PRELIMINARY DRAINAGE REPORT

6601 COLORADO BOULEVARD INDUSTRIAL AT CLAIRE AND ALYSSA INDUSTRIAL SUBDIVISION

Commerce City, Colorado

PREPARED FOR:
6601 COLORADO HOLDING, LLC
2551 N York St
Denver, CO 80205
Attn: Karl Umland

PREPARED BY:
Galloway & Company, Inc.
5500 Greenwood Plaza Blvd, Suite 200
Greenwood Village, CO 80111
Attn: Jenny Romano

PREPARED:
October 24, 2022

REVISED:
September 27, 2023

ENGINEER'S STATEMENT

I affirm that this report and plan for the Final drainage design for 6601 Colorado Holding, LLC was prepared by me (or under my direct supervision) in accordance with the provisions of the Commerce City Storm Drainage Design and Technical Criteria Manual for the owners thereof. I understand that the City of Commerce City does not and will not assume liability for drainage facilities designed by others.

Jennifer Romano, PE #44401 Date
For and on behalf of Galloway & Company, Inc.

DEVELOPER'S CERTIFICATION

"6601 Colorado Holding, LLC hereby certifies that the drainage facilities for the 6601 Colorado Boulevard Industrial facility shall be constructed according to the design presented in this report. I understand that the City of Commerce City does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the City of Commerce City reviews drainage plans pursuant to the Municipal Code; but cannot, on behalf of 6601 Colorado Holding, LLC, guarantee that final drainage design review will absolve 6601 Colorado Holding, LLC and/or their successors and/or assigns of future liability for improper design."

Authorized Signature Date
6601 Colorado Holding, LLC – Karl Umland

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I. General Location and Description

Location

The 6601 Colorado Holding site, is located on a parcel of land situated in the SW ¼ of Section 1, Township 3 south, Range 68 West of the 6th Principal Meridian, Commerce City, County of Adams, State of Colorado. The site is currently developed as a light vehicle storage yard, unused fields, a small collection of storage buildings, and two single family residences. The site is bound by Colorado Boulevard to the east, industrial private lots to the north and south, and the O'Brian canal to the west. See Appendix A for a Vicinity Map of the site.

Description of Property

The site is currently developed as a storage yard with a few acres of unused field area and is zoned I-1 light industrial and AG agricultural. The project seeks to rezone the site as medium industrial (I-2). The area of disturbance is estimated to be approximately 11.36. acres. The west half of the site generally slopes to the northwest at 1-3% slopes while the east portion of the site slopes at less than 1% generally to the east.

According to the USDA NRCS Web Soil Survey for Adams County the site contains Terrace escarpments and Vona sandy loam, 0 to 1 percent, which are both classified as Hydrologic Soil Group A. Refer to Appendix A for soil survey information.

There are no known existing irrigation canals or irrigation ditches on the project site. There are no wetlands present on-site. O'Brian canal is located directly west of the site and will not be impacted by this development. Surrounding properties to the north and south of the site are zoned for industrial (I-1 and I-2). There's an existing Suncor pipeline easement along the south edge of the property as well as an easement for the O'Brian canal west of the site.

This report will present the proposed drainage design for this development, which includes regrading of the open yard of the site and a proposed warehouse building with associated paving on the east side of the site. On-site stormwater will be managed with a series of inlets connected to an infiltration pond. No existing connection to a public storm sewer exists or is proposed.

Proposed Project Description

The project proposes to demolish all existing buildings on site as well as two existing water wells. The existing yard composing the majority of the site will be regraded to discourage ponding on site and route surface runoff to a proposed infiltration pond at the southwest corner of the site. A 30,000 SF light industrial building is proposed on the east side of the site. Paved parking and access drives surround the proposed building. Additional site improvements include installation of an approximately 263,260 SF reclaimed asphalt storage yard, utility services to the building, additional fencing and new access gates, site lights, and landscaping improvements. The development will be served by two access points along Colorado Boulevard.

Drainage Studies Relevant to the Site

There are no known drainage studies relevant to the site or adjacent areas.

II. Drainage Basins and Sub-Basins

Existing Basin Description

The majority of the existing site, primarily the western section of the property, sheet flows west and outfalls to the existing O'Brian Canal. The remainder of the site is sloped at less than 1% generally sloping to the east. There are no existing detention or water quality facilities located on the project site

and there is no existing storm infrastructure in close proximity to the site. The proposed development will include stormwater infrastructure to collect and infiltrate water on site at a pond located in the southeast corner of the site. No offsite basins are accounted for in the proposed drainage design. No history of flooding is documented at the site as shown in the FEMA FIRM included in Appendix A of this report.

Proposed Sub-Basin Descriptions

The proposed drainage plan for the site consists of nine drainage basins over the 11.55 acre site

As will be discussed later, the below proposed basin coverages are not reflected in the infiltration pond sizing. The pond has been sized to accommodate potential future use. In the existing and proposed condition, no off-site flows are anticipated to flow on site. Below is a breakdown of the site coverages as proposed:

Basin A-1 (0.69 acres) represents the proposed building roof area. Downspouts on the south side of the building route runoff to the concrete and asphalt paved area south of the building before runoff is collected and piped to the proposed infiltration pond.

Basin A-2 and A-3 (0.87 and 1.07 acres respectfully) are located on the eastern side of the site and consist of mostly paved areas surrounding the proposed building. They consist of asphalt and concrete pavement, sidewalks, and landscaping. Drainage from the basins is collected at a pair of inlets north and south of the proposed building. These inlets are routed to the proposed infiltration pond.

Basin A-4 through A-7 (2.90, 0.17, 1.87, and 3.65 acres respectfully) are located on the west portion of the site. The majority of this area is proposed as reclaimed asphalt storage/parking areas. Landscaping surrounds the yard. The individual basins are broken apart by drainage point. Runoff within basins A-4, A-5, and A-6 are routed by grass-lined swales and collected by inlets placed at low spots on the site. These inlets discharge to the proposed infiltration pond. Meanwhile, Basin A-7 sheet flows to the proposed infiltration pond.

Basin B-1 (0.13 acres) is located on the eastern most edge of the site. Due to proposed grading, this area is unable to be collected on site and is discharged to Colorado Boulevard.

Basing C-1 (0.19 acres) represents the landscaped edge of the existing canal that is infeasible to route to the proposed pond. Runoff on this sliver of land routes to the drainage ditch.

