

## PRELIMINARY DRAINAGE REPORT Providence at the Heights Subdivision Filing No. 1

City of Aurora  
05/31/2018

JN: DCS17-4101

Prepared for:

### Providence at the Heights Subdivision Filing No. 1

Second Chance Center  
9722 E 16<sup>th</sup> Ave  
Aurora, CO 80010

Prepared by:

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Ted Swan, PE No. 43903  
Project Engineer

<b>Approved For One Year From This Date</b>	
<hr/>	
<hr/> <b>City Engineer</b>	<hr/> <b>Date</b>
<hr/> <b>Water Department</b>	<hr/> <b>Date</b>

# WARE MALCOMB

ARCHITECTURE | PLANNING | INTERIORS  
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## CERTIFICATION

"I hereby certify that this Preliminary Drainage Report for The Providence at the Heights Subdivision Filing No. 1 was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Aurora Storm Drainage Design and Technical Criteria for the owners thereof.

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Ted Swan, PE

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Date

State of Colorado Registration No. 43903

For and on behalf of Ware Malcomb

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The purpose of this drainage report is to present an urban water management system consisting of conveyance methods and water quality methods which will transport storm runoff in a safe manner from The Providence at the Heights Subdivision Filing No. 1 site and downstream thereafter. This report assesses onsite proposed hydrology and presents anticipated storm requirements in accordance with The City of Aurora criteria.

## A. INTRODUCTION

### 1. Location

The subject property is located in the Aurora Alliance Subdivision Filing No. 1 of Block 1, Lots 1 and 2, in The City of Aurora at the intersection of East Alameda Parkway & South Joplin Street. The site is a part of the Northwest 1/4 Section 17, Township 4 South, Range 66 West of the 6th principal meridian, City of Aurora, County of Arapahoe, State of Colorado. The property is bounded on the north by Alameda parkway, on the west by Toll Gate Creek, on the south by Block 2 of Toll Gate Village Subdivision Filing No. 11, and on the east by Block 1 of Toll Gate Terrace Subdivision Filing No. 1. The current zoning is for a Planned Community Zone District.

See Exhibit A, below for a vicinity map of the area.

*Exhibit A – Vicinity Map*



### 2. Proposed Development

The 4.48 acre property is a replat of Lot 1, Block 1 of the Aurora Alliance Subdivision Filing No. 1. It contains Lot 1 and Lot 2 of the Aurora Alliance Subdivision Filing No. 1. Lot 1 is 3.064 acres and is currently developed with Aurora Alliance Church. Lot 2 is 1.412 acres and currently contains undisturbed natural grasses and shrubs.

The proposed developments to the site include a proposed apartment building on the southern portion of the site and proposed improvements to the existing development.

Proposed grading for this site will disturb approximately 2.0 acres and will be balanced in the current layout. Proposed improvements to East Alameda Parkway will include removal and replacement of the sidewalk paralleling the south side, handicap ramp improvements, and utility work in street for both of the water connections.

The sidewalk addition will be 10 feet wide and include a 10 foot tree lawn between the walk and East Alameda Parkway. The sidewalk improvements will also require a new handicap ramp at the northwest corner of the eastern drive.

The site will also include improvements to the existing through roadway located on the east side of the property. The existing roadway will be expanded to match the City of Aurora Local Type 3 Roadway Section. Including a 12 foot through lane and an 8 foot on street parking area. The drive will only be improved on the Lot 1, Block 1, Aurora Alliance Subdivision, Filing No. 1.

The building finished floor has been set based on the existing topography of the site and ensured to be well above the Toll Gate Creek 100 year flood plain elevation. The site sits in FEMA floodplain Zone X and has been determined to be an area of minimal flood hazard.

The site has been classified by the Natural Soils Conservation Service (NRCS) as 100% Weld Loam, hydrologic group D, with 0-2% slopes within the property. Vegetation is light, with a majority of the site consisting of the church development to the north and sparse grass cover to the south.

A variance for COA detention requirement is being requested based on the fact that the site discharges directly into West Toll Gate Creek.

## **B. HISTORIC DRAINAGE**

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

This site is located within Zone X of the West Toll Gate Creek Basin. There are no offsite basins associated with this site.

The FIRM panel number is 08005C0183K. See Appendix A for the UDFCD Floodplain Map.

