FINAL DRAINAGE REPORT

QuikTrip #4207

E. 81st Ave. & Tower Rd.
Commerce City, CO 80022

PREPARED FOR:
QuikTrip Corporation

PREPARED BY:
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5500 Greenwood Plaza Blvd, Suite 200
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DATE:
January 5, 2023

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FINAL DRAINAGE REPORT

QuikTrip #4207

Legal Description
A parcel of land located in the southeast 1/4 of Section 28, Township 2 South, Range 66 West of the Principal Meridian, City of Commerce City, County of Adams, State of Colorado, containing 635,908 square feet or 14.60 acres of land more or less.

Preparation Date
December 28, 2020
Revised: 01/17/2022
Revised: 7/19/2022
Revised: 1/05/2023

Prepared for
QuikTrip Corporation
12000 N. Washington Street, Suite 175
Thornton, CO 80241
Phone (913) 593-1690
Attn: Mike Talcott

Prepared by:

Duncan Rady

Reviewed by:

Jenny Romano

ENGINEER'S STATEMENT

I hereby certify that this final drainage study for the QuikTrip #4207 was prepared by me (or under my direct supervision) in accordance with the provisions of the City of 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
Registered Professional Engineer
State of Colorado No. 44401

Date

DEVELOPER'S CERTIFICATION

"QuikTrip Corporation hereby certifies that the drainage facilities for QuikTrip #4207 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 QuikTrip #4207, guarantee that final drainage design review will absolve QuikTrip Corporation and/or their successors and/or assigns of future liability for improper design."

Authorized Signature
Mike Talcott

Date

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I. General Location and Description

A. Location

The proposed QuikTrip is located in unincorporated Adams County, at the southwest corner of East 81st Avenue and Tower Road, in Commerce City, Colorado, and consists of approximately 14.60 acres of undeveloped land. The site is contained in the southeast quarter of Section 28, Township 2 South, Range 66 West of the Principal Meridian. The site is bordered by E. 81st Avenue to the north, Tower Road to the east, USAirport Parking to the west, and the South line of Section 28, Township 2 South, Range 66 West of the 6th P.M. to the south. In between the project site and the USAirport Parking is a tributary to Second Creek, which flows from the south to the north. This project site in existing conditions discharged into the tributary, and it is the intent of this development to continue this drainage pattern. No water quality or detention is currently associated with this lot.

B. Description of Property

The project site consists of vacant land, comprised of native grasses, and is divided into two parcels. The proposed development will include the development of the QuikTrip parcel, the overlot grading of the second parcel, the detention and water quality pond for the site, and associated utility and road infrastructure. For the purposes of this drainage report, the undeveloped land was treated as commercial development to account for future use. The approximately 14.60 acres of undeveloped land generally slopes from southeast to northwest.

The NRCS Web Soil Survey of Adams County, Colorado, indicates site soils to be Arvada loam, Plater loam, and Wiley-Adena-Renohill complex soils, Hydrologic Soil Groups C and D, and with varying slopes of 0-20 percent. Group C soils have moderately high runoff potential and moderate clay content, and Group D soils have high runoff potential with high clay content.

The FEMA Flood Insurance Map (08001C0635H) dated March 5, 2007 shows that this site is located in Zone X, which is outside the 0.2% annual chance flood plain. No office calculation or field surveying was performed to determine this information. A copy of the FIRM map is included for reference in the appendices.

There are no irrigation facilities on-site, or nearby, which flow through the project site. The site is undeveloped and slopes steeply towards the Second Creek Tributary with no reports of flooding. Currently, there are various slope/drainage easements, utility easements, as well as temporary utility easements. The slope/drainage easements will be vacated along the 81st Ave. and Tower Rd. property lines since the site will be raised and drainage facilities proposed. The temporary utility easements will be vacated as well in addition to the existing 10-foot utility easements. Proposed 10-foot utility easements will be provided along all property lines per utility company specifications. Bore samples were gathered for the site in January 2020 and the results of these samples are included in the appendix. After review of the bore logs, it appears that the shallowest water that was encountered on site was approximately 19' deep. It appears that this site has no information regarding any areas of known or suspected contamination.

II. Drainage Basins and Sub-basins

A. Existing Basin Description

The site is part of the existing Second Creek Basin, which consists of 11,161.40 acres as outlined in the Tower Road Widening Drainage Report Final Draft, prepared by Huitt-Zollars, Inc. and dated October 9, 2015 (hereby known as *Existing Report*). The basin consists of undeveloped land, all of which flows west to Second Creek, where it is ultimately conveyed to the South Platte River. Any off-site flows into Tower Road will be collected by the existing storm sewer system, and conveyed to Pond A, which was proposed with the Tower Road Widening Drainage Report.

This section of the Second Creek Tributary is discussed and analyzed within the *Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning (OSP) Study Update* dated August 2004. This report analyzed the Second Creek Tributary to have an approximate longitudinal slope of 0.80% and convey approximately 2,983 cfs during the 100-year storm event. This flow rate was used to analyze the creek tributary during the existing as well as the proposed conditions. A summary of these results will be discussed in a later section of this report.

B. Sub-basin Descriptions

Specifically, this site consists of approximately 14.60 acres of undeveloped land which sheet flows from the southeast to the northwest of the lot and into the Second Creek Tributary. Once in the drainage channel runoff is routed through the existing culvert beneath 81st Avenue. The existing site produces approximately 31.54 cfs of runoff.

Additional off-site runoff, Drainage Area 3 on sheet "MAP-4" from the *Existing Report*, enters the site from the east by means of a 36-inch reinforced concrete pipe (RCP) beneath Tower Road. This area produces approximately 200.6 cfs during the 100-year storm event. Per coordination with Commerce City, this offsite flow will be routed by a closed conduit through the proposed site and will be contained within a drainage easement per the City of Commerce City Storm Drainage Criteria Manual requirements.

Approximately 7.52 acres of the existing 14.60 acre lot is expected to be developed with this plan, and a future commercial development, while the remaining acreage will remain undeveloped. The extents of the proposed improvements are contained primarily along Tower Road and 81st Avenue. The existing Second

Creek Tributary will remain undisturbed. Of the 7.52 acres being developed, approximately 1.32 acres will drain towards a grass buffer and grass swale to provide disconnected impervious areas per the 20/10 rule detailed within the Drainage Criteria Manual. The remainder of the site will be collected with curb inlets and routed into the proposed detention and water quality facility. The proposed facility will discharge at or below existing runoff values for this site.

III. Design Criteria

A. Development Criteria References and Constraints

As previously mentioned, the Tower Road Widening Drainage Report Final Draft, prepared by Huitt-Zollars, Inc. and dated October 9, 2015, analyzed the majority of the offsite areas that affect the proposed site. Specifically, the offsite flow being routed beneath Tower Road from the east. Besides this report the City of Commerce City Storm Drainage and Design and Technical Criteria manual was referenced to perform the hydrologic analysis and hydraulic design for the project location. The existing and proposed 100-year flood limits were analyzed for this section of tributary channel to ensure no adverse impacts will occur with the redevelopment of this site. Based on the *"Outfall Systems Planning Study Update"* prepared by Kiowa Engineering Corporation dated February 2004, an anticipated flow during the 100-year storm event is 2,983 CFS. Using existing topographic survey data adjacent to the site, along with Google Earth export for extents beyond the project scope, a model was created based on the above terrain. Further discussion is provided in the Channel Floodplain Limits section of this report.

B. Hydrologic Criteria

The Rational Method was used to calculate the flows generated within each basin for both the 5-year and 100-year storm events. All soils on-site are Arvada loam, Plater loam, and Wiley-Adena-Renohill complex soils, classified as Hydrologic Soil Groups C and D. Intensities, times of concentrations, and routed flow accumulations were all calculated using the formulas and/or charts provided in the City of Commerce City Storm Drainage Design and Technical Criteria Manual. Composite "C" values and site imperviousness were derived from runoff coefficients provided for pavement, landscaping, and roofs in the Mile High Flood District Urban Storm Drainage Criteria Manual. Calculations herein demonstrate runoff and flow accumulations for the 5- and 100-year events.

Detention and storm water quality will be provided on-site by the proposed detention and water quality pond located on the west side of the site. The pond will release stormwater at the historic rate into the existing Second Creek, where it will be conveyed to the ultimate receiving waters, the South Platte River. The Mile High Flood District Detention spreadsheet was used to verify pond storage and outlet structure design. Calculations are included in the appendices of this report.

C. Hydraulic Criteria

Inlets have been sized with the aid of the MHFD spreadsheet design program UD Inlet v5.03. All storm sewer inlets are designed to capture and convey the major storm event. Inlet calculations are included in the appendices. StormCAD modeling has been utilized to verify pipe capacity and Hydraulic Grade Lines for the 5-year and 100-year storm events through all proposed piping. Analysis of the channel and 100-year flood limits is provided further in this report and discusses the impacts of development.

D. Stormwater Quality

This project proposes to satisfy the MS4 Permit requirements by providing water quality within the detention facility and releasing runoff from the pond at or below the historic rates into the Second Creek

Tributary. Runoff which flows beneath the diesel canopy will be collected by trench drains and routed to the oil/water separator prior to continuing to the on-site detention facility to remove oil from the runoff. To meet the MDCIA Requirement of a disconnected impervious area, from the drainage system, a combination grass buffer and grass swale will be used. Specifically, drainage basin B-2 will be routed by curb and gutter to a series of curb cuts along the western curb and gutter. From the curb cuts the runoff will flow through a 66-foot grass buffer at slopes ranging between 8.50% to 7%. This grass swale directs runoff into a 172-foot long 18-foot wide grass swale with a longitudinal slope of 2%. The grass swale will then discharge directly into the detention and water quality pond. The MHFD BMP spreadsheet was used to ensure the grass buffer and swale meet MHFD requirements and excerpts of the calculations are included in the appendices. Basin B-2 accounts for approximately 23% of the impervious area of the developed site, and the grass buffer and swale footprint is approximately 28% of the impervious area being collected by the grass buffer and swale.

IV. Drainage Plan

A. General Concept

The following information outlines the concepts for collecting and conveying excess site rainfall. Refer to the appendices for the Drainage Plan.

All proposed on-site storm sewer is routed to the on-site detention and water quality pond. The on-site runoff is collected by CDOT Type R inlets and conveyed through the proposed storm sewer system to the pond. Treatment to permanent water quality standards is provided here and the runoff eventually outfalls on the northwest side of the pond to the Second Creek Tributary, where it is ultimately conveyed to the South Platte River. Maintenance of the facilities is the responsibility of the Property Owner.

In the existing conditions off-site runoff from east of Tower Rd. was discharged onto the subject property, through a 36” reinforced concrete pipe, and freely flowed within a small drainage channel before entering Second Creek. Per discussions held with Commerce City this development has proposed to route this off-site flow through the site by means of closed conduit and discharge into the Second Creek at approximately the same location as in existing conditions. Hydraulic analysis has been performed for the final drainage report to ensure adequate capacity is provided. This new drainage system will be placed in a 25-foot drainage easement, dedicated by the Denver International Airpark Filing No. 2.

All on-site runoff will be routed to the proposed on-site water quality and detention facility, a summary table of elevations, volume storage, and release rates is provided below.

PROPOSED DETENTION POND SUMMARY TABLE

Attribute	Value
Tributary Sub-basin	A1-A4, B1-B3, C1, & R1-R3
Area (acres)	7.03
Imperviousness %	75%
WQCV Volume Req. (ac-ft)	0.175
WQCV WSEL (ft)	5227.04
EURV Volume Req. (ac-ft)	0.340
EURV WSEL (ft)	5229.18
100-Year Volume Req. (ac-ft)	0.859
Volume Provided (ac-ft)	1.383
100-Year WSEL	5230.86
Top of Pond	5232.50
Freeboard (ft)	1.64
Q_{ALL} (cfs)	9.42
Q_{ACT} (cfs)	3.40
Total Runoff Into Pond (cfs)	44.80
Pond Spillway Flowline (ft)	5231.50
Clogged 100-Yr WSEL (ft)	5232.25
Freeboard (ft)	0.25

B. Specific Details

Collection and conveyance within and from each of the sub-basins is detailed below. Basin delineations can be found on the Drainage Map in the appendices of this report.

Basin DA-A1 (1.13 AC, Q_5=2.12 cfs, Q_{100}=5.45 cfs): a basin located at the northeast side of the site and consisting of a portion of the parking, drives, and landscaping. Runoff will be routed by curb and gutter to a proposed Type R inlet, Inlet A1, located in sump.

Basin DA-A2 (0.03 AC, Q_5=0.14 cfs, Q_{100}=0.27 cfs): a basin immediately west of the proposed building that flows into the proposed 6” trench drain.

Basin DA-A3 (0.67 AC, Q_5=2.60 cfs, Q_{100}=5.12 cfs): a basin comprised of pavement. Runoff will sheet flow to the proposed curb and gutter where it will be collected in Inlet A3, a Type R inlet located on the northwest side of the site.

Basin DA-A4 (0.04 AC, Q_5=0.15 cfs, Q_{100}=0.29 cfs): a basin consisting of pavement that surrounds the proposed diesel canopy. This runoff is directed to two separate 6” trench drains where runoff is routed to the oil/water separator.

Basin DA-B1 (2.35 AC, Q_5=8.79 cfs, Q_{100}=17.83 cfs): a basin consisting of a proposed drive and a large area of future commercial development, where runoff flows to the proposed curb and gutter and is collected in a Type R inlet, Inlet B1, located on the northwest side of the drive.

Basin DA-B2 (1.32 AC, Q_2=4.02 cfs, Q_{100}=8.57 cfs): A basin consisting mainly paved roadway and a portion of the future commercial lot. This area drains to various curb cuts along the western curb line where runoff will flow through a grass buffer and grass swale into the proposed water quality and detention facility.

Basin DA-B3 (0.56 AC, Q_5=0.10 cfs, Q_{100}=1.92 cfs): A basin consisting of the grass buffer and grass swale and ultimately into the proposed water quality and detention facility.

Basin DA-C1 (0.52 AC, Q_5=0.12 cfs, Q_{100}=2.24 cfs): a basin consisting of the proposed detention pond. Runoff in this basin will enter the detention pond and will be released at the historic rate.

Basin DA-R1 (0.18 AC, Q_5=0.64 cfs, Q_{100}=1.34 cfs): a basin defining the roof of the proposed QuikTrip. Runoff will flow into a downspout, which will tie into the proposed storm sewer system underground with an inserta-tee. This runoff will be conveyed to the proposed detention pond.

Basin DA-R2 (0.07 AC, Q_5=0.26 cfs, Q_{100}=0.53 cfs): a basin defining the roof of the proposed diesel canopy. Runoff will flow into downspouts which will tie into the proposed storm sewer system. This runoff will be conveyed to the proposed detention pond.

Basin DA-R3 (0.17 AC, Q_5=0.60 cfs, Q_{100}=1.24 cfs): a basin defining the roof of the proposed fuel canopy. Runoff will flow into downspouts which will tie into the proposed storm sewer system. This runoff will be conveyed to the proposed detention pond.

Basin DA-OS1 (0.52 AC, Q_5=0.32 cfs, Q_{100}=1.87 cfs): a basin consisting of a portion of the parking and drives, and some landscaping area. The runoff from this basin will sheet flow through the parking lot and into E. 81st Ave. where it will be conveyed to Second Creek per existing drainage patterns.

Basin DA-OS2 (0.65 AC, Q_5=0.14 cfs, Q_{100}=2.62 cfs): a basin consisting of landscaped area and a retaining wall. Runoff from this area will flow east and will be conveyed to Second Creek per existing drainage patterns.

Basin DA-OS3 (0.31 AC, Q_5=1.06 cfs, Q_{100}=2.26 cfs): a basin consisting of primarily drives and a small amount of landscaping, that flows north east into Tower Road, where it is conveyed by existing curb and gutter to an existing CDOT Type R inlet located on Tower Road at the intersection of Tower Road and E. 81st Ave.

Basin DA-OS4 (6.52 AC, Q_5=0.83 cfs, Q_{100}=15.37 cfs): a basin consisting of currently undeveloped land. Currently, this basin is analyzed as undeveloped. If it will be developed in the future for commercial uses, the current pond will need to be modified to accommodate this area, or a new pond constructed. The runoff currently follows existing drainage patterns, flowing northwest, into Second

Creek. With development, proper storm drainage infrastructure will need to be constructed to ensure that the runoff from the development does not overwhelm the downstream storm sewer system.

Detention and storm water quality will be provided on-site by the proposed detention and water quality pond located on the west side of the site. The pond will release stormwater at the historic rate into the existing Second Creek, where it will be conveyed to the ultimate receiving waters, the South Platte River. The Mile High Flood District Detention spreadsheet was used to verify pond storage and outlet structure design. The emergency spillway has been designed to accommodate the full 100-year storm runoff of the site. The emergency spillway will have a 20-foot bottom width and a total depth of 1-foot with 4:1 side slopes to convey 44.80 cfs. Maintenance and access is provided to the detention pond by a 10-foot wide access ramp with a maximum longitudinal slope of 10%. Additionally, an access/maintenance ramp is provided for the public drainage pipe collecting the off-site flow and within the 25-foot public drainage easement.

Channel Floodplain Limits

Due to no existing floodplain limits, a model was created to determine the floodplain limits of the existing channel bordering the proposed site. Based on the *"Outfall Systems Planning Study Update"* prepared by Kiowa Engineering Corporation dated February 2004, an anticipated flow during the 100-year storm event is 2983 CFS. Using existing topographic survey data adjacent to the site, along with Google Earth export for extents beyond the project scope, a model was created based on the above terrain.
A model was created using Geo-HEC RAS 5.10, having cross sections every 50'. The limits of the analysis extended approximately 200' beyond the box culverts at E. 81st Ave and the southern property line. The downstream condition was determined to be outlet controlled by the three (3) 18'W X 10.5'H box culverts at E. 81st Ave. In the 100-year event, the floodplain limits extend within the property line bordering the channel and the proposed site, being contained by the proposed graded 4:1 slope bordering the hardscaped development. Please refer to EX-1 for limits of floodplain.

After comparison of the existing condition and proposed condition grading, there is a deviation from the two models between cross sections 1007 to 1017. Due to the grading of the proposed pond and development, velocities and water surface elevations increase for approximately 500' before eventually lowering to near existing condition levels prior to entering the box culvert. The change in water surface elevation increases no more than 0.43'. Change in velocities increase by 3.08 feet per as well. It is recommended that additional erosion control measures shall be installed to armor the banks of the channel along the stretch of cross section 1013 to 1009.

V. Conclusions

A. Compliance with Standards

This report has been prepared using the criteria and methods as described in the City of Commerce City Storm Drainage and Technical Criteria Manual, provisions of the Mile-High Flood District Urban Storm Drainage Criteria Manual, and the Tower Road Widening Drainage Report Final Draft. With development, site imperviousness and runoff will increase compared to historic rates, but will not adversely impact downstream properties or existing drainage infrastructure. The proposed detention and water quality will ensure runoff into Second Creek does not exceed historic rates and that proper water quality is provided.

A grass buffer and grass swale, designed to MHFD standards, will ensure the MDCIA requirements are met.

B. Drainage Design

The proposed detention and water quality pond will discharge at, or below, historic rates into the Second Creek Tributary. Additionally, rip rap will be provided at the two flared end sections entering the Second Creek Tributary to provide stability and energy control. MS4 and MDCIA compliance will be achieved with water quality detention design and water quality grass buffers and a grass swale. The proposed water quality and detention facility will all be privately owned and maintained.

C. Water Quality

MS4 and MDCIA compliance will be achieved with water quality detention design and water quality grass buffers and a grass swale. This swale will have a minimum 2% longitudinal slope to convey the 2-year storm event per MHFD design criteria. The UD-BMP spreadsheet has been included in the appendices of this report to verify design parameters. The proposed water quality grass swale and buffer will be privately owned and maintained.

VI. References

1. Urban Storm Drainage Criteria Manual, Mile High Flood District, January 2016 (with current revisions).

2. Storm Drainage Design and Technical Criteria Manual, City of Commerce City, Colorado, August 2022.

3. Tower Road Widening Drainage Report Final Draft, Huitt-Zollars, Inc., October 9, 2015.

4. Flood Insurance Rate Map – Adams County, Colorado and Incorporated Areas Community Panel No. 08001C0635H, Effective March 5, 2007

5. Soil Map – Adams County Area, Parts of Adams and Denver Counties, Colorado as available through the Natural Resources Conservation Service National Cooperative Soil Survey web site via Web Soil Survey 2.0.

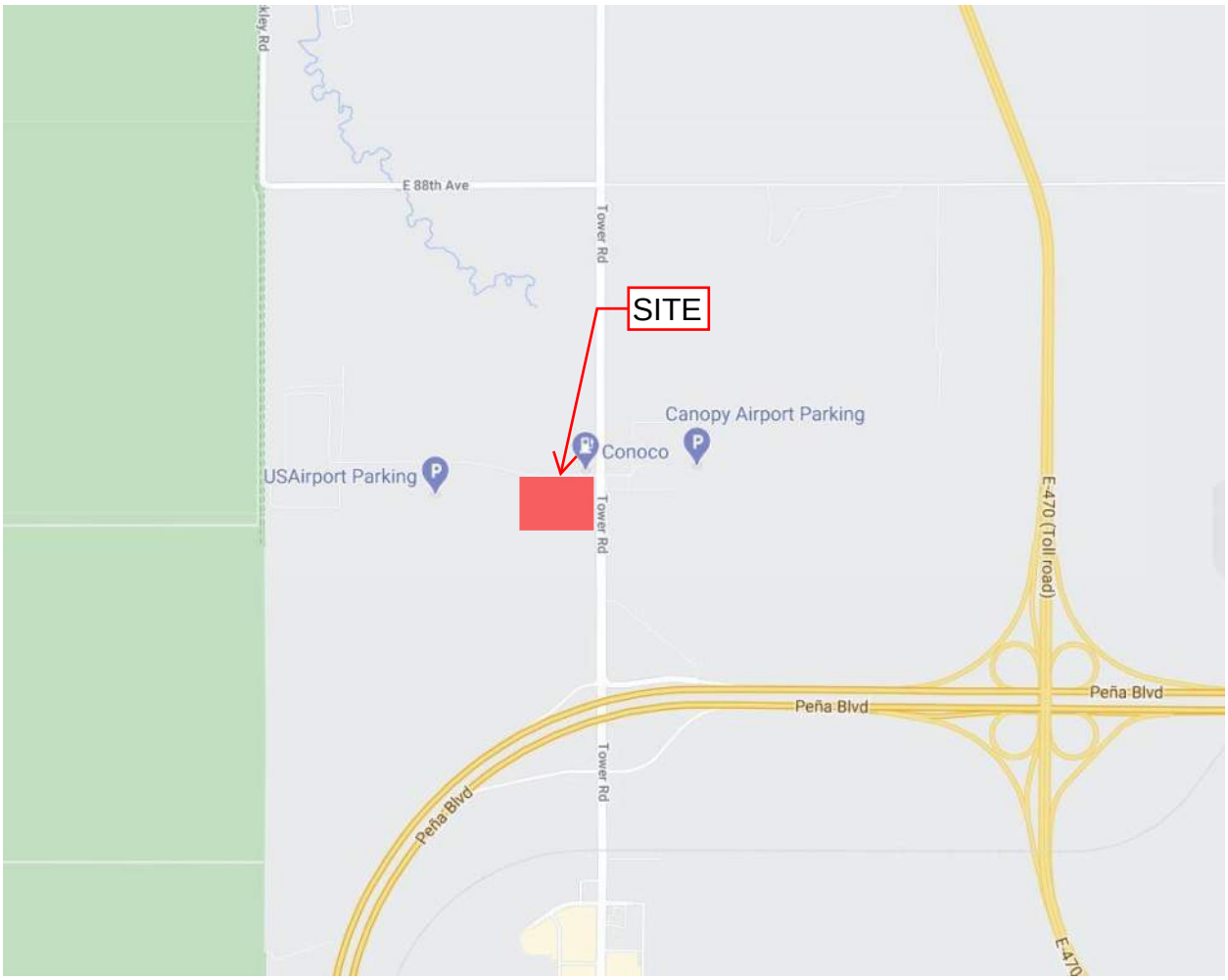
6. Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning Study Update, Kiowa Engineering Corporation, August 2004.

VII. Appendices

A. Exhibits and Figures
B. Hydrologic Computations
C. Hydraulic Computations
D. Drainage Map
E. City Checklist

APPENDIX A

Exhibits and Figures



VICINITY MAP

SCALE: 1” = 2000’

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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

Base map information shown on this FIRM was provided by the Adams County and Commerce City GIS departments. The coordinate system used for the production of the digital FIRM is Universe Transverse Mercator, Zone 13N, referenced to North American Datum of 1983 and the GRS 80 spheroid, Western Hemisphere.

