Phase III Drainage Report

For:

Park Meadows – Mixed Use Development

8401 Park Meadows Center Dr, Lone Tree, CO 80124

Prepared: 11/07/2022
Revised: 03/20/2023

For:

Park Meadows Mall, LLC/ Park Meadows Anchor Acquisition
8401 Pak Meadows Center Drive
Lone Tree, CO 80124

By:

1120 Lincoln Street, Suite 1000
Denver, CO 80203
303-623-6300
HKS Project No.220407
Mark A. West, P.E., C.F.M.

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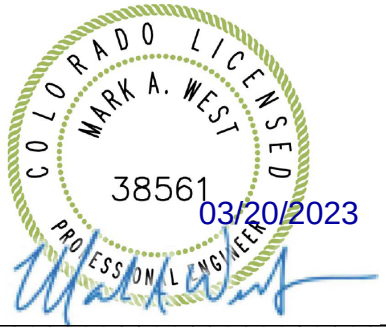
CERTIFICATION

I hereby affirm that this Phase III Drainage Report for Park Meadows – Mixed Use Development was prepared under my direct supervision in accordance with the provisions of the City of Lone Tree Storm Drainage Criteria for the owners thereof. I understand that the City of Lone Tree does not and will not assume liability for drainage facilities designed by others.



Mark A. West, P.E., C.F.M.
State of Colorado License No. 38561
On Behalf of Harris Kocher Smith

I. INTRODUCTION

A. SITE LOCATION

The Park Meadows – Mixed Use Development (Project) lies within Lot 4-A and Lot 21, of the Park Meadows Town Center Filing 1-A, 1st Amendment. The Project is situated in Section 3, Township 6 South, Range 67 West of the 6th Principal Meridian, Douglas County, Colorado. A Vicinity Map is located in Appendix A of this report.

The Project is bounded East County Line Road to the north, South Yosemite Street to the west, State Route 470 to the south, and by Highway 25 to the east. The Park Meadows Mall adjoins many other properties belonging to hotels, restaurants, and retail stores.

B. SITE DESCRIPTION

The Park Meadows – Mixed Use Development currently consists of approximately 10.22 acres of existing parking lot. The parking lot has slopes of 1 – 4%, with existing storm sewers generally draining southward, toward detention basin A.

The total area to be developed and total disturbed area is approximately 13.06-acres. There are no known irrigation facilities on, adjacent to, or otherwise impacting the Project. The Project site generally slopes to the southeast. According to the Natural Resources Conservation Service (NRCS) – Web Soil Survey, the underlying soils are primarily RmE Renohill-Buick complex which are classified as Hydrologic Group C/D (see Appendix A).

The site lies within Flood Insurance Rate Map (FIRM) Community Panel Numbers 08035C0034G (effective 3/16/2016), 08035C0053G (effective 2/17/2017), and C8035CC0061H. As shown on these maps in Appendix A, the Site/Project does not lie within a FEMA designated floodplain.

C. PROPOSED PROJECT DESCRIPTION

The Project will be developed as multi-family residential housing, retail, and structured parking in three main buildings. The proposed development will include several courtyards and numerous vehicle and pedestrian access pathways. Runoff will be conveyed by a series of proposed inlets and storm sewer to the existing storm outfall in the area. Detention Basin A, an existing detention system located south of the site, will manage and treat flows before discharging to the public system.

D. FLOOD HAZARD AND DRAINAGE STUDIES RELEVANT TO THE SITE

The project area has previously been investigated in drainage reports for the original mall development and a subsequent expansion of the mall to the south. Reports are listed below:

- Phase III Drainage Report for Park Meadows by Paller-Roberts Engineering, revised in April 1995.
- Drainage Report for Park Meadows Mall Expansion, Douglas County, Colorado by National Survey and Engineering as revised November 2006.

As previously noted, this Project is not included in any FEMA designated floodplain. Relevant pages from previous studies are included in Appendix F.

II. HISTORIC DRAINAGE SYSTEM

A. MAJOR BASIN DESCRIPTION

The 1995 Phase III Drainage Report for Park Meadows delineates major drainage basins within the development. This proposed Project lies within Drainage Area "A", which per the existing drainage report encompasses the southeastern portion of the mall site along with development parcels south of Park Meadows Center Drive, and the Park Meadows Drive roadway itself. This area contains a total of 85.0-acres. Storm line "AA" collects runoff from the development area and conveys to Detention Basin "A".

The 2006 mall addition expanded the mall southward. To provide water quality, the developer modified Detention Basin "A" located south of Park Meadows Center Drive by adding a paved forebay, a trickle channel, a micropool, and a water quality outlet structure. Relevant pages from previous studies are included in Appendix F.

The proposed Project lies within the Willow Creek Watershed as outlined in the *Willow Creek, Little Dry Creek, and Greenwood Gulch Outfall Systems Planning Study* prepared by CH2MHILL, dated February, 2010. Flows from Detention Pond A discharge via an existing 24" RCP southwest to an existing inlet and pipe along E-470. Flows then discharge south and west where they ultimately enter Willow Creek.

III. PROPOSED DRAINAGE SYSTEM

A. CRITERIA

The basis for design and analysis of the drainage system and drainage impacts for the Project are the Douglas County Storm Drainage Design and Technical Criteria Manual (Criteria), most recent updates; and the *Urban Storm Drainage Criteria Manuals* (Mile High Flood District, formerly known as Urban Drainage and Flood Control District), Volumes 1, 2 and 3.

The total area of the Project to be developed is 10.22 acres. The Rational Method is appropriate and was used to calculate peak rates of stormwater runoff. The design storms analyzed for this Project are the 5-year and 100-year for the initial and major storms, respectively. The rainfall intensities of these storms were determined through use of the Douglas County Storm Drainage Design and Technical Criteria Manual.

Results of hydrologic and hydraulic analysis are included within the appendix of this report.

B. RUNOFF

The proposed Project area is broken into six sub-basins with the prefix “R” and ten basins with the prefix “S”. Individual sub-basins are described in more detail below.

Subbasin R1 (1.08-acres) is located on the rooftop of the proposed northernmost building. It consists of rooftop surfaces. Runoff from this subbasin will drain through downspouts and tie to the proposed storm sewer system routed to Detention Basin “A”.

Subbasin R2 (0.22-acres) is located on the rooftop of the proposed northernmost building. It consists of rooftop surfaces. Runoff from this subbasin will flow through downspouts and tie into the proposed storm sewer system routed to Detention Basin “A”.

Subbasin R3 (1.33-acres) is located on the north half of the rooftop of the proposed central building. It consists of rooftop surfaces. Runoff from this subbasin will flow through downspouts and tie into the proposed storm sewer system routed to Detention Basin “A”.

Subbasin R4 (1.81-acres) is located on the south half of the rooftop of the proposed central building. It consists of rooftop surfaces. Runoff from this

subbasin will flow through downspouts and tie into the proposed storm sewer system routed to Detention Basin “A”.

Subbasin R5 (0.68-acres) is located on the rooftop of the proposed southernmost building. It consists of rooftop surfaces. Runoff from this subbasin will flow through downspouts and tie into the proposed storm sewer system routed to Detention Basin “A”.

Subbasin S1 (0.27-acres) is located on the street between the north and central buildings. It consists of asphalt, concrete, and grass surfaces. Runoff from this subbasin will flow through the proposed storm sewer system routed to Detention Basin “A”.

Subbasin S2 (0.32-acres) is located on the street between the north and central buildings. It consists of asphalt, concrete, and grass surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

Subbasin S3 (0.60-acres) is located on the street at the northwest corner of the central building. It consists of asphalt, concrete, and grass surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

Subbasin S4 (0.58-acres) is located west of the northernmost building. It consists of only concrete surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

Subbasin S5 (0.54-acres) is located west of the northwest corner of the central building. It consists of only concrete surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

Subbasin S6 (0.60-acres) is located west of the central parking garage. It consists of only concrete surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

Subbasin S7 (0.45-acres) is located just south of the central parking garage. It consists of asphalt, concrete, and grass surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

Subbasin S8 (0.82-acres) is located just north of the southernmost building. It consists of asphalt, concrete, and grass surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

Subbasin S9 (0.30-acres) is located south of the southernmost building. It consists of asphalt, concrete, and grass surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

Subbasin S10 (0.18-acres) is located on the edge of the site. It consists of asphalt, concrete, and grass surfaces. Runoff from this subbasin will flow through the proposed storm system routed to Detention Basin “A”.

C. WATER QUALITY & DETENTION

The area of the Project drains through storm lines A and B to the existing Detention Basin A which was designed to provide detention for the 85-acre contributing area. To accommodate the Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV), it is proposed that the outlet structure to Detention Basin “A” be replaced to update the structure and provide the required WQCV and EURV. The update will involve providing the WQCV and EURV for the entire 85-acre area contributing to the pond. A plan sheet detailing the revised outlet structure is included with the construction plans, and calculations for the revision utilizing the MHFD-Detention workbook are included in the appendix.

D. STREETS

Although the proposed Site has private drives and surface parking, no public streets are to be constructed internal to the Site. Inlets are proposed to intercept runoff and connect to pipes to convey the flow to the proposed on-site drainage facilities.

Interception rates at all inlets have been calculated based on MHFD-Inlet (v5.01) spreadsheets; copies of these spreadsheet computations are included in the appendix. The MHFD-Inlet spreadsheet calculation for local depression at a curb inlet assumes a 6-inch curb head. Curb inlets are primarily located where the curb is only 4 inches tall; the 2-inch difference is, by default, put into the local depression. Streets were designed to convey runoff in accordance with criteria for local streets.

E. OPEN CHANNEL FLOW

No open channels are proposed with this project.

F. STORM SEWERS AND CULVERTS

The on-site and off-site storm sewer systems have been designed in accordance with Douglas County’s criteria. Hydraulic grade lines for the minor and major

storms were generated utilizing Bentley StormCAD hydraulic modeling software. Output from the model is included in Appendix C.

IV. CONCLUSIONS

A. IMPACT OF IMPROVEMENTS

All proposed onsite drainage infrastructure shown on the final drainage plan will be designed to convey the major storm event.

B. COMPLIANCE WITH APPLICABLE CRITERIA

All drainage infrastructure was designed in accordance with the Douglas County Storm Drainage Design and Technical Criteria Manual and Mile High Flood District Manuals.

V. REFERENCES

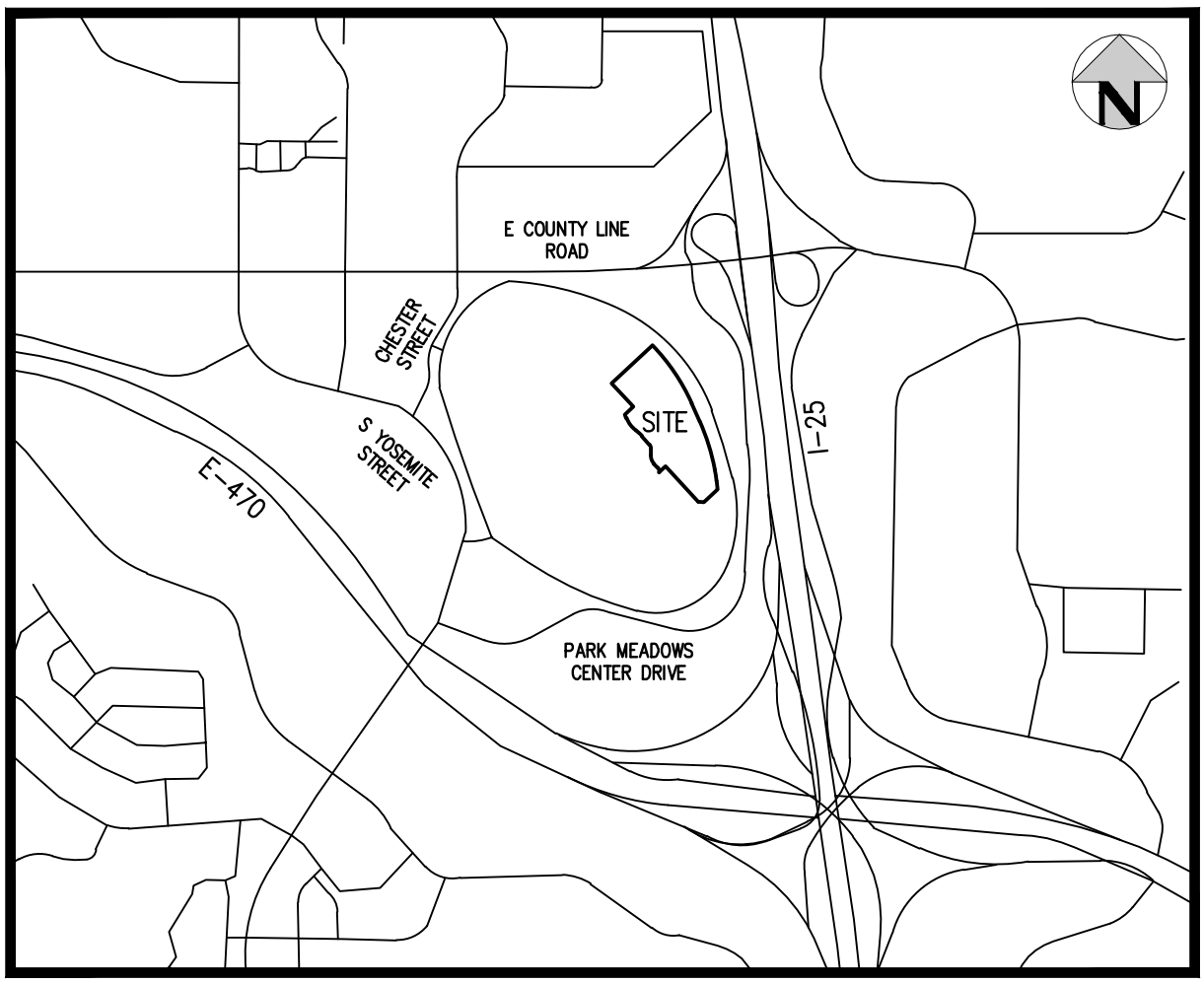
1. Douglas County Storm Drainage Design and Technical Criteria Manual, and Updates.
2. Urban Storm Drainage Criteria Manual (USDCM), Mile High Flood District (MHFD, formerly known as Urban Drainage and Flood Control District, UDFCD) and Updates.
   Volume 1, Management, Hydrology and Hydraulics
   Volume 2, Structures, Storage and Recreation
   Volume 3, Stormwater Quality
3. Phase III Drainage Report for Park Meadows by Paller-Roberts Engineering, revised in April 1995.
4. Drainage Report for Park Meadows Mall Expansion, Douglas County, Colorado by National Survey and Engineering as revised November 2006.
5. Willow Creek, Little Dry Creek, and Greenwood Gulch Outfall Systems Planning Study by CH2MHILL as prepared February 2010.

APPENDIX A

Vicinity Map

NRCS Soils Report

FEMA Map



Vicinity Map

SCALE: 1"=1000'

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

1000 0 1000 2000

SCALE: 1" = 1000'

PROJECT #: 220407

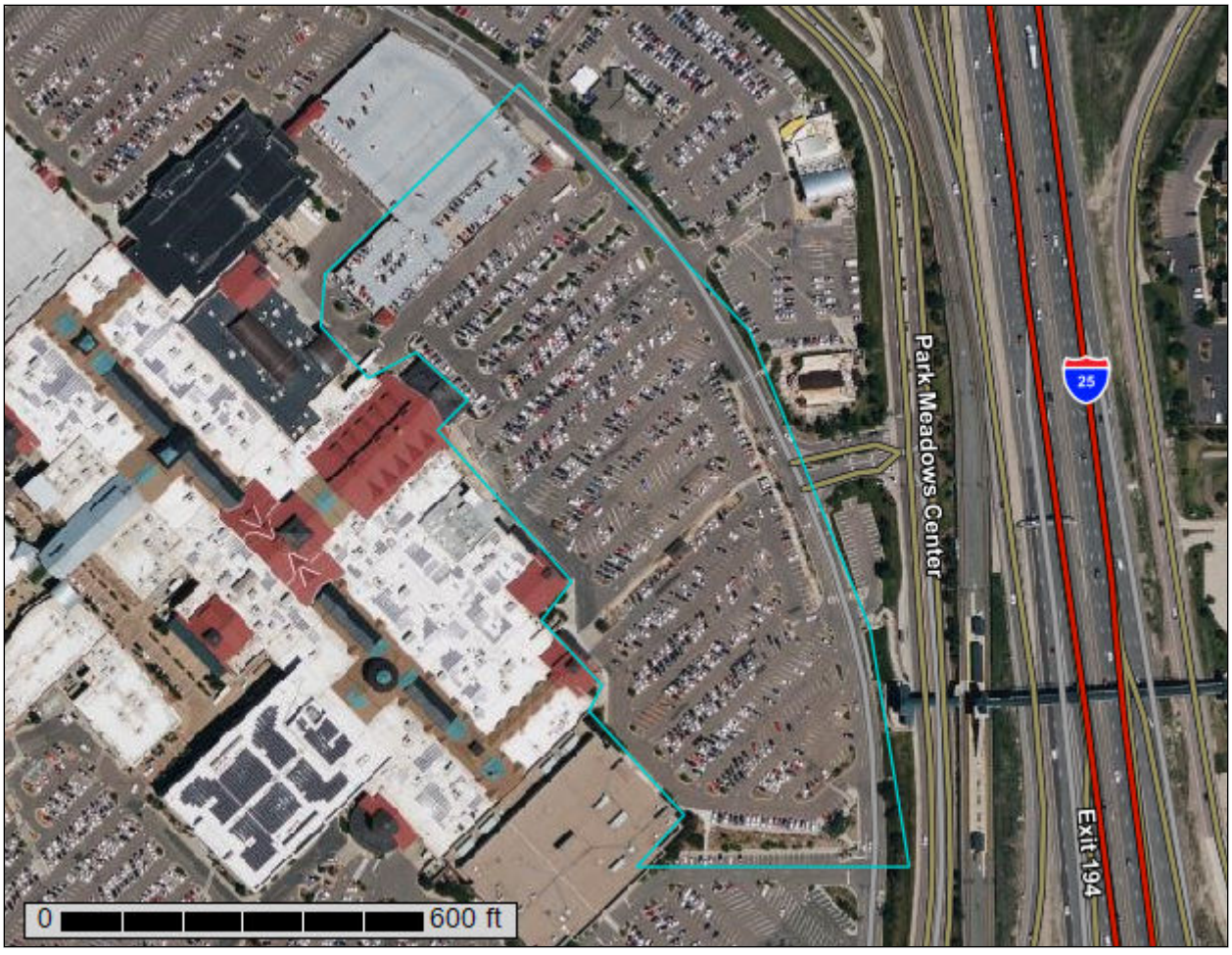
United States Department of Agriculture

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 Castle Rock Area, Colorado



November 7, 2022

Custom Soil Resource Report
Soil Map

Map Scale: 1:2,310 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

Castle Rock Area, Colorado

FoD—Fondis clay loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: jqyp
Elevation: 5,500 to 6,800 feet
Mean annual precipitation: 15 to 19 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 120 to 135 days
Farmland classification: Not prime farmland

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

Landform: Ridges, buttes, mesas
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits over coarse-silty outwash derived from arkose

Typical profile

H1 - 0 to 7 inches: clay loam
H2 - 7 to 24 inches: clay
H3 - 24 to 60 inches: sandy clay loam

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
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 supply, 0 to 60 inches: High (about 9.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R049XB208CO - Clayey Foothill
Hydric soil rating: No

Minor Components

Kutch

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

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

Denver
Percent of map unit: 4 percent
Hydric soil rating: No

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

RmE—Renohill-Buick complex, 5 to 25 percent slopes

Map Unit Setting
National map unit symbol: jqzy
Elevation: 5,500 to 6,200 feet
Mean annual precipitation: 15 to 17 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 120 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition
Renohill and similar soils: 50 percent
Buick and similar soils: 30 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Renohill

Setting
Landform: Hills
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Weathered, calcareous clayey shale

Typical profile
H1 - 0 to 3 inches: clay loam
H2 - 3 to 12 inches: clay loam
H3 - 12 to 24 inches: clay loam
H4 - 24 to 28 inches: unweathered bedrock

Properties and qualities
Slope: 5 to 25 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: High
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 supply, 0 to 60 inches: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R049XC202CO - Loamy Foothill 14-19 PZ
Hydric soil rating: No

Description of Buick

Setting

Landform: Hills
Landform position (three-dimensional): Base slope, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits over silty alluvium

Typical profile

H1 - 0 to 4 inches: loam
H2 - 4 to 15 inches: silty clay loam
H3 - 15 to 22 inches: loam
H4 - 22 to 60 inches: sandy clay loam

Properties and qualities

Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 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 supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R049XC202CO - Loamy Foothill 14-19 PZ
Hydric soil rating: No

Minor Components

Manzanola

Percent of map unit: 6 percent
Hydric soil rating: No

Satanta

Percent of map unit: 6 percent

Hydric soil rating: No

Fondis

Percent of map unit: 6 percent
Hydric soil rating: No

Aquic haplustolls

Percent of map unit: 2 percent
Landform: Swales
Hydric soil rating: Yes

National Flood Hazard Layer FIRMette

FEMA

104°52'54"W 39°34'1"N

104°52'16"W 39°33'33"N

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/7/2022 at 1:30 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

APPENDIX B

Hydrologic Calculations

IMPERVIOUSNESS AND RUNOFF COEFFICIENTS CALCULATIONS, PROPOSED DEVELOPMENT

CALC'D BY: AML
DATE: 11/07/22
NRCS Hydrologic Soil Group: C

PROJECT: Park Meadows
PROJ. NO: 220407

LAND USE TYPES (per MHFD Table 6-3):

STREETS		ROOFS, DRIVES, PARKING, WALKS		LAWN, CLAY OR SANDY SOIL	
% Imp =	100%	% Imp =	90%	% Imp =	2%

		ACRES					RUNOFF COEFFICIENTS PER MHFD USDCM TABLE 6-4		
SUB-BASIN	Areas	STREETS	ROOFS, DRIVES, PARKING, WALKS	LAWN, CLAY OR SANDY SOIL	% Imperv.	Imperv. Acres	C_5=	C_{100}=	C_{500}=
S1	0.28				85.00%	0.24	0.73	0.83	0.81
S2	0.32				85.00%	0.27	0.73	0.83	0.81
S3	0.60				85.00%	0.51	0.73	0.83	0.81
S4	0.58				85.00%	0.49	0.73	0.83	0.81
S5	0.54				85.00%	0.46	0.73	0.83	0.81
S6	0.60				85.00%	0.51	0.73	0.83	0.81
S7	0.45				85.00%	0.38	0.73	0.83	0.81
S8	0.82				85.00%	0.70	0.73	0.83	0.81
S9	0.30				85.00%	0.26	0.73	0.83	0.81
S10	0.18				85.00%	0.15	0.73	0.83	0.81
R1	1.08				90.00%	0.97	0.77	0.85	0.82
R2	0.22				90.00%	0.20	0.77	0.85	0.82
R3	1.33				90.00%	1.20	0.77	0.85	0.82
R4	1.81				90.00%	1.63	0.77	0.85	0.82
R5	0.68				90.00%	0.61	0.77	0.85	0.82
L1	0.20				85.00%	0.17	0.73	0.83	0.81
L2	0.16				85.00%	0.14	0.73	0.83	0.81
L3	0.09				85.00%	0.08	0.73	0.83	0.81
X1	0.54				85.00%	0.46	0.73	0.83	0.81
X2	0.09				85.00%	0.08	0.73	0.83	0.81
X3	0.05				85.00%	0.04	0.73	0.83	0.81
X4	0.05				85.00%	0.04	0.73	0.83	0.81
OS1	0.19				90.00%	0.17	0.77	0.85	0.82
OS2	0.18				90.00%	0.16	0.77	0.85	0.82
OS3	0.17				90.00%	0.15	0.77	0.85	0.82
OS4	0.40				90.00%	0.36	0.77	0.85	0.82
OS5	0.82				90.00%	0.74	0.77	0.85	0.82
OS6	1.23				90.00%	1.11	0.77	0.85	0.82

MHFD criteria per August 2018 USDCM Vol. 1, check website for updates:

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group	Storm Return Period						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.88i^{1.124}$	$C_A = 0.85i+0.025$	$C_A = 0.78i+0.110$	$C_A = 0.65i+0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i+0.057$	$C_B = 0.63i+0.249$	$C_B = 0.56i+0.328$	$C_B = 0.47i+0.426$	$C_B = 0.37i+0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i+0.035$	$C_{C/D} = 0.74i+0.132$	$C_{C/D} = 0.56i+0.319$	$C_{C/D} = 0.49i+0.393$	$C_{C/D} = 0.41i+0.484$	$C_{C/D} = 0.32i+0.588$

Where:

i = % imperviousness (expressed as a decimal)

C_A = Runoff coefficient for Natural Resources Conservation Service (NRCS) HSG A soils

C_B = Runoff coefficient for NRCS HSG B soils

$C_{C/D}$ = Runoff coefficient for NRCS HSG C and D soils.

