RTD Park-n-Ride
Niwot Road and 63rd Street
CO 119 Safety and Mobility Improvement

PRELIMINARY DRAINAGE REPORT

August 4, 2022

Prepared by:

Regional Transportation District
1560 Broadway, Suite 700
Denver, CO 80202

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I. PROJECT DESCRIPTION AND LOCATION

The proposed CO 119 Safety and Mobility Improvements project is a joint effort project between Colorado Department of Transportation (CDOT) and Regional Transportation District (RTD). The main purpose of the proposed CO 119 project is to improve and update the existing state highway corridor and make traveling safer, faster, and reliable for all modes of available transportation.

The proposed CO 119 project improvements will include queue bypass lanes, bus rapid transit (BRT) stations, RTD Park-n-Rides (P-n-R), and many other physical and signal improvements on the corridor. A new RTD P-n-R facility will be located at the intersection of CO 119 and 63rd Street and an existing smaller RTD P-n-R at the intersection of CO 119 and Niwot Road will be replaced with a larger P-n-R as part of this project. The two proposed RTD P-n-Rs are located within the CDOT Right-of-Way (ROW) in Boulder County, Colorado. The 63rd Street and Niwot Road P-n-R locations are shown on the Location Map (Figure 1, Appendix A).

The purpose of this drainage report is to document the preliminary drainage analysis and design for the two proposed RTD P-n-Rs included in the CO 119 project. For discussions and drainage information on the other proposed CO 119 highway improvements, please refer to the Preliminary Drainage Report for CO 119 Safety and Mobility Improvement Project, dated August 2022, prepared by Muller Engineering Company (Reference 4).

A. Niwot Road P-n-R

The proposed RTD Niwot Road P-n-R is located within the CDOT ROW/highway median area between the CO 119 southbound (SB) and northbound (NB) lanes, immediately north of Niwot Road. Currently, a small paved RTD P-n-R is located at this location. Outside of the footprint of the existing P-n-R and roadways, the site is undeveloped and mainly consists of grassy vegetation. An existing earthen embankment separates the project site from an existing CDOT water quality basin which is located north of the P-n-R site. There is an existing 18” RCP under the earthen embankment that drains the project site into the CDOT water quality basin.

1. Major Drainageway

There is no major drainageway that crosses the proposed Niwot Road P-n-R project site. The surface runoff from the project site and adjacent roadways currently drains north into an existing CDOT water quality basin which is located directly north of the project site within the CDOT ROW. Also, there is an existing 18-inch RCP culvert under Niwot Road near CO 119 NB lanes which

conveys flows north from the CO 119 median area (south of Niwot Road) through the project site to the existing CDOT water quality basin.

2. Natural Resources Conservation Service (NRCS) Soils Classification

The predominant NRCS hydrologic soil classification for the proposed Niwot Road P-n-R site and the surrounding area is Type C. Type C soil has a slow rate of storm water infiltration when saturated. Detailed NRCS map and soil information are included in Appendix C.

3. Irrigation Facilities

The Niwot Road P-n-R project site does not contain any existing ditches or canals that convey irrigation flows.

4. FEMA Floodplain

As shown on the FEMA Flood Insurance Rate Map (FIRM) Panel 410 of 615 (Map Number 08013C0410J), revised December 18, 2012, for Boulder County, Colorado and Incorporated Areas, the Niwot P-n-R project site is not located within the FEMA Special Flood Hazard Areas (see FEMA Firmette in Appendix B). The proposed P-n-R site is currently designated as unshaded Zone X, area of minimal flood hazard.

B. 63rd Street P-n-R

The proposed 63rd Street P-n-R is located within the CDOT ROW/highway median area between the CO 119 southbound (SB) and northbound (NB) lanes, immediately west of 63rd street. Currently, the site is undeveloped outside of the footprint of the existing roadways and mainly consists of grassy vegetation.

1. Major Drainageway

A tributary creek known as Little Dry Creek, which connects to Dry Creek North at a downstream location, dissects the proposed 63rd Street P-n-R project site. Little Dry Creek conveys runoff from the offsite drainage basin area, north and west of the SB CO 119 and flow releases from the Boulder Reservoir through the proposed RTD P-n-R site. There is an existing 10'x6' concrete box culvert (CBC) under both SB and NB CO 119 elevated roadway embankments. The surface runoff from the proposed P-n-R project

site currently sheet flows into Little Dry Creek, upstream of the CO 119 NB CBC crossing.

In order to build the proposed 63rd Street P-n-R, the existing Little Dry Creek between the NB and SB CO 119 will be filled in and replaced with 10'x6' CBCs which will connect with the existing 10'x6' CBCs under NB and SB CO 119. For more detailed discussions regarding the hydrologic and hydraulic analyses and design of the existing and proposed 10'x6' CBCs, please refer to the Preliminary Drainage Report for CO 119 Safety and Mobility Improvement Project, dated August 2022, prepared by Muller Engineering Company (Reference 4).

2. Natural Resources Conservation Service (NRCS) Soils Classification

The predominant NRCS hydrologic soil classification for the 63rd Street P-n-R project site and the surrounding area is Type D. Type D soil has a very slow rate of storm water infiltration when saturated. Detailed NRCS map and soil information are included in Appendix C.

3. Irrigation Facilities

The 63rd Street P-n-R project site does not contain any existing ditches or canals that convey irrigation flows.

4. FEMA Floodplain

As shown on the FEMA Flood Insurance Rate Map (FIRM) Panel 404 of 615 (Map Number 08013C0404J), revised December 18, 2012, for Boulder County, Colorado and Incorporated Areas, the RTD P-n-R project site is not located within the FEMA Special Flood Hazard Areas (see FEMA Firmette in Appendix B). The proposed P-n-R site is currently designated as unshaded Zone X, area of minimal flood hazard.

II. DRAINAGE DESIGN CRITERIA

A. Hydrology Criteria

1. Design Rainfall

The rainfall depths used for the two proposed RTD P-n-R project sites were obtained from NOAA Atlas 14 Precipitation Frequency Atlas of the United States, Volume 8, Version 2 (Reference 1).

2. Runoff Calculation Method

Rational Method was used to estimate peak flow rates for all existing and proposed conditions drainage basins since they are less than 90 areas in size. Mile High Flood District's (MHFD) spreadsheet program, UD-Rational, Version 2.0 was used to perform the Rational Method hydrologic calculations.

3. Design Storm Recurrence Intervals

The following minor and major design storm events are used for the proposed P-n-R sites based on the guidelines provided in the Boulder County Storm Drainage Criteria Manual (Reference 2).

- Minor Storm: 5-year
- Major Storm: 100-year

B. Hydraulics Criteria

The proposed storm drain inlets and pipes are designed to convey the computed 100-year peak flow rates for the proposed P-n-R site developed conditions. The design capacities of the proposed storm drain inlets were analyzed utilizing the MHFD's spreadsheet program MHFD-Inlet v5.01. Per RTD's P-n-R design criteria, all proposed storm drain inlets are designed to capture the computed 100-year peak flows with maximum ponding depths of 6 inches or less.