This map reflects more detailed and up- to- date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

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

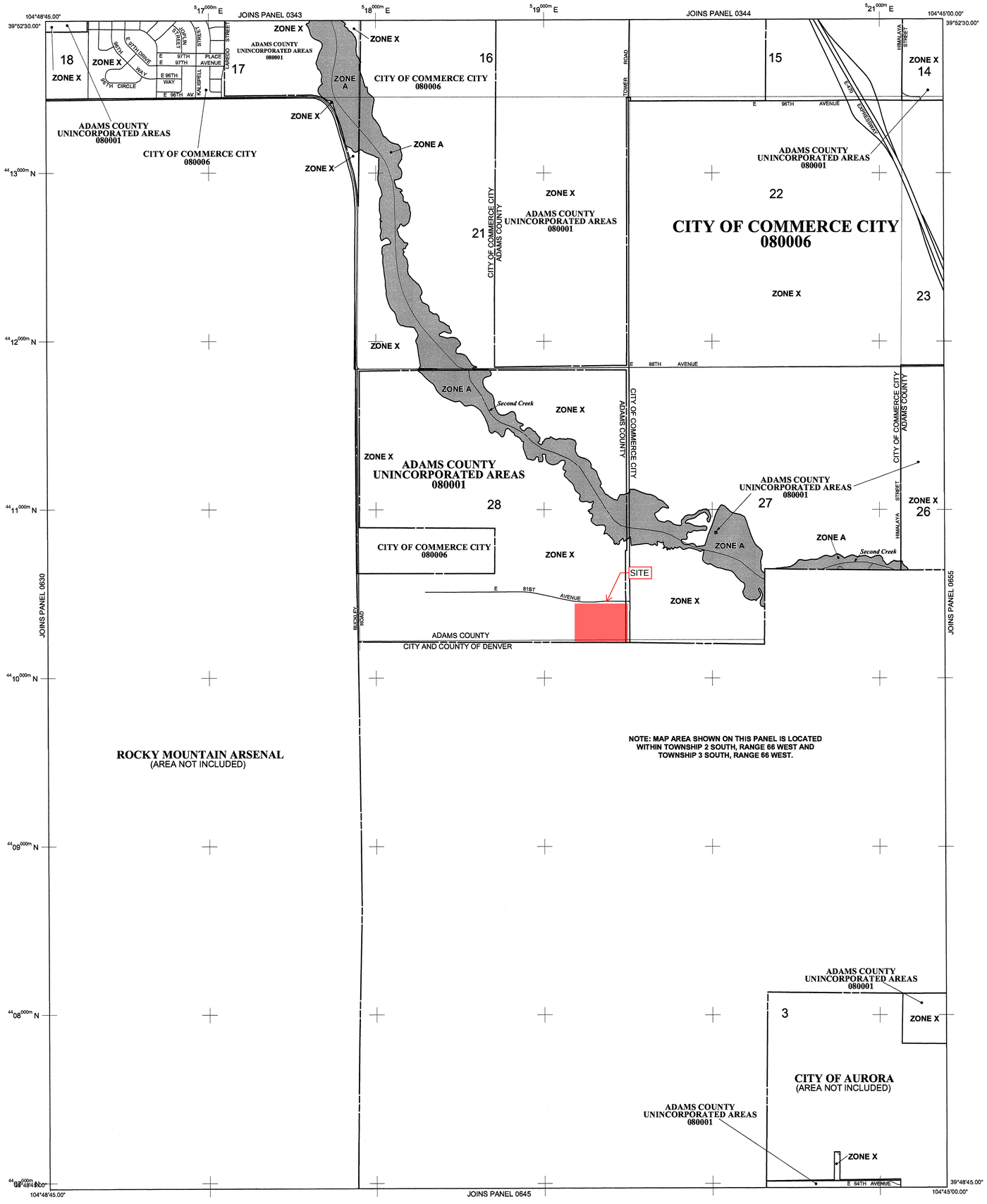
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which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

Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a *Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

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

This digital Flood Insurance Rate Map (FIRM) was produced through a cooperative partnership between the State of Colorado Water Conservation Board, the Urban Drainage and Flood Control District, and the Federal Emergency Management Agency (FEMA). The State of Colorado Water Conservation Board and the Urban Drainage and Flood Control District have implemented a long-term approach of floodplain management to reduce the costs associated with flooding. As part of this effort, both the State of Colorado and the Urban Drainage and Flood Control District have joined in Cooperating Technical Partner agreements with FEMA to produce this digital FIRM.

Additional flood hazard information and resources are available from local communities, the Colorado Water Conservation Board, and the Urban Drainage and Flood Control District.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 Base Flood Elevation line and value; elevation in feet*
(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A–A Cross section line
23–23 Transect line
97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275 000mN 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 M 5000-foot grid ticks: Alabama State Plane coordinate system, east zone (FIPSZONE 0101), Transverse Mercator
DX5510 Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1- 800- 638- 6620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0635H

FIRM
FLOOD INSURANCE RATE MAP
ADAMS COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 635 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ADAMS COUNTY	080001	0635	H
COMMERCE CITY, CITY OF	080006	0635	H

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 08001C0635H
MAP REVISED MARCH 5, 2007

Federal Emergency Management Agency

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 Adams County Area, Parts of Adams and Denver Counties, Colorado

December 5, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

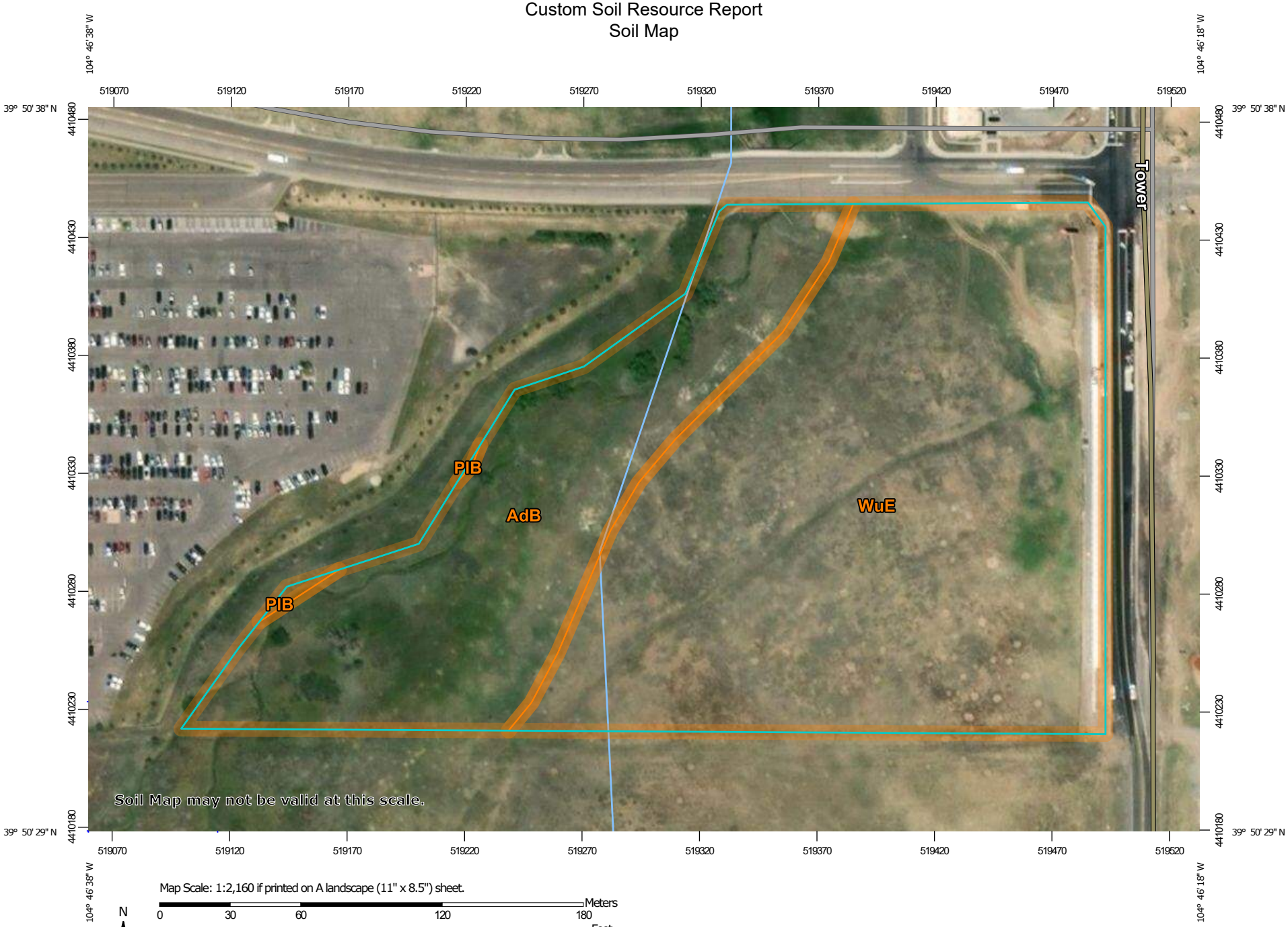
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:2,160 if printed on A landscape (11" x 8.5") 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

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 16, Sep 12, 2019

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

Date(s) aerial images were photographed: Jul 4, 2010—Oct 16, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

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
AdB	Arvada loam, 0 to 3 percent slopes	5.0	32.7%
PlB	Platner loam, 0 to 3 percent slopes	0.0	0.2%
WuE	Wiley-Adena-Renohill complex, 3 to 20 percent slopes	10.2	67.1%
Totals for Area of Interest		**15.2**	**100.0%**

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

Adams County Area, Parts of Adams and Denver Counties, Colorado

AdB—Arvada loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 34vj
Elevation: 4,400 to 5,600 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 125 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Arvada and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arvada

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

H1 - 0 to 2 inches: loam
H2 - 2 to 4 inches: sandy loam
H3 - 4 to 15 inches: clay
H4 - 15 to 28 inches: sandy clay
H5 - 28 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 30.0
Available water storage in profile: Moderate (about 6.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Ecological site: Salt Flat (R067XY033CO)

Hydric soil rating: No

Minor Components

Nunn

Percent of map unit: 20 percent
Hydric soil rating: No

PlB—Platner loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tln0
Elevation: 4,000 to 4,930 feet
Mean annual precipitation: 14 to 17 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Platner

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed eolian deposits over tertiary aged alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

Ap - 0 to 6 inches: loam
Bt1 - 6 to 11 inches: clay
Bt2 - 11 to 20 inches: clay
Bk1 - 20 to 27 inches: loam
Bk2 - 27 to 37 inches: sandy clay loam
C - 37 to 80 inches: sandy clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
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 in profile: 15 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups
Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: C
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Minor Components

Ascalon
Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Rago, rarely flooded
Percent of map unit: 4 percent
Landform: Drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: Overflow (R067BY036CO)
Hydric soil rating: No

Rago, ponded
Percent of map unit: 1 percent
Landform: Playas
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: Closed Upland Depression (R067BY010CO)
Hydric soil rating: No

WuE—Wiley-Adena-Renohill complex, 3 to 20 percent slopes

Map Unit Setting
National map unit symbol: 34xk
Elevation: 4,000 to 5,600 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 55 degrees F

Frost-free period: 120 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Wiley and similar soils: 40 percent
Adena and similar soils: 30 percent
Renohill and similar soils: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wiley

Setting

Landform: Hills
Landform position (three-dimensional): Base slope, side slope, nose slope, head slope
Down-slope shape: Linear
Across-slope shape: Linear

Typical profile

H1 - 0 to 3 inches: loam
H2 - 3 to 13 inches: clay loam
H3 - 13 to 60 inches: very fine sandy loam

Properties and qualities

Slope: 9 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural 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 in profile: 15 percent
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Description of Adena

Setting

Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits derived from mixed

Typical profile

H1 - 0 to 4 inches: loam
H2 - 4 to 22 inches: silty clay loam
H3 - 22 to 60 inches: silt loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
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 in profile: 15 percent
Available water storage in profile: High (about 10.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Description of Renohill

Setting

Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from shale

Typical profile

H1 - 0 to 4 inches: loam
H2 - 4 to 23 inches: clay
H3 - 23 to 28 inches: clay loam
H4 - 28 to 32 inches: unweathered bedrock

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
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 in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Minor Components

Colby

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

Samsil

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

Shingle

Percent of map unit: 3 percent
Hydric soil rating: No

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United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

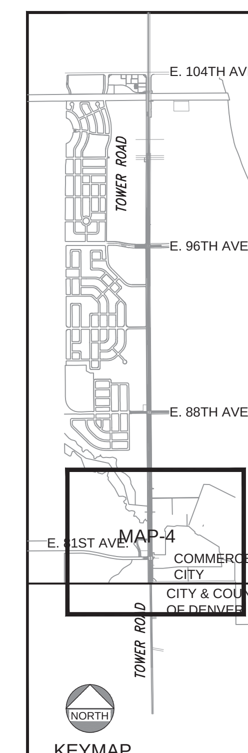
MATCHLINE SEE SHEET MAP-3

DRAINAGE LEGEND

- 8 / 353.24 — HISTORIC DRAINAGE BASIN
- 43 — HISTORIC DESIGN POINT
- DRAINAGE DIRECTION
- DRAINAGE PATH
- BASIN BOUNDARY
- 5280 — EXISTING CONTOUR

DESIGN POINT	TRIBUTARY AREA (AC)	Q5 (CFS)	Q100 (CFS)
3	101.4	34.3	200.6
4	11.81	6.2	36.4
5	11161.4	139*	4700*
5B	2.6	1.5	7.9
7	344.0	---	345
8	353.2	---	269
9A	19.6	8.9	52.3
9B	32.2	15.1	88.4
10	37.9	14.9	87.2
11	102.6	39.9	233.8
12A	42.0	18.9	110.6
12B	30.0	12.7	74.6

* FLOWS TAKEN FROM THE 1976 FHAD FOR SECOND CREEK



KEYMAP
NTS

Commerce CITY

MARK | DESCRIPTION | DATE | APPR.

PREPARED UNDER THE SUPERVISION OF :
FINAL REVIEW (W/O T88)
NOT FOR CONSTRUCTION
G. PRUSIK
P.E. 25083
10-09-2015
DATE

DESIGNED BY: BSR/S/BM
DRAWN BY: GM/JMP/DK
CHECKED BY: BSR
DRAWING CODE:
JOB NO. PW-03-2014
CCC NO. 302130.01
HZ NO. 302130.01
PLOT DATE: Oct-15
SCALE: AS SHOWN

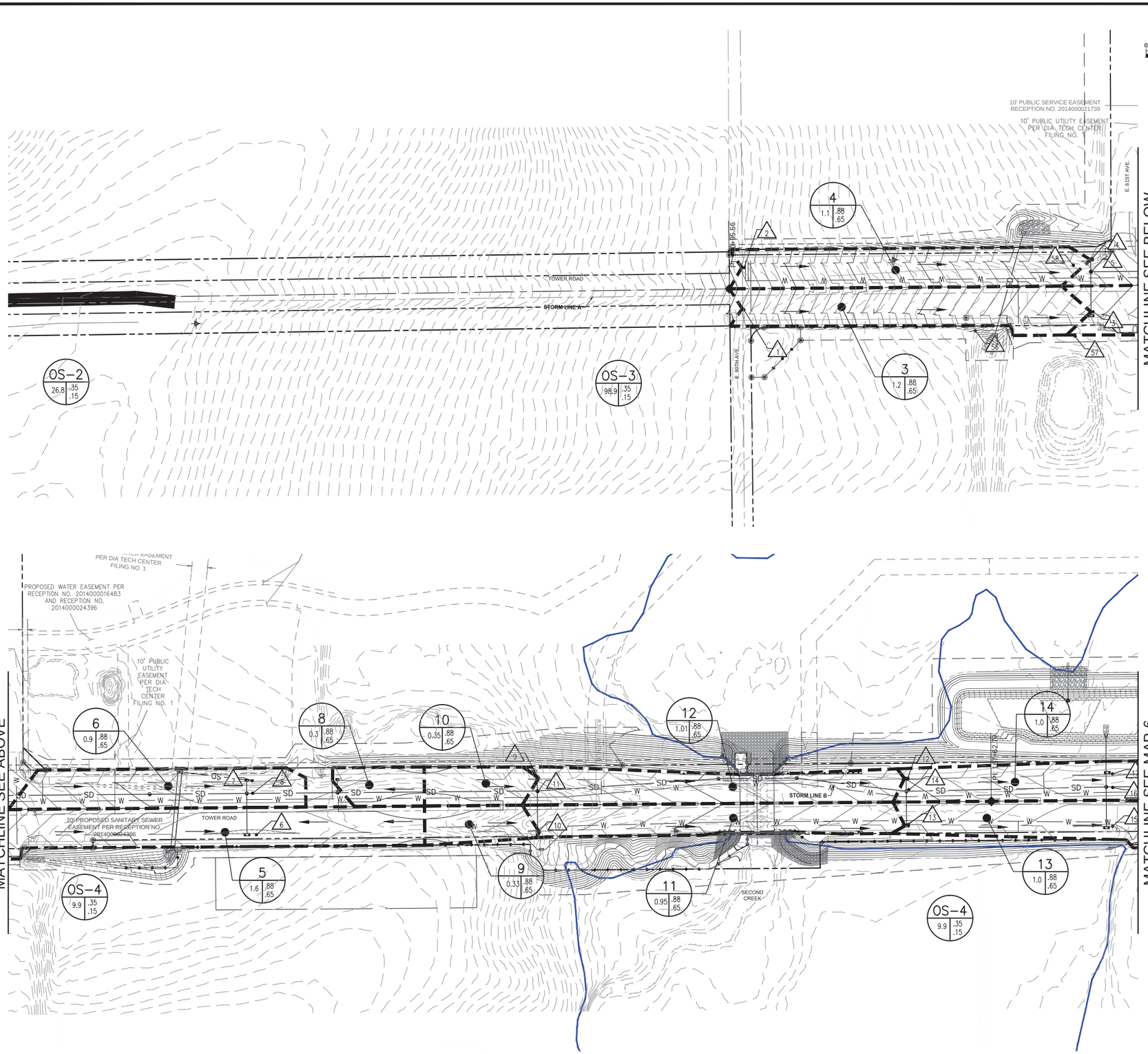
COMMERCE CITY
PUBLIC WORKS DEPARTMENT

HUITT-ZOLLARS
Huitt-Zollars, Inc. Denver
4582 South Ulster Street, Ste 240
Denver, Colorado 80237
Phone (303) 740-7325 Fax (303) 224-9997

TOWER ROAD WIDENING
NO. PW-03-2014

EXISTING DRAINAGE BASINS
MAP-4

Sheet Reference Number
MAP-4



DRAINAGE LEGEND

- BASIN ID / ACREAGE — 12 / 1.2 — .88 MAJOR STORM (C100) / .65 MINOR STORM (C5) — HISTORIC DRAINAGE BASIN
- 1 — DESIGN POINT
- DRAINAGE DIRECTION
- DRAINAGE PATH
- BASIN BOUNDARY

Commerce CITY

MARK	DESCRIPTION	DATE	APPR.

PREPARED UNDER THE SUPERVISION OF :

FINAL REVIEW (W/O T88)
NOT FOR CONSTRUCTION

G. PRUSIK
P.E. 25083

10-09-2015
DATE

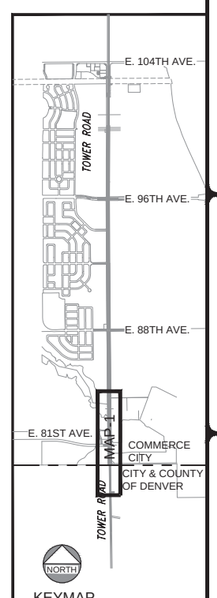
DESIGNED BY: DEVELOPED
DRAWN BY: GM/JMP/DK
CHECKED BY: BSR
DRAWING CODE:
JOB NO. PW-03-2014
CO. NO. 3021.30.01
SCALE: AS SHOWN
PLOT DATE: Oct-15

COMMERCE CITY
PUBLIC WORKS DEPARTMENT

HUITT-ZOLLARS Denver
Huitt-Zollars, Inc.
4582 South Ulster Street, Ste 240
Denver, Colorado 80237
Phone (303) 740-7325
Fax (303) 224-9997

TOWER ROAD WIDENING
NO. PW-03-2014

DEVELOPED DRAINAGE BASINS MAP-5



KEYMAP
NTS

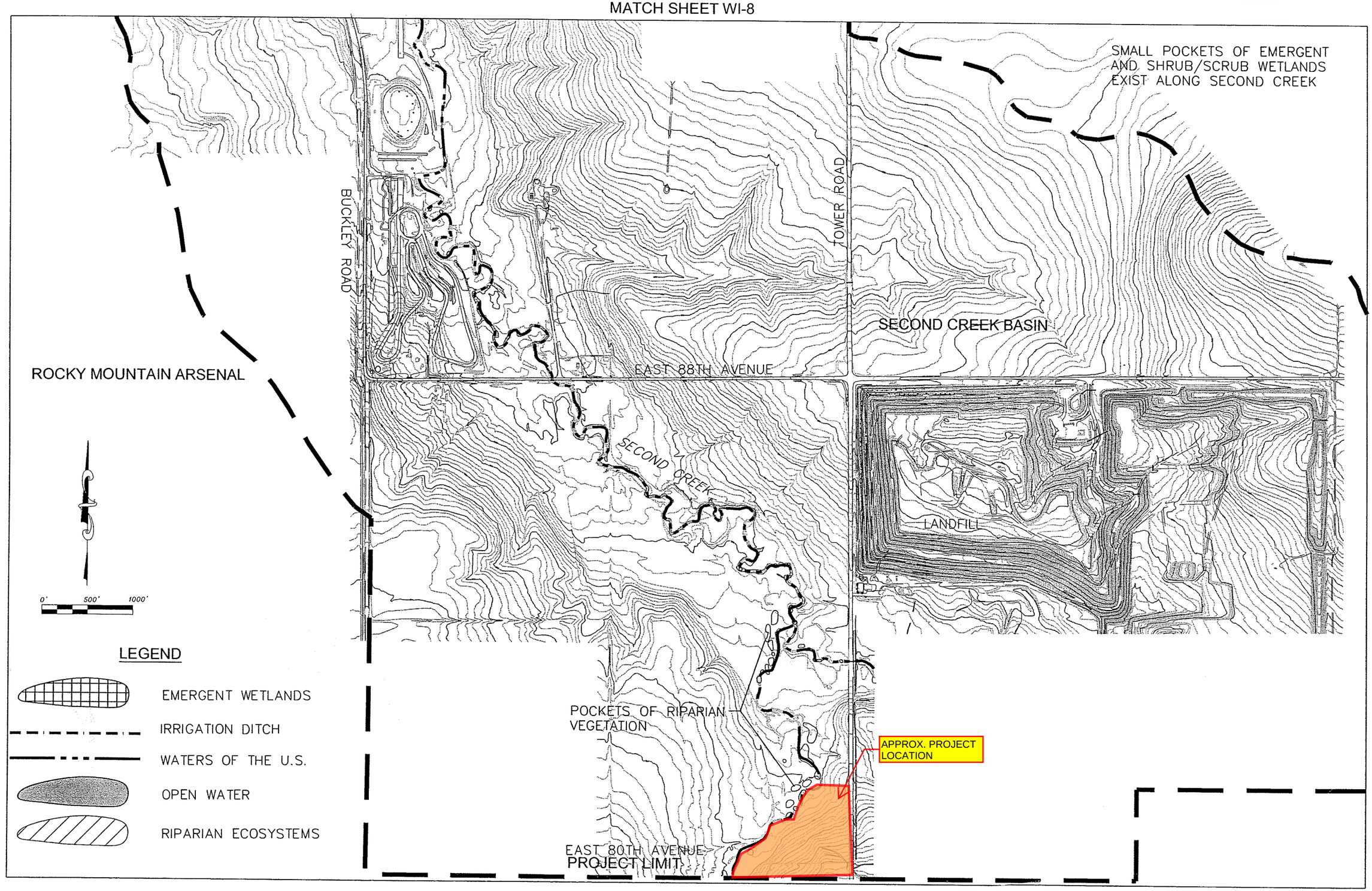
Sheet Reference Number

MAP-5

5 OF 8

I:\pw\3\3021\30.01 Tower Road Widening\H_DESIGN\CAD\C3D\LCAD\14SS COMBINED\3021301-20.dwg, Layout: MAP-5, Oct 09 2015 9:51am

MATCH SHEET WI-8



	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	WETLANDS INVENTORY	WI-8

COMMENTARY SHEET 20

Major Drainageway: West Fork 3501 **Stations:** 0+00 to 44+00

EXISTING CONDITIONS:

West Fork is a west bank tributary with a channel length of 4400 feet within the study limits. This tributary enters Second Creek near station 745+30. The average channel slope in this reach is 0.8%. West Fork is the largest tributary to Second Creek, however, most of the area lies outside of the study limits.