III. Design Criteria

Regulations

The proposed drainage design complies with the Mile High Flood District *Urban Storm Drainage Criteria Manual* and the Commerce City *Storm Drainage Design and Technical Criteria Manual*.

Hydrology

The drainage calculations will be based on the *Storm Drainage Design and Technical Criteria Manual*. The design point rainfall values listed below will be utilized in the design calculations at a later stage in the project. These values were obtained from Chapter 5.2 of the *Storm Drainage Design and Technical Criteria Manual* (refer to Appendix A).

	Average Recurrence Interval (years)				
Duration	**2**	**5**	**10**	**50**	**100**
60-min	0.97	1.37	1.55	2.24	2.58

The time of concentration for each basin is assumed to be 5 minutes, which is based on the minimum allowable standards per the *Urban Storm Drainage Criteria Manual, Chapter 6*.

The rational method will used to calculate peak flows as the tributary areas are less than 100 acres. The rational method has proven to be accurate for basins of this size and is based on the following formula:

$$Q = CIA$$

Where:

Q = Peak Discharge (cfs)
C = Runoff Coefficient
I = Runoff Intensity (inches/hour)
A = Drainage Area (acres)

Hydraulics

Sheet flow, swales, and inlets shall convey runoff through the site to the designated infiltration pond. The WQCV water surface elevation, EURV water surface elevation, and 100-year water surface elevation were calculated using the Mile High Flood District Detention Basin Design Workbook (refer to Appendix C).

Water Quality Enhancement

The proposed infiltration pond will provide water quality for approximately 97.2% of the site, which meets the state MS4 permit requirement of 80% minimum. The remaining 0.32 acres (Basins B-1 and C-1) of the site will flow offsite untreated since it is infeasible to capture and treat runoff from these areas, as allowed by the MS4 permit. The proposed infiltration pond will be seeded and grown to established vegetation that will assist in the removal of soluble pollutants such as phosphorous and nitrogen through biological uptake. Sediment will be removed during the percolation process.

The site is required to disconnect impervious areas per section 14.3.1 of the City Storm Drainage Criteria Manual. 20% of the upstream impervious area must be disconnected via a combination of landscape buffers, swales, or permeable pavement. The project proposes to disconnect basin A-4 and A-6. These basins are characterized primarily by reclaimed asphalt yard area totaling 4.03 acres. Reclaimed asphalt is not counted as fully impervious. Instead, this area is modeled as 80% impervious which equates to 27.9% of the upstream impervious area of the total site. This fulfills the area requirements of section 14.3.1.

The area within these basins is disconnected via grass lined swales that convey water to inlets that discharge to the proposed infiltration pond on site. Calculations for these swales are provided in Appendix C. Specifically, swales 1, 6, and 7 (as identified on the drainage plan) have been analyzed. The entirety of the A-6 area was assumed to drain to swale 1. The flow in basin A-4 was split equally between swales 6 and 7. Swales 1 and 7 have slopes less than 2% in order to keep velocities below 1 ft/s. These two swales have underdrains that connect to the sump inlets at the end of each swale. In addition, the project proposes a series of riprap check dams within the swales to reduce swale velocities.

IV. Stormwater Management Facility Design

Stormwater Conveyance Facilities

Stormwater runoff will be conveyed through the site via sheet flow or vegetated swales, inlets, and pipes to the proposed infiltration pond.

Stormwater Storage Facilities

A single infiltration pond will be provided at the southwest corner of the site. Infiltration was chosen because there is no existing storm infrastructure available on or adjacent to the site to outfall detained runoff nor can it be released into the O'Brian Canal. Percolation testing was performed in three pits on site and established a design infiltration rate of 50 in/hr. Nearby sites have utilized a similar approach for drainage conformance in Commerce City. As proposed, a majority of the site is proposed as a reclaimed asphalt paving yard suitable for storage or parking. Per coordination with Commerce City, the impervious value for reclaimed/recycled asphalt has been taken from the City of Fort Collins Criteria Manual, Chapter 5 Table RO-11. This table provides an impervious value of 80% for gravel areas. In Appendix B the composite percent impervious calculations show that this approach leads to an overall basin imperviousness of 63.1%. Therefore, the pond is sufficiently sized for the proposed development with additional capacity for further impervious development on the site.

A MHFD-Detention spreadsheet was utilized to calculate the 100-year water surface elevation for the pond. The 1-hour point rainfall data built into this spreadsheet was utilized. The Rain Garden – Bioretention BMP was used since this provides the most accurate approximation for an infiltration pond. The infiltration pond was sized for two times the required 100-year detention volume per Commerce City requirements. The percolation test performed by Ground indicates a design percolation rate of 50 in/hr. For the pond bottom area of 12,306 SF, this corresponds to an outflow rate of 14.24 cfs. An underdrain for the Rain Garden BMP was sized to match this infiltration rate. Because additional detention volume was provided a factor of safety was not applied to the release rates of the pond. The required design volume (2*100-year detention volume) is 2.65 acre-feet. Based on the MHFD-Detention spreadsheet the provided storage volume in the 100-year storm event is 2.92 acre-feet.

V. Conclusions

Compliance with Standards

The proposed storm drainage design has been performed in accordance with applicable sections of the MHFD *Urban Storm Drainage Criteria Manual*, the Commerce City *Storm Drainage Design and Technical Criteria Manual*, and sound engineering principles. The proposed improvements will modify existing drainage patterns to limit runoff currently running to neighboring properties or the existing canal by diverting flows to the proposed infiltration pond. The design shows that the runoff from the proposed and existing site improvements will be safely conveyed and treated with no adverse effects to downstream systems. Detailed calculations provided in this report show the design will be adequate for the proposed development.

VI. References

1. Urban Storm Drainage Criteria Manual, Mile High Flood District, August 2018 (with current revisions).

2. Storm Drainage Design and Technical Criteria Manual, City of Commerce City, May 2023.

3. Fort Collins Stormwater Criteria Manual, City of Fort Collins, December 2018.

4. Soil Map – Adams County, Colorado as available through the Natural Resources Conservation Service National Cooperative Soil Survey web site via Web Soil Survey 2.0.

