0.19	0.01	0.50	4.04	0.49	0.51
A2	2.740	0.88	0.30	0.10	0.19	0.08	0.87	2.36	0.75	0.85
A3	2.610	0.88	0.35	0.12	0.19	0.10	0.87	2.16	0.72	0.84
<b>TOTAL A</b>	<b>9.490</b>									<b>0.70</b>
B1	0.100	0.88	0.08	0.69	0.19	0.02	0.87	0.00	0.00	0.73
B2	0.110	0.88	0.09	0.69	0.19	0.02	0.87	0.00	0.00	0.73
<b>TOTAL B</b>	<b>0.210</b>									<b>0.73</b>
D-C	1.310	0.88	1.06	0.71	0.19	0.25	0.87	0.00	0.00	0.75
<b>TOTAL D-C</b>	<b>1.310</b>									<b>0.74</b>
<b>TOTAL ONSITE</b>	<b>11.010</b>									<b>0.71</b>

**OFFSITE BASINS**

D4-1	3.80									0.87
D4-2	2.60									0.87
<b>TOTAL D4</b>	<b>6.40</b>									<b>0.87</b>
D10-1	1.40									0.87
D10-2	6.90									0.87
<b>TOTAL D10</b>	<b>8.30</b>									<b>0.87</b>

\*Note: 2-yr and 100-yr C Values of 0.87 and 0.89 for offsite basins are from previously-approved drainage report

**TABLE 1  
RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS**

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY		
		2	5	10
Business:				
Commercial Areas	95	87	87	88
Neighborhood Areas	85	60	65	70
Residential:				
Single-Family (**)	40	45	45	50
Multi-Unit (detached)	60	45	50	60
Multi-Unit (attached)	75	60	65	70
1/2 Acre Lot or Larger	(*)	30	35	40
Apartments	80	65	70	80
Industrial:				
Warehouses	80	71	73	76
Heavy Areas	90	80	80	85
Parks, Cemeteries:	5	10	10	35
Playgrounds:	10	15	25	35
Schools:	50	45	50	60
Railroad Yard Areas:	15	40	45	50
Undeveloped Areas:				
Historic Flow Analysis, Greenbelt, Agricultural	2			
Off-Site Flow Analysis (when land use not defined)	45	43	47	55
				65

(See "Lamas")

**TABLE 1 (continued)  
RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS**

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY		
		2	5	10
Sheet Paved Gravel	100	87	88	90
Concrete Drives and Walks	40	15	25	35
Roofs:				
Asphalt Shingles	96	87	87	88
Lamas, Sandy Soil (A and B Soils):	2	80	85	90
2% Slope		05	06	08
2-7% Slope		10	11	13
>7% Slope		15	16	18
Lamas, Clay Soil (C and D Soils):	5			
2% Slope		13	14	15
2-7% Slope		18	19	20
>7% Slope		25	27	30

NOTE: These Rational Formula coefficients may not be valid for large basins

(\*) See Figures EC-1 through EC-5 of USDCM Volume 1 for percent impervious.

(\*\*) Up to 5 units per acre. Single-family with more than 5 units per acre, use values for multi-unit/detached

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

Subdivision: Cross Creek  
 Location: Aurora  
 Design Storm: 2-Year

Project Name: Cross Creek Commercial  
 Project No.: 158879-20  
 Calculated By: TCSM  
 Checked By: TGS  
 Date: 7/9/20

Flow	Design Point	DIRECT RUNOFF				TOTAL RUNOFF			STREET			PIPE			TRAVEL TIME			REMARKS			
		Basin ID	Area (Ac)	Runoff Coeff.	$t_c$ (min)	C*A (Ac)	$f$ (in/hr)	Q (cfs)	$t_c$ (min)	C*A (ac)	$f$ (in/hr)	Q (cfs)	Slope (%)	C <sub>pipe</sub> (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)		Length (ft)	Velocity (fps)	$t_t$ (min)
Surface	1.2	A1	4.14	0.46	14.19	1.90	2.28	4.33						4.3	1.9	1.0	18	560	5.6	1.7	Surface flow from Basin A1 Captured flow by sump inlet piped to DP1.1
Surface		A2	2.74	0.85	9.30	2.33	2.73	6.36						6.4	2.3	1.0	18	40	6.2	0.1	Surface flow from Basin A2 Captured flow by sump inlet piped to DP1.1
Surface		A3	2.61	0.84	9.80	2.20	2.67	5.87													Surface flow from Basin A3 Captured flow by sump inlet Combined flow from Basins A1, A2, A3
Pipe	1.1							15.9	6.43	2.17	14.0			14.0	6.4	1.0	30	270	7.5	0.6	Surface flow from Basin D-C
Surface		D-C	1.31	0.74	5.00	0.97	3.32	3.22													
Pipe	1					Total Basin A Run-off			16.5	7.40	2.13	15.8									
Surface		B2	0.11	0.72	5.00	0.08	3.32	0.27						0.3	0.1	1.0	18	40	2.4	0.3	Pond D-C Outfall @ DP1 Surface flow from Basin B2 Captured flow routed to DP2.1
Surface		B1	0.10	0.72	5.00	0.07	3.32	0.23													Surface flow from Basin B1
Pipe	2.1							5.3	0.15	3.28	0.5			0.5	0.2	1.0	24	55	2.8	0.3	Combined flow from Basins B1, B2 Routed to DP2
Pipe	2							5.6	0.15	3.22	14.4										Outfall into existing storm O=13.9cfs from previous approved report

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

Subdivision: Cross Creek  
 Location: Aurora  
 Design Storm: 100-Year

Project Name: Cross Creek Commercial  
 Project No.: 15879.20  
 Calculated By: ZGM  
 Checked By: JGS  
 Date: 7/9/20

STREET	Design Point	DIRECT RUNOFF				TOTAL RUNOFF		STREET			PIPE			TRAVEL TIME		REMARKS					
		Basin ID	Area (ac)	Runoff Coeff.	$t_c$ (min)	C <sub>A</sub> (ac)	$f$ (in/hr)	Q (cfs)	C <sub>A</sub> (ac)	Q <sub>street</sub> (cfs)	Slope (%)	C <sub>A</sub> (ac)	Slope (%)	Q <sub>pipe</sub> (cfs)	Length (ft)		Velocity (fps)	$t_t$ (min)			
Surface	1.2	A1	4.14	0.70	14.19	2.91	6.2	18.04					18.0	2.9	1.0	18	560	10.2	0.9	Surface flow from basin A1 Captured flow by sump inlet piped to DP1.1	
Surface		A2	2.74	0.87	9.30	2.40	7.4	17.76					17.8	2.4	1.0	18	40	10.1	0.1	Surface flow from basin A2 Captured flow by sump inlet piped to DP1.1	
Surface		A3	2.61	0.87	9.80	2.27	7.25	16.46												Surface flow from basin A3 Captured flow by sump inlet Combined flow from basins A1, A2, A3	
Pipe	1.1	D-C	1.31	0.79	5.00	1.04	9.02	9.38	15.1	7.58	6.02	45.6	45.6	7.6	1.0	30	270	9.3	0.5	Surface flow from Basin D-C	
Pipe	1	Total Basin A Run-off							15.6	8.62	5.93	51.1									Pond D-C Outfall @ DP1 Surface flow from Basin B2
Surface		B2	0.11	0.77	5.00	0.09	9.02	0.81						0.8	0.1	1.0	18	40	3.4	0.2	Captured flow routed to DP2.1
Surface		B1	0.10	0.77	5.00	0.08	9.02	0.72												Surface flow from Basin B1	
Pipe	2.1								5.2	0.17	8.93	1.5		1.5	0.2	1.0	24	55	4.0	0.2	Combined flow from Basins B1, B2 Routed to DP2
Pipe	2								5.4	0.17	8.82	33.6								0.2	Outfall into existing storm Or-32.1 cfs from previous approved report