CALCULATED BY: AML
CHECKED BY: < >
DATE: 11/7/2022

Standard Form SF-1
Time of Concentration

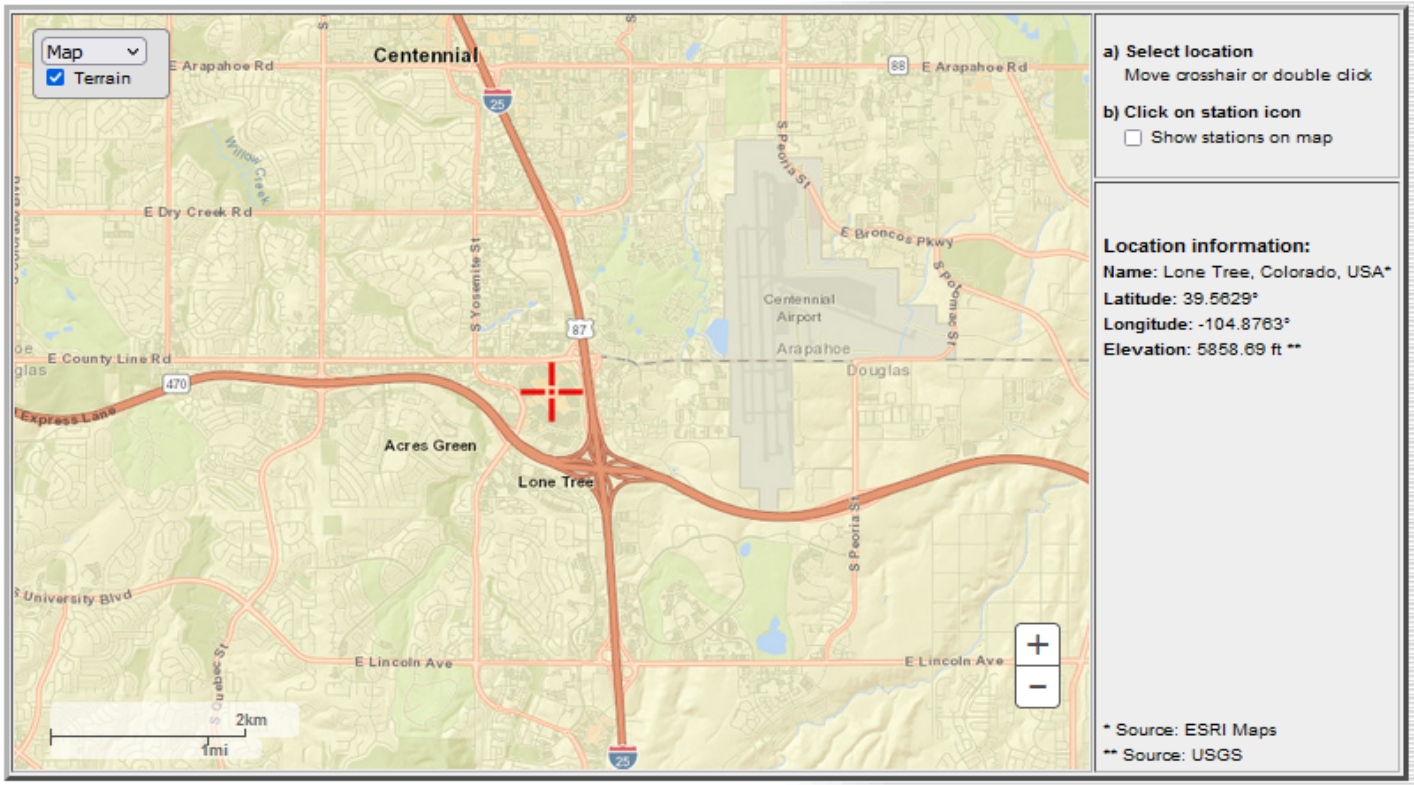
JOB NO: 220407
PROJECT: Park Meadows
REVISED: < >

SUB-BASIN DATA			INITIAL/OVERLAND TIME (T_i)			TRAVEL TIME (T_t)					T_c CHECK (URBANIZED BASINS)				FINAL $5 < T_c < 10$	REMARKS
SUB-BASIN	AREA (AC)	C_5	LENGTH (FT)	SLOPE %	T_i (MIN)	LENGTH (FT)	SLOPE %	K	VELOCITY (FPS)	T_t (MIN)	COMPOS. $T_c = T_i + T_t$ (MIN)	L_t, TOTAL LENGTH	AVG SLOPE	$T_c = \frac{L_t}{(26-17i)+60(14i+9)\sqrt{S_t}}$	(MIN)	
S1	0.28	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S2	0.32	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S3	0.60	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S4	0.58	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S5	0.54	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S6	0.60	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S7	0.45	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S8	0.82	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S9	0.30	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
S10	0.18	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
R1	1.08	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
R2	0.22	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
R3	1.33	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
R4	1.81	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
R5	0.68	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
L1	0.20	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
L2	0.16	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
L3	0.09	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
X1	0.54	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
X2	0.09	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
X3	0.05	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
X4	0.05	0.73	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
OS1	0.19	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
OS2	0.18	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
OS3	0.17	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
OS4	0.40	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
OS5	0.82	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed
OS6	1.23	0.77	-	-	-	-	-	-	-	-	-	-	-	-	5.0	Minimum Tc Assumed

1-HR Rainfall

Site Specific (NOAA Atlas 14 PPF Estimates)			Douglas County Criteria	
Return Interval (YR)	1-hour Rainfall		Return Interval (YR	1-hour Rainfall
WQ	0.60	(WQ per MHFD USDCM Vol 3, p 1-9 [29 of 577])	WQ	0.60
1	0.694		1	unknown
2	0.842		2	1.060
5	1.10		5	1.43
10	1.34		10	1.66
25	1.69		25	unknown
50	1.98		50	2.26
100	2.29		100	2.60
500	3.10		500	unknown

https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=co



CALCULATED BY: AML
DATE: 11/7/2022
CHECKED BY: < >
PROJECT MANAGER: LE

Standard Form SF-2 (modified)
Storm Drainage System Design
(Rational Method Procedure)
Proposed Development

JOB NO: 220407
PROJECT: Park Meadows
DESIGN STORM: 5 YR

SUB-BASIN(s)	DESIGN POINT (DP)	DIRECT RUNOFF						TOTAL RUNOFF				STREET (approx, compare to Inlet calcs)			INLET		PIPE (for preliminary pipe design and travel time)						
		AREA (AC)	RUNOFF COEFF	T_c (min)	C x A (AC)	I (IN/HR)	Q (CFS)	T_c (MIN)	Σ(C x A) (AC)	I (IN/HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	CAPACITY: 1/2 STREET (TO LESSER OF FACE OF WALK OR CROWN), ALLEY (FULL SECTION)	INLET INTERCEPTION (CFS)	BYPASS (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (IN)	QFULL (CFS)	LENGTH (FT)	VELOCITY (FPS)	T_t (min)
L1		0.20	0.73	5.00	0.15	3.73	0.55																
S1		0.28	0.73	5.00	0.20	3.73	0.76																
R1		1.08	0.77	5.00	0.83	3.73	3.11																
S2		0.32	0.73	5.00	0.23	3.73	0.87																
R1 + S2	1							5.0	1.07	3.73	3.99												
L1 + S1 + DP1	2							5.0	1.42	3.73	5.30												
R2		0.22	0.77	5.00	0.17	3.73	0.63																
S4		0.58	0.73	5.00	0.42	3.73	1.58																
R2 + S4	3							5.0	0.59	3.73	2.22												
R3		1.33	0.77	5.00	1.03	3.73	3.84																
S3		0.60	0.73	5.00	0.44	3.73	1.64																
R3 + S3	4							5.0	1.47	3.73	5.47												
DP2 + DP3 + DP4	5							5.0	3.48	3.73	12.99												
OS1		0.19	0.77	5.00	0.15	3.73	0.55																
DP5 + OS1	6							5.0	3.63	3.73	13.54												
OS2		0.18	0.77	5.00	0.14	3.73	0.52																
DP6 + OS2	7							5.0	3.77	3.73	14.06												
OS3		0.17	0.77	5.00	0.13	3.73	0.49																
DP7 + OS3	8							5.0	3.90	3.73	14.55												
S5		0.54	0.73	5.00	0.40	3.73	1.47																
DP8 + S5	9							5.0	4.30	3.73	16.03												
OS4		0.40	0.77	5.00	0.31	3.73	1.15																
DP9 + OS4	10							5.0	4.60	3.73	17.18												
S6		0.60	0.73	5.00	0.44	3.73	1.64																
DP10 + S6	11							5.0	5.04	3.73	18.82												
OS5		0.82	0.77	5.00	0.63	3.73	2.36																
DP11 + OS5	12							5.0	5.68	3.73	21.18												
L2		0.16	0.73	5.00	0.12	3.73	0.44																
R4		1.81	0.77	5.00	1.40	3.73	5.22																

SUB-BASIN(s)	DESIGN POINT (DP)	DIRECT RUNOFF						TOTAL RUNOFF				STREET (approx, compare to Inlet calcs)			INLET		PIPE (for preliminary pipe design and travel time)						
		AREA (AC)	RUNOFF COEFF	T_c (min)	C x A (AC)	I (IN/HR)	Q (CFS)	T_c (MIN)	Σ(C x A) (AC)	I (IN/HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	CAPACITY: 1/2 STREET (TO LESSER OF FACE OF WALK OR CROWN), ALLEY (FULL SECTION)	INLET INTERCEPTION (CFS)	BYPASS (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (IN)	QFULL (CFS)	LENGTH (FT)	VELOCITY (FPS)	T_t (min)
S7		0.45	0.73	5.00	0.33	3.73	1.23																
R4 + S7	13							5.0	1.73	3.73	6.45												
S8		0.82	0.73	5.00	0.60	3.73	2.24																
L2 + DP13 + S8	14							5.0	2.45	3.73	9.13												
DP12 + DP14	15							5.0	8.1	3.73	30.31												
R5		0.68	0.77	5.00	0.53	3.73	1.96																
DP15 + R5	16							5.0	8.6	3.73	32.27												
OS6		1.23	0.77	5.00	0.95	3.73	3.55																
X2		0.09	0.73	5.00	0.07	3.73	0.25																
X3		0.05	0.73	5.00	0.04	3.73	0.14																
OS6 + X2 + X3	17							5.0	1.1	3.73	3.93												
S9		0.30	0.73	5.00	0.22	3.73	0.82																
S10		0.18	0.73	5.00	0.13	3.73	0.49																
DP17 + S9 + S10	18							5.0	1.40	3.73	5.24												
DP16 + DP18	19							5.0	10.1	3.73	37.51												

CALCULATED BY: AML
DATE: 11/7/2022
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PROJECT MANAGER: LE

Standard Form SF-2 (modified)
Storm Drainage System Design
(Rational Method Procedure)
Proposed Development

JOB NO: 220407
PROJECT: Park Meadows
DESIGN STORM: **100** YR

SUB-BASIN(s)	DESIGN POINT (DP)	DIRECT RUNOFF						TOTAL RUNOFF				STREET (approx, compare to Inlet calcs)			INLET		PIPE (for preliminary pipe design and travel time)						
		AREA (AC)	RUNOFF COEFF	T_c (min)	C x A (AC)	I (IN/HR)	Q (CFS)	T_c (MIN)	Σ(C x A) (AC)	I (IN/HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	CAPACITY: 1/2 STREET (TO LESSER OF FACE OF WALK OR CROWN), ALLEY (FULL SECTION) (CFS)	INLET INTERCEPTION (CFS)	BYPASS (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (IN)	QFULL (CFS)	LENGTH (FT)	VELOCITY (FPS)	T_t (min)
L1		0.20	0.83	5.00	0.17	7.77	1.29																
S1		0.28	0.83	5.00	0.23	7.77	1.81																
R1		1.08	0.85	5.00	0.92	7.77	7.16																
S2		0.32	0.83	5.00	0.27	7.77	2.07																
R1 + S2	1							5.0	1.19	7.77	9.22												
L1 + S1 + DP1	2							5.0	1.59	7.77	12.33												
R2		0.22	0.85	5.00	0.19	7.77	1.46																
S4		0.58	0.83	5.00	0.48	7.77	3.75																
R2 + S4	3							5.0	0.67	7.77	5.21												
R3		1.33	0.85	5.00	1.13	7.77	8.81																
S3		0.60	0.83	5.00	0.50	7.77	3.88																
R3 + S3	4							5.0	1.63	7.77	12.69												
DP2 + DP3 + DP4	5							5.0	3.89	7.77	30.23												
OS1		0.19	0.85	5.00	0.16	7.77	1.26																
DP5 + OS1	6							5.0	4.05	7.77	31.49												
OS2		0.18	0.85	5.00	0.15	7.77	1.19																
DP6 + OS2	7							5.0	4.21	7.77	32.68												
OS3		0.17	0.85	5.00	0.15	7.77	1.13																
DP7 + OS3	8							5.0	4.35	7.77	33.81												
S5		0.54	0.83	5.00	0.45	7.77	3.49																
DP8 + S5	9							5.0	4.80	7.77	37.30												
OS4		0.40	0.85	5.00	0.34	7.77	2.65																
DP9 + OS4	10							5.0	5.14	7.77	39.95												
S6		0.60	0.83	5.00	0.50	7.77	3.88																
DP10 + S6	11							5.0	5.64	7.77	43.83												
OS5		0.82	0.85	5.00	0.70	7.77	5.43																
DP11 + OS5	12							5.0	6.34	7.77	49.26												
L2		0.16	0.83	5.00	0.13	7.77	1.03																
R4		1.81	0.85	5.00	1.54	7.77	11.99																
S7		0.45	0.83	5.00	0.37	7.77	2.91																
R4 + S7	13							5.0	1.92	7.77	14.90												
S8		0.82	0.83	5.00	0.68	7.77	5.30																
L2 + DP13 + S8	14							5.0	2.73	7.77	21.24												
DP12 + DP14	15							5.0	9.1	7.77	70.50												
R5		0.68	0.85	5.00	0.58	7.77	4.51																
DP15 + R5	16							5.0	9.7	7.77	75.01												
OS6		1.23	0.85	5.00	1.05	7.77	8.15																

SUB-BASIN(s)	DESIGN POINT (DP)	DIRECT RUNOFF						TOTAL RUNOFF				STREET (approx, compare to Inlet calcs)			INLET		PIPE (for preliminary pipe design and travel time)						
		AREA (AC)	RUNOFF COEFF	T_c (min)	C x A (AC)	I (IN/HR)	Q (CFS)	T_c (MIN)	Σ(C x A) (AC)	I (IN/HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	CAPACITY: 1/2 STREET (TO LESSER OF FACE OF WALK OR CROWN), ALLEY (FULL SECTION) (CFS)	INLET INTERCEPTION (CFS)	BYPASS (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (IN)	QFULL (CFS)	LENGTH (FT)	VELOCITY (FPS)	T_t (min)
X2		0.09	0.83	5.00	0.07	7.77	0.58																
X3		0.05	0.83	5.00	0.04	7.77	0.32																
OS6 + X2 + X3	17							5.0	1.2	7.77	9.05												
S9		0.30	0.83	5.00	0.25	7.77	1.94																
S10		0.18	0.83	5.00	0.15	7.77	1.16																
DP17 + S9 + S10	18							5.0	1.57	7.77	12.16												
DP16 + DP18	19							5.0	11.2	7.77	87.16												

APPENDIX C

Hydraulic Calculations

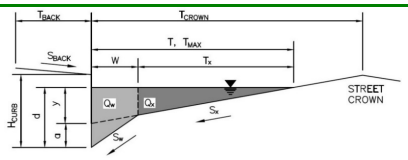
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: Park Meadows Mall Expansion

Inlet ID: S1



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.075		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.5	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

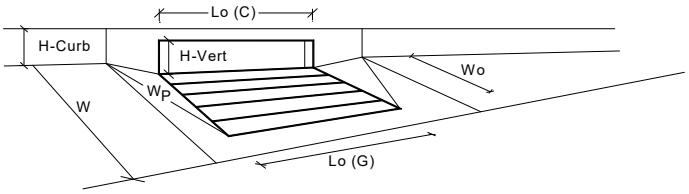
MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)

		MINOR	MAJOR	
Type of Inlet (CDOT/Denver 13 Valley Grate)	Type =	CDOT/Denver 13 Valley Grate		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.4	4.4	inches

Grate Information

		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.43	0.43	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.30	3.30	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	

Curb Opening Information

		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	N/A	N/A	

Low Head Performance Reduction (Calculated)

		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.400	0.400	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.52	0.52	

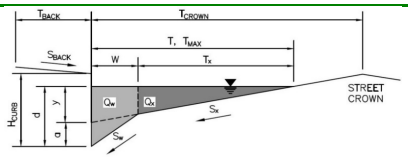
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**1.8**	**1.8**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.8	1.8	cfs

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

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

Project: **Park Meadows Mall Expansion**

Inlet ID: **S2**



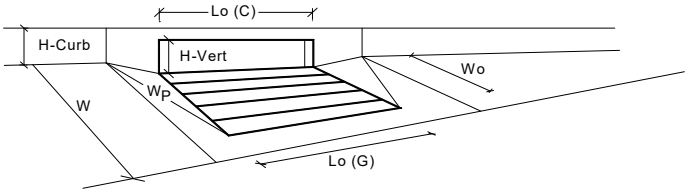
	Gutter Geometry:			
	Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
	Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
	Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.016	
	Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
	Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Warning 1	Gutter Width	W =	2.00	ft
	Street Transverse Slope	S_x =	0.020	ft/ft
	Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.075	ft/ft
	Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
	Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
	Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
	Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.5	inches
	Check boxes are not applicable in SUMP conditions		☐	☐	

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

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



	Design Information (Input)	CDOT/Denver 13 Valley Grate			
			MINOR	MAJOR	
	Type of Inlet	Type =	CDOT/Denver 13 Valley Grate		
	Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
	Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
	Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.4	4.4	inches
	Grate Information		MINOR	MAJOR	☐ Override Depths
	Length of a Unit Grate	L_o (G) =	15.00	15.00	feet
	Width of a Unit Grate	W_o =	1.73	1.73	feet
	Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.43	0.43	
	Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
	Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.30	3.30	
	Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
	Curb Opening Information		MINOR	MAJOR	
	Length of a Unit Curb Opening	L_o (C) =	N/A	N/A	feet
	Height of Vertical Curb Opening in Inches	H_{vert} =	N/A	N/A	inches
	Height of Curb Orifice Throat in Inches	H_{throat} =	N/A	N/A	inches
	Angle of Throat (see USDCM Figure ST-5)	Theta =	N/A	N/A	degrees
	Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	N/A	N/A	feet
	Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	N/A	N/A	
	Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	N/A	N/A	
	Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	N/A	N/A	
	Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
	Depth for Grate Midwidth	d_{Grate} =	0.400	0.400	ft
	Depth for Curb Opening Weir Equation	d_{Curb} =	N/A	N/A	ft
	Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
	Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
	Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.42	0.42	
			MINOR	MAJOR	
	Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**2.3**	**2.3**	**cfs**
	Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.9	2.1	cfs

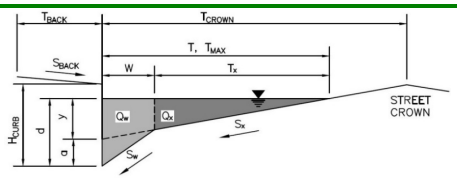
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: Park Meadows Mall Expansion

Inlet ID: S6

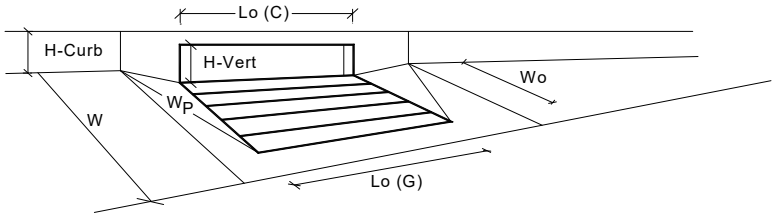


Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	5.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.048	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.075	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.0	9.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)	CDOT/Denver 13 Valley Grate			
		MINOR	MAJOR	
Type of Inlet	Type =	CDOT/Denver 13 Valley Grate		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.0	8.1	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.43	0.43	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.30	3.30	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	N/A	N/A	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.446	0.702	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.78	1.00	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**1.7**	**4.1**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.3	3.1	cfs

