



**PRELIMINARY DRAINAGE REPORT  
FOR  
SUMMERFIELD SOUTH**

Keenesburg, Colorado

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**Appendix A – Hydrologic Calculations and Site Maps**

**Appendix B – Hydraulic Computations**

**Appendix C – Existing and Developed Drainage Maps**

## **I. Introduction and Description**

The purpose of this preliminary drainage report is to present drainage design concepts for the proposed Summerfield South development.

The proposed Summerfield South development is located in Keenesburg. It is located south of the principal population center of Keenesburg, bounded on the east by Weld County Road 59. A site location map is contained in Appendix A. The development occupies a portion of the northeast corner of section 35 in township 2 north, range 54 west of the 6<sup>th</sup> principal meridian in Keenesburg and Weld County, Colorado.

The area proposed for development covers approximately 147.3 acres. A total of 503 single family lots are proposed to be developed over the site. The site is currently being used for agricultural purposes. Approximately 63% of the site is covered by NRCS hydrologic soil group B soils, with the remainder being group C/D soils.

## **II. Historic Drainage System**

### **A. Major Basin Description**

The development is located just south of the Lost Creek drainage. Lost Creek is a FEMA Zone A 100-year floodplain. Refer to FEMA FIRM Map No. 08123C2157E (Reference 5) with an effective date of January 20, 2016 (see Appendix A). Development will take place outside of the floodplain. Runoff generally discharges northeast across the existing site before entering Lost Creek.

### **B. Site Sub-Basin Description**

Onsite drainage basins have been delineated as shown in Appendix C. Approximately 63.6 acres of offsite drainage area discharge onto the site through the southern boundary.

## **III. Proposed Drainage System**

### **A. Hydrology Criteria**

In accordance with Mile High Flood District (MHFD) criteria, the 5-year storm is the initial storm and the 100-year storm is the major storm for design purposes. One hour rainfalls of 1.14-in (5-year) and 2.65-in (100-yr) have been selected using NOAA Atlas 14 point precipitation frequency estimates.

Site imperviousness values were calculated in accordance with the latest MHFD guidance.

The rational method will be used size inlets and storm sewer in subsequent design phases. The MHFD-Detention workbook uses the Colorado Urban Hydrograph Procedure (CUHP) to calculate volumes and flowrates.



## **B. Hydraulic Criteria**

MHFD full-spectrum detention criteria was used to size the detention pond for the site. The MHFD-Detention workbook was used to perform detention calculations.

Street capacity will be analyzed in subsequent phases of design. No curb overtopping will be allowed during the initial (5-year) storm, and a maximum flowline depth of 12-inches will be allowed during major (100-year) storm. The latest MHFD-Inlet workbook will be used to evaluate street and inlet capacity.

Storm sewer capacity will be evaluated using StormCAD software in subsequent design phases. The 100-year hydraulic grade line will be kept below the surface.

The open channel system along the southern and eastern border of the site will be evaluated in subsequent phases with Flowmaster software using Manning's equation. One foot of freeboard will be provided between the 100-yr water surface and the lots.

## **C. Variances from Criteria**

No variances are currently requested.

## **D. Runoff**

Rational method calculations will be performed in subsequent design phases. Overall site runoff for existing and developed conditions is contained in the MHFD-Detention workbook. Maps showing existing and developed basins are contained in Appendix C. Basin areas and approximate imperviousness are shown on the maps, which will be used to calculate runoff rates in subsequent design phases.

Streets and storm sewer will be the primary runoff conveyance mechanisms throughout the development. A swale system is proposed along the southern and eastern edges of the development. The swale will convey offsite runoff from the south around the development. The swale will end at an outfall into Lost Creek.

## **E. Detention**

A detention pond for the site is proposed at the northeast corner of the site. Details of the detention pond are contained in the MHFD-Detention workbook in Appendix B. The pond is a full-spectrum extended detention basin with a preliminary 100-yr volume of 14.0 ac-ft. Some overdetention may be added to this pending final analysis (see the paragraph below). The peak 100-year inflow flowrate to the pond is 288 cfs while the peak 100-year discharge rate is 115 cfs. The pond accepts runoff from Basin 2 as delineated in the developed plansheet in Appendix C. Basin 2 covers approximately 104.5 acres with an imperviousness of 58.2%.

Basin 1, and possibly Basins 2A, 3, 4 and 5 contain some small amounts undetained impervious areas that bypass detention in Basin 2. To compensate for this, the pond will contain compensatory detention as needed. Water quality features such as water quality ponds, porous landscape detention, grass buffers and

grass swales will also be implemented in basins where detention is bypassed. Compensatory detention analysis will take place during final design and will take into account runoff reduction from water quality features.

#### **IV. Conclusions**

##### **A. Compliance with Applicable Code**

Drainage detention and conveyance infrastructure is designed in accordance with Town of Keenesburg requirements and the latest version of the Mile High Flood District's Urban Storm Drainage Criteria Manual.

##### **B. Flood Hazard**

The proposed development will take place outside of the limits of the 100-yr floodplain of Lost Creek to the north of the site.

##### **C. Impact of the Improvements**

The proposed street and drainage improvements will safely convey storm drainage through the development into the detention pond. The detention pond will improve water quality and reduce peak flowrates before discharging into Lost Creek.

##### **D. Maintenance of the Improvements**

Maintenance of the detention pond will be the responsibility of the Homeowners' Association initially and may be transferred to a metropolitan district once a district is established.

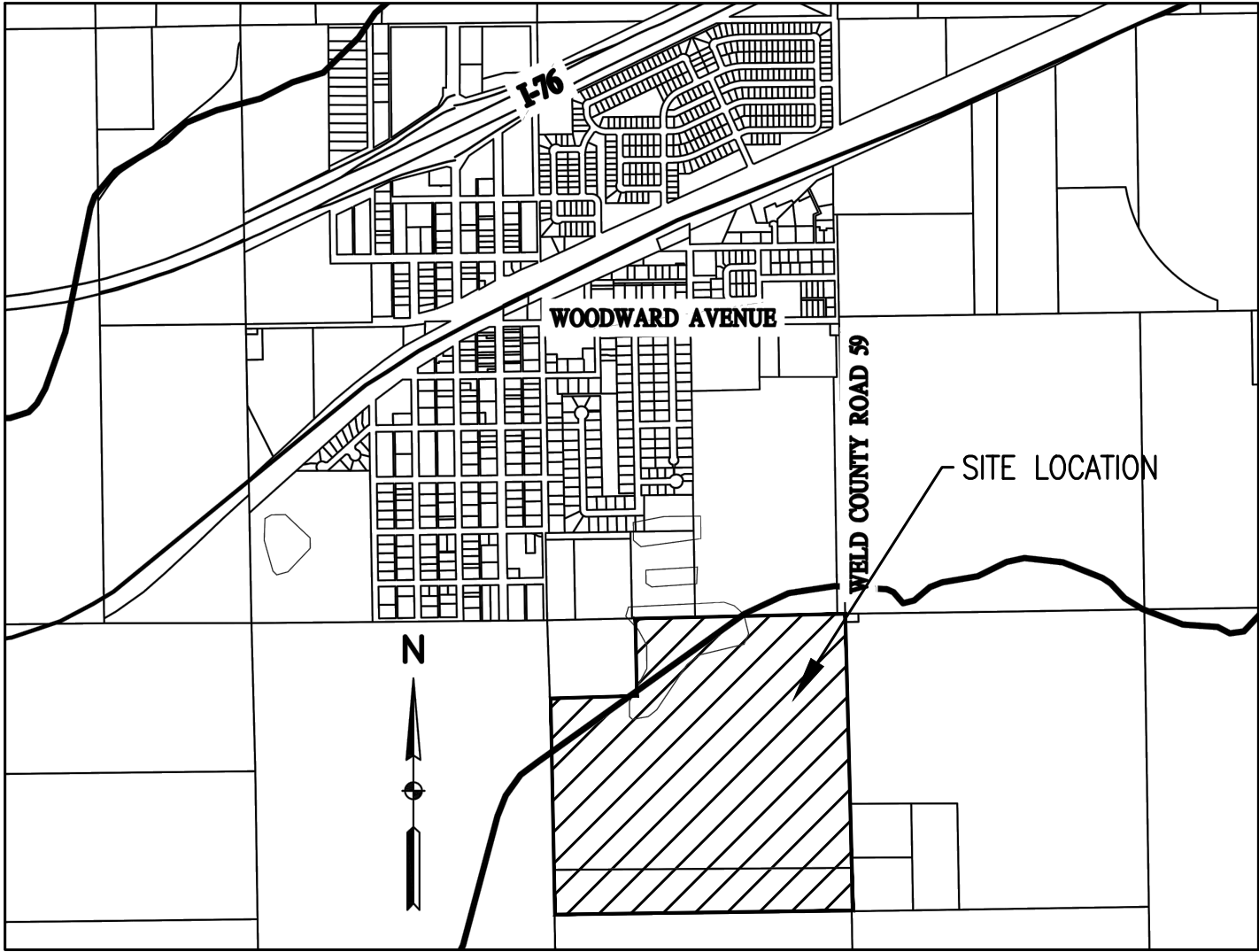
## **V. References**

1. Urban Storm Drainage Criteria Manual, Volumes 1-3, accessed online at [www.mhfd.org](http://www.mhfd.org).
2. Federal Emergency Management Agency Flood Insurance Rate Map, Community Panel Number 08123C2157E revised January 20, 2016.
3. National Oceanic and Atmospheric Administration, Atlas 14, accessed online.
4. Natural Resources Conservation Service Web Soil Survey, accessed online.

## **VI. Appendix**

## **SUMMERFIELD SOUTH**

### **APPENDIX A**



VICINITY MAP  
(N.T.S.)