APPENDIX A – Reference Material

Vicinity Map

NRCS Soils Map

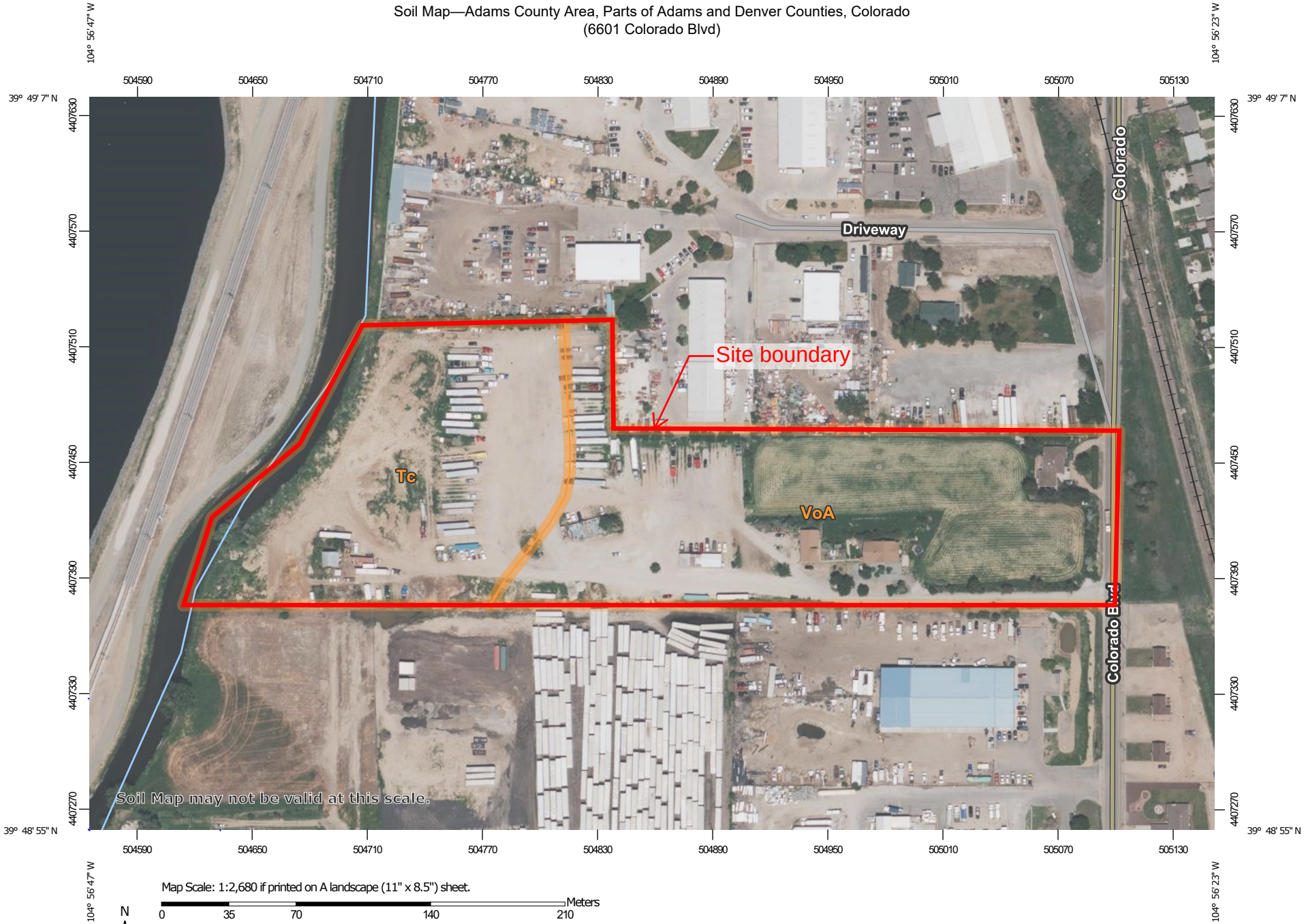
FEMA FIRM

N

VICINITY MAP

NTS

Soil Map—Adams County Area, Parts of Adams and Denver Counties, Colorado
(6601 Colorado Blvd)



Map Scale: 1:2,680 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 35 70 140 210

Feet
0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 18, Aug 31, 2021

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

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

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Tc	Terrace escarpments	5.3	42.9%
VoA	Vona sandy loam, 0 to 1 percent slopes	7.1	57.1%
Totals for Area of Interest		**12.4**	**100.0%**

National Flood Hazard Layer FIRMette

FEMA

104°56'49"W 39°49'14"N

104°56'12"W 39°48'46"N

Feet

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

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 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 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 2/7/2023 at 2:27 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 – Hydrology Calculations

COMPOSITE % IMPERVIOUS CALCULATIONS

Subdivision: Lot 1, CLAIRE AND ALYSSA INDUSTRIAL SUBDIVISION
Location: CO, Commerce City

Project Name: 6601 Colorado Blvd
Project No.: 6CH01
Calculated By: MSJ
Checked By: JRR
Date: 2/7/22

Basin ID	Total Area (ac)	Paved Roads			Lawns			Roofs			Reclaimed Asphalt Surfacing			Basins Total Weighted % Imp.	
		% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.		
A-1	0.69	100	0.00	0.00	0	0.00	0.00	90	0.69	90.20	80	0.00	0.00	90.20	
A-2	0.87	100	0.63	72.69	0	0.24	0.00	90	0.00	0.00	80	0.00	0.00	72.69	
A-3	1.07	100	1.03	95.87	0	0.05	0.00	90	0.00	0.00	80	0.00	0.00	95.87	
A-4	2.90	100	0.00	0.00	0	0.24	0.00	90	0.00	0.00	80	2.66	73.50	73.50	
A-5	0.17	100	0.00	0.00	0	0.17	0.00	90	0.00	0.00	80	0.00	0.00	0.00	
A-6	1.87	100	0.00	0.00	0	0.50	0.00	90	0.00	0.00	80	1.37	58.60	58.60	
A-7	3.65	100	0.00	0.00	0	1.47	0.00	90	0.00	0.00	80	2.19	47.90	47.90	
B-1	0.14	100	0.04	28.57	0	0.10	0.00	90	0.00	0.00	80	0.00	0.00	28.57	
C-1	0.19	100	0.00	0.00	0	0.19	0.00	90	0.00	0.00	80	0.00	0.00	0.00	
Total	11.55	100	1.70	14.71	0	2.96	0.00	90	0.69	5.40	80	6.22	43.10	63.21	Total Site As Designed

COMPOSITE % IMPERVIOUS CALCULATIONS

Subdivision: Lot 1, CLAIRE AND ALYSSA INDUSTRIAL SUBDIVISION
Location: CO, Commerce City