The proposed storm drain pipes are initially sized based on normal depth calculations using Bentley FlowMaster V8i for the Preliminary Drainage Report. The MHFD's UDSewer program will be used to check the HGL/EGL elevations of the proposed storm drain pipe systems for the Final Drainage Report.

Based on the water quality and detention requirements for new developments outlined in the Boulder County Storm Drainage Criteria Manual (Reference 2), a full-spectrum detention basin (DB) will be provided at both proposed RTD P-n-R locations. The MHFD's detention basin design workbook, MHFD-Detention, Version 4.05 was used to perform preliminary analyses of the proposed full-spectrum detention basins.

C. Waivers from Criteria

None identified at the current stage of P-n-R drainage system design.

III. EXISTING DRAINAGE CONDITIONS

A. Niwot Road P-n-R

The existing conditions drainage basin boundaries have been delineated based on the recent survey of the proposed P-n-R site as shown on Figure 2 (Appendix D). Surface runoff from the delineated drainage basin NW-EX1 concentrates at the low-lying area adjacent to the earthen embankment (CP N1) and flow north through an existing 18-inch RCP culvert into the CDOT water quality basin. There is no existing formal detention basin within NW-EX1.

Currently, a small paved RTD P-n-R facility is located within basin NW-EX1. Surface runoffs from the existing paved Niwot Road and CO 119 NB and SB lanes within basin NW-EX1 sheet flow to CP N1. Outside of the footprint of the existing P-n-R and roadways, the site is undeveloped and mainly consists of grassy vegetation. The computed existing conditions 100-year peak flow rate from basin NW-EX1 is 15.5 cfs.

There is an existing 18-inch RCP culvert under Niwot Road near CO 119 NB lanes which conveys flows north from the CO 119 median area (south of Niwot Road) through basin NW-EX1 to the existing CDOT water quality basin. The approximate flow conveyance capacity of the existing 18-inch RCP culvert under Niwot Road was estimated (13.3 cfs) using a flowing-full pipe culvert normal depth calculation (Appendix G).

B. 63rd Street P-n-R

The existing conditions drainage basin boundaries have been delineated based on the recent survey of the proposed P-n-R site as shown on Figure 4 (Appendix D). Surface runoff from the delineated drainage basin 63-EX1 flows into Little Dry Creek and concentrates near the inlet of the existing 10’x6’ CBC under CO 119 NB lanes (CP 1). Surface runoffs from the existing paved 63rd Street and CO 119 NB and SB lanes within the basin 63-EX1 sheet flow to CP 1. Outside of the footprint of the existing paved roadways and trail, the site is undeveloped and mainly consists of grassy vegetation. The computed existing conditions 100-year peak flow rate from basin 63-EX1 is 17.3 cfs. An offsite drainage basin (P172C) which is comprised of CO 119 median area between NB ad SB lanes, south of the proposed P-n-R site, also flows into Little Dry Creek near CP 1. The computed 100-year peak flow rate from basin P172C is 11.9 cfs (Reference 4).

Little Dry Creek conveys runoff from the offsite drainage basin area, north and west of the SB CO 119 and flow releases from the Boulder Reservoir through the proposed RTD P-n-R site. There is an existing 10’x6’ concrete

box culvert (CBC) under both SB and NB CO 119 elevated roadway embankments. The flows in Little Dry Creek combine with surface runoffs from basins 63-EX1 and P172C and flow through the existing 10'x6' CBC under CO 119 and 63rd Street in a southeasterly direction.

In order to build the proposed 63rd Street P-n-R, the existing Little Dry Creek between the NB and SB CO 119 will be filled in and replaced with 10'x6' CBCs which will connect with the existing 10'x6' CBCs under NB and SB CO 119. For detailed discussions and analysis/design information on the existing and proposed 10'x6' CBCs and basin P172C, please refer to the Preliminary Drainage Report for CO 119 Safety and Mobility Improvement Project, dated August 2022, prepared by Muller Engineering Company (Reference 4).

IV. PROPOSED DRAINAGE CONDITIONS

A. Niwot Road P-n-R

1. Proposed Drainage Basins

The proposed conditions drainage subbasin boundaries (NW-PR1 through NW-PR8) have been delineated to reflect the proposed site improvement conditions (see Figure 3, Appendix D). In general, the 100-year flows from the proposed RTD P-n-R improvements (NW-PR1 through NW-PR5) including bus ramps, station platforms, and P-n-R parking lot will be captured and conveyed to the proposed onsite full spectrum detention basin (DB). However, some portions of Niwot Road and CO 119 that surface drain into the proposed bus ramps will also be captured and conveyed to the proposed onsite DB. Surface runoffs from the remaining Niwot Road and CO 119 NB and SB lanes (NW-PR6 through NW-PR8) will flow directly into the existing CDOT water quality basin.

The proposed adjacent paved bike trail area (approximately 5960 sf) will drain south to new sump pumps at the low point of the Niwot Road trail underpass. This bike trail area is excluded from RTD's P-n-R proposed conditions hydrologic analysis since the trail area will not drain into RTD's onsite storm drainage and detention systems and the location of the sump pump discharge outfall has not been identified at the current stage of the trail design.

2. Storm Drain Improvements

The proposed P-n-R onsite storm drain systems are sized to capture and convey the computed 100-year peak flows to the proposed onsite full-spectrum detention basin (DB). Specifically,

the 100-year flows from subbasins NW-PR1 through NW-PR5 will be captured and conveyed to the proposed onsite DB.

The surface runoff from Niwot Road (subbasin NW-PR6) will be captured and conveyed in a roadside ditch and combine with the offsite flows from the CDOT median area (south of Niwot Road) conveyed by the existing 18" RCP under Niwot Road. The combined flows will bypass the onsite DB and discharge directly into the existing CDOT water quality basin. Flows from CO 119 NB and SB lanes (subbasins NW-PR7 and NW-PR8) will also bypass the onsite DB and discharge directly into the existing CDOT water quality basin.

All proposed storm drain (SD) inlets and pipes are designed to sufficiently handle the computed 100-year design flows for the proposed site development conditions as summarized in the SD system design flow rates table in Appendix G. In accordance with the RTD P-n-R design criteria, the proposed SD inlets will be designed to capture the 100-year flows with maximum ponding depths of 6 inches or less.

The proposed SD pipes were initially sized based on normal depth calculations using Bentley FlowMaster V8i for the Preliminary Drainage Report. The MHFD's UDSewer program will be used to check the HGL/EGL elevations for the proposed storm drain systems for the Final Drainage Report. Per RTD's design criteria, the minimum SD pipe size used in the proposed P-n-R project will be 18" RCP.

3. Detention and Water Quality Basin

A new onsite full spectrum detention basin (DB) will be provided to capture and route flows from subbasins NW-PR1 through NW-PR5 (up to the 100-year design storm event). The total contributing drainage area for the proposed onsite DB is approximately 2.98 acres with approximately 81.1 percent impervious areas. The MHFD full spectrum detention basin design program, MHFD-Detention, Version 4.05, was used to perform preliminary analysis of the proposed onsite DB. (See detention basin calculations in Appendix F). The outflows from the onsite DB will discharge directly into the existing CDOT water quality basin.