# Custom Soil Resource Report Soil Map



# Custom Soil Resource Report


## 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 1:24,000.

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: Weld County, Colorado, Southern Part  
Survey Area Data: Version 20, Aug 31, 2021

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

Date(s) aerial images were photographed: Jul 19, 2018—Aug 10, 2018

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
15	Colby loam, 1 to 3 percent slopes	236.5	32.9%
16	Colby loam, 3 to 5 percent slopes	97.3	13.5%
17	Colby loam, 5 to 9 percent slopes	82.7	11.5%
18	Colby-Adena loams, 3 to 9 percent slopes	114.1	15.9%
26	Haverson loam, 1 to 3 percent slopes	19.2	2.7%
60	Shingle-Renohill complex, 3 to 9 percent slopes	90.4	12.6%
79	Weld loam, 1 to 3 percent slopes	74.3	10.3%
85	Water	5.2	0.7%
<b>Totals for Area of Interest</b>		<b>719.8</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

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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.

## Weld County, Colorado, Southern Part

### 15—Colby loam, 1 to 3 percent slopes

#### Map Unit Setting

*National map unit symbol:* 361q  
*Elevation:* 4,850 to 5,050 feet  
*Mean annual precipitation:* 12 to 16 inches  
*Mean annual air temperature:* 48 to 50 degrees F  
*Frost-free period:* 135 to 155 days  
*Farmland classification:* Prime farmland if irrigated

#### Map Unit Composition

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

#### Description of Colby

##### Setting

*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Calcareous eolian deposits

##### Typical profile

*H1 - 0 to 7 inches:* loam  
*H2 - 7 to 60 inches:* silt loam

##### Properties and qualities

*Slope:* 1 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*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 content:* 15 percent  
*Available water supply, 0 to 60 inches:* High (about 10.6 inches)

##### Interpretive groups

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

#### Minor Components

##### Wiley

*Percent of map unit:* 9 percent  
*Hydric soil rating:* No

##### Keith

*Percent of map unit:* 6 percent

*Hydric soil rating:* No

## **16—Colby loam, 3 to 5 percent slopes**

### **Map Unit Setting**

*National map unit symbol:* 361r

*Elevation:* 4,850 to 5,050 feet

*Mean annual precipitation:* 12 to 16 inches

*Mean annual air temperature:* 48 to 50 degrees F

*Frost-free period:* 135 to 155 days

*Farmland classification:* Farmland of statewide importance

### **Map Unit Composition**

*Colby and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### **Description of Colby**

#### **Setting**

*Landform:* Ridges, hills

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Calcareous eolian deposits

#### **Typical profile**

*H1 - 0 to 7 inches:* loam

*H2 - 7 to 60 inches:* silt loam

#### **Properties and qualities**

*Slope:* 3 to 5 percent

*Depth to restrictive feature:* More than 80 inches

*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 content:* 15 percent

*Available water supply, 0 to 60 inches:* High (about 10.6 inches)

#### **Interpretive groups**

*Land capability classification (irrigated):* 3e

*Land capability classification (nonirrigated):* 4e

*Hydrologic Soil Group:* B

*Ecological site:* R067BY002CO - Loamy Plains

*Hydric soil rating:* No

## Minor Components

### Wiley

*Percent of map unit:* 8 percent

*Hydric soil rating:* No

### Keith

*Percent of map unit:* 7 percent

*Hydric soil rating:* No

## 17—Colby loam, 5 to 9 percent slopes

### Map Unit Setting

*National map unit symbol:* 361s

*Elevation:* 4,850 to 5,050 feet

*Mean annual precipitation:* 12 to 16 inches

*Mean annual air temperature:* 48 to 50 degrees F

*Frost-free period:* 135 to 155 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Colby and similar soils:* 90 percent

*Minor components:* 10 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Colby

#### Setting

*Landform:* Ridges, hills

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Calcareous eolian deposits

#### Typical profile

*H1 - 0 to 7 inches:* loam

*H2 - 7 to 60 inches:* silt loam

#### Properties and qualities

*Slope:* 5 to 9 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high 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 content:* 15 percent

*Available water supply, 0 to 60 inches:* High (about 10.6 inches)

**Interpretive groups**

*Land capability classification (irrigated): 6e*  
*Land capability classification (nonirrigated): 6e*  
*Hydrologic Soil Group: B*  
*Ecological site: R067BY008CO - Loamy Slopes*  
*Hydric soil rating: No*

**Minor Components**

**Wiley**

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

**18—Colby-Adena loams, 3 to 9 percent slopes**

**Map Unit Setting**

*National map unit symbol: 361t*  
*Elevation: 4,750 to 4,900 feet*  
*Mean annual precipitation: 12 to 16 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**

*Colby and similar soils: 55 percent*  
*Adena and similar soils: 30 percent*  
*Minor components: 15 percent*  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Colby**

**Setting**

*Landform: Ridges, hills, plains*  
*Down-slope shape: Linear*  
*Across-slope shape: Linear*  
*Parent material: Calcareous eolian deposits*

**Typical profile**

*H1 - 0 to 7 inches: loam*  
*H2 - 7 to 60 inches: silt loam*

**Properties and qualities**

*Slope: 5 to 9 percent*  
*Depth to restrictive feature: More than 80 inches*  
*Drainage class: Well drained*  
*Runoff class: Medium*  
*Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high*  
*(0.57 to 2.00 in/hr)*  
*Depth to water table: More than 80 inches*  
*Frequency of flooding: None*

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*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Available water supply, 0 to 60 inches:* High (about 10.6 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* B  
*Ecological site:* R067BY008CO - Loamy Slopes  
*Hydric soil rating:* No

### Description of Adena

#### Setting

*Landform:* Hills, plains, ridges  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Calcareous eolian deposits

#### Typical profile

*H1 - 0 to 6 inches:* loam  
*H2 - 6 to 9 inches:* clay loam  
*H3 - 9 to 60 inches:* silt loam

#### Properties and qualities

*Slope:* 3 to 7 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Available water supply, 0 to 60 inches:* High (about 10.1 inches)

### Interpretive groups

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

### Minor Components

#### Kim

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

#### Keith

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

#### Weld

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

**Wiley**

*Percent of map unit:* 3 percent

*Hydric soil rating:* No

**26—Haverson loam, 1 to 3 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 2tlq0

*Elevation:* 4,140 to 5,080 feet

*Mean annual precipitation:* 13 to 17 inches

*Mean annual air temperature:* 50 to 54 degrees F

*Frost-free period:* 135 to 160 days

*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Haverson, rarely flooded, and similar soils:* 90 percent

*Minor components:* 10 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Haverson, Rarely Flooded**

**Setting**

*Landform:* Terraces, flood plains

*Landform position (three-dimensional):* Tread

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Stratified alluvium derived from mixed sources

**Typical profile**

*Ap - 0 to 4 inches:* loam

*A - 4 to 11 inches:* loam

*C1 - 11 to 19 inches:* loam

*C2 - 19 to 80 inches:* stratified sandy loam to loam

**Properties and qualities**

*Slope:* 1 to 3 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Low

*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:* More than 80 inches

*Frequency of flooding:* Rare

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 5 percent

*Maximum salinity:* Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)

*Sodium adsorption ratio, maximum:* 1.0

*Available water supply, 0 to 60 inches:* Moderate (about 7.6 inches)



**Interpretive groups**

*Land capability classification (irrigated): 3e*  
*Land capability classification (nonirrigated): 4c*  
*Hydrologic Soil Group: B*  
*Ecological site: R067BY036CO - Overflow*  
*Hydric soil rating: No*

**Minor Components**

**Bijou**

*Percent of map unit: 10 percent*  
*Landform: Stream terraces*  
*Landform position (three-dimensional): Tread*  
*Down-slope shape: Linear*  
*Across-slope shape: Linear*  
*Ecological site: R067BY024CO - Sandy Plains*  
*Hydric soil rating: No*

**60—Shingle-Renohill complex, 3 to 9 percent slopes**

**Map Unit Setting**

*National map unit symbol: 363b*  
*Elevation: 4,600 to 4,750 feet*  
*Mean annual precipitation: 10 to 16 inches*  
*Mean annual air temperature: 46 to 48 degrees F*  
*Frost-free period: 100 to 160 days*  
*Farmland classification: Not prime farmland*

**Map Unit Composition**

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

**Description of Shingle**

**Setting**

*Landform: Ridges, hills, plains*  
*Down-slope shape: Linear*  
*Across-slope shape: Linear*  
*Parent material: Residuum weathered from calcareous shale*

**Typical profile**

*H1 - 0 to 6 inches: loam*  
*H2 - 6 to 18 inches: clay loam*  
*H3 - 18 to 22 inches: unweathered bedrock*

**Properties and qualities**

*Slope: 3 to 9 percent*  
*Depth to restrictive feature: 10 to 20 inches to paralithic bedrock*

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*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 content:* 15 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water supply, 0 to 60 inches:* Low (about 3.3 inches)

### Interpretive groups

*Land capability classification (irrigated):* 6s  
*Land capability classification (nonirrigated):* 6s  
*Hydrologic Soil Group:* D  
*Ecological site:* R067BY045CO - Shaly Plains  
*Hydric soil rating:* No

### Description of Renohill

#### Setting

*Landform:* Hills, plains, ridges  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Residuum weathered from shale

#### Typical profile

*H1 - 0 to 9 inches:* clay loam  
*H2 - 9 to 32 inches:* clay loam  
*H3 - 32 to 36 inches:* unweathered bedrock

#### Properties and qualities

*Slope:* 3 to 9 percent  
*Depth to restrictive feature:* 20 to 40 inches to paralithic bedrock  
*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 content:* 5 percent  
*Available water supply, 0 to 60 inches:* Low (about 5.6 inches)

### Interpretive groups

*Land capability classification (irrigated):* 4e  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* D  
*Ecological site:* R067BY042CO - Clayey Plains  
*Hydric soil rating:* No

### Minor Components

#### Terry

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

**Rock outcrop**

*Percent of map unit:* 3 percent

*Hydric soil rating:* No

**Ulm**

*Percent of map unit:* 2 percent

*Hydric soil rating:* No

**Stoneham**

*Percent of map unit:* 2 percent

*Hydric soil rating:* No

**79—Weld loam, 1 to 3 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 2x0hw

*Elevation:* 3,600 to 5,750 feet

*Mean annual precipitation:* 12 to 17 inches

*Mean annual air temperature:* 46 to 54 degrees F

*Frost-free period:* 115 to 155 days

*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Weld and similar soils:* 80 percent