Project Name: 6601 Colorado Blvd
Project No.: 6CH01
Calculated By: MSJ
Checked By: JRR
Date: 2/7/22

Basin ID	Total Area (ac)	Paved Roads			Lawns			Roofs			Reclaimed Asphalt Surfacing			Basins Total Weighted % Imp.	
		% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.		
A-1	0.69	100	0.00	0.00	0	0.00	0.00	90	0.69	90.20	80	0.00	0.00	90.20	
A-2	0.87	100	0.63	72.69	0	0.24	0.00	90	0.00	0.00	80	0.00	0.00	72.69	
A-3	1.07	100	1.03	95.87	0	0.05	0.00	90	0.00	0.00	80	0.00	0.00	95.87	
A-4	2.90	100	0.00	0.00	0	0.24	0.00	90	0.00	0.00	80	2.66	73.50	73.50	
A-5	0.17	100	0.00	0.00	0	0.17	0.00	90	0.00	0.00	80	0.00	0.00	0.00	
A-6	1.87	100	0.00	0.00	0	0.50	0.00	90	0.00	0.00	80	1.37	58.60	58.60	
A-7	3.65	100	0.00	0.00	0	1.47	0.00	90	0.00	0.00	80	2.19	47.90	47.90	
B-1	0.13	100	0.03	22.73	0	0.10	0.00	90	0.00	0.00	80	0.00	0.00	22.73	
C-1	0.19	100	0.00	0.00	0	0.19	0.00	90	0.00	0.00	80	0.00	0.00	0.00	
Total	11.55	100	1.69	14.64	0	2.96	0.00	90	0.69	5.40	80	6.22	43.10	63.14	Total Site As Designed

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Lot 1, CLAIRE AND ALYSSA INDUSTRIAL SUBDIVISION
Location: CO, Commerce City

Project Name: 6601 Colorado Blvd
Project No.: 6CH01
Calculated By: MSJ
Checked By: JRR
Date: 2/7/22

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					Tc CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (AC)	Hydrologic Soils Group	Impervious (%)	C_{100}	C_5	L (FT)	S (%)	T_i (MIN)	L (FT)	S (%)	Cv	VEL. (FPS)	T_t (MIN)	COMP. T_c (MIN)	TOTAL LENGTH (FT)	Urbanized T_c (MIN)	T_c (MIN)
A-1	0.69	A	90.2	0.81	0.75												5.0
A-2	0.87	A	72.7	0.68	0.57												5.0
A-3	1.07	A	95.9	0.86	0.82												5.0
A-4	2.90	A	73.5	0.68	0.58												5.0
A-5	0.17	A	0.0	0.11	0.00												5.0
A-6	1.87	A	58.6	0.57	0.44												5.0
A-7	3.65	A	47.9	0.48	0.34												5.0
B-1	0.14	A	28.6	0.33	0.17												5.0
C-1	0.19	A	0.0	0.11	0.00												5.0
Total	11.55	A	63.2	0.60	0.48												5.0
																	5.0

NOTES:

T_i = (0.395*(1.1 - C_5)*(L)^0.5)/((S)^0.33), S in ft/ft

T_t=L/60V (Velocity From Fig. 501)

Velocity V=Cv*S^0.5, S in ft/ft

Tc Check = 10+L/180

For Urbanized basins a minimum T_c of 5.0 minutes is required.

For non-urbanized basins a minimum T_c of 10.0 minutes is required

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Lot 1, CLAIRE AND ALYSSA INDUSTRIAL SUBDIVISION
Location: CO, Commerce City
Design Storm: 5-Year

Project Name: 6601 Colorado Blvd
Project No.: 6CH01
Calculated By: MSJ
Checked By: JRR
Date: 2/7/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
	1	A-1	0.69	0.75	5.0	0.52	4.79	2.5													Building Roof area
	1	A-2	0.87	0.57	5.0	0.49	4.79	2.3													Parking lot area north of building
	1	A-3	1.07	0.82	5.0	0.88	4.79	4.2													Parking lot area south of building
	1	A-4	2.90	0.58	5.0	1.68	4.79	8.0													Gravel lot, swale and inlet at north prop edge
	1	A-5	0.17	0.00	5.0	0.00	4.79	0.0													Landscape area, swale and inlet at north prop edge
	1	A-6	1.87	0.44	5.0	0.82	4.79	3.9													Gravel lot, swale and inlet along north and west edge
	1	A-7	3.65	0.34	5.0	1.24	4.79	5.9													Gravel lot, sheet flow to infiltration pond
									5.0	5.63	4.79	27.0									Total runoff from on-site to infiltration pond
	2	B-1	0.14	0.17	5.0	0.02	4.79	0.1													East frontage of site sheet flowing east to Colo. Blvd
									5.0	0.02	4.79	0.1									Total runoff from on-site to Colorado Blvd
	3	C-1	0.19	0.00	5.0	0.00	4.79	0.0													Existing area to remain. All Lscape. Sheet flow to canal
									5.0	0.00	4.79	0.0									Total runoff from on-site to O'Brian Canal

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

Subdivision: Lot 1, CLAIRE AND ALYSSA INDUSTRIAL SUBDIVISION
Location: CO, Commerce City
Design Storm: 100-Year

Project Name: 6601 Colorado Blvd
Project No.: 6CH01
Calculated By: MSJ
Checked By: JRR
Date: 2/7/22

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
	1	A-1	0.69	0.81	5.0	0.56	9.02	5.1													Building Roof area
	1	A-2	0.87	0.68	5.0	0.59	9.02	5.3													Parking lot area north of building
	1	A-3	1.07	0.86	5.0	0.92	9.02	8.3													Parking lot area south of building
	1	A-4	2.90	0.68	5.0	1.97	9.02	17.8													Gravel lot, swale and inlet at north prop edge
	1	A-5	0.17	0.11	5.0	0.02	9.02	0.2													Landscape area, swale and inlet at north prop edge
	1	A-6	1.87	0.57	5.0	1.07	9.02	9.7													Gravel lot, swale and inlet along north and west edge
	1	A-7	3.65	0.48	5.0	1.75	9.02	15.8													Gravel lot, sheet flow to infiltration pond
									5.0	6.88	4.79	33.0									Total runoff from on-site to infiltration pond
	2	B-1	0.14	0.33	5.0	0.05	9.02	0.5													East frontage of site sheet flowing east to Colo. Blvd
									5.0	0.05	4.79	0.2									Total runoff from on-site to Colorado Blvd
	3	C-1	0.19	0.11	5.0	0.02	9.02	0.2													Existing area to remain. All Lscape. Sheet flow to canal
									5.0	0.02	4.79	0.1									Total runoff from on-site to O'Brian Canal