The computed water quality capture volume (WQCV), excess urban runoff volume (EURV), and 100-year detention storage volume will be provided in the proposed full-spectrum onsite detention basin (DB) as summarized in the table below. An emergency overflow

spillway will be provided along the improved earthen embankment between the proposed onsite DB and the existing CDOT water quality basin.

Design Event	Total Required Volume (ac. ft.)
WQCV	0.083
EURV	0.237
100-year	0.411

As summarized in the table below, the proposed conditions 100-year combined peak flow rate from the proposed subbasins NW-PR1 through NW-PR8 is less than the existing conditions 100-year peak flow rate of 15.5 cfs from basin NW-EX1.

Basin ID	Q100 (cfs)
DB Outflow (NW-PR1 through NW-PR5)	3.1
NW-PR6	3.1
NW-PR7	3.9
NW-PR8	2.9
Total	13.0

B. 63rd Street P-n-R

1. Proposed Drainage Basins

The proposed conditions drainage subbasin boundaries (63-PR1 through 63-PR8) have been delineated to reflect the proposed site improvement conditions (see Figure 5, Appendix D). In general, the 100-year flows from the proposed RTD P-n-R improvements (63-PR1 through 63-PR5) including bus ramps, station platforms, and P-n-R parking lot will be captured and conveyed to the proposed onsite full spectrum detention basin (DB). However, some portions of CO 119 lanes that surface drain into the proposed bus ramps will also be captured and conveyed to the proposed onsite DB. Surface runoffs from the remaining 63rd Street and CO 119 NB and SB lanes (63-PR6 through 63-PR8) will flow directly into the proposed 10'x6' concrete box culvert (CBC).

The proposed adjacent paved bike trail area (approximately 8144 sf) will drain north to new sump pumps at the low point of the 63rd Street trail underpass. This bike trail area is excluded from RTD's P-n-R proposed conditions hydrologic analysis since the trail area will not drain into RTD's onsite storm drainage and detention systems and the location of the sump pump discharge outfall has

not been identified at the current stage of the trail design.

2. Storm Drain Improvements

The proposed P-n-R onsite storm drain systems are sized to capture and convey the computed 100-year peak flows to the proposed onsite full-spectrum detention basin (DB). Specifically, the 100-year flows from subbasins 63-PR1 through 63-PR5 will be captured and conveyed to the proposed onsite DB. The surface runoff from 63rd Street (subbasin 63-PR7) and CO 119 NB and SB lanes (subbasins 63-PR6 and 63-PR8) will bypass the onsite DB and discharge directly into the proposed 10'x6' CBCs. The offsite flows from basin P172C will also bypass the proposed DB and connect directly to the 10'x6' CBCs.

All proposed storm drain (SD) inlets and pipes are designed to sufficiently handle the computed 100-year design flows for the proposed site development conditions as summarized in the SD system design flow rates table in Appendix G. In accordance with the RTD P-n-R design criteria, the proposed SD inlets will be designed to capture the 100-year flows with maximum ponding depths of 6 inches or less.

The proposed SD pipes were initially sized based on normal depth calculations using Bentley FlowMaster V8i for the Preliminary Drainage Report. The MHFD's UDSewer program will be used to check the HGL/EGL elevations for the proposed storm drain systems for the Final Drainage Report. Per RTD's design criteria, the minimum SD pipe size used in the proposed P-n-R project will be 18" RCP.

3. Detention and Water Quality Basin

A new onsite full spectrum detention basin (DB) will be provided to capture and route flows from subbasins 63-PR1 through 63-PR5 (up to the 100-year design storm event). The total contributing drainage area for the proposed onsite DB is approximately 3.52 acres with approximately 72.8 percent impervious areas. The MHFD full spectrum detention basin design program, MHFD-Detention, Version 4.05, was used to perform preliminary analysis of the proposed onsite DB. (See detention basin calculations in Appendix F). The outflow from the onsite DB will combine with flows from subbasin 63-PR8 and offsite basin P172C and discharge into the proposed 10'x6' CBC.

The computed water quality capture volume (WQCV), excess urban

runoff volume (EURV), and 100-year detention storage volume will be provided in the proposed full-spectrum onsite detention basin (DB) as summarized in the table below. An emergency overflow spillway will be provided along the eastern embankment of the proposed onsite DB.

Design Event	Required Total Volume (ac. ft.)
WQCV	0.084
EURV	0.249
100-year	0.433

As summarized in the table below, the proposed conditions 100-year combined peak flow rate from the proposed subbasins 63-PR1 through 63-PR8 is less than the existing conditions 100-year peak flow rate of 17.3 cfs from basin 63-EX1.

Basin ID	Q100 (cfs)
DB Outflow (63-PR1 through 63-PR5)	3.1
63-PR6	3.7
63-PR7	5.8
63-PR8	2.5
Total	15.1

V. CONCLUSIONS

As previously discussed in sections above in detail, the design of drainage facilities for the proposed RTD's P-n-Rs at both 63rd Street and Niwot Road locations will be in general compliance with the Boulder County Storm Drainage Criteria Manual and MHFD's Urban Storm Drainage Criteria Manual (References 2 and 3). The proposed drainage improvements will provide the required flood protection for the RTD's P-n-R facilities.

VI. REFERENCES

1. NOAA Atlas 14 Precipitation Frequency Atlas of the United States, Volume 8, Version 2, National Oceanic and Atmospheric Administration (NOAA), 2013.

2. Boulder County Storm Drainage Criteria Manual, November 2016.

3. Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Volumes 1 and 2, Updated January 2016 and Volume 3, Updated November 2010.

