

**E-470 Storage Subdivision Filing No. 1, Lot 1, Block 1
A parcel of land being a part of the South 1/2 of Section 25,
Township 4 South, Range 66 West of the Sixth Principal Meridian,
City of Aurora, County of Arapahoe, State of Colorado**

PRELIMINARY DRAINAGE REPORT

**Project:
470 Storage
Aurora, Colorado**

**Client:
DB Endeavors
25072 East Davies Drive
Aurora, Colorado 80016
Stephanie Beguin
(720) 244-5976**

**Prepared By:
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February 6, 2018

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

ENGINEER'S CERTIFICATION

This report and plan for the drainage design of 470 Storage was prepared by me (or under my direct supervision) in accordance with the provisions of City of Aurora Storm Drainage Design and Technical Criteria, and was designed to comply with the provisions thereof.

Randall J. Phelps, P.E.
Registered Professional Engineer
State of Colorado No. 35204

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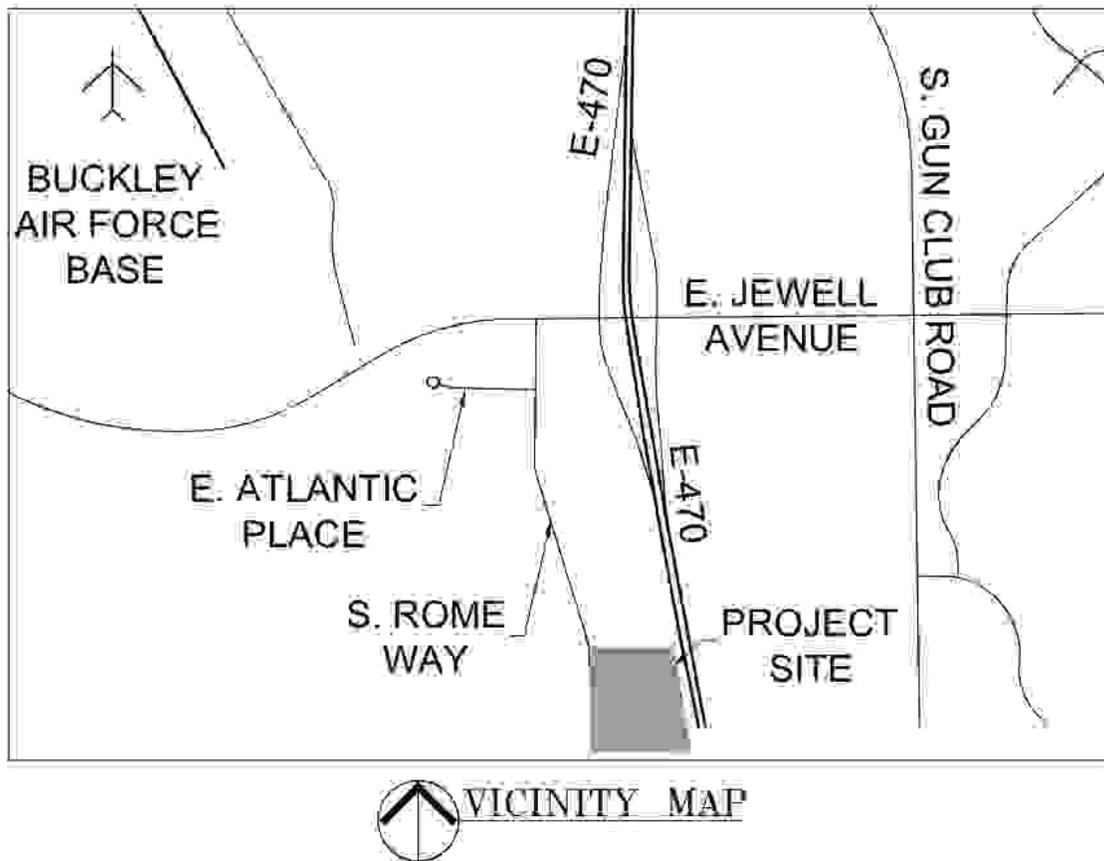
INTRODUCTION

Location

The site is located south of the intersection of Jewell Street and E-470, situated in the South 1/2 of Section 25, Township 4 South, Range 66 West of the 6th Principal Meridian, City of Aurora, County of Arapahoe, State of Colorado. The proposed site is bound by an undeveloped lot to the north and south, Rome Way and the Plains Conservation to the west and E-470 to the east. The 38.0+/- acre project site is currently undeveloped and consists of primarily sparse native grass, weeds, and brush cover.

Vicinity Map

A vicinity map is provided below for reference:



Proposed Development

The proposed development (the Project) consists of +/- 14.4-acres of RV Storage, with +/- 12.9-acres of future RV Storage expansion to the south and +/- 7.93-acres of future self-storage to the north. The RV storage area consists of recycled asphalt paving. No buildings are proposed within this +/- 14.4-acre development. A 26-foot wide fire lane is proposed around the inside perimeter of the project site connecting to South Rome Way. There are no buildings proposed as part of the RV Storage site.

A NRCS soil study for the project area was obtained to determine soil characteristics of the site. The results of this study show that the soils are silty loam in nature and 100 percent of the site is Soil Type C. A custom NRCS Web Soil Survey is provided in Appendix A.

The development of this project results in an overall imperviousness of 76% percent for the entire site, including development of future lots north and south of the 470 Storage development. Onsite runoff will overland flow to several 4' wide concrete pans that direct flows to proposed inlets located on the east side of the site. The flows will then be routed to a detention pond that will release flows at historical rates to an existing 54" flared end section located north east of the site.

No variances are requested at this time.

HISTORIC DRAINAGE

Overall Sub-Basin Description

The Site is not part of any Master Drainage Report.

This development is adjacent to a UDFCD FHAD (Flood Hazard Area Delineation) study, "Toll Gate Creek and East Toll Gate Creek downstream of Hampden, Major Drainageway Plan, May 14, 2014, J3 Engineering Consultants" (the FHAD Study). This FHAD Study delineates basin area tributary to Toll Gate Creek and East Toll Gate Creek, located west of this development. The easterly basin boundary for this development from this document was utilized to determine tributary area to the project. Approximately 1.71 acres of offsite flows are tributary to the Project.

The site is located within FEMA Flood Insurance Rate Map (FIRM) Number 08005C0211L, which is in a preliminary stage. The FHAD was used as a reference for the location of the project area relative to East Toll Gate Creek floodplain. The project site is outside of all tributary major basins and therefore, outside of the 100-year floodplain.

The project site is currently undeveloped and generally sheet flows from southwest to northeast with slopes between 2% and 4%.

The Site and area around the Site generally drain from west to east. Offsite flows will discharge to the proposed storm infrastructure and will be detained by the detention vault. A basin delineation of this area can be seen in Appendix F.

Outfalls Downstream from Property

Site drainage currently sheet flows east to west to an existing swale located east of the site adjacent to E-470. The swale runs from the south to the north to an existing 54" RCP with headwall, and discharges to the east side of the E-470. Flows that are north of the site will continue to flow north east to an existing culvert crossing beneath E. Jewell Avenue.

DESIGN CRITERIA

The "City of Aurora Storm Drainage Design and Technical Criteria," revised October 2010 (The "Criteria") and the "Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual" Volumes 1, 2, and 3 (The "Manual"), with latest revisions, were used for preparing storm calculations.