*Minor components:* 20 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Weld**

**Setting**

*Landform:* Interfluves

*Landform position (two-dimensional):* Summit

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Calcareous loess

**Typical profile**

*Ap - 0 to 8 inches:* loam

*Bt1 - 8 to 12 inches:* clay

*Bt2 - 12 to 15 inches:* clay loam

*Btk - 15 to 28 inches:* loam

*Bk - 28 to 60 inches:* silt loam

*C - 60 to 80 inches:* silt loam

**Properties and qualities**

*Slope:* 1 to 3 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Medium

## Custom Soil Resource Report

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 14 percent

*Maximum salinity:* Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)

*Sodium adsorption ratio, maximum:* 5.0

*Available water supply, 0 to 60 inches:* High (about 11.3 inches)

### Interpretive groups

*Land capability classification (irrigated):* 2e

*Land capability classification (nonirrigated):* 3c

*Hydrologic Soil Group:* C

*Ecological site:* R067BY002CO - Loamy Plains

*Hydric soil rating:* No

### Minor Components

#### Adena

*Percent of map unit:* 8 percent

*Landform:* Interfluves

*Landform position (two-dimensional):* Shoulder

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Ecological site:* R067BY002CO - Loamy Plains

*Hydric soil rating:* No

#### Colby

*Percent of map unit:* 7 percent

*Landform:* Hillslopes

*Landform position (two-dimensional):* Backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Ecological site:* R067BY002CO - Loamy Plains

*Hydric soil rating:* No

#### Keith

*Percent of map unit:* 3 percent

*Landform:* Interfluves

*Landform position (two-dimensional):* Summit

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Ecological site:* R067BY002CO - Loamy Plains

*Hydric soil rating:* No

#### Baca

*Percent of map unit:* 2 percent

*Landform:* Interfluves

*Landform position (two-dimensional):* Summit, shoulder

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Convex, linear

*Across-slope shape:* Convex, linear

*Ecological site:* R067BY002CO - Loamy Plains

*Hydric soil rating:* No

## **85—Water**

### **Map Unit Composition**

*Water:* 95 percent

*Minor components:* 5 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### **Minor Components**

#### **Aquolls**

*Percent of map unit:* 5 percent

*Landform:* Marshes

*Hydric soil rating:* Yes

## 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 to 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 NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM areas 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, NNGS12  
National Geodetic Survey  
SSMC-3, #9202  
1315 East-West Highway  
Silver Spring, Maryland 20910-3282  
(301) 713-3242

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 derived from NAIP Orthophotography produced with a one meter ground resolution from photography dated 2013.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

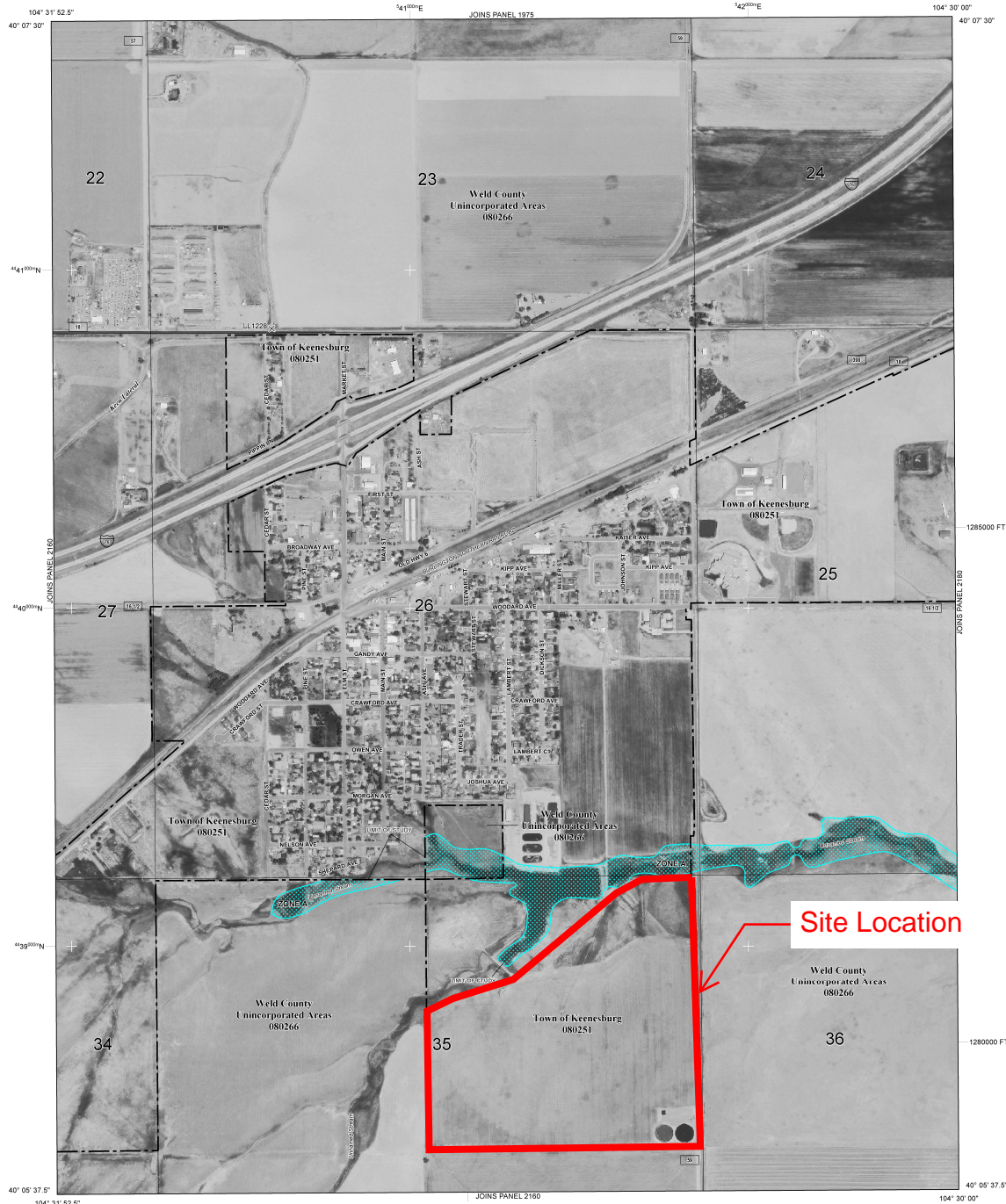
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables for multiple streams 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.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** 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 MSC website.

If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information exchange (FMIX)** at 1-877-FEMA-MAP (1-877-336-6267) or visit the FEMA website at <http://www.fema.gov/business/fip>.



## LEGEND

**SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**  
The 1% annual chance flood (50-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 area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone 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; cross sections shown for flooding; velocities also determined.
- ZONE AR** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently destroyed. Zone AR indicates that the former flood control system is being retained to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Areas to be protected from the 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 the 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)**

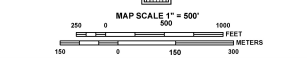
- CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.
- 1% Annual Chance Floodplain Boundary
- 0.2% Annual Chance Floodplain Boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas and boundary bounding Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
- Base Flood Elevation line and value, elevation in feet\*
- (BL 987)
- Base Flood Elevation value where uniform within zone; elevation in feet\*

\*Referenced to the North American Vertical Datum of 1988

- (A) --- (A)** Cross section line
- Truncated line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 3100000 FT
- 5000-foot ticks: Colorado State Plane Central Zone (FIPS Zone 5002), Lambert Conformal Conic projection
- 1000-meter Universal Transverse Mercator grid values, zone 13
- 89°00'N
- DX5510 X
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- Base file
- MAP REPOSITORIES
- Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
- January 25, 2016
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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 1-800-438-6620.



**NFIP**

PANEL 2157E

**FIRM**

**FLOOD INSURANCE RATE MAP**

**WELD COUNTY, COLORADO AND INCORPORATED AREAS**

PANEL 2167 OF 2260  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
KEENEWORTH TOWN OF	080251	2157	E
WELD COUNTY	080266	2167	E

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**  
**08123C2157E**

**EFFECTIVE DATE**  
**JANUARY 20, 2016**

Federal Emergency Management Agency

NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 2 NORTH AND RANGE 64 WEST.