4. CO 119 Safety and Mobility Improvement Project, Preliminary Drainage Report, August 2022, Muller Engineering Company.

APPENDIX

A. LOCATION MAP

B. FEMA FIRMETTE

C. NRCS SOILS MAPS

D. DRAINAGE BASIN DELINEATION MAPS

E. HYDROLOGIC CALCULATIONS

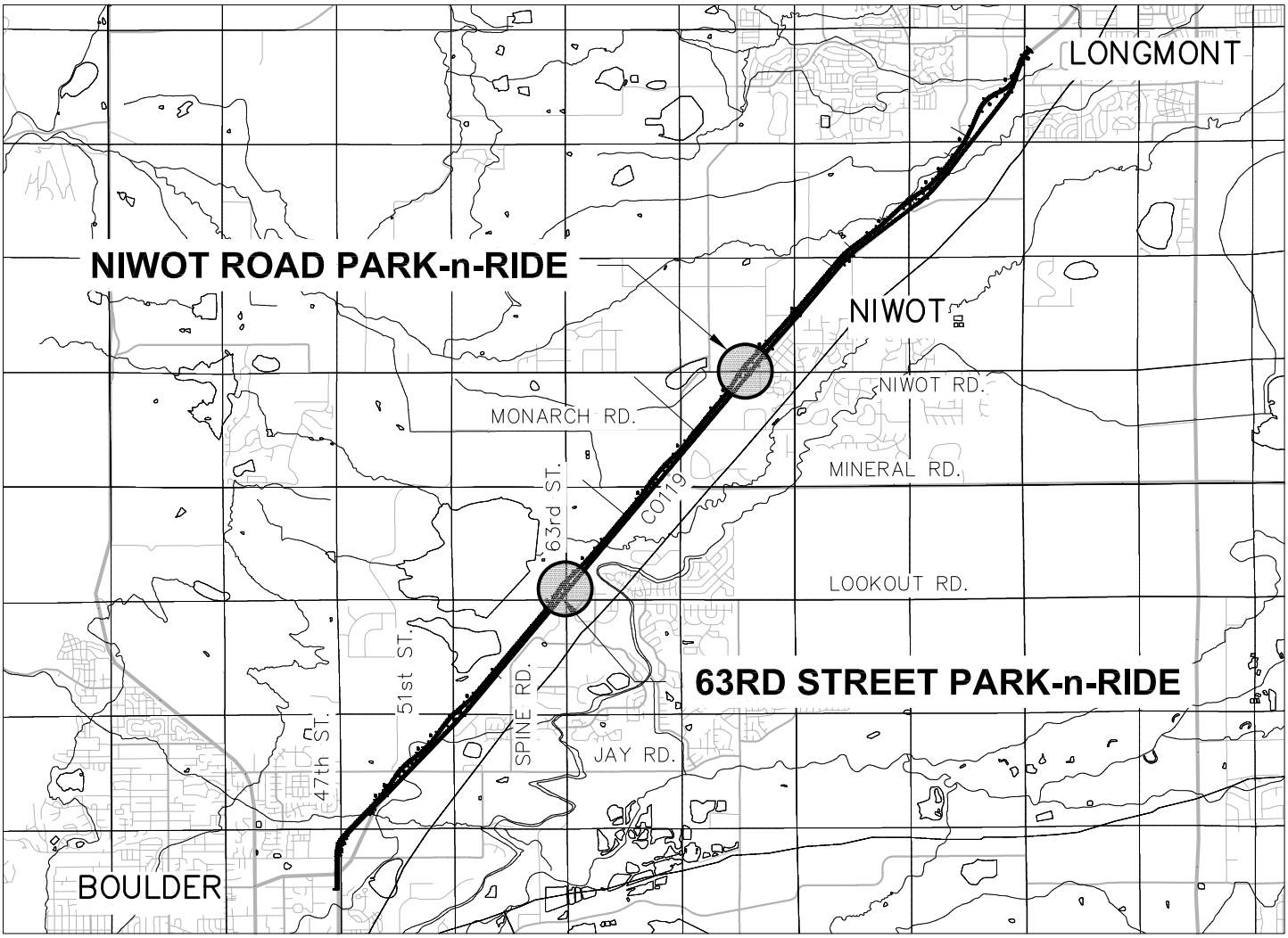
F. DETENTION BASIN DESIGN CALCULATIONS

G. STORM DRAIN SYSTEM CALCULATIONS

H. FIR DRAINAGE PLANS

APPENDIX A

LOCATION MAP



N

NOT TO SCALE

LOCATION MAP

REGIONAL TRANSPORTATION DISTRICT
1660 BLAKE STREET
DENVER, COLORADO 80202
(303) 628-9000

CO119 SAFETY & MOBILITY PROJECT

FIGURE 1

APPENDIX B

FEMA FIRMETTE

National Flood Hazard Layer FIRMette

FEMA

105°10'55"W 40°6'21"N

105°10'18"W 40°5'54"N

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/21/2022 at 6:18 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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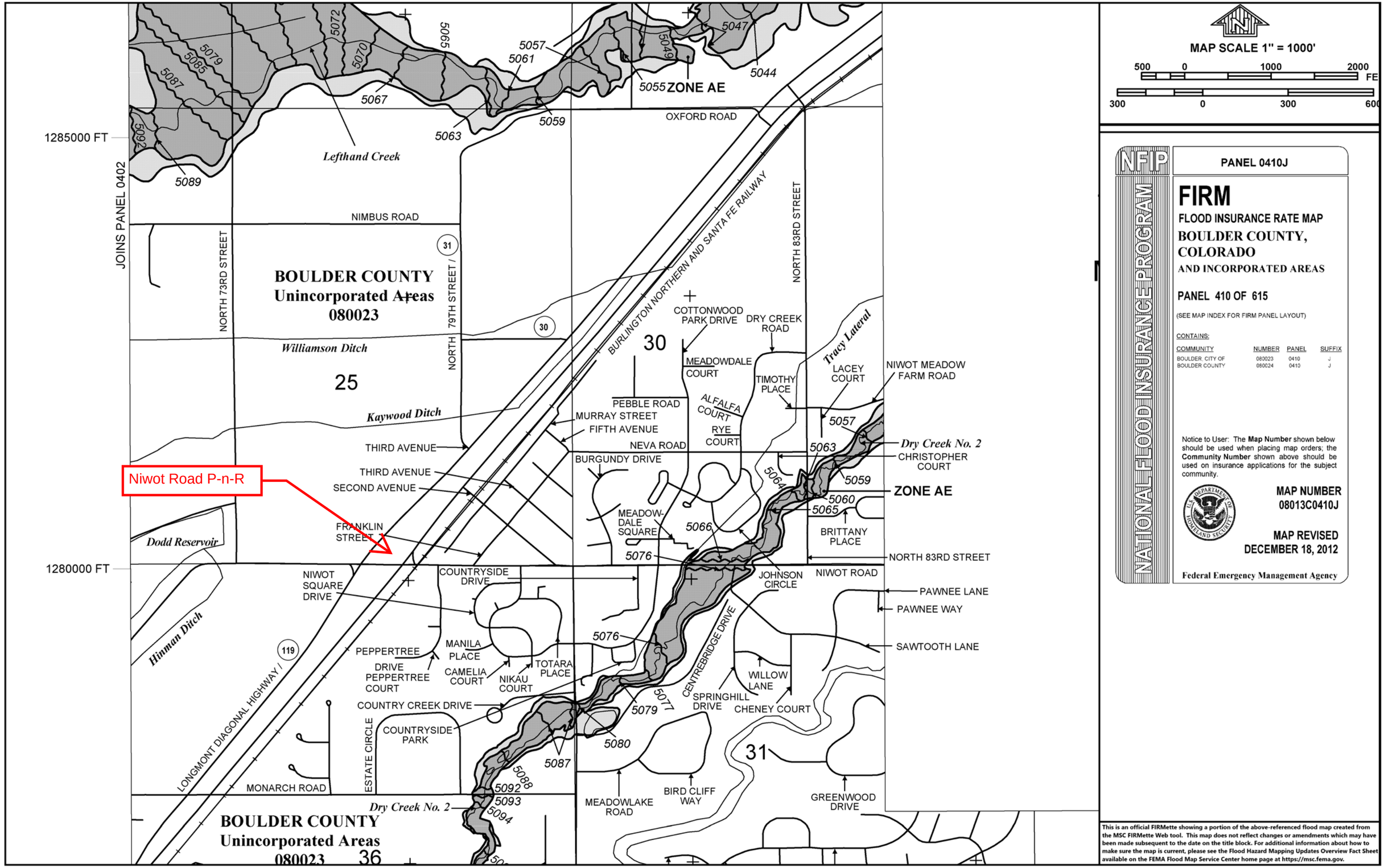
MAP SCALE 1" = 1000'
500 0 1000 2000 FE
300 0 300 600
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0410J
FIRM
FLOOD INSURANCE RATE MAP
BOULDER COUNTY, COLORADO
AND INCORPORATED AREAS
PANEL 410 OF 615
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
BOULDER, CITY OF 080023 0410 J
BOULDER COUNTY 080024 0410 J
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
08013C0410J
MAP REVISED
DECEMBER 18, 2012
Federal Emergency Management Agency
1285000 FT
1280000 FT
JOINS PANEL 0402
Lefthand Creek
Williamson Ditch
Kaywood Ditch
Dodd Reservoir
Hinman Ditch
Dry Creek No. 2
Tracy Lateral
BOULDER COUNTY
Unincorporated Areas
080023
BOULDER COUNTY
Unincorporated Areas
080023
ZONE AE
NIMBUS ROAD
OXFORD ROAD
NORTH 73RD STREET
NORTH 79TH STREET
NORTH 83RD STREET
BURLINGTON NORTHERN AND SANTA FE RAILWAY
COTTONWOOD PARK DRIVE
DRY CREEK ROAD
MEADOWDALE COURT
TIMOTHY PLACE
LACEY COURT
NIWOT MEADOW FARM ROAD
PEBBLE ROAD
MURRAY STREET
FIFTH AVENUE
ALFALFA COURT
RYE COURT
NEVA ROAD
BURGUNDY DRIVE
THIRD AVENUE
SECOND AVENUE
FRANKLIN STREET
MEADOW-DALE SQUARE
CHRISTOPHER COURT
BRITTANY PLACE
NORTH 83RD STREET
NIWOT ROAD
JOHNSON CIRCLE
PAWNEE LANE
PAWNEE WAY
SAWTOOTH LANE
CENTREBRIDGE DRIVE
WILLOW LANE
SPRINGHILL DRIVE
CHENEY COURT
NIWOT SQUARE DRIVE
COUNTRYSIDE DRIVE
PEPPERTREE DRIVE
PEPPERTREE COURT
MANILA PLACE
CAMELIA COURT
NIKAU COURT
TOTARA PLACE
COUNTRY CREEK DRIVE
COUNTRYSIDE PARK
ESTATE CIRCLE
MONARCH ROAD
LONGMONT DIAGONAL HIGHWAY
MEADOWLAKE ROAD
BIRD CLIFF WAY
GREENWOOD DRIVE
Niwot Road P-n-R
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119
This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at https://msc.fema.gov.