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

Historic drainage patterns generally flow from east to west. The site does not collect any offsite flows from any of the surrounding sites. The site to the east (Tollgate Terrace) and the site to the south (Tollgate Village #11) do not contribute any offsite flows to the property

### 3. Outfalls Downstream from Property

Runoff from the site is gathered onsite and conveyed offsite to West Toll Gate Creek.

## C. DESIGN CRITERIA

### 1. List References

Urban Storm Drainage Criteria Manual

City of Aurora Storm Drainage and Technical Criteria Manual

Web Soil Survey

Aurora Topographical map

### 2. Hydrologic Criteria

The peak discharge for the onsite basins were calculated using the following Rational Method formula:

$$Q=CIA$$

Where:

Q = peak discharge (cfs)

C = runoff coefficient from Aurora Storm Drainage Design and Criteria Manual

I = rainfall intensity (inches/hour) from USDCM

A = drainage area (acres)

See Appendix B for Rational Method Flow Calculations.

The minor and major storm frequencies for pipe and inlet design are the 2-year and 100-year storm events with P values of 0.98 in/hr and 2.58 in/hr, respectively, from UDFCD 1 hour point rainfall maps. There are two water quality grass swales proposed for the site. Grass Swale A was calculated to have a residence time of 5.0 minutes and Grass Swale B was calculated to have a residence time of 4.5 minutes. These were calculated using the UD-BMP Design Procedure Form for Grass Swales. The design of grass swales is further outlined in T-2 of the Urban Storm Drainage Criteria Manual Volume 3.

### 3. Hydraulic Criteria

#### i. References

The City of Aurora Storm Drainage Design and Technical Criteria, dated October 11, 2010, was used as a reference.

ii. Design Storm Frequencies

Calculations were performed for both the minor (2-Year) and major (100-Year) storm events.

iii. Water Surface Profile Method

Water surface profiles will be calculated using UD Sewer v1.40, developed by UDFCD.

iv. Major Drainageways

As previously mentioned, the site is adjacent to West Toll Gate Creek.

## D. DRAINAGE PLAN

### 1. General Concept

This project proposes improvements to the existing development as well as the construction of an apartment building on what is presently vacant. The proposed structure will collect rainfall via several roof drains. These flows will be piped internally and released into a grass swale on the southern portion of the site. This combination of improvements will provide the site's water quality capture volume. Rainfall flows falling on the parking lot surrounding the building will be collected by proposed inlets and routed to the grass swale. Ownership will provide all maintenance and upkeep associated with the grass swale, downspouts, and sidewalk chase drains.

The site will drain via curb and gutter as well as concrete pans to storm sewer which will outfall directly into the proposed grass swale. Furthermore, as the grass swale outfalls directly into, and is adjacent to, Toll Gate Creek; a low tail water stilling basin will be required with the grass swale outfall construction. Due to the adjacency to Toll Gate Creek a concrete cutoff wall will be required at the location of the emergency overflow weir.

### 2. Specific Details

The site has been defined with 3 sub-basins for the purposes of analyzing storm conveyance capacities and their downstream effects, as well as water quality requirements. A runoff flow summary has been included following the sub-basin descriptions.

Basin A is 0.58 acres and is associated with a portion of the existing building and a portion of the proposed parking lot. It is of rooftop, asphalt, concrete, and landscaping and has a weighted imperviousness of 77%. Runoff from the sub-basin will be diverted to an inlet and piped internally to the grass swale where it will be further treated for water quality. Flows will then be released to West Toll Gate Creek. The emergency overflow path for Basin A will overtop into Basin B.

Basin B is 0.15 acres and is associated with the proposed parking lot. It is comprised of concrete, asphalt, and landscaping and imperviousness of 87%. Runoff from the sub-basin will be diverted to an inlet and piped internally to the grass swale where it will be further treated for water quality. Flows will then be released to West Toll Gate Creek. The emergency overflow path for Basin B will overtop into West Toll Gate Creek.

Basin C is 0.14 acres and is associated with the proposed building and grass swale. It is comprised of concrete, rooftop, and landscaping, and has a weighted imperviousness of 90%. Runoff from the sub-basin will either be collected via roof drains or sheet flow to the grass swale where it will be further treated for water quality. Flows will then be released to West Toll Gate Creek.