Hydrologic Criteria

The 2-year and 100-year design storm events will be used in determining rainfall and runoff for the proposed site. Chapter 5 of the Criteria was used to determine rainfall data for the storm events. Table 1 of the City of Aurora Storm Drainage Design and Technical Criteria was utilized to obtain the runoff coefficients and percent imperviousness values for commercial development. The Manual, adopted by the City of Aurora, was used to calculate runoff using the Rational Method for sub-basins less than 160 acres in size. Figures RA-1 through RA-6, of the Manual, were used to determine the P1 values for the intensity values used. One hour rainfall depths used for the calculations at the site are 0.97 inches and 2.63 inches for the 2-year and 100-year events, respectively. Hydrologic calculations can be found in Appendix B of this report.

Hydraulic Criteria

The project will construct a private internal storm sewer network, including inlets, to capture runoff.

Updated

All inlets will be sized using the UD Inlet spreadsheet to intercept the 100-year event, and all pipes will be sized to convey the 100-year event design. The 2-year design storm is required to be contained within the finished grade. Hydraulic calculations can be found in Appendix C.

FAA and V=KA are different methods. You will also have used V=KA which meets COA requirements.

Detention and water quality will be provided by this project. The Criteria requires a detention volume of the 100-Year storm event with ½ volume of the Excess Urban Runoff Volume (EURV) per the Manual. The 100-Year Volume was sized per the ~~FAA~~ V=KA Method and the EURV was calculated using Equations from Chapter 12 of Volume 2 of the Manual. The pond was designed to detain the required volumes and will release the EURV within 72 hours.

The detention pond is sized based on a tributary area of 37.89 acres with an overall imperviousness of 73%. The required storage volume of the pond is 5.26 acre-feet. This pond is sized north and south of the 470 Storage dev

For detention basin - you are very close to Buckley AFB. Please confirm the required drain time for the pond. It may be 48 hr per FAA circular 150/5200-33B. Please confirm and design accordingly.

Drain time modified to be 40 hrs for the EURV drain time and the 100-year flows.

DRAINAGE PLAN

General Concept

Stormwater will generally flow from west to east in a historic manner via overland flow, channelized flow, and storm sewer. Flows will be detained by the proposed detention pond before releasing through an outlet structure at flow rates required by the Criteria. The property owner is responsible for maintaining the proposed storm infrastructure within the property as well as the detention pond.

Offsite flows entering the site will discharge to the proposed storm infrastructure and will be detained by the proposed detention pond.

Specific Details

Onsite flows will be conveyed directly to the proposed detention pond located north of the site. Detention and water quality will be provided via a forebay and channel and micropool designed per the Manual. Flows directly north of the site flow to the proposed pond. Flows south of the development flow east of the site an existing swale and will be conveyed by the existing 54" RCP that routes storm east of E-470. The proposed detention pond has been calculated to provide approximately 5.27 acre-feet of storage for the E470 Storage development, future parcels located directly north and south of the Site and 1.71 acres of offsite area. The pond was sized to provide detention for the 100-Year Event and half of the EURV as required per the Criteria. The site located north of the development was assumed to have a developed imperviousness of 85%. The development to the south of E470 Storage was assumed to have an overall imperviousness of 73%. The pond will release the EURV with a 72 hour drain time. The 100-year release rate of the pond is 32.79 cfs. This was determined by taking the entire area of 37.89 acres and applying the 1 cfs/acre for the entire area yielding a flow rate of 37.89 cfs. The undetained flows (5.1 cfs) were subtracted from the 37.89 cfs yielding a release rate from the detention pond of 32.79 cfs. Calculations for the detention pond are provided in Appendix D.

Updated

86% in calcs

Discharge rate updated to provide a 40 hour drain time

Allowable discharge rate from pond should be (tributary on-site area) X (1 cfs/acre) + existing condition tributary off-site flows.

An emergency spillway is proposed on the north side of the pond. Flows will overtop and flow north to an existing crossing beneath Jewell Avenue.

Sub-basin Descriptions

A Drainage Map has been provided to illustrate the sub-basins proposed with this project. Individual sub-basin details such as runoff, coefficient calculations, and imperviousness percentages are provided in Appendix B. The 2-year and 100-year peak flows for each sub-basin are also provided in Appendix B.

Sub-basins A-1 through A-5

Sub-basins A-1 through A-5 have areas ranging from 2.20 – 2.66 acres and consist of asphalt paving and landscaping. Runoff will sheet flow across landscaping and asphalt drives to concrete pans in the parking area where it will be conveyed to a triple Denver

Type 16 Inlet. The runoff coefficients for these sub-basins range from 0.75 – 0.82 and 0.81 – 0.88 for the 2-year and 100-year storm, respectively.

Sub-basin A-6

Sub-basin A-6 is comprised of 0.46 acres and is located north of the asphalt paving and consists primarily of landscaping, a small amount of asphalt paving connecting the site to South Rome Way and a portion of the fire access road. Runoff will flow from south to north and flow to undeveloped basin F-2 to the north. The runoff coefficients for sub-basin A6 are 0.26 and 0.31 for the 2-year and 100-year storm, respectively.

Sub-basin B-1

Sub-basin B-1 is comprised of ~~2.46~~ ^{2.73} acres and is located northeast of the site and includes the proposed detention pond. Flows from this basin will flow into the detention pond. This sub-basin is 2.73 acres of landscaped area and has runoff coefficients of 0.18 and 0.22 for the 2-year and 100-year, respectively.

Updated

Sub-basin F-1

Sub-basin F-1 is located south of the site and consists of 12.86 acres of existing, undeveloped land with slopes that range from 2-4% draining from west to east. Runoff from this sub-basin drains east and flows north to the existing 54" RCP.

Updated

73% in calcs and earlier text

Future conditions are assumed to consist of asphalt paving, roof and landscaping. Runoff will sheet flow across the landscaping and drive areas to concrete pans in the parking area where it will be conveyed to inlets. An impervious value of 72% was assumed for the development. The future runoff coefficients for this sub-basin range from 0.67 and 0.73 for the 2-year and 100-year storm, respectively. The storm sewer onsite has been sized to account for the development of sub-basin F-1.

Sub-basin F-2

Sub-basin F-2 is located north of the site and consists of 7.93 acres of existing, undeveloped land with slopes that range from 2-5% draining from southwest to northeast. Runoff from this sub-basin drains to a proposed swale located west of the pond. The flows will be collected by a proposed inlet and discharge to the proposed detention pond. This basin also has runoff from sub-basin A-6 that also flows to the detention pond.

86% in calcs Updated

Future conditions are assumed to consist of self-storage buildings, asphalt paving and landscaping. Runoff will discharge via roof drains and sheet flow across the drive areas to concrete pans in the parking area, where it will be conveyed to inlets. The future impervious was assumed to be 85%. The future runoff coefficients for this sub-basin range from 0.77 and 0.82 for the 2-year and 100-year storm, respectively.

Sub-basin OS-1

Sub-basin OS-1 contains 1.78 acres and consists of the landscape berm east of the site. This off-site area sheet flows north to the existing 54" flared end section northeast of the site. Runoff coefficients for this sub-basin are 0.18 and 0.22 for the 2-year and 100-year storm, respectively.