**NOAA Atlas 14, Volume 8, Version 2**  
**Location name: Keenesburg, Colorado, USA\***  
**Latitude: 40.0992°, Longitude: -104.512°**  
**Elevation: 4922.39 ft\*\***  
\* source: ESRI Maps  
\*\* source: USGS



### POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

[PF\\_tabular](#) | [PF\\_graphical](#) | [Maps\\_&\\_aerials](#)

### PF tabular

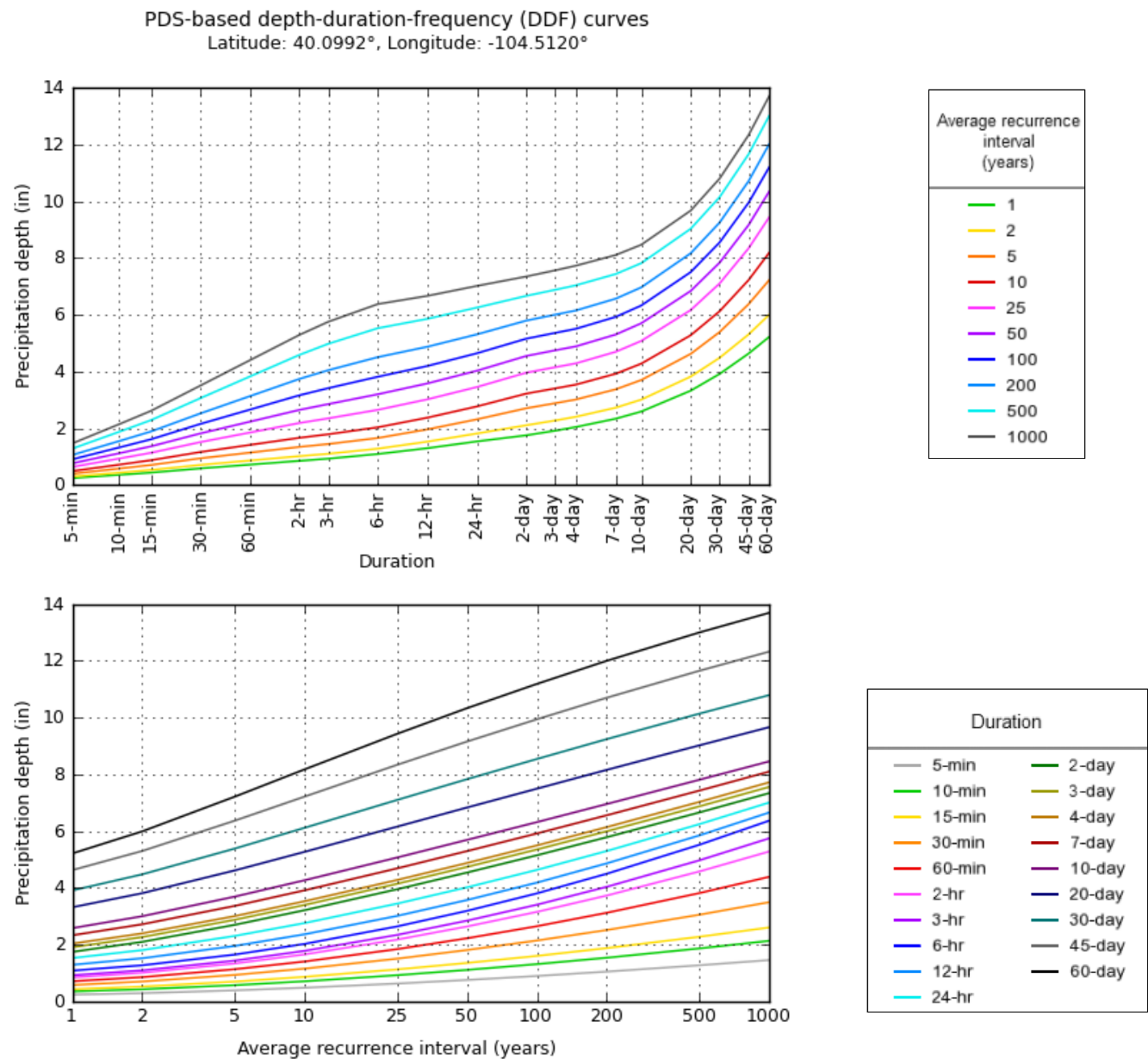
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) <sup>1</sup>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.243 (0.194-0.306)	0.296 (0.236-0.373)	0.394 (0.313-0.498)	0.488 (0.385-0.619)	0.634 (0.492-0.854)	0.761 (0.572-1.03)	0.901 (0.652-1.25)	1.06 (0.730-1.50)	1.28 (0.848-1.86)	1.46 (0.937-2.13)
10-min	0.356 (0.285-0.449)	0.433 (0.345-0.546)	0.577 (0.459-0.729)	0.714 (0.564-0.906)	0.929 (0.720-1.25)	1.12 (0.838-1.51)	1.32 (0.954-1.83)	1.54 (1.07-2.19)	1.87 (1.24-2.72)	2.14 (1.37-3.12)
15-min	0.434 (0.347-0.547)	0.528 (0.421-0.666)	0.703 (0.559-0.889)	0.871 (0.688-1.11)	1.13 (0.878-1.53)	1.36 (1.02-1.84)	1.61 (1.16-2.23)	1.88 (1.30-2.67)	2.28 (1.51-3.32)	2.61 (1.67-3.81)
30-min	0.583 (0.466-0.734)	0.706 (0.563-0.890)	0.938 (0.746-1.19)	1.16 (0.917-1.47)	1.51 (1.17-2.04)	1.82 (1.36-2.46)	2.15 (1.56-2.98)	2.52 (1.75-3.58)	3.06 (2.03-4.45)	3.50 (2.25-5.11)
60-min	0.716 (0.572-0.902)	0.860 (0.686-1.08)	1.14 (0.905-1.44)	1.41 (1.12-1.79)	1.85 (1.44-2.50)	2.23 (1.68-3.03)	2.65 (1.92-3.69)	3.13 (2.17-4.45)	3.82 (2.54-5.57)	4.39 (2.82-6.41)
2-hr	0.849 (0.684-1.06)	1.01 (0.815-1.27)	1.34 (1.07-1.68)	1.66 (1.32-2.09)	2.18 (1.71-2.93)	2.64 (2.01-3.57)	3.16 (2.31-4.35)	3.74 (2.61-5.27)	4.58 (3.07-6.62)	5.29 (3.42-7.63)
3-hr	0.926 (0.748-1.15)	1.10 (0.886-1.37)	1.44 (1.16-1.80)	1.79 (1.43-2.24)	2.35 (1.86-3.14)	2.85 (2.18-3.83)	3.41 (2.51-4.68)	4.04 (2.85-5.68)	4.97 (3.36-7.14)	5.75 (3.74-8.25)
6-hr	1.09 (0.887-1.34)	1.28 (1.04-1.58)	1.65 (1.34-2.04)	2.03 (1.64-2.52)	2.65 (2.11-3.50)	3.20 (2.46-4.25)	3.81 (2.83-5.17)	4.50 (3.20-6.26)	5.52 (3.76-7.85)	6.37 (4.19-9.05)
12-hr	1.30 (1.06-1.58)	1.53 (1.25-1.86)	1.96 (1.60-2.40)	2.37 (1.93-2.91)	3.02 (2.40-3.92)	3.58 (2.77-4.68)	4.19 (3.13-5.60)	4.87 (3.48-6.66)	5.85 (4.01-8.20)	6.66 (4.42-9.36)
24-hr	1.53 (1.27-1.85)	1.81 (1.50-2.19)	2.31 (1.90-2.81)	2.77 (2.26-3.37)	3.45 (2.76-4.40)	4.02 (3.13-5.18)	4.64 (3.48-6.10)	5.30 (3.81-7.15)	6.25 (4.32-8.63)	7.01 (4.70-9.75)
2-day	1.75 (1.46-2.10)	2.10 (1.75-2.52)	2.70 (2.24-3.25)	3.22 (2.66-3.88)	3.96 (3.16-4.95)	4.54 (3.55-5.75)	5.15 (3.88-6.67)	5.79 (4.18-7.68)	6.66 (4.63-9.06)	7.34 (4.97-10.1)
3-day	1.91 (1.60-2.28)	2.27 (1.90-2.71)	2.88 (2.40-3.44)	3.40 (2.82-4.09)	4.15 (3.33-5.15)	4.74 (3.72-5.96)	5.36 (4.06-6.89)	6.00 (4.36-7.91)	6.88 (4.81-9.29)	7.56 (5.14-10.3)
4-day	2.04 (1.72-2.42)	2.40 (2.02-2.85)	3.01 (2.52-3.59)	3.53 (2.94-4.23)	4.28 (3.45-5.30)	4.88 (3.84-6.11)	5.50 (4.18-7.04)	6.15 (4.49-8.07)	7.03 (4.94-9.46)	7.72 (5.28-10.5)
7-day	2.33 (1.97-2.75)	2.72 (2.30-3.21)	3.37 (2.84-3.98)	3.92 (3.28-4.65)	4.69 (3.80-5.74)	5.30 (4.20-6.57)	5.92 (4.53-7.50)	6.56 (4.82-8.52)	7.43 (5.25-9.90)	8.10 (5.58-10.9)
10-day	2.59 (2.20-3.03)	3.01 (2.55-3.53)	3.70 (3.13-4.35)	4.27 (3.59-5.05)	5.07 (4.12-6.16)	5.70 (4.53-7.01)	6.32 (4.86-7.95)	6.96 (5.13-8.97)	7.81 (5.55-10.3)	8.46 (5.86-11.4)
20-day	3.32 (2.84-3.86)	3.82 (3.26-4.44)	4.62 (3.94-5.38)	5.27 (4.47-6.17)	6.16 (5.04-7.38)	6.84 (5.47-8.30)	7.50 (5.81-9.31)	8.16 (6.07-10.4)	9.03 (6.46-11.8)	9.67 (6.76-12.8)
30-day	3.91 (3.37-4.52)	4.48 (3.85-5.18)	5.39 (4.61-6.25)	6.12 (5.21-7.12)	7.10 (5.83-8.44)	7.83 (6.30-9.44)	8.55 (6.65-10.5)	9.25 (6.91-11.7)	10.1 (7.30-13.1)	10.8 (7.59-14.2)
45-day	4.63 (4.00-5.32)	5.30 (4.58-6.10)	6.37 (5.48-7.34)	7.22 (6.18-8.35)	8.34 (6.87-9.84)	9.16 (7.40-11.0)	9.94 (7.77-12.2)	10.7 (8.04-13.4)	11.7 (8.43-15.0)	12.3 (8.72-16.1)
60-day	5.22 (4.52-5.97)	6.00 (5.19-6.87)	7.22 (6.23-8.29)	8.18 (7.02-9.43)	9.43 (7.79-11.1)	10.3 (8.37-12.3)	11.2 (8.77-13.6)	12.0 (9.04-14.9)	13.0 (9.43-16.6)	13.7 (9.73-17.9)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).  
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.  
Please refer to NOAA Atlas 14 document for more information.