Basin D is 0.16 acres and is associated with the proposed building and grass swale. It is comprised of concrete, rooftop, and landscaping, and has a weighted imperviousness of 90%. Runoff from the sub-basin will either be collected via roof drains or sheet flow to the grass swale where it will be further treated for water quality. Flows will then be released to West Toll Gate Creek.

Basin E is 0.47 acres and is associated with the proposed parking and landscape area to the west of the existing building. It is comprised of concrete, asphalt, rooftop, and landscaping, and has a weighted imperviousness of 41%. Runoff from the sub-basin will be collected via sheet flow where it will be diverted to an inlet and piped internally to the grass swale where it will be further treated for water quality. Flows will then be released to West Toll Gate Creek. The emergency overflow path for Basin E will overtop into Basin A.

Basin F is 0.56 acres and is associated with the proposed grass swale and landscape area to the south of the proposed building. It is comprised of concrete and landscaping, and has a weighted imperviousness of 12%. Runoff from the sub-basin will be collected via sheet flow to the grass swale where it will be further treated for water quality. Flows will then be released to West Toll Gate Creek.

Drainage patterns of minor and major storm flows will be the same.

See runoff flow summary below. Please reference hydrology section for further detail.

RUNOFF SUMMARY						
BASIN LABEL	DESIGN POINT	AREA	LOCAL (CFS)		ACCUMULATIVE (CFS)	
			Q <sub>5</sub>	Q <sub>100</sub>	Q <sub>5</sub>	Q <sub>100</sub>
A	1	0.58	1.7	3.4	1.7	3.4
B	2	0.15	0.6	1.1	2.2	4.2
	3				2.1	4.1



E	4	0.47	0.9	1.7	0.9	1.7
D	6	0.16	0.5	0.9	0.5	0.9
C	7	0.14	0.4	0.8	0.9	1.7
F		0.56	0.5	0.9	2.2	4.2

### 3. Detention / Water Quality Requirements

As previously stated the proposed site will be routed to the grass swale. The emergency overflow path for the grass swale will spill into West Toll Gate Creek at the south-west portion of the site (see Drainage Map). The grass swale will be designed in accordance with UDFCD criteria. All drainage design will be done in conformance with City of Aurora storm drainage design criteria.

### 4. Stormwater Management Design

During construction, various best management practices will be put in place to prevent sedimentation within adjacent roadways, properties, and existing storm systems in accordance with an approved Erosion and Sediment Control Plan for this development.

### 5. Maintenance

The owner, successors, and heirs are responsible for all on-site private drainage facilities. The water quality facility that serves this site is to be maintained by the owners of Providence at the Heights Subdivision Filing No. 1.

## E. CONCLUSIONS

### 1. Compliance with Standards

This drainage report has been prepared in conformance with The City of Aurora Storm Drainage Design & Technical Criteria and Urban Drainage Criteria Manuals. The proposed drainage facilities shall safely and effectively convey significant storm events to an adequate outfall.

### 2. Summary of Concept

The site is designed so that the buildings are the high point with all grading directed away. Runoff general sheet flows to swales or curb & gutter before being conveyed to proposed inlets within the site.

The design complies with previously approved drainage reports and studies, providing conveyance of all runoff to the grass swale where it gets treated and eventually released into West Toll Gate Creek.

The proposed site drainage patterns are in conformance with all approved drainage reports and studies. Adjacent and surrounding developments are not being negatively impacted by the design as shown on this report.

## F. REFERENCES

1. *Urban Storm Drainage Criteria Manual, volumes 1, 2, and 3*, Urban Drainage and Flood Control District, June 2001, with updates to November 2010.
2. *City of Aurora Storm Drainage Design and Technical Criteria Manual, Aurora, CO, September 2010.*
3. *Natural Resources Conservation Service*, Web Soil Survey, accessed online on 12 March 2018.