APPENDIX C – Hydraulic Calculations

UD-Detention Spreadsheet

Emergency Spillway Sizing

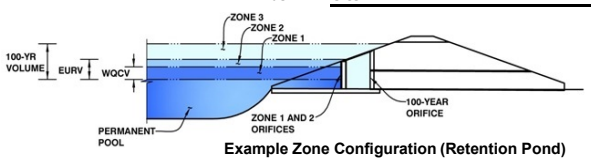
UD-BMP Spreadsheets for Swales

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: 6601 Colorado Boulevard

Basin ID: Site



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.63	0.185	Filtration Media
Zone 2 (EURV)	2.59	0.687	
Zone 3 (User)	#VALUE!	2.521	
Total (all zones)		3.392	

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

Underdrain Orifice Invert Depth =	1.00	ft (distance below the filtration media surface)	Underdrain Orifice Area =	1.6	ft^2
Underdrain Orifice Diameter =	17.25	inches	Underdrain Orifice Centroid =	0.72	feet

Calculated Parameters for Underdrain

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)

Invert of Lowest Orifice =		ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =		ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =		inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =		inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (optional)	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)								
Orifice Area (sq. inches)								

	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)

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

Calculated Parameters for Vertical Orifice

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

Calculated Parameters for Overflow Weir

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =	feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =	acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =	acre-ft

Calculated Parameters for Spillway

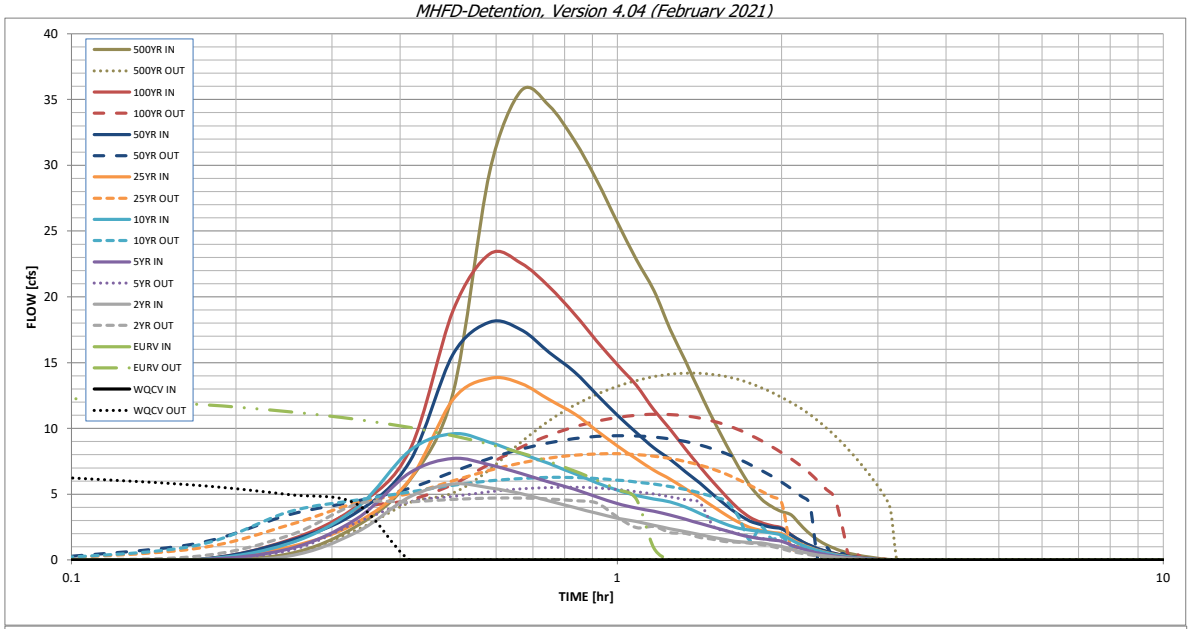
Routed Hydrograph Results

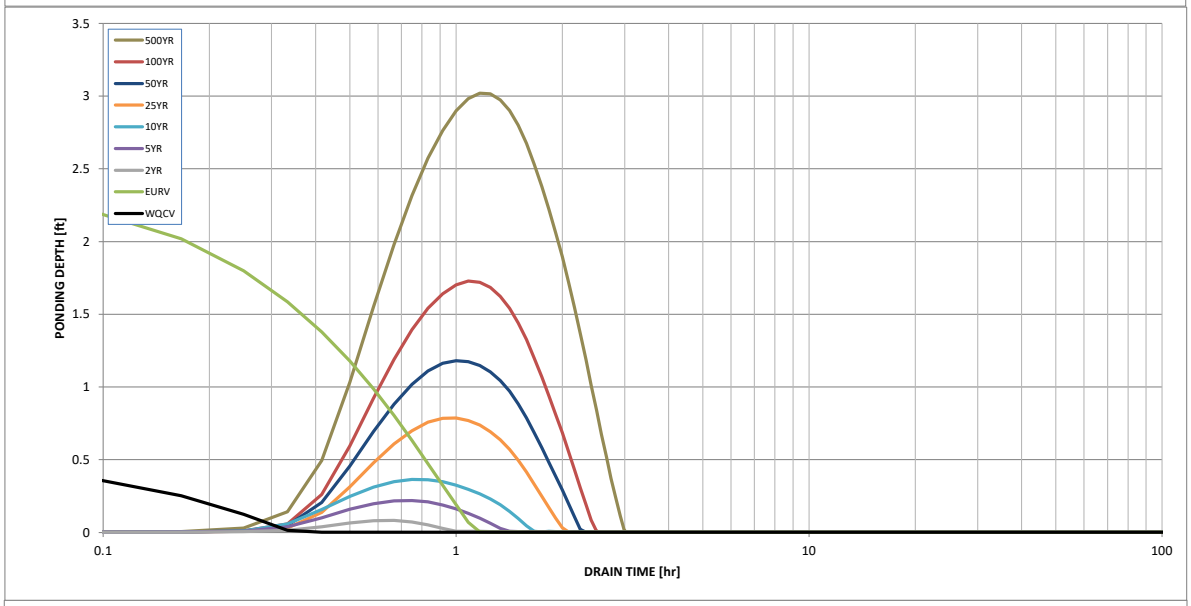
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