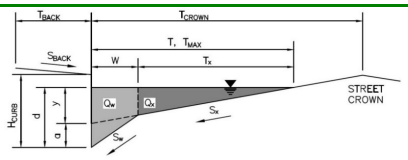
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: Park Meadows Mall Expansion

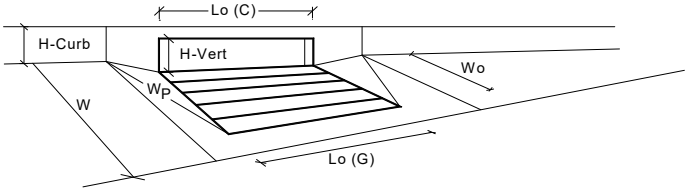
Inlet ID: S7



Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.075		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	7.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)	CDOT/Denver 13 Combination	MINOR	MAJOR	
Type of Inlet	Type =	CDOT/Denver 13 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3	3	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.4	4.4	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.43	0.43	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.30	3.30	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.400	0.400	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.22	0.22	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.42	0.42	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.86	0.86	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.42	0.42	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**2.9**	**2.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.2	2.9	cfs

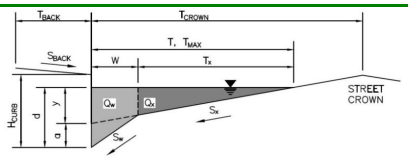
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: Park Meadows Mall Expansion

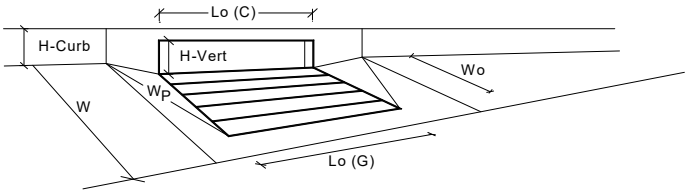
Inlet ID: S8



Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.075		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.5	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

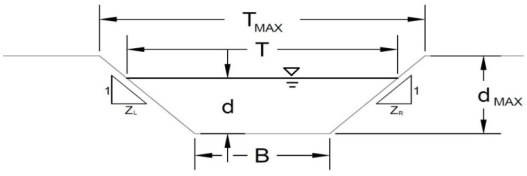


Design Information (Input)	CDOT Type R Curb Opening	MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.4	4.4	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	20.00	20.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.22	0.22	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.42	0.42	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.68	0.68	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.7**	**5.7**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.2	5.3	cfs

AREA INLET IN A SWALE

Park Meadows Mall Expansion

S9



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.016	
Channel Invert Slope	S_O =	0.0244	ft/ft
Bottom Width	B =	2.00	ft
Left Side Slope	Z1 =	26.25	ft/ft
Right Side Sloe	Z2 =	33.67	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- ○ Non-Cohesive
- ○ Cohesive
- ◉ Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**52.50**	**52.50**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**0.50**	**0.50**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**51.0**	**51.0**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**0.50**	**0.50**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.8**	**1.9**	**cfs**
Water Depth	**d** =	**0.09**	**0.13**	**ft**

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

AREA INLET IN A SWALE

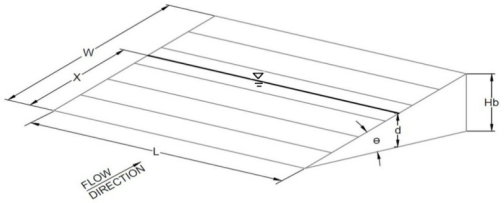
Park Meadows Mall Expansion

S9

Inlet Design Information (Input)

Type of Inlet: CDOT Type D (In Series)

Inlet Type = CDOT Type D (In Series)



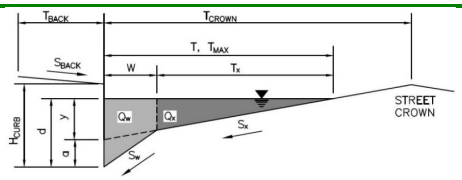
Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00	degrees
Width of Grate	W =	3.00	ft
Length of Grate	L =	6.00	ft
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	ft
Clogging Factor	C_f =	0.38	
Grate Discharge Coefficient	C_d =	0.78	
Orifice Coefficient	C_o =	0.52	
Weir Coefficient	C_w =	1.67	

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.09	0.13	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**0.7**	**1.3**	**cfs**
Bypassed Flow	**Q_b =**	**0.1**	**0.6**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**91**	**69**	**%**

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

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

Project: **Park Meadows Mall Expansion**
Inlet ID: **S10**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.024	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

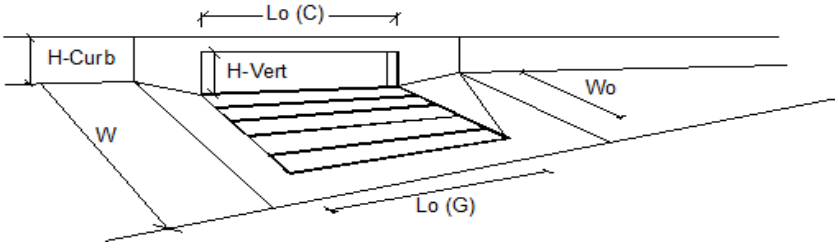
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	7.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**10.8**	**10.8**	**cfs**

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

INLET ON A CONTINUOUS GRADE

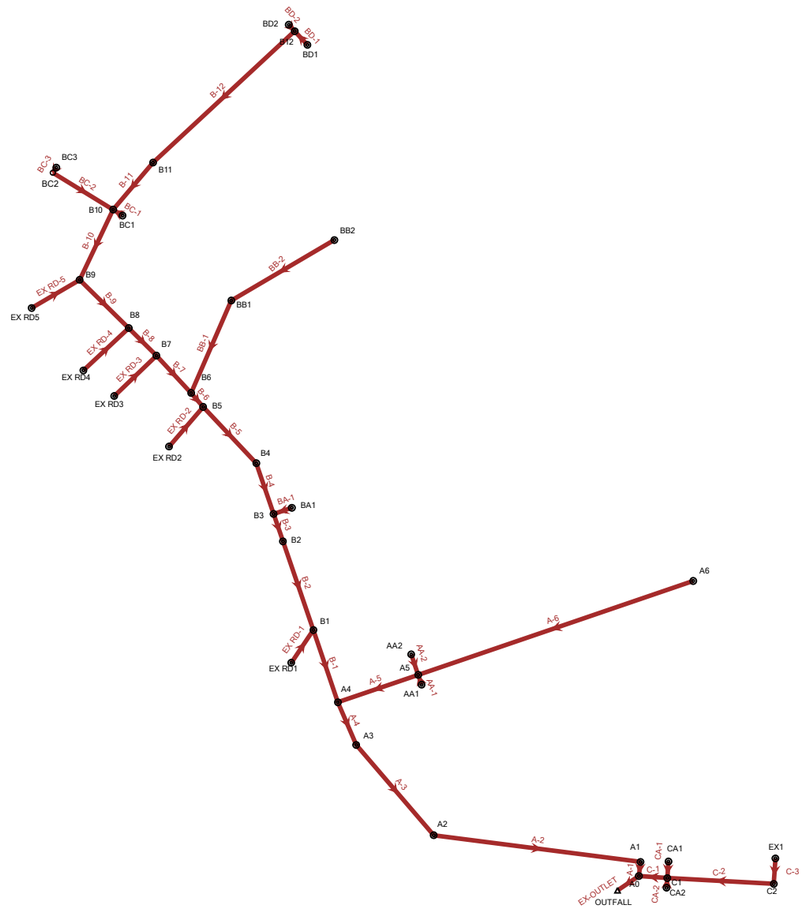
MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.5**	**1.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**99**	**%**

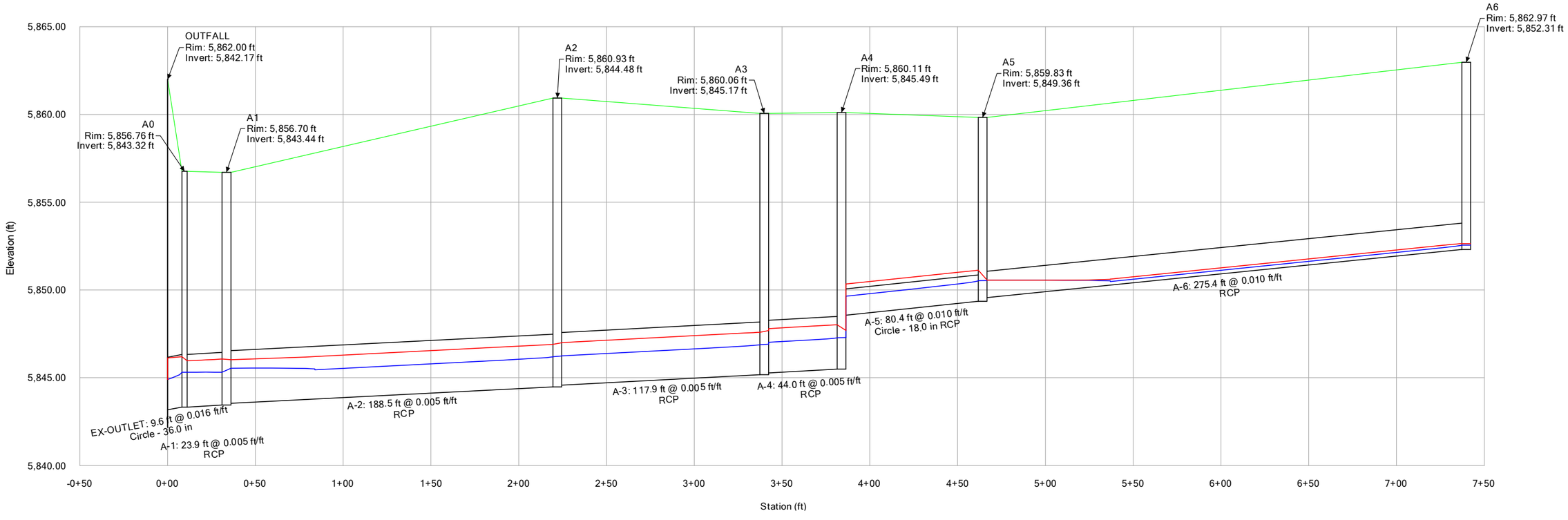
Park Meadows Mall Expansion
Scenario: 100 YR
Active Scenario: 100 YR



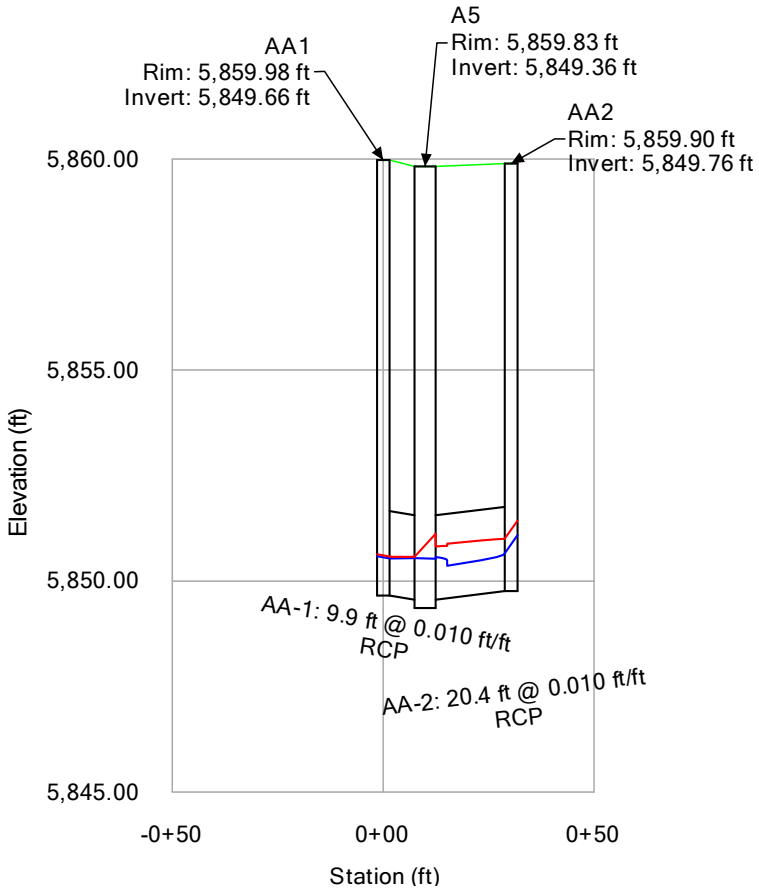
Park Meadows Mall Expansion
FlexTable: Conduit Table
Active Scenario: 100 YR

ID	Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	System Known Flow (cfs)	Capacity (Full Flow) (cfs)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)	Manning's n	Area (Flow) (ft²)
124	BB-2	BB2	BB1	120.9	12.0	5,858.00	5,855.58	0.020	3.49	5.04	5,858.80	5,856.38	6.93	5,864.40	5,863.41	0.013	0.5
159	EX RD-5	EX RD5	B9	38.8	12.0	5,855.96	5,850.17	0.149	1.26	13.77	5,856.43	5,856.45	10.92	5,862.11	5,862.11	0.013	0.1
160	EX RD-4	EX RD4	B8	40.8	12.0	5,856.30	5,849.22	0.173	1.19	14.84	5,856.76	5,856.01	11.31	5,862.11	5,862.11	0.013	0.1
161	EX RD-3	EX RD3	B7	34.6	12.0	5,856.30	5,848.57	0.223	1.13	16.84	5,856.75	5,855.75	12.20	5,862.45	5,862.45	0.013	0.1
162	EX RD-2	EX RD2	B5	29.9	12.0	5,856.30	5,848.00	0.277	2.65	18.76	5,857.00	5,855.17	16.89	5,862.61	5,862.61	0.013	0.2
69	EX RD-1	EX RD1	B1	38.6	18.0	5,856.30	5,852.05	0.110	5.43	37.74	5,857.20	5,852.46	15.18	5,861.63	5,860.70	0.012	0.4
73	A-6	A6	A5	275.4	18.0	5,852.31	5,849.56	0.010	1.03	10.50	5,859.86	5,859.83	0.58	5,862.97	5,859.83	0.013	0.3
86	BC-2	BC2	B10	20.5	18.0	5,854.56	5,854.36	0.010	5.21	10.38	5,857.92	5,857.86	2.95	5,861.70	5,861.27	0.013	0.9
91	A-5	A5	A4	80.4	18.0	5,849.36	5,848.56	0.010	21.24	10.48	5,855.27	5,851.98	12.02	5,859.83	5,860.11	0.013	1.8
95	BD-1	BD1	B12	17.8	18.0	5,856.24	5,856.07	0.010	1.81	10.28	5,858.54	5,858.53	1.02	5,859.79	5,859.72	0.013	0.4
96	BC-3	BC3	BC2	5.3	18.0	5,854.61	5,854.56	0.009	5.21	10.17	5,858.06	5,858.05	2.95	5,859.20	5,861.70	0.013	0.9
99	C-2	C2	C1	46.8	18.0	5,850.14	5,849.67	0.010	9.05	10.53	5,851.30	5,851.13	6.70	5,854.99	5,856.78	0.013	1.4
100	CA-2	CA2	C1	6.0	18.0	5,849.93	5,849.87	0.010	1.16	10.50	5,851.03	5,851.03	3.91	5,855.94	5,856.78	0.013	0.3
101	CA-1	CA1	C1	19.3	18.0	5,850.06	5,849.87	0.010	1.94	10.44	5,851.04	5,851.04	4.52	5,855.89	5,856.78	0.013	0.4
102	C-3	EX1	C2	24.8	18.0	5,850.49	5,850.24	0.010	9.05	10.54	5,851.65	5,851.32	6.71	5,855.34	5,854.99	0.013	1.3
122	BB-1	BB1	B6	59.9	18.0	5,853.71	5,853.41	0.005	3.49	7.43	5,856.38	5,856.32	1.97	5,863.41	5,862.66	0.013	0.8
129	C-1	C1	A0	24.7	18.0	5,849.57	5,849.32	0.010	12.16	10.58	5,851.03	5,850.64	6.88	5,856.78	5,856.76	0.013	1.8
79	B-11	B11	B10	58.4	24.0	5,852.26	5,851.21	0.018	12.33	30.32	5,857.84	5,857.67	3.92	5,861.40	5,861.27	0.013	1.3
80	B-12	B12	B11	183.1	24.0	5,855.53	5,852.26	0.018	12.33	30.23	5,858.46	5,857.91	3.92	5,859.72	5,861.40	0.013	1.4
84	BA-1	BA1	B3	5.9	24.0	5,850.01	5,849.95	0.010	3.88	22.79	5,854.31	5,854.31	1.24	5,860.98	5,861.13	0.013	0.7
85	BC-1	BC1	B10	10.6	24.0	5,853.72	5,853.61	0.010	12.69	23.01	5,857.90	5,857.86	4.04	5,860.87	5,861.27	0.013	1.7
92	AA-1	AA1	A5	9.9	24.0	5,849.66	5,849.56	0.010	5.30	22.72	5,856.53	5,856.53	1.69	5,859.98	5,859.83	0.013	0.9
93	AA-2	AA2	A5	20.4	24.0	5,849.76	5,849.56	0.010	14.90	22.39	5,859.22	5,859.13	4.74	5,859.90	5,859.83	0.013	2.0
94	BD-2	BD2	B12	8.3	24.0	5,856.15	5,856.07	0.010	9.22	22.26	5,858.55	5,858.53	2.93	5,859.80	5,859.72	0.013	1.4
75	B-5	B5	B4	80.7	30.0	5,847.59	5,847.19	0.005	39.95	28.88	5,855.17	5,854.40	8.14	5,862.61	5,861.32	0.013	4.9
78	B-10	B10	B9	73.7	30.0	5,851.21	5,850.10	0.015	30.23	50.32	5,857.34	5,856.94	6.16	5,861.27	5,862.11	0.013	2.8
81	B-3	B3	B2	33.2	30.0	5,846.77	5,846.60	0.005	48.83	29.37	5,852.92	5,852.45	9.95	5,861.13	5,861.39	0.013	4.9
83	B-4	B4	B3	45.1	30.0	5,847.09	5,846.87	0.005	35.47	28.64	5,853.96	5,853.62	7.23	5,861.32	5,861.13	0.013	4.9
125	B-8	B8	B7	40.5	30.0	5,849.11	5,848.55	0.014	32.68	48.22	5,856.01	5,855.75	6.66	5,862.11	5,862.45	0.013	3.1
148	B-6	B6	B5	10.4	30.0	5,847.82	5,847.69	0.013	37.30	45.97	5,855.26	5,855.17	7.60	5,862.66	5,862.61	0.013	3.6
153	B-9	B9	B8	64.6	30.0	5,850.00	5,849.11	0.014	31.49	48.14	5,856.39	5,856.01	6.42	5,862.11	5,862.11	0.013	3.0
154	B-7	B7	B6	45.2	30.0	5,848.55	5,847.92	0.014	33.81	48.40	5,855.75	5,855.44	6.89	5,862.45	5,862.66	0.013	3.2
82	B-2	B2	B1	91.5	36.0	5,846.50	5,846.04	0.005	51.21	47.29	5,852.29	5,851.75	7.24	5,861.39	5,860.70	0.013	7.1
87	B-1	B1	A4	69.7	36.0	5,845.94	5,845.59	0.005	49.26	47.25	5,851.70	5,851.32	6.97	5,860.70	5,860.11	0.013	6.5
88	A-3	A3	A2	117.9	36.0	5,845.17	5,844.58	0.005	65.42	47.19	5,850.45	5,849.32	9.26	5,860.06	5,860.93	0.013	7.1
89	A-2	A2	A1	188.5	36.0	5,844.48	5,843.54	0.005	65.42	47.10	5,849.01	5,847.20	9.26	5,860.93	5,856.70	0.013	7.1
90	A-4	A4	A3	44.0	36.0	5,845.49	5,845.27	0.005	70.50	47.15	5,851.17	5,850.68	9.97	5,860.11	5,860.06	0.013	7.1
97	A-1	A1	A0	23.9	36.0	5,843.44	5,843.32	0.005	75.01	47.26	5,846.51	5,846.11	10.61	5,856.70	5,856.76	0.013	7.1
174	EX-OUTLET	A0	OUTFALL	9.6	36.0	5,843.32	5,843.17	0.016	82.66	83.20	5,846.11	5,845.85	13.42	5,856.76	5,862.00	0.013	6.2

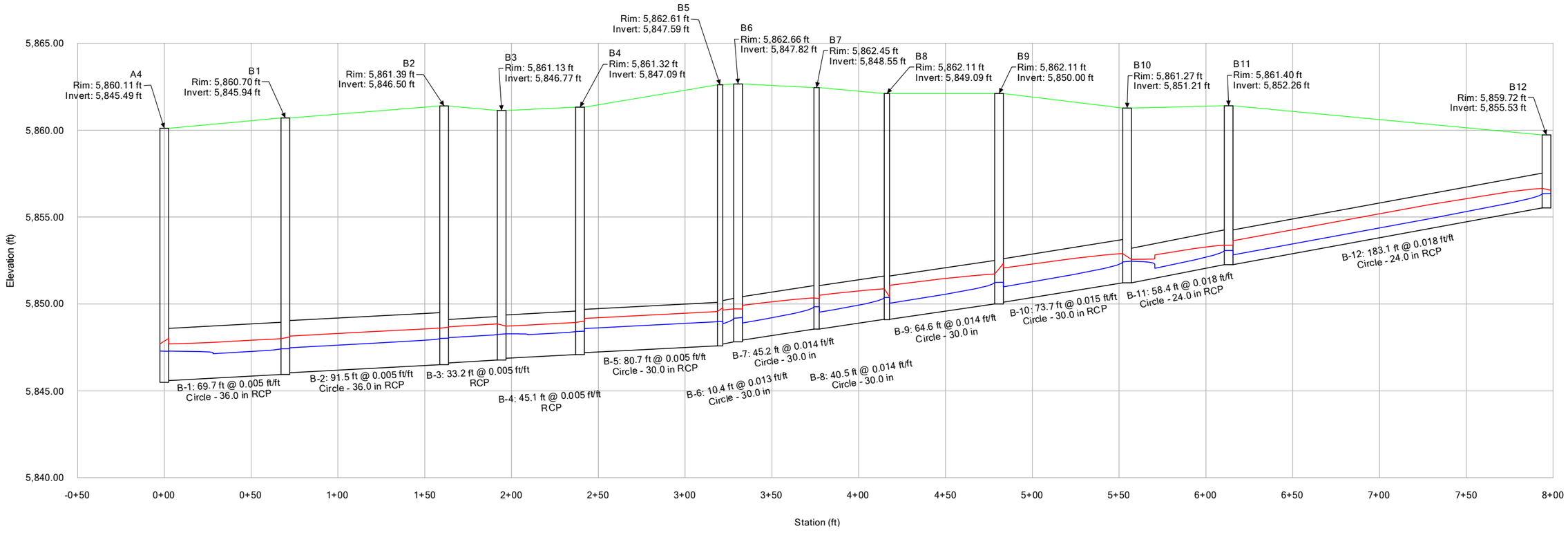
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE A (220407 - Storm Network Model_new.stsw)
Active Scenario: 5 YR