Problem areas in this reach include: potential erosion along the steep slopes, a poorly defined channel, and potential water quality degradation.

PROPOSED IMPROVEMENTS:

Based on flow magnitudes and channel conditions, a stable slope of 0.50% was calculated for this reach. A series of two check structures will maintain longitudinal slope stability when erosion begins to degrade the channel bottom. The check structures will allow the channel to naturally degrade to a maximum depth of 3 feet. This plan allows the channel to evolve naturally to increased upstream flows, but hold the maximum erosion to a controlled level.

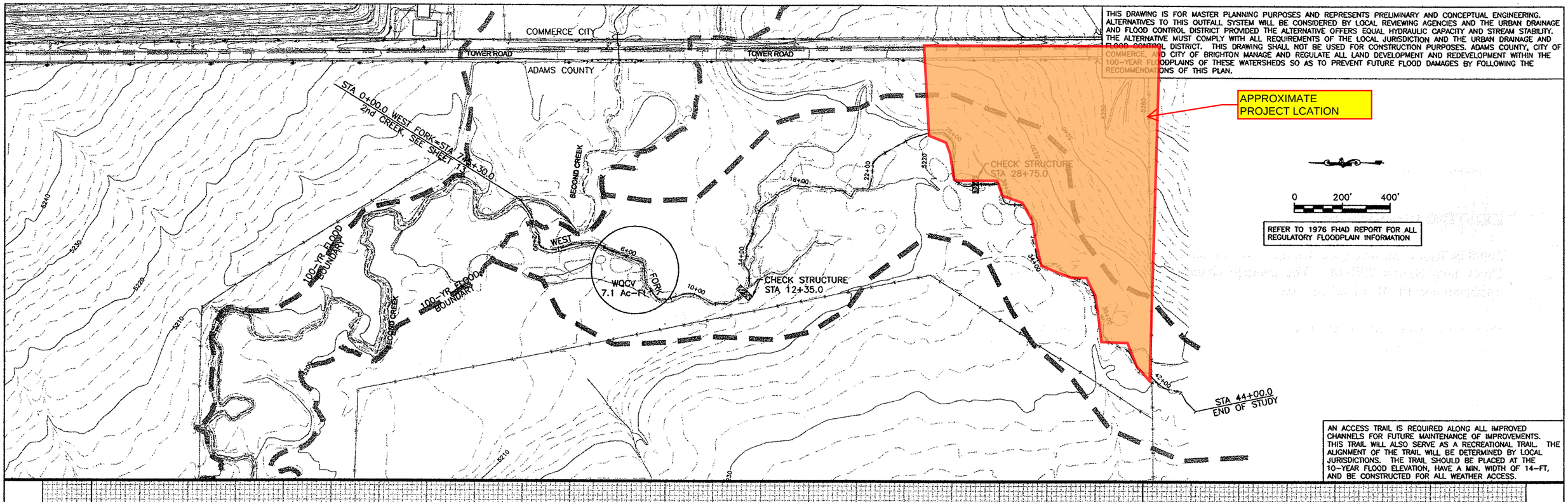
A water quality basin near the outfall to Second Creek will capture any pollutants and sediments, and settle them from the water prior to releasing to the main channel of Second Creek. This basin effectively treats runoff from the maximum area of 640 upstream acres.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 20

West Fork

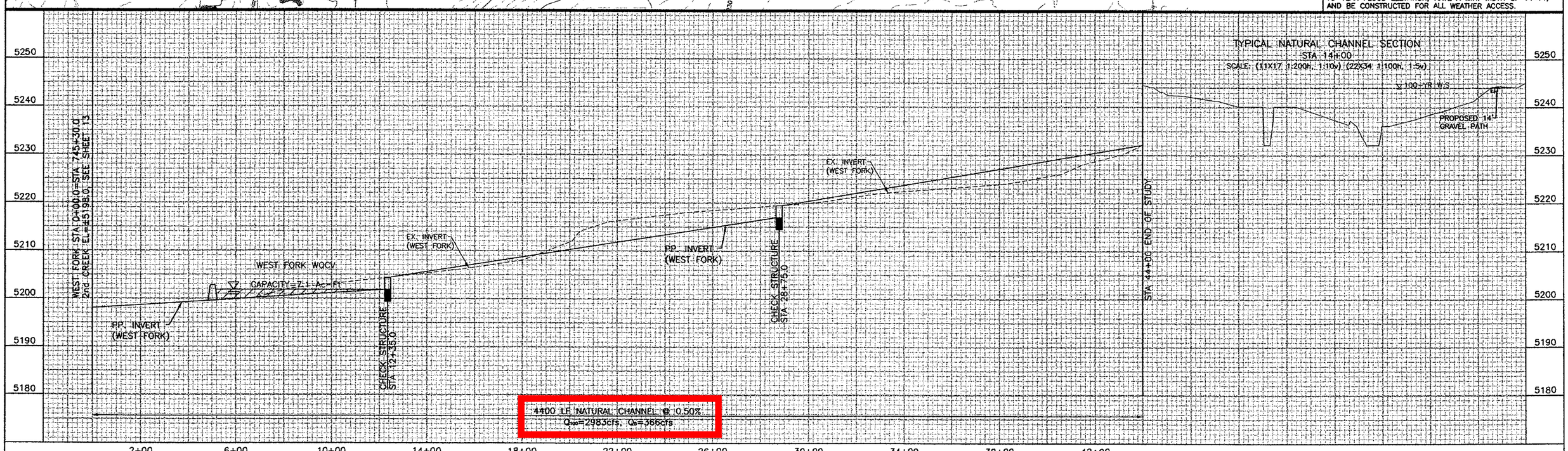
Improvement	Quantity	Unit	Unit Cost	Total Cost
Check structure	2	EA	$10,000	$20,000
Preserve Floodplain				$0
Water Quality Basin	7.1	AF	$25,000	$177,500
Maintenance Trail	4400	LF	$25	$110,000
Total Estimated Construction Cost				$307,500
Utility Relocation (5% of Construction Cost)				$15,375
Engr. and Contingency (35% of Construction + Utility)				$113,006
Land Value	7.4	Acres	$65,340	$484,638
Total Estimated Cost				**$920,519**

THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY LOCAL REVIEWING AGENCIES AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PROVIDED THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY AND STREAM STABILITY. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE LOCAL JURISDICTION AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES. ADAMS COUNTY, CITY OF COMMERCE, AND CITY OF BRIGHTON MANAGE AND REGULATE ALL LAND DEVELOPMENT AND REDEVELOPMENT WITHIN THE 100-YEAR FLOODPLAINS OF THESE WATERSHEDS SO AS TO PREVENT FUTURE FLOOD DAMAGES BY FOLLOWING THE RECOMMENDATIONS OF THIS PLAN.



REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001

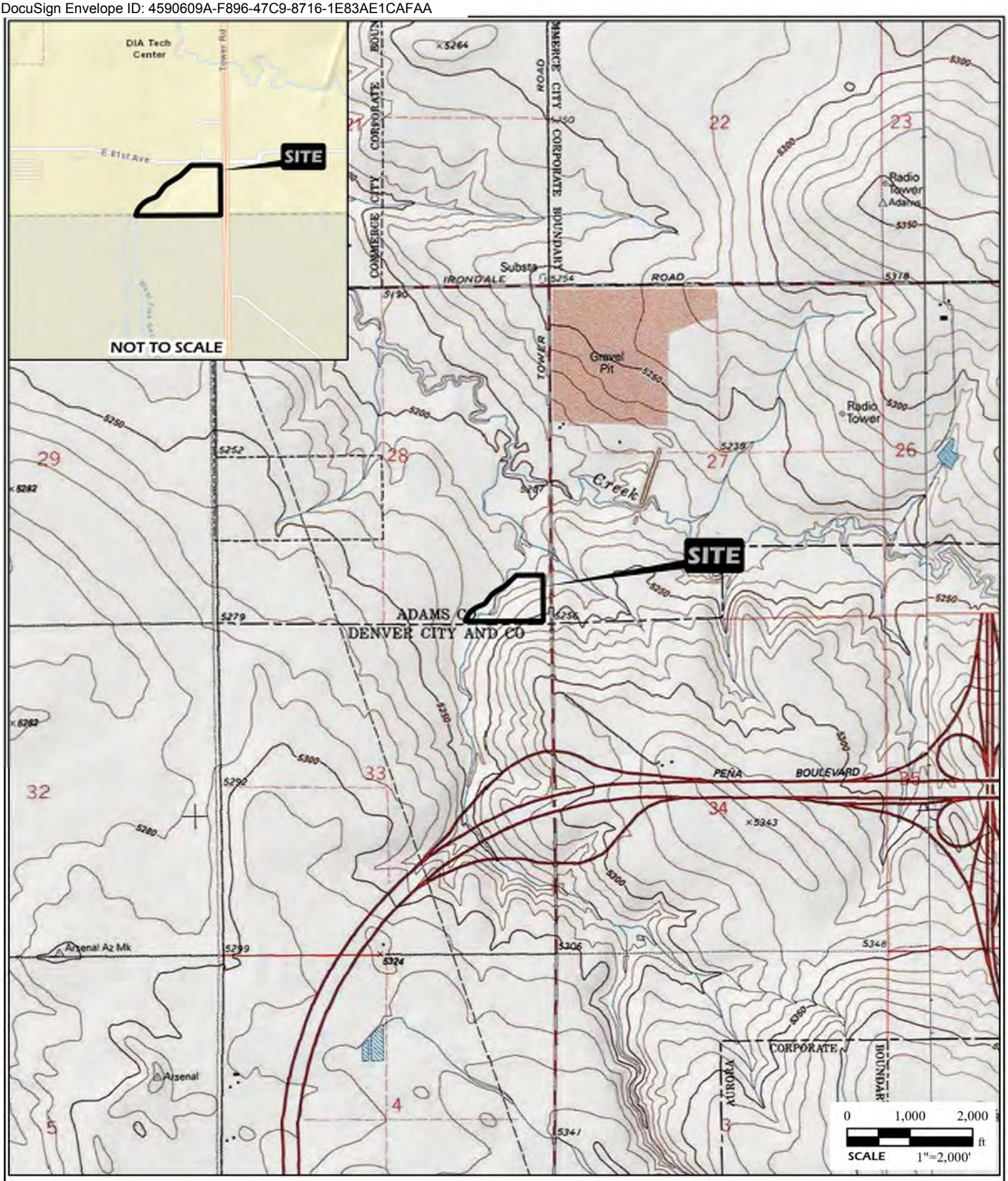
Kiowa Engineering Corporation
7175 W. Jefferson Avenue, Suite 3400
Lakewood, Colorado 80235
(303) 692-0388
KIOWA PROJECT NO. 01085

DESIGNED BJW/DDR DATE 02/04
DRAWN DDR DATE 02/04
CHECKED BJW DATE 02/04

ADAMS COUNTY, CITY OF BRIGHTON
CITY OF COMMERCE CITY, AND
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY UPDATE
SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS

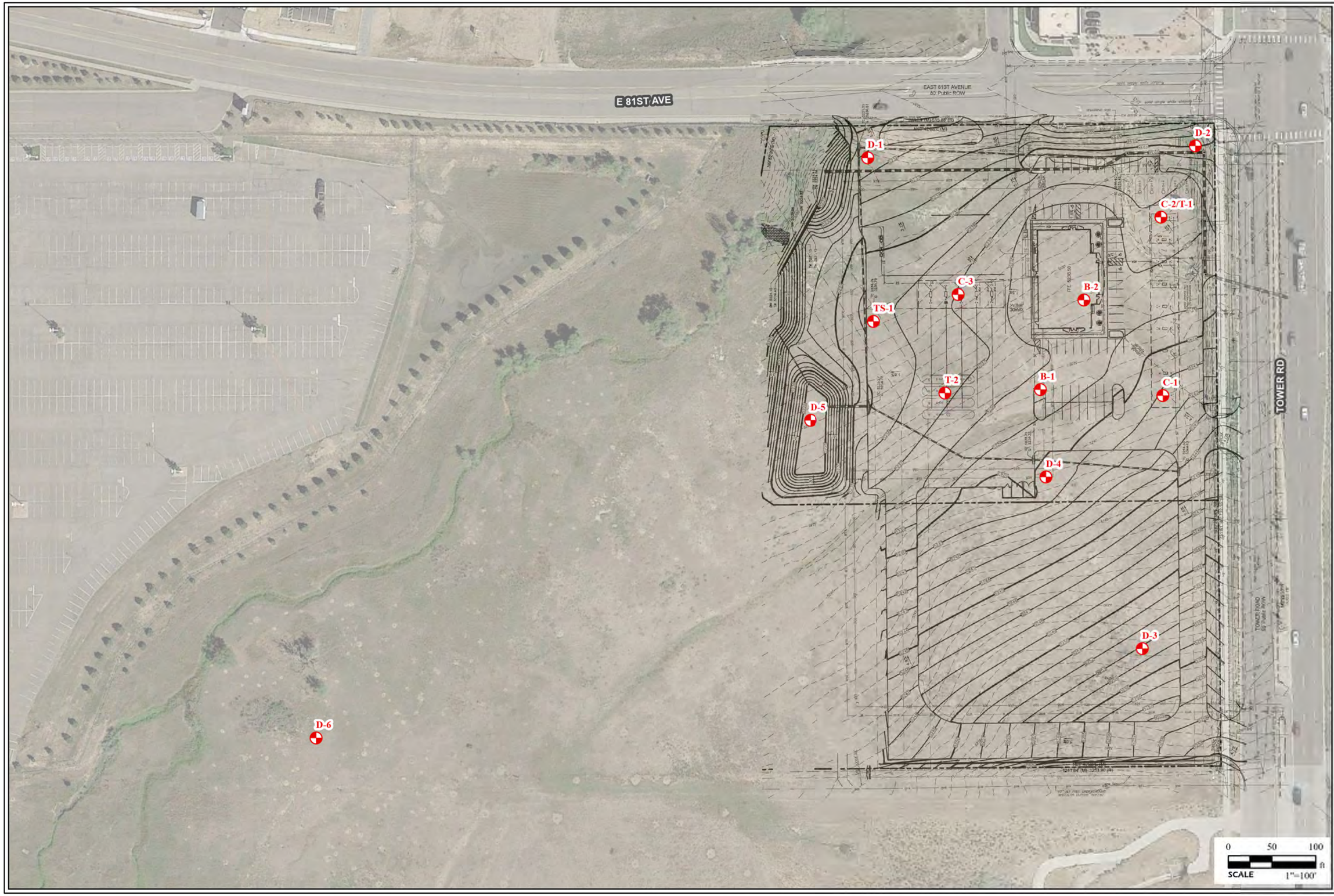
WEST FORK 3501
STA 0+00 to 44+00



	PROJECT NAME QUIKTRIP 4207 COMMERCE CITY, COLORADO			GENERAL NOTES/LEGEND USGS TOPOGRAPHIC MAP SABLE, COLORADO QUADRANGLE DATED 1965, PHOTO REVISED 1986 10' CONTOURS STREET MAP HTTP://GOTO.ARCGISONLINE.COM/MAPS/WORLD_STREET_MAP
	VICINITY AND TOPOGRAPHIC MAP			
	DRAWN BY RCV	DATE	JOB NUMBER	
	CHECKED BY TJC	05/2020	2020-0053.10	

N W E S

FIGURE 1



GENERAL NOTES/LEGEND

APPROXIMATE SOIL BORING LOCATIONS

UNDATED PLAN PROVIDED 5/01/2020 BY QUIKTRIP.
AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH, DATED 09/2019.
DIMENSIONS AND LOCATIONS ARE APPROXIMATE. ACTUAL MAY VARY. DRAWING SHALL NOT BE USED OUTSIDE THE CONTEXT OF THE REPORT FOR WHICH IT WAS GENERATED.

PROJECT NAME
QUIKTRIP 4207
COMMERCE CITY, COLORADO

AERIAL PHOTOGRAPH

N
W
E
S

JOB NUMBER 2020-0053.10
DATE 05/2020
DRAWN BY RCV
CHECKED BY TJC
FIGURE 2

SCI ENGINEERING, INC.
390 Interlocken Crescent, Suite 350
Broomfield, Colorado 80021
720-544-3663
www.sciengineering.com

BORING LOG LEGEND AND NOMENCLATURE

Depth is in feet below ground surface. **Elevation** is in feet mean sea level, site datum, or as otherwise noted.

Sample Type

- **SS** Split-spoon sample, disturbed, obtained by driving a 2-inch-O.D. split-spoon sampler (ASTM D 1586).
- **NX** Diamond core bit, nominal 2-inch-diameter rock sample (ASTM D 2113).
- **ST** Thin-walled (Shelby) tube sample, relatively undisturbed, obtained by pushing a 3-inch-diameter, tube (ASTM D 1587).
- **CS** Continuous sample tube system, relatively undisturbed, obtained by split-barrel sampler in conjunction with auger advancement.
- **SV** Shear vane, field test to determine strength of cohesive soil by pushing or driving a 2-inch-diameter vane, and then shearing by torquing soil in existing and remolded states (ASTM D 2573).
- **BS** Bag sample, disturbed, obtained from cuttings.

Recovery is expressed as a ratio of the length recovered to the total length pushed, driven, cored.

Blows Numbers indicate blows per 6 inches of split-spoon sampler penetration when driven with a 140-pound hammer falling freely 30 inches. The number of total blows obtained for the second and third 6-inch increments is the N value (Standard Penetration Test or SPT) in blows per foot (ASTM D 1586). Practical refusal is considered to be 50 or more blows without achieving 6 inches of penetration, and is expressed as a ratio of 50 to actual penetration, e.g., 50/2 (50 blows for 2 inches).

For analysis, the N value is used when obtained by a cathead and rope system. When obtained by an automatic hammer, the N value may be increased by a factor of 1.3.

Vane Shear Strength is expressed as the peak strength (existing state) / the residual strength (remolded state).

Description indicates soil constituents and other classification characteristics (ASTM D 2488) and the Unified Soil Classification (ASTM D 2487). Secondary soil constituents (expressed as a percentage) are described as follows:

Trace	<5
Few	5-15
With	>15-30

Stratigraphic Breaks may be observed or interpreted, and are indicated by a dashed line. Transition between described materials may be gradual.

Laboratory Test Results

- Natural moisture content (ASTM D 2216) in percent.
- Dry density in pounds per cubic foot (pcf).
- Hand penetrometer value of apparently intact cohesive sample in kips per square foot (ksf).
- Unconfined compressive strength (ASTM D 2166) in kips per square foot (ksf).
- Liquid and Plastic Limits (ASTM D 4318) in percent.

RQD (Rock Quality Designation) is the ratio between the total length of core segments 4 inches or more in length and the total length of core drilled. RQD (expressed as a percentage) indicates insitu rock quality as follows:

Excellent	90 to 100
Good	75 to 90
Fair	50 to 75
Poor	25 to 50
Very Poor	0 to 25

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** B-1
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5236± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS: MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					SANDY FAT CLAY (CH): Gray, sand is fine to coarse, some fine gravel									5235
	1	ST	24/24					13	92		6.8	66	46	
3														
	2	SS	18/18	10 15 27	Sand become fine, no gravel			41		3.5				5232
					SHALEY FAT CLAY (CH): Gray, some fine sand									
6	3	SS	18/18	9 18 19				34		8.0				5229
9	4	SS	18/18	8 15 23				28		8.5				5226
12					FAT CLAY (CH): Brown, with fine sand									
	5	SS	18/18	8 18 15				41		3.0				5223
15														5220
18														
	6	SS	18/18	15 20 23				19		7.0				5217

Boring terminated at 20 feet.

WATER LEVEL:
X NONE OBSERVED WHILE DRILLING
____ ft WHILE DRILLING
____ ft ____ HRS AFTER DRILLING
____ ft ____ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** B-2
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5232± **DATE DRILLED** 01/30/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					2" TOPSOIL									
					FAT CLAY (CH): Light brown, with fine sand									
	1	SS	12/18	10 16 18				31		6.0		68	34	
3														5229
	2	SS	18/18	9 15 15				39		2.5				
6														5226
	3	SS	14/18	8 8 9	Becomes brown			33		4.0				
					Becomes light brown, some shale									
9	4	SS	18/18	5 10 12				43		5.0				5223
12														5220
	5	SS	18/18	7 11 12				43		5.0				
15														5217
					SHALEY FAT CLAY (CH): Gray, trace orange, some fine sand, trace calcareous deposits									
18														5214
	6	SS	18/18	10 19 21				41		4.5				
					Boring terminated at 20 feet.									

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
____ ft WHILE DRILLING
____ ft ____ HRS AFTER DRILLING
____ ft ____ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** C-1
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5236± **DATE DRILLED** 01/30/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					SHALEY FAT CLAY (CH): Gray, trace orange, some fine sand, trace calcareous deposits									
	1	SS	16/18	8 14 15				34		>9.0				5235
3														
	2	SS	18/18	10 14 21				45		6.5		86	64	5232
6	3	ST												
	4	SS	18/18	9 14 15				35		5.0				5229
9	5	SS	18/18	8 16 14	Becomes light brown, trace orange			39		7.5				5226
12														5223
	6	SS	18/18	4 8 10	Becomes brown, trace orange			58		2.0				
15					Boring terminated at 15 feet.									5220
18														5217

WATER LEVEL:

X	NONE OBSERVED WHILE DRILLING
	ft WHILE DRILLING
	ft ___ HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** C-2/T-1
LOCATION Commerce, Colorado **SHEET** 1 **of** 2
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5230± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					FILL: Brown, lean clay, some fine sand, trace roots									
	1	SS	12/18	10 19 15				17		8.0		44	26	5229
3														
	2	SS	18/18	16 20 26	Becomes grayish brown, trace organics			38		7.5				5226
6														
	3	SS	18/18	10 14 26	Trace fine sand			43		2.5				
					FAT CLAY (CH): Gray, trace orange, with fine sand			25		3.0				5223
					SHALEY FAT CLAY (CH): Gray, trace orange, with fine sand									
9	4	SS	18/18	13 15 18				42		5.0				5220
12														5217
	5	SS	18/18	11 16 18	No orange			40		3.5				
15														5214
					CLAYEY GRAVEL (GC): Brown, fine to medium limestone, with fine to coarse sand, clay is fat									
18	6	SS	10/12	37 50			1	44		1.0				5211

WATER LEVEL:

	NONE OBSERVED WHILE DRILLING
19.0	ft WHILE DRILLING
	ft ___ HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

1) Percent passing #200 = 25%

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** C-2/T-1
LOCATION Commerce, Colorado **SHEET** 2 **of** 2
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5230± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
21					CLAYEY GRAVEL (GC): Brown, fine to medium limestone, with fine to coarse sand, clay is fat *(Continued)*									5208
24	7	SS	18/18	7 14 24	ORGANIC FAT CLAY (OH): Black, trace fine sand			39		-				5205
27					SHALEY FAT CLAY (CH): Dark gray									5202
	8	SS	11/18	21 50				25		5.0				
30					Boring terminated at 30 feet.									5199
33														5196
36														5193
39														

WATER LEVEL:

	NONE OBSERVED WHILE DRILLING
19.0	ft WHILE DRILLING
	ft ___ HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** C-3
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5227± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					FILL: Gray, lean clay									
	1	SS	12/18	8 16 9				28		>9.0				5226
3					FAT CLAY (CH): Gray, some fine sand									
	2	SS	18/18	8 13 13				36		>9.0				5223
6					Becomes dark brown									
	3	SS	18/18	5 10 12				37		5.0				5220
9					Becomes gray									
	4	SS	18/18	9 11 15				49		4.5		79	54	5217
12														5214
	5	SS	18/18	11 17 24	Becomes light brown, trace orange, trace calcareous deposits			43		5.5				
15					Boring terminated at 15 feet.									5211
18														5208

WATER LEVEL:

X	NONE OBSERVED WHILE DRILLING
	ft WHILE DRILLING
13.0	ft 24 HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** D-1
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5222± **DATE DRILLED** 01/30/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					2" TOPSOIL									
	1	SS	18/18	6 8 9	SANDY LEAN CLAY (CL): Brown, sand is fine to medium, some calcareous deposits			26		3.0				5220
3					FAT CLAY (CH): Brown, trace fine sand, trace calcareous deposits									
	2	SS	18/18	4 6 8				27		2.5				5217
6					No calcareous deposits									
	3	SS	14/18	4 6 9				30		2.5				5214
9	4	SS	18/18	4 5 7				28		2.0				5211
12														
	5	SS	18/18	5 6 8	Trace calcareous deposits			29		2.0				5208
15					Boring terminated at 15 feet.									5205
18														