Sub-basin OS-2

Sub-basin OS-2 contains 1.43 acres and consists of undeveloped land northeast of the site. This off-site area sheet flows east to the existing 54" flared end section. Runoff coefficients for this sub-basin are 0.18 and 0.22 for the 2-year and 100-year storm, respectively.

Sub-basin OS-N

Sub-basin OS-N contains 1.71 acres and consists of undeveloped land west of the site. Runoff from this area will flow from west to east to the proposed site. The flows will be captured by proposed storm infrastructure and will be detained. Runoff coefficients for this sub-basin are 0.18 and 0.22 for the 2-year and 100-year storm, respectively.

CONCLUSIONS

Compliance with Standards

The project complies with the City of Aurora criteria for storm drainage design. City of Aurora Storm Drainage Design and Technical Criteria and the Urban Drainage Flood Control District Urban Storm Drainage Criteria Manual Volumes 1, 2, and 3 have been utilized in the design of the storm sewer system as well as Best Management Practices. The ultimate storm sewer system for this site will provide for the 100-year storm event and will not surcharge the storm sewer in the minor event.

Summary of Drainage Concept

The project runoff is tributary to Alexandra Gulch, which flows to Gun Club Creek, which then discharges to Murphy Creek and ultimately to the South Platte River. Runoff generated within the site is collected using storm inlets. The flows will then be detained and treated by the forebay, trickle channel, and micropool per UDFCD requirements. The proposed detention pond releases flows at rates defined by the Criteria to an existing 54" RCP located northeast of the detention pond. The proposed pond is sized to accommodate the additional flows for developed conditions for the entire +/- 38-acre property.

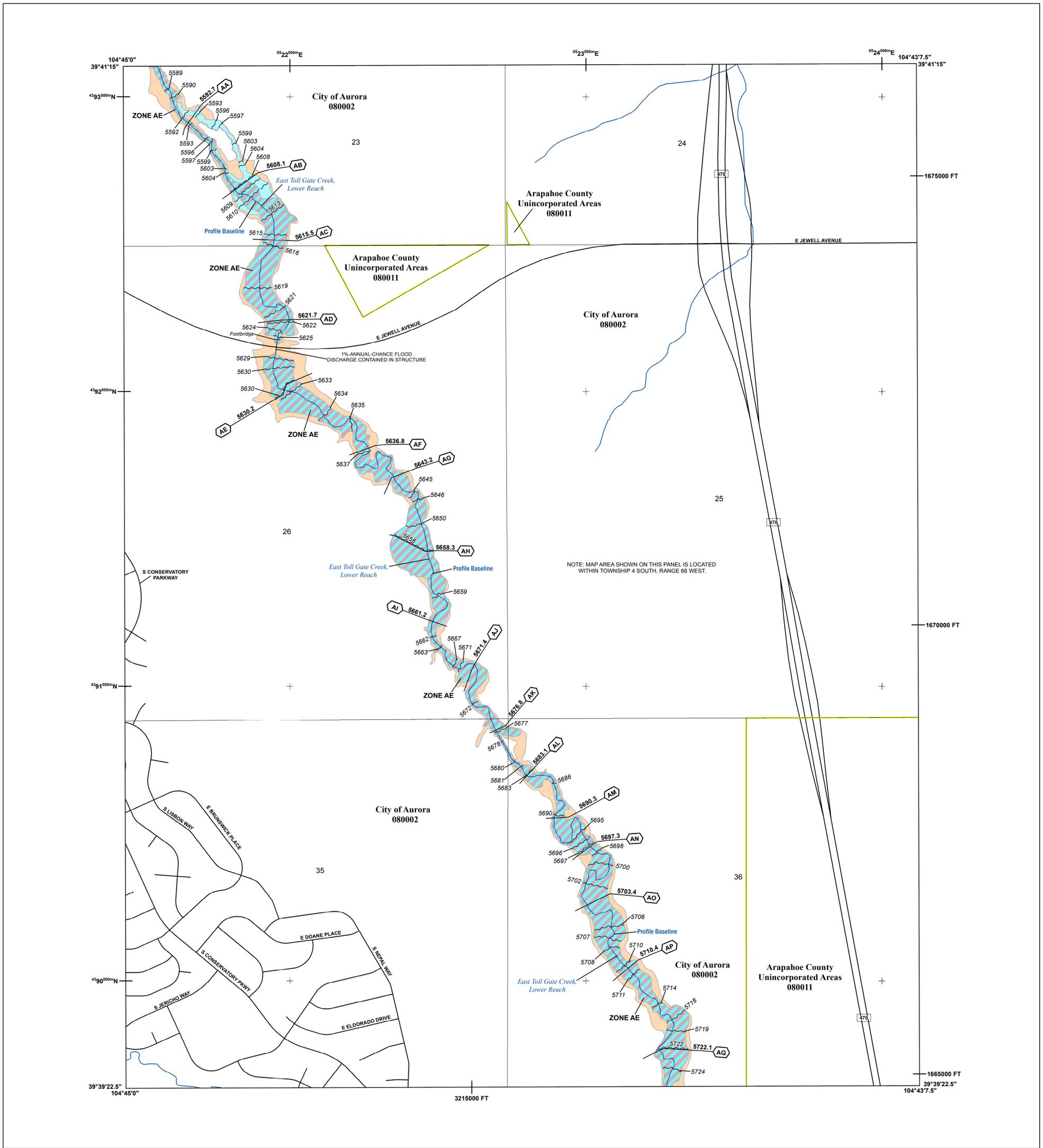
REFERENCES

Storm Drainage Design and Technical Criteria, City of Aurora; October 2010.

Urban Storm Drainage Criteria Manual, Volumes 1-3, Urban Drainage and Flood Control District, June 2001 with latest revisions.

Toll Gate Creek and East Toll Gate Creek, Downstream of Hampden, Major Drainageway Plan, May 14, 2014, J3 Engineering Consultants

APPENDIX A –NRCS SOILS REPORT



FLOOD HAZARD INFORMATION

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

	Without Base Flood Elevation (BFE) Zone A, V, A99
	With BFE or Depth Zone AE, AO, AH, VE, AR
	Regulatory Floodway
	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
	Future Conditions 1% Annual Chance Flood Hazard Zone X
	Area with Reduced Flood Risk due to Levee See Notes, Zone X
	NO SCREEN Areas of Minimal Flood Hazard Zone X
	Area of Undetermined Flood Hazard Zone D
	Channel, Culvert, or Storm Sewer
	Accredited or Provisionally Accredited Levee, Dike, or Floodwall
	Non-accredited Levee, Dike, or Floodwall
	Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

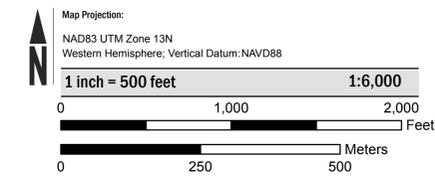
For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the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

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

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

Base map information shown on this FIRM is current as of 2015, provided in digital format by the Arapahoe County, City of Aurora, and City of Littleton Geographic Information System (GIS) Departments.