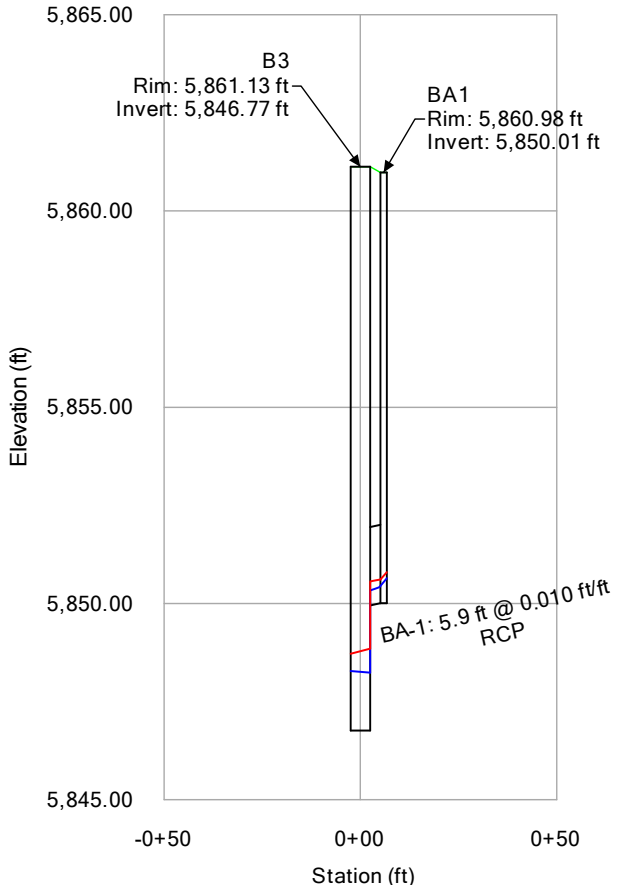
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE AA (220407 - Storm Network Model_new.stsw)
Active Scenario: 5 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE B (220407 - Storm Network Model_new.stsw)
Active Scenario: 5 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE BA (220407 - Storm Network Model_new.stsw)
Active Scenario: 5 YR

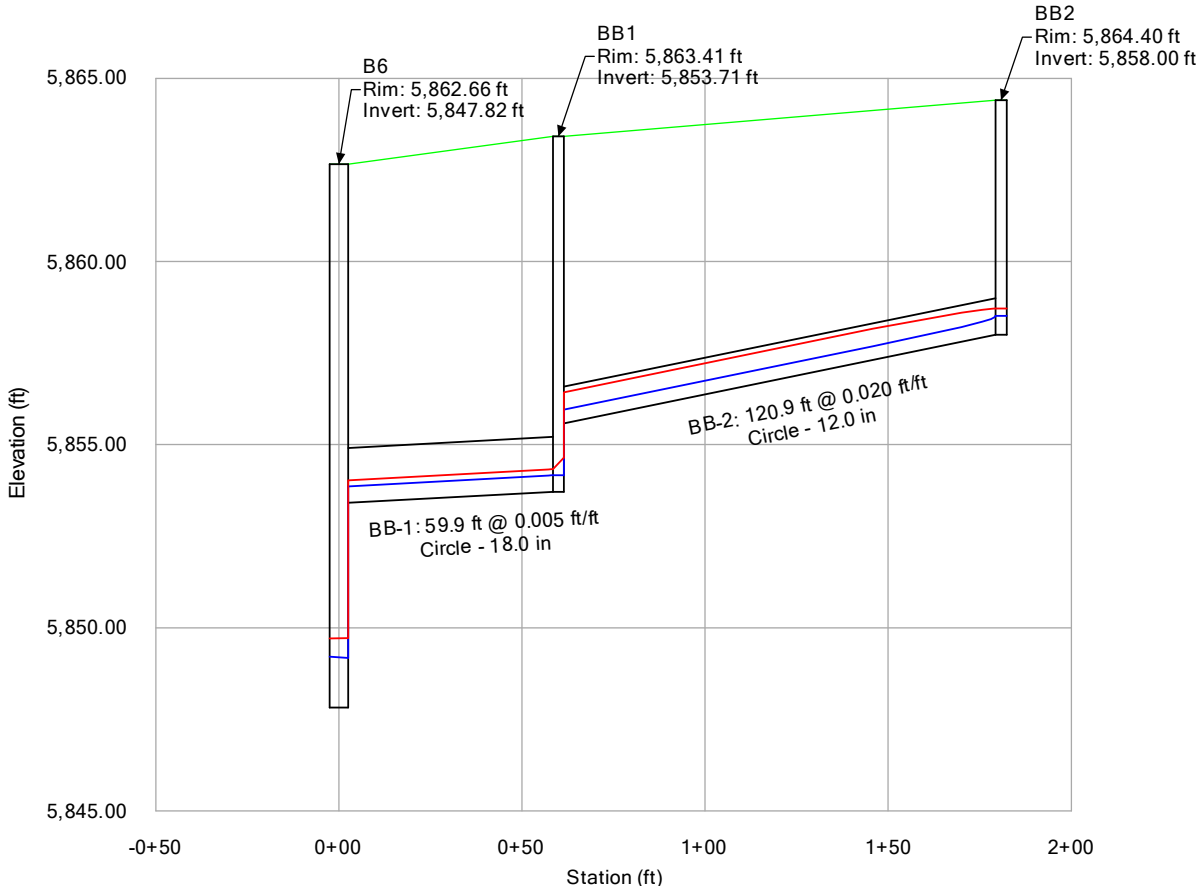


Park Meadows Mall Expansion

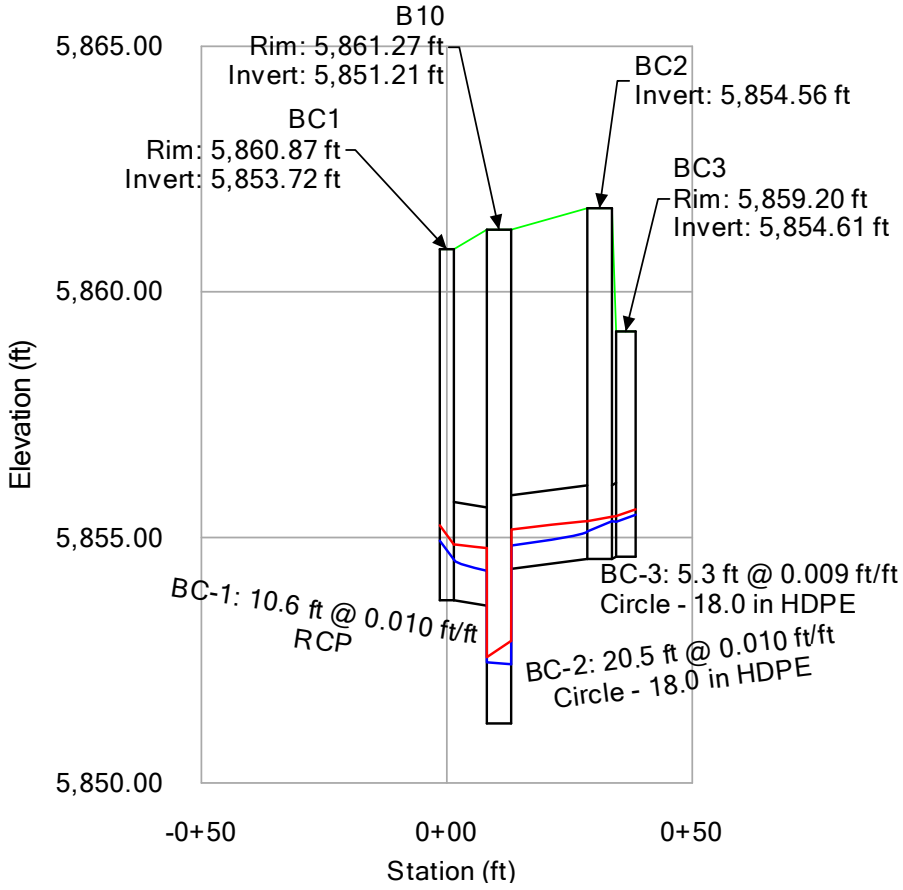
Profile Report

Engineering Profile - LINE BB (220407 - Storm Network Model_new.stsw)

Active Scenario: 5 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE BC (220407 - Storm Network Model_new.stsw)
Active Scenario: 5 YR

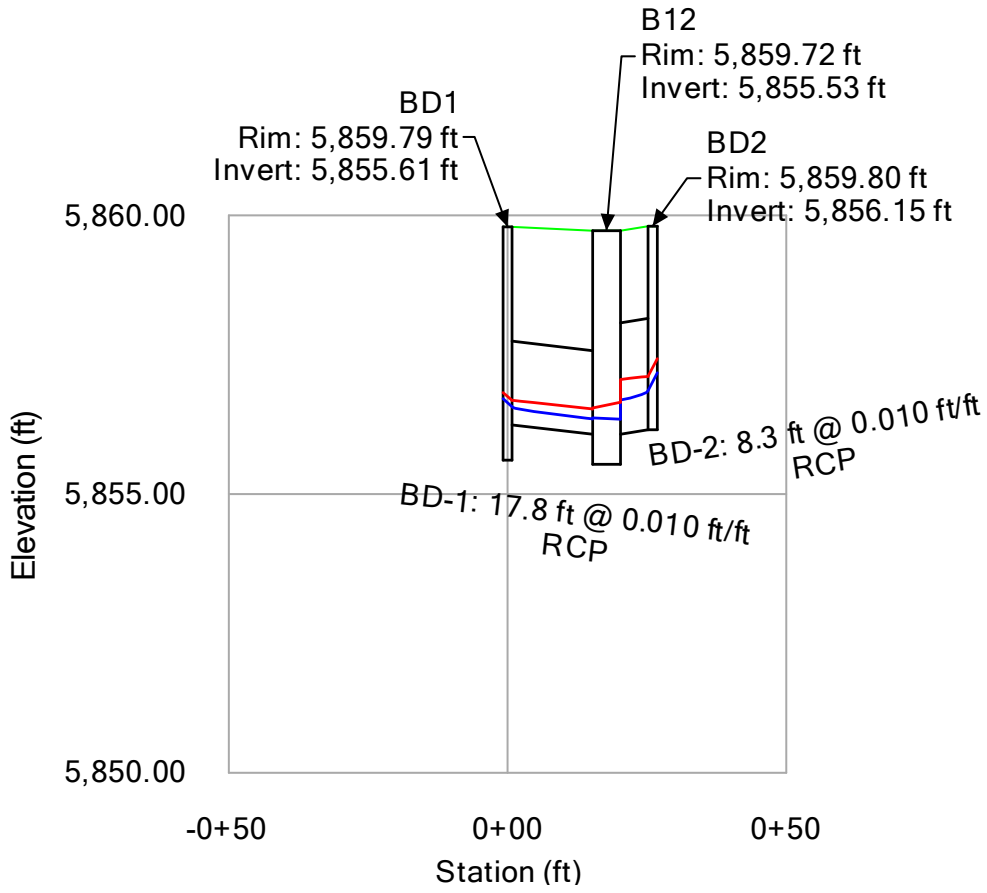


Park Meadows Mall Expansion

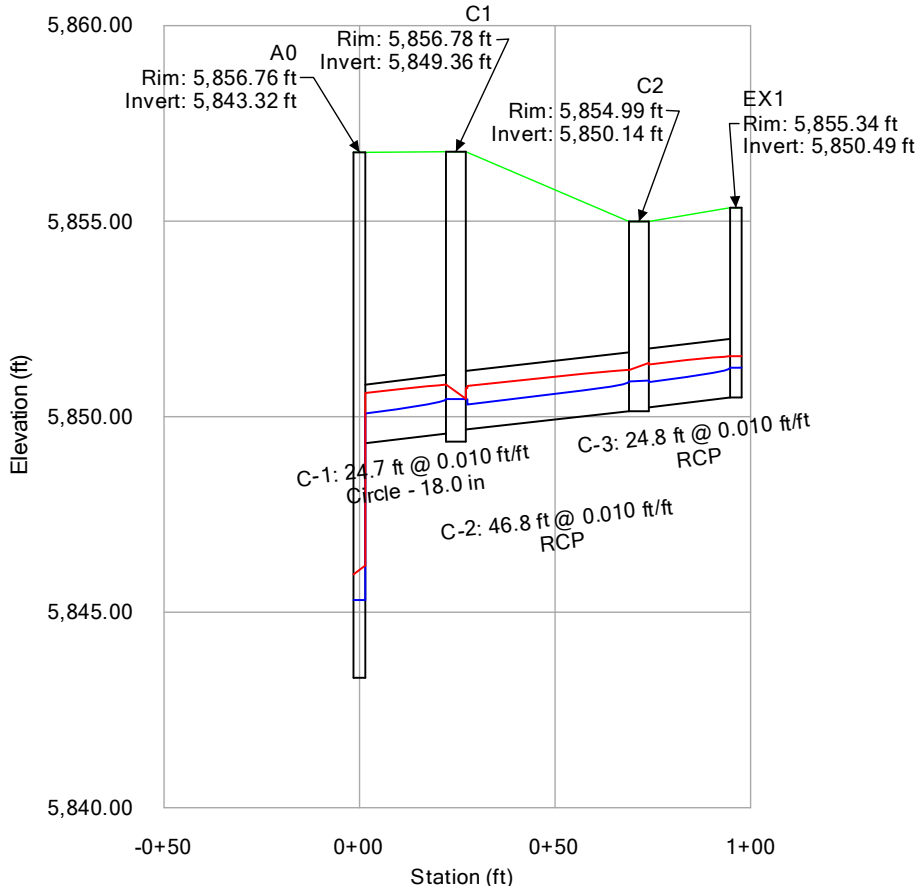
Profile Report

Engineering Profile - LINE BD (220407 - Storm Network Model_new.stsw)

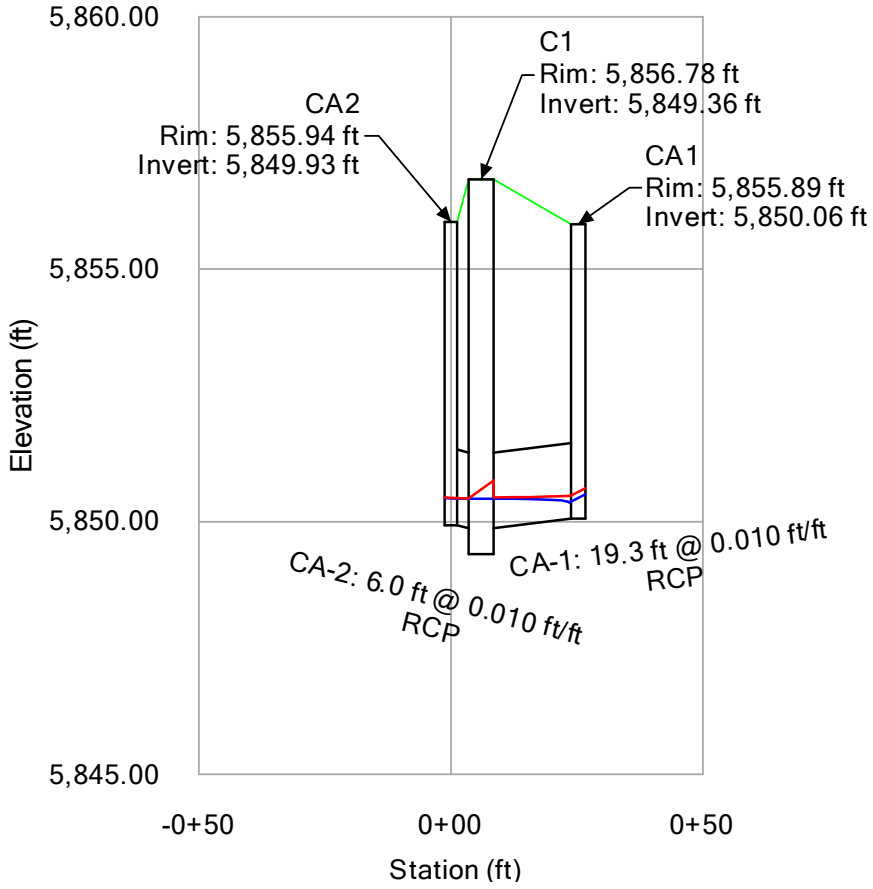
Active Scenario: 5 YR



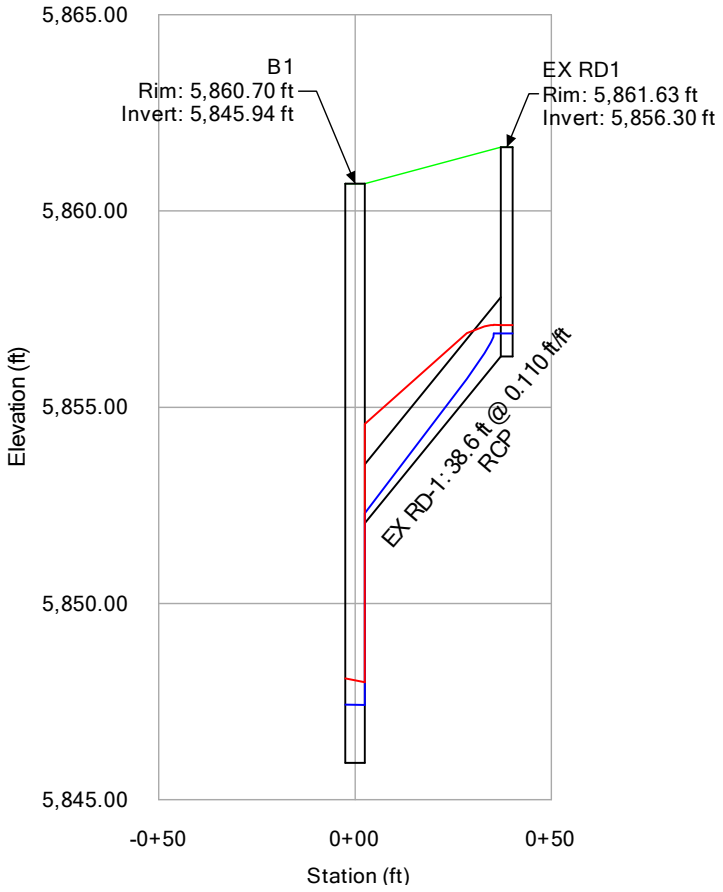
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE C (220407 - Storm Network Model_new.stsw)
Active Scenario: 5 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE CA (220407 - Storm Network Model_new.stsw)
Active Scenario: 5 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE EX RD1 (220407 - Storm Network Model_new.stsw)
Active Scenario: 5 YR

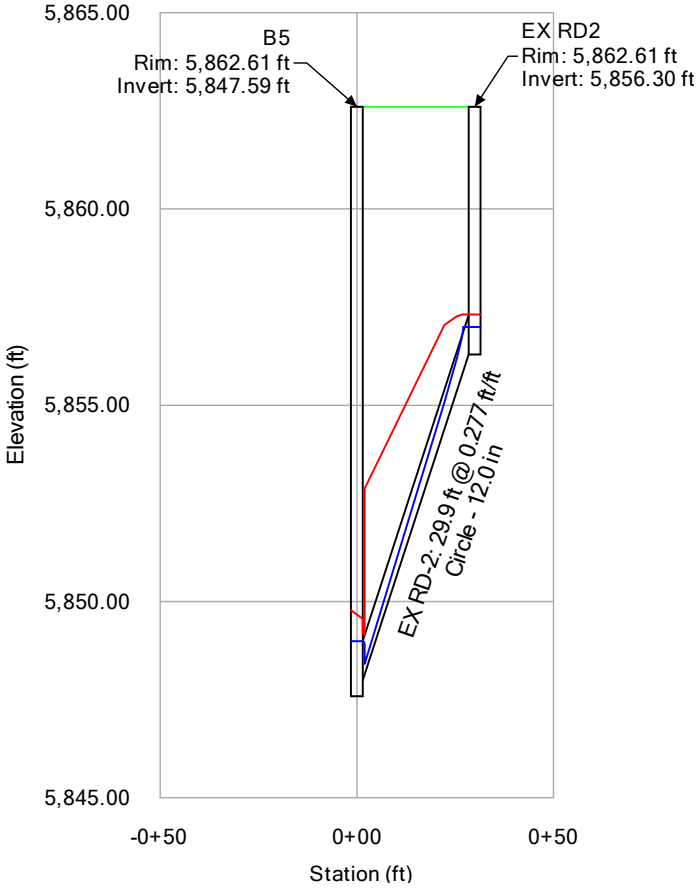


Park Meadows Mall Expansion

Profile Report

Engineering Profile - LINE EX RD2 (220407 - Storm Network Model_new.stsw)

Active Scenario: 5 YR



Park Meadows Mall Expansion

Profile Report

Engineering Profile - LINE EX RD3 (220407 - Storm Network Model_new.stsw)