WATER LEVEL:
X NONE OBSERVED WHILE DRILLING
____ ft WHILE DRILLING
____ ft ____ HRS AFTER DRILLING
____ ft ____ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** D-2
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5231± **DATE DRILLED** 01/30/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					2" TOPSOIL									
					FAT CLAY (CH): Brown, trace calcareous deposits									
	1	SS	14/18	6 10 15				21		>9.0				5229
3														
	2	SS	14/18	8 11 11	Some fine sand			17		6.5				5226
6					SANDY FAT CLAY (CH): Brown, sand is fine									
	3	SS	18/18	6 8 8				17		1.0				5223
					FAT CLAY (CH): Brown, some fine to medium sand									
9	4	SS	18/18	6 7 7				32		2.0				5220
12														
	5	SS	18/18	13 21 28	Becomes light brown and red, trace fine sand			43		8.5				5217
15					Boring terminated at 15 feet.									5214
18														

WATER LEVEL:

X	NONE OBSERVED WHILE DRILLING
	ft WHILE DRILLING
	ft ___ HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** D-3
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5253± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					2" TOPSOIL									
					FAT CLAY (CH): Brown, trace calcareous deposits, trace fine sand									
	1	SS	17/18	14 24 26				12		>9.0				
3														5250
	2	SS	6/18	24 29 26				11		>9.0				
					SHALEY FAT CLAY (CH): Brown, trace fine sand, trace calcareous deposits									
6														5247
	3	SS	12/18	9 6 5				47		8.5				
9	4	SS	10/18	3 4 10				33		>9.0				5244
12					FAT CLAY (CH): Brown and gray, trace fine sand, trace calcareous deposits									5241
	5	SS	18/18	9 14 21				47		>9.0				
15					Boring terminated at 15 feet.									5238
18														5235

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
____ ft WHILE DRILLING
____ ft ____ HRS AFTER DRILLING
____ ft ____ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** D-4
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5241± **DATE DRILLED** 01/30/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					2" TOPSOIL									
					SHALEY FAT CLAY (CH): Gray, some fine sand									
	1	SS	14/18	10 15 13				21		>9.0				
3														5238
	2	SS	18/18	8 19 23				30		>9.0				
6														5235
	3	SS	18/18	9 16 13	FAT CLAY (CH): Brown and gray, trace calcareous deposits, trace fine sand			45		8.5				
9	4	SS	18/18	10 13 17				37		4.5				5232
					Boring terminated at 10 feet.									
12														5229
15														5226
18														5223

WATER LEVEL:

X	NONE OBSERVED WHILE DRILLING
____ ft	WHILE DRILLING
____ ft	____ HRS AFTER DRILLING
____ ft	____ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** D-5
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5230± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					2" TOPSOIL									
					SANDY FAT CLAY (CH): Tan, sand is fine									5229
	1	SS	12/18	12 14 12				24		6.5				
3														
	2	SS	12/18	11 16 20				29		5.0				5226
6														
	3	SS	18/18	11 19 18	SHALEY FAT CLAY (CH): Gray and tan, with fine to coarse sand, trace organics			33		5.5				5223
					SANDY SHALEY FAT CLAY (CH): Gray and tan, some orange, some black, sand is fine			41		4.5				
9	4	SS	18/18	9 12 13	ORGANIC FAT CLAY (OH): Black, trace fine to medium sand			74		2.5				5220
12					SHALEY FAT CLAY (CH): Gray, some orange, trace organics									5217
	5	SS	18/18	6 12 13				27		3.5				
15					Boring terminated at 15 feet.									5214
18														5211

WATER LEVEL:

X	NONE OBSERVED WHILE DRILLING
	ft WHILE DRILLING
13.9	ft 24 HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** D-6
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5228± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
					FAT CLAY (CH): Grayish brown, with fine sand									
	1	SS	18/18	4 5 6				21		2.0				5226
3														
	2	SS	12/18	4 2 3				24		<0.5				5223
6														
	3	SS	18/18	2 3 3				26		1.0				5220
9	4	SS	18/18	3 4 4				25		<0.5				
					CLAYEY SAND (SC): Grayish brown, fine to medium, clay is fat									5217
12														
	5	SS	18/18	4 6 8	SHALEY FAT CLAY (CH): Grayish tan, with fine to medium sand			33		4.0				5214
15					Boring terminated at 15 feet.									
														5211
18														

WATER LEVEL:

	NONE OBSERVED WHILE DRILLING
5.0	ft WHILE DRILLING
3.5	ft 24 HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** T-2
LOCATION Commerce, Colorado **SHEET** 1 **of** 2
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5233± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS: MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					2" TOPSOIL									
					SANDY LEAN CLAY (CL): Tan, sand is fine to medium, trace calcareous deposits									5232
	1	SS	18/18	14 21 18				27		>9.0				
3														
	2	SS	18/18	9 21 29			1	34		>9.0				5229
					Becomes tan and brown, trace organics									
6	3	SS	18/18	12 17 30				29		5.0				5226
9	4	SS	18/18	13 22 29				27		4.5				5223
12					ORGANIC FAT CLAY (OH): Dark brown, with fine to medium sand									5220
	5	SS	18/18	8 12 19				52		4.0				
15														5217
					SHALEY FAT CLAY (CH): Grayish brown, trace black, trace orange, with fine sand									
18														
	6	SS	18/18	9 13 21				41		5.0				5214

WATER LEVEL:

	NONE OBSERVED WHILE DRILLING
28.0	ft WHILE DRILLING
	ft ___ HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

1) Percent passing #200 = 68.0%

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** T-2
LOCATION Commerce, Colorado **SHEET** 2 **of** 2
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5233± **DATE DRILLED** 01/29/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LAB: MOISTURE CONTENT (%)	LAB: DRY DENSITY (pcf)	LAB: HAND PENETROMETER (ksf)	LAB: UNCONFINED COMPRESSIVE STRENGTH (ksf)	LAB: LIQUID LIMIT	LAB: PLASTICITY INDEX	ELEVATION (ft)
21					SHALEY FAT CLAY (CH): Grayish brown, trace black, trace orange, with fine sand *(Continued)*									5211
24	7	SS	18/18	16 20 38				41		3.0				5208
27					SANDY SHALEY FAT CLAY (CH): Gray, some orange, trace black, sand is fine									5205
	8	SS	18/18	9 22 27				38		8.0				
30					Boring terminated at 30 feet.									5202
33														5199
36														5196
39														

WATER LEVEL:

	NONE OBSERVED WHILE DRILLING
28.0	ft WHILE DRILLING
	ft ___ HRS AFTER DRILLING
	ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT QuikTrip 4207 **BORING NUMBER** TS-1
LOCATION Commerce, Colorado **SHEET** 1 **of** 1
DRILLER Dakota **HAMMER** Auto **PROJECT NO.** 2020-0053.10 Task:100
EQUIPMENT Dietrich D50 w/HSA **ELEVATION** 5226± **DATE DRILLED** 01/30/20

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS: MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					SHALEY FAT CLAY (CH): Brownish gray, with black, organic fat clay, trace calcareous deposits									
	1	SS	12/18	6 10 9				39		7.0				
3														5223
	2	ST	24/24		ORGANIC FAT CLAY (OH): Black, trace calcareous deposits, trace sandy fat clay, fine to coarse sand		1	58	61.4		2.8	91	51	
					With sandy fat clay									
					SANDY FAT CLAY (CH): Brown, fine to coarse sand, with black, organic fat clay		2							
					SHALEY FAT CLAY (CH): Tan, some fine to medium sand									
6														5220
	3	SS	18/18	6 10 10	Becomes grayish-brown, some orange, some black, with fine sand			56		4.0				
9	4	SS	18/18	10 10 13	Becomes tan			39		5.0				5217
12														5214
					SANDY FAT CLAY (CH): Tan, trace orange, trace gray, sand is fine									
	5	SS	18/18	10 19 23				38		3.5				
15					Boring terminated at 15 feet.									5211
18														5208

WATER LEVEL:

X	**NONE OBSERVED WHILE DRILLING**
____ ft	**WHILE DRILLING**
____ ft ____	**HRS AFTER DRILLING**
____ ft ____	**DAYS AFTER DRILLING**

REMARKS:

1) Organic Content = 55.6%
2) Organic Content = 2.7%

APPENDIX B

Hydrologic Computations

EXCERPT FROM TOWER ROAD
DRAINAGE REPORT, FINAL DRAFT

COEFFICIENTS OF DEVELOPMENT

EXISTING CONDITIONS

Project: Tower Road
FHU Project #: 114070-01
Date: 10/9/15

BASIN	AREA ACRES	IMPERVIOUSNESS			SOIL TYPE			RUNOFF COEFF.			
		Open % Imp. 0 Acres	Paved % Imp. 100 Acres	Comp. % Imp.	A Percent of Total Area	B Percent of Total Area	C/D Percent of Total Area	2 YEAR	5 YEAR	10 YEAR	100 YEAR
1	12.64			2.00			100.0	0.06	0.16	0.26	0.51
2	27.15			2.00			100.0	0.06	0.16	0.26	0.51
3	101.39			2.00			100.0	0.06	0.16	0.26	0.51
4	11.81			2.00			100.0	0.06	0.16	0.26	0.51
5	62.23			5.00			100.0	0.08	0.18	0.28	0.52
6	88.94			5.00			100.0	0.08	0.18	0.28	0.52
9	51.74			2.00			100.0	0.06	0.16	0.26	0.51
10	37.99			2.00			100.0	0.06	0.16	0.26	0.51
11	102.55			2.00			100.0	0.06	0.16	0.26	0.51
12	72.00			2.00			100.0	0.06	0.16	0.26	0.51
13	26.03			2.00			100.0	0.06	0.16	0.26	0.51
14	49.73			2.00			100.0	0.06	0.16	0.26	0.51

PROJECT: QuikTrip 83-4207
LOCATION: 81st and Tower
Commerce City, Colorado

Project No.: QKT004207
Date: December 12, 2022
Engineer: D. Rady

*PERCENT IMPERVIOUS VALUES	
LANDSCAPE	2
PAVING	100
ROOFING	90
COMMERCIAL	95

* RUNOFF COEFFICIENTS USED (Group C Soils)				
	2-Year	5-Year	10-year	100-Year
LANDSCAPE	0.01	0.05	0.15	0.49
PAVING	0.83	0.85	0.87	0.89
ROOFING	0.74	0.77	0.79	0.85
COMMERCIAL	0.79	0.81	0.83	0.87

* Table 6-5, Chapter 6, USDCM Vol. I

Composite Runoff Coefficients and Percent Imperviousness for Existing Drainage Basins

BASIN DESIG.	OVERALL AREA (sf)	LANDSCAPE AREA (sf)	PAVED AREA (sf)	ROOF AREA (sf)	COMMERCIAL AREA (sf)	2-YEAR COEFF.	5-YEAR COEFF.	10-YEAR COEFF.	100-YEAR COEFF.	PERCENT IMPERVIOUS
DA-A1	635,716	635,716	0	0	0	0.01	0.05	0.15	0.49	2%
TOTAL TO SECOND CREEK	**635,716**	**635,716**	**0**	**0**	**0**	**0.01**	**0.05**	**0.15**	**0.49**	**2%**

PROJECT: QuikTrip 83-4207
LOCATION: 81st and Tower
Commerce City, Colorado

Project No.: QKT004207
Date: December 12, 2022
Engineer: D. Rady

*PERCENT IMPERVIOUS VALUES	
LANDSCAPE	2
PAVING	100
ROOFING	90
COMMERCIAL	95

* RUNOFF COEFFICIENTS USED (Group C Soils)				
	2-Year	5-Year	10-year	100-Year
LANDSCAPE	0.01	0.05	0.15	0.49
PAVING	0.83	0.85	0.87	0.89
ROOFING	0.74	0.77	0.79	0.85
COMMERCIAL	0.79	0.81	0.83	0.87

* Table 6-5, Chapter 6, USDCM Vol. I

Composite Runoff Coefficients and Percent Imperviousness for Developed Drainage Basins

BASIN DESIG.	OVERALL AREA (sf)	LANDSCAPE AREA (sf)	PAVED AREA (sf)	ROOF AREA (sf)	COMMERCIAL AREA (sf)	2-YEAR COEFF.	5-YEAR COEFF.	10-YEAR COEFF.	100-YEAR COEFF.	PERCENT IMPERVIOUS
DA-A1	49,079	19,148	29,931	0	0	0.51	0.54	0.59	0.73	62%
DA-A2	1,500	0	1,500	0	0	0.83	0.85	0.87	0.89	100%
DA-A3	29,115	0	29,115	0	0	0.83	0.85	0.87	0.89	100%
DA-A4	1,623	0	1,623	0	0	0.83	0.85	0.87	0.89	100%
DA-B1	102,358	3,132	45,804	0	53,422	0.78	0.80	0.83	0.87	94%
DA-B2	57,289	4,042	27,310	0	25,937	0.75	0.78	0.80	0.85	91%
DA-B3	24,297	24,297	0	0	0	0.01	0.05	0.15	0.49	2%
DA-C1	22,744	22,744	0	0	0	0.01	0.05	0.15	0.49	2%
DA-R1	7,822	0	0	7,822	0	0.74	0.77	0.79	0.85	90%
DA-R2	3,124	0	0	3,124	0	0.74	0.77	0.79	0.85	90%
DA-R3	7,286	0	0	7,286	0	0.74	0.77	0.79	0.85	90%
TOTAL TO POND	**306,237**	**73,363**	**135,283**	**18,232**	**79,359**	**0.62**	**0.64**	**0.68**	**0.79**	**75%**
DA-OS1	22,540	18,918	3,622	0	0	0.14	0.18	0.27	0.55	18%
DA-OS2	28,235	28,235	0	0	0	0.01	0.05	0.15	0.49	2%
DA-OS3	13,458	1,839	11,619	0	0	0.72	0.74	0.77	0.84	87%
DA-OS4	284,019	284,019	0	0	0	0.01	0.05	0.15	0.49	2%
TOTAL OFFSITE	**348,252**	**333,011**	**15,241**	**0**	**0**	**0.05**	**0.09**	**0.18**	**0.51**	**6%**
TOTAL SITE	**654,489**	**406,374**	**150,524**	**18,232**	**79,359**	**0.31**	**0.35**	**0.42**	**0.64**	**38%**

PROJECT: QuikTrip 83-4207
LOCATION: 81st and Tower
Commerce City, Colorado

Project No.: QKT004207
Date: December 12, 2022
Engineer: D. Rady

Time of Concentration, 5 Year Coefficient

Basin Design	Overall Area (ac)	5-Year Coeff C5	Initial / Overland Time, ti			Travel Time, tt				ti +tt	Result	
			Length (ft)	Slope (%)	ti (min)	Length (ft)	SLOPE (%)	Velocity (fps)	tt (min)	tc (min)	tc (min)	Notes
DA-A1	1.13	0.54	271	4.50%	10.09	341	4.00%	4.00	1.4	11.5	11.5	
DA-A2	0.03	0.85	-	-	-	-	-	-	-	5.0	5.0	Use minimum tc
DA-A3	0.67	0.85	275	2.75%	5.33	-	-	-	0.0	5.3	5.3	
DA-A4	0.04	0.85	-	-	-	-	-	-	-	5.0	5.0	Use minimum tc
DA-B1	2.35	0.80	88	4.50%	3.02	241	4.75%	4.36	0.9	3.9	5.0	
DA-B2	1.32	0.78	378	3.50%	7.48	92	4.70%	4.34	0.4	7.8	7.8	
DA-B3	0.56	0.05	143	16.00%	8.97	177	2.50%	3.16	0.9	9.9	9.9	
DA-C1	0.52	0.05	23	13.10%	3.85	140	3.00%	3.46	0.7	4.5	5.0	Use minimum tc
DA-R1	0.18	0.77	-	-	-	-	-	-	-	5.0	5.0	Use minimum tc
DA-R2	0.07	0.77	-	-	-	-	-	-	-	5.0	5.0	Use minimum tc
DA-R3	0.17	0.77	-	-	-	-	-	-	-	5.0	5.0	Use minimum tc
DA-OS1	0.52	0.27	180	5.00%	11.78	-	-	-	0.0	11.8	11.8	
DA-OS2	0.65	0.15	70	13.40%	6.02	86	24.00%	9.80	0.1	6.2	6.2	
DA-OS3	0.31	0.77	54	5.40%	2.48	0	1.00%	2.00	0.0	2.5	5.0	Use minimum tc
DA-OS4	6.52	0.15	77	4.70%	8.96	1117	0.50%	1.41	13.2	22.1	22.1	
EXISTING												
DA-A1	14.59	0.05	570	7.00%	23.59	546	4.00%	4.00	2.3	25.9	25.9	

PROJECT: QuikTrip 83-4207
LOCATION: 81st and Tower

Project No.: QKT004207
Date: 12/12/2022
Engineer: D. Rady

2-YR RUNOFF COMPUTATIONS (RATIONAL METHOD)

PROPOSED BASIN INFORMATION				DIRECT RUNOFF				TOTAL RUNOFF	REMARKS
DESIGN PT.	BASIN	AREA (acres)	RUNOFF COEFF.	Tc (min)	C x A (acres)	I (in/hr)	Q (cfs)	Q (cfs)	
1	DA-A1	1.13	0.51	11.51	0.57	3.50	2.01		
2	DA-A2	0.03	0.83	5.00	0.03	4.65	0.13		
3	DA-A3	0.67	0.83	5.33	0.55	4.57	2.53		
2	DA-A4	0.04	0.83	5.00	0.03	4.65	0.14		
4	DA-B1	2.35	0.78	5.00	1.84	4.65	8.56		
5	DA-B2	1.32	0.75	7.83	0.99	4.06	4.02		
6	DA-B3	0.56	0.01	9.90	0.01	3.72	0.02		
7	DA-C1	0.52	0.01	5.00	0.01	4.65	0.02		
-	DA-R1	0.18	0.74	5.00	0.13	4.65	0.62		
-	DA-R2	0.07	0.74	5.00	0.05	4.65	0.25		
-	DA-R3	0.17	0.74	5.00	0.12	4.65	0.58		
	TOTAL TO POND	7.03	0.62				18.89		
8	DA-OS1	0.52	0.14	11.78	0.07	3.47	0.25		
8	DA-OS2	0.65	0.01	6.17	0.01	4.38	0.03		
8	DA-OS3	0.31	0.72	5.00	0.22	4.65	1.03		
8	DA-OS4	6.52	0.01	22.12	0.07	2.55	0.17		
	TOTAL OFFSITE	7.99	0.05				1.48		
	TOTAL SITE	15.03	0.31				20.37		

EXISTING BASIN INFORMATION				DIRECT RUNOFF				TOTAL RUNOFF	REMARKS
DESIGN PT.	BASIN	AREA (acres)	RUNOFF COEFF.	Tc (min)	C x A (acres)	I (in/hr)	Q (cfs)	Q (cfs)	
1	DA-A1	14.59	0.01	25.86	0.15	2.34	0.34		
	TOTAL SITE	14.59					0.34		

Use minimum Time of Concentration = 5 minutes
Use composite coefficients

Ration Method: Q = CIA

PROJECT: QuikTrip 83-4207
LOCATION: 81st and Tower

Project No.: QKT004207
Date: 12/12/2022
Engineer: D. Rady

5-YR RUNOFF COMPUTATIONS (RATIONAL METHOD)

PROPOSED BASIN INFORMATION				DIRECT RUNOFF				TOTAL RUNOFF	REMARKS
DESIGN PT.	BASIN	AREA (acres)	RUNOFF COEFF.	Tc (min)	C x A (acres)	I (in/hr)	Q (cfs)	Q (cfs)	
1	DA-A1	1.13	0.54	11.51	0.61	3.50	2.12		
2	DA-A2	0.03	0.85	5.00	0.03	4.65	0.14		
3	DA-A3	0.67	0.85	5.33	0.57	4.57	2.60		
2	DA-A4	0.04	0.85	5.00	0.03	4.65	0.15		
4	DA-B1	2.35	0.80	5.00	1.89	4.65	8.79		
5	DA-B2	1.32	0.78	7.83	1.02	4.06	4.14		
6	DA-B3	0.56	0.05	9.90	0.03	3.72	0.10		
7	DA-C1	0.52	0.05	5.00	0.03	4.65	0.12		
-	DA-R1	0.18	0.77	5.00	0.14	4.65	0.64		
-	DA-R2	0.07	0.77	5.00	0.06	4.65	0.26		
-	DA-R3	0.17	0.77	5.00	0.13	4.65	0.60		
	TOTAL TO POND	7.03	0.64				19.65		
8	DA-OS1	0.52	0.18	11.78	0.09	3.47	0.32		
8	DA-OS2	0.65	0.05	6.17	0.03	4.38	0.14		
8	DA-OS3	0.31	0.74	5.00	0.23	4.65	1.06		
8	DA-OS4	6.52	0.05	22.12	0.33	2.55	0.83		
	TOTAL OFFSITE	7.99	0.09				2.36		
	TOTAL SITE	15.03	0.35				22.00		

EXISTING BASIN INFORMATION				DIRECT RUNOFF				TOTAL RUNOFF	REMARKS
DESIGN PT.	BASIN	AREA (acres)	RUNOFF COEFF.	Tc (min)	C x A (acres)	I (in/hr)	Q (cfs)	Q (cfs)	
1	DA-A1	14.59	0.05	25.86	0.73	2.34	1.71		
	TOTAL SITE	14.59					1.71		

Use minimum Time of Concentration = 5 minutes
Use composite coefficients

Ration Method: Q = CIA

PROJECT: QuikTrip 83-4207
LOCATION: 81st and Tower

Project No.: QKT004207
Date: 12/12/2022
Engineer: D. Rady

100-YR RUNOFF COMPUTATIONS (RATIONAL METHOD)

PROPOSED BASIN INFORMATION				DIRECT RUNOFF				TOTAL RUNOFF	REMARKS
DESIGN PT.	BASIN	AREA (acres)	RUNOFF COEFF.	Tc (min)	C x A (acres)	I (in/hr)	Q (cfs)	Q (cfs)	
1	DA-A1	1.13	0.73	11.51	0.83	6.59	5.45		
2	DA-A2	0.03	0.89	5.00	0.03	8.75	0.27		
3	DA-A3	0.67	0.89	5.33	0.59	8.60	5.12		
2	DA-A4	0.04	0.89	5.00	0.03	8.75	0.29		
4	DA-B1	2.35	0.87	5.00	2.04	8.75	17.83		
5	DA-B2	1.32	0.85	7.83	1.12	7.64	8.57		
6	DA-B3	0.56	0.49	9.90	0.27	7.01	1.92		
7	DA-C1	0.52	0.49	5.00	0.26	8.75	2.24		
-	DA-R1	0.18	0.85	5.00	0.15	8.75	1.34		
-	DA-R2	0.07	0.85	5.00	0.06	8.75	0.53		
-	DA-R3	0.17	0.85	5.00	0.14	8.75	1.24		
	TOTAL TO POND	7.03	0.79				44.80		
8	DA-OS1	0.52	0.55	11.78	0.29	6.53	1.87		
8	DA-OS2	0.65	0.49	6.17	0.32	8.25	2.62		
8	DA-OS3	0.31	0.84	5.00	0.26	8.75	2.26		
8	DA-OS4	6.52	0.49	22.12	3.19	4.81	15.37		
	TOTAL OFFSITE	7.99	0.51				22.12		
	TOTAL SITE	15.03	0.64				66.91		

EXISTING BASIN INFORMATION				DIRECT RUNOFF				TOTAL RUNOFF	REMARKS
DESIGN PT.	BASIN	AREA (acres)	RUNOFF COEFF.	Tc (min)	C x A (acres)	I (in/hr)	Q (cfs)	Q (cfs)	
1	DA-A1	14.59	0.49	25.86	7.15	4.41	31.54		
	TOTAL SITE	14.59					31.54		

Use minimum Time of Concentration = 5 minutes
Use composite coefficients

Ration Method: Q = CIA

APPENDIX C

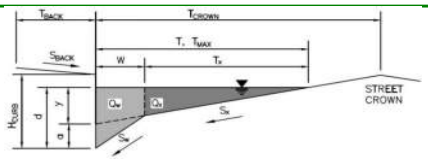
Hydraulic Computations

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

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

Project:

Inlet ID: **Inlet S-9**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	50.0	ft
Gutter Width	W =	1.50	ft
Street Transverse Slope	S_X =	0.010	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 =	0.000	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} =	50.0	50.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	6.00	6.00	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.5	1.5	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.31	1.31	inches
Water Depth at Gutter Flowline	d =	7.31	7.31	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	48.5	48.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.092	0.092	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	39.1	39.1	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	37.6	37.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.121	0.121	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

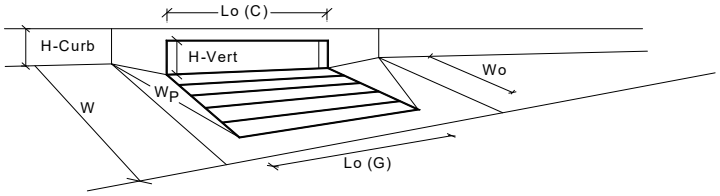
MINOR STORM Allowable Capacity is based on Depth Criterion

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)



CDOT Type R Curb Opening

Design Information (Input)		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	Override Depths
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	
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) =	5.00	5.00	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 =	1.50	1.50	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	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb Opening as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	6.4	6.4	cfs
Interception with Clogging	Q_{wa} =	5.7	5.7	cfs
Curb Opening as an Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	9.8	9.8	cfs
Interception with Clogging	Q_{oa} =	8.8	8.8	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	7.3	7.3	cfs
Interception with Clogging	Q_{ma} =	6.6	6.6	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**5.7**	**5.7**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	39.1	39.1	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
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} =	0.38	0.38	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	0.77	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
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)	$Q_{PEAK\ REQUIRED}$ =	2.1	5.5	cfs

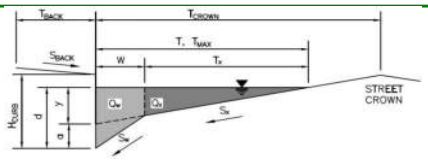
Warning 5: The width of unit is greater than the gutter width.