National Flood Hazard Layer FIRMette

FEMA

105°12'44"W 40°4'42"N

105°12'6"W 40°4'14"N

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

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- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
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- 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*

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- 17.5 Water Surface Elevation
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- Profile Baseline
- Hydrographic Feature

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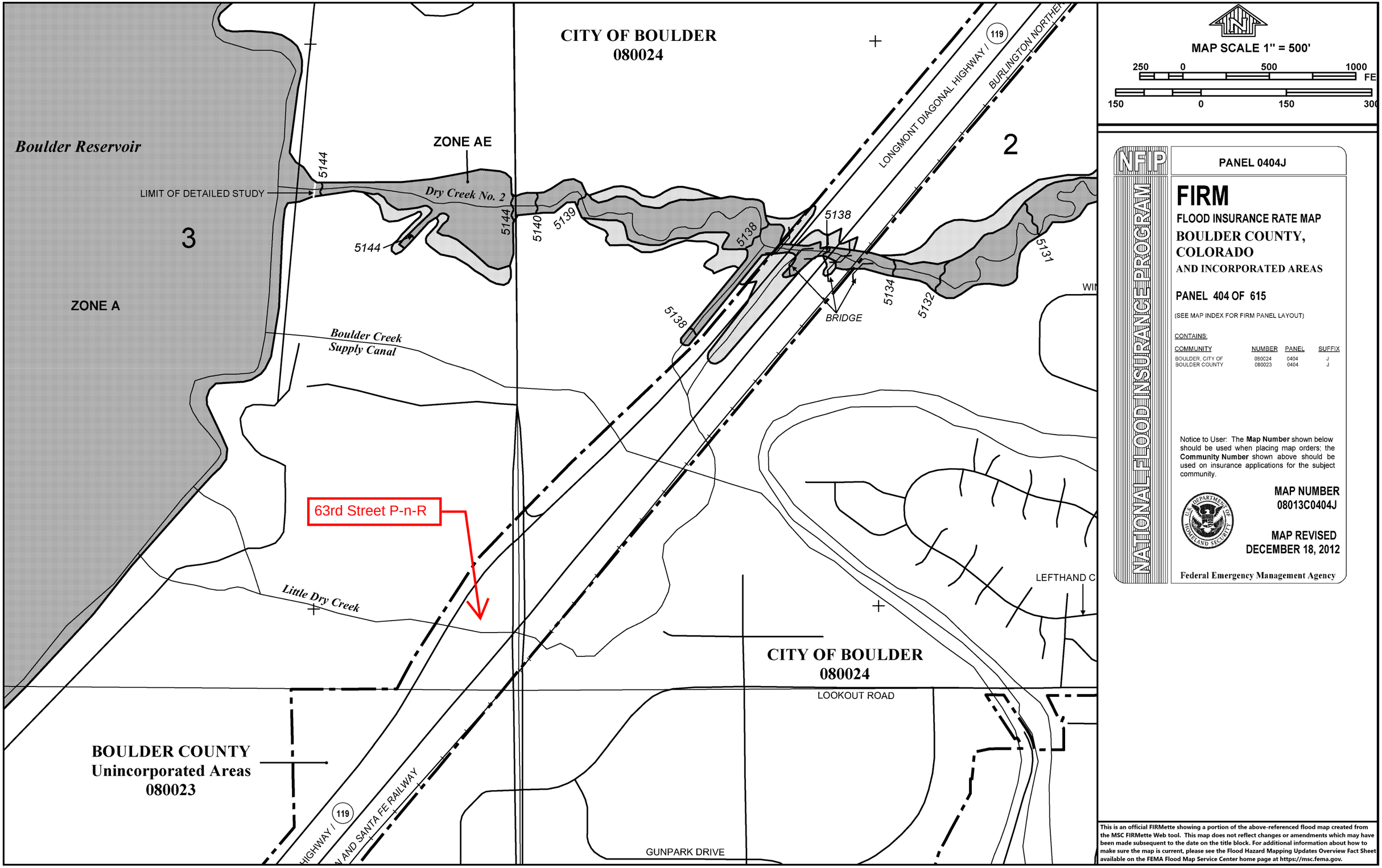
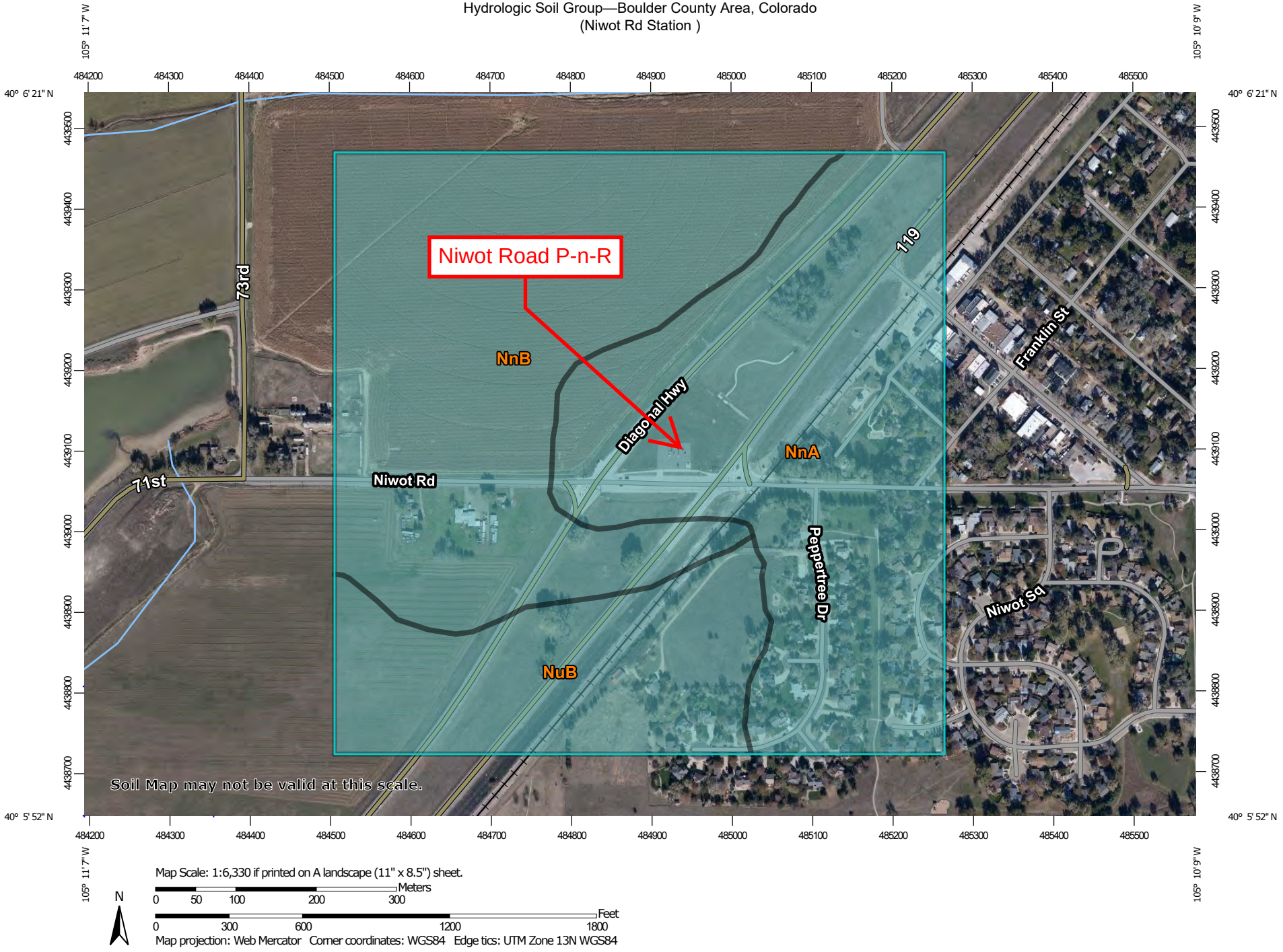