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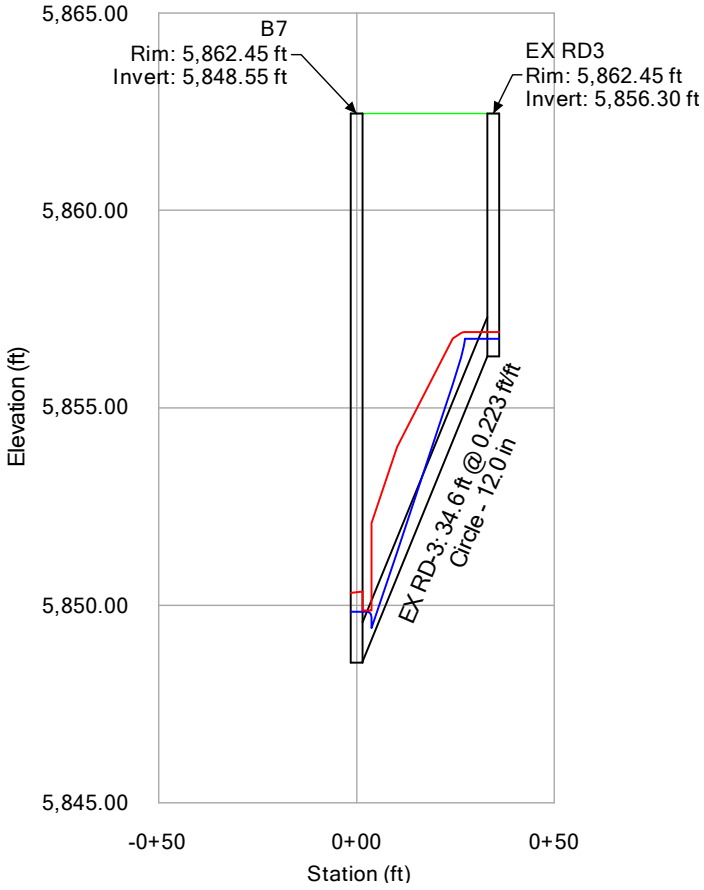
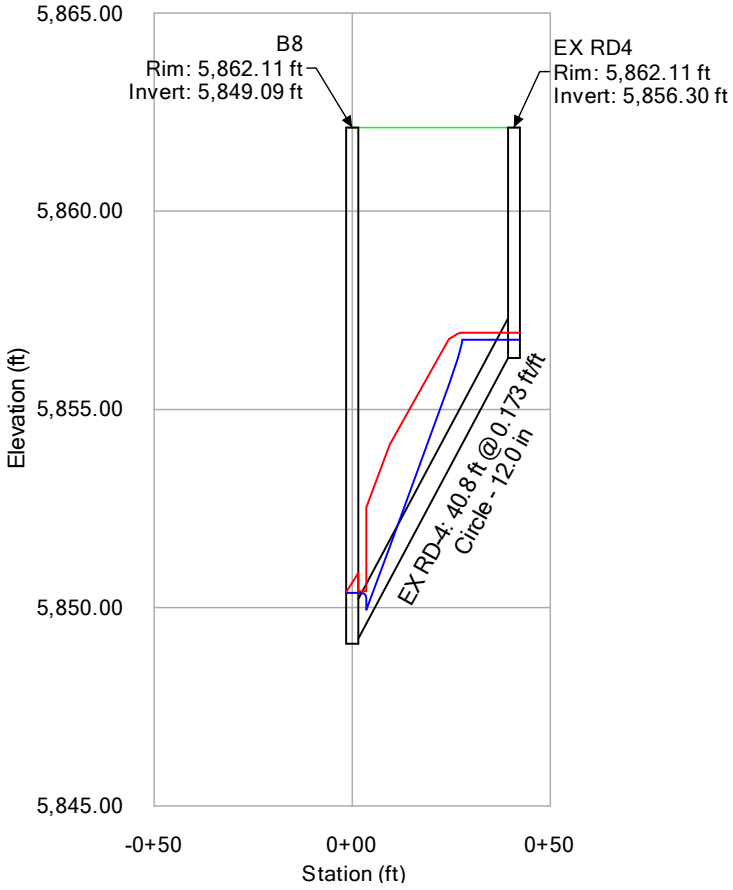


Park Meadows Mall Expansion

Profile Report

Engineering Profile - LINE EX RD4 (220407 - Storm Network Model_new.stsw)

Active Scenario: 5 YR

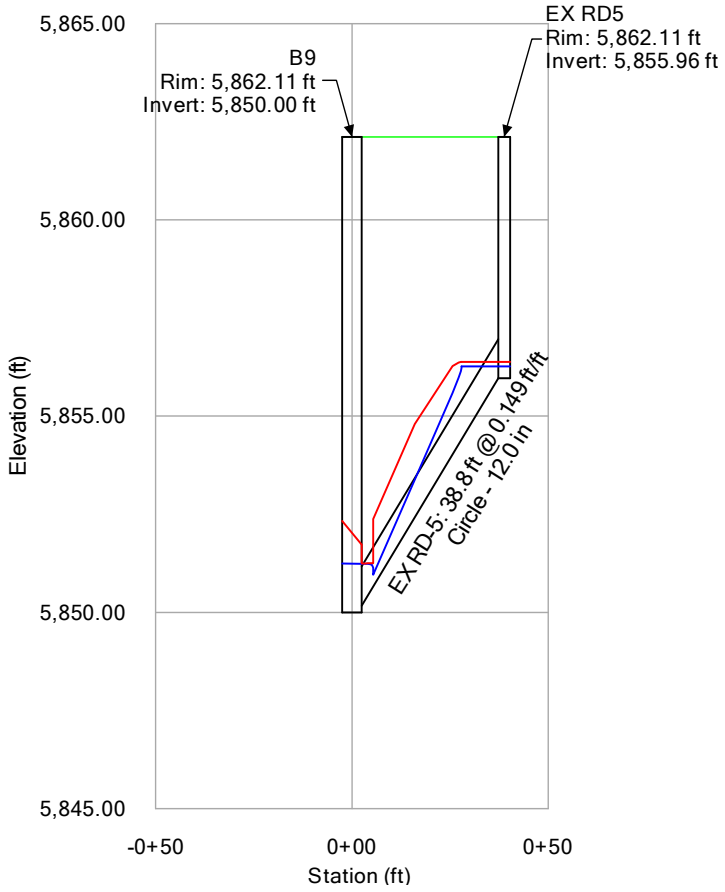


Park Meadows Mall Expansion

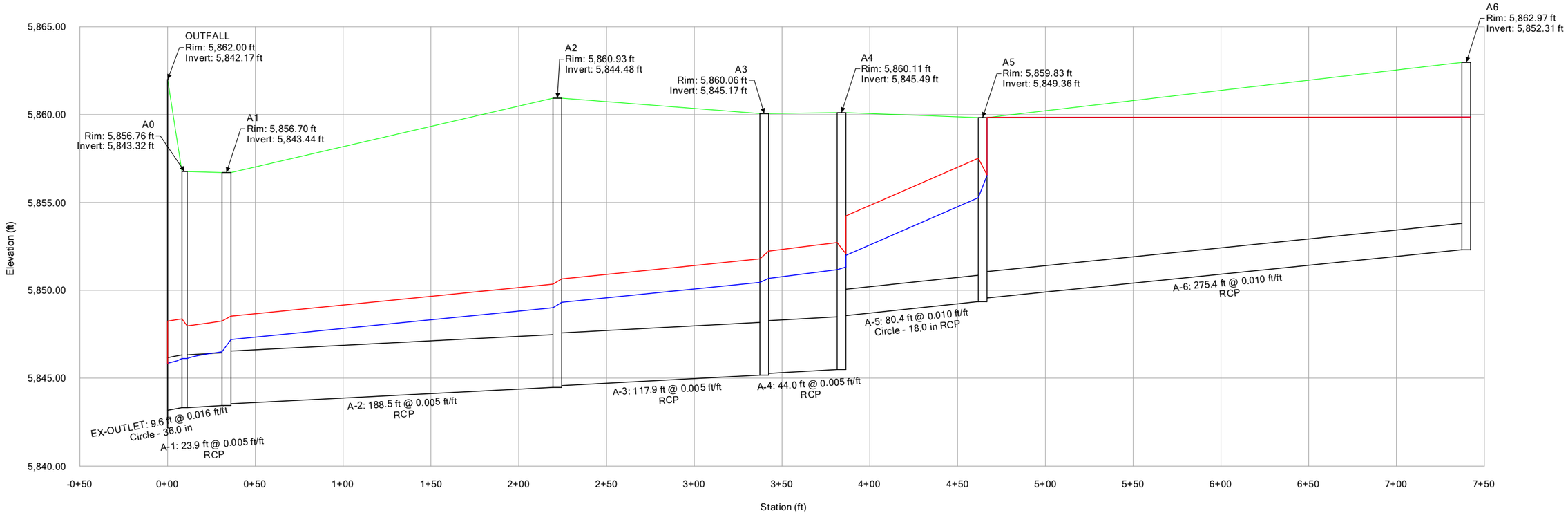
Profile Report

Engineering Profile - LINE EX RD5 (220407 - Storm Network Model_new.stsw)

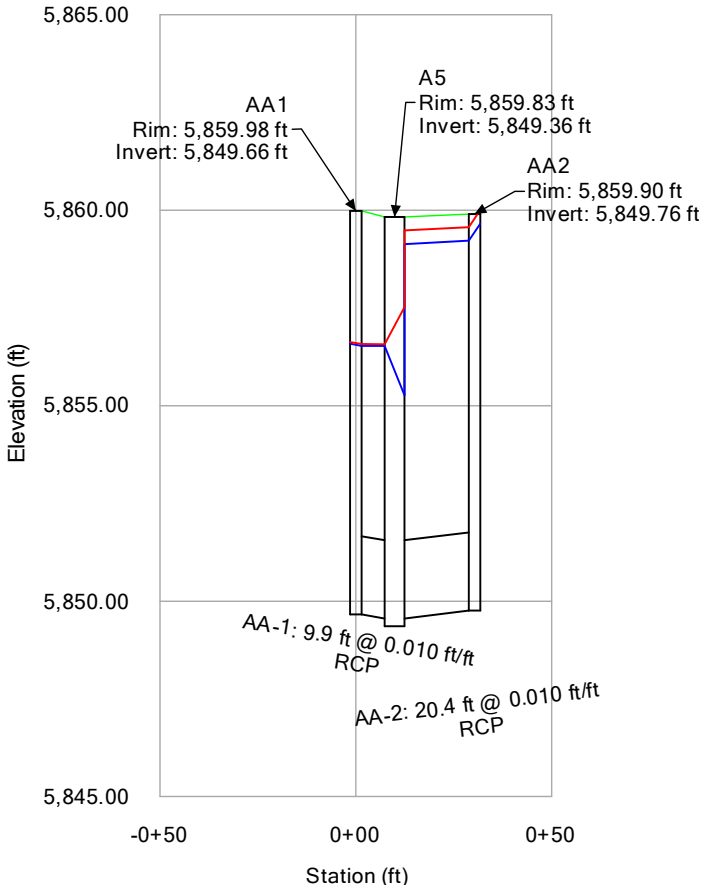
Active Scenario: 5 YR



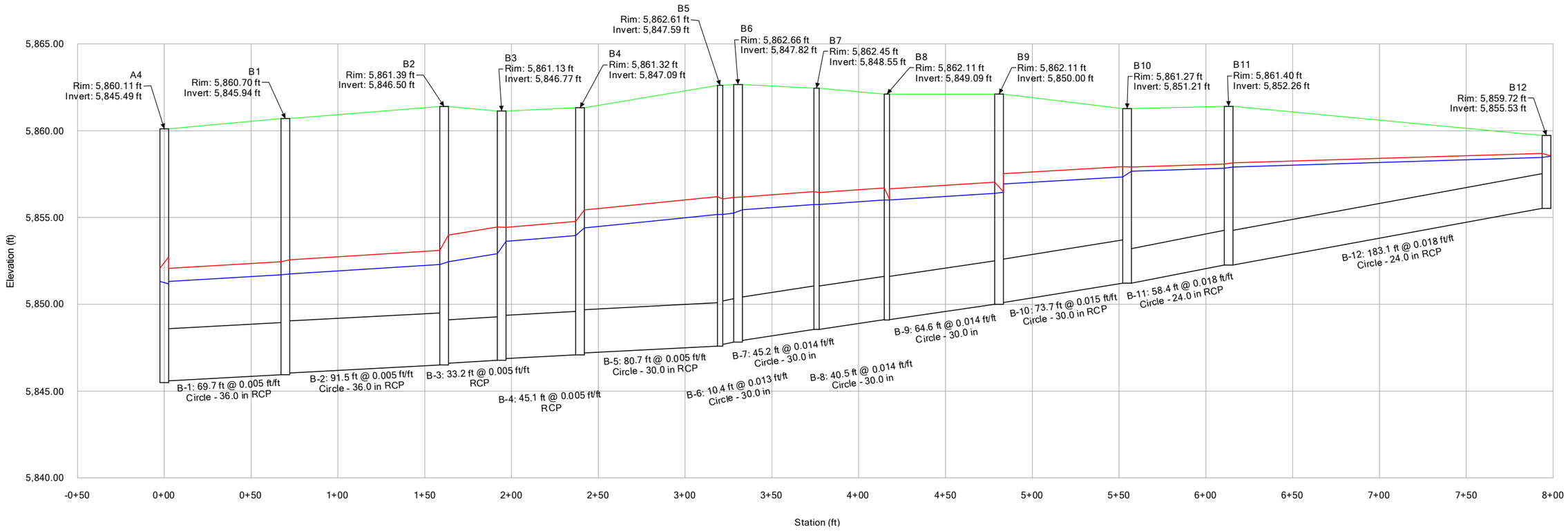
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE A (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



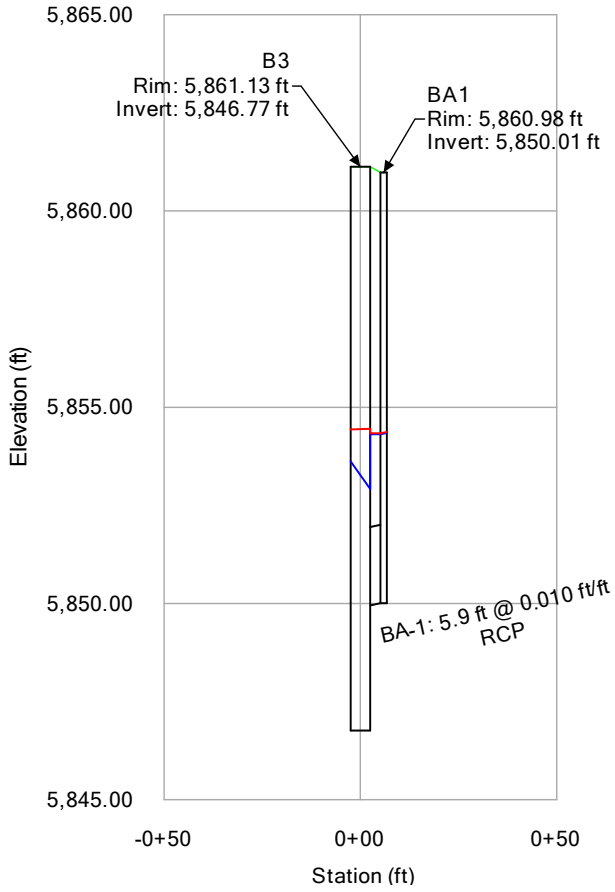
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE AA (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE B (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE BA (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR

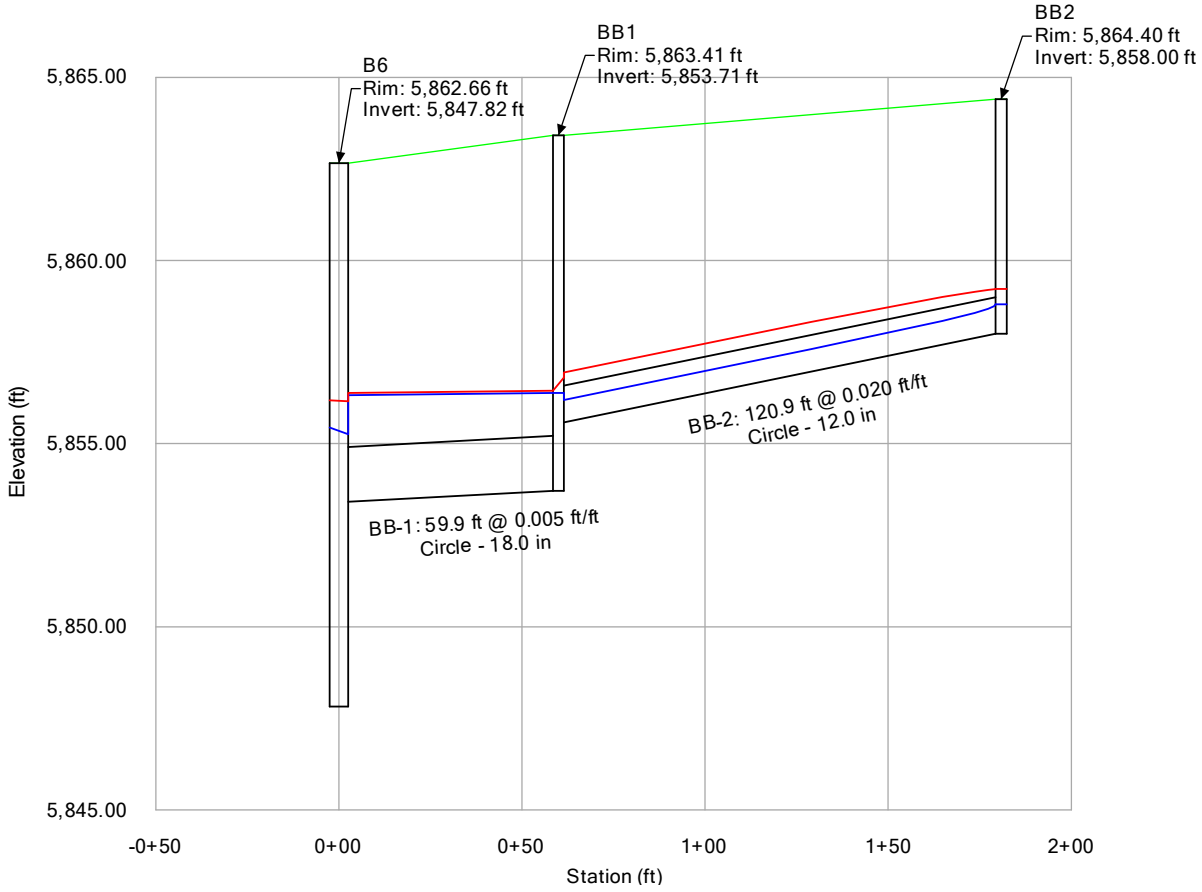


Park Meadows Mall Expansion

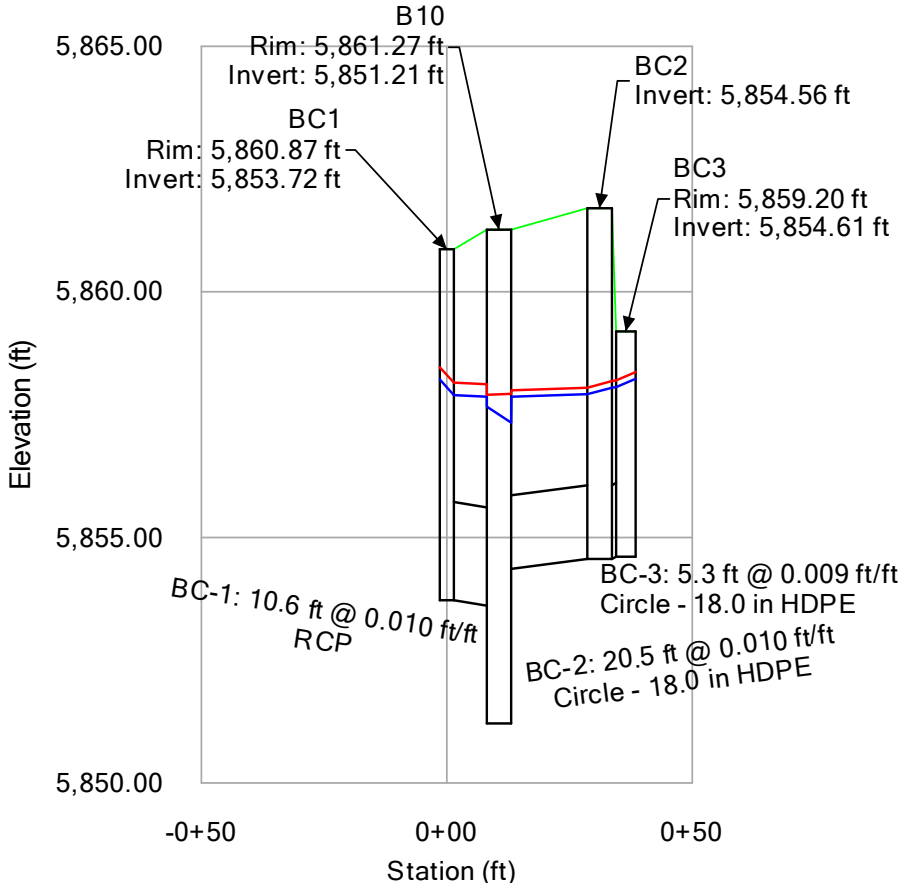
Profile Report

Engineering Profile - LINE BB (220407 - Storm Network Model_new.stsw)

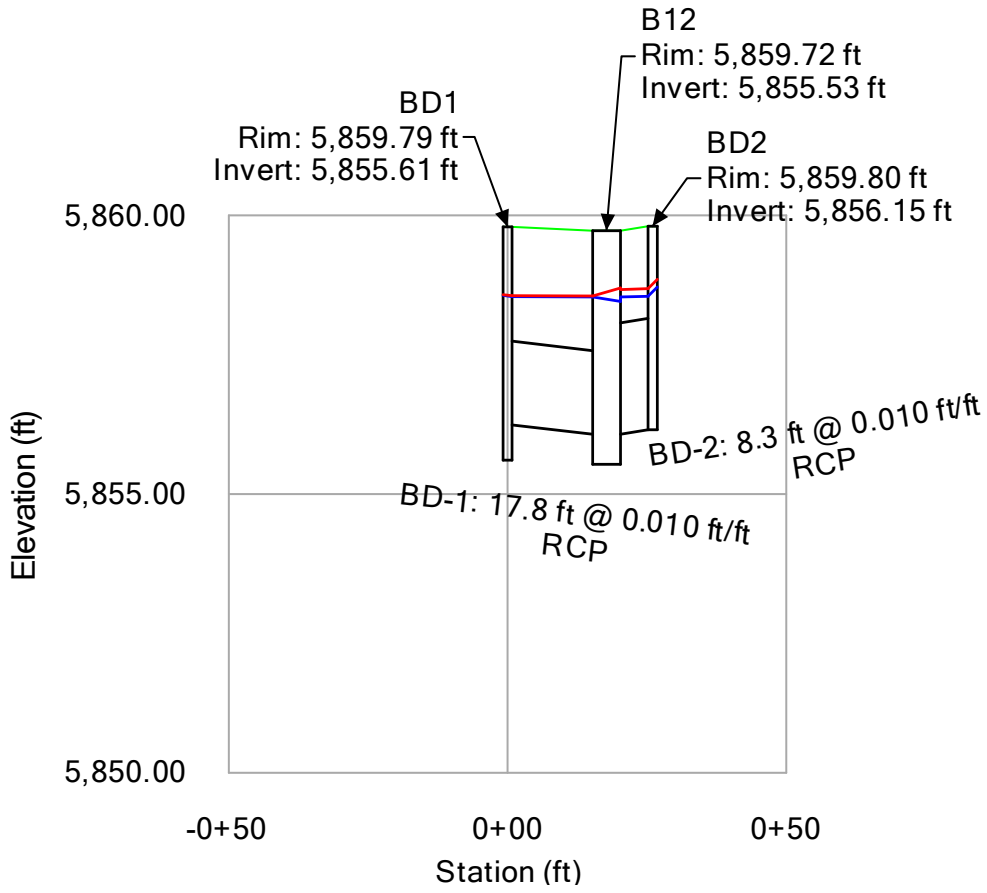
Active Scenario: 100 YR



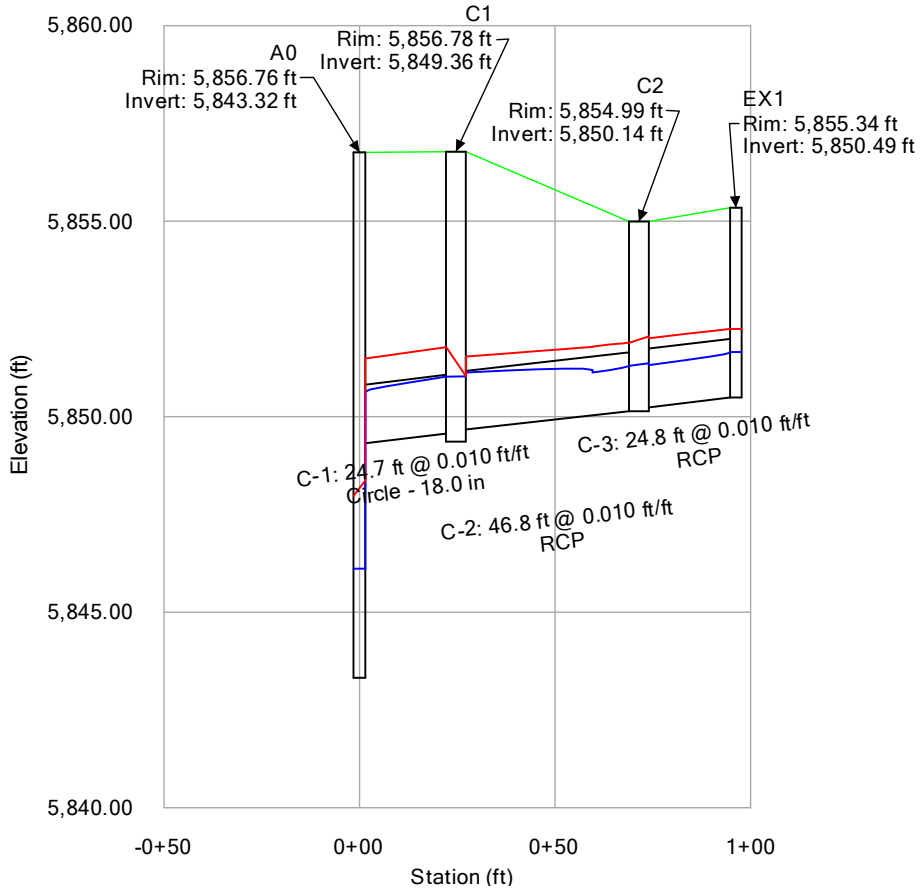
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE BC (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