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

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

Project:

Inlet ID: **Inlet S-10**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	250.0	ft
Gutter Width	W =	1.50	ft
Street Transverse Slope	S_X =	0.030	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 =	0.000	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} =	250.0	250.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	90.00	90.00	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.5	1.5	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.95	0.95	inches
Water Depth at Gutter Flowline	d =	90.95	90.95	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	248.5	248.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.016	0.016	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	14.0	14.0	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	12.5	12.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.293	0.293	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

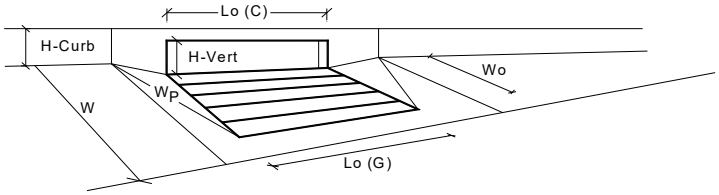
MINOR STORM Allowable Capacity is based on Depth Criterion

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)



CDOT Type R Curb Opening

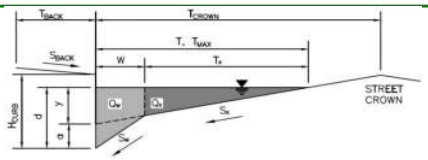
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	☐ Override Depths
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	
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) =	5.00	5.00	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 =	1.50	1.50	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	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb Opening as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	6.4	6.4	cfs
Interception with Clogging	Q_{wa} =	5.7	5.7	cfs
Curb Opening as an Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	9.8	9.8	cfs
Interception with Clogging	Q_{oa} =	8.8	8.8	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	7.3	7.3	cfs
Interception with Clogging	Q_{ma} =	6.6	6.6	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**5.7**	**5.7**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	14.0	14.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
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} =	0.38	0.38	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	0.77	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
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)	$Q_{PEAK\ REQUIRED}$ =	2.6	5.1	cfs

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

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

Project:

Inlet ID: **Inlets S-3 & S-8**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	130.0	ft
Gutter Width	W =	1.50	ft
Street Transverse Slope	S_X =	0.010	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 =	0.000	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} =	130.0	130.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	15.60	15.60	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.5	1.5	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.31	1.31	inches
Water Depth at Gutter Flowline	d =	16.91	16.91	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	128.5	128.5	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.033	0.033	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	39.1	39.1	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	37.6	37.6	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.121	0.121	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

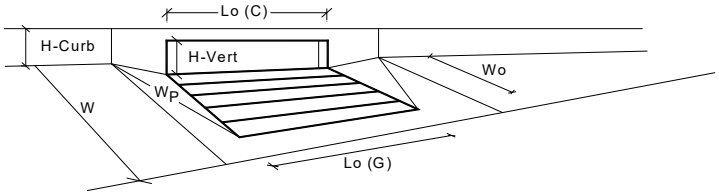
MINOR STORM Allowable Capacity is based on Depth Criterion

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)



CDOT Type R Curb Opening

Design Information (Input)		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 =	4	4	Override Depths
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	
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) =	5.00	5.00	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 =	1.50	1.50	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	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.33	1.33	
Clogging Factor for Multiple Units	Clog =	0.03	0.03	
Curb Opening as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	20.1	20.1	cfs
Interception with Clogging	Q_{wa} =	19.4	19.4	cfs
Curb Opening as an Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	39.0	39.0	cfs
Interception with Clogging	Q_{oa} =	37.7	37.7	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	26.0	26.0	cfs
Interception with Clogging	Q_{ma} =	25.2	25.2	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**19.4**	**19.4**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	20.00	20.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	39.1	39.1	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
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} =	0.38	0.38	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.57	0.57	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.79	0.79	
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 =**	**19.4**	**19.4**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	8.8	17.8	cfs

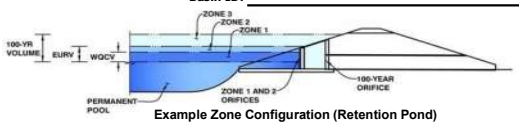
Warning 5: The width of unit is greater than the gutter width.

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: _____

Basin ID: _____



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	7.03	acres
Watershed Length =	600	ft
Watershed Length to Centroid =	125	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	75.00%	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 =	D.I.A.	

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) =	0.175	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.515	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	0.289	acre-feet	inches
5-yr Runoff Volume (P1 = 1.13 in.) =	0.414	acre-feet	inches
10-yr Runoff Volume (P1 = 1.39 in.) =	0.539	acre-feet	inches
25-yr Runoff Volume (P1 = 1.8 in.) =	0.754	acre-feet	inches
50-yr Runoff Volume (P1 = 2.15 in.) =	0.932	acre-feet	inches
100-yr Runoff Volume (P1 = 2.53 in.) =	1.134	acre-feet	inches
500-yr Runoff Volume (P1 = 3.55 in.) =	1.658	acre-feet	inches
Approximate 2-yr Detention Volume =	0.331	acre-feet	
Approximate 5-yr Detention Volume =	0.482	acre-feet	
Approximate 10-yr Detention Volume =	0.584	acre-feet	
Approximate 25-yr Detention Volume =	0.703	acre-feet	
Approximate 50-yr Detention Volume =	0.765	acre-feet	
Approximate 100-yr Detention Volume =	0.859	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.175	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.340	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.343	acre-feet
Total Detention Basin Volume =	0.859	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

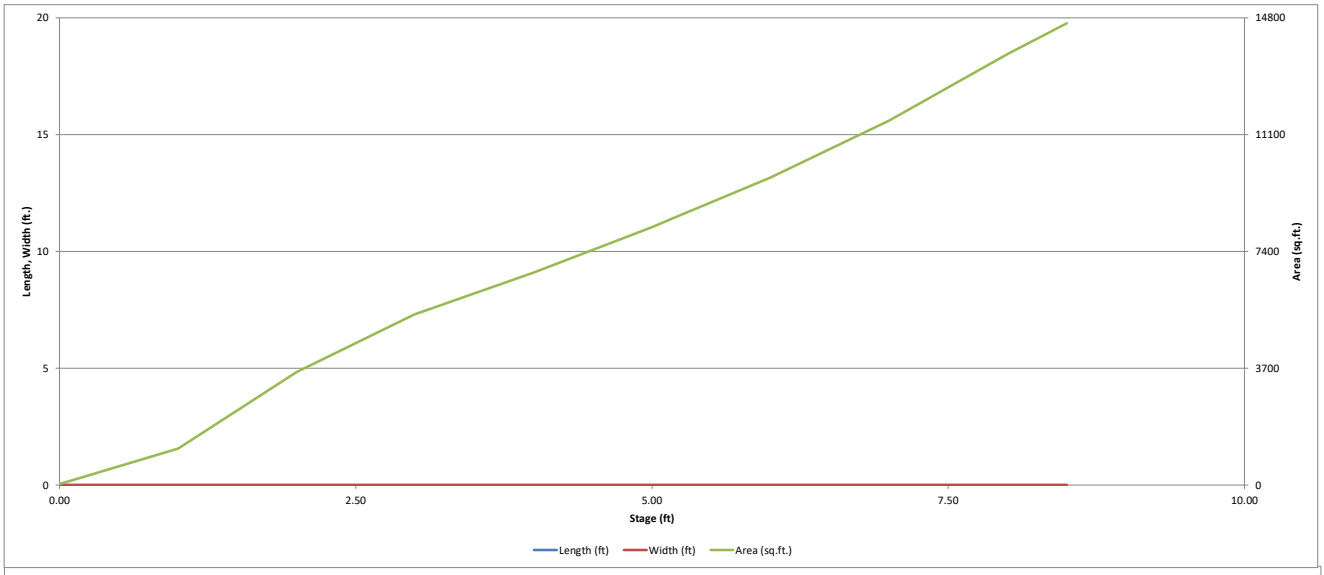
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

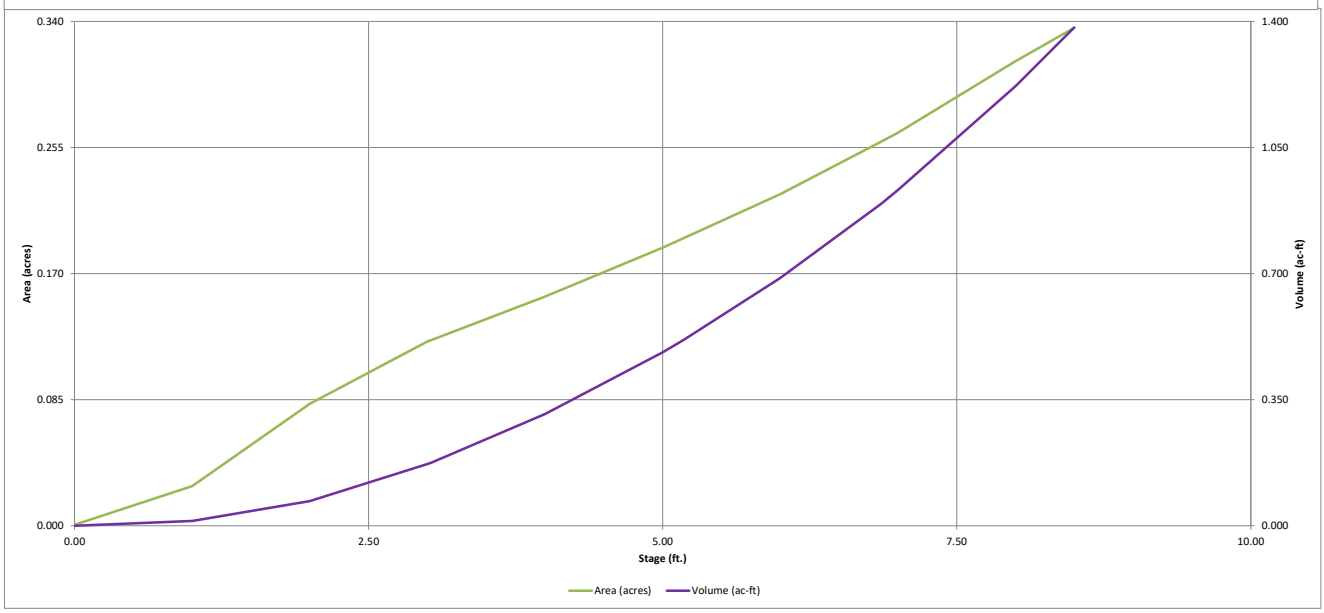
Depth Increment = _____ ft

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	--	--	--	33	0.001		
5225	--	1.00	--	--	--	1,162	0.027	597	0.014
5226	--	2.00	--	--	--	3,577	0.082	2,967	0.068
5227	--	3.00	--	--	--	5,409	0.124	7,460	0.171
5227.04	--	3.04	--	--	--	5,462	0.125	7,677	0.176
5228	--	4.00	--	--	--	6,733	0.155	13,531	0.311
5229	--	5.00	--	--	--	8,170	0.188	20,982	0.482
5229.18	--	5.18	--	--	--	8,452	0.194	22,478	0.516
5230	--	6.00	--	--	--	9,737	0.224	29,936	0.687
5230.86	--	6.86	--	--	--	11,288	0.259	38,977	0.895
5231	--	7.00	--	--	--	11,540	0.265	40,575	0.931
5232	--	8.00	--	--	--	13,648	0.313	53,169	1.221
5232.5	--	8.50	--	--	--	14,628	0.336	60,238	1.383

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



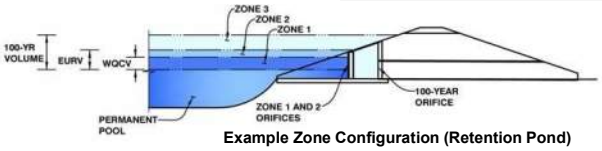


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project:

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.04	0.175	Orifice Plate
Zone 2 (EURV)	5.18	0.340	Rectangular Orifice
Zone 3 (100-year)	6.72	0.343	Weir&Pipe (Restrict)
Total (all zones)		0.859	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	4.514E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.95	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	9.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.65	sq. inches (diameter = 7/8 inch)	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 (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	0.98	1.97					
Orifice Area (sq. inches)	0.65	0.65	0.65					

	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)

	Zone 2 Rectangular	Not Selected		Calculated Parameters for Vertical Orifice: Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	3.06	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.08	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	5.18	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A	feet
Vertical Orifice Height =	2.00	N/A	inches				
Vertical Orifice Width =	6.00		inches				

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir: Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.75	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	6.42	N/A	feet
Overflow Weir Front Edge Length =	2.00	N/A	feet	Overflow Weir Slope Length =	2.11	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	2.91	N/A	
Horiz. Length of Weir Sides =	2.00	N/A	feet	Overflow Grate Open Area w/o Debris =	2.93	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	1.47	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate: Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.01	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.48	N/A	feet
Restrictor Plate Height Above Pipe Invert =	10.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.68	N/A	radians

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

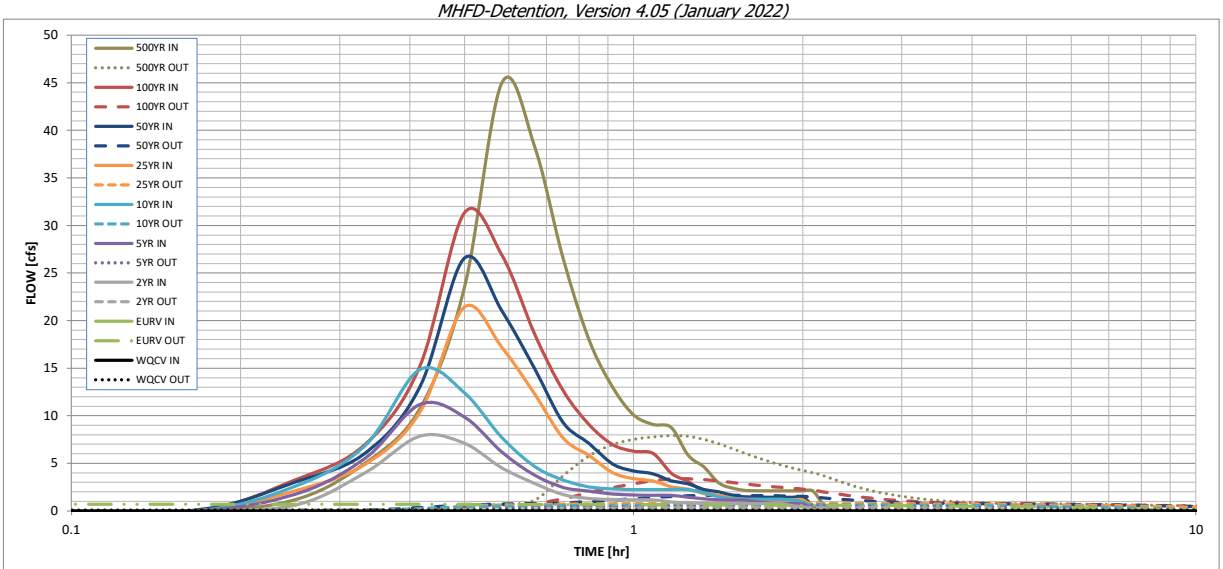
Routed Hydrograph Results

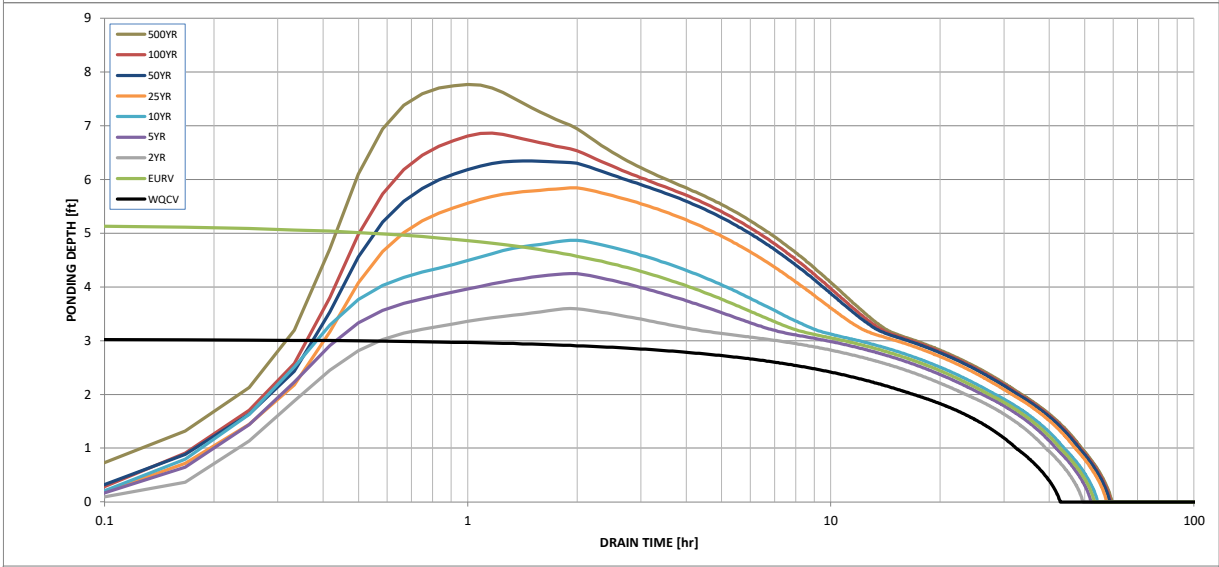
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

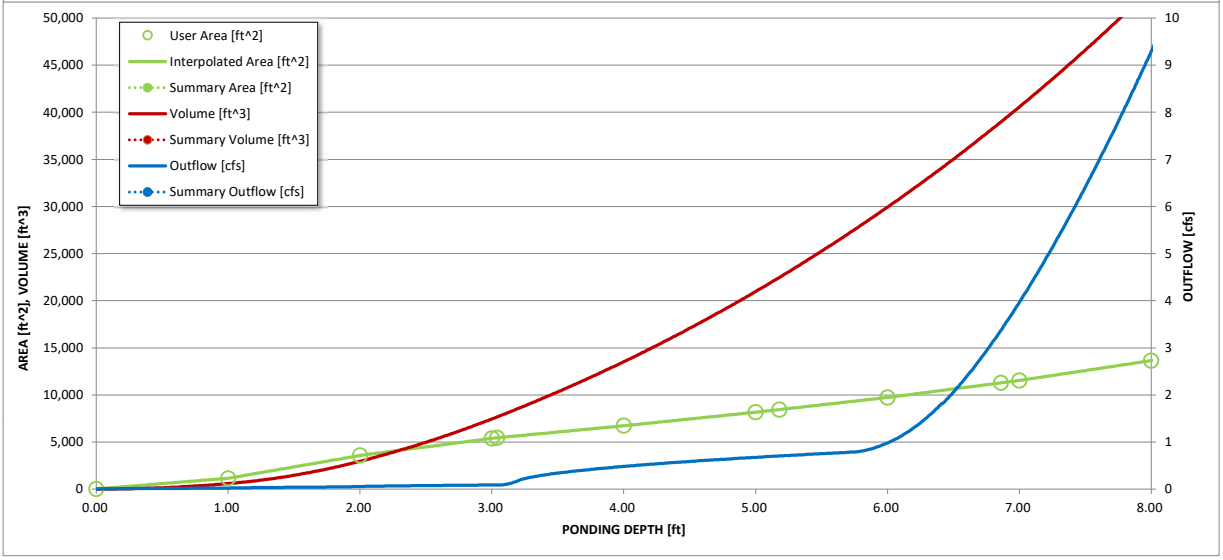
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.13	1.39	1.80	2.15	2.53	3.55
CUHP Runoff Volume (acre-ft) =	0.175	0.515	0.289	0.414	0.539	0.754	0.932	1.134	1.658
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.289	0.414	0.539	0.754	0.932	1.134	1.658
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	1.6	4.1	9.1	12.9	17.4	27.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.23	0.58	1.30	1.83	2.47	3.97
Peak Inflow Q (cfs) =	N/A	N/A	7.9	11.2	14.9	21.4	26.6	31.3	45.0
Peak Outflow Q (cfs) =	0.1	0.7	0.4	0.5	0.7	0.8	1.6	3.4	7.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.2	0.1	0.1	0.2	0.3
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.0	0.3	0.8	2.3
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	42	42	43	43	44	43	42	38
Time to Drain 99% of Inflow Volume (hours) =	**41**	48	46	48	49	51	51	50	48
Maximum Ponding Depth (ft) =	3.04	5.18	3.60	4.25	4.87	5.84	6.35	6.86	7.77
Area at Maximum Ponding Depth (acres) =	0.13	0.19	0.14	0.16	0.18	0.22	0.24	0.26	0.30
Maximum Volume Stored (acre-ft) =	0.176	0.516	0.250	0.349	0.458	0.652	0.766	0.895	1.147

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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	0.09	0.03	1.17
	0:15:00	0.00	0.00	0.61	1.74	2.59	2.12	3.02	3.25	5.03
	0:20:00	0.00	0.00	4.01	5.54	6.89	4.90	6.06	7.00	10.72
	0:25:00	0.00	0.00	7.86	11.19	14.86	10.35	13.00	15.18	23.41
	0:30:00	0.00	0.00	7.10	9.89	12.43	21.42	26.55	31.31	45.04
	0:35:00	0.00	0.00	4.51	6.17	7.69	17.16	20.99	26.86	38.31
	0:40:00	0.00	0.00	2.90	3.75	4.67	12.28	14.95	18.59	26.44
	0:45:00	0.00	0.00	1.70	2.46	3.23	7.61	9.25	12.61	17.98
	0:50:00	0.00	0.00	1.31	2.09	2.52	5.83	7.10	9.08	13.03
	0:55:00	0.00	0.00	1.19	1.78	2.31	4.02	4.94	6.98	10.09
	1:00:00	0.00	0.00	1.17	1.68	2.24	3.39	4.19	6.26	9.08
	1:05:00	0.00	0.00	1.17	1.64	2.23	3.15	3.91	6.04	8.76
	1:10:00	0.00	0.00	0.93	1.63	2.24	2.53	3.16	3.96	5.84
	1:15:00	0.00	0.00	0.83	1.44	2.24	2.28	2.86	3.09	4.62
	1:20:00	0.00	0.00	0.79	1.25	1.90	1.81	2.24	1.98	2.95
	1:25:00	0.00	0.00	0.78	1.17	1.47	1.63	2.00	1.59	2.36
	1:30:00	0.00	0.00	0.78	1.14	1.29	1.32	1.62	1.46	2.15
	1:35:00	0.00	0.00	0.78	1.14	1.23	1.21	1.48	1.43	2.11
	1:40:00	0.00	0.00	0.78	0.92	1.22	1.16	1.43	1.43	2.11
	1:45:00	0.00	0.00	0.78	0.83	1.22	1.15	1.42	1.43	2.11
	1:50:00	0.00	0.00	0.78	0.79	1.22	1.15	1.42	1.43	2.11
	1:55:00	0.00	0.00	0.54	0.78	1.14	1.15	1.42	1.43	2.11
	2:00:00	0.00	0.00	0.44	0.71	0.95	1.15	1.42	1.43	2.11
	2:05:00	0.00	0.00	0.16	0.28	0.36	0.45	0.56	0.56	0.83
	2:10:00	0.00	0.00	0.05	0.09	0.12	0.16	0.19	0.19	0.28
	2:15:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.05
	2:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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 4.05 (January 2022)

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).