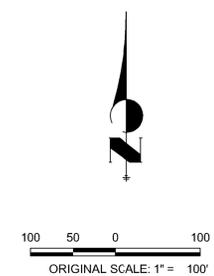
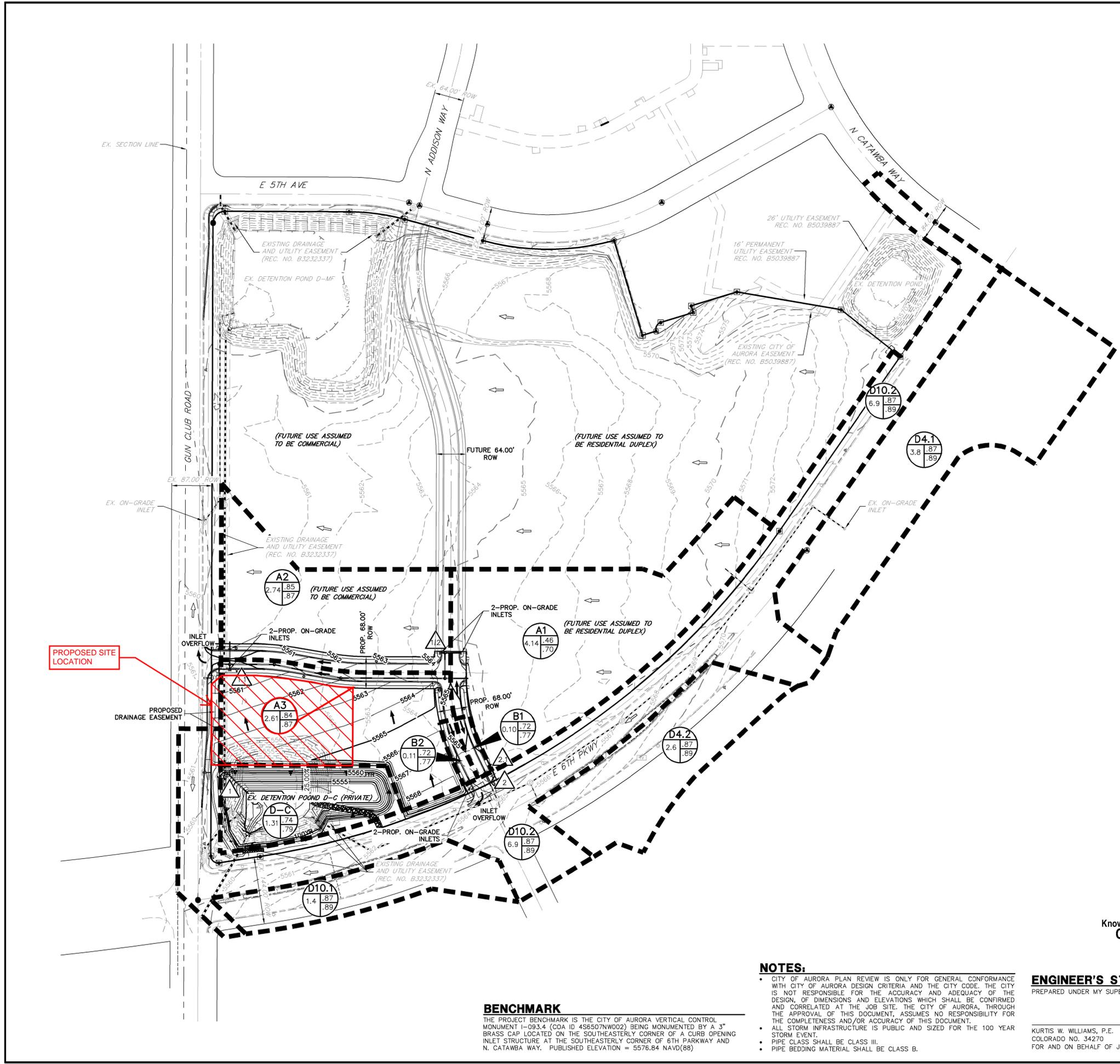
Notes: Time of concentration of 5.0 minutes conservatively assumed

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, OR ENGINEERING APPROVES THEIR USE, THESE DRAWINGS ARE DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR  
**STRATEGIC CAPITAL CORP.**  
 575 MADISON AVE  
 SUITE 1006  
 NEW YORK, NY 10022

**J.R. ENGINEERING**  
 A Westman Company  
 Centennial 303-740-9883 • Colorado Springs 719-583-2583  
 Fort Collins 970-491-9888 • www.jrengineering.com

BASIN SUMMARY TABLE							
Tributary Sub-basin	Area (acres)	Percent Impervious	C <sub>2</sub>	C <sub>100</sub>	t <sub>c</sub> (min)	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)
A1	4.14	61%	0.46	0.70	14.19	4.3	18.1
A2	2.74	93%	0.85	0.87	9.30	6.4	17.7
A3	2.61	92%	0.84	0.87	9.80	5.9	16.4
B1	0.10	79%	0.72	0.77	5.00	0.2	0.7
B2	0.11	79%	0.72	0.77	5.00	0.3	0.8
D-C	1.31	82%	0.74	0.79	5.00	3.2	9.4
D4.1	3.80	88%	0.87	0.89	5.00	11.0	30.5
D4.2	2.60	88%	0.87	0.89	5.00	7.5	20.9
D10.1	1.40	88%	0.87	0.89	5.00	4.0	11.2
D10.2	6.90	88%	0.87	0.89	5.00	19.9	55.4



- LEGEND**
- 5680 — EXISTING CONTOUR
  - 5680 — PROPOSED CONTOUR
  - PROPOSED FLOW ARROW
  - ⇨ EXISTING FLOW ARROW
  - — — — PROPOSED STORM SEWER
  - — — — EXISTING STORM SEWER
  - ⊙ A B C D A = BASIN DESIGNATION  
B = AREA IN ACRES  
C = 2-YR RUNOFF COEFFICIENT  
D = 100-YR RUNOFF COEFFICIENT
  - △ 1 DESIGN POINT
  - — — — PROPERTY LINE
  - — — — BASIN BOUNDARY
  - — — — PROPOSED DRAINAGE DITCH

**NOTE:**  
 THE DEVELOPER SHALL HAVE A LICENSED PROFESSIONAL ENGINEER CERTIFY EACH STORMWATER DETENTION POND AND/OR WATER QUALITY BMP IS BUILT ACCORDING TO THE APPROVED PLANS AND SPECIFICATIONS AND THE REQUIRED DETENTION VOLUME, INCLUDING THE WQCV WHEN USED, IS MET. THE CERTIFICATION SHALL ALSO VERIFY ALL PERTINENT DIMENSIONS, ELEVATIONS, REQUIRED OUTLET ORIFICE PLATES FOR DETENTION AND WQCV AND OTHER PERMANENT BMP'S REQUIREMENTS ARE INSTALLED PER THE APPROVED PLANS AND SPECIFICATIONS, AND SHALL SHOW THE AS-BUILT VOLUMES FOR THE 100-YEAR, 10-YEAR STORM EVENTS, AND FOR THE WQCV AND OTHER PERTINENT DIMENSIONS, ELEVATIONS AND CAPACITY REQUIREMENTS ASSOCIATED WITH THE WQ BMP USED. THE CERTIFICATION SHALL BE PROVIDED TO THE CITY OF AURORA ENGINEERING CONTROL SECTION SENIOR ENGINEER BEFORE A CERTIFICATED OF OCCUPANCY WILL BE ISSUED.



Know what's below.  
 Call before you dig.

- NOTES:**
- CITY OF AURORA PLAN REVIEW IS ONLY FOR GENERAL CONFORMANCE WITH CITY OF AURORA DESIGN CRITERIA AND THE CITY CODE. THE CITY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, OF DIMENSIONS AND ELEVATIONS WHICH SHALL BE CONFIRMED AND CORRELATED AT THE JOB SITE. THE CITY OF AURORA, THROUGH THE APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR THE COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.
  - ALL STORM INFRASTRUCTURE IS PUBLIC AND SIZED FOR THE 100 YEAR STORM EVENT.
  - PIPE CLASS SHALL BE CLASS III.
  - PIPE BEDDING MATERIAL SHALL BE CLASS B.

**BENCHMARK**  
 THE PROJECT BENCHMARK IS THE CITY OF AURORA VERTICAL CONTROL MONUMENT I-093.4 (COA ID 456507NW002) BEING MONUMENTED BY A 3" BRASS CAP LOCATED ON THE SOUTHEASTERLY CORNER OF A CURB OPENING INLET STRUCTURE AT THE SOUTHEASTERLY CORNER OF 6TH PARKWAY AND N. CATAWBA WAY. PUBLISHED ELEVATION = 5576.84 NAVD(88)

**ENGINEER'S STATEMENT**  
 PREPARED UNDER MY SUPERVISION

KURTIS W. WILLIAMS, P.E.  
 COLORADO NO. 34270  
 FOR AND ON BEHALF OF JR ENGINEERING, LLC.