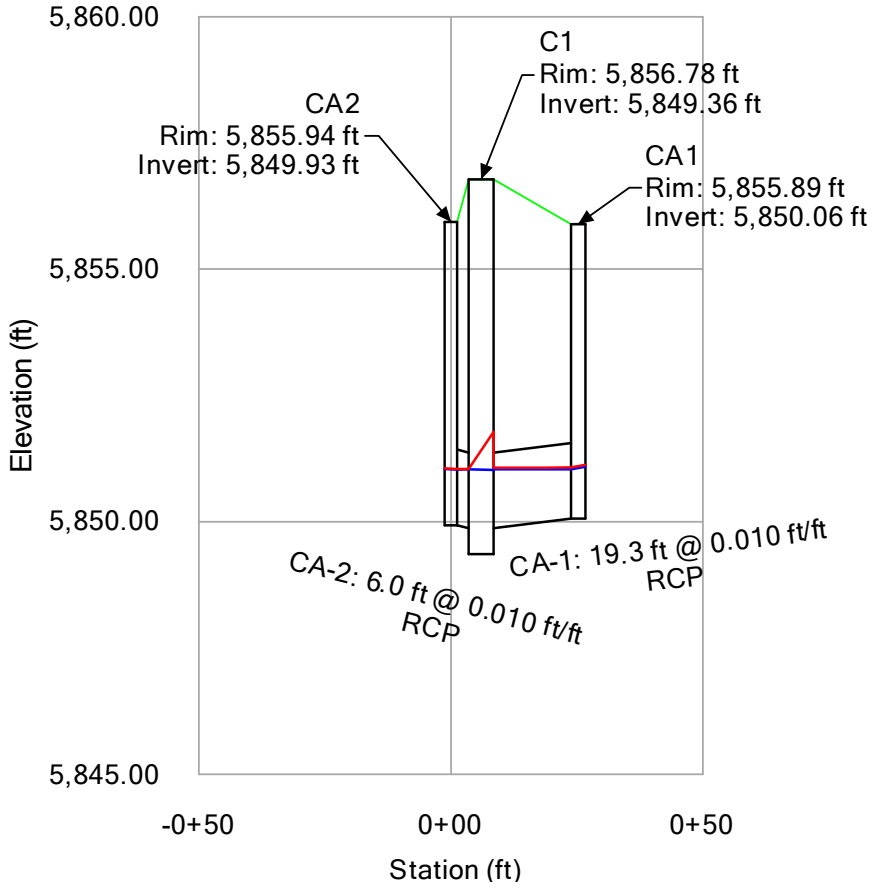
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE BD (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



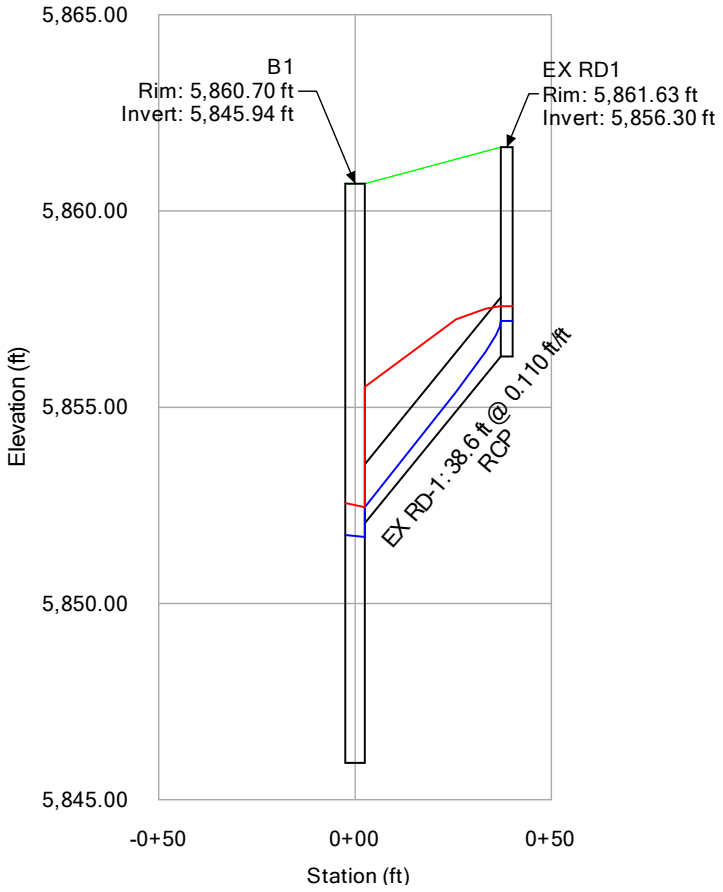
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE C (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE CA (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE EX RD1 (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR

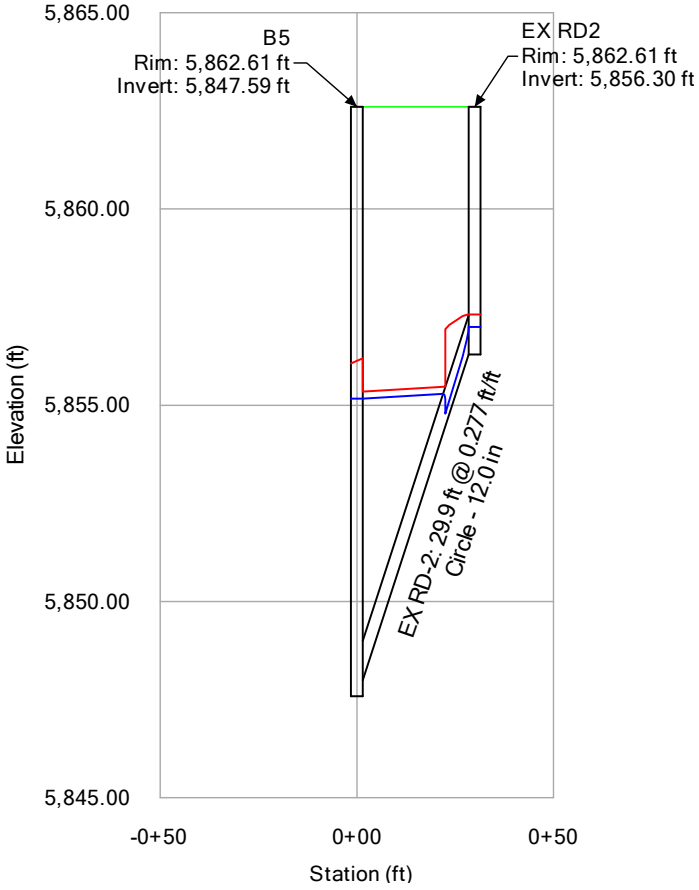


Park Meadows Mall Expansion

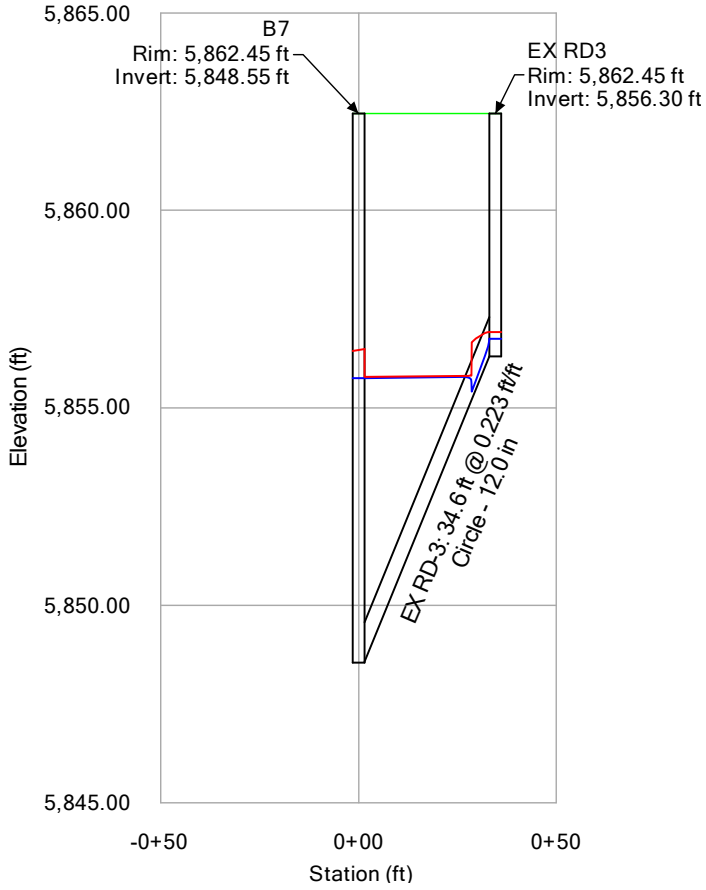
Profile Report

Engineering Profile - LINE EX RD2 (220407 - Storm Network Model_new.stsw)

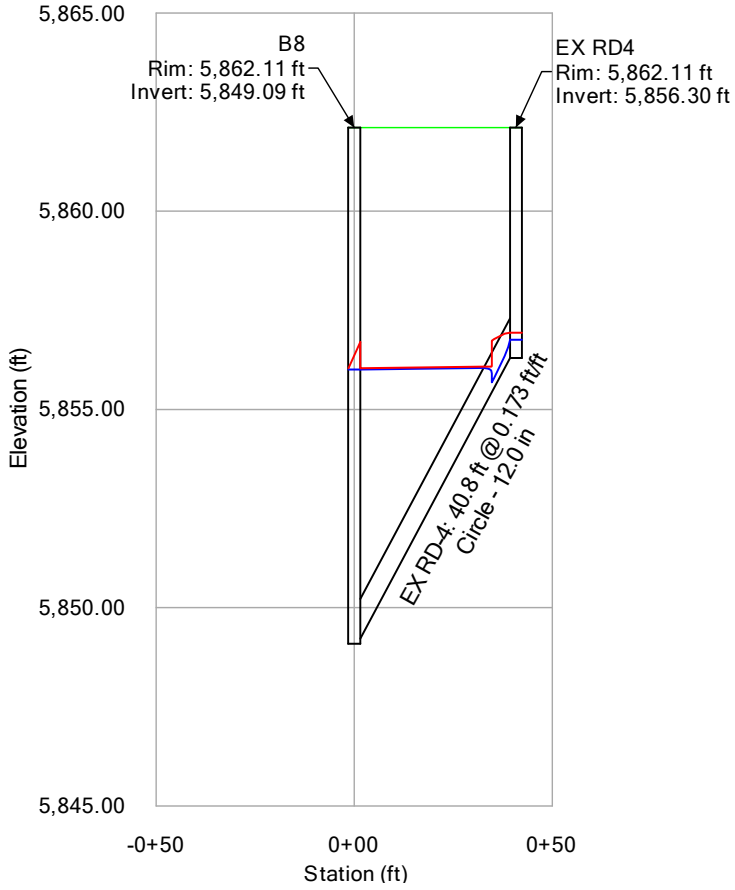
Active Scenario: 100 YR



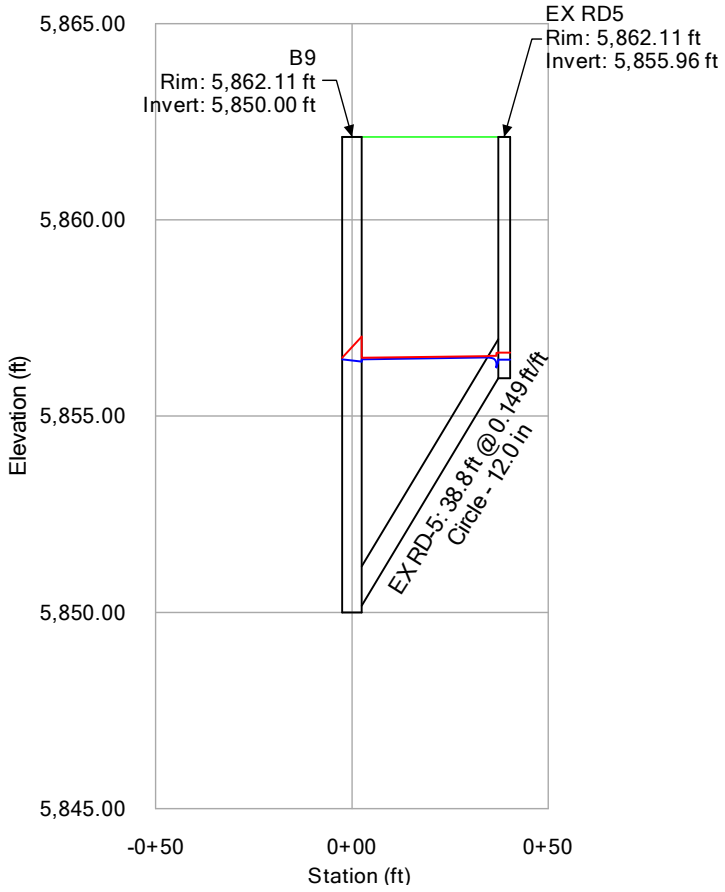
Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE EX RD3 (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE EX RD4 (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



Park Meadows Mall Expansion
Profile Report
Engineering Profile - LINE EX RD5 (220407 - Storm Network Model_new.stsw)
Active Scenario: 100 YR



APPENDIX D

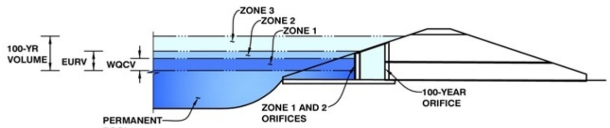
Water Quality and Detention Calculations

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **Park Meadows**

Basin ID: **Basin A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	85.50	acres
Watershed Length =	2,675	ft
Watershed Length to Centroid =	1,300	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	95.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Lone Tree - Municipal Court	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	3.187	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	8.089	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	5.400	acre-feet		inches
5-yr Runoff Volume (P1 = 1.1 in.) =	7.369	acre-feet		inches
10-yr Runoff Volume (P1 = 1.33 in.) =	9.101	acre-feet		inches
25-yr Runoff Volume (P1 = 1.68 in.) =	11.777	acre-feet		inches
50-yr Runoff Volume (P1 = 1.97 in.) =	13.985	acre-feet		inches
100-yr Runoff Volume (P1 = 2.28 in.) =	16.367	acre-feet		inches
500-yr Runoff Volume (P1 = 3.07 in.) =	22.393	acre-feet		inches
Approximate 2-yr Detention Volume =	5.187	acre-feet		
Approximate 5-yr Detention Volume =	7.162	acre-feet		
Approximate 10-yr Detention Volume =	8.631	acre-feet		
Approximate 25-yr Detention Volume =	10.085	acre-feet		
Approximate 50-yr Detention Volume =	10.719	acre-feet		
Approximate 100-yr Detention Volume =	11.389	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	3.187	acre-feet
Zone 2 Volume (EURV - Zone 1) =	4.903	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.300	acre-feet
Total Detention Basin Volume =	11.389	acre-feet

Depth Increement = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	2,000	0.046		
5816	--	0.75	--	--	--	4,956	0.114	2,608	0.060
	--	1.75	--	--	--	16,274	0.374	13,223	0.304
	--	2.75	--	--	--	22,159	0.509	32,440	0.745
	--	3.75	--	--	--	33,927	0.779	60,483	1.388
5820	--	4.75	--	--	--	16,309	0.374	85,601	1.965
	--	5.75	--	--	--	38,971	0.895	113,241	2.600
	--	6.75	--	--	--	41,615	0.955	153,534	3.525
	--	7.75	--	--	--	44,357	1.018	196,520	4.511
	--	8.75	--	--	--	47,183	1.083	242,290	5.562
5825	--	9.75	--	--	--	50,305	1.155	291,034	6.681
	--	10.75	--	--	--	53,497	1.228	342,935	7.873
	--	11.75	--	--	--	56,810	1.304	398,088	9.139
	--	12.75	--	--	--	60,210	1.382	456,598	10.482
	--	13.75	--	--	--	63,788	1.464	518,597	11.905
5830	--	14.75	--	--	--	72,067	1.654	586,525	13.465
	--	15.75	--	--	--	77,290	1.774	661,203	15.179
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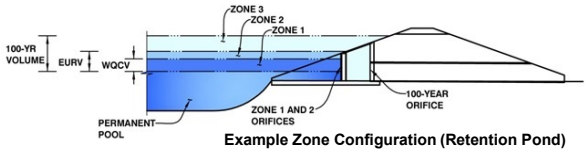
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Park Meadows**

Basin ID: **Basin A**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	6.40	3.187	Orifice Plate
Zone 2 (EURV)	10.93	4.903	Orifice Plate
Zone 3 (100-year)	13.40	3.300	Weir&Pipe (Restrict)
Total (all zones)		11.389	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

			Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

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

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	9.028E-02	ft^2
Depth at top of Zone using Orifice Plate =	10.93	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	13.00	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	3.60	7.20					
Orifice Area (sq. inches)	13.00	13.00	13.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

				Calculated Parameters for Overflow Weir		
	Zone 3 Weir	Not Selected		Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	10.93	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	12.26	N/A feet
Overflow Weir Front Edge Length =	28.00	N/A	feet	Overflow Weir Slope Length =	4.22	N/A feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	26.16	N/A
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	82.17	N/A ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	41.08	N/A ft^2
Debris Clogging % =	50%	N/A	%			

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

				Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate		
	Zone 3 Restrictor	Not Selected		Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.38	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	3.14	N/A ft^2
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	1.00	N/A feet
Restrictor Plate Height Above Pipe Invert =	28.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	14.22	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.81	feet
Spillway Crest Length =	35.00	feet	Stage at Top of Freeboard =	17.03	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.77	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	15.18	acre-ft

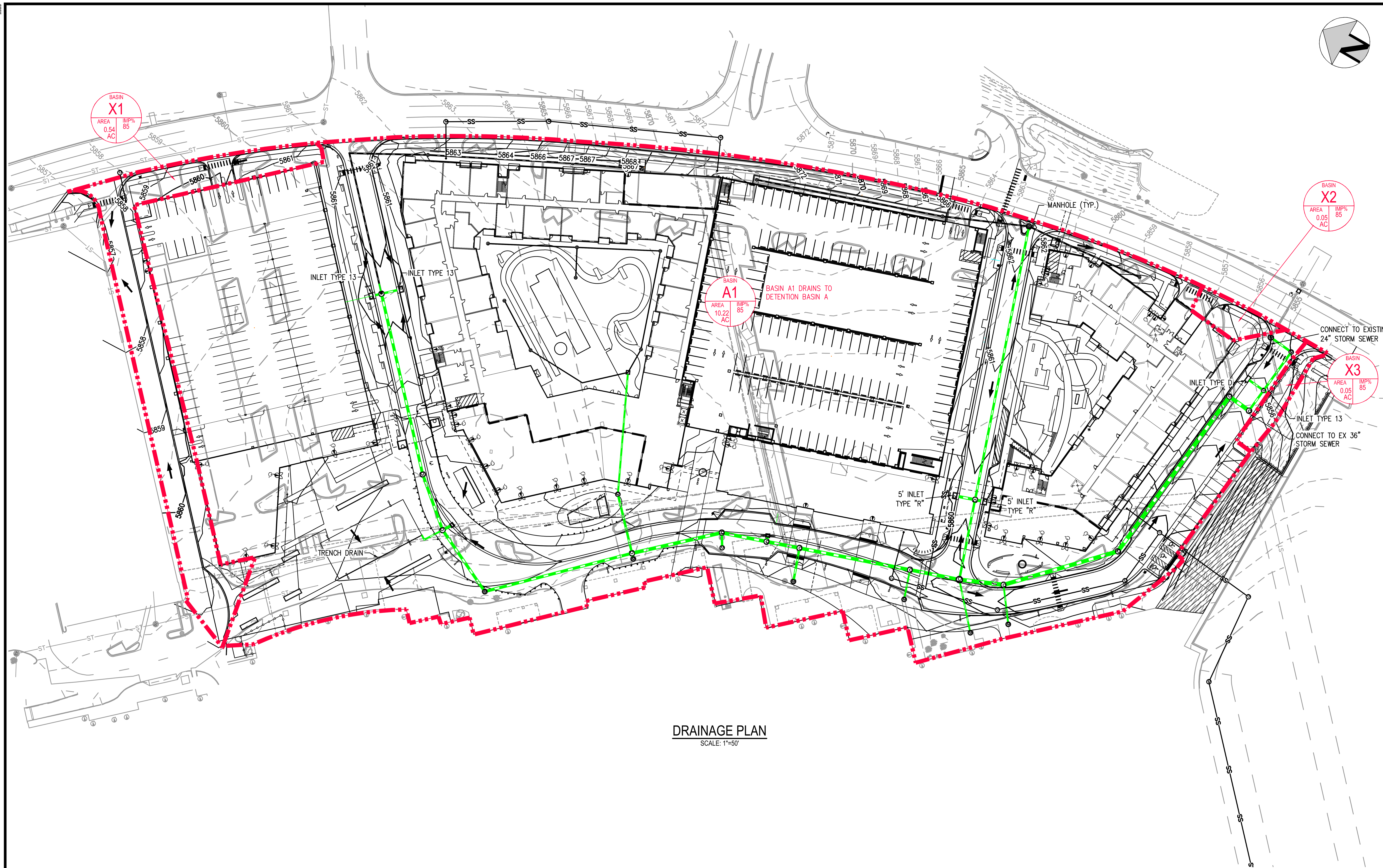
Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