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### PF graphical





NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Thu Apr 7 16:01:50 2022

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Maps & aerials

Small scale terrain



**SUMMERFIELD SOUTH**

**APPENDIX B**



## MILE HIGH FLOOD DISTRICT DETENTION BASIN DESIGN WORKBOOK

*MHFD-Detention, Version 4.05 (January 2022)*  
*Mile High Flood District*  
*Denver, Colorado*  
*[www.mhfd.org](http://www.mhfd.org)*

### **Purpose:**

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

### **Function:**

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.
2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

---

### **Content:**

**This workbook consists of the following sheets:**

**Basin** Tabulates stage-area-volume relationship estimates based on watershed parameters

**Outlet Structure** Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).

**Reference** Provides reference equations and figures.

**User Tips and Tools** Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.

**BMP Zone Images** Provides images of typical BMP zone configurations corresponding with Zone pulldown selections.

**Acknowledgements:** ***Spreadsheet Development Team:***  
**Ken MacKenzie, P.E., Holly Piza, P.E.**  
Mile High Flood District

**Derek N. Rapp, P.E.**  
Peak Stormwater Engineering, LLC

**Dr. James C.Y. Guo, Ph.D., P.E.**  
Professor, Department of Civil Engineering, University of Colorado at Denver

### **Comments?** **Revisions?**

Direct all comments regarding this spreadsheet workbook to:  
Check for revised versions of this or any other workbook at:

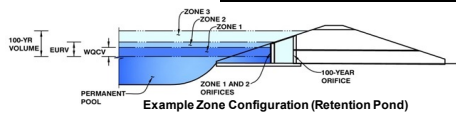
**[MHFD E-Mail](#)**  
**[Downloads](#)**

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **Summerfield**

Basin ID: **Northeast Pond Stage 0.00 = Elev 4893.00'**



Example Zone Configuration (Retention Pond)

## Watershed Information

Selected BMP Type =	<b>EDB</b>
Watershed Area =	106.60 acres
Watershed Length =	3,390 ft
Watershed Length to Centroid =	2,238 ft
Watershed Slope =	0.018 ft/ft
Watershed Imperviousness =	58.70% percent
Percentage Hydrologic Soil Group A =	0.0% percent
Percentage Hydrologic Soil Group B =	63.5% percent
Percentage Hydrologic Soil Groups C/D =	36.5% percent
Target WQCV Drain Time =	40.0 hours
Location for 1-hr Rainfall Depths =	Brighton - City Hall

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

Water Quality Capture Volume (WQCV) =	2.060 acre-feet
Excess Urban Runoff Volume (EURV) =	6.491 acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	4.148 acre-feet
5-yr Runoff Volume (P1 = 1.14 in.) =	5.984 acre-feet
10-yr Runoff Volume (P1 = 1.41 in.) =	8.146 acre-feet
25-yr Runoff Volume (P1 = 1.85 in.) =	12.482 acre-feet
50-yr Runoff Volume (P1 = 2.23 in.) =	15.945 acre-feet
100-yr Runoff Volume (P1 = 2.65 in.) =	20.137 acre-feet
500-yr Runoff Volume (P1 = 3.82 in.) =	31.246 acre-feet
Approximate 2-yr Detention Volume =	3.794 acre-feet
Approximate 5-yr Detention Volume =	5.530 acre-feet
Approximate 10-yr Detention Volume =	7.235 acre-feet
Approximate 25-yr Detention Volume =	8.962 acre-feet
Approximate 50-yr Detention Volume =	9.976 acre-feet
Approximate 100-yr Detention Volume =	11.645 acre-feet

## Optional User Overrides

	acre-feet
	acre-feet
0.86	inches
1.14	inches
1.41	inches
1.85	inches
2.23	inches
2.65	inches
3.82	inches

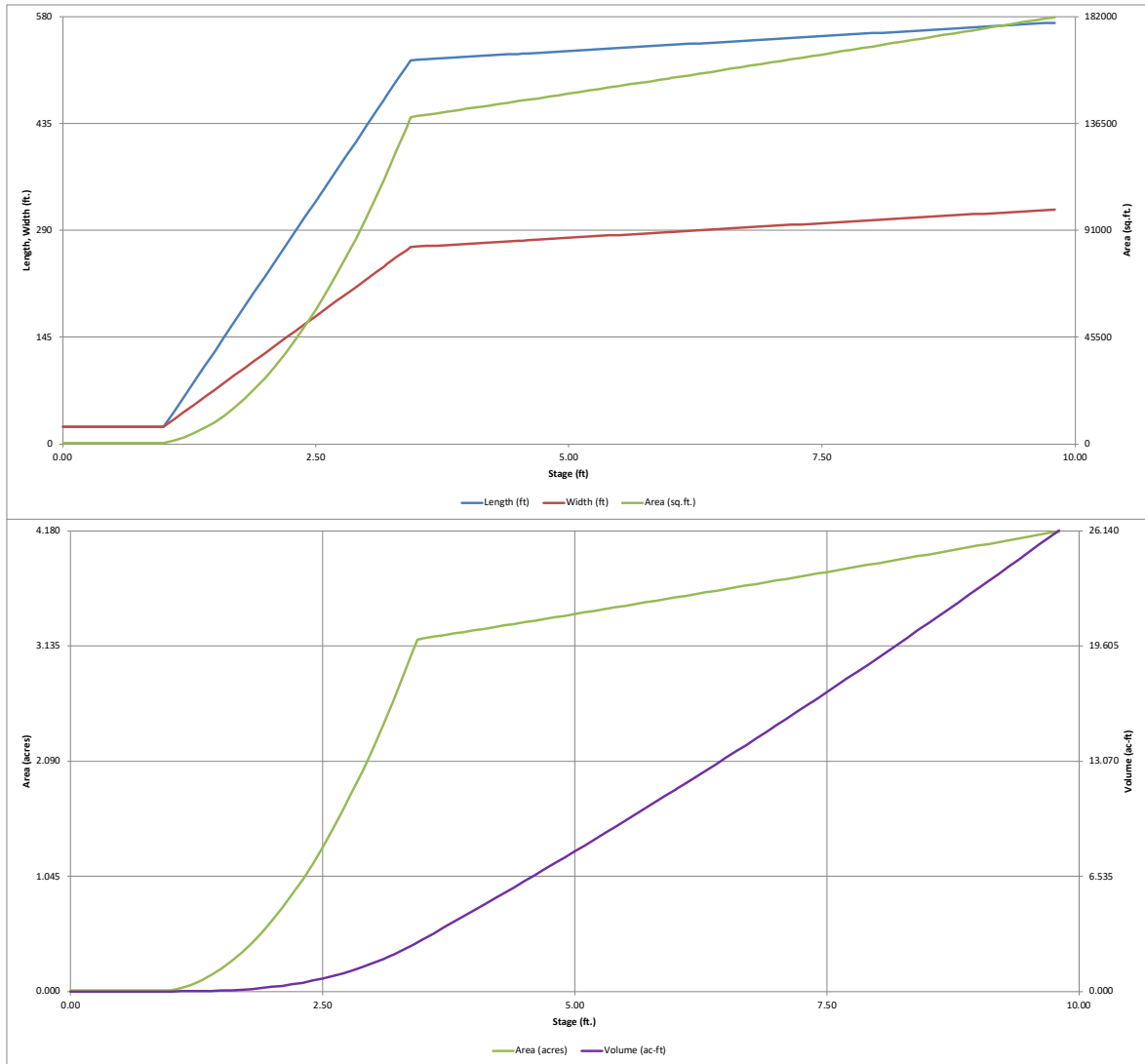
## Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	2.060 acre-feet
Zone 2 Volume (EURV - Zone 1) =	4.431 acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	5.153 acre-feet
Total Detention Basin Volume =	11.645 acre-feet
Initial Surcharge Volume (ISV) =	269 ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	0.50 ft
Total Available Detention Depth (H <sub>total</sub> ) =	6.00 ft
Depth of Trickle Channel (H <sub>tr</sub> ) =	0.50 ft
Slope of Trickle Channel (S <sub>tr</sub> ) =	0.005 ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	4 ft:H
Basin Length-to-Width Ratio (R <sub>L/W</sub> ) =	2
Initial Surcharge Area (A <sub>ISV</sub> ) =	538 ft <sup>2</sup>
Surcharge Volume Length (L <sub>ISV</sub> ) =	23.2 ft
Surcharge Volume Width (W <sub>ISV</sub> ) =	23.2 ft
Depth of Basin Floor (H <sub>floor</sub> ) =	2.44 ft
Length of Basin Floor (L <sub>floor</sub> ) =	521.0 ft
Width of Basin Floor (W <sub>floor</sub> ) =	267.2 ft
Area of Basin Floor (A <sub>floor</sub> ) =	139,203 ft <sup>2</sup>
Volume of Basin Floor (V <sub>floor</sub> ) =	120,697 ft <sup>3</sup>
Depth of Main Basin (H <sub>main</sub> ) =	2.56 ft
Length of Main Basin (L <sub>main</sub> ) =	541.4 ft
Width of Main Basin (W <sub>main</sub> ) =	287.7 ft
Area of Main Basin (A <sub>main</sub> ) =	155,764 ft <sup>2</sup>
Volume of Main Basin (V <sub>main</sub> ) =	377,359 ft <sup>3</sup>
Calculated Total Basin Volume (V <sub>total</sub> ) =	11.446 acre-feet