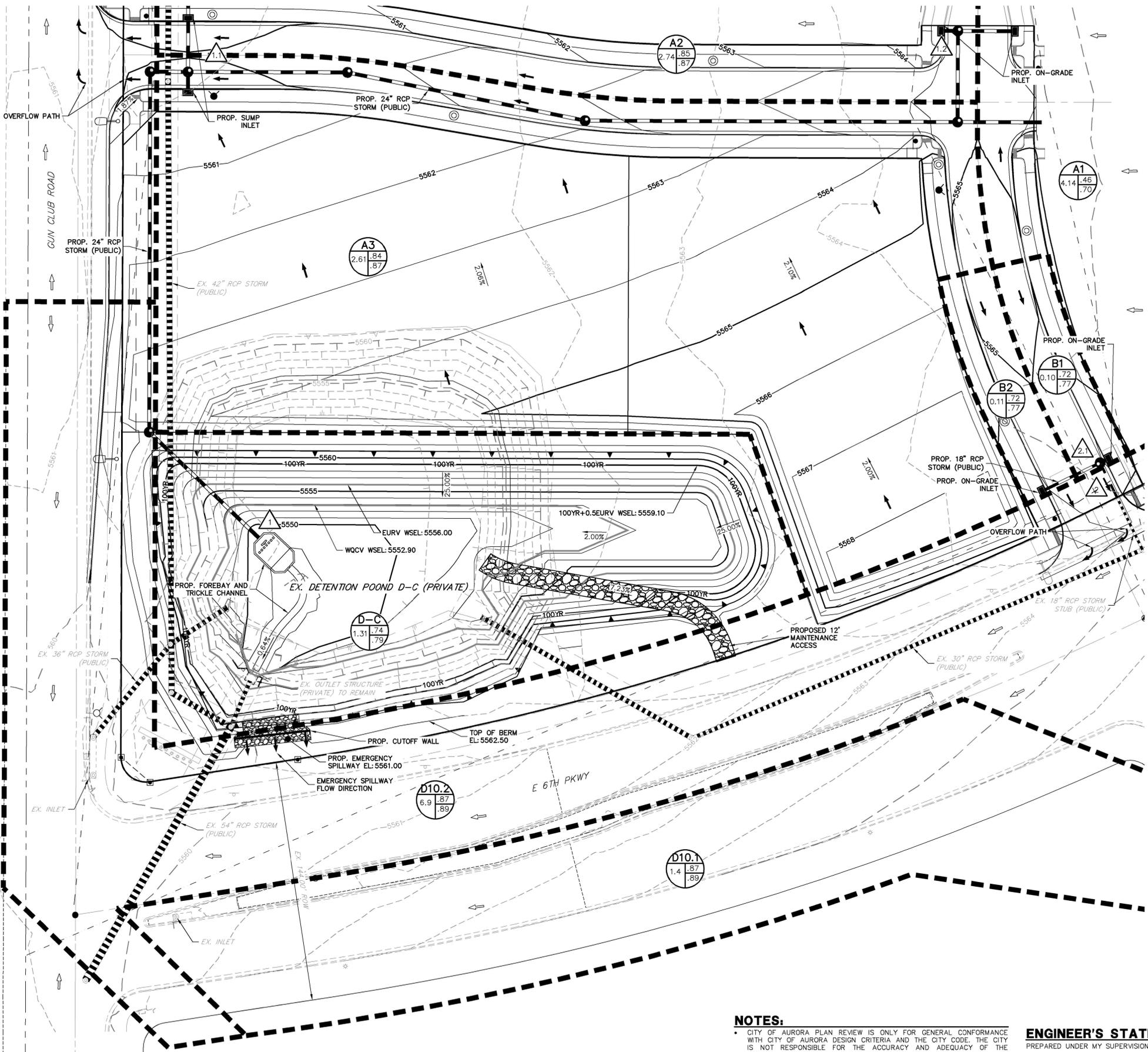
**APPROVED FOR ONE YEAR FROM THIS DATE**

\_\_\_\_\_  
 CITY ENGINEER DATE

\_\_\_\_\_  
 WATER DEPARTMENT DATE

H-SCALE	V-SCALE	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	No.	REVISION	BY	DATE
CROSS CREEK FILING #04									
CROSS CREEK COMMERCIAL									
OVERALL DRAINAGE PLAN									
SHEET 1 OF 2									
JOB NO. 15879.20									

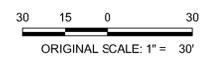
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BASIN SUMMARY TABLE							
Tributary Sub-basin	Area (acres)	Percent Impervious	C <sub>2</sub>	C <sub>100</sub>	t <sub>e</sub> (min)	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)
A1	4.14	61%	0.46	0.70	14.19	4.3	18.1
A2	2.74	93%	0.85	0.87	9.30	6.4	17.7
A3	2.61	92%	0.84	0.87	9.80	5.9	16.4
B1	0.10	79%	0.72	0.77	5.00	0.2	0.7
B2	0.11	79%	0.72	0.77	5.00	0.3	0.8
D-C	1.31	82%	0.74	0.79	5.00	3.2	9.4
D4.1	3.80	88%	0.87	0.89	5.00	11.0	30.5
D4.2	2.60	88%	0.87	0.89	5.00	7.5	20.9
D10.1	1.40	88%	0.87	0.89	5.00	4.0	11.2
D10.2	6.90	88%	0.87	0.89	5.00	19.9	55.4



Know what's below.  
Call before you dig.



**LEGEND**

- 5680 — EXISTING CONTOUR
- 5680 — PROPOSED CONTOUR
- PROPOSED FLOW ARROW
- ⇨ EXISTING FLOW ARROW
- PROPOSED STORM SEWER
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- PROPERTY LINE
- BASIN BOUNDARY
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**NOTE:**  
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**BENCHMARK**

THE PROJECT BENCHMARK IS THE CITY OF AURORA VERTICAL CONTROL MONUMENT I-093.4 (COA ID 456507N002) BEING MONUMENTED BY A 3" BRASS CAP LOCATED ON THE SOUTHEASTERLY CORNER OF A CURB OPENING INLET STRUCTURE AT THE SOUTHEASTERLY CORNER OF 6TH PARKWAY AND N. CATAWBA WAY. PUBLISHED ELEVATION = 5576.84 NAVD(88)

**ENGINEER'S STATEMENT**

PREPARED UNDER MY SUPERVISION

KURTIS W. WILLIAMS, P.E.  
COLORADO NO. 34270  
FOR AND ON BEHALF OF JR ENGINEERING, LLC.



APPROVED FOR ONE YEAR FROM THIS DATE

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_  
WATER DEPARTMENT \_\_\_\_\_ DATE \_\_\_\_\_

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, OR ENGINEERING APPROVES THEIR USES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR  
**STRATEGIC CAPITAL CORP.**  
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NEW YORK, NY 10022

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Central 303-740-9883 • Colorado Springs 719-583-2583  
Fort Collins 970-491-9888 • www.jrengineering.com

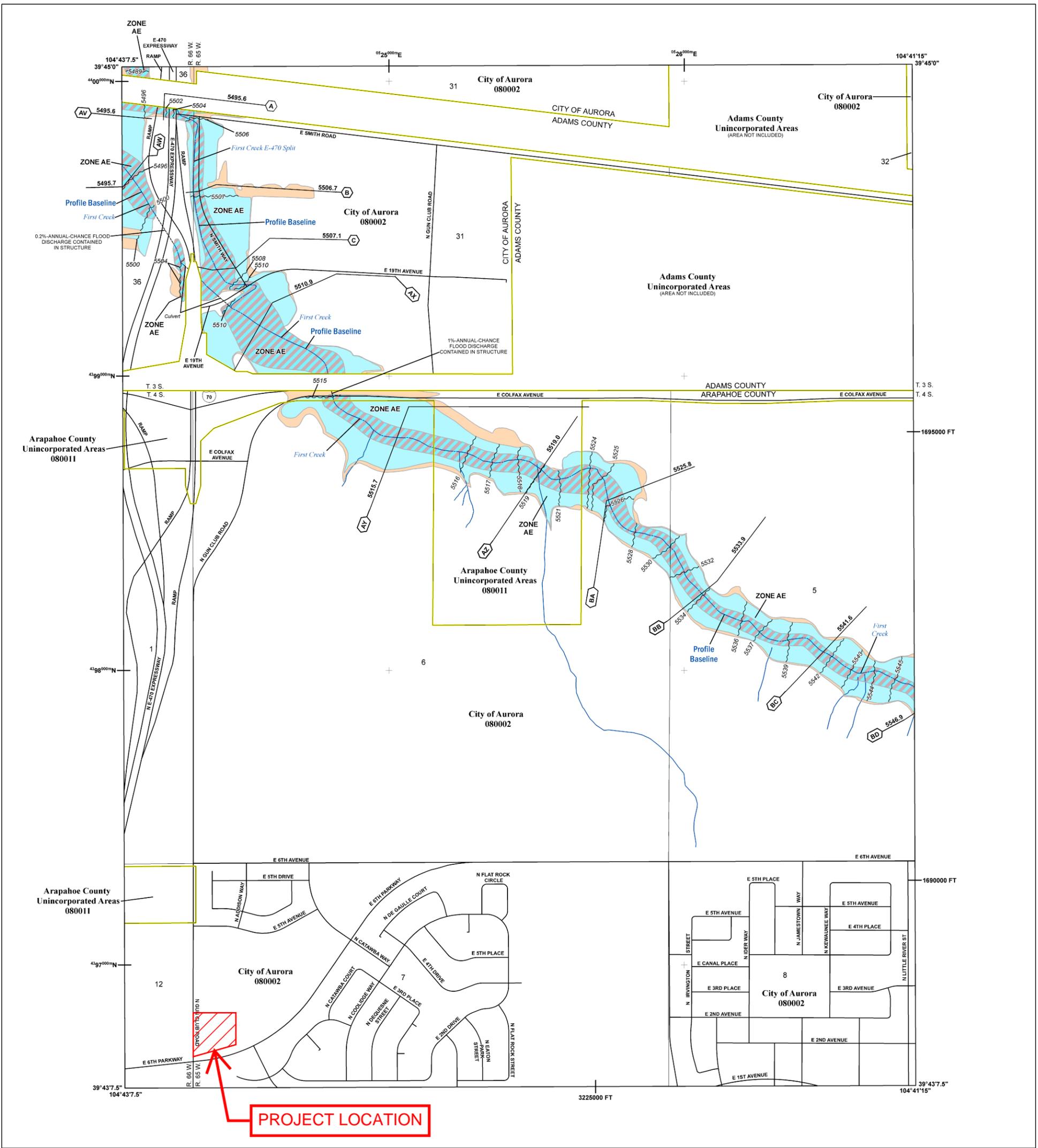
BY	DATE	NO.	REVISION

H-SCALE 1"=30'  
V-SCALE N/A  
DATE 10/26/20  
DESIGNED BY CGM  
DRAWN BY CGM  
CHECKED BY

**CROSS CREEK FILING #04**  
**CROSS CREEK COMMERCIAL**  
**DRAINAGE PLAN**

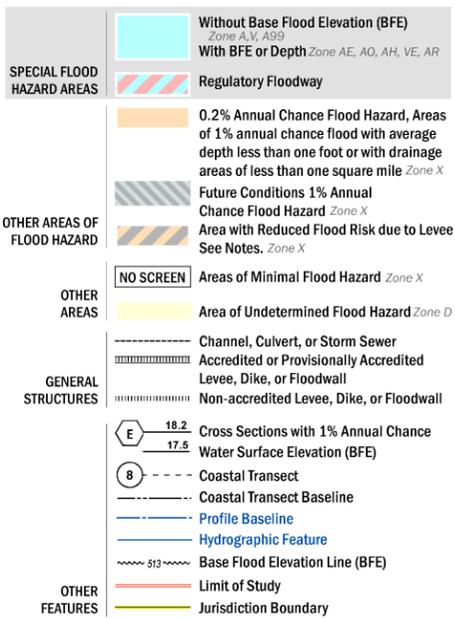
SHEET 2 OF 2  
JOB NO. 15879.20

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**FLOOD HAZARD INFORMATION**