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## **Appendix A**

RUNOFF SUMMARY						
BASIN LABEL	DESIGN POINT	AREA	LOCAL (CFS)		ACCUMULATIVE (CFS)	
			Q <sub>5</sub>	Q <sub>100</sub>	Q <sub>5</sub>	Q <sub>100</sub>
A	1	0.58	1.7	3.4	1.7	3.4
B	2	0.15	0.6	1.1	2.2	4.2
	3				2.1	4.1
E	4	0.47	0.9	1.7	0.9	1.7
D	6	0.16	0.5	0.9	0.5	0.9
C	7	0.14	0.4	0.8	0.9	1.7
F		0.56	0.5	0.9	2.2	4.2

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PROJECT: Providence At The Heights  
JOB NO.: DCS17-4101  
CALC. BY: B. MULLER  
DATE: 5/31/2018

## Impervious Percentages - from City of Aurora Storm Drainage Design and Technical Criteria

		C-Values Based on Frequency (yrs)			
	% Imp	2	5	10	100
ASPHALT	100%	0.87	0.88	0.90	0.93
CONCRETE	96%	0.87	0.87	0.88	0.89
ROOF	90%	0.80	0.85	0.90	0.90
LANDSCAPE (2%)	5%	0.13	0.14	0.15	0.17

Corresponds to type C or D soils

## PROPOSED COMPOSITE IMPERVIOUSNESS

		Areas (ac)				Weighted Impervious and C Values				
Basin	Area (ac)	ASPHALT	CONCRETE	ROOF	LANDSCAPE (2%)	Imp.	C <sub>2</sub>	C <sub>5</sub>	C <sub>10</sub>	C <sub>100</sub>
A	0.58	0.196	0.038	0.233	0.117	77%	0.69	0.72	0.75	0.76
B	0.15	0.117	0.016		0.021	87%	0.77	0.78	0.80	0.82
C	0.14			0.142		90%	0.80	0.85	0.90	0.90
D	0.16			0.155		90%	0.80	0.85	0.90	0.90
E	0.47	0.150	0.033		0.290	41%	0.42	0.43	0.44	0.46
F	0.56		0.045		0.519	12%	0.19	0.20	0.21	0.23
T	2.07	0.46	0.13	0.53	0.95	54%	0.51	0.53	0.56	0.57

Checked By:

**STANDARD FORM SF-2**  
TIME OF CONCENTRATION SUMMARY

Project: Providence At The Heights

Job No.: DCS17-4101

[illegible]



Date: 5/31/2018

Checked By:

100-yr, 1-hour rainfall= 2.67

# STANDARD FORM SF-3

## STORM DRAINAGE SYSTEM DESIGN (RATIONAL METHOD PROCEDURE)

Project:

Job No.:

Design Storm:

[illegible]



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## **Appendix B**

# Design Procedure Form: Grass Swale (GS)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 1

Designer: **SAB**

Company: **Ware Malcomb**

Date: **May 31, 2018**

Project: **Providence at the Heights (SWALE A)**

Location: **Aurora**

1. Design Discharge for 2-Year Return Period	$Q_2 = 1.50$ cfs
2. Hydraulic Residence Time A) : Length of Grass Swale B) Calculated Residence Time (based on design velocity below)	$L_S = 140.0$ ft $T_{HR} = 5.0$ minutes
3. Longitudinal Slope (vertical distance per unit horizontal) A) Available Slope (based on site constraints) B) Design Slope	$S_{avail} = 0.005$ ft / ft $S_D = 0.005$ ft / ft
4. Swale Geometry A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical) B) Bottom Width of Swale (enter 0 for triangular section)	$Z = 4.00$ ft / ft $W_B = 0.00$ ft
5. Vegetation A) Type of Planting (seed vs. sod, affects vegetal retardance factor)	Choose One <input type="radio"/> Grass From Seed <input checked="" type="radio"/> Grass From Sod
6. Design Velocity (0.467 ft / s maximum for desirable 5-minute residence time)	$V_2 = 0.46$ ft / s
7. Design Flow Depth (1 foot maximum) A) Flow Area B) Top Width of Swale C) Froude Number (0.50 maximum) D) Hydraulic Radius E) Velocity-Hydraulic Radius Product for Vegetal Retardance F) Manning's n (based on SCS vegetal retardance curve D for sodded grass) G) Cumulative Height of Grade Control Structures Required	$D_2 = 0.90$ ft $A_2 = 3.2$ sq ft $W_T = 7.2$ ft $F = 0.12$ $R_H = 0.44$ $VR = 0.20$ $n = 0.132$ $H_D = 0.00$ ft
8. Underdrain (Is an underdrain necessary?)	Choose One <input checked="" type="radio"/> YES <input type="radio"/> NO <b>AN UNDERDRAIN IS REQUIRED IF THE DESIGN SLOPE &lt; 2.0%</b>
9. Soil Preparation (Describe soil amendment)	
10. Irrigation	Choose One <input type="radio"/> Temporary <input type="radio"/> Permanent