Weir Report

QT4207 - Pond Spillway

Trapezoidal Weir

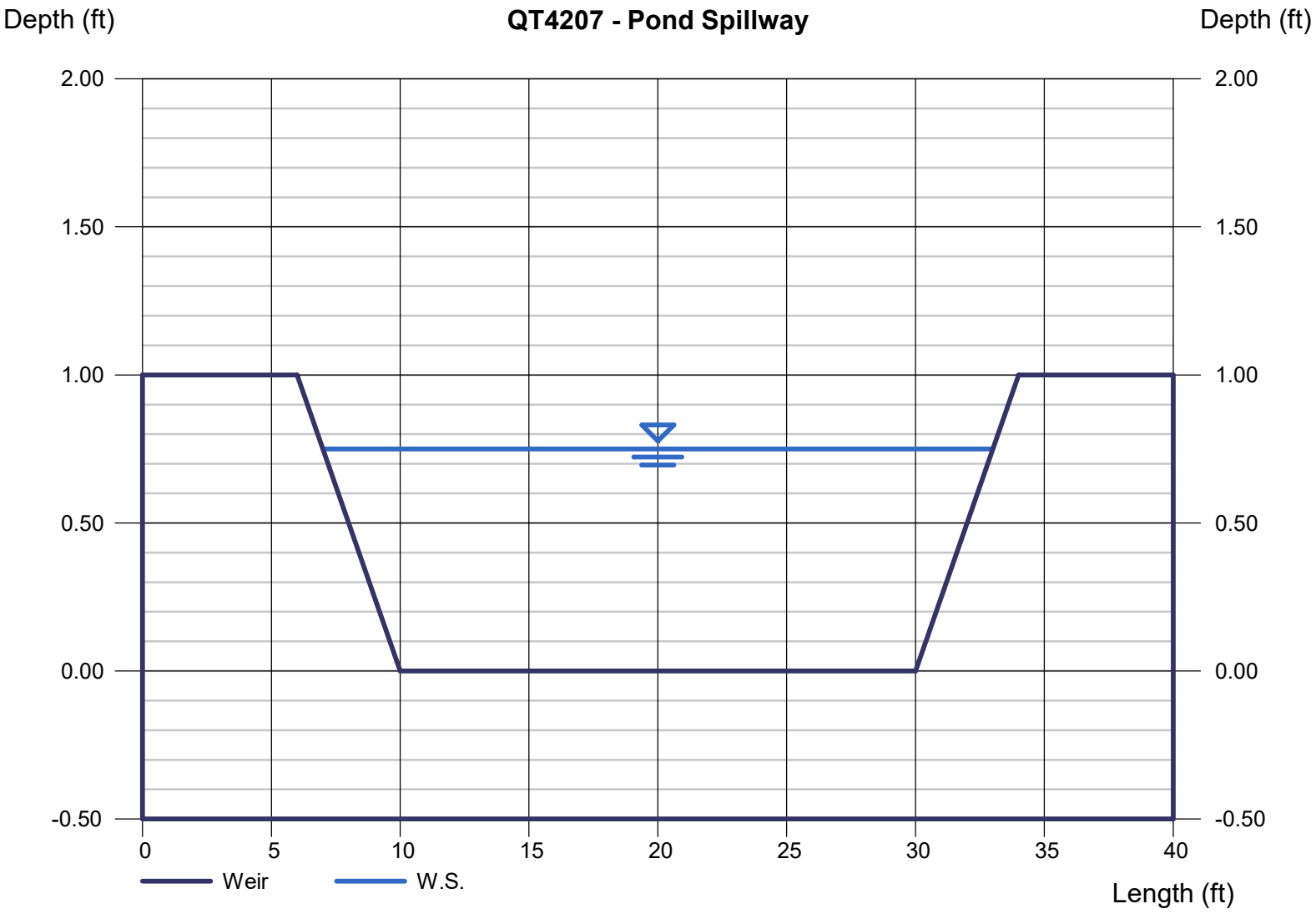
Crest	= Sharp
Bottom Length (ft)	= 20.00
Total Depth (ft)	= 1.00
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 44.80

Highlighted

Depth (ft)	= 0.75
Q (cfs)	= 44.80
Area (sqft)	= 17.25
Velocity (ft/s)	= 2.60
Top Width (ft)	= 26.00



Design Procedure Form: Grass Buffer (GB)

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

Designer: DLR
Company: Galloway
Date: December 7, 2022
Project: QuikTrip Store #4207
Location: Commerce City, Colorado

1. Design Discharge A) 2-Year Peak Flow Rate of the Area Draining to the Grass Buffer	Q_2 = 4.0 cfs
2. Minimum Width of Grass Buffer	W_G = 81 ft
3. Length of Grass Buffer (14' or greater recommended)	L_G = 65 ft
4. Buffer Slope (in the direction of flow, not to exceed 0.1 ft / ft)	S_G = 0.080 ft / ft
5. Flow Characteristics (sheet or concentrated) A) Does runoff flow into the grass buffer across the entire width of the buffer?	Choose One: ○ Yes ◉ No
B) Watershed Flow Length	F_L = ft
C) Interface Slope (normal to flow)	S_I = ft / ft
D) Type of Flow Sheet Flow: $F_L * S_I \leq 1$ Concentrated Flow: $F_L * S_I > 1$	CONCENTRATED FLOW
6. Flow Distribution for Concentrated Flows	Choose One: ○ None (sheet flow) ◉ Slotted Curbing ○ Level Spreader ○ Other (Explain): 8 - 5' curb cuts along entire width of buffer
7 Soil Preparation (Describe soil amendment)	
8 Vegetation (Check the type used or describe "Other")	Choose One: ○ Existing Xeric Turf Grass ◉ Irrigated Turf Grass ○ Other (Explain):
9. Irrigation (*Select None if existing buffer area has 80% vegetation AND will not be disturbed during construction.)	Choose One: ◉ Temporary ○ Permanent ○ None*
10. Outflow Collection (Check the type used or describe "Other")	Choose One: ◉ Grass Swale ○ Street Gutter ○ Storm Sewer Inlet ○ Other (Explain):

Notes:

Design Procedure Form: Grass Swale (GS)

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

Designer: DLR
Company: Galloway
Date: December 7, 2022
Project: QuikTrip Store #4207
Location: Commerce City, Colorado

1. Design Discharge for 2-Year Return Period	Q_2 = 4.04 cfs
2. Hydraulic Residence Time	
A) : Length of Grass Swale	L_S = 173.0 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} = 0.040 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 = 4.00 ft / ft
B) Bottom Width of Swale (enter 0 for triangular section)	W_B = 10.00 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 (0.577 ft / s maximum for desirable 5-minute residence time)	V_2 = 0.95 ft / s
7. Design Flow Depth (1 foot maximum)	D_2 = 0.37 ft
A) Flow Area	A_2 = 4.2 sq ft
B) Top Width of Swale	W_T = 13.0 ft
C) Froude Number (0.50 maximum)	F = 0.29
D) Hydraulic Radius	R_H = 0.33
E) Velocity-Hydraulic Radius Product for Vegetal Retardance	VR = 0.31
F) Manning's n (based on SCS vegetal retardance curve D for sodded grass)	n = 0.105
G) Cumulative Height of Grade Control Structures Required	H_D = 3.50 ft
8. Underdrain (Is an underdrain necessary?)	Choose One ○ YES ◉ NO
9. Soil Preparation (Describe soil amendment)	
10. Irrigation	Choose One ◉ Temporary ○ Permanent

Notes:

Detention Pond Forebay Calculations

Project: QuikTrip #4207 Date: 12/15/2022
Note: By: Galloway

Pond Inlet Forebay: (Areas A-1, A-2 & A-5 through A-8)

WQCV = a (0.91i^3 – 1.19i^2 + 0.78i) * 1.2

a: 1 (based on drain time)
I: 0.75 (imperviousness)

WQCV= 0.357 watershed in.
Area 7.03 acres
0.209 ac-ft ([Area*Watershed Inches]/[12])
9113 cubic-feet

Table 3-2. Drain Time Coefficients for WQCV Calculations

Drain Time (hours)	Coefficient, a
12 hours (filtration BMPs and retention ponds)	0.8
24 hours (constructed wetland ponds)	0.9
40 hours (extended detention)	1.0
No attenuation (e.g., grass buffer or swale)	1.0

Forebay Volume:

Per Table EDB-4, Section T-5 of USDCM Voume 3 - Forebay Volume = 2% of WQCV and be 18" depth since watershed is up to 5 impervious acres
Forebay Volume = 2% of WQCV = 182.27 cubic feet
with forebay depth at 1.5', Forebay Area = 121.51 sq-ft (minimum)

Forebay Discharge:

Per Table EDB-4, Section T-5 of USDCM Volume 3 - Forebay Discharge = 2% of 100-yr flow into pond

Q100= 44.80 cfs
Forebay Discharge= 0.90 cfs

Forebay Slot: $Q = C*L*H^{1.5}$

Q= 0.90 cfs
L= 0.30 ft 3.58 inches
H= 1.00 ft
C= 3.00 -

5-Yr Storm Event

FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Unified) (ft)	Slope (Calculated) (ft/ft)	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Froude Number (Normal)
P-3 (STM LINE)	S-4 (STM LINE)	5,233.55	S-5 (STM LINE)	5,234.52	129.4	-0.007	0.60	3.08	3.04	1.156
P-12 (STM LINE)	S-14 (STM LINE)	5,227.93	S-15 (STM LINE)	5,229.92	132.8	-0.015	34.30	175.85	10.85	2.059
P-13 (STM LINE)	S-15 (STM LINE)	5,229.92	MH-1	5,230.07	10.3	-0.015	34.30	173.46	10.74	2.031
P-2 (STM LINE)	S-22 (STM LINE)	5,226.01	S-4 (STM LINE)	5,229.80	94.6	-0.040	0.60	45.28	5.04	2.687
P-8 (STM LINE)	S-20 (STM LINE)	5,227.29	CB-1	5,230.60	314.9	-0.011	2.12	10.77	4.74	1.464
P-6 (STM LINE)	CB-5	5,230.17	CB-4	5,230.40	11.8	-0.020	4.40	14.69	2.49	1.983
P-7 (STM LINE)	CB-5	5,230.17	S-21 (STM LINE)	5,229.35	40.8	0.020	8.80	14.89	8.78	1.887
P-9 (1) (STM LINE)	S-19 (STM LINE)	5,221.58	S-12 (STM LINE)	5,225.16	179.2	-0.020	34.30	406.05	9.83	2.340
P-7 (2) (STM LINE)	S-21 (STM LINE)	5,225.98	S-20 (STM LINE)	5,226.79	162.3	-0.005	5.36	28.97	4.51	1.098
P-1 (1) (STM LINE)	S-22 (STM LINE)	5,225.17	S-21 (STM LINE)	5,225.43	51.6	-0.005	14.07	37.53	5.87	1.101
P-7 (1) (STM LINE)	S-20 (STM LINE)	5,227.29	CB-3	5,227.61	64.3	-0.005	2.60	15.96	3.74	1.056
P-15 (STM LINE)	S-19 (STM LINE)	5,221.38	S-11 (STM LINE)	5,218.00	225.1	0.015	34.30	351.98	8.89	2.038
P-14 (STM LINE)	O-1	5,223.00	S-18 (STM LINE)	5,224.51	96.7	-0.016	0.50	13.14	3.57	1.701
P-1 (STM LINE)	S-2 (STM LINE)	5,225.00	S-22 (STM LINE)	5,225.17	33.0	-0.005	14.67	47.87	5.95	1.141
CO-1	S-14 (STM LINE)	5,227.93	S-12 (STM LINE)	5,227.21	57.7	0.012	34.30	160.42	10.16	1.878
CO-2	S-5 (STM LINE)	5,234.52	MH-2	5,234.72	27.3	-0.007	0.60	3.05	3.02	1.143
CO-3	MH-2	5,234.72	MH-3	5,234.77	7.1	-0.007	0.60	3.00	2.98	1.122
CO-4	MH-3	5,234.77	MH-4	5,235.66	118.3	-0.008	0.60	3.09	3.05	1.158

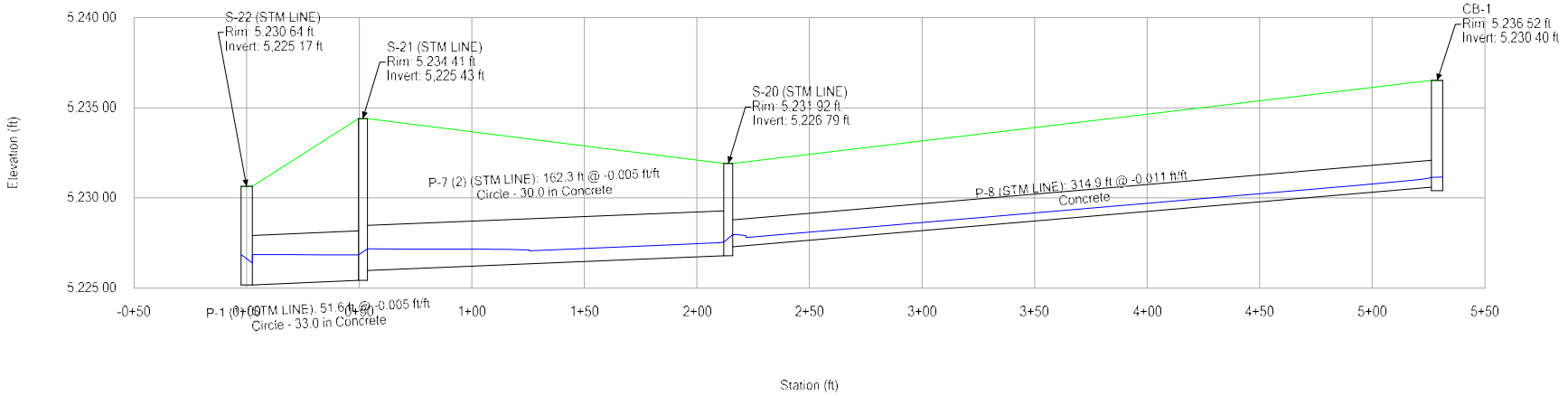
100-Yr Storm Event

FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Unified) (ft)	Slope (Calculated) (ft/ft)	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Froude Number (Normal)
P-3 (STM LINE)	S-4 (STM LINE)	5,233.55	S-5 (STM LINE)	5,234.52	129.4	-0.007	0.00	3.08	0.00	(N/A)
P-12 (STM LINE)	S-14 (STM LINE)	5,227.93	S-15 (STM LINE)	5,229.92	132.8	-0.015	200.60	175.85	15.96	1.407
P-13 (STM LINE)	S-15 (STM LINE)	5,229.92	MH-1	5,230.07	10.3	-0.015	200.60	173.46	15.96	1.407
P-2 (STM LINE)	S-22 (STM LINE)	5,226.01	S-4 (STM LINE)	5,229.80	94.6	-0.040	1.24	45.28	6.27	2.801
P-8 (STM LINE)	S-20 (STM LINE)	5,227.29	CB-1	5,230.60	314.9	-0.011	5.45	10.77	3.08	1.398
P-6 (STM LINE)	CB-5	5,230.17	CB-4	5,230.40	11.8	-0.020	8.92	14.69	5.05	1.853
P-7 (STM LINE)	CB-5	5,230.17	S-21 (STM LINE)	5,229.35	40.8	0.020	17.84	14.89	10.10	1.453
P-9 (1) (STM LINE)	S-19 (STM LINE)	5,221.58	S-12 (STM LINE)	5,225.16	179.2	-0.020	200.60	406.05	16.11	2.276
P-7 (2) (STM LINE)	S-21 (STM LINE)	5,225.98	S-20 (STM LINE)	5,226.79	162.3	-0.005	11.89	28.97	2.42	1.071
P-1 (1) (STM LINE)	S-22 (STM LINE)	5,225.17	S-21 (STM LINE)	5,225.43	51.6	-0.005	29.48	37.53	4.96	0.967
P-7 (1) (STM LINE)	S-20 (STM LINE)	5,227.29	CB-3	5,227.61	64.3	-0.005	5.10	15.96	1.62	1.047
P-15 (STM LINE)	S-19 (STM LINE)	5,221.38	S-11 (STM LINE)	5,218.00	225.1	0.015	200.60	351.98	7.98	0.704
P-14 (STM LINE)	O-1	5,223.00	S-18 (STM LINE)	5,224.51	96.7	-0.016	3.80	13.14	2.15	1.775
P-1 (STM LINE)	S-2 (STM LINE)	5,225.00	S-22 (STM LINE)	5,225.17	33.0	-0.005	30.72	47.87	4.35	1.054
CO-1	S-14 (STM LINE)	5,227.93	S-12 (STM LINE)	5,227.21	57.7	0.012	200.60	160.42	15.96	1.407
CO-2	S-5 (STM LINE)	5,234.52	MH-2	5,234.72	27.3	-0.007	0.00	3.05	0.00	(N/A)
CO-3	MH-2	5,234.72	MH-3	5,234.77	7.1	-0.007	0.00	3.00	0.00	(N/A)
CO-4	MH-3	5,234.77	MH-4	5,235.66	118.3	-0.008	0.00	3.09	0.00	(N/A)

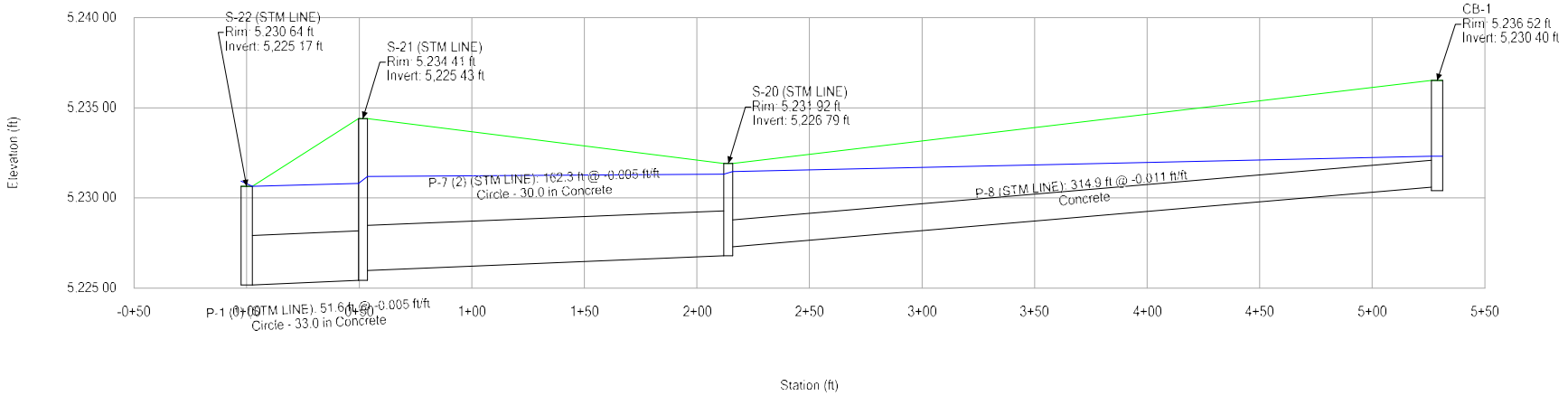
5-Yr Storm Event

Profile Report
Engineering Profile - SD-A (83-4207 StormCAD.stsw)



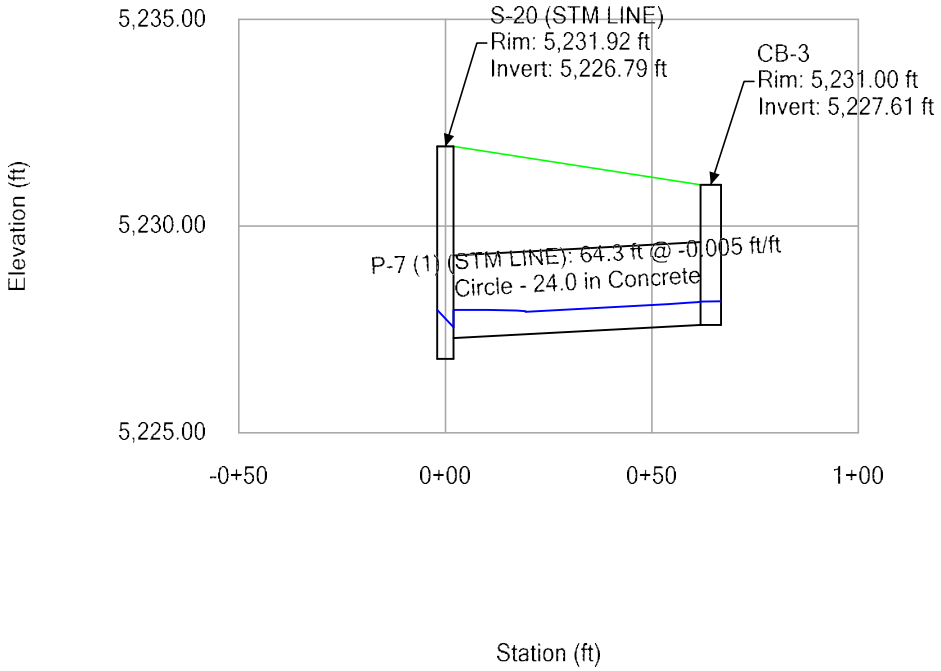
100-Yr Storm Event

Profile Report
Engineering Profile - SD-A (83-4207 StormCAD.stsw)



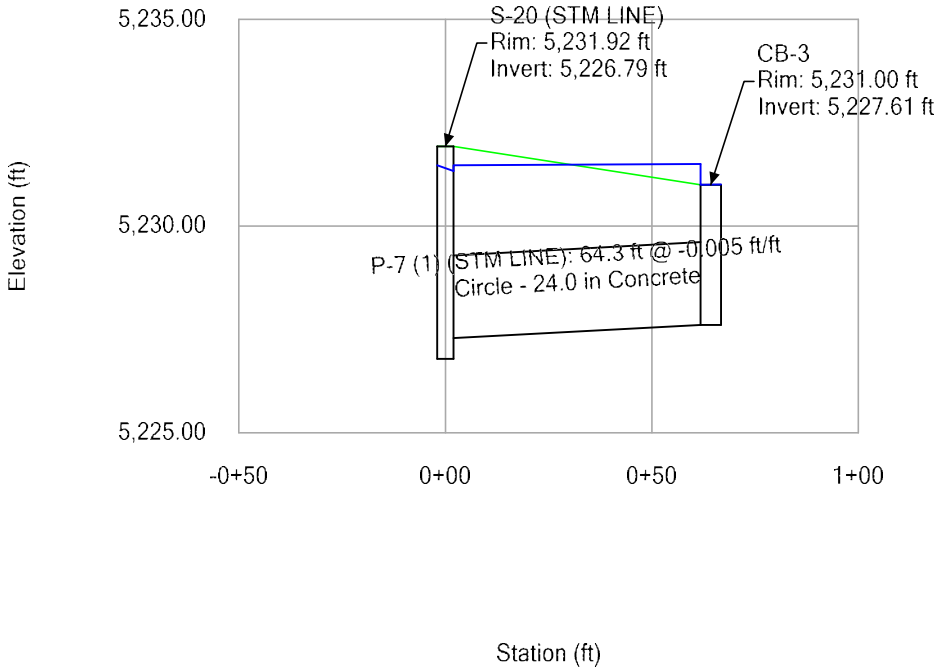
5-Yr Storm Event

Profile Report
Engineering Profile - SD-A1 (83-4207 StormCAD.stsw)