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP  
 THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING  
 DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT  
[HTTP://MSC.FEMA.GOV](http://MSC.FEMA.GOV)



**NOTES TO USERS**

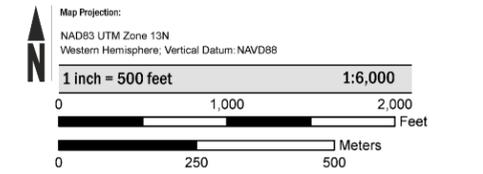
For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at <http://msc.fema.gov>. Available products may include: previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

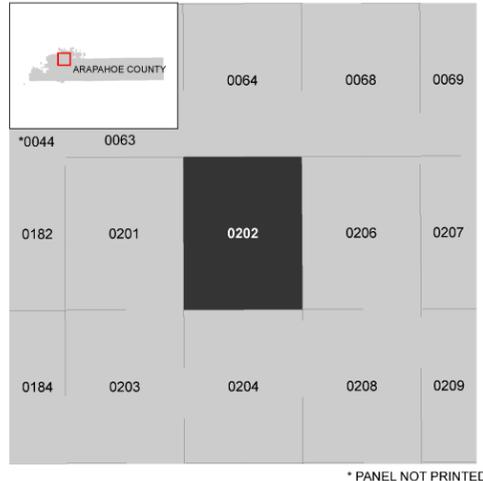
For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction. To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided by the Arapahoe County and Cities of Aurora and Littleton GIS depts. The coordinate system used for production of the digital FIRM is Universal Transverse Mercator, Zone 13N, referenced to the North American Datum of 1983 and the GRS 1980 spheroid, Western Hemisphere.

**SCALE**



**PANEL LOCATOR**



**NATIONAL FLOOD INSURANCE PROGRAM**  
 FLOOD INSURANCE RATE MAP

ARAPAHOE COUNTY, COLORADO  
 And Incorporated Areas

PANEL 202 OF 725

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARAPAHOE COUNTY	080011	0202	L
AURORA, CITY OF	080002	0202	L

VERSION NUMBER  
 2.3.3.2

MAP NUMBER  
 08005C0202L

MAP REVISED  
 FEBRUARY 17, 2017



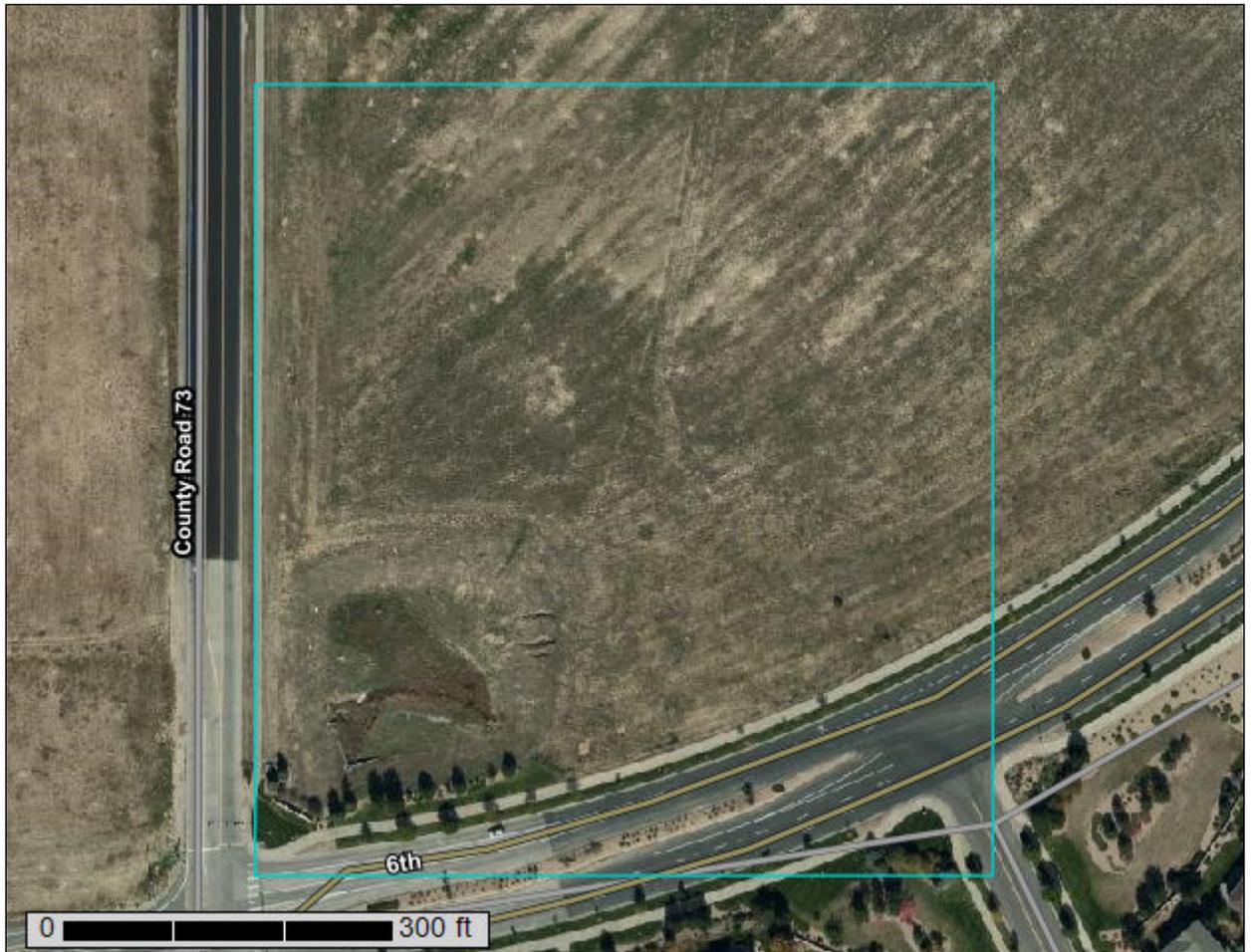
United States  
Department of  
Agriculture

**NRCS**

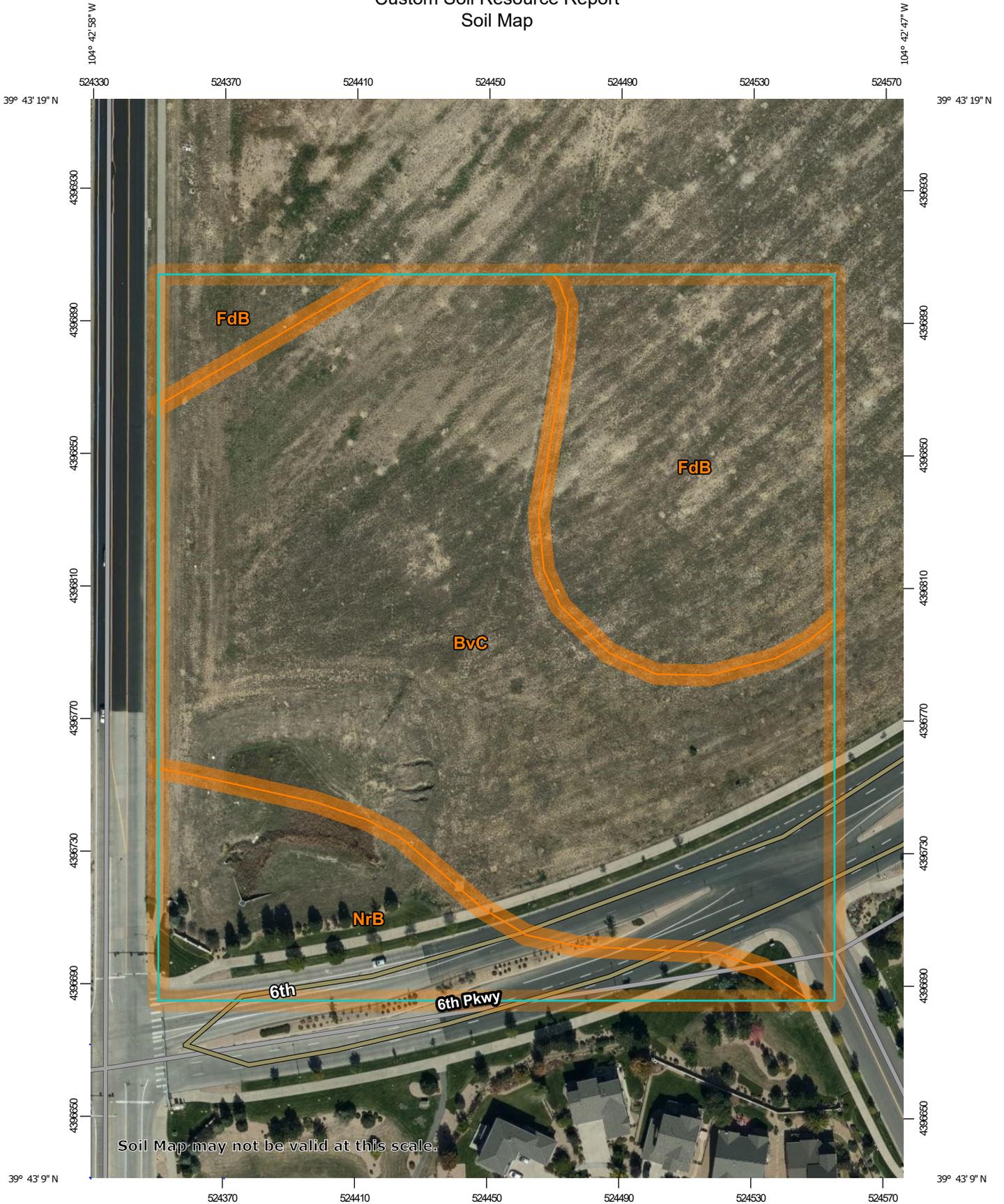
Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for **Arapahoe County, Colorado**