SCALE



PANEL LOCATOR

ARAPAHOE COUNTY				
		0203	0204	0208
0191	0192	0211	0212	0216
0193	0194	0213	0214	0218

* PANEL NOT PRINTED

NATIONAL FLOOD INSURANCE PROGRAM
 FLOOD INSURANCE RATE MAP

ARAPAHOE COUNTY, COLORADO
 And Incorporated Areas

PANEL 211 OF 725

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARAPAHOE COUNTY	080011	0211	L
AURORA, CITY OF	080002	0211	L

PRELIMINARY
 JUNE 30, 2016

VERSION NUMBER
 2.3.3.2

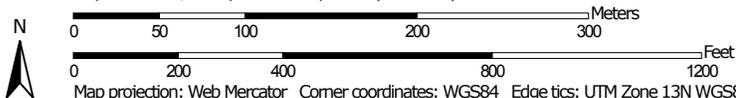
MAP NUMBER
 08005C0211L

MAP REVISED

Custom Soil Resource Report Soil Map



Map Scale: 1:4,380 if printed on A portrait (8.5" x 11") sheet.



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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
FoC	Fondis-Colby silt loams, 3 to 5 percent slopes	48.6	100.0%
Totals for Area of Interest		48.6	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.

Arapahoe County, Colorado

FoC—Fondis-Colby silt loams, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 34yl
Elevation: 4,700 to 6,200 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 150 to 170 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Fondis and similar soils: 65 percent
Colby and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fondis

Setting

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

Typical profile

H1 - 0 to 5 inches: silt loam
H2 - 5 to 17 inches: clay
H3 - 17 to 60 inches: clay 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 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
Available water storage in profile: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C ←
Ecological site: LOAMY FOOTHILL (R067XY202CO)
Hydric soil rating: No

This soil is type B and C. Using C as type c is more conservative for flows and detention

Next page for Colby says Group B? Which applies?

Description of Colby

Setting

Landform: Ridges
Down-slope shape: Linear

Custom Soil Resource Report

Across-slope shape: Linear

Parent material: Fine-loamy eolian deposits and/or fine-silty eolian deposits

Typical profile

H1 - 0 to 4 inches: silt loam

H2 - 4 to 60 inches: silt loam, loam

H2 - 4 to 60 inches:

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 to high (0.57 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 20 percent

Available water storage in profile: Very high (about 19.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3c

Hydrologic Soil Group: B

Ecological site: LOAMY FOOTHILL (R067XY202CO)

Hydric soil rating: No

Minor Components

Weld

Percent of map unit: 6 percent

Hydric soil rating: No

Ft collins

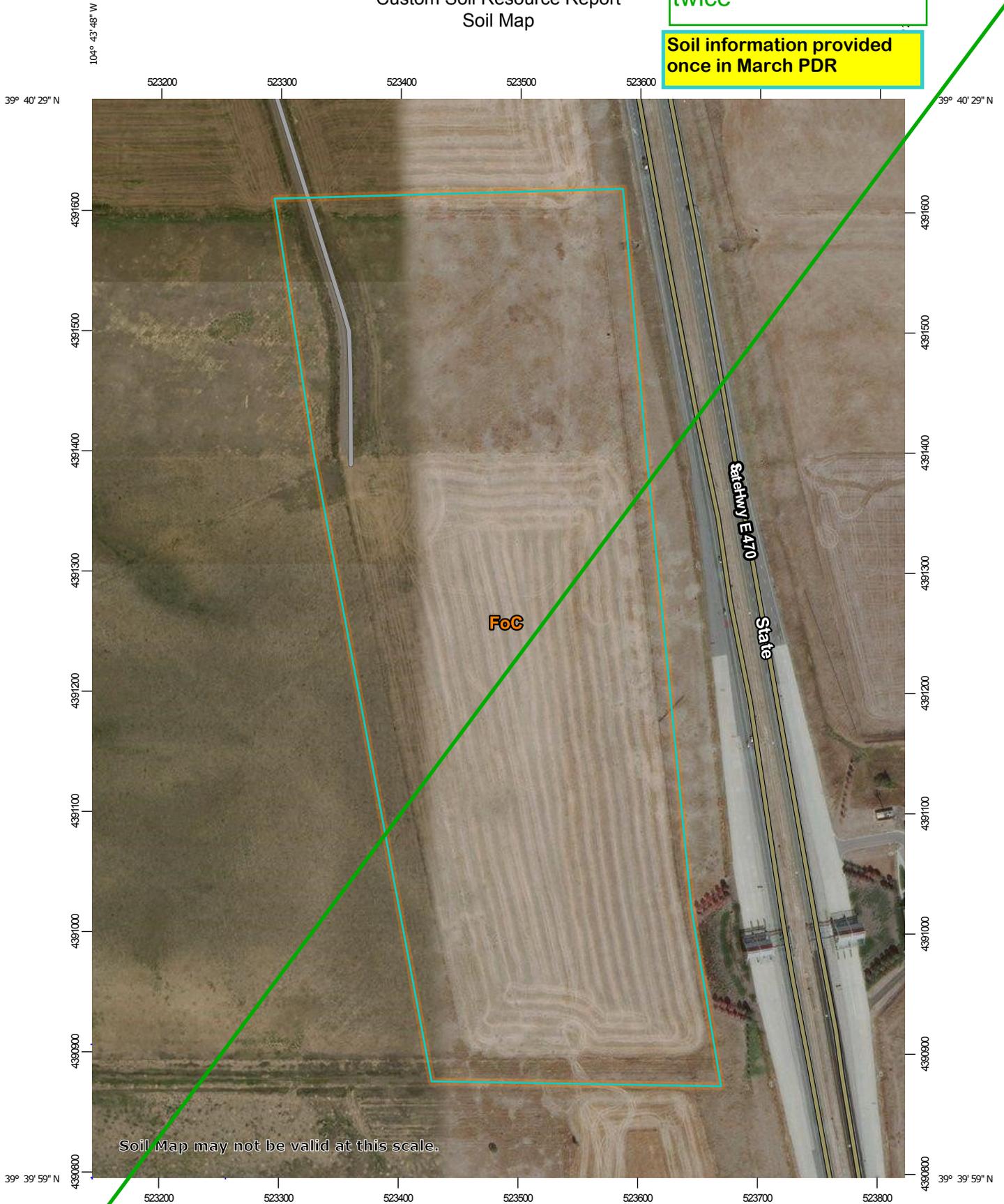
Percent of map unit: 4 percent

Hydric soil rating: No

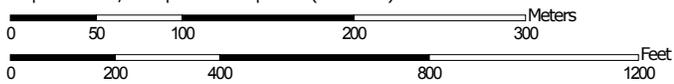
Custom Soil Resource Report
Soil Map

Soils info included
twice

Soil information provided
once in March PDR



Map Scale: 1:4,380 if printed on A portrait (8.5" x 11") sheet.