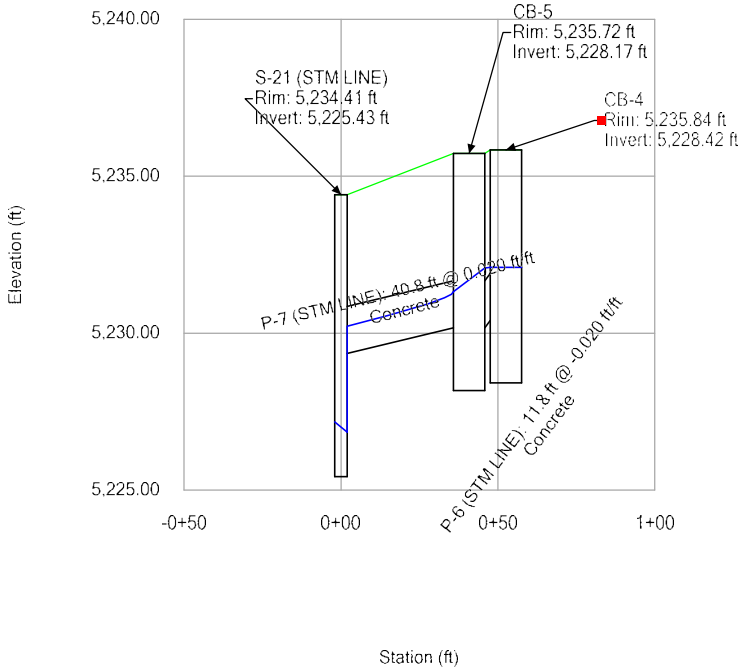
100-Yr Storm Event

Profile Report
Engineering Profile - SD-A1 (83-4207 StormCAD.stsw)



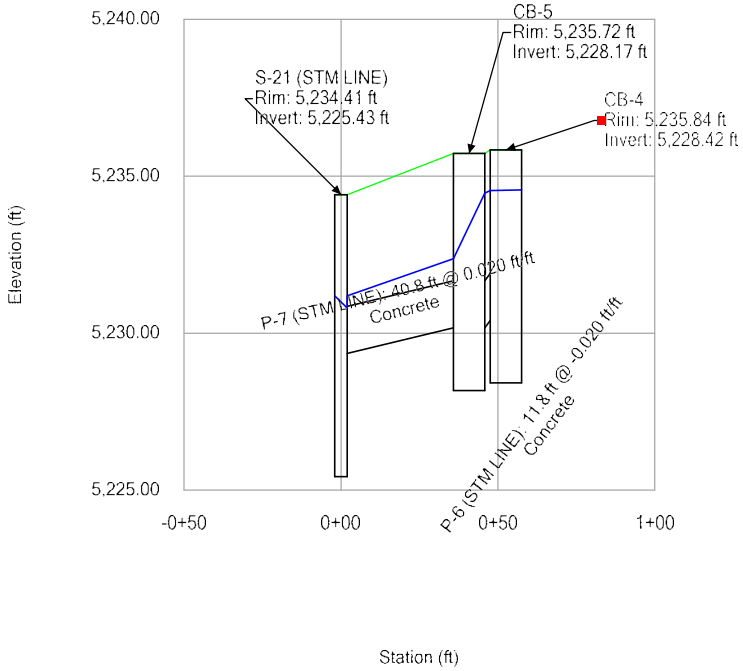
5-Yr Storm Event

Profile Report
Engineering Profile - SD-A2 (83-4207 StormCAD.stsw)



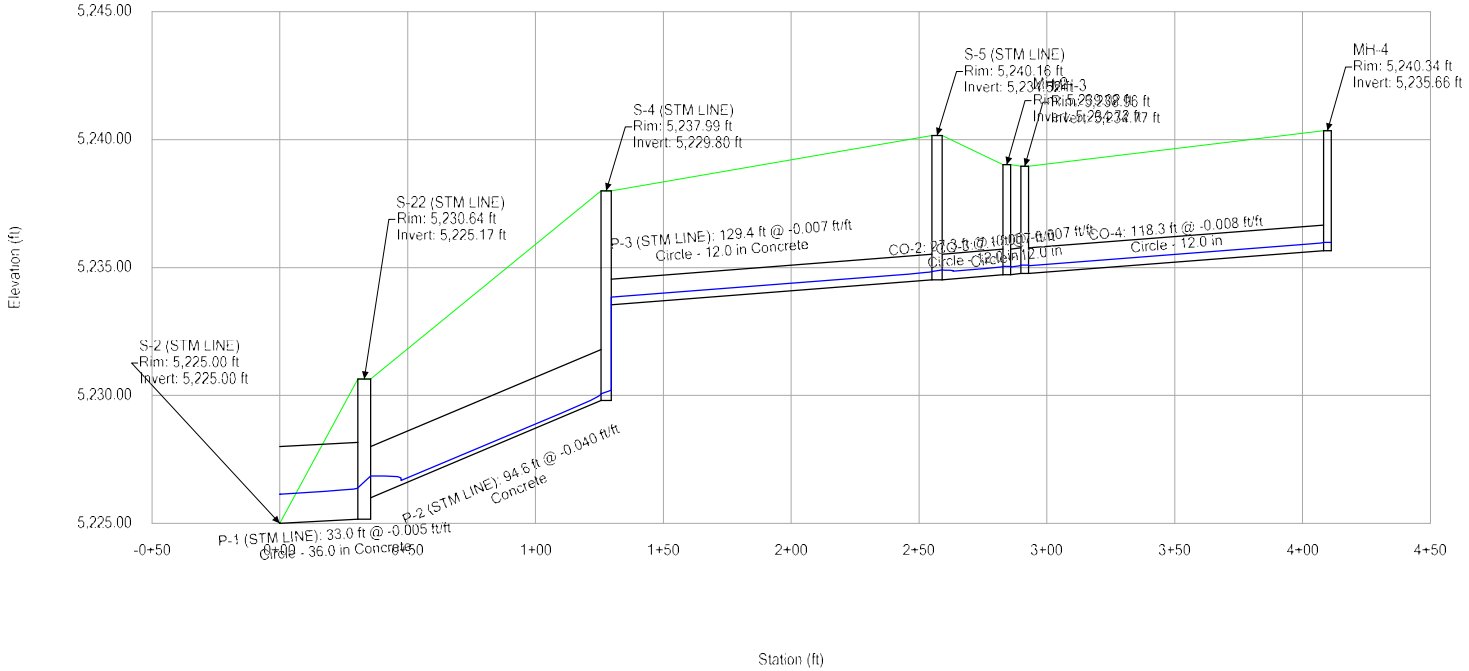
100-Yr Storm Event

Profile Report
Engineering Profile - SD-A2 (83-4207 StormCAD.stsw)



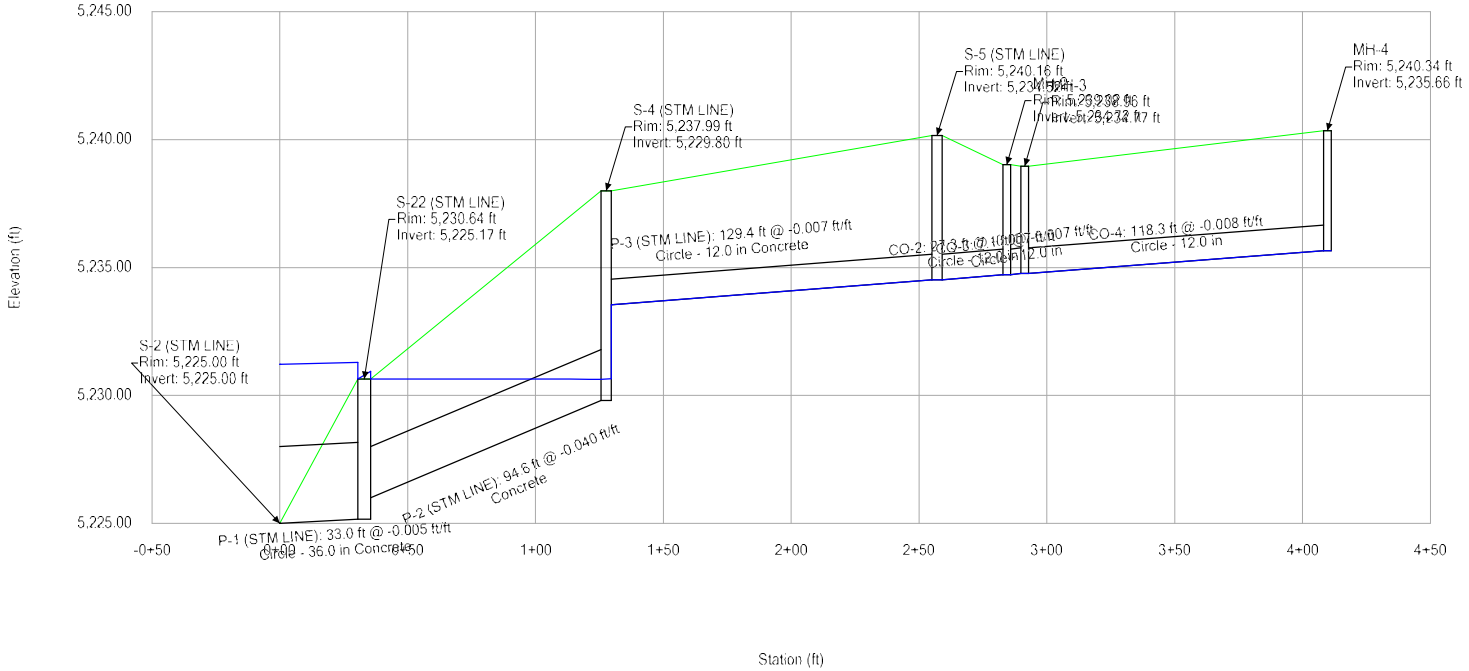
5-Yr Storm Event

Profile Report
Engineering Profile - SD-B (83-4207 StormCAD.stsw)



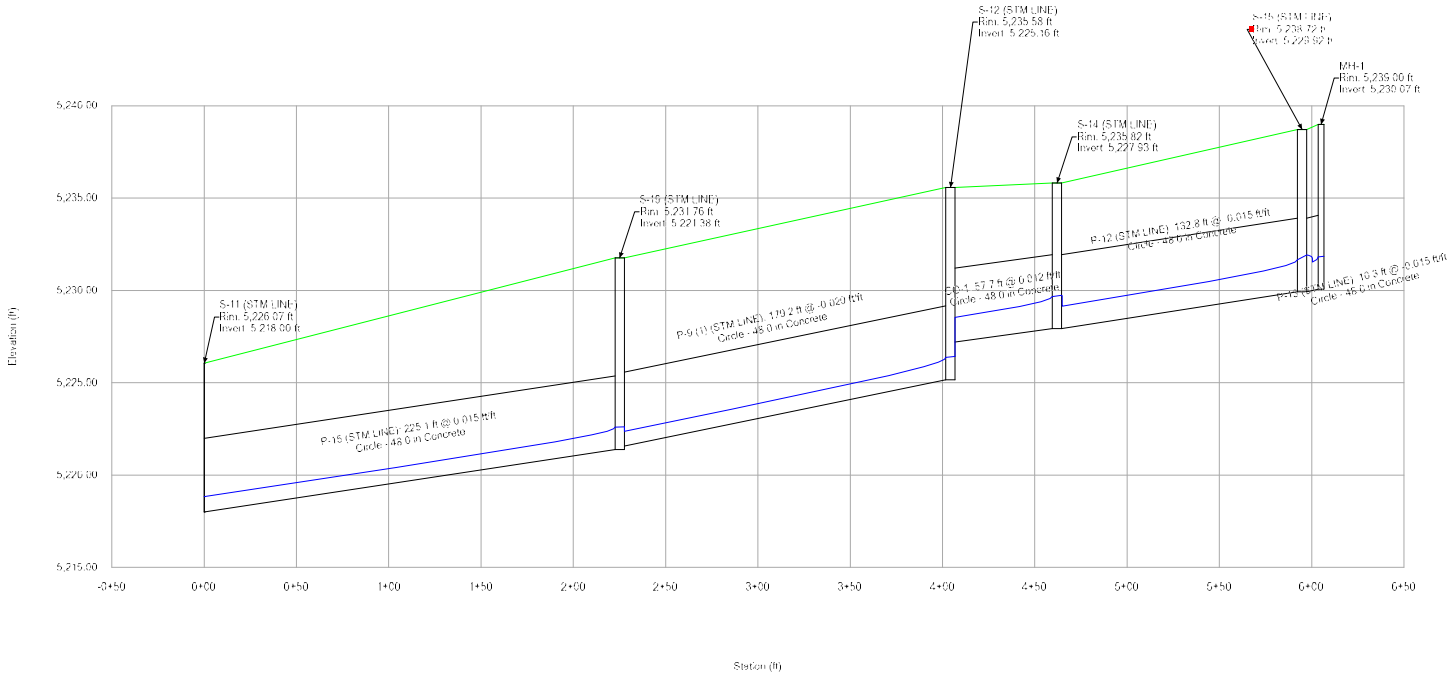
100-Yr Storm Event

Profile Report
Engineering Profile - SD-B (83-4207 StormCAD.stsw)



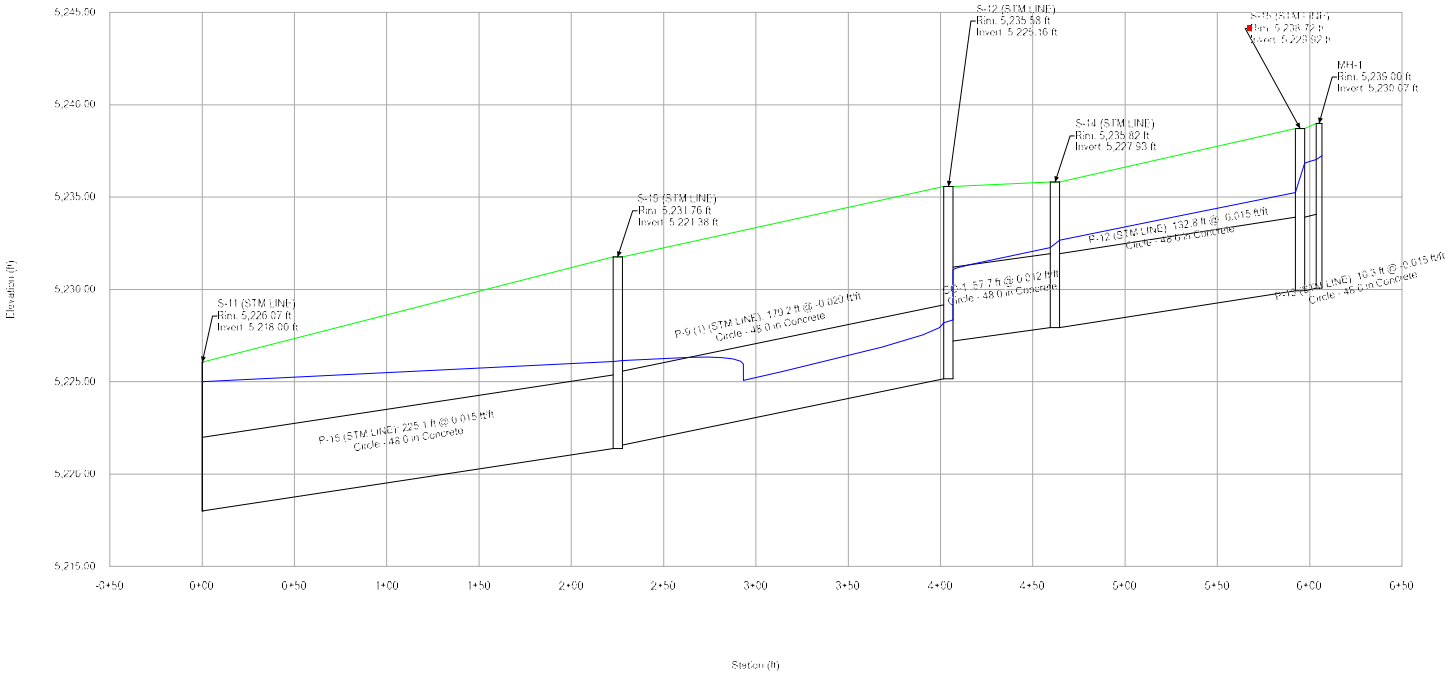
5-Yr Storm Event

Profile Report
Engineering Profile - SD-C (83-4207 StormCAD.stsw)



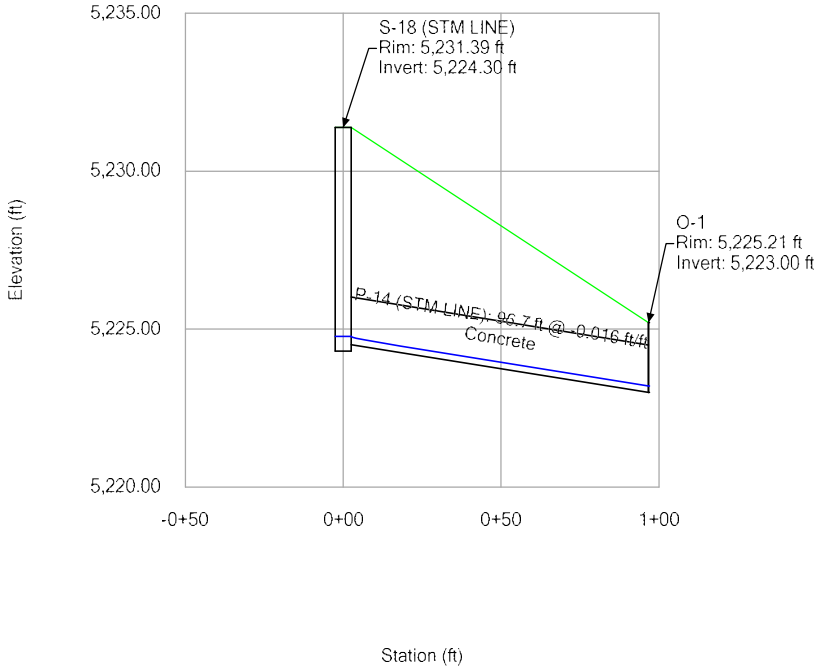
100-Yr Storm Event

Profile Report
Engineering Profile - SD-C (83-4207 StormCAD.stsw)



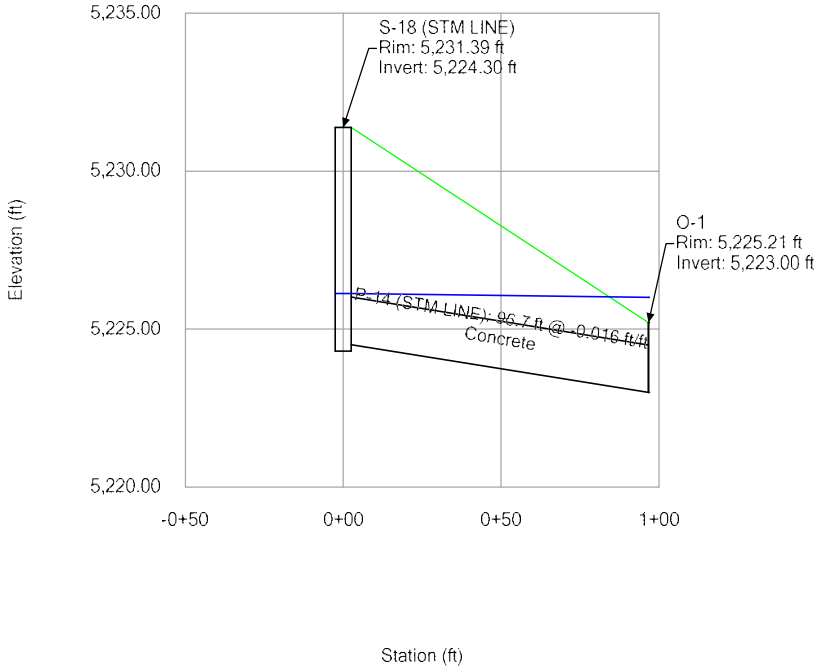
5-Yr Storm Event

Profile Report
Engineering Profile - SD-D (83-4207 StormCAD.stsw)



100-Yr Storm Event

Profile Report
Engineering Profile - SD-D (83-4207 StormCAD.stsw)



APPENDIX D

Drainage Map

PROJECT NO.: QKT004207

Galloway
6500 Greenwood Plaza Blvd., Ste 200
Greenwood Village, CO 80111
303.770.8884
GallowayUS.com

QuikTrip No. 4207

18400 E. 81st Ave.
COMMERCE CITY, CO 80022

PROTOTYPE:	P-107 (8/01/21)
DIVISION:	83
VERSION:	001
DESIGNED BY:	ACJ
DRAWN BY:	ACJ
REVIEWED BY:	JRR

REV	DATE	DESCRIPTION
1	2/14/22	2ND DP SUBMITTAL
2	5/9/22	3RD DP SUBMITTAL
3	11/16/22	4TH DP SUBMITTAL

ORIGINAL ISSUE DATE: 03/04/2021

SHEET TITLE:
GENERAL LOCATION MAP

SHEET NUMBER:
-

FILE LOCATION:H:\Quiktrip\QKT004207--Commerce City, CO\CADD\3 CD\QKT4207_Civil.dwg TAB NAME:Drainage Location Map USER:Duncan_Redy SAVED:1/3/2023 12:01 PM PLOTTED:1/3/2023 12:14 PM

EXISTING BASIN SUMMARY TABLE

BASIN	C2	C5	C100	Q_2 (cfs)	Q_5 (cfs)	Q_{100} (cfs)
DA-A1	0.01	0.05	0.15	0.34	1.71	31.54

LEGEND

- wtr — WATER LINE
- ss — SANITARY SEWER LINE
- UGET — UNDERGROUND ELECTRIC LINE
- ugt — UNDERGROUND TELEPHONE LINE
- st — STORM PIPE (≤ 10")
- STORM PIPE (≥ 12")
- XXX — MAJOR CONTOUR
- XXX — MINOR CONTOUR
- CONCRETE CURB AND GUTTER
- FLOW PATH
- FLOW ARROW
- DESIGN POINT

DA-A1
635,716 SF
14.59 ACRES
C(5)=0.05
C(100)=0.15
Q(5)=1.71 CFS
Q(100)=31.54 CFS

FLOW PATH

TOWER ROAD
135' PUBLIC
RIGHT-OF-WAY

EAST 81ST AVENUE
80' WIDE
RIGHT-OF-WAY

70 0 70 140

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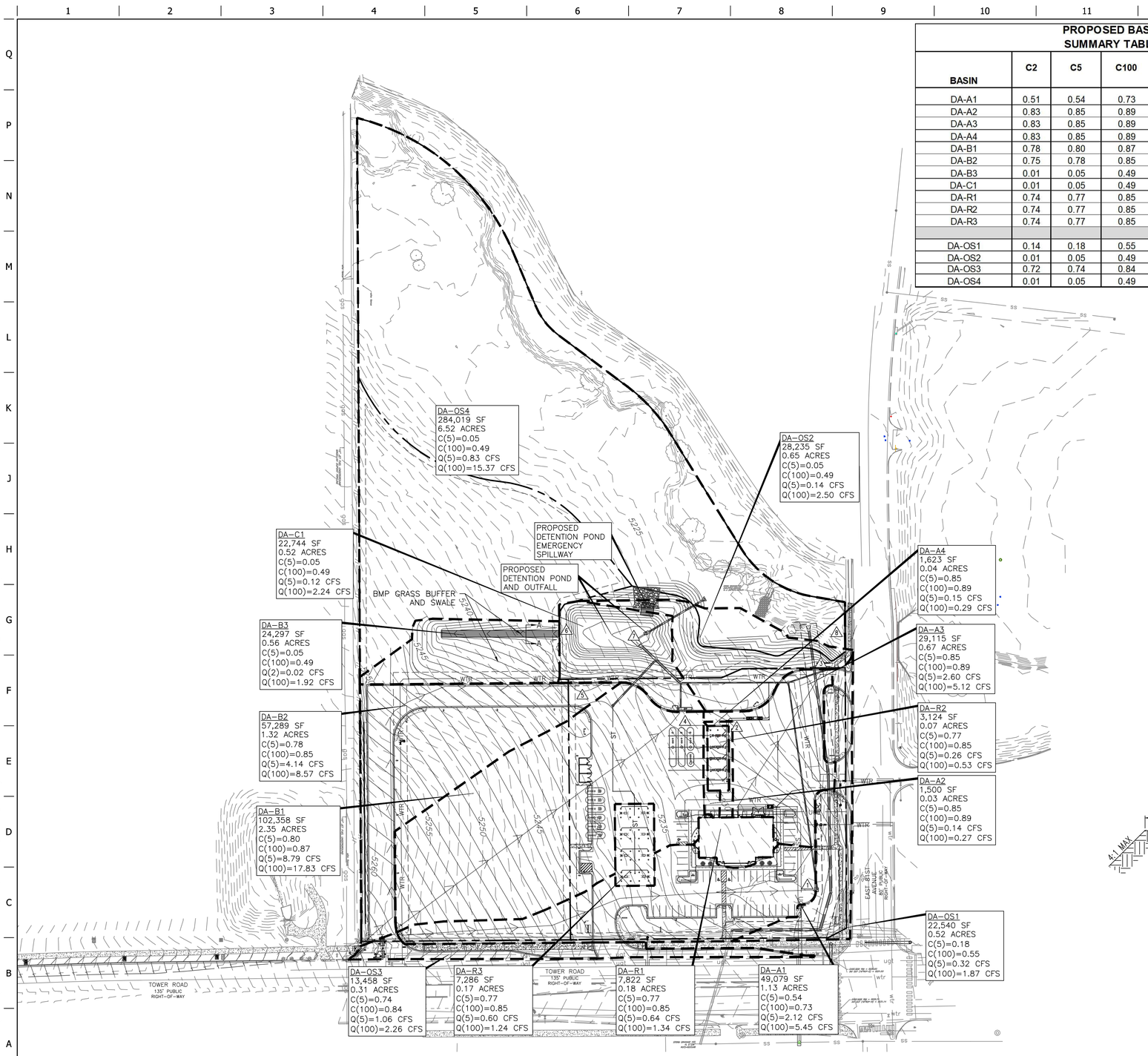
1	2/14/22	2ND DP SUBMITTAL
2	5/9/22	3RD DP SUBMITTAL
3	11/16/22	4TH DP SUBMITTAL