Notes:

# Design Procedure Form: Grass Swale (GS)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 1

Designer: **SAB**

Company: **Ware Malcomb**

Date: **May 31, 2018**

Project: **Providence at the Heights (SWALE B)**

Location: **Aurora**

1. Design Discharge for 2-Year Return Period	$Q_2 = 1.50$ cfs
2. Hydraulic Residence Time A) : Length of Grass Swale B) Calculated Residence Time (based on design velocity below)	$L_S = 100.0$ ft $T_{HR} = 4.5$ minutes
3. Longitudinal Slope (vertical distance per unit horizontal) A) Available Slope (based on site constraints) B) Design Slope	$S_{avail} = 0.005$ ft / ft $S_D = 0.005$ ft / ft
4. Swale Geometry A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical) B) Bottom Width of Swale (enter 0 for triangular section)	$Z = 6.00$ ft / ft $W_B = 0.00$ ft
5. Vegetation A) Type of Planting (seed vs. sod, affects vegetal retardance factor)	Choose One <input type="radio"/> Grass From Seed <input checked="" type="radio"/> Grass From Sod
6. Design Velocity (0.333 ft / s maximum for desirable 5-minute residence time)	$V_2 = 0.37$ ft / s
7. Design Flow Depth (1 foot maximum) A) Flow Area B) Top Width of Swale C) Froude Number (0.50 maximum) D) Hydraulic Radius E) Velocity-Hydraulic Radius Product for Vegetal Retardance F) Manning's n (based on SCS vegetal retardance curve D for sodded grass) G) Cumulative Height of Grade Control Structures Required	$D_2 = 0.82$ ft $A_2 = 4.0$ sq ft $W_T = 9.8$ ft $F = 0.10$ $R_H = 0.40$ $VR = 0.15$ $n = 0.154$ $H_D = 0.00$ ft
8. Underdrain (Is an underdrain necessary?)	Choose One <input checked="" type="radio"/> YES <input type="radio"/> NO <b>AN UNDERDRAIN IS REQUIRED IF THE DESIGN SLOPE &lt; 2.0%</b>
9. Soil Preparation (Describe soil amendment)	
10. Irrigation	Choose One <input type="radio"/> Temporary <input type="radio"/> Permanent

Notes:

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## **Appendix C**



United States  
Department of  
Agriculture

NRCS

Natural  
Resources  
Conservation  
Service

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

# Custom Soil Resource Report for Arapahoe County, Colorado

DCS17-4101



March 12, 2018

# Preface

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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](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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# How Soil Surveys Are Made

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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.