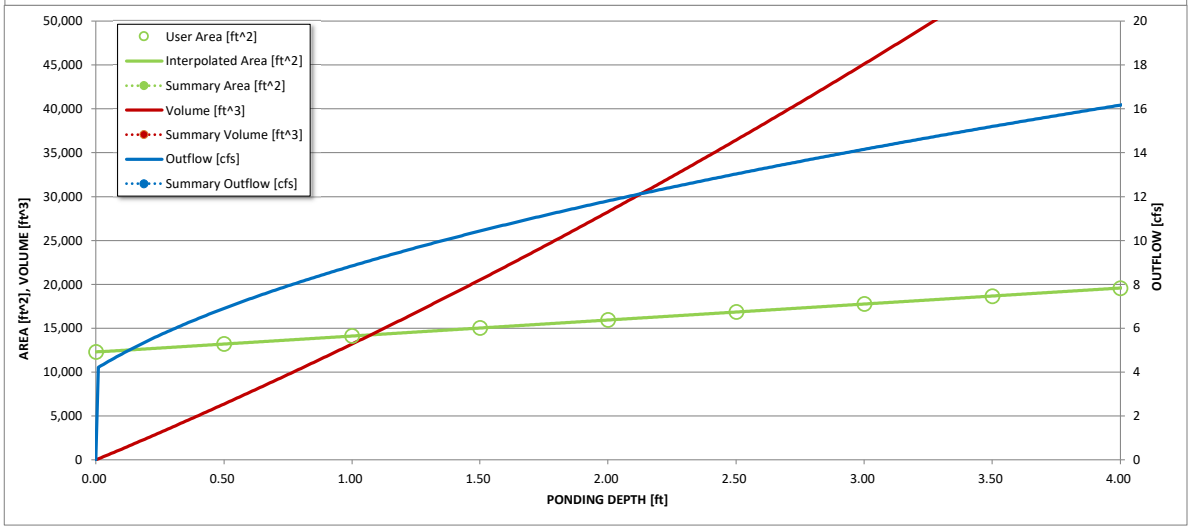
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.84	1.12	1.37	1.75	2.08	2.43	3.35
CUHP Runoff Volume (acre-ft) =	0.185	0.871	0.437	0.599	0.754	1.016	1.285	1.606	2.445
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.437	0.599	0.754	1.016	1.285	1.606	2.445
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.1	0.2	2.0	4.5	11.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.01	0.02	0.18	0.40	0.98
Peak Inflow Q (cfs) =	N/A	N/A	5.8	7.7	9.6	13.8	18.1	23.3	35.7
Peak Outflow Q (cfs) =	7.1	13.0	4.7	5.5	6.3	8.1	9.4	11.1	14.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	145.3	73.8	38.5	4.6	2.5	1.3
Structure Controlling Flow =	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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) =	0	1	1	1	2	2	2	2	3
Time to Drain 99% of Inflow Volume (hours) =	**0**	1	1	1	2	2	2	3	3
Maximum Ponding Depth (ft) =	0.63	2.59	0.08	0.22	0.36	0.79	1.18	1.73	3.02
Area at Maximum Ponding Depth (acres) =	0.31	0.39	0.29	0.29	0.30	0.32	0.33	0.35	0.41
Maximum Volume Stored (acre-ft) =	0.186	0.872	0.023	0.060	0.104	0.233	0.362	0.548	1.040

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48
	0:15:00	0.00	0.00	0.29	0.84	1.25	0.99	1.44	1.52	2.59
	0:20:00	0.00	0.00	2.12	3.13	3.97	2.84	3.63	4.09	6.05
	0:25:00	0.00	0.00	4.80	6.62	8.31	6.11	7.47	8.34	12.66
	0:30:00	0.00	0.00	5.77	7.71	9.59	12.19	15.63	18.93	29.50
	0:35:00	0.00	0.00	5.49	7.24	8.94	13.80	18.07	23.26	35.66
	0:40:00	0.00	0.00	5.05	6.57	8.09	13.42	17.51	22.55	34.53
	0:45:00	0.00	0.00	4.48	5.92	7.32	12.18	15.78	20.76	31.91
	0:50:00	0.00	0.00	3.99	5.38	6.56	11.12	14.32	18.72	28.88
	0:55:00	0.00	0.00	3.55	4.79	5.88	9.83	12.58	16.65	25.66
	1:00:00	0.00	0.00	3.18	4.28	5.30	8.67	11.01	14.84	22.86
	1:05:00	0.00	0.00	2.93	3.94	4.91	7.69	9.69	13.28	20.48
	1:10:00	0.00	0.00	2.63	3.70	4.64	6.82	8.53	11.41	17.51
	1:15:00	0.00	0.00	2.38	3.41	4.40	6.13	7.63	9.93	15.11
	1:20:00	0.00	0.00	2.15	3.09	4.03	5.41	6.71	8.43	12.74
	1:25:00	0.00	0.00	1.93	2.78	3.54	4.75	5.85	7.09	10.64
	1:30:00	0.00	0.00	1.72	2.49	3.09	4.05	4.95	5.90	8.77
	1:35:00	0.00	0.00	1.53	2.23	2.71	3.41	4.14	4.83	7.10
	1:40:00	0.00	0.00	1.39	1.94	2.43	2.87	3.45	3.90	5.66
	1:45:00	0.00	0.00	1.32	1.75	2.27	2.47	2.96	3.24	4.66
	1:50:00	0.00	0.00	1.29	1.62	2.16	2.25	2.67	2.85	4.06
	1:55:00	0.00	0.00	1.15	1.53	2.06	2.10	2.49	2.61	3.68
	2:00:00	0.00	0.00	1.03	1.42	1.89	2.00	2.37	2.44	3.41
	2:05:00	0.00	0.00	0.82	1.13	1.51	1.59	1.88	1.91	2.66
	2:10:00	0.00	0.00	0.64	0.88	1.18	1.23	1.46	1.45	2.00
	2:15:00	0.00	0.00	0.50	0.68	0.91	0.95	1.12	1.10	1.51
	2:20:00	0.00	0.00	0.38	0.53	0.70	0.73	0.86	0.84	1.15
	2:25:00	0.00	0.00	0.29	0.40	0.53	0.56	0.66	0.64	0.88
	2:30:00	0.00	0.00	0.22	0.30	0.40	0.42	0.49	0.48	0.66
	2:35:00	0.00	0.00	0.17	0.22	0.30	0.31	0.37	0.36	0.49
	2:40:00	0.00	0.00	0.12	0.16	0.23	0.23	0.28	0.28	0.38
	2:45:00	0.00	0.00	0.09	0.12	0.16	0.17	0.20	0.20	0.28
	2:50:00	0.00	0.00	0.06	0.08	0.11	0.12	0.14	0.14	0.19
	2:55:00	0.00	0.00	0.04	0.05	0.07	0.08	0.09	0.09	0.12
	3:00:00	0.00	0.00	0.02	0.03	0.04	0.05	0.05	0.05	0.07
	3:05:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.03
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Emergency spillway sizing