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

Soil information provided
once in March PDR

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Soil information provided
once in March PDR

Arapahoe County, Colorado

FoC—Fondis-Colby silt loams, 3 to 5 percent slopes

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

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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
Available water storage in profile: High (about 10.8 inches)

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Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C
Ecological site: LOAMY FOOTHILL (R067XY202CO)
Hydric soil rating: No

Description of Colby

Setting

Landform: Ridges
Down-slope shape: Linear

Soil information provided
once in March PDR

Across-slope shape: Linear

Parent material: Fine-loamy eolian deposits and/or fine-silty eolian deposits

Typical profile

H1 - 0 to 4 inches: silt loam

H2 - 4 to 60 inches: silt loam, loam

H2 - 4 to 60 inches:

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 to high (0.57 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 20 percent

Available water storage in profile: Very high (about 19.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3c

Hydrologic Soil Group: B

Ecological site: LOAMY FOOTHILL (R067XY202CO)

Hydric soil rating: No

Minor Components

Weld

Percent of map unit: 6 percent

Hydric soil rating: No

Ft collins

Percent of map unit: 4 percent

Hydric soil rating: No

APPENDIX B – HYDROLOGY CALCULATIONS



RAINFALL INTENSITY

$$I = \frac{28.5 P_1}{(10 + T_C)^{0.786}}$$

Where:

I = rainfall intensity (inches per hour)

P₁ = one-hour rainfall depth (inches) from figures RA1-RA-6
in USDCM, Volume 1

T_C = time of concentration (minutes)

$$P_1 = \begin{array}{cccc} \underline{2\text{-yr}} & \underline{5\text{-yr}} & \underline{10\text{-yr}} & \underline{100\text{-yr}} \\ 0.97 & 1.39 & 1.63 & 2.63 \end{array}$$

Time Intensity Frequency Tabulation

TIME	2 YR	5 YR	10 YR	100 YR
5	3.29	4.71	5.53	8.92
10	2.62	3.76	4.41	7.12
15	2.20	3.16	3.70	5.97
20	1.91	2.73	3.21	5.17
25	1.69	2.42	2.84	4.58
30	1.52	2.18	2.56	4.13
40	1.28	1.83	2.15	3.46
50	1.11	1.59	1.86	3.00
60	0.98	1.40	1.65	2.66
120	0.60	0.86	1.01	1.63

BASIN IMPERVIOUSNESS AND RUNOFF COEFFICIENT

	Imp.	C2	C5	C10	C100
Landscape	5%	0.18	0.19	0.20	0.22
Light Industrial	80%	0.71	0.72	0.76	0.82
Roof	90%	0.80	0.85	0.90	0.90
Concrete	96%	0.87	0.87	0.88	0.89
Street - Paved	100%	0.87	0.88	0.90	0.93

ON-SITE BASINS

Basin ID	Roof (SF)	Landscape (SF)	Concrete (SF)	Street - Paved (SF)	Total Basin Area (SF)	Total Basin Area (Acres)	Basin Imperviousness	C2	C5	C100
A-1	0	16739	0	79181	95920	2.20	83%	0.75	0.76	0.81
A-2	0	8195	0	102372	110567	2.54	93%	0.82	0.83	0.88
A-3	0	8369	0	105009	113379	2.60	93%	0.82	0.83	0.88
A-4	0	8387	0	107381	115768	2.66	93%	0.82	0.83	0.88
A-5	0	10444	0	85584	96028	2.20	90%	0.79	0.80	0.85
A-6	0	17436	0	2431	19866	0.46	17%	0.26	0.27	0.31
B-1	0	118909	0	0	118909	2.73	5%	0.18	0.19	0.22
F-1	0	159975	0	400000	559975	12.86	73%	0.67	0.68	0.73
F-2	0	52449	0	293000	345449	7.93	86%	0.77	0.78	0.82
Total	0	400903	0	1174958	1575861	36.18	76%	0.69	0.70	0.75

OFF-SITE BASINS

OS-1	0	77701	0	0	77701	1.78	0.05	0.18	0.19	0.22
OS-2	0	62258	0	0	62258	1.43	0.05	0.18	0.19	0.22
OS-N	0	74479	0	0	74479	1.71	0.05	0.18	0.19	0.22
Total	0	214438	0	0	214438	4.92	0.05	0.18	0.19	0.22

Total Onsite and Offsite	0	615341	0	1174958	1790299	41.10	0.67	0.63	0.64	0.69
--------------------------	---	--------	---	---------	---------	-------	------	------	------	------

TIME OF CONCENTRATION

Watercourse Coefficient																	
					Forest & Meadow 2.50			Short Grass Pasture & Lawns 7.00			Grassed Waterway 15.00						
					Fallow or Cultivation 5.00			Nearly Bare Ground 10.00			Paved Area & Shallow Gutter 20.00						
SUB-BASIN DATA					INITIAL / OVERLAND T(i)			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T(c)	
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope ft/ft	T(i) min	Length ft.	Slope ft/ft	Coef.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.	
A-1	A-1	95,920	2.20	0.76	130	0.04	4.6	445	0.030	20	3.5	2.1	6.7	575	13.2	6.7	
A-2	A-2	110,567	2.54	0.83	150	0.03	4.1	445	0.030	20	3.5	2.1	6.2	595	13.3	6.2	
A-3	A-3	113,379	2.60	0.83	145	0.04	3.8	470	0.030	20	3.5	2.3	6.1	615	13.4	6.1	
A-4	A-4	115,768	2.66	0.83	140	0.05	3.4	485	0.030	20	3.5	2.3	5.7	625	13.5	5.7	
A-5	A-5	96,028	2.20	0.80	140	0.03	4.3	500	0.030	20	3.5	2.4	6.7	640	13.6	6.7	
A-6	A-6	19,866	0.46	0.27	70	0.04	7.8	0	0.000	20	0.0	0.0	7.8	70	10.4	7.8	
B-1	B-1	118,909	2.73	0.19	170	0.07	11.6	403	0.005	7	0.5	13.6	25.2	573	13.2	13.2	
F-1	F-1	559,975	12.86	0.68	300	0.03	9.2	433	0.030	20	3.5	2.1	11.3	733	14.1	11.3	
F-2	F-2	345,449	7.93	0.78	300	0.03	7.1	336	0.030	20	3.5	1.6	8.7	636	13.5	8.7	
OS-1	OS-1	77,701	1.78	0.19	75	0.07	7.5	55	0.030	7	1.2	0.8	8.3	130	10.7	8.3	
OS-2	OS-2	62,258	1.43	0.19	250	0.05	15.4	127	0.040	7	1.4	1.5	16.9	377	12.1	12.1	

Calcs for basin OS-N missing. Also see comments on off-site basin map - appears there are addition areas to the west tributary to your site.

Calculations revised to show all OS basins

Revised

RUNOFF CALCULATIONS

These are 100 yr intensities - revise to 2yr

Design Storm 2 Year												
BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				REMARKS
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	
A-1	A-1	2.20	0.75	6.7	1.65	3.06	5.0	11.3	10.30	6.82	70.3	F1+A1
A-2	A-2	2.54	0.82	6.2	2.08	3.12	6.5	11.3	12.38	6.82	84.4	F1+A1+A2
A-3	A-3	2.60	0.82	6.1	2.13	3.15	6.7	11.3	14.51	6.82	99.0	F1+A1+A2+A3
A-4	A-4	2.66	0.82	5.7	2.18	3.19	7.0	11.3	16.69	6.82	113.9	F1+A1+A2+A3+A4
A-5	A-5	2.20	0.79	6.7	1.75	3.06	5.4	11.3	27.06	6.82	184.6	F1+A1+A2+A3+A4+A5+OS-N
A-6	A-6	0.46	0.26	7.8	0.12	2.92	0.4					
B-1	B-1	2.73	0.18	13.2	0.49	2.35	1.2					
F-1	F-1	12.86	0.67	11.3	8.65	2.52	21.8					
F-2	F-2	7.93	0.77	8.7	6.07	2.80	17.0					
SUMMARY:								13.2	25.43	6.38	162.3	All Onsite Basins + OS-N
OS-1	OS-1	1.78	0.18	8.3	0.32	2.86	0.92					
OS-2	OS-2	1.43	0.18	12.1	0.26	2.45	0.63					

Drainage Basin updated to show all contributing areas west of the site using COA contour data.