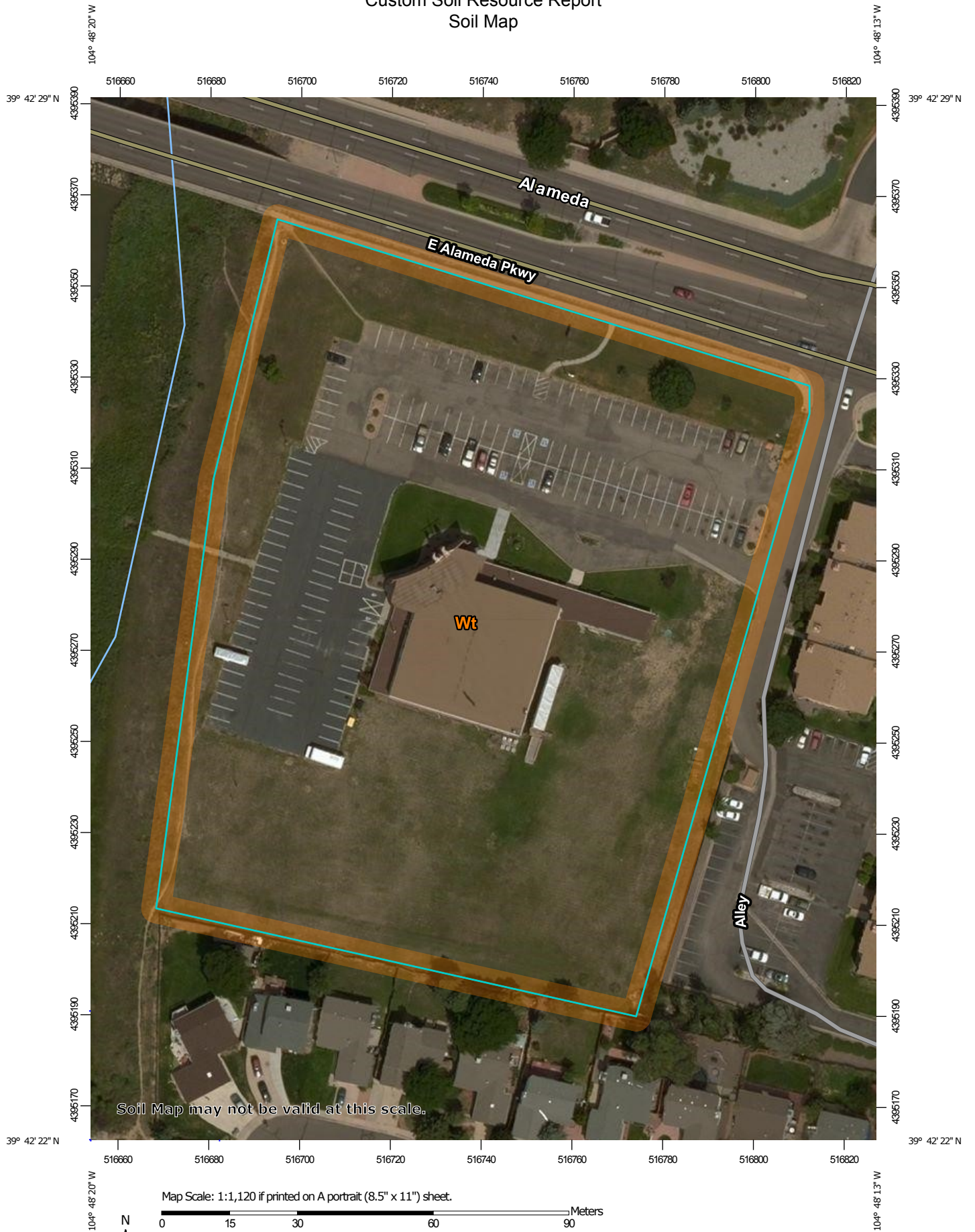
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

# Soil Map

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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 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: Arapahoe County, Colorado  
Survey Area Data: Version 13, Oct 10, 2017

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

Date(s) aerial images were photographed: Jun 10, 2014—Aug 21, 2014

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

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Wt	Wet alluvial land	4.4	100.0%
<b>Totals for Area of Interest</b>		<b>4.4</b>	<b>100.0%</b>

## Map Unit Descriptions

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

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

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

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

## Custom Soil Resource Report

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.

## Arapahoe County, Colorado

### Wt—Wet alluvial land

#### Map Unit Setting

*National map unit symbol:* 34zw  
*Elevation:* 3,500 to 4,500 feet  
*Mean annual precipitation:* 13 to 17 inches  
*Mean annual air temperature:* 46 to 55 degrees F  
*Frost-free period:* 110 to 165 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Wet alluvial land:* 75 percent  
*Minor components:* 25 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Wet Alluvial Land

#### Setting

*Landform:* Flood plains, streams  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Sandy alluvium and/or loamy alluvium

#### Typical profile

*H1 - 0 to 60 inches:* variable

#### Properties and qualities

*Slope:* 0 to 2 percent  
*Natural drainage class:* Poorly drained  
*Runoff class:* Very high  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 6.00 in/hr)  
*Depth to water table:* About 0 to 24 inches  
*Frequency of flooding:* Occasional

#### Interpretive groups

*Land capability classification (irrigated):* 6w  
*Land capability classification (nonirrigated):* 6w  
*Hydrologic Soil Group:* D  
*Ecological site:* Wet Meadow (R067BY038CO)  
*Hydric soil rating:* Yes

### Minor Components

#### Edgewater

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

#### Heldt

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

#### Loamy alluvial land

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



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# National Flood Hazard Layer FIRMette



FEMA

## Legend

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

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth
		Regulatory Floodway Zone AE, AO, AH, VE, AR
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **5/4/2018 at 9:51:57 AM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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



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## **Appendix D**