Depth Increment =	0.10	ft							
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft <sup>2</sup> )	Optional Override Area (ft <sup>2</sup> )	Area (acre)	Volume (ft <sup>3</sup> )	Volume (ac-ft)
Top of Micropool	0.00		23.2	23.2	538		0.012		
ISV	0.50		23.2	23.2	538		0.012	269	0.006
	0.60		23.2	23.2	538		0.012	323	0.007
	0.70		23.2	23.2	538		0.012	377	0.009
	0.80		23.2	23.2	538		0.012	431	0.010
	0.90		23.2	23.2	538		0.012	485	0.011
1.00		23.2	23.2	538		0.012	538	0.012	
1.10		43.6	33.2	1,448		0.033	634	0.015	
1.20		64.0	43.2	2,765		0.063	842	0.019	
1.30		84.4	53.2	4,490		0.103	1,201	0.028	
1.40		104.8	63.2	6,624		0.152	1,753	0.040	
1.50		125.2	73.2	9,165		0.210	2,539	0.058	
1.60		145.6	83.2	12,115		0.278	3,600	0.083	
1.70		166.0	93.2	15,472		0.355	4,976	0.114	
1.80		186.4	103.2	19,237		0.442	6,708	0.154	
1.90		206.8	113.2	23,411		0.537	8,837	0.203	
2.00		227.2	123.2	27,992		0.643	11,404	0.262	
2.10		247.6	133.2	32,981		0.757	14,449	0.332	
2.20		268.0	143.2	38,379		0.881	18,013	0.414	
2.30		288.4	153.2	44,184		1.014	22,138	0.508	
2.40		308.8	163.2	50,397		1.157	26,864	0.617	
2.50		329.2	173.2	57,019		1.309	32,231	0.740	
2.60		349.6	183.2	64,048		1.470	38,281	0.879	
2.70		370.0	193.2	71,486		1.641	45,055	1.034	
2.80		390.4	203.2	79,331		1.821	52,592	1.207	
2.90		410.8	213.2	87,584		2.011	60,934	1.399	
3.00		431.2	223.2	96,246		2.209	70,122	1.610	
3.10		451.6	233.2	105,315		2.418	80,197	1.841	
Zone 1 (WQCV)	3.18		467.9	241.2	112,864		2.591	88,922	2.041
	3.20		472.0	243.2	114,792		2.635	91,199	2.094
3.30		492.4	253.2	124,678		2.862	103,169	2.368	
3.40		512.8	263.2	134,971		3.099	116,148	2.666	
Floor	3.44		521.0	267.2	139,203		3.196	121,631	2.792
	3.50		521.4	267.7	139,581		3.204	129,995	2.984
	3.60		522.2	268.5	140,213		3.219	143,985	3.305
	3.70		523.0	269.3	140,846		3.233	158,038	3.628
	3.80		523.8	270.1	141,481		3.248	172,154	3.952
	3.90		524.6	270.9	142,117		3.263	186,334	4.278
	4.00		525.4	271.7	142,754		3.277	200,577	4.605
	4.10		526.2	272.5	143,392		3.292	214,885	4.933
	4.20		527.0	273.3	144,032		3.307	229,256	5.263
	4.30		527.8	274.1	144,673		3.321	243,691	5.594
	4.40		528.6	274.9	145,315		3.336	258,190	5.927
	4.50		529.4	275.7	145,958		3.351	272,754	6.262
Zone 2 (EURV)	4.54		529.8	276.0	146,216		3.357	278,598	6.396
	4.60		530.2	276.5	146,603		3.366	287,382	6.597
	4.70		531.0	277.3	147,249		3.380	302,075	6.935
	4.80		531.8	278.1	147,896		3.395	316,832	7.273
	4.90		532.6	278.9	148,545		3.410	331,654	7.614
	5.00		533.4	279.7	149,195		3.425	346,541	7.955
	5.10		534.2	280.5	149,846		3.440	361,493	8.299
	5.20		535.0	281.3	150,498		3.455	376,510	8.643
	5.30		535.8	282.1	151,152		3.470	391,593	8.990
	5.40		536.6	282.9	151,807		3.485	406,741	9.337
	5.50		537.4	283.7	152,463		3.500	421,954	9.687
	5.60		538.2	284.5	153,121		3.515	437,233	10.037
5.70		539.0	285.3	153,780		3.530	452,578	10.390	
5.80		539.8	286.1	154,440		3.545	467,989	10.744	
5.90		540.6	286.9	155,101		3.561	483,466	11.099	
Zone 3 (100-year)	6.00		541.4	287.7	155,764		3.576	499,010	11.456
	6.01		541.5	287.8	155,830		3.577	500,568	11.491
	6.10		542.2	288.5	156,428		3.591	514,619	11.814
	6.20		543.0	289.3	157,093		3.606	530,295	12.174
	6.30		543.8	290.1	157,759		3.622	546,038	12.535
	6.40		544.6	290.9	158,427		3.637	561,847	12.898
	6.50		545.4	291.7	159,096		3.652	577,723	13.263
	6.60		546.2	292.5	159,767		3.668	593,666	13.629
	6.70		547.0	293.3	160,438		3.683	609,677	13.996
	6.80		547.8	294.1	161,111		3.699	625,754	14.365
	6.90		548.6	294.9	161,785		3.714	641,899	14.736
	7.00		549.4	295.7	162,461		3.730	658,111	15.108
	7.10		550.2	296.5	163,138		3.745	674,391	15.482
	7.20		551.0	297.3	163,816		3.761	690,739	15.857
	7.30		551.8	298.1	164,495		3.776	707,154	16.234
	7.40		552.6	298.9	165,175		3.792	723,638	16.612
	7.50		553.4	299.7	165,857		3.808	740,189	16.992
	7.60		554.2	300.5	166,540		3.823	756,809	17.374
	7.70		555.0	301.3	167,225		3.839	773,498	17.757
	7.80		555.8	302.1	167,911		3.855	790,254	18.142
	7.90		556.6	302.9	168,598		3.870	807,080	18.528
	8.00		557.4	303.7	169,286		3.886	823,974	18.916
	8.10		558.2	304.5	169,975		3.902	840,937	19.305
	8.20		559.0	305.3	170,666		3.918	857,969	19.696
8.30		559.8	306.1	171,358		3.934	875,070	20.089	
8.40		560.6	306.9	172,052		3.950	892,241	20.483	
8.50		561.4	307.7	172,746		3.966	909,481	20.879	
8.60		562.2	308.5	173,442		3.982	926,790	21.276	
8.70		563.0	309.3	174,139		3.998	944,169	21.675	
8.80		563.8	310.1	174,838		4.014	961,618	22.076	
8.90		564.6	310.9	175,538		4.030	979,137	22.478	
9.00		565.4	311.7	176,239		4.046	996,725	22.882	
9.10		566.2	312.5	176,941		4.062	1,014,384	23.287	
9.20		567.0	313.3	177,645		4.078	1,032,114	23.694	
9.30		567.8	314.1	178,350		4.094	1,049,913	24.103	
9.40		568.6	314.9	179,056		4.111	1,067,784	24.513	
9.50		569.4	315.7	179,763		4.127	1,085,725	24.925	
9.60		570.2	316.5	180,472		4.143	1,103,736	25.338	
9.70		571.0	317.3	181,182		4.159	1,121,819	25.753	
9.80		571.8	318.1	181,893		4.176	1,139,973	26.170	

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Depotion, Version 4.05 (January 2022)

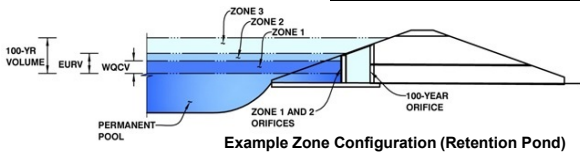


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: Summerfield

Basin ID: Northeast Pond Stage 0.00 = Elev 4893.00'



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.19	2.060	Orifice Plate
Zone 2 (EURV)	4.57	4.431	Orifice Plate
Zone 3 (100-year)	6.06	5.153	Weir&Pipe (Restrict)
Total (all zones)		11.645	

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 Diameter = N/A inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = N/A ft<sup>2</sup>  
Underdrain Orifice Centroid = N/A feet

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

Calculated Parameters for Plate

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate = 4.57 ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing = 18.30 inches  
Orifice Plate: Orifice Area per Row = N/A sq. inches

WQ Orifice Area per Row = N/A ft<sup>2</sup>  
Elliptical Half-Width = N/A feet  
Elliptical Slot Centroid = N/A feet  
Elliptical Slot Area = N/A ft<sup>2</sup>

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	1.52	3.05					
Orifice Area (sq. inches)	7.00	7.24	18.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft <sup>2</sup>
Vertical Orifice Centroid =	N/A	N/A	feet

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

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, H <sub>o</sub> =	4.57	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	25.00	N/A	feet
Overflow Weir Gate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	6.00	N/A	feet
Overflow Gate Type =	Type C Gate	N/A	
Debris Clogging % =	50%	N/A	%

	Zone 3 Weir	Not Selected	
Height of Gate Upper Edge, H <sub>u</sub> =	6.07	N/A	feet
Overflow Weir Slope Length =	6.18	N/A	feet
Gate Open Area / 100-yr Orifice Area =	10.27	N/A	
Overflow Gate Open Area w/o Debris =	107.61	N/A	ft <sup>2</sup>
Overflow Gate Open Area w/ Debris =	53.81	N/A	ft <sup>2</sup>

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	54.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	33.80		inches

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	10.47	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	1.59	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.83	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage =	7.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	96.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Spillway Design Flow Depth =	0.98 feet
Stage at Top of Freeboard =	8.98 feet
Basin Area at Top of Freeboard =	4.04 acres
Basin Volume at Top of Freeboard =	22.80 acre-ft