ORIGINAL ISSUE DATE: 03/04/2021

SHEET TITLE:
PRE DEVELOPED DRAINAGE MAP

SHEET NUMBER:
C126



PROPOSED BASIN SUMMARY TABLE

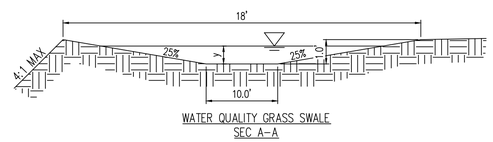
BASIN	C2	C5	C100	Q_2 (cfs)	Q_5 (cfs)	Q_{100} (cfs)
DA-A1	0.51	0.54	0.73	2.01	2.12	5.45
DA-A2	0.83	0.85	0.89	0.13	0.14	0.27
DA-A3	0.83	0.85	0.89	2.53	2.60	5.12
DA-A4	0.83	0.85	0.89	0.14	0.15	0.29
DA-B1	0.78	0.80	0.87	8.56	8.79	17.83
DA-B2	0.75	0.78	0.85	4.02	4.14	8.57
DA-B3	0.01	0.05	0.49	0.02	0.10	1.92
DA-C1	0.01	0.05	0.49	0.02	0.12	2.24
DA-R1	0.74	0.77	0.85	0.62	0.64	1.34
DA-R2	0.74	0.77	0.85	0.25	0.26	0.53
DA-R3	0.74	0.77	0.85	0.58	0.60	1.24
DA-OS1	0.14	0.18	0.55	0.25	0.32	1.87
DA-OS2	0.01	0.05	0.49	0.03	0.14	2.62
DA-OS3	0.72	0.74	0.84	1.03	1.06	2.26
DA-OS4	0.01	0.05	0.49	0.17	0.83	15.37

LEGEND

- WTR — WATER LINE
- SS — SANITARY SEWER LINE
- UGET — UNDERGROUND ELECTRIC LINE
- UGT — UNDERGROUND TELEPHONE LINE
- ST — STORM PIPE (≤ 10")
- STORM PIPE (≥ 12")
- XXX — MAJOR CONTOUR
- XXX — MINOR CONTOUR
- CONCRETE CURB AND GUTTER
- FLOW PATH
- FLOW ARROW
- DESIGN POINT

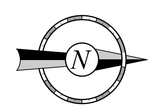
PROPOSED DETENTION POND SUMMARY TABLE

Attribute	Value
Tributary Sub-basin	A1-A4, B1-B3, C1, & R1-R3
Area (acres)	7.03
Imperviousness %	75%
WQCV Volume Req. (ac-ft)	0.175
WQCV WSEL (ft)	5227.04
EURV Volume Req. (ac-ft)	0.340
EURV WSEL (ft)	5229.18
100-Year Volume Req. (ac-ft)	0.859
Volume Provided (ac-ft)	1.383
100-Year WSEL	5230.86
Top of Pond	5232.50
Freeboard (ft)	1.64
Q_{ALL} (cfs)	9.42
Q_{ACT} (cfs)	3.40
Total Runoff Into Pond (cfs)	44.80
Pond Spillway Flowline (ft)	5231.50
Clogged 100-Yr WSEL (ft)	5232.25
Freeboard (ft)	0.25



WATER QUALITY GRASS SWALE
SEC A-A

Q2=4.04 C.F.S
n = 0.105 (MHFD BMP SPREADSHEET)
SLOPE = 2.00%
y = 0.37 FT
V = 0.95 FT/S



80 40 0 80 160

PROJECT NO.: QKT004207

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COMMERCE CITY, CO 80022

PROTOTYPE:	P-107 (8/01/21)
DIVISION:	83
VERSION:	001
DESIGNED BY:	ACJ
DRAWN BY:	ACJ
REVIEWED BY:	JRR

REV	DATE	DESCRIPTION
1	7/14/22	2ND DP SUBMITTAL
2	5/9/22	3RD DP SUBMITTAL
3	11/16/23	4TH DP SUBMITTAL

ORIGINAL ISSUE DATE: 03/04/2021

SHEET TITLE:
POST DEVELOPED DRAINAGE MAP

SHEET NUMBER:
C127

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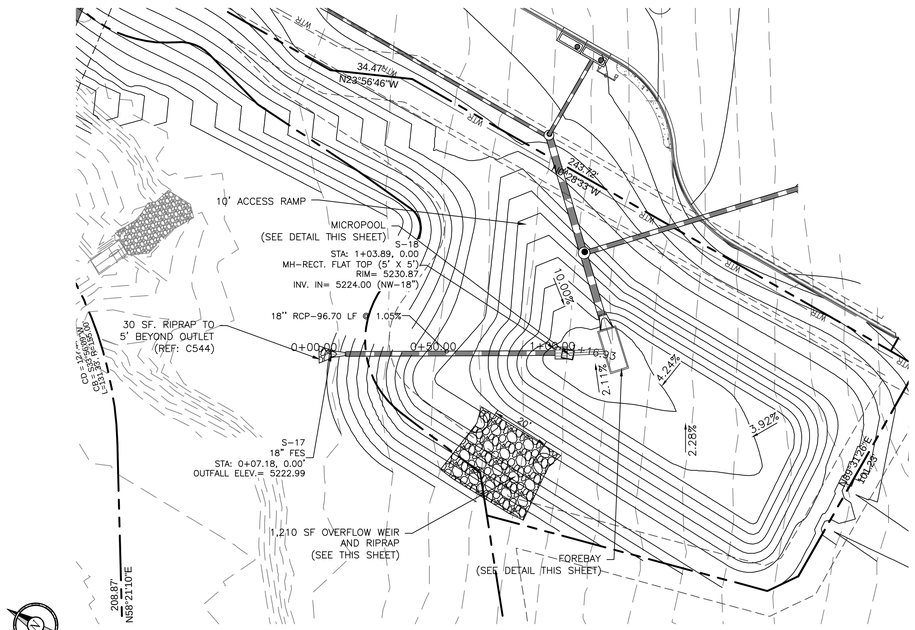

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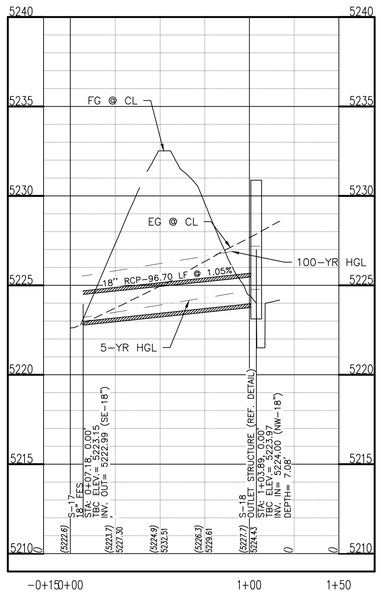
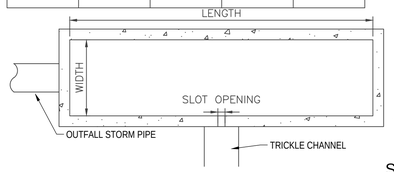
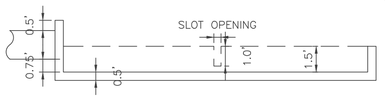


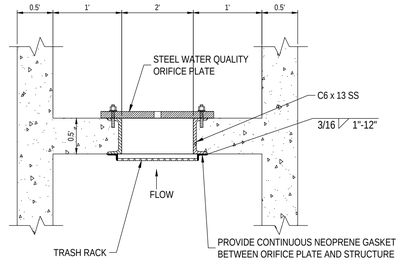
STM LINE D
STA: -0+15 - 1+50
SCALE: H: 1"=40' V: 1"=10'

FOREBAY DESIGN

WIDTH (FT.)	LENGTH (FT.)	VOLUME REQ. (SF.)	VOLUME PROV. (SF.)	SLOT WIDTH (IN.)
7	17.5	121.5	122.5	3.6

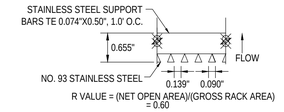






SECTION D-D

NOT TO SCALE



R VALUE = (NET OPEN AREA)/(GROSS RACK AREA)
= 0.60

TRASH RACK SECTION

NOT TO SCALE

STORM SEWER LEGEND

ST	STORM PIPE (< 10" NEW)
CD	BACK OF CURB DRAIN
	STORM PIPE (> 12" NEW)
	STORM PIPE (> 12" EXISTING)
	MAJOR CONTOUR (NEW)
	MINOR CONTOUR (NEW)
XXX	MAJOR CONTOUR (EXISTING)
XXX	MINOR CONTOUR (EXISTING)
	STORM GRATE (NEW)

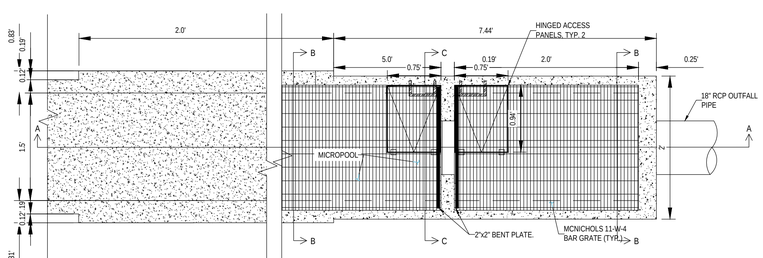
GENERAL NOTES

1. TBC ELEVATIONS NOTED ON CURB INLETS ARE EQUIVALENT TO TOP OF CURB OF ELEVATIONS. FLOWLINE ELEVATIONS SHALL BE 0.5 FT LOWER THAN TBC ELEVATIONS. LOCALIZED DEPRESSIONS AT INLETS SHALL BE PER STANDARD DETAILS.
2. RIM ELEVATIONS NOTED ON MANHOLES ARE EQUIVALENT TO THE TOP OF PAVEMENT ELEVATIONS.

STORM SEWER GENERAL NOTES

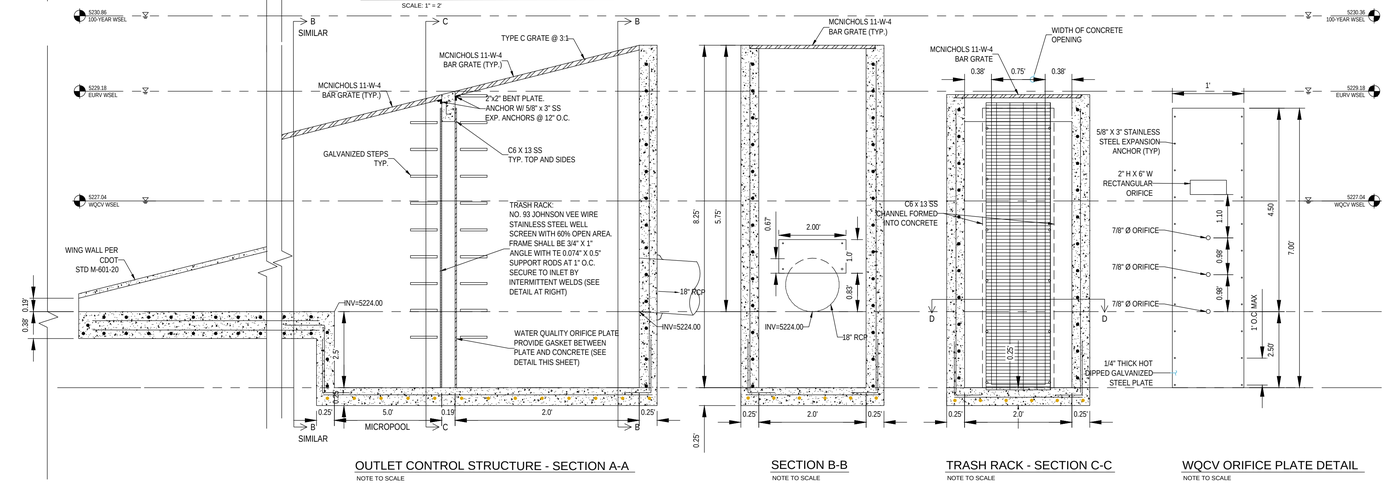
STORM SEWER INSTALLATION CONSIDERATIONS

PRIOR TO THE CONSTRUCTION OF, OR CONNECTION TO ANY STORM DRAIN OR ANY OTHER ELEVATION SENSITIVE UTILITY, THE CONTRACTOR SHALL EXCAVATE, VERIFY AND CALCULATE ALL POINTS OF CONNECTIONS AND ALL UTILITY CROSSINGS. THE CONTRACTOR SHALL INFORM THE ENGINEER AND THE OWNER OF ANY CONFLICT OR REQUIRED DEVIATIONS FROM THE PLAN. THE ENGINEER AND OWNER WILL BE HELD HARMLESS IN THE EVENT THE ENGINEER AND OWNER ARE NOT NOTIFIED OF A DESIGN CONFLICT.



OUTLET CONTROL STRUCTURE - PLAN DETAIL

SCALE: 1" = 2'



OUTLET CONTROL STRUCTURE - SECTION A-A

NOTE TO SCALE

SECTION B-B

NOTE TO SCALE

TRASH RACK - SECTION C-C

NOTE TO SCALE

WQCV ORIFICE PLATE DETAIL

NOTE TO SCALE

EMERGENCY SPILLWAY DETAIL

NOT TO SCALE

PROJECT NO.: QKT004207

Galloway
6500 Greenwood Plaza Blvd., Ste 200
Greenwood Village, CO 80111
303.770.8884
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QuikTrip No. 4207

18400 E. 81st Ave.
COMMERCE CITY, CO 80022

PROTOTYPE:	P-107 (8/01/21)
DIVISION:	83
VERSION:	001
DESIGNED BY:	ACJ
DRAWN BY:	ACJ
REVIEWED BY:	JRR

REV	DATE	DESCRIPTION

ORIGINAL ISSUE DATE: 12/16/2022

SHEET TITLE:

POND OUTLET STRUCTURE

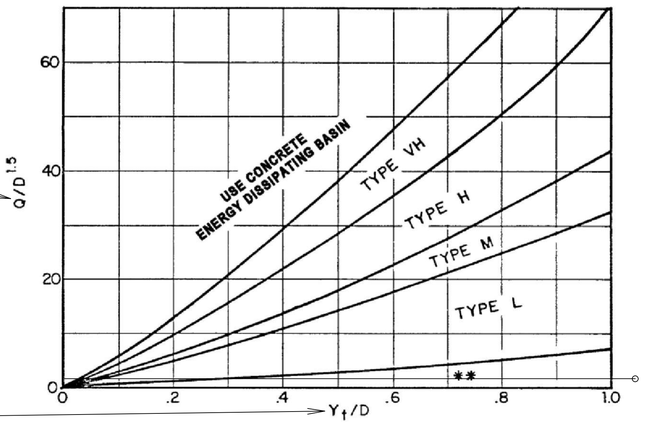
SHEET NUMBER:

C125

FILE LOCATION:H:\Quiktrip\QKT004207-Commerce City, CO\CADD\3 CD\QKT4207_Civil.dwg TAB NAME:Storm P&P - 5 OUTLET USER:Duncan_Rady SAVED:12/15/2022 2:48 PM PLOTTED:12/15/2022 2:53 PM

POND OUTLET Q=3.40 CFS
D = 1.50 FT
=1.33

POND OUTLET Yt=3.00 FT
D=1.50 FT
=2.0



the barrel.

** Use Type L for a distance of 3D downstream.

ROCK AND RIPRAP GRADATIONS

TABLE 1. RIPRAP GRADATIONS

D50 MEDIAN STONE SIZE (INCHES)	% OF MATERIAL SMALLER THAN TYPICAL STONE	TYPICAL STONE EQUIVALENT DIAMETER (INCHES)	TYPICAL STONE WEIGHT (POUNDS)
6	70 - 100 50 - 70 35 - 50 2 - 10	12 9 6 2	85 35 10 0.4
9	70 - 100 50 - 70 35 - 50 2 - 10	15 12 9 3	160 85 35 1.3
12	70 - 100 50 - 70 35 - 50 2 - 10	21 18 12 4	440 275 85 3
18	100 50 - 70 35 - 50 2 - 10	30 24 18 6	1280 650 275 10
24	100 50 - 70 35 - 50 2 - 10	42 33 24 9	3500 1700 650 35

TABLE 2. RIPRAP BEDDING

SIEVE SIZE	MASS PERCENT PASSING SQUARE MESH SIEVES
	CLASS A
3"	100
1 1/2"	20 - 90
NO. 4	0 - 20
NO. 200	0 - 3
MATCHES SPECIFICATIONS FOR CDOT CLASS A FILTER MATERIAL AND UDFCD TYPE 1 BEDDING. ALL ROCK SHALL BE FRACTURED FACE, ALL SIDES.	

TABLE 3. 1 1/2" CRUSHED ROCK

SIEVE SIZE	MASS PERCENT PASSING SQUARE MESH SIEVES
	NO. 4
2"	100
1 1/2"	90 - 100
1"	20 - 55
3/4"	0 - 15
3/8"	0 - 5
MATCHES SPECIFICATIONS FOR NO. 4 COARSE AGGREGATE FOR CONCRETE PER AASHTO M43. ALL ROCK SHALL BE FRACTURED FACE, ALL SIDES.	

COMPUTER FILE INFORMATION	
Creation Date: 03/10/2016	Initials: CJC
Last Modification Date: 5/4/2016	Initials: CJC
Full Path: WWW.C3GOV.COM	
Drawing Name: $FILE$$	
Scale: $SCALESHORT$	Units: ENGLISH

APPROVAL

CITY ENGINEER — 05-27-16 DATE

CITY OF COMMERCE CITY
Department of Public Works
8602 Rosemary St.
Commerce City, CO 80022
Ph: 303-289-8150

EROSION & SEDIMENT CONTROL

ENGINEERING CONSTRUCTION STANDARDS

DETAIL NO. 800-14

Sheet No. 14 of 14

PROJECT NO.: QKT004207

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

QuikTrip No. 4207
18400 E. 81st Ave.
COMMERCE CITY, CO 80022

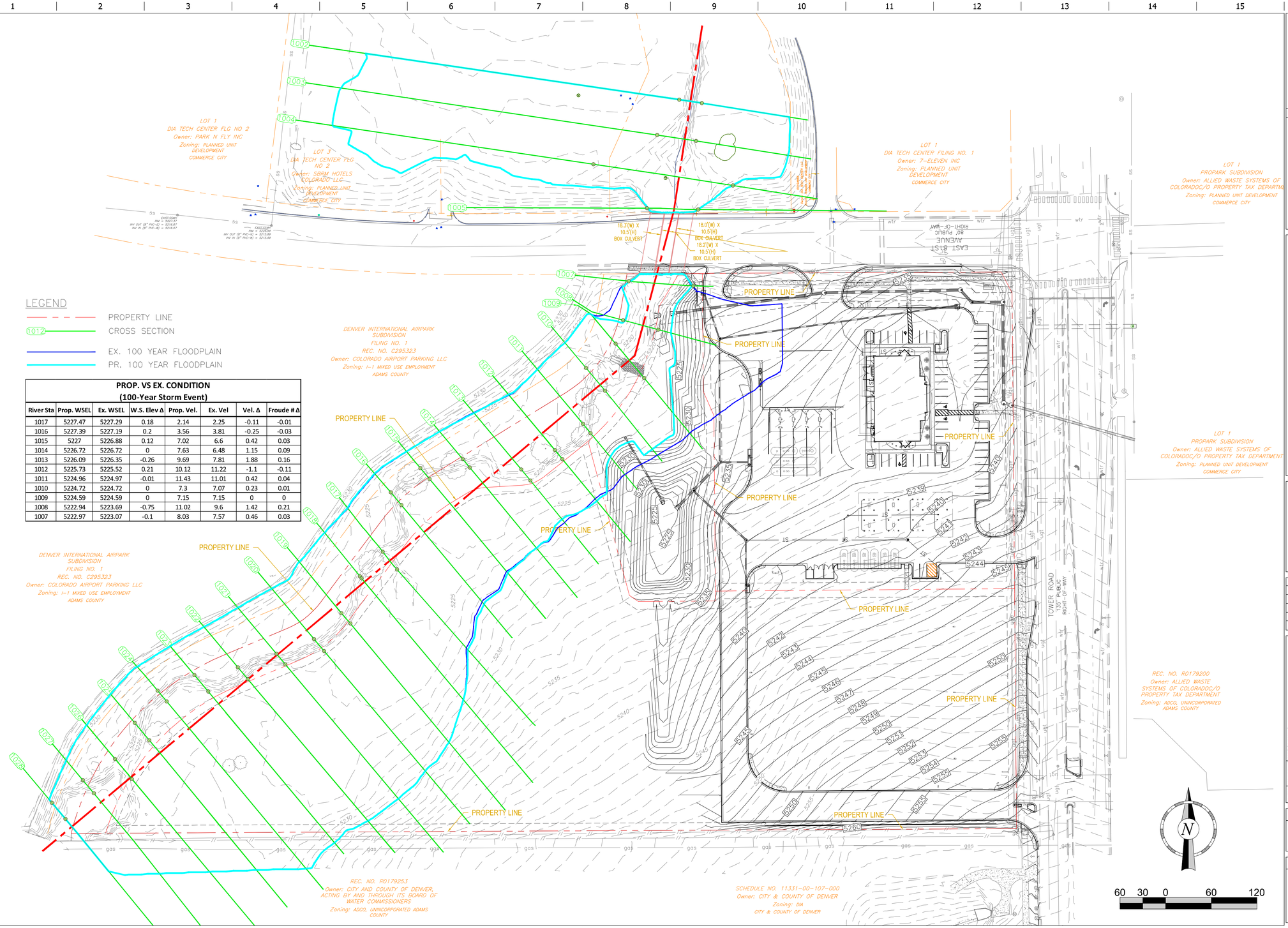
PROTOTYPE:	P-107 (8/01/21)
DIVISION:	83
VERSION:	001
DESIGNED BY:	ACJ
DRAWN BY:	ACJ
REVIEWED BY:	JRR

REV	DATE	DESCRIPTION

ORIGINAL ISSUE DATE: 12/16/2022

SHEET TITLE: DRAINAGE DETAILS

SHEET NUMBER: C544



PROP. VS EX. CONDITION (100-Year Storm Event)

River Sta	Prop. WSEL	Ex. WSEL	W.S. Elev Δ	Prop. Vel.	Ex. Vel	Vel. Δ	Froude # Δ
1017	5227.47	5227.29	0.18	2.14	2.25	-0.11	-0.01
1016	5227.39	5227.19	0.2	3.56	3.81	-0.25	-0.03
1015	5227	5226.88	0.12	7.02	6.6	0.42	0.03
1014	5226.72	5226.72	0	7.63	6.48	1.15	0.09
1013	5226.09	5226.35	-0.26	9.69	7.81	1.88	0.16
1012	5225.73	5225.52	0.21	10.12	11.22	-1.1	-0.11
1011	5224.96	5224.97	-0.01	11.43	11.01	0.42	0.04
1010	5224.72	5224.72	0	7.3	7.07	0.23	0.01
1009	5224.59	5224.59	0	7.15	7.15	0	0
1008	5222.94	5223.69	-0.75	11.02	9.6	1.42	0.21
1007	5222.97	5223.07	-0.1	8.03	7.57	0.46	0.03

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SHEET TITLE:
HEC-RAS CROSS-SECTION MAP

SHEET NUMBER:
EX-1

FILE LOCATION:H:\Quiktrip\QKT004207-Commerce City, CO\3 Permit\3.04 Grading Drainage\3.04-2 Proposed Drainage Reports--Info\GeoHECRAS\100yr Storm Exhibit.dwg TAB NAME:CD Grading - West USER:Matthew_Pepin SAVED:2/8/2023 12:16 PM PLOTTED:2/9/2023 2:35 PM