CITY OF BOULDER
080024
Boulder Reservoir
ZONE AE
LIMIT OF DETAILED STUDY
Dry Creek No. 2
5144
5140
5139
5138
5134
5132
5131
3
2
ZONE A
BRIDGE
LONGMONT DIAGONAL HIGHWAY / 119
BURLINGTON NORTHER
Boulder Creek
Supply Canal
63rd Street P-n-R
Little Dry Creek
LEFTHAND C
CITY OF BOULDER
080024
LOOKOUT ROAD
BOULDER COUNTY
Unincorporated Areas
080023
HIGHWAY / 119
AND SANTA FE RAILWAY
GUNPARK DRIVE
MAP SCALE 1" = 500'
250 0 500 1000
150 0 150
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0404J
FIRM
FLOOD INSURANCE RATE MAP
BOULDER COUNTY, COLORADO
AND INCORPORATED AREAS
PANEL 404 OF 615
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
BOULDER, CITY OF 080024 0404 J
BOULDER COUNTY 080023 0404 J
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
08013C0404J
MAP REVISED
DECEMBER 18, 2012
Federal Emergency Management Agency
This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at https://msc.fema.gov.

APPENDIX C

NRCS SOILS MAPS

Hydrologic Soil Group—Boulder County Area, Colorado
(Niwot Rd Station)



Hydrologic Soil Group—Boulder County Area, Colorado
(Niwot Rd Station)

MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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: Boulder County Area, Colorado
Survey Area Data: Version 18, Sep 2, 2021

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

Date(s) aerial images were photographed: Oct 1, 2018—Oct 31, 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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NnA	Nunn sandy clay loam, 0 to 1 percent slopes	C	57.2	40.7%
NnB	Nunn sandy clay loam, 1 to 3 percent slopes	C	57.9	41.2%
NuB	Nunn clay loam, 1 to 3 percent slopes	C	25.6	18.2%
Totals for Area of Interest			**140.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