C_BCW	3		C_BCW	3	
L	16	ft	Z	20	H:V
H	0.926202	ft	H	0.926202	ft
Q_horizontal	42.78584	cfs	Q_slope	19.81417	cfs
Q_total	62.60001	cfs			

$$Q = C_{BCW} L H^{1.5}$$ Equation 12-8

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

Sloping Broad-Crested Weir: Figure 12-20 shows an example of a sloping broad-crested weir. The equation to calculate the flow over the sloping portion of the weir is as follows:

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5}$$ Equation 12-9

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

Z = side slope (horizontal: vertical)

H = head above weir crest (ft)

Design Procedure Form: Grass Swale (GS)

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer: MSJ
Company: Galloway
Date: September 27, 2023
Project: 6601 Colorado Boulevard
Location: Commerce City, CO - SWALE 1

1. Design Discharge for 2-Year Return Period	Q_2 = 3.90 cfs
2. Hydraulic Residence Time	
A) : Length of Grass Swale	L_S = 257.0 ft
B) Calculated Residence Time (based on design velocity below)	T_{HR} = 4.4 minutes
3. Longitudinal Slope (vertical distance per unit horizontal)	
A) Available Slope (based on site constraints)	S_{avail} = 0.020 ft / ft
B) Design Slope	S_D = 0.008 ft / ft
4. Swale Geometry	
A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical)	Z = 4.00 ft / ft
B) Bottom Width of Swale (enter 0 for triangular section)	W_B = 0.00 ft
5. Vegetation	Choose One: ○ Grass From Seed ◉ Grass From Sod
A) Type of Planting (seed vs. sod, affects vegetal retardance factor)	
6. Design Velocity (0.857 ft / s maximum for desirable 5-minute residence time)	V_2 = 0.98 ft / s
7. Design Flow Depth (1 foot maximum)	D_2 = 1.00 ft
A) Flow Area	A_2 = 4.0 sq ft
B) Top Width of Swale	W_T = 8.0 ft
C) Froude Number (0.50 maximum)	F = 0.24
D) Hydraulic Radius	R_H = 0.49
E) Velocity-Hydraulic Radius Product for Vegetal Retardance	VR = 0.47
F) Manning's n (based on SCS vegetal retardance curve D for sodded grass)	n = 0.084
G) Cumulative Height of Grade Control Structures Required	H_D = 3.10 ft
8. Underdrain (Is an underdrain necessary?)	Choose One: ◉ YES ○ NO — **AN UNDERDRAIN IS REQUIRED IF THE DESIGN SLOPE < 2.0%**
9. Soil Preparation (Describe soil amendment)	
10. Irrigation	Choose One: ○ Temporary ◉ Permanent

Notes:

Design Procedure Form: Grass Swale (GS)

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer: MSJ
Company: Galloway
Date: May 26, 2023
Project: 6601 Colorado Boulevard
Location: Commerce City, CO - SWALE 6

1. Design Discharge for 2-Year Return Period	Q_2 = 4.00 cfs
2. Hydraulic Residence Time	
A) : Length of Grass Swale	L_S = 165.0 ft
B) Calculated Residence Time (based on design velocity below)	T_{HR} = 3.0 minutes
3. Longitudinal Slope (vertical distance per unit horizontal)	
A) Available Slope (based on site constraints)	S_{avail} = 0.020 ft / ft
B) Design Slope	S_D = 0.020 ft / ft
4. Swale Geometry	
A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical)	Z = 10.30 ft / ft
B) Bottom Width of Swale (enter 0 for triangular section)	W_B = 0.00 ft
5. Vegetation A) Type of Planting (seed vs. sod, affects vegetal retardance factor)	Choose One: ○ Grass From Seed ◉ Grass From Sod
6. Design Velocity (0.55 ft / s maximum for desirable 5-minute residence time)	V_2 = 0.92 ft / s
7. Design Flow Depth (1 foot maximum)	D_2 = 0.65 ft
A) Flow Area	A_2 = 4.4 sq ft
B) Top Width of Swale	W_T = 13.4 ft
C) Froude Number (0.50 maximum)	F = 0.28
D) Hydraulic Radius	R_H = 0.32
E) Velocity-Hydraulic Radius Product for Vegetal Retardance	VR = 0.30
F) Manning's n (based on SCS vegetal retardance curve D for sodded grass)	n = 0.107
G) Cumulative Height of Grade Control Structures Required	H_D = 0.00 ft
8. Underdrain (Is an underdrain necessary?)	Choose One: ○ YES ◉ NO
9. Soil Preparation (Describe soil amendment)	
10. Irrigation	Choose One: ○ Temporary ◉ Permanent

Notes:

Design Procedure Form: Grass Swale (GS)