Calcs for basin OS-N missing. Also see comments on off-site basin map - appears there are addition areas to the west tributary to your site.

RUNOFF CALCULATIONS

<i>Design Storm 100 Year</i>												
BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				REMARKS
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	
A-1	A-1	2.20	0.81	6.7	1.78	8.29	14.7	11.3	11.12	6.82	75.9	F1+A1
A-2	A-2	2.54	0.88	6.2	2.23	8.47	18.9	11.3	13.35	6.82	91.1	F1+A1+A2
A-3	A-3	2.60	0.88	6.1	2.28	8.54	19.5	11.3	15.63	6.82	106.6	F1+A1+A2+A3
A-4	A-4	2.66	0.88	5.7	2.33	8.66	20.2	11.3	17.97	6.82	122.6	F1+A1+A2+A3+A4
A-5	A-5	2.20	0.85	6.7	1.88	8.30	15.6	11.3	20.23	6.82	138.0	F1+A1+A2+A3+A4+A5+OS-N
A-6	A-6	0.46	0.31	7.8	0.14	7.91	1.1					
B-1	B-1	2.73	0.22	13.2	0.60	6.38	3.8					
F-1	F-1	12.86	0.73	11.3	9.35	6.82	63.8					
F-2	F-2	7.93	0.82	8.7	6.52	7.58	49.4					
SUMMARY:								13.2	27.49	6.38	175.4	All Onsite Basins + OS-N
OS-1	OS-1	1.78	0.22	8.3	0.39	7.74	3.0					
OS-2	OS-2	1.43	0.22	12.1	0.31	6.63	2.1					

Calculations revised to show all OS basins

Calcs for basin OS-N missing. Also see comments on off-site basin map - appears there are addition areas to the west tributary to your site.

**470 Storage
Aurora, CO**

Based on 100yr intensities - please revise.

Revised

			Direct Flows		Cumulative Flows	
DESIGN POINT	DRAIN BASIN	AREA Ac	Q ₂ CFS	Q ₁₀₀ CFS	Q ₂ CFS	Q ₁₀₀ CFS
A-1	A-1	2.20	5.0	14.7	70.27	75.9
A-2	A-2	2.54	6.5	18.9	84.44	91.1
A-3	A-3	2.60	6.7	19.5	98.99	106.6
A-4	A-4	2.66	7.0	20.2	113.85	122.6
A-5	A-5	2.20	5.4	15.6	184.61	138.0
A-6	A-6	0.46	0.4	1.1	0.35	1.1
B-1	B-1	2.73	1.2	3.8	1.16	3.8
F-1	F-1	12.86	21.8	63.8	21.76	63.8
F-2	F-2	7.93	17.0	49.4	16.96	49.4
OS-1	OS-1	1.78	0.9	3.0	0.9	3.0
OS-2	OS-2	1.43	0.6	2.1	0.6	2.1
OS-N	O-N	1.71	0.9	2.9	0.9	2.9