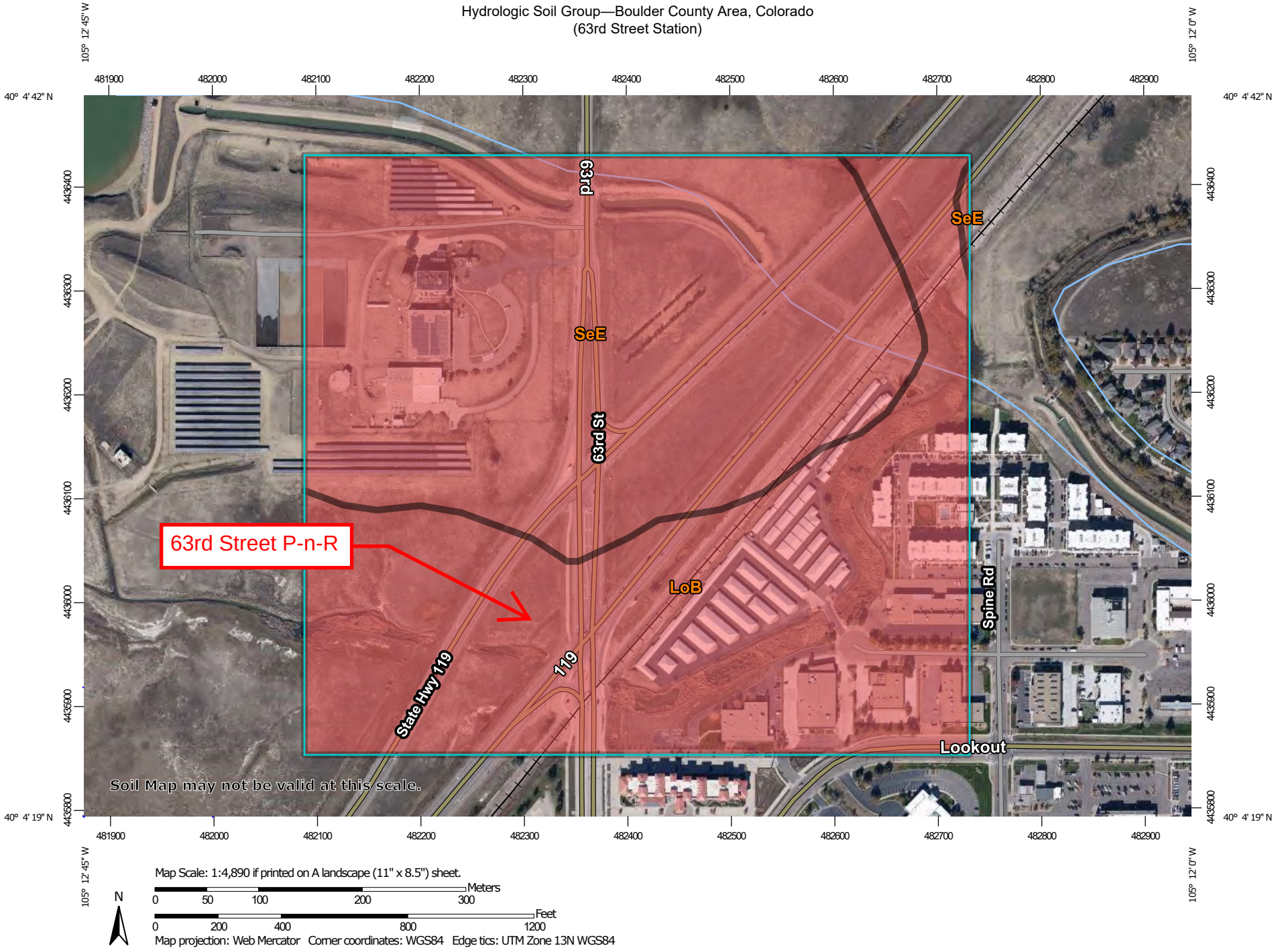
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Hydrologic Soil Group—Boulder County Area, Colorado
(63rd Street Station)



Map Scale: 1:4,890 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

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

Hydrologic Soil Group—Boulder County Area, Colorado
(63rd Street Station)

MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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: Boulder County Area, Colorado
Survey Area Data: Version 18, Sep 2, 2021

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

Date(s) aerial images were photographed: Oct 1, 2018—Oct 31, 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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
LoB	Longmont clay, 0 to 3 percent slopes	D	44.3	48.1%
SeE	Samsil-Shingle complex, 5 to 25 percent slopes	D	47.8	51.9%
Totals for Area of Interest			**92.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

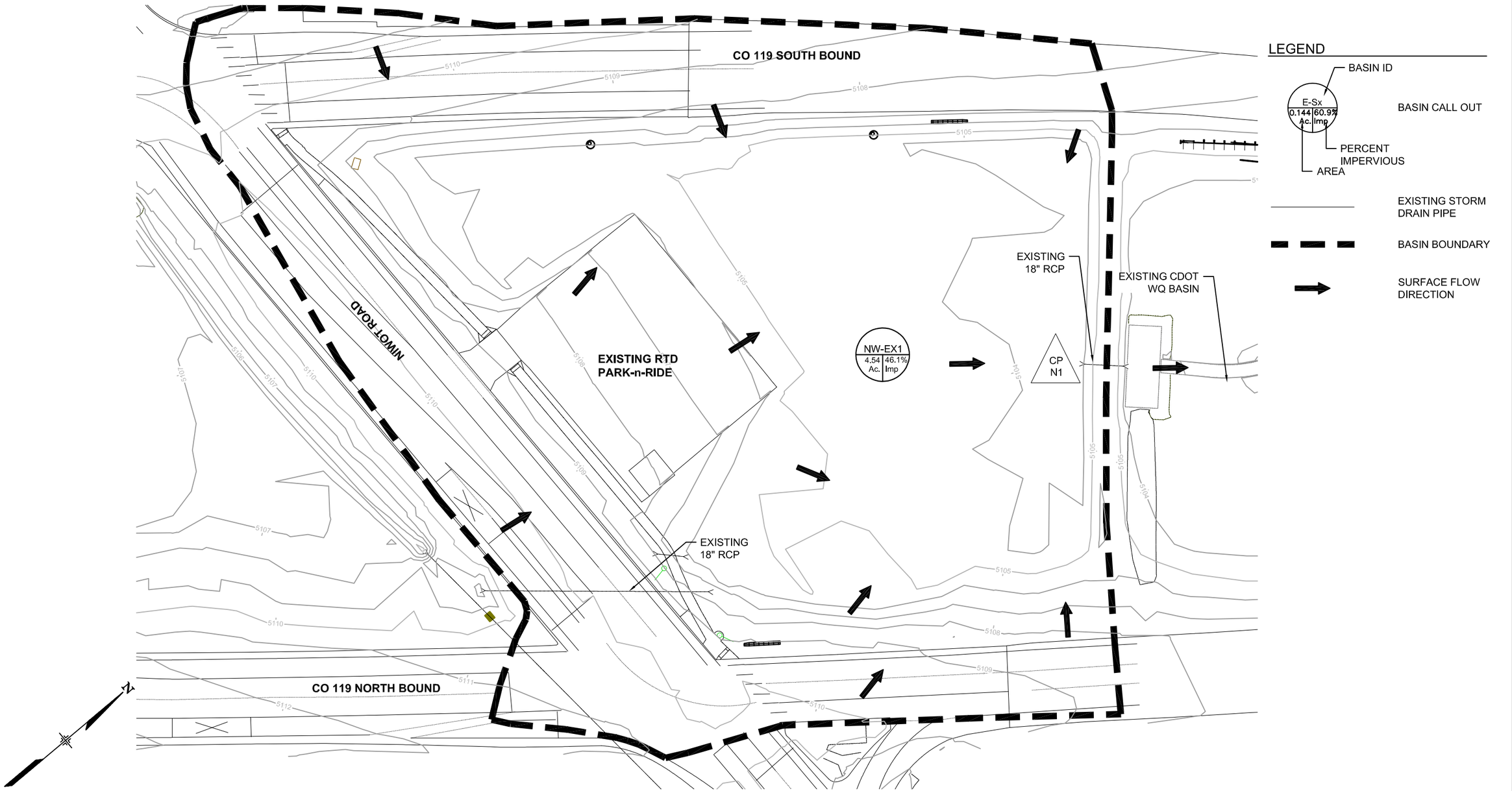
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