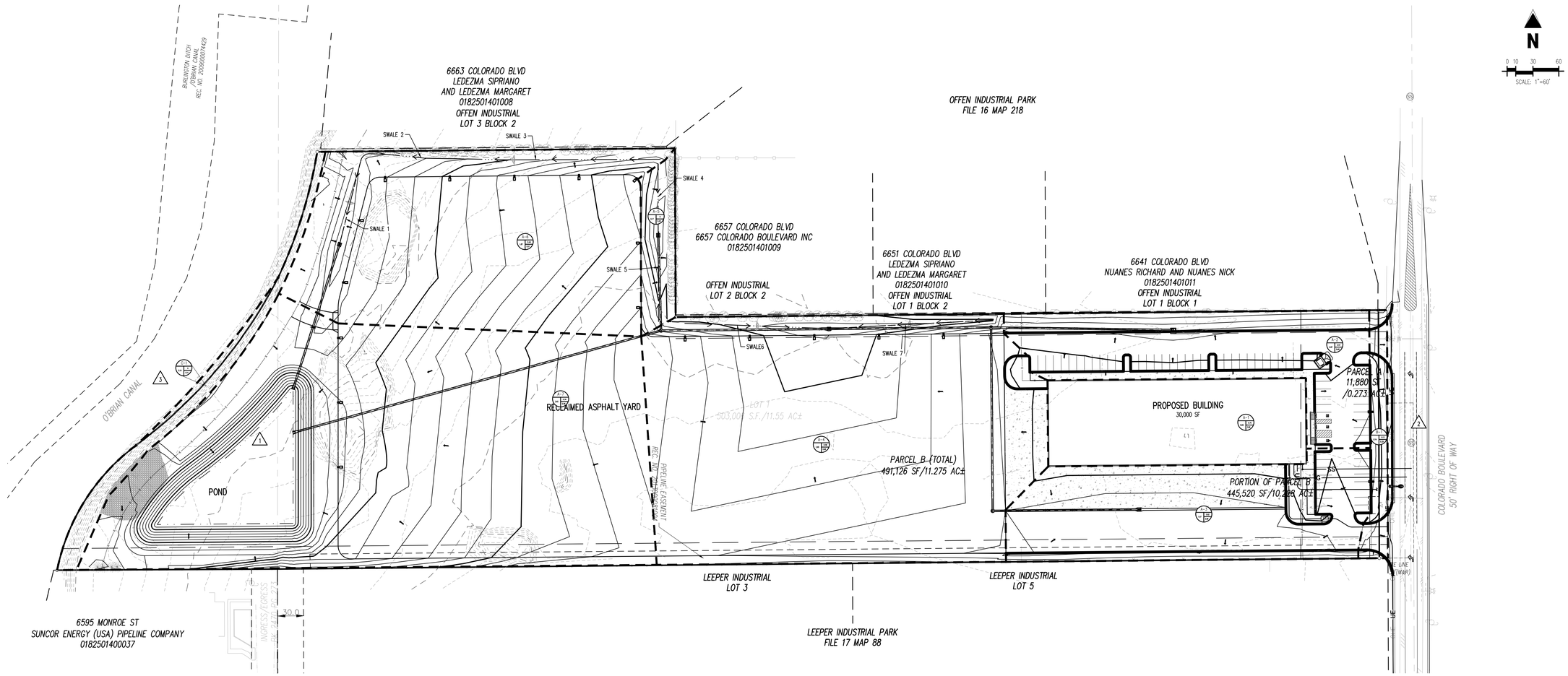
UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer: MSJ
Company: Galloway
Date: September 27, 2023
Project: 6601 Colorado Boulevard
Location: Commerce City, CO - SWALE 7

1. Design Discharge for 2-Year Return Period	Q_2 = 4.00 cfs
2. Hydraulic Residence Time	
A) : Length of Grass Swale	L_S = 187.5 ft
B) Calculated Residence Time (based on design velocity below)	T_{HR} = 3.2 minutes
3. Longitudinal Slope (vertical distance per unit horizontal)	
A) Available Slope (based on site constraints)	S_{avail} = 0.020 ft / ft
B) Design Slope	S_D = 0.010 ft / ft
4. Swale Geometry	
A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical)	Z = 5.00 ft / ft
B) Bottom Width of Swale (enter 0 for triangular section)	W_B = 0.00 ft
5. Vegetation	Choose One: ○ Grass From Seed ◉ Grass From Sod
A) Type of Planting (seed vs. sod, affects vegetal retardance factor)	
6. Design Velocity (0.625 ft / s maximum for desirable 5-minute residence time)	V_2 = 0.99 ft / s
7. Design Flow Depth (1 foot maximum)	D_2 = 0.90 ft
A) Flow Area	A_2 = 4.1 sq ft
B) Top Width of Swale	W_T = 9.0 ft
C) Froude Number (0.50 maximum)	F = 0.26
D) Hydraulic Radius	R_H = 0.44
E) Velocity-Hydraulic Radius Product for Vegetal Retardance	VR = 0.44
F) Manning's n (based on SCS vegetal retardance curve D for sodded grass)	n = 0.088
G) Cumulative Height of Grade Control Structures Required	H_D = 1.90 ft
8. Underdrain (Is an underdrain necessary?)	Choose One: ◉ YES ○ NO — **AN UNDERDRAIN IS REQUIRED IF THE DESIGN SLOPE < 2.0%**
9. Soil Preparation (Describe soil amendment)	
10. Irrigation	Choose One: ○ Temporary ◉ Permanent

Notes:

APPENDIX D – Drainage Map



DRAINAGE LEGEND

- PROPERTY BOUNDARY LINE
- ADJACENT PROPERTY BOUNDARY LINE
- RIGHT OF WAY BOUNDARY LINE
- EXISTING EASEMENT LINE
- PROPOSED EASEMENT LINE
- SD — PROPOSED STORM SEWER (LESS THAN 12"ø)
- PROPOSED STORM SEWER (12"ø AND LARGER)
- PROPOSED CURB AND GUTTER (SPILL)
- PROPOSED CURB AND GUTTER (CATCH)
- 5460 — EXISTING MAJOR CONTOUR
- 52 — EXISTING MINOR CONTOUR
- 5465 — PROPOSED MAJOR CONTOUR
- 66 — PROPOSED MINOR CONTOUR
- MAJOR BASIN BOUNDARY LINE
- 5 — DESIGN POINT
- FLOW ARROW
- 100 — BASIN DESIGNATION
- 0.00 — 5-YEAR RUNOFF COEFFICIENT
- 0.00 — 100-YEAR RUNOFF COEFFICIENT
- 0.00 — BASIN AREA IN ACRES

CITY STAFF CERTIFICATE

APPROVED BY THE DEPARTMENT OF COMMUNITY DEVELOPMENT OF THE CITY OF COMMERCE CITY, THIS _____ DAY OF _____, _____ A.D.

DEPARTMENT OF COMMUNITY DEVELOPMENT SIGNATURE

Galloway
5500 Greenwood Plaza Blvd., Suite 200
Greenwood Village, CO 80111
303.770.8884
GallowayUS.com

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NOT FOR CONSTRUCTION

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DRAINAGE MAP
LOT 1, CLAIRE AND ALYSSA INDUSTRIAL SUBDIVISION

6601 COLORADO BOULEVARD
COMMERCE CITY, COLORADO

#	Date	Issue / Description	Init.

Project No:	6CH000001
Drawn By:	RDG
Checked By:	MSJ
Date:	09/27/2023

FINAL DRAINAGE PLAN

DR1