Custom Soil Resource Report  
Soil Map



Map Scale: 1:1,590 if printed on A portrait (8.5" x 11") sheet.



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

## MAP LEGEND

	Area of Interest (AOI)		Spoil Area
	Area of Interest (AOI)		Stony Spot
<b>Soils</b>			Very Stony Spot
	Soil Map Unit Polygons		Wet Spot
	Soil Map Unit Lines		Other
	Soil Map Unit Points		Special Line Features
<b>Special Point Features</b>		<b>Water Features</b>	
	Blowout		Streams and Canals
	Borrow Pit	<b>Transportation</b>	
	Clay Spot		Rails
	Closed Depression		Interstate Highways
	Gravel Pit		US Routes
	Gravelly Spot		Major Roads
	Landfill		Local Roads
	Lava Flow		Aerial Photography
	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		

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Arapahoe County, Colorado  
 Survey Area Data: Version 16, Jun 4, 2020

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

Date(s) aerial images were photographed: Oct 3, 2018—Dec 4, 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
BvC	Bresser-Truckton sandy loams, 3 to 5 percent slopes	6.6	59.7%
FdB	Fondis silt loam, 1 to 3 percent slopes	2.8	24.8%
NrB	Nunn-Bresser-Ascalon complex, 0 to 3 percent slopes	1.7	15.5%
<b>Totals for Area of Interest</b>		<b>11.1</b>	<b>100.0%</b>

## 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

## Arapahoe County, Colorado

### BvC—Bresser-Truckton sandy loams, 3 to 5 percent slopes

#### Map Unit Setting

*National map unit symbol:* 34y5

*Elevation:* 4,500 to 6,800 feet

*Mean annual precipitation:* 12 to 18 inches

*Mean annual air temperature:* 46 to 52 degrees F

*Frost-free period:* 125 to 180 days

*Farmland classification:* Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

#### Map Unit Composition

*Bresser and similar soils:* 55 percent

*Truckton and similar soils:* 30 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Bresser

##### Setting

*Landform:* Playas, drainageways, stream terraces

*Landform position (three-dimensional):* Tread

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Noncalcareous sandy alluvium and/or noncalcareous sandy eolian deposits

##### Typical profile

*H1 - 0 to 6 inches:* sandy loam

*H2 - 6 to 26 inches:* sandy clay loam, clay loam

*H2 - 6 to 26 inches:* sandy loam, coarse sandy loam, gravelly sandy loam

*H3 - 26 to 32 inches:* loamy coarse sand, gravelly loamy sand

*H3 - 26 to 32 inches:*

*H3 - 26 to 32 inches:*

*H4 - 32 to 60 inches:*

*H4 - 32 to 60 inches:*

##### Properties and qualities

*Slope:* 3 to 5 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 2.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 10 percent

*Available water capacity:* Very high (about 13.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 3e

*Land capability classification (nonirrigated):* 4e

## Custom Soil Resource Report

*Hydrologic Soil Group:* B  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

### Description of Truckton

#### Setting

*Landform:* Ridges  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Eolian deposits

#### Typical profile

*H1 - 0 to 5 inches:* sandy loam  
*H2 - 5 to 20 inches:* sandy loam  
*H3 - 20 to 60 inches:* sandy loam, loamy sand, loamy coarse sand  
*H3 - 20 to 60 inches:*  
*H3 - 20 to 60 inches:*

#### Properties and qualities

*Slope:* 3 to 5 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 (1.98 to 6.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water capacity:* Very high (about 13.1 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* A  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

### Minor Components

#### Nunn

*Percent of map unit:* 8 percent  
*Hydric soil rating:* No

#### Ascalon

*Percent of map unit:* 7 percent  
*Hydric soil rating:* No

## **FdB—Fondis silt loam, 1 to 3 percent slopes**

### **Map Unit Setting**

*National map unit symbol:* 34yh  
*Elevation:* 4,700 to 6,200 feet  
*Mean annual precipitation:* 14 to 16 inches  
*Mean annual air temperature:* 48 to 52 degrees F  
*Frost-free period:* 150 to 170 days  
*Farmland classification:* Prime farmland if irrigated

### **Map Unit Composition**

*Fondis and similar soils:* 85 percent  
*Minor components:* 15 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### **Description of Fondis**

#### **Setting**

*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Silty and/or loamy

#### **Typical profile**

*H1 - 0 to 7 inches:* silt loam  
*H2 - 7 to 27 inches:* clay  
*H3 - 27 to 60 inches:* clay loam

#### **Properties and qualities**

*Slope:* 1 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Available water capacity:* High (about 10.5 inches)

#### **Interpretive groups**

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 3c  
*Hydrologic Soil Group:* C  
*Ecological site:* R049XY202CO - Loamy Foothill  
*Hydric soil rating:* No

**Minor Components**

**Weld**

*Percent of map unit: 10 percent*  
*Hydric soil rating: No*

**Buick**

*Percent of map unit: 5 percent*  
*Hydric soil rating: No*

**NrB—Nunn-Bresser-Ascalon complex, 0 to 3 percent slopes**

**Map Unit Setting**

*National map unit symbol: 34yw*  
*Elevation: 4,500 to 6,800 feet*  
*Mean annual precipitation: 12 to 18 inches*  
*Mean annual air temperature: 46 to 57 degrees F*  
*Frost-free period: 115 to 180 days*  
*Farmland classification: Prime farmland if irrigated*

**Map Unit Composition**

*Nunn and similar soils: 40 percent*  
*Bresser and similar soils: 25 percent*  
*Ascalon and similar soils: 20 percent*  
*Minor components: 15 percent*  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Nunn**

**Setting**

*Landform: Streams, stream terraces, playas*  
*Landform position (three-dimensional): Tread*  
*Down-slope shape: Linear*  
*Across-slope shape: Linear*  
*Parent material: Eolian deposits*

**Typical profile**

*H1 - 0 to 8 inches: loam*  
*H2 - 8 to 28 inches: clay loam, clay*  
*H2 - 8 to 28 inches: sandy clay loam, fine sandy loam, sandy loam*  
*H3 - 28 to 60 inches:*  
*H3 - 28 to 60 inches:*  
*H3 - 28 to 60 inches:*

**Properties and qualities**

*Slope: 0 to 3 percent*  
*Depth to restrictive feature: More than 80 inches*  
*Drainage class: Well drained*  
*Runoff class: Low*

## Custom Soil Resource Report

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water capacity:* Very high (about 20.5 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 3c  
*Hydrologic Soil Group:* C  
*Ecological site:* R049XY202CO - Loamy Foothill  
*Hydric soil rating:* No

### Description of Bresser

#### Setting

*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Noncalcareous sandy alluvium and/or noncalcareous sandy eolian deposits

#### Typical profile

*H1 - 0 to 6 inches:* sandy loam  
*H2 - 6 to 26 inches:* sandy clay loam, clay loam  
*H2 - 6 to 26 inches:* loamy coarse sand, gravelly loamy sand  
*H3 - 26 to 60 inches:*  
*H3 - 26 to 60 inches:*

#### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 10 percent  
*Available water capacity:* Very high (about 12.2 inches)

### Interpretive groups

*Land capability classification (irrigated):* 2e  
*Land capability classification (nonirrigated):* 4c  
*Hydrologic Soil Group:* B  
*Ecological site:* R049XY202CO - Loamy Foothill  
*Hydric soil rating:* No

### Description of Ascalon

#### Setting

*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Reworked by wind outwash

## Custom Soil Resource Report

### Typical profile

*H1 - 0 to 6 inches:* sandy loam  
*H2 - 6 to 17 inches:* sandy clay loam, sandy loam  
*H2 - 6 to 17 inches:* fine sandy loam, loamy fine sand, sandy loam  
*H3 - 17 to 60 inches:*  
*H3 - 17 to 60 inches:*  
*H3 - 17 to 60 inches:*

### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.60 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 10 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water capacity:* Very high (about 16.8 inches)