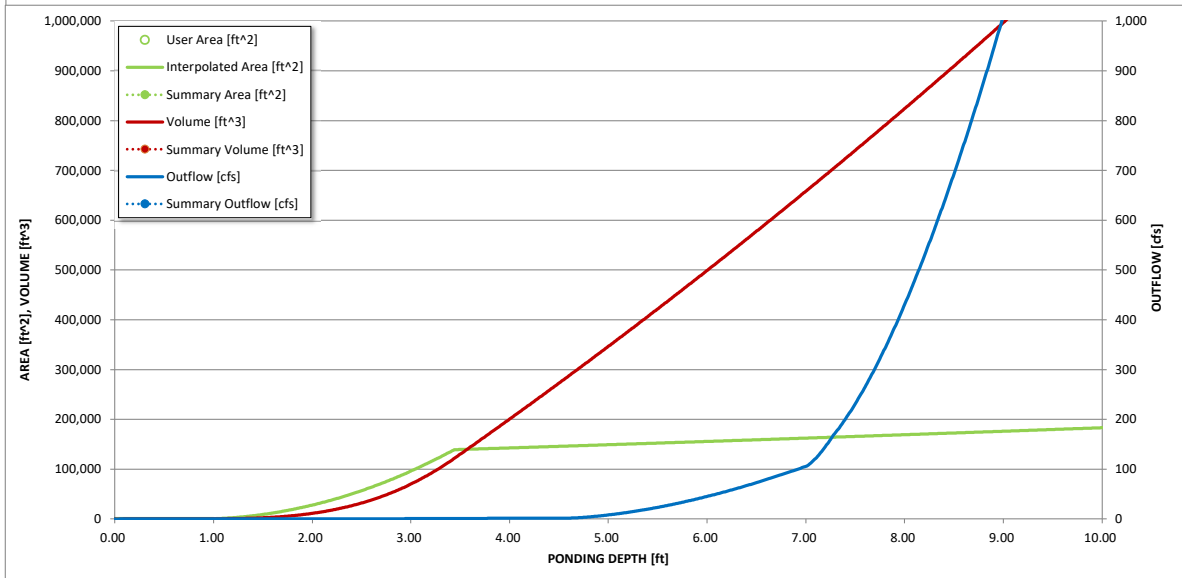
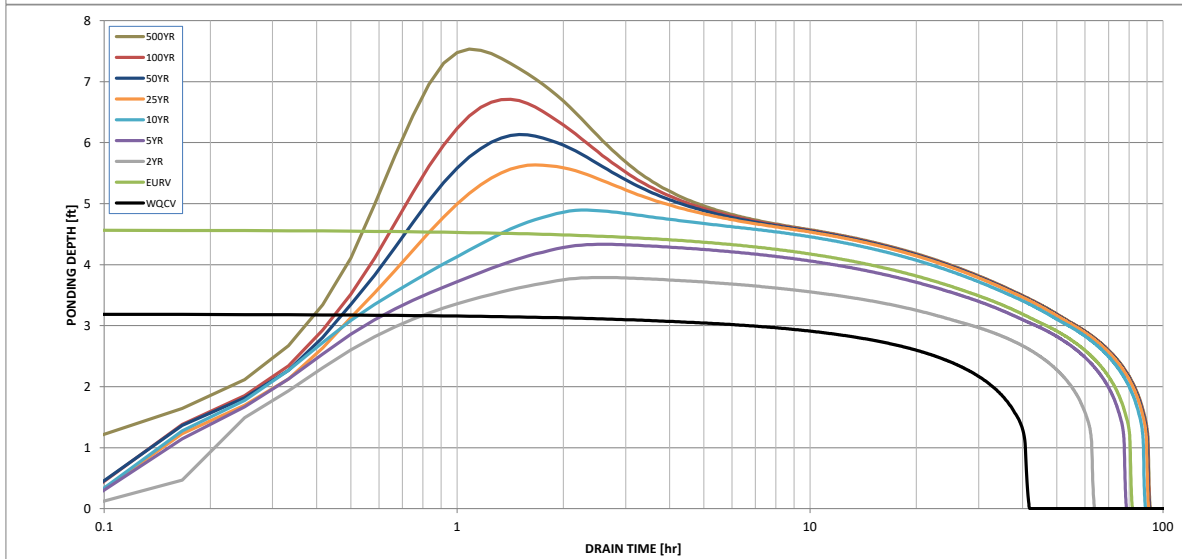
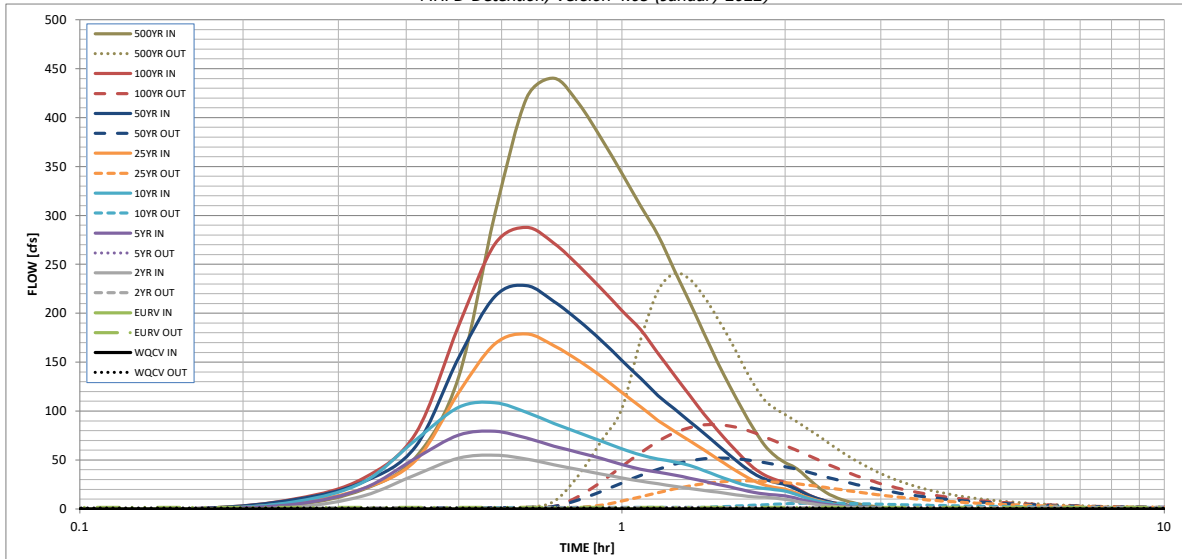
## Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.65	3.82
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.65	3.82
CUHP Runoff Volume (acre-ft) =	2.060	6.491	4.148	5.984	8.146	12.482	15.945	20.137	31.246
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	4.148	5.984	8.146	12.482	15.945	20.137	31.246
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	5.6	20.1	62.6	89.9	125.4	213.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.05	0.19	0.59	0.84	1.18	2.00
Peak Inflow Q (cfs) =	N/A	N/A	55.0	79.3	108.5	178.8	228.3	287.7	440.3
Peak Outflow Q (cfs) =	1.0	1.7	1.3	1.6	5.8	28.6	52.0	86.1	240.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.3	0.5	0.6	0.7	1.1
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.2	0.5	0.8	1.2
Max Velocity through Gate 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) =	39	75	59	72	81	80	78	75	69
Time to Drain 99% of Inflow Volume (hours) =	40	79	62	76	85	86	85	84	82
Maximum Ponding Depth (ft) =	3.19	4.57	3.79	4.33	4.89	5.63	6.13	6.71	7.53
Area at Maximum Ponding Depth (acres) =	2.61	3.36	3.25	3.33	3.41	3.52	3.60	3.68	3.81
Maximum Volume Stored (acre-ft) =	2.067	6.496	3.887	5.694	7.580	10.143	11.922	13.996	17.069

# 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	0.55	0.47	4.17
	0:15:00	0.00	0.00	1.83	4.97	7.48	6.36	9.56	10.28	20.00
	0:20:00	0.00	0.00	13.28	20.85	27.47	20.94	27.56	31.35	52.83
	0:25:00	0.00	0.00	34.98	51.85	70.42	49.49	64.04	77.32	134.94
	0:30:00	0.00	0.00	51.83	75.61	103.84	118.98	154.55	187.26	301.44
	0:35:00	0.00	0.00	55.00	79.31	108.55	168.69	217.24	270.71	419.78
	0:40:00	0.00	0.00	50.98	72.37	98.59	178.82	228.27	287.73	440.33
	0:45:00	0.00	0.00	45.18	64.11	87.37	166.60	211.85	271.47	413.88
	0:50:00	0.00	0.00	39.98	57.58	77.80	151.34	192.23	248.13	378.27
	0:55:00	0.00	0.00	35.58	51.46	69.20	135.27	172.10	224.82	342.99
	1:00:00	0.00	0.00	31.60	45.52	61.46	118.96	151.71	202.83	309.45
	1:05:00	0.00	0.00	28.38	40.58	55.04	104.35	133.34	183.04	279.42
	1:10:00	0.00	0.00	25.60	37.38	51.01	90.25	115.66	158.80	243.92
	1:15:00	0.00	0.00	23.15	34.56	48.10	79.44	102.15	136.65	211.34
	1:20:00	0.00	0.00	20.94	31.40	44.34	69.48	89.36	115.99	179.82
	1:25:00	0.00	0.00	18.98	28.22	39.30	60.31	77.40	97.19	150.46
	1:30:00	0.00	0.00	17.08	25.20	34.02	51.32	65.60	80.75	124.79
	1:35:00	0.00	0.00	15.22	22.42	29.21	42.90	54.54	66.08	101.96
	1:40:00	0.00	0.00	13.56	19.40	25.20	35.25	44.53	52.95	81.64
	1:45:00	0.00	0.00	12.42	16.85	22.43	28.73	36.05	41.89	64.93
	1:50:00	0.00	0.00	11.85	15.20	20.82	24.38	30.51	34.61	54.11
	1:55:00	0.00	0.00	10.90	14.15	19.60	21.74	27.10	30.04	47.23
	2:00:00	0.00	0.00	9.74	13.21	18.16	20.06	24.89	26.95	42.52
	2:05:00	0.00	0.00	8.12	11.19	15.30	16.86	20.86	22.16	35.04
	2:10:00	0.00	0.00	6.40	8.79	12.02	13.10	16.17	16.82	26.61
	2:15:00	0.00	0.00	4.97	6.78	9.27	9.98	12.28	12.47	19.73
	2:20:00	0.00	0.00	3.86	5.26	7.14	7.62	9.34	9.28	14.68
	2:25:00	0.00	0.00	2.99	4.06	5.46	5.83	7.12	7.05	11.14
	2:30:00	0.00	0.00	2.30	3.08	4.11	4.41	5.36	5.34	8.40
	2:35:00	0.00	0.00	1.75	2.30	3.08	3.30	4.00	4.02	6.32
	2:40:00	0.00	0.00	1.31	1.70	2.31	2.46	2.98	3.03	4.76
	2:45:00	0.00	0.00	0.98	1.26	1.74	1.87	2.26	2.30	3.61
	2:50:00	0.00	0.00	0.69	0.90	1.25	1.36	1.64	1.67	2.62
	2:55:00	0.00	0.00	0.45	0.61	0.84	0.94	1.13	1.14	1.78
	3:00:00	0.00	0.00	0.27	0.39	0.52	0.59	0.71	0.72	1.11
	3:05:00	0.00	0.00	0.14	0.21	0.27	0.32	0.39	0.39	0.59
	3:10:00	0.00	0.00	0.06	0.09	0.11	0.14	0.16	0.16	0.24
	3:15:00	0.00	0.00	0.02	0.02	0.02	0.03	0.03	0.03	0.04
	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.