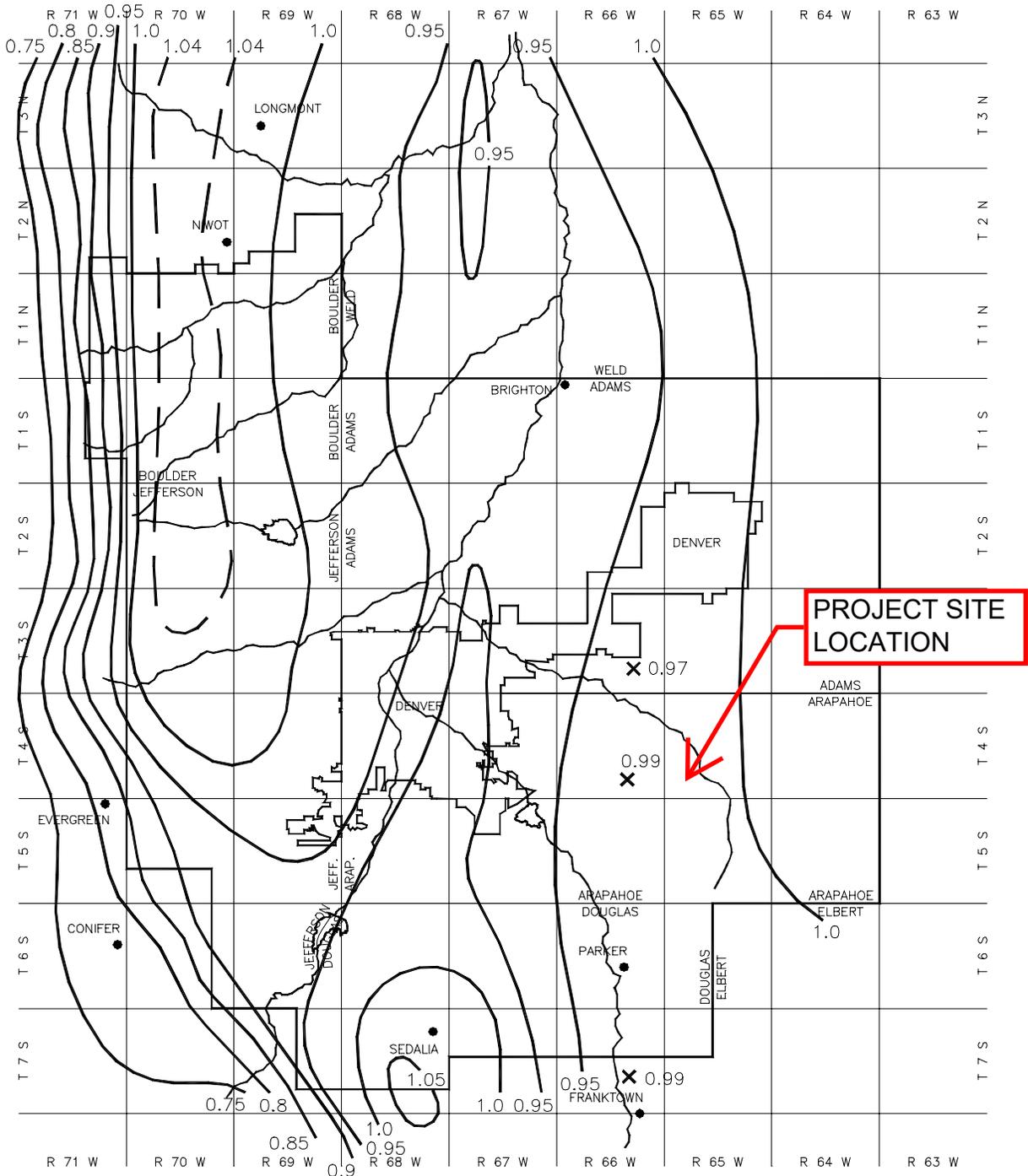


Figure 5-1. Rainfall depth-duration-frequency: 2-year, 1-hour rainfall

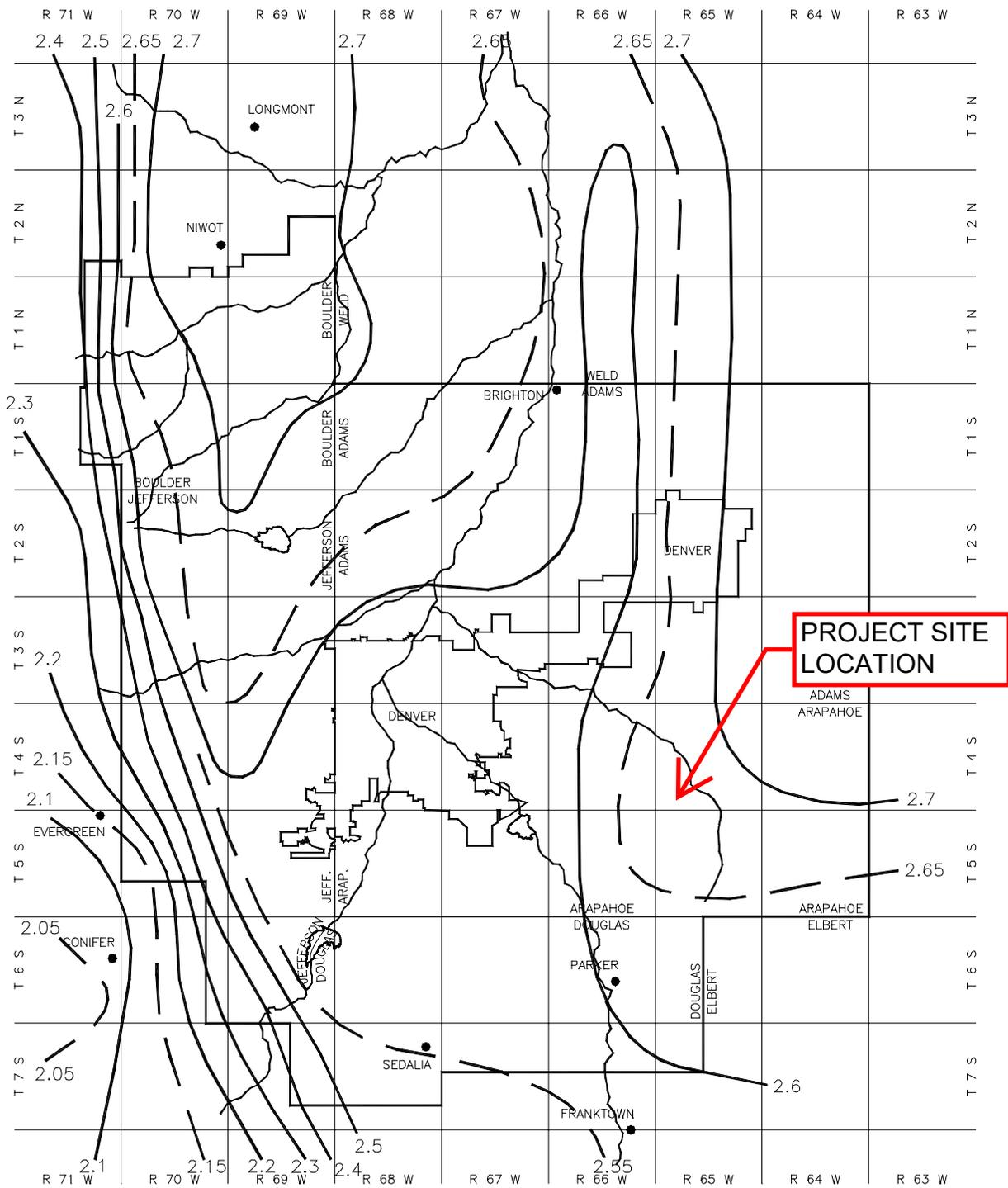


Figure 5-6. Rainfall depth-duration-frequency: 100-year, 1-hour rainfall

APPENDIX C – DETENTION CALCULATIONS

Refers to facilities serving 160 ac or more

Updated

Updated



4582 S Ulster Street - Suite 1500
Denver, Colorado 80237

Project: 470 Storage
Project Number: 096648000
Date: 2/5/2018

Prepared By: KBP
Checked By: RJP

See other comments - 37.89 does not appear to include all of the area tributary to your site from the west.

~~Regional~~ Detention Storage Volume (V=KA Method)

Contributing Basin Characteristics	
	Area (Ac)
Site Area =	37.89

Water Quality Capture Volume	
UDFCD V3 Equation 3-1 WQ Watershed Inches = $a * (0.91i^3 - 1.19i^2 + .078i)$	
	$a_{12} = 0.8$ (12-Hr Drain Time)
	$a_{24} = 0.9$ (24-Hr Drain Time)
	$a_{40} = 1.0$ (40-Hr Drain Time)
UDFCD V3 Equation 3-3 WQCV = (WQCV/12) * (Area)	
WQCV Impervious (Site) =	72.6%
a =	0.9
WQ Watershed Inches (Site) =	0.259
WQCV Area (Site) =	37.89
WQ Capture Volume (Site) =	0.816 AC-FT
WQ Design Volume (Site) =	0.816 AC-FT
	35,561 Cu Ft
EURV (UDFCD v3.07)	0.85 AC-FT

Updated

Per UDFCD, 24 hr drain time may be used for a "Constructed Wetland Pond" which requires a perennial flow (or high enough groundwater table) and water rights for the storage. Unless these conditions will be met, the pond will be an "Extended Detention Basin" with a 40hr drain time and a=1.0.

EURV revised to be calculated in AC-FT.

0.85 is EURV in "watershed inches". Need to multiply by area to get volume.

5-Year Detention	
UDFCD V2 Eq. SO-1 $V_i = K_i A$	
UDFCD V2 Eq. SO-3 $K_{100} = (1.78i - .002i^2 - 3.56) / (900)$	
$k_5 =$	0.053
5-Yr Detention Volume =	2.018
5-Yr Detention Volume =	87891.8 Cu Ft

Design for 5yr not required. COA requirements are EURV and 100yr.

5-year removed from calculations

100-Year Detention	
UDFCD V2 Eq. SO-1 $V_i = K_i A$	
UDFCD V2 Eq. SO-2 $K_{100} = (1.78i - .002i^2 - 3.56) / (900)$	
$k_{100} =$	0.128
100-Yr Detention Volume =	4.847
100-Yr Detention Volume =	211127.7

WQ Capture Volume =	0.82 AC-FT
5-Yr Volume plus WQCV =	2.82 AC-FT
100-Yr Volume =	4.85 AC-FT
100-Yr Volume plus 1/2 EURV =	5.27 AC-FT

Revised: need 6.24 ac-ft

Revise based on EURV calc comment above.

BASIN IMPERVIOUSNESS AND RUNOFF COEFFICIENT

This page is for reference only. It is a calculation of the basins tributary to the proposed detention pond and calculates the overall imperviousness and area.