### Interpretive groups

*Land capability classification (irrigated):* 2e  
*Land capability classification (nonirrigated):* 3e  
*Hydrologic Soil Group:* B  
*Ecological site:* R049XY202CO - Loamy Foothill  
*Hydric soil rating:* No

### Minor Components

#### Olney

*Percent of map unit:* 10 percent  
*Hydric soil rating:* No

#### Aquic ustochrepts

*Percent of map unit:* 5 percent  
*Landform:* Swales  
*Hydric soil rating:* Yes

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## Appendix B – Hydrologic Computations

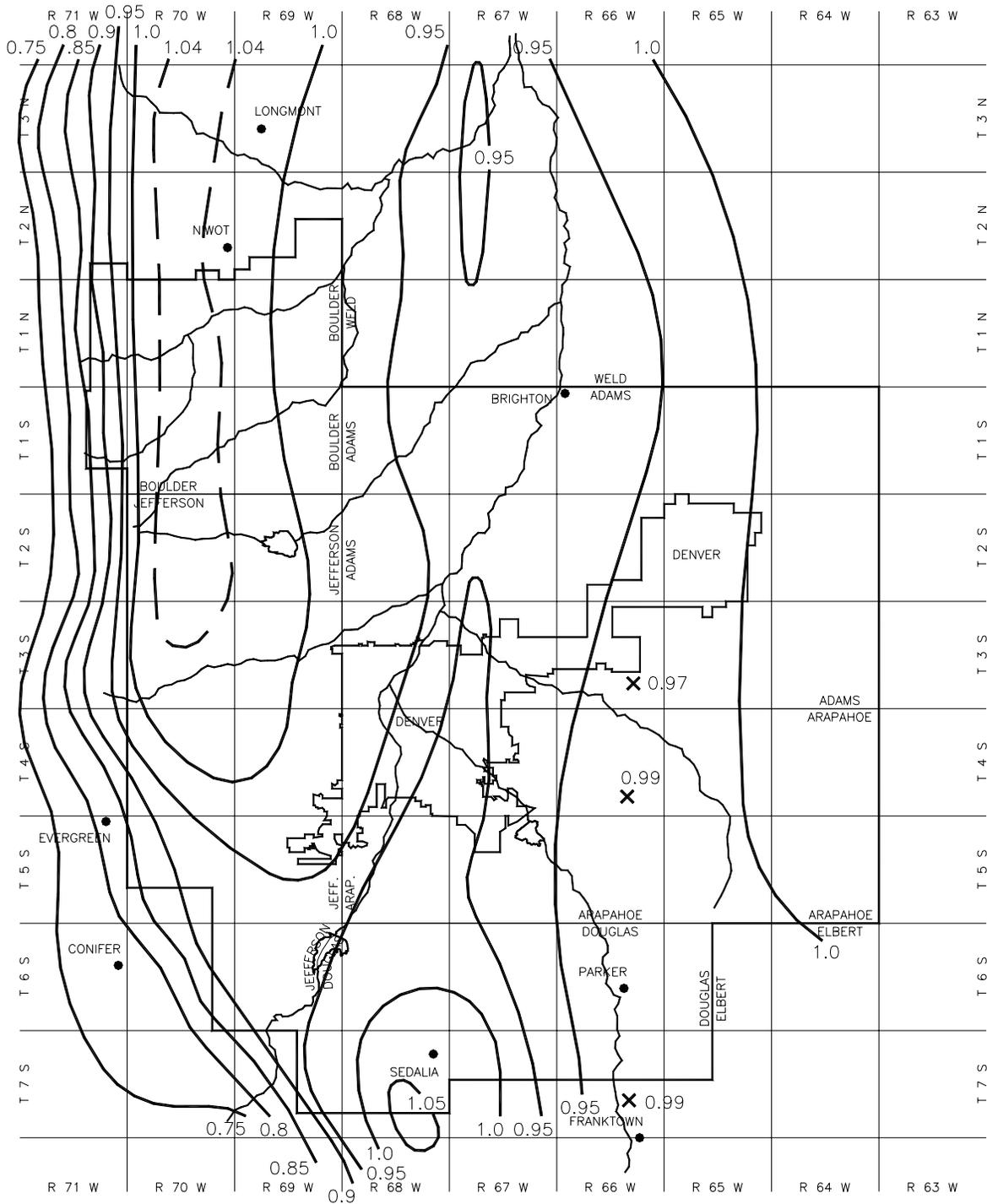


Figure RA-1—Rainfall Depth-Duration-Frequency: 2-Year, 1-Hour Rainfall

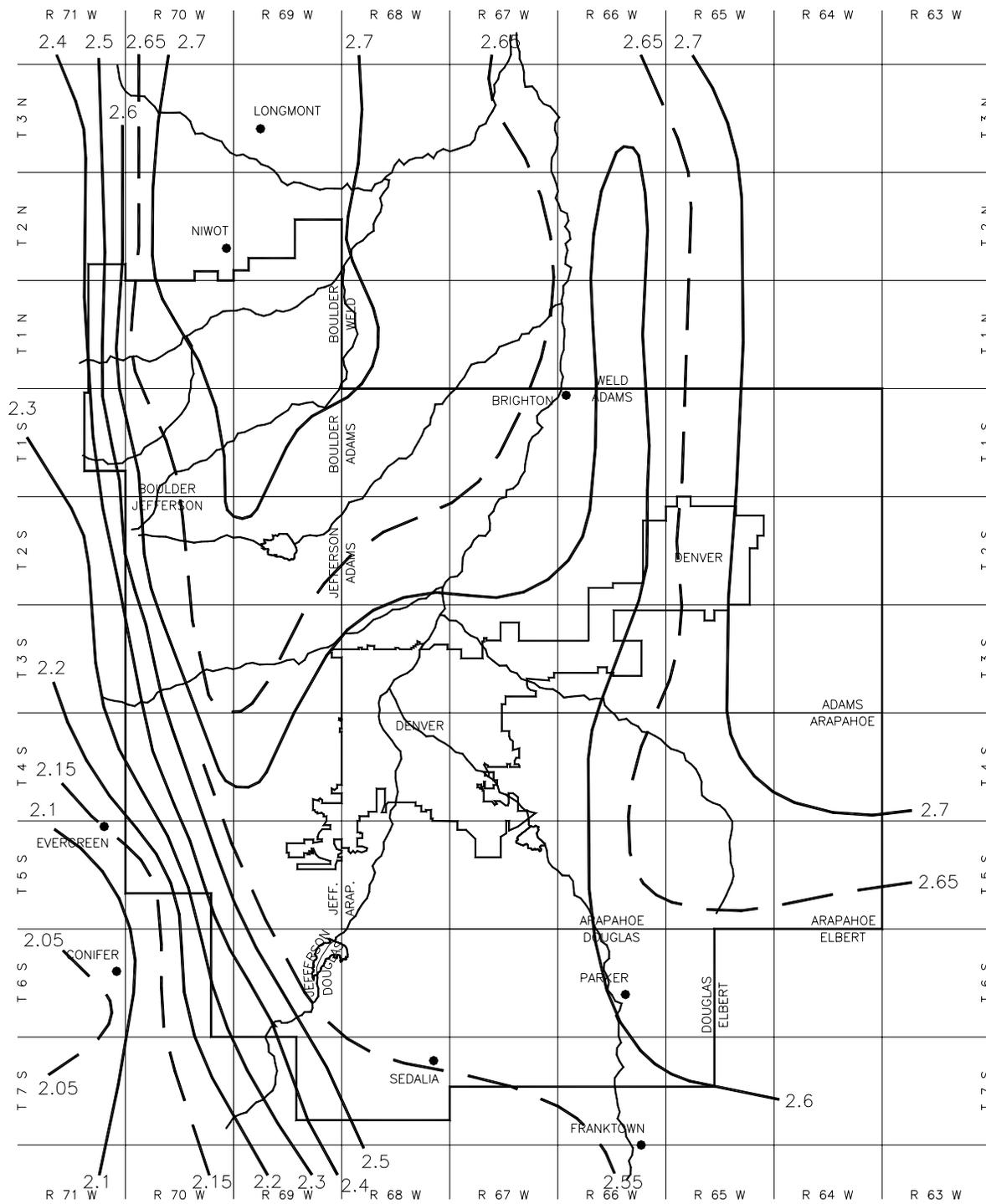


Figure RA-6—Rainfall Depth-Duration-Frequency: 100-Year, 1-Hour Rainfall

**TABLE 1**  
**RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS**

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY			
		2	5	10	100
<u>Business:</u>					
Commercial Areas	95	.87	.87	.88	.89
Neighborhood Areas	85	.60	.65	.70	.80
<u>Residential:</u>					
Single-Family (**)	(*)	.40	.45	.50	.60
Multi-Unit (detached)	60	.45	.50	.60	.70
Multi-Unit (attached)	75	.60	.65	.70	.80
1/2 Acre Lot or Larger	(*)	.30	.35	.40	.60
Apartments	80	.65	.70	.70	.80
<u>Industrial:</u>					
Light Areas	80	.71	.72	.76	.82
Heavy Areas	90	.80	.80	.85	.90
<u>Parks, Cemeteries</u>	5	.10	.10	.35	.60
<u>Playgrounds</u>	10	.15	.25	.35	.65
<u>Schools</u>	50	.45	.50	.60	.70
<u>Railroad Yard Areas</u>	15	.40	.45	.50	.60
<u>Undeveloped Areas:</u>					
Historic Flow Analysis, Greenbelts, Agricultural	2	(See "Lawns")			
Off-Site Flow Analysis (when land use not defined)	45	.43	.47	.55	.65

**TABLE 1** (continued)

**RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS**

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY			
		2	5	10	100
<u>Streets:</u>					
Paved	100	.87	.88	.90	.93
Gravel	40	.15	.25	.35	.65
<u>Concrete Drive and Walks</u>	96	.87	.87	.88	.89
<u>Roofs</u>	90	.80	.85	.90	.90
<u>Lawns, Sandy Soil (A and B Soils):</u>	2				
2% Slope		.05	.06	.08	.10
2-7% Slope		.10	.11	.13	.15
>7% Slope		.15	.16	.18	.20
<u>Lawns, Clay Soil (C and D Soils):</u>	5				
2% Slope		.13	.14	.15	.17
2-7% Slope		.18	.19	.20	.22
>7% Slope		.25	.27	.30	.35

NOTE: These Rational Formula coefficients may not be valid for large basins

(\*)See Figures RO-3 through RO-5 of USDCM Volume 1 for percent impervious.