[illegible]

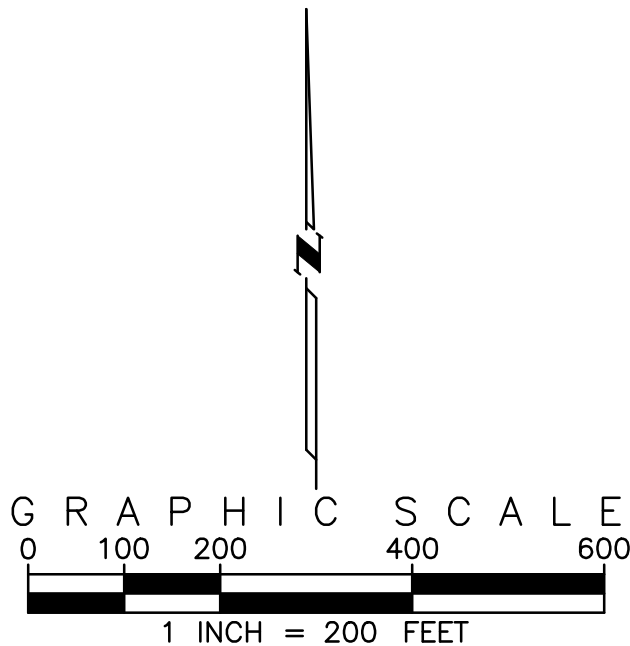
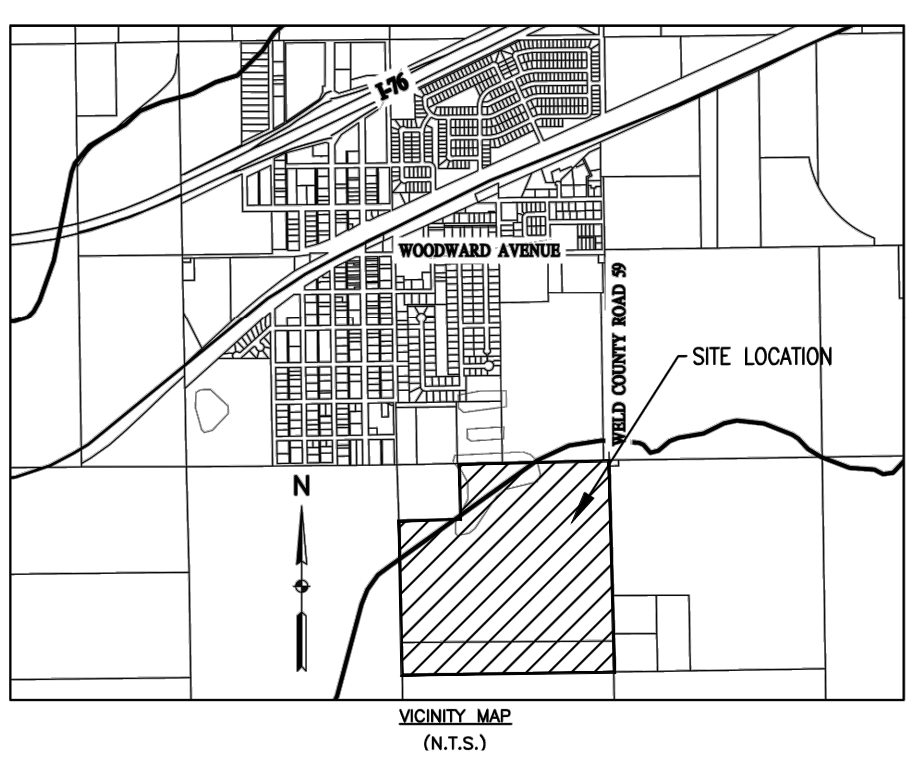


**SUMMERFIELD SOUTH**

**APPENDIX C**



1/1/18 Summerfield Kreschong Drainage SDBS DBS-Existing Conditions.dwg, 3/30/2022 12:53 PM, det. 1/1



**LEGEND**

- C3 — BASIN DESIGNATION
- 341.8 | 2% — PERCENT IMPERVIOUSNESS
- BASIN AREA IN ACRES
- △ x — DESIGN POINT— RATIONAL METHOD
- BASIN BOUNDARY
- FLOW DIRECTION ARROW
- - - - - EXISTING 2-FT CONTOUR
- - - 5510 - - - EXISTING 10-FT CONTOUR
- PROPOSED 2-FT CONTOUR
- 5510 — PROPOSED 10-FT CONTOUR
- → → → PROPOSED CHANNEL

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NO.	DESCRIPTION	DATE	BY		

**SUMMERFIELD**

**EXISTING DRAINAGE LAYOUT**

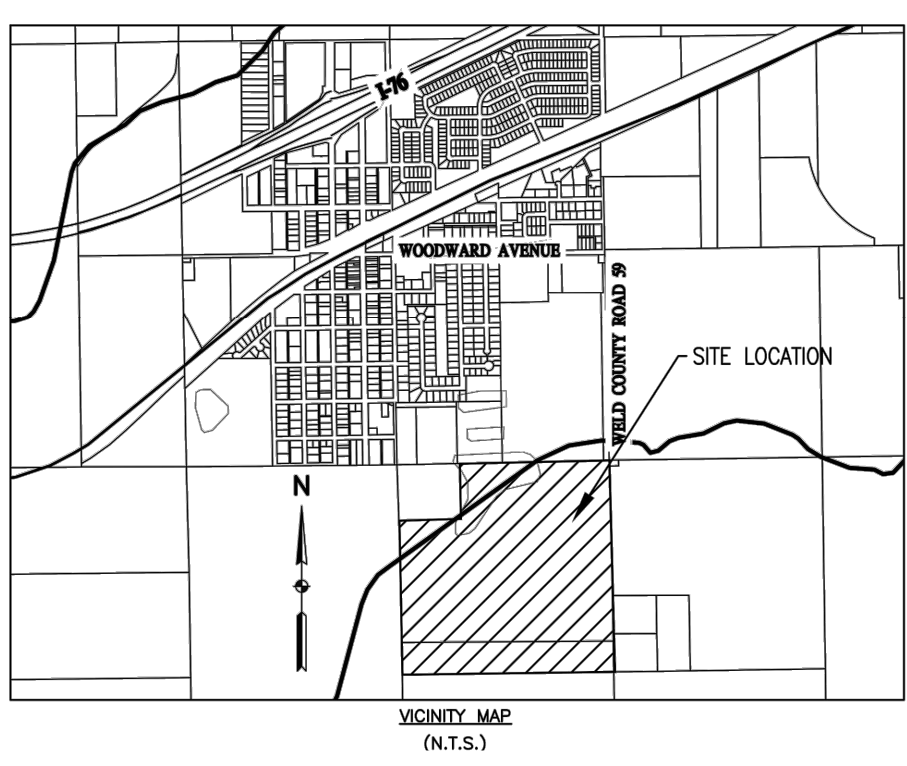
DATE: 03/30/2022  
JOB NO: 13318.00

SCALE  
HORIZONTAL  
1" = 200'

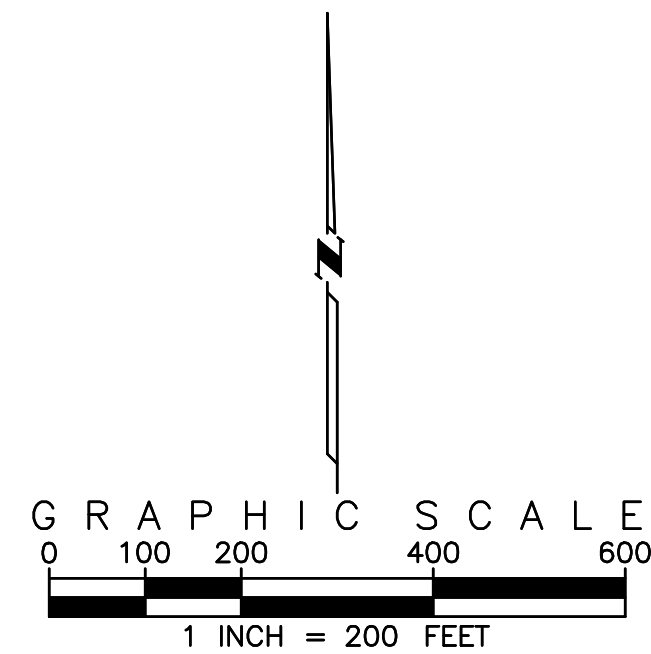
1 of 2



\\13118 Summerfield\Kensheng\Drawings\Summerfield\Summerfield.dwg, 4/7/2021 10:00 PM, 1:1



#### NOTES



#### LEGEND

- BASIN DESIGNATION
- PERCENT IMPERVIOUSNESS
- BASIN AREA IN ACRES
- DESIGN POINT - RATIONAL METHOD
- BASIN BOUNDARY
- FLOW DIRECTION ARROW
- EXISTING 2-FT CONTOUR
- EXISTING 10-FT CONTOUR
- PROPOSED 2-FT CONTOUR
- PROPOSED 10-FT CONTOUR
- PROPOSED CHANNEL

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NO.	DESCRIPTION	DATE	BY	DATE	BY

SUMMERFIELD

DEVELOPED DRAINAGE LAYOUT

DATE: 04/07/2022

JOB NO: 13318.00

SCALE  
HORIZONTAL  
1" = 200'

2

of 2