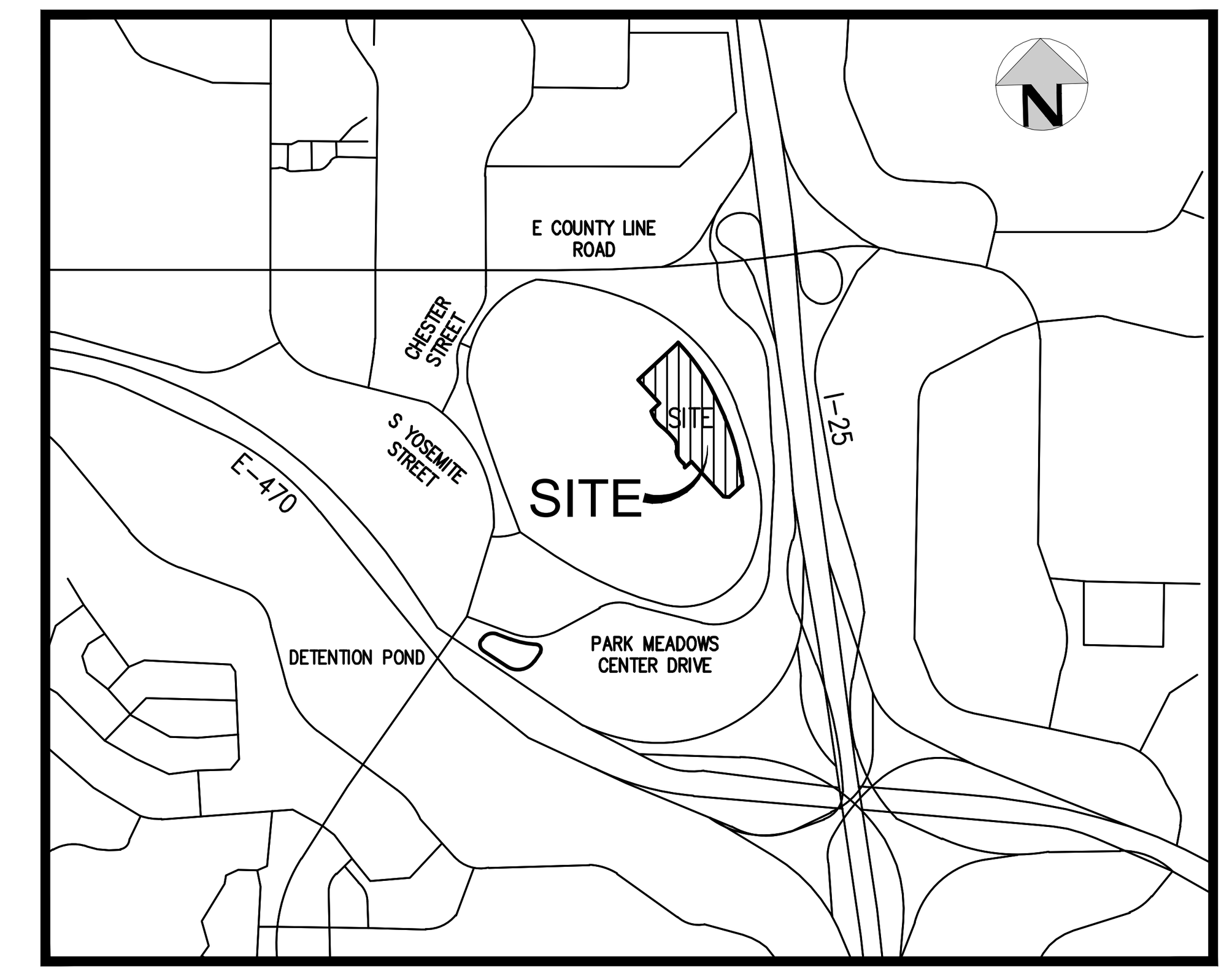
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.84	1.10	1.33	1.68	1.97	2.28	3.07
CUHP Runoff Volume (acre-ft) =	3.187	8.089	5.400	7.369	9.101	11.777	13.985	16.367	22.393
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	5.400	7.369	9.101	11.777	13.985	16.367	22.393
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.9	8.4	22.2	56.6	77.7	104.8	163.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.10	0.26	0.66	0.91	1.23	1.92
Peak Inflow Q (cfs) =	N/A	N/A	101.2	133.9	160.5	212.2	251.1	300.4	408.3
Peak Outflow Q (cfs) =	1.8	3.4	2.6	3.2	6.2	24.6	44.2	55.0	158.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.3	0.4	0.6	0.5	1.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.3	0.5	0.6	0.6
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	56	49	55	59	59	57	56	53
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	52	59	64	64	63	63	62
Maximum Ponding Depth (ft) =	6.40	10.93	8.26	9.95	11.26	12.17	12.81	13.86	15.14
Area at Maximum Ponding Depth (acres) =	0.93	1.24	1.05	1.17	1.27	1.34	1.39	1.49	1.70
Maximum Volume Stored (acre-ft) =	3.194	8.095	5.029	6.902	8.509	9.680	10.551	12.068	14.119

APPENDIX E

Drainage Plans



DRAINAGE PLAN
SCALE: 1"=50'



VICINITY MAP
SCALE: 1"=1000'

LEGEND:

- BASIN BOUNDARY
- PROPOSED STORM SEWER
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS

BASIN DESIGNATION — OS 1
BASIN SIZE IN ACRES — AREA 1.23 AC
BASIN IMPERVIOUSNESS — IMPERV. 2%
BASIN DESIGN POINT

FILEPATH: K:\220407\ENGINEERING\DRAINAGE\DRAINAGE PLANS\DRAINAGE PLAN.DWG LAYOUT: MAJOR DRAINAGE PLAN

811 Know what's below. Call before you dig.

SCALE: 1" = 50'

DESIGNED BY: LME
CHECKED BY: JDO
DRAWN BY: LME

ISSUE DATE: ##########

DATE	REVISION COMMENTS
#	#
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HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

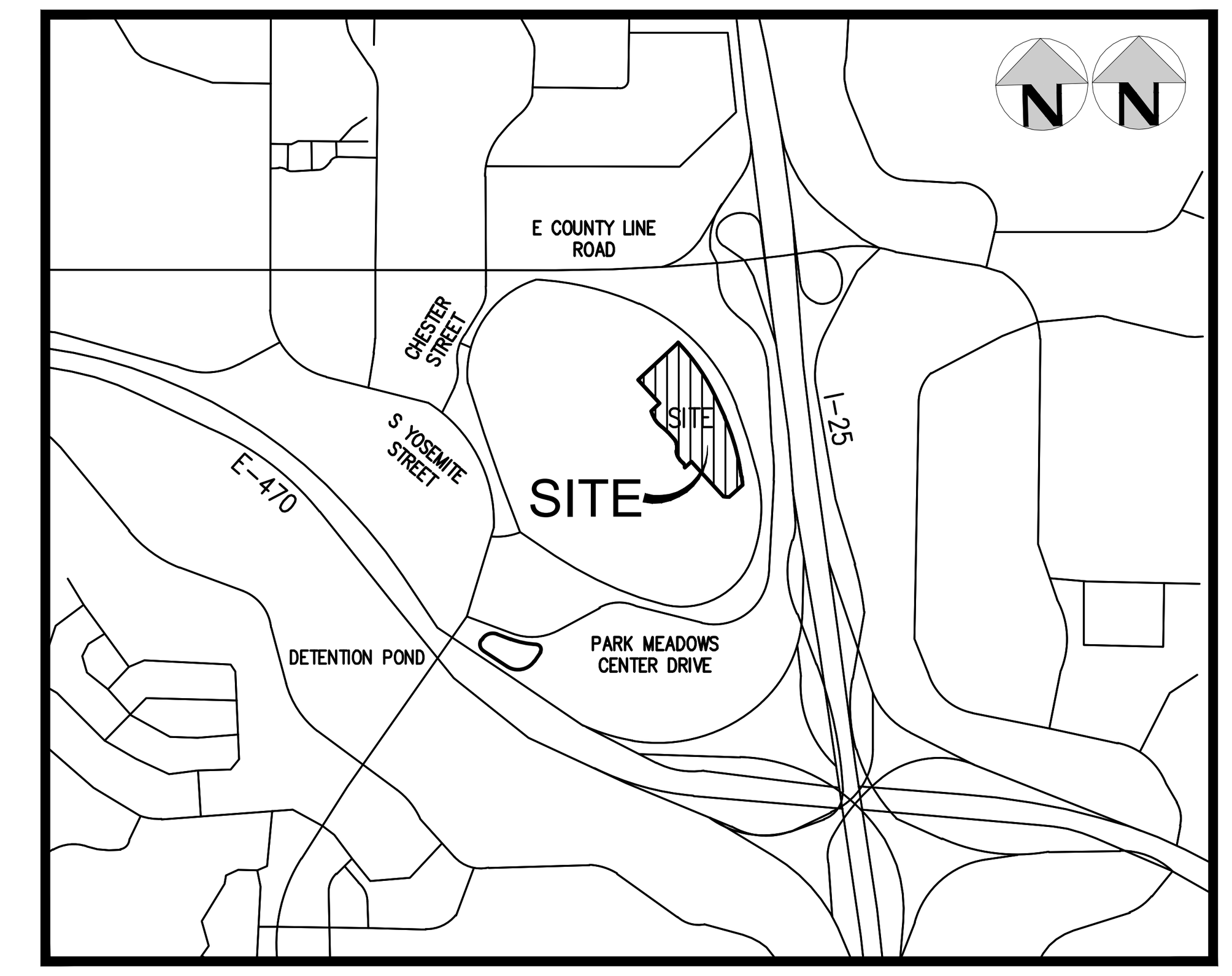
PARK MEADOWS MALL, LLC /
PARK MEADOWS ANCHOR ACQUISITION

PARK MEADOWS - MIEXED USE DEVELOPMENT
MAJOR DRAINAGE PLAN

PROJECT #: 220407
SHEET NUMBER
SW1
1 OF 2

DRAINAGE PLAN

SCALE: 1"=50'



VICINITY MAP

SCALE: 1"=1000'

LEGEND:

- ROOF AREA
- BASIN BOUNDARY
- PROPOSED STORM SEWER
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS

BASIN DESIGNATION — OS 1; BASIN SIZE IN ACRES — AREA 1.23 AC; BASIN IMPERVIOUSNESS — IMPERV. 2%; BASIN DESIGN POINT — 1

FILEPATH: K:\22040\ENGINEERING\DRAINAGE\DRAINAGE PLANS\DRAINAGE PLAN.DWG LAYOUT: MINOR DRAINAGE PLAN
PLOTTED BY: AIDAN LOWE

811 Know what's below. Call before you dig.

SCALE: 1" = 50' (50 0 50 100)

DESIGNED BY: LME
CHECKED BY: JDO
DRAWN BY: LME

ISSUE DATE: ##########

DATE	REVISION COMMENTS
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#	#
#	#
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#	#
#	#
#	#

HKS HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

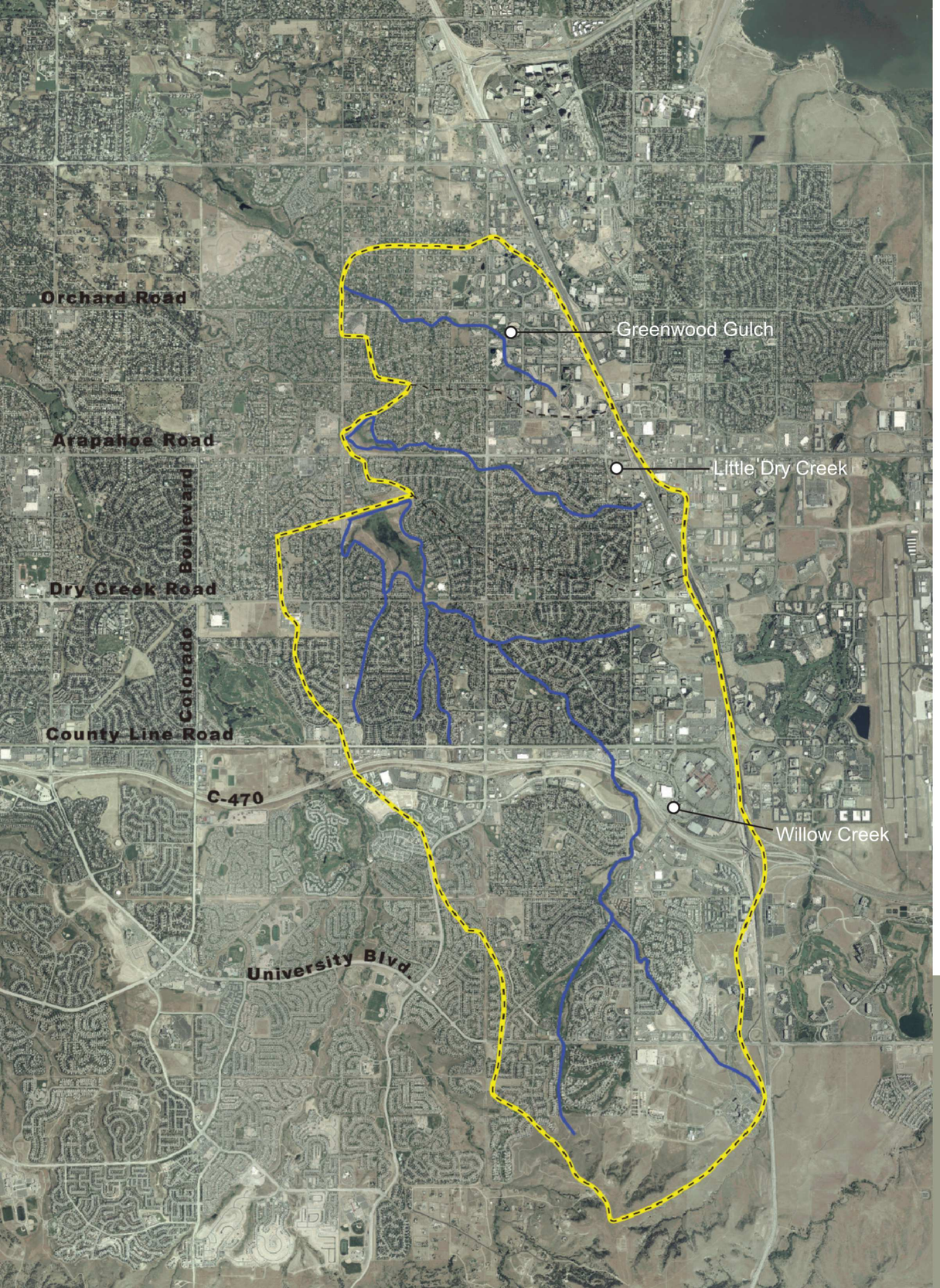
PARK MEADOWS MALL, LLC
PARK MEADOWS ANCHOR ACQUISITION

PARK MEADOWS - MIXED USE DEVELOPMENT
MINOR ##############

PROJECT #: ######
SHEET NUMBER
SW2
2 OF 2

APPENDIX F

Relevant Portions of Past Reports



Willow Creek, Little Dry Creek, and Greenwood Gulch Outfall Systems Planning Study

Planning Report

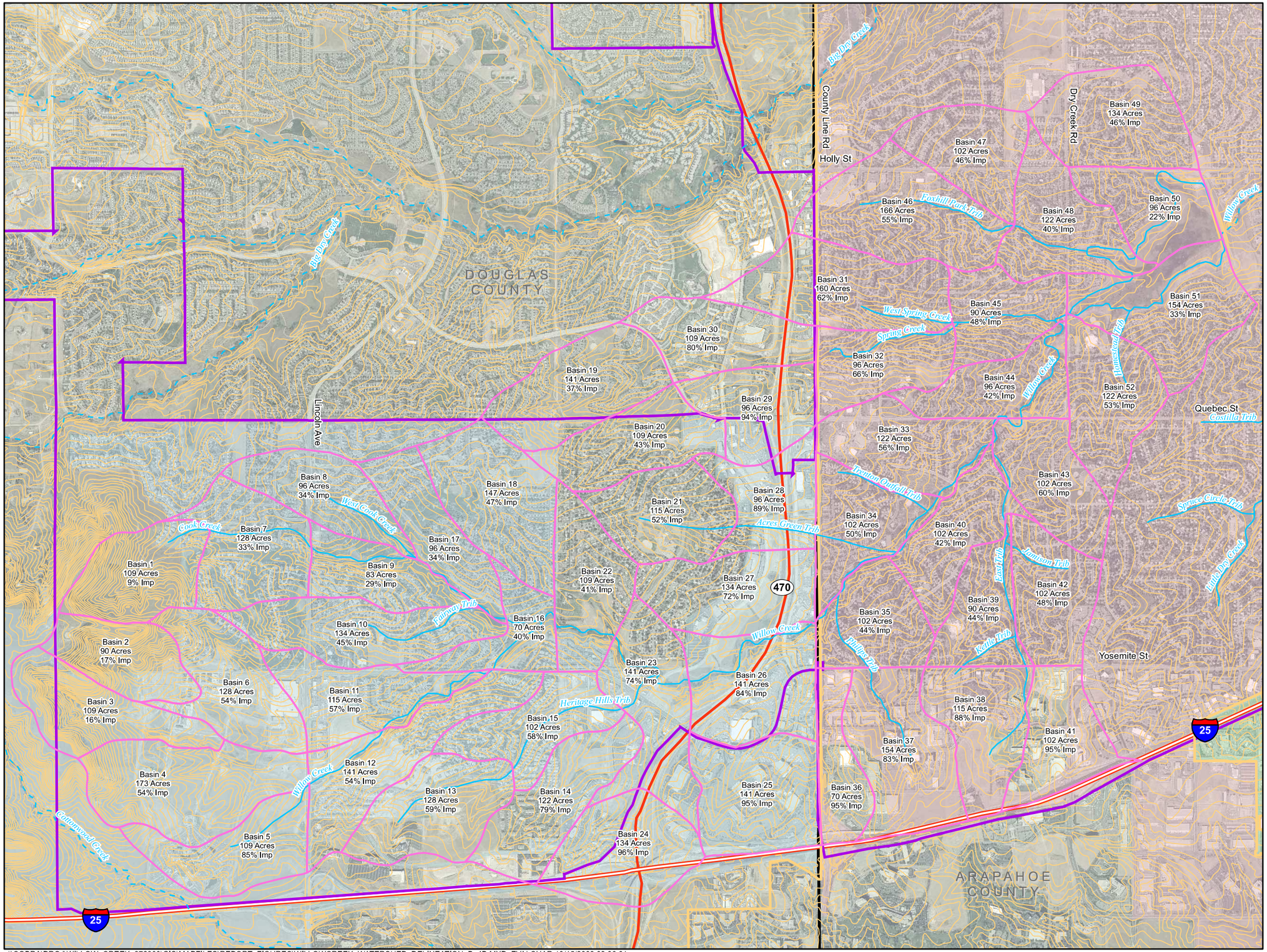
February 2010

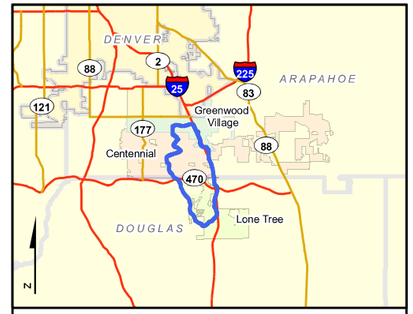
Prepared for

Prepared by

CH2MHILL

9191 South Jamaica Street
Englewood, CO 80112-5946





Watershed Location

Willow Creek, Litte Dry Creek, and Greenwood Gulch Outfall Systems Planning Study

Legend

- Studied Stream Reaches
- Non Studied Streams Reaches
- USGS 10ft Contours
- SEMSWA Service Area
- SSPRD Boundary
- County Boundary