(\*\*)Up to 5 units per acre. Single-family with more than 5 units per acre, use values for multi-unit/detached

**Runoff Coefficients**

Corridor / Design Package: 7-Eleven - Gun Club Road  
 System Name: Developed Condition

Computed: DSI Date: 2/24/2021  
 Checked: KH Date: 2/24/2021

Sub-Basin Data			Composite C			Sub Area (Pavement)				Sub Area (Roof)				Sub Area(Lawns B Group soils)			
Basin ID	Description	Total Area (ac)	C <sub>2</sub>	C <sub>100</sub>	i	C <sub>2</sub>	C <sub>100</sub>	i	Area (ac)	C <sub>2</sub>	C <sub>100</sub>	i	Area (ac)	C <sub>2</sub>	C <sub>100</sub>	i	Area (ac)
P1	PARKING, SIDEWALK	0.10	0.87	0.93	100.00	0.87	0.93	100	0.100	0.80	0.90	96	0.000	0.10	0.15	2	0.000
P2	HARDSCAPE, LANDSCAPING	0.56	0.76	0.82	86.00	0.87	0.93	100	0.480	0.80	0.90	96	0.000	0.10	0.15	2	0.080
P3	C-STORE BUILDING	0.09	0.80	0.90	96.00	0.87	0.93	100	0.000	0.80	0.90	96	0.090	0.10	0.15	2	0.000
P4	6MPD FUEL CANOPY	0.07	0.80	0.90	96.00	0.87	0.93	100	0.000	0.80	0.90	96	0.070	0.10	0.15	2	0.000
P5	CAR WASH, DRIVE, LANDSCAPING	0.17	0.53	0.60	58.47	0.87	0.93	100	0.050	0.80	0.90	96	0.050	0.10	0.15	2	0.070
P6	LANDSCAPING	0.10	0.10	0.15	2.00	0.87	0.93	100	0.000	0.80	0.90	96	0.000	0.10	0.15	2	0.100
P7	LANDSCAPING, SIDEWALK	0.19	0.18	0.23	12.32	0.87	0.93	100	0.020	0.80	0.90	96	0.000	0.10	0.15	2	0.170
	<i>On-site Composite</i>	1.28	0.61	0.67	67.19	0.87	0.93	100	0.650	0.80	0.90	96	0.21	0.10	0.15	2	0.420

Standard Form SF-1 . Time of Concentration

Corridor / Design Package: 7-Eleven - Gun Club Road  
 System Name: Developed Condition

Computed: DSI Date: 2/24/2021  
 Checked: MK Date: 2/24/2021

SUB-BASIN DATA				INITIAL/OVERLAND FLOW (t <sub>i</sub> )			TRAVEL TIME (t <sub>t</sub> ) Type of Land Surface							Total t <sub>c</sub> = t <sub>i</sub> + t <sub>t</sub> (min)	Tc CHECK (Urbanized basins)			FINAL Tc (min)	
Basin ID	Description	C <sub>s</sub>	Area (ac)	Length (ft)	Slope (ft/ft)	t <sub>i</sub> (min)	Length (ft)	Slope (ft/ft)	Code	Description	Convey Coef (C <sub>w</sub> )	V	t <sub>t</sub> (min)		Urban (Yes/No)	Length (ft)	T <sub>c</sub> max (min)		T <sub>c</sub> max > t <sub>c</sub>
P1	PARKING, SIDEWALK	0.87	0.10	25	0.021	1.6	47.5	0.025	6	Areas and shallow paved sv	20	3.162	0.25	1.88	Yes	73	0.40	Regional Tc	5.00
P2	HARDSCAPE, LANDSCAPING	0.76	0.56	45	0.02	3.3	211.0	0.023	6	Areas and shallow paved sv	20	3.033	1.16	4.44	Yes	256	1.42	Regional Tc	5.00
P3	C-STORE BUILDING	0.80	0.09	25	0.02	2.2	0.0	0	6	Areas and shallow paved sv	20	0	0.00	2.15	Yes	25	0.14	Regional Tc	5.00
P4	6MPD FUEL CANOPY	0.80	0.07	18.3	0.02	1.8	0.0	0	6	Areas and shallow paved sv	20	0	0.00	1.84	Yes	18	0.10	Regional Tc	5.00
P5	CAR WASH, DRIVE, LANDSCAPING	0.53	0.17	25	0.02	4.1	99.2	0.035	6	Areas and shallow paved sv	20	3.742	0.44	4.52	Yes	124	0.69	Regional Tc	5.00
P6	LANDSCAPING	0.10	0.10	25	0.235	3.2	5.0	0.25	3	Short pasture and lawns	7	3.5	0.02	3.21	Yes	30	0.17	Regional Tc	5.00
P7	LANDSCAPING, SIDEWALK	0.18	0.19	25	0.045	5.1	9.2	0.045	3	Short pasture and lawns	7	1.485	0.10	5.15	Yes	34	0.19	Regional Tc	5.15

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Corridor / Design Package: 7-Eleven - Gun Club Road  
 System Name: Developed Condition

Computed: DSI Date: 2/24/2021  
 Checked: MK Date: 2/24/2021

Design Storm: Proposed 2-yr P = 0.98 in

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME		REMARKS		
		AREA DESIGN	AREA (AC)	RUNOFF COEFF	$t_c$ (MIN)	C.A. (AC)	IN / HR	Q (CFS)	$t_c$ (MIN)	SUM (C*A)(AC)	IN / HR	Q (CFS)	SLOPE(%)	STREETFLOW (C)	DESIGNFLOW (C)	SLOPE(%)	PIPE SIZE(IN)	LENGTH(FT)	VELOCITY(FPS)		$t_t$ (MIN)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
P1	PARKING, SIDEWALK	1	P1	0.10	0.87	5.00	0.087	3.32	0.29					1	1	1	1	1	1	1	1	
P2	HARDSCAPE, LANDSCAPING	2	P2	0.56	0.76	5.00	0.426	3.32	1.41					1	1	1	1	1	1	1	1	
P3	C-STORE BUILDING	3	P3	0.09	0.80	5.00	0.072	3.32	0.24					1	1	1	1	1	1	1	1	
P4	6MPD FUEL CANOPY	4	P4	0.07	0.80	5.00	0.056	3.32	0.19					1	1	1	1	1	1	1	1	
P5	CAR WASH, DRIVE, LANDSCAPING	5	P5	0.17	0.53	5.00	0.091	3.32	0.30					1	1	1	1	1	1	1	1	
P6	LANDSCAPING	6	P6	0.10	0.10	5.00	0.010	3.32	0.033					1	1	1	1	1	1	1	1	
P7	LANDSCAPING, SIDEWALK	7	P7	0.19	0.18	5.15	0.034	3.30	0.11					1	1	1	1	1	1	1	1	

Design Storm: Proposed 100-yr P = 2.67 in

LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME		REMARKS		
		AREA DESIGN	AREA (AC)	RUNOFF COEFF	$t_c$ (MIN)	C.A. (AC)	IN / HR	Q (CFS)	$t_c$ (MIN)	SUM (C*A)(AC)	IN / HR	Q (CFS)	SLOPE(%)	STREETFLOW (C)	DESIGNFLOW (C)	SLOPE(%)	PIPE SIZE(IN)	LENGTH(FT)	VELOCITY(FPS)		$t_t$ (MIN)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
P1	PARKING, SIDEWALK	1	P1	0.10	0.93	5.00	0.09	9.06	0.84					1	1	1	1	1	1	1	1	
P2	HARDSCAPE, LANDSCAPING	2	P2	0.56	0.82	5.00	0.46	9.06	4.15					1	1	1	1	1	1	1	1	
P3	C-STORE BUILDING	3	P3	0.09	0.90	5.00	0.08	9.06	0.73					1	1	1	1	1	1	1	1	
P4	6MPD FUEL CANOPY	4	P4	0.07	0.90	5.00	0.06	9.06	0.57					1	1	1	1	1	1	1	1	
P5	CAR WASH, DRIVE, LANDSCAPING	5	P5	0.17	0.60	5.00	0.10	9.06	0.92					1	1	1	1	1	1	1	1	
P6	LANDSCAPING	6	P6	0.10	0.15	5.00	0.02	9.06	0.14					1	1	1	1	1	1	1	1	
P7	LANDSCAPING, SIDEWALK	7	P7	0.19	0.23	5.15	0.04	8.98	0.40					1	1	1	1	1	1	1	1	