	Imp.	C2	C5	C10	C100
Landscape	5%	0.03	0.08	0.36	0.50
Light Industrial	80%	0.71	0.72	0.76	0.82
Roof	90%	0.80	0.85	0.90	0.90
Concrete	96%	0.87	0.87	0.88	0.89
Street - Paved	100%	0.87	0.88	0.90	0.93

Basins to Detention Pond

Basin ID	Roof (SF)	Landscape (SF)	Concrete (SF)	Street - Paved (SF)	Total Basin Area (SF)	Total Basin Area (Acres)	Basin Imperviousness	C2	C5	C100
A-1	0	16739	0	79181	95920	2.20	0.83	0.72	0.74	0.86
A-2	0	8195	0	102372	110567	2.54	0.93	0.81	0.82	0.90
A-3	0	8369	0	105009	113379	2.60	0.93	0.81	0.82	0.90
A-4	0	8387	0	107381	115768	2.66	0.93	0.81	0.82	0.90
A-5	0	10444	0	85584	96028	2.20	0.90	0.78	0.79	0.88
A-6	0	17436	0	2431	19866	0.46	0.17	0.13	0.17	0.56
B-1	0	118909	0	0	118909	2.73	0.05	0.03	0.08	0.50
F-1	0	159975	0	400000	559975	12.86	0.73	0.63	0.65	0.81
F-2	0	52449	0	293000	345449	7.93	0.86	0.74	0.76	0.87
OS-N	0	74479	0	0	74479	1.71	0.05	0.03	0.08	0.50
Total	0	475382	0	1174958	1650340	37.89	0.73	0.63	0.65	0.81

Revised

Project: 470 Storage
Project Number: 096648000
Date: 02/05/18

Prepared By: KBK
Checked By: RJP

PRISMOIDAL METHOD
Volume Required = V=KA Method
Prismoidal Calculation Method = $(1/3) * (ELEV1 - ELEV2) * (AREA1 + AREA2) + (SQRT(AREA1 * AREA2) * (ELEV1 + ELEV2) / 3)$

Bottom of pond shown on plan appears to be 5710?

Revised

Pond Volume Summary

Tributary Area =
Volume Required = 5.27

Top of pond embankment on east side of pond shown on plan appears to be 5716?

Pond Elevation (FT)	Incremental Area (SQ-FT)	Incremental Volume (CF)	Cumulative Volume (CF)	Cumulative Volume (AC-FT)
5711.00	21,297	0	0	0.00
5712.00	43,963	31,953	31,953	0.73
5713.00	59,355	51,467	83,419	1.92
5714.00	64,718	62,017	145,436	3.34
5715.00	70,193	67,437	212,873	4.89
5716.00	75,644	72,902	285,775	6.56
5717.00	81,147	78,379	364,154	8.36
5718.00	86,745	83,930	448,084	10.29

It is an 18, contour labels added for clarification

WQCV
EURV
100-Year Water Surface Elevation
100-Year Water Surface Elevation + 1/2 EURV

	VOLUME (AC-FT)	ELEV. (FT)
WQCV	0.82	5712.07
EURV	0.85	5712.10
100-Year Water Surface Elevation	4.85	5714.98
100-Year Water Surface Elevation + 1/2 EURV	5.27	5715.23

Revised EURV Volume and Elevation

*Note: Riser pipe is not provided based on the basin volume being retained below the outfall elevation. Pumping may be required when 50% of provided volume is filled with sediment and water.

Does this apply to this project? Facility should be gravity drained if at all possible. If pumping is proposed please contact George Slovensky in COA Public Works to set up a meeting to discuss.

This is not applicable and has been removed.

Kimley » Horn

4582 S. Ulster Street, Suite 1500
Denver, Colorado 80237

Project: 470 Storage
Project Number: 096648000
Date: 02/05/18

Prepared By: BKM
Checked By: RJP

Revise per comment on earlier page

$$Q = C_o A_o (2gH_o)^{0.5}$$

EURV Volume	0.85 AC-FT
	37026 CF

Drain Time	72 Hours
	259200 Seconds

Release Rate	0.14 cfs
Design Depth	1.9 ft

Q _{design}	0.14 cfs
---------------------	----------

C _o	0.60	
H	1.73 ft	
g	32.2 ft/s ²	
A _o	0.095 ft ²	
Q _{calc}	0.60 cfs	

Discharge coefficient for square-edge orifice
Height to Centroid (Design Depth - Radius)

Please use the standard UDFCD spreadsheet to size WQ and EURV orifices. Include this in the Final Drainage Report - please do not include this orifice sizing in this Prelim Drainage Report.

Radius	0.174 ft
Radius	2.0880 in
Diameter	4.18 in

Notes:

- 1.) This is an interactive process in which a radius size is input into the Radius (ft) cell and a release rate is calculated based on known parameters.
- 2.) Green Cells are input values.
- 3.) Blue Cells are known values.
- 4.) Yellow cells are calculated values.

Restrictor plate provided in Urban Drainage Spreadsheet

Restrictor Plate

Project Description

Solve For Opening Area

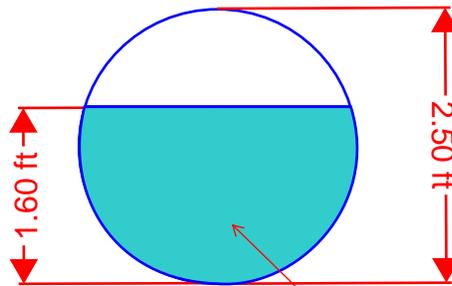
Input Data

Discharge	32.79	ft ³ /s
Headwater Elevation	5715.23	ft
Centroid Elevation	5710.95	ft
Tailwater Elevation	5710.95	ft
Discharge Coefficient	0.60	

Revise based on comments made on previous sheets of this report. include a calc which clearly shows how the discharge rate is arrived at.

Results

Opening Area	3.29	ft ²
Headwater Height Above Centroid	4.28	ft
Tailwater Height Above Centroid	0.00	ft
Velocity	9.96	ft/s



30" Pipe. Use Restrictor Plate to control the 100-year Release. Place Restrictor Plate at 1.60' above the invert of the pipe

Area = 3.29 ft²

Emergency Spillway

Project Description

Solve For Headwater Elevation

Input Data

Discharge	175.40	ft ³ /s
Crest Elevation	5716.23	ft
Tailwater Elevation	5716.00	ft
Weir Coefficient	3.37	US
Crest Length	50.00	ft

1-foot above the 100-Year + 1/2 EURV Elevation.

Results

Headwater Elevation	5717.26	ft
Headwater Height Above Crest	1.03	ft
Tailwater Height Above Crest	-0.23	ft
Equal Side Slopes	0.25	ft/ft (H:V)
Flow Area	51.65	ft ²
Velocity	3.40	ft/s
Wetted Perimeter	52.12	ft
Top Width	50.51	ft

How will flows at this elevation be confined to the emergency weir? Plan appears to show top of embankment near 5716 around a large portion of the north and east sides of the pond.

Note that UDFCD requirements are that 1 ft of freeboard minimum be provided from this elevation of flows over the emergency spillway up to the top of the embankment. City will sometimes accept less if site precludes 1 ft. Please indicate freeboard provided and justify any deviation from UDFCD.

Pond has a top elevation of 5718 elevation. Spot elevations provided

APPENDIX D – DRAINAGE MAP