Watershed

- Willow Creek

Municipalities

- Centennial
- Greenwood Village
- Lone Tree

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Feet

WILLOW CREEK BASIN DELINEATION FIGURE B-4B

CH2MHILL

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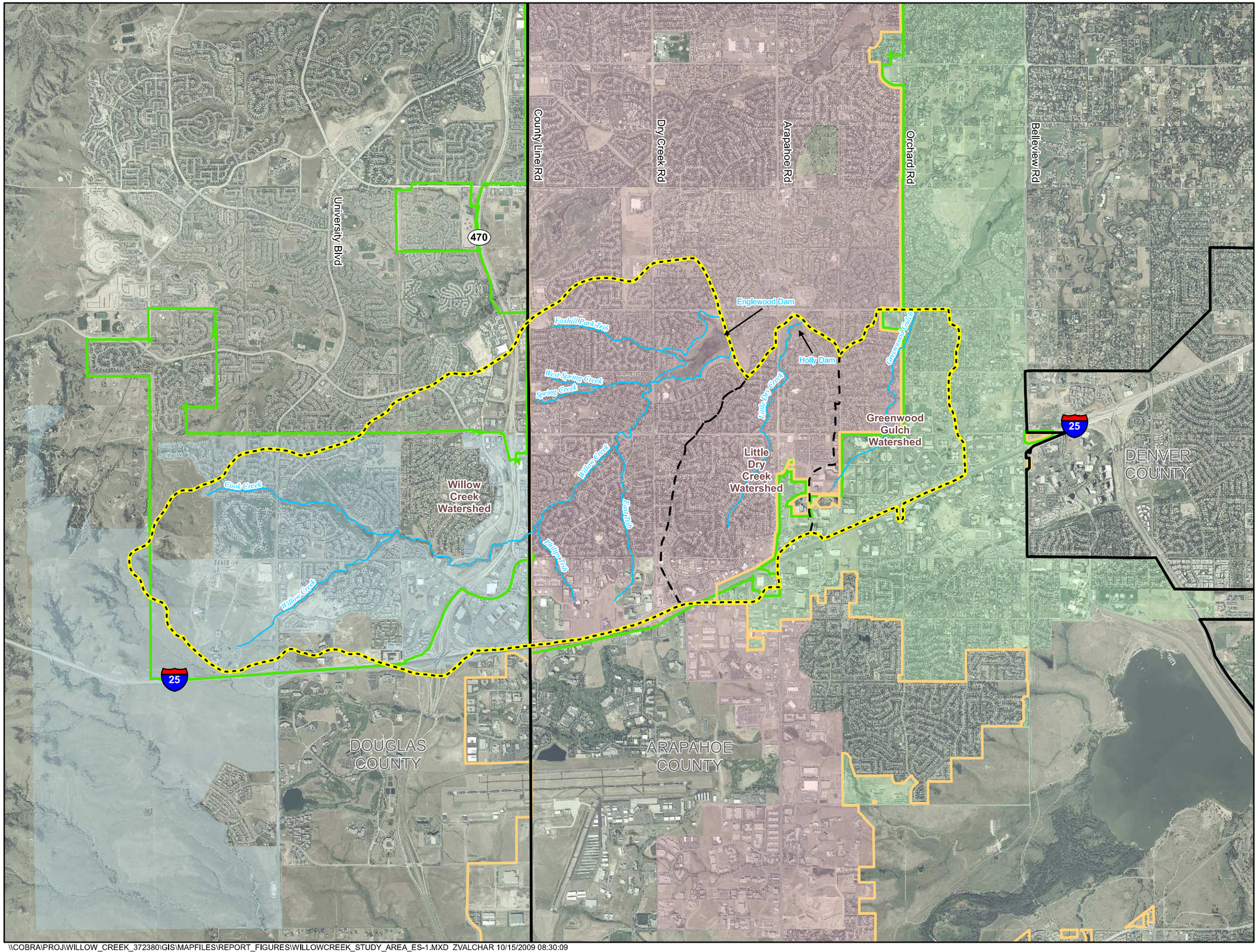

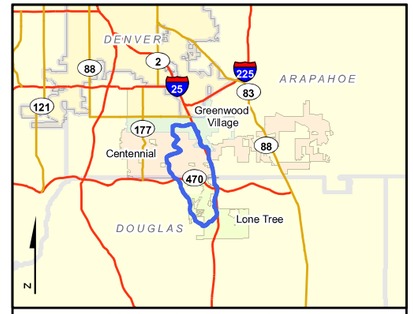

Watershed Location

Willow Creek, Little Dry Creek, and Greenwood Gulch Outfall Systems Planning Study

Legend

- Perennial Streams and Creeks
- Study Area
- Watershed Boundary
- SEMSWA Service Area
- SSPRD Boundary
- County Boundary

Municipalities

- Centennial
- Greenwood Village
- Lone Tree

Note: Urban Drainage and Flood Control District Service Area encompasses entire mapped area shown

W S N E

0 2,000 4,000

Feet

WILLOW CREEK, LITTLE DRY CREEK, AND GREENWOOD GULCH STUDY AREA FIGURE ES-1

CH2MHILL

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Repair Alternative Commentary Page 7

Willow Creek - Willow Creek Part to Park Meadows Drive (Station 130+00 to Station 200+00)

Acres Green Tributary

Reach Description - Willow Creek, UDFCD Drainageway ID 5402, has the largest contributing area to the downstream project limit of Holly Street. In general, flow in the Willow Creek watershed is from the south to the north and has approximately 15.4 miles of stream length including tributaries. The Willow Creek drainageway includes a series of tributary streams that make up the stream network for the watershed. The channel continues toward the northwest and parallels the north side of the Willow Creek Park. The channel through this reach is similar to the channel immediately upstream with large trees and mature vegetation. Willow Creek crosses Mineral Drive and flows toward the Quebec Street crossing and the confluence with the East Tributary. The reach between Mineral Drive and Quebec Street also has very mature vegetation and large trees. There are locations of bank erosion mostly located at the outside of channel bends. The channel grade has been stabilized by a large concrete baffle shoot drop structure located downstream of the confluence with the East Tributary.

The East Tributary to Willow Creek flows from east to west and originates in the Panorama Park office park. The runoff from the commercial area is collected in the Panorama Park stormwater detention pond just east of Yosemite Street. The pond discharges to the East Tributary into a linear park that is bordered by single family homes. For much of the channel between Yosemite and Rosemary Way the low flow channel is boulder lined, and the overbanks are maintained turf grass. Through this reach there are multiple pedestrian crossings of the channel as well as grouted boulder drop structures. Downstream of the Rosemary Way crossing the channel parallels Jamison Drive and is no longer in a linear park. The channel between the confluence with the main stem of Willow Creek and Rosemary Way is trapezoidal in shape with an approximately 8' wide bottom and native grass lined channel banks. There are a few drop structures that are providing channel grade control through this reach.

Willow Creek Repair Alternative Improvements - Channel bank stabilization is required in multiple locations of Willow Creek, most frequently along the outside of channel bends, the existing grade control structures . Sediment deposition needs to be removed at the outfall of the County Line box culvert. Outfall protection is required at the pipe outfall from the eastern collection system just upstream of County Line Road.

Acres Green Tributary Repair Alternative Improvements - Perform a collection system repair at Phillips Circle to increase the capacity.

Drainageway	Jurisdiction	Item	Unit	Quantity	Unit Cost	Total Cost	Reach Cost
Acres Green Tributary	Centennial/SEMSWA	Increase Collection System Capacity	LS	1	$ 50,000	$ 50,000	
		Mobilization Costs (5% of Drainageway Costs)				$ 2,500	
		Utility Costs (5% of Drainageway Costs)				$ 2,500	
		Contingency (30%)				$ 16,500	
		Engineering, Admin, Legal Services (20%)				$ 11,000	**$ 82,500**
Willow Creek (STA 130+00 to 153+00)	Centennial/SEMSWA	Soil Riprap Armoring	CY	500	$ 65	$ 32,500	
		Earthwork (Haul off site)	CY	950	$ 20	$ 19,000	
		Revegetation	AC	0.25	$ 2,500	$ 625	
		Low Flow Channel Repair	LF	1000	$ 100	$ 100,000	
		Mobilization Costs (5% of Drainageway Costs)				$ 7,606	
		Utility Costs (5% of Drainageway Costs)				$ 7,606	
		Contingency (30%)				$ 50,201	
		Engineering, Admin, Legal Services (20%)				$ 33,468	
		Operations & Maintenance (50-years)	LS	1	$ 107,900	$ 107,900	**$ 358,906**
Willow Creek (STA 153+00 to 200+00)	City of Lone Tree	Low Flow Channel Repair	LF	250	$ 100	$ 25,000	
		Water Quality Outlet Structure	EA	1	$ 20,000	$ 20,000	
		Earthwork (Haul off site)	CY	41000	$ 20	$ 820,000	
		Soil Riprap Armoring	CY	10900	$ 65	$ 708,500	
		Outlet Protection	EA	1	$ 25,000	$ 25,000	
		Revegetation	AC	4.5	$ 2,500	$ 11,250	
		Mobilization Costs (5% of Drainageway Costs)				$ 80,488	
		Utility Costs (5% of Drainageway Costs)				$ 80,488	
		Contingency (30%)				$ 531,218	
		Engineering, Admin, Legal Services (20%)				$ 354,145	
		Operations & Maintenance (50-years)	LS	1	$ 218,100	$ 218,100	**$ 2,874,188**

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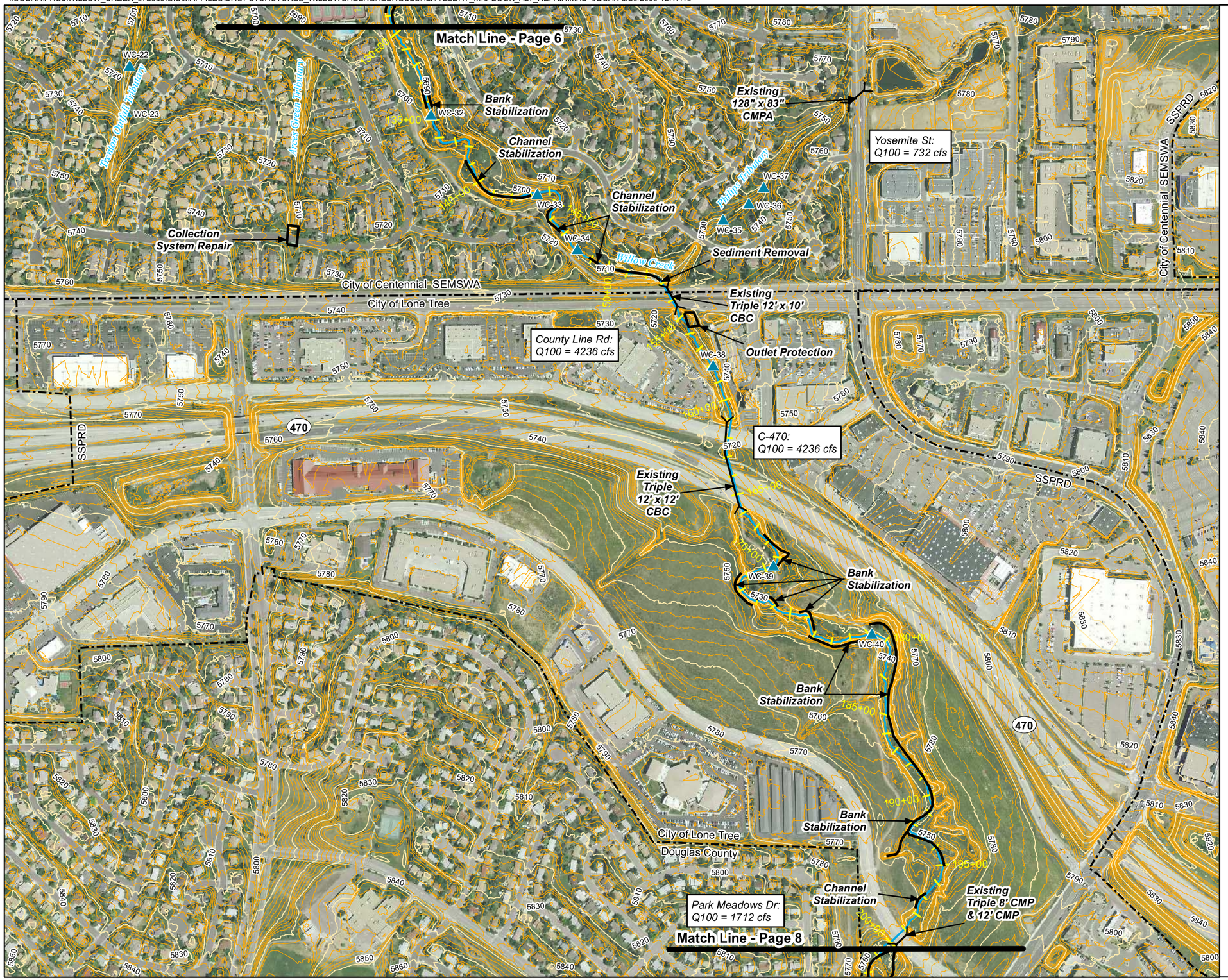

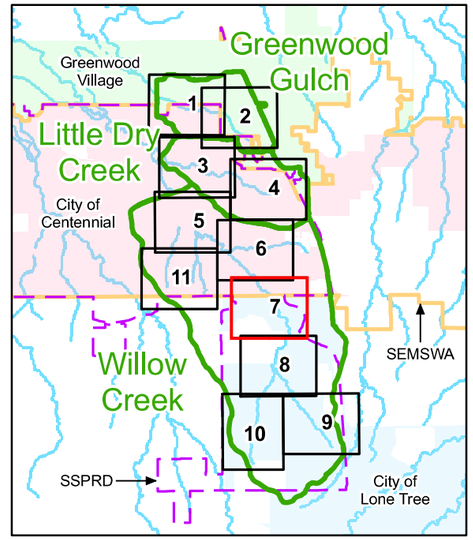

LEGEND

- Jurisdictional Boundary
- Watershed Boundary
- Existing Detention

Existing Drop Structures

- Greenwood Gulch
- Little Dry Creek
- Willow Creek

Alternatives

- Repair Alternative

N
W E
S

Repair Alternative
Willow Creek
Acres Green Tributary
Trenton Outfall Tributary
Phillips Tributary

0 250 500
Feet

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Repair Alternative Commentary Page 8

Willow Creek - Park Meadows Drive to Upstream of Yosemite Street (Station 200+00 to Station 268+00)

Cook Creek - Station 0+00 to Station 25+00

Reach Description - Cook Creek is an approximately 1.6 mile long tributary to Willow Creek located entirely in the City of Lone Tree. The upper reaches of Cook Creek are bordered by single family residential development. In the past, the channel was been improved with grouted boulder drop structures and turf grass overbanks. Much of the channel travels through Lone Tree Golf Course, where the channel is characterized by dense willows along the water edge and a series of drop structures to control the grade. The channel flows into a large storm water detention pond that has a large permanent pool and is a feature on the golf course. The outfall of the pond passes under Lone Tree Parkway and discharges adjacent to the Lone Tree Civic Center. Cook Creek continues to the north through an open space area and confluences with the main stem of Willow Creek at Cook Creek Park located North of Lone Tree Parkway and West of Yosemite St. The Main Stem of Willow Creek has a bike trail that parallels the channel from this reach to the downstream limits of the study at Englewood Dam. The channel through this reach is deep and narrow with locations of low flow channel degradation and bank erosion. Vegetation in this reach is mature with various tree species, willows, and native grasses. The channel continues to the north and crosses both Maximus Drive and Park Meadows Drive. As the channel leaves the open space and enters a more urbanized setting the vegetation along the channel is characterized by more grasses and fewer willows and trees.

Cook Creek Repair Alternative Improvements - Stabilize the channel banks between stations 25+00 to 30+00. Complete costs for this repair are included on Sheet 10. Only O&M costs are accounted for on this sheet.

Willow Creek Repair Alternative Improvements - Repair the channel between stations 247+30 and 249+30. Install a water quality outlet structure at the existing Willow Creek Regional Pond outlet. Stabilize the bank between stations 263+10 and 264+90 and between stations 266+20 and 267+50. Stabilize the low flow channel between stations 203+00 and 206+55, 209+20 and 210+60, and between stations 228+50 and 230+30. Stabilize the bank between stations 212+50 and 216+00, including the tributary coming in from the southwest at station 215+00. Stabilize the banks between stations 218+00 and 220+00, and between stations 220+90 and 222+30. Stabilize the low flow channel between stations 200+00 and 203+00, including the Heritage Hills Tributary. Stabilize the bank between stations 223+00 and 224+45, and between stations 230+50 and 232+30. Stabilize the low flow channel between stations 234+00 and 238+40.

Drainageway	Jurisdiction	Item	Unit	Quantity	Unit Cost	Total Cost	Reach Cost
Cook Creek (STA 0+00 to 26+00)	City of Lone Tree	Operations and maintenance (50 years)	LS	1	$ 122,000	$ 122,000	**$ 122,000**
Willow Creek (STA 203+00 to 232+00)	Douglas County	Low Flow Channel Repair	LF	1650	$ 100	$ 165,000	
		Earthwork (Haul off site)	CY	13500	$ 20	$ 270,000	
		Soil Riprap Armoring	CY	4500	$ 65	$ 292,500	
		Revegetation	AC	2	$ 2,500	$ 5,000	
		Mobilization Costs (5% of Drainageway Costs)				$ 36,625	
		Utility Costs (5% of Drainageway Costs)				$ 36,625	
		Contingency (30%)				$ 241,725	
		Engineering, Admin, Legal Services (20%)				$ 161,150	
		Operations & Maintenance (50-years)	LS	1	$ 136,000	$ 136,000	**$ 1,344,625**
Willow Creek (STA 232+00 to 268+00)	City of Lone Tree	Low Flow Channel Repair	LF	600	$ 100	$ 60,000	
		Earthwork (Haul off site)	CY	2970	$ 20	$ 59,400	
		Soil Riprap Armoring	CY	1155	$ 65	$ 75,075	
		Revegetation	AC	0.5	$ 2,500	$ 1,250	
		Water Quality Outlet Structure	EA	1	$ 20,000	$ 20,000	
		Mobilization Costs (5% of Drainageway Costs)				$ 10,786	
		Utility Costs (5% of Drainageway Costs)				$ 10,786	
		Contingency (30%)				$ 71,189	
		Engineering, Admin, Legal Services (20%)				$ 47,460	
		Operations & Maintenance (50-years)	LS	1	$ 168,900	$ 168,900	**$ 524,846**

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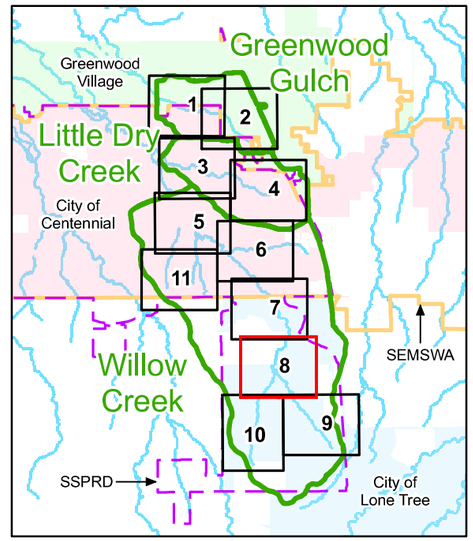

LEGEND

- Jurisdictional Boundary
- Watershed Boundary
- Existing Detention

Existing Drop Structures

- Greenwood Gulch
- Little Dry Creek
- Willow Creek

Alternatives

- Repair Alternative

N W E S

Repair Alternative
Willow Creek
Heritage Hills Tributary
Fairway Tributary
Cook Creek
Page 8

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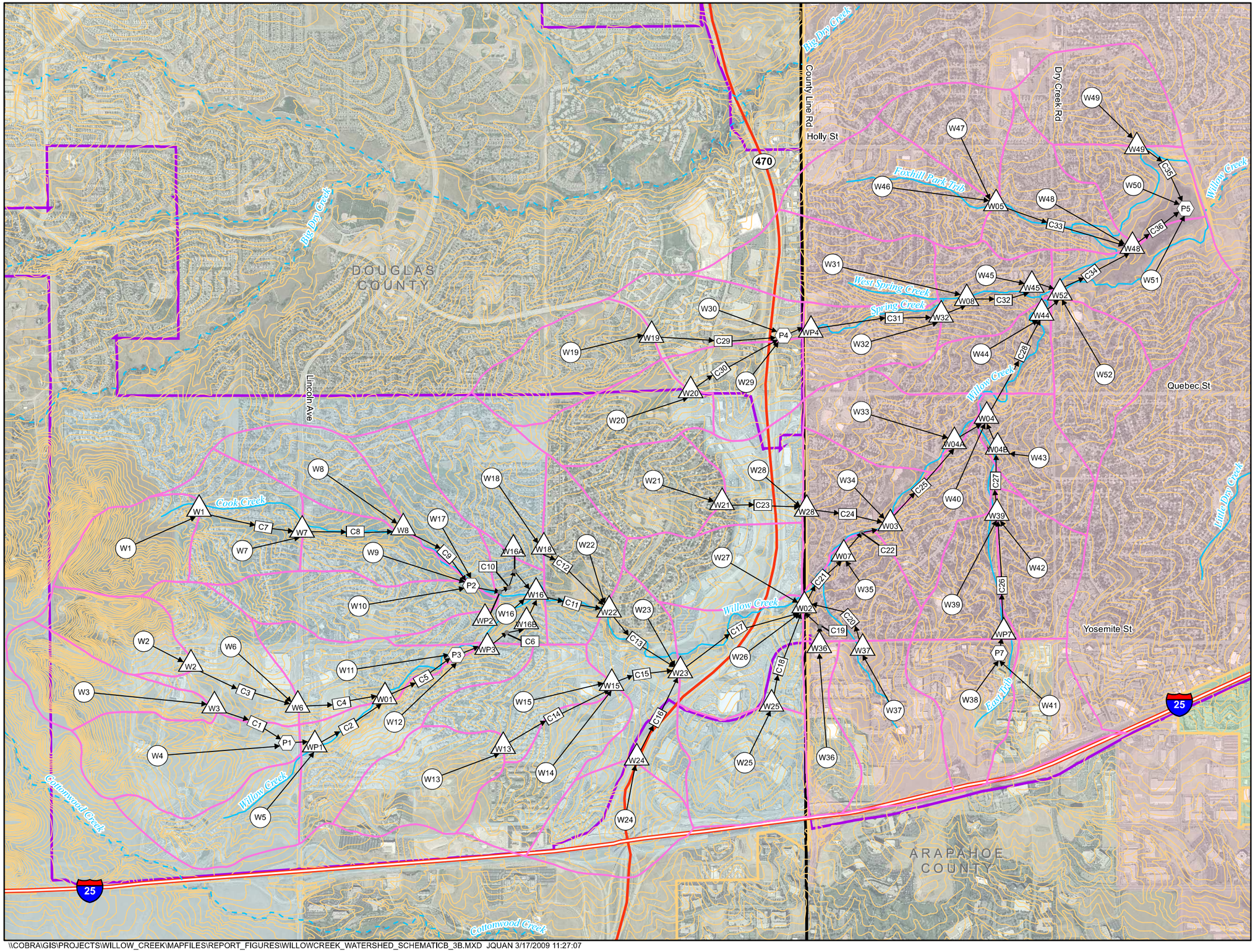

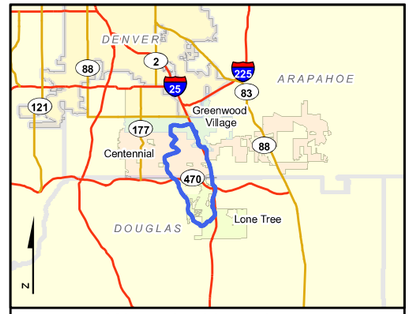

Watershed Location

Willow Creek, Litte Dry Creek, and Greenwood Gulch Outfall Systems Planning Study

Legend

- Studied Stream Reaches
- Non Studied Stream Reaches
- USGS 10ft Contours
- County Boundary
- SEMSWA Service Area
- SSPRD Boundary

Watershed

- Willow Creek

Municipalities

- Centennial
- Greenwood Village
- Lone Tree

- Conveyance Element
- Pond
- Flow Junction
- Flow Direction
- Basin

W
S
N
E

0 1,000 2,000
Feet

WILLOW CREEK MODEL SCHEMATIC FIGURE B-6B

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