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

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

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

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

Impervious Comparison						
Existing			Proposed			
	Area	Impervious		Area	Impervious	
A3	2.61	92.1%	Lot 1	1.28	67.2%	
			Lot 2	1.03	95.0%	
			A3 - Landscaping	0.102	5.0%	
			A3 - Hardscape	0.35	100.0%	
			Total	2.76	79.4%	

## Appendix C – Hydraulic Computations

**INLET MANAGEMENT**

Worksheet Protected

<b>INLET NAME</b>	DP1
Site Type (Urban or Rural)	URBAN
Inlet Application (Street or Area)	STREET
Hydraulic Condition	In Sump
Inlet Type	CDOT Type R Curb Opening

**USER-DEFINED INPUT**

<b>User-Defined Design Flows</b>	
Minor $Q_{\text{known}}$ (cfs)	0.3
Major $Q_{\text{known}}$ (cfs)	0.8
<b>Bypass (Carry-Over) Flow from Upstream</b>	
Receive Bypass Flow from:	No Bypass Flow Received
Minor Bypass Flow Received, $Q_b$ (cfs)	0.0
Major Bypass Flow Received, $Q_b$ (cfs)	0.0
<b>Watershed Characteristics</b>	
Subcatchment Area (acres)	
Percent Impervious	
NRCS Soil Type	
<b>Watershed Profile</b>	
Overland Slope (ft/ft)	
Overland Length (ft)	
Channel Slope (ft/ft)	
Channel Length (ft)	
<b>Minor Storm Rainfall Input</b>	
Design Storm Return Period, $T_r$ (years)	
One-Hour Precipitation, $P_1$ (inches)	
<b>Major Storm Rainfall Input</b>	
Design Storm Return Period, $T_r$ (years)	
One-Hour Precipitation, $P_1$ (inches)	

**CALCULATED OUTPUT**

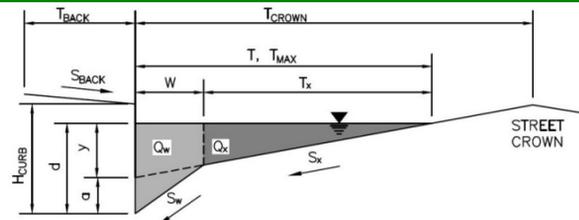
<b>Minor Total Design Peak Flow, Q (cfs)</b>	<b>0.3</b>
<b>Major Total Design Peak Flow, Q (cfs)</b>	<b>0.8</b>
Minor Flow Bypassed Downstream, $Q_b$ (cfs)	N/A
Major Flow Bypassed Downstream, $Q_b$ (cfs)	N/A
<b>Minor Storm (Calculated) Analysis of Flow Time</b>	
C	N/A
$C_5$	N/A
Overland Flow Velocity, $V_i$	N/A
Channel Flow Velocity, $V_t$	N/A
Overland Flow Time, $T_i$	N/A
Channel Travel Time, $T_t$	N/A
Calculated Time of Concentration, $T_c$	N/A
Regional $T_c$	N/A
Recommended $T_c$	N/A
$T_c$ selected by User	N/A
Design Rainfall Intensity, I	N/A
Calculated Local Peak Flow, $Q_p$	N/A
<b>Major Storm (Calculated) Analysis of Flow Time</b>	
C	N/A
$C_5$	N/A
Overland Flow Velocity, $V_i$	N/A
Channel Flow Velocity, $V_t$	N/A
Overland Flow Time, $T_i$	N/A
Channel Travel Time, $T_t$	N/A
Calculated Time of Concentration, $T_c$	N/A
Regional $T_c$	N/A
Recommended $T_c$	N/A
$T_c$ selected by User	N/A
Design Rainfall Intensity, I	N/A
Calculated Local Peak Flow, $Q_p$	N/A

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

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

Project: Enter Your Project Name Here

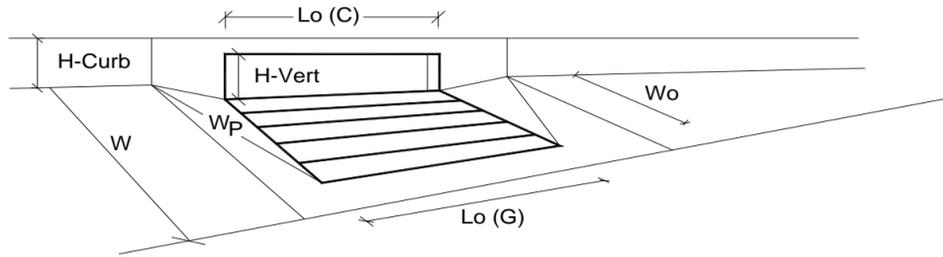
Inlet ID: DP1



<b>Gutter Geometry (Enter data in the blue cells)</b>							
Maximum Allowable Width for Spread Behind Curb	T <sub>BACK</sub> = <span style="border: 1px solid blue; padding: 2px;">0.5</span> ft						
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S <sub>BACK</sub> = <span style="border: 1px solid blue; padding: 2px;"></span> ft/ft						
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n <sub>BACK</sub> = <span style="border: 1px solid blue; padding: 2px;">0.020</span>						
Height of Curb at Gutter Flow Line	H <sub>CURB</sub> = <span style="border: 1px solid blue; padding: 2px;">6.00</span> inches						
Distance from Curb Face to Street Crown	T <sub>CROWN</sub> = <span style="border: 1px solid blue; padding: 2px;">19.0</span> ft						
Gutter Width	W = <span style="border: 1px solid blue; padding: 2px;">1.00</span> ft						
Street Transverse Slope	S <sub>x</sub> = <span style="border: 1px solid blue; padding: 2px;">0.020</span> ft/ft						
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S <sub>w</sub> = <span style="border: 1px solid blue; padding: 2px;">0.083</span> ft/ft						
Street Longitudinal Slope - Enter 0 for sump condition	S <sub>o</sub> = <span style="border: 1px solid blue; padding: 2px;">0.000</span> ft/ft						
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n <sub>STREET</sub> = <span style="border: 1px solid blue; padding: 2px;">0.012</span>						
Max. Allowable Spread for Minor & Major Storm	<table border="1" style="margin: auto;"> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;"></th> </tr> <tr> <td style="border: 1px solid blue; text-align: center;">19.0</td> <td style="border: 1px solid blue; text-align: center;">19.0</td> <td style="padding: 2px;">ft</td> </tr> </table>	Minor Storm	Major Storm		19.0	19.0	ft
Minor Storm	Major Storm						
19.0	19.0	ft					
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	<table border="1" style="margin: auto;"> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;"></th> </tr> <tr> <td style="border: 1px solid blue; text-align: center;">6.0</td> <td style="border: 1px solid blue; text-align: center;">6.0</td> <td style="padding: 2px;">inches</td> </tr> </table>	Minor Storm	Major Storm		6.0	6.0	inches
Minor Storm	Major Storm						
6.0	6.0	inches					
Check boxes are not applicable in SUMP conditions	<table border="1" style="margin: auto;"> <tr> <td style="padding: 2px;"><input type="checkbox"/></td> <td style="padding: 2px;"><input type="checkbox"/></td> </tr> </table>	<input type="checkbox"/>	<input type="checkbox"/>				
<input type="checkbox"/>	<input type="checkbox"/>						
<b>MINOR STORM Allowable Capacity is based on Depth Criterion</b>							
<b>MAJOR STORM Allowable Capacity is based on Depth Criterion</b>							
	<table border="1" style="margin: auto;"> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;"></th> </tr> <tr> <td style="border: 1px solid green; text-align: center;">SUMP</td> <td style="border: 1px solid green; text-align: center;">SUMP</td> <td style="padding: 2px;">cfs</td> </tr> </table>	Minor Storm	Major Storm		SUMP	SUMP	cfs
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)	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	1	1	
Water Depth at Flowline (outside of local depression)	5.3	5.3	inches
<b>Grate Information</b>			
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>			
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)	1.00	1.00	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>			
Depth for Grate Midwidth	N/A	N/A	ft
Depth for Curb Opening Weir Equation	0.36	0.36	ft
Combination Inlet Performance Reduction Factor for Long Inlets	0.68	0.68	
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>			
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	4.8	4.8	cfs
Q PEAK REQUIRED	0.3	0.8	cfs

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## 18" RCP

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### Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

### Input Data

Roughness Coefficient	0.013
Channel Slope	1.00 %
Diameter	18.00 in
Discharge	0.75 ft <sup>3</sup> /s

### Results

Normal Depth	0.27 ft
Flow Area	0.22 ft <sup>2</sup>
Wetted Perimeter	1.32 ft
Hydraulic Radius	0.17 ft
Top Width	1.15 ft
Critical Depth	0.32 ft
Percent Full	18.1 %
Critical Slope	0.00501 ft/ft
Velocity	3.44 ft/s
Velocity Head	0.18 ft
Specific Energy	0.46 ft
Froude Number	1.40
Maximum Discharge	11.30 ft <sup>3</sup> /s
Discharge Full	10.50 ft <sup>3</sup> /s
Slope Full	0.00005 ft/ft
Flow Type	SuperCritical

### GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

### GVF Output Data

Upstream Depth	0.00 ft
Profile Description	
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.00 %
Normal Depth Over Rise	18.09 %
Downstream Velocity	Infinity ft/s

## Appendix D – Drainage Plans