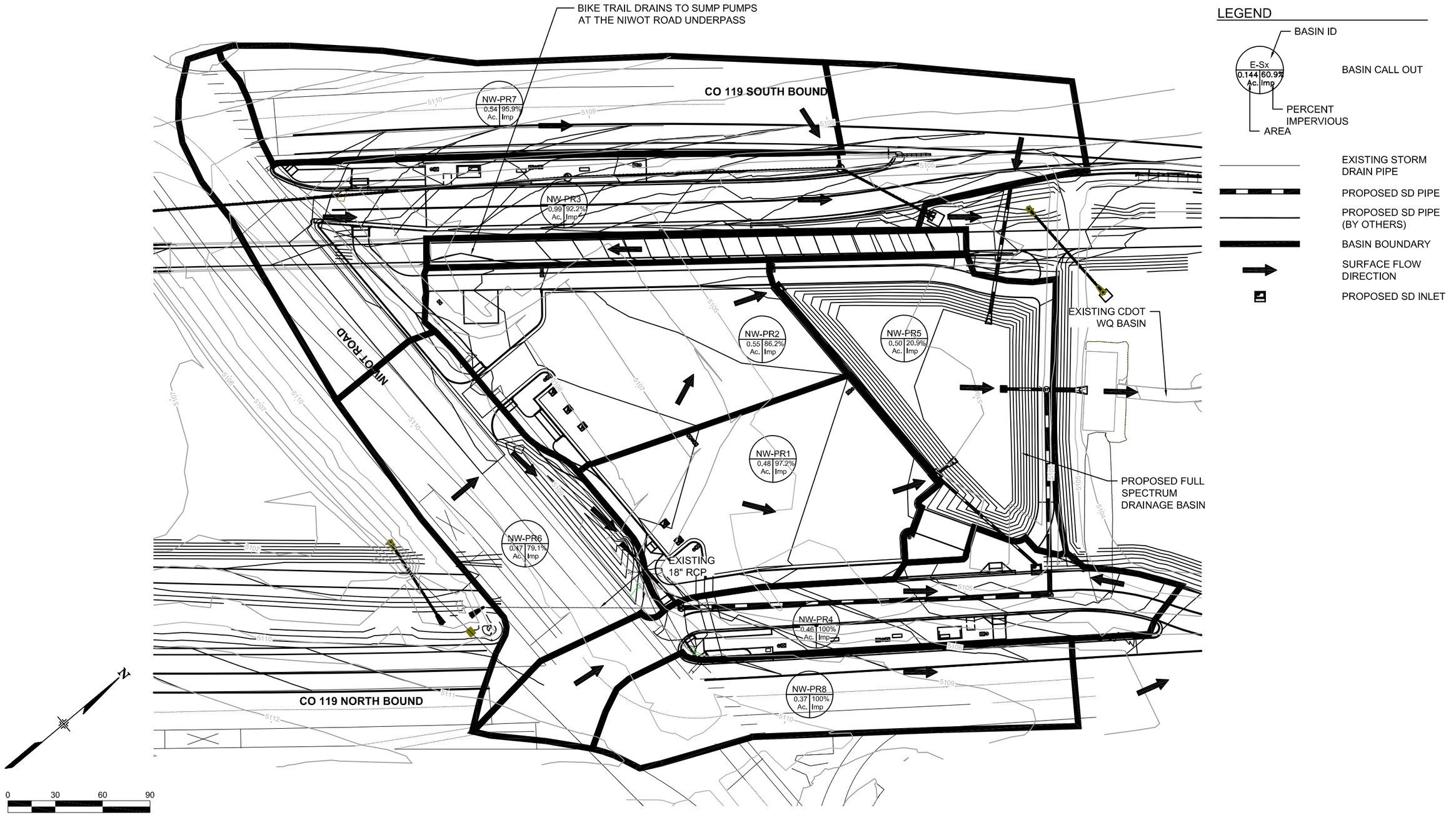
Tie-break Rule: Higher

APPENDIX D

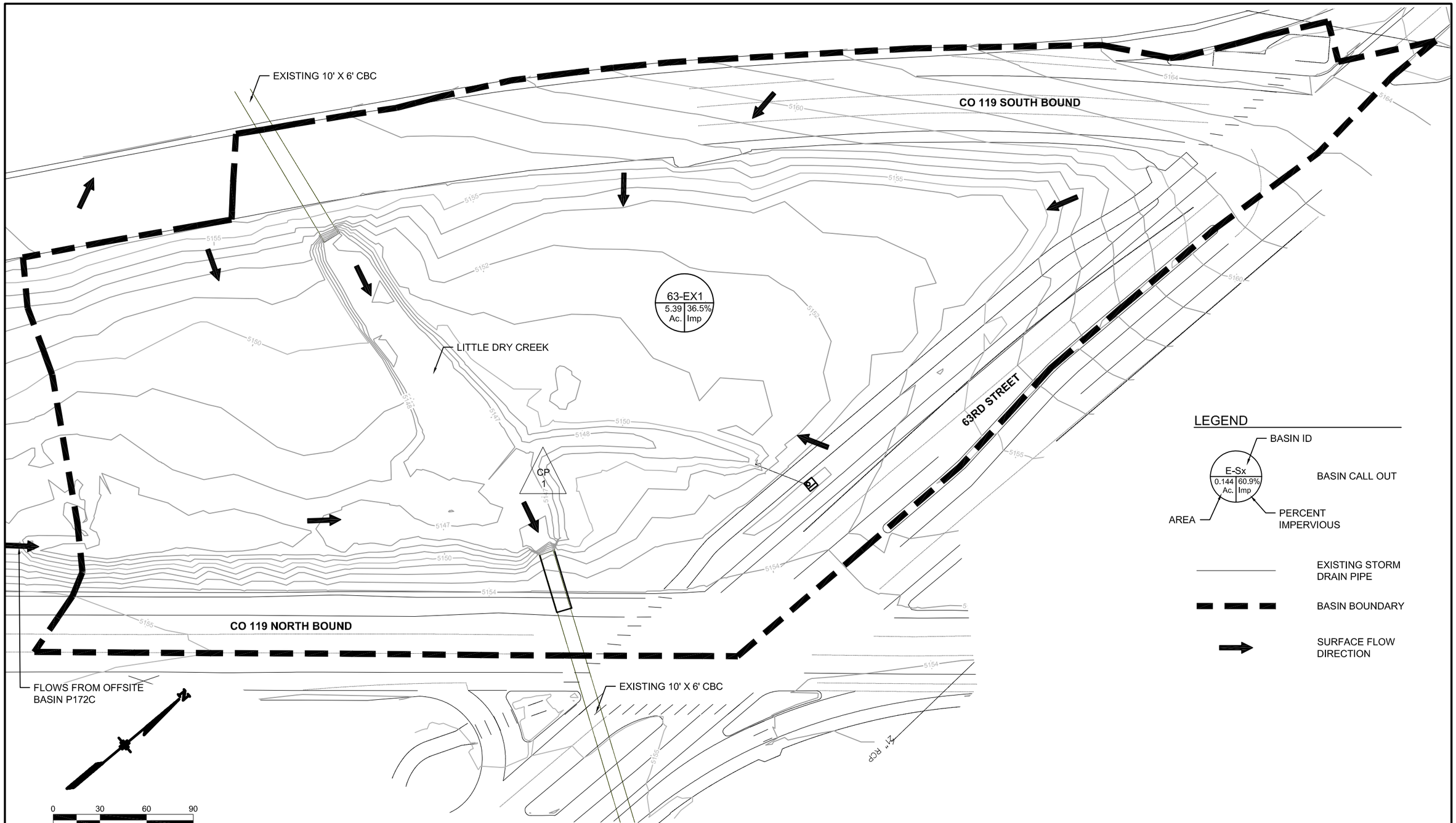
DRAINAGE BASIN DELINEATION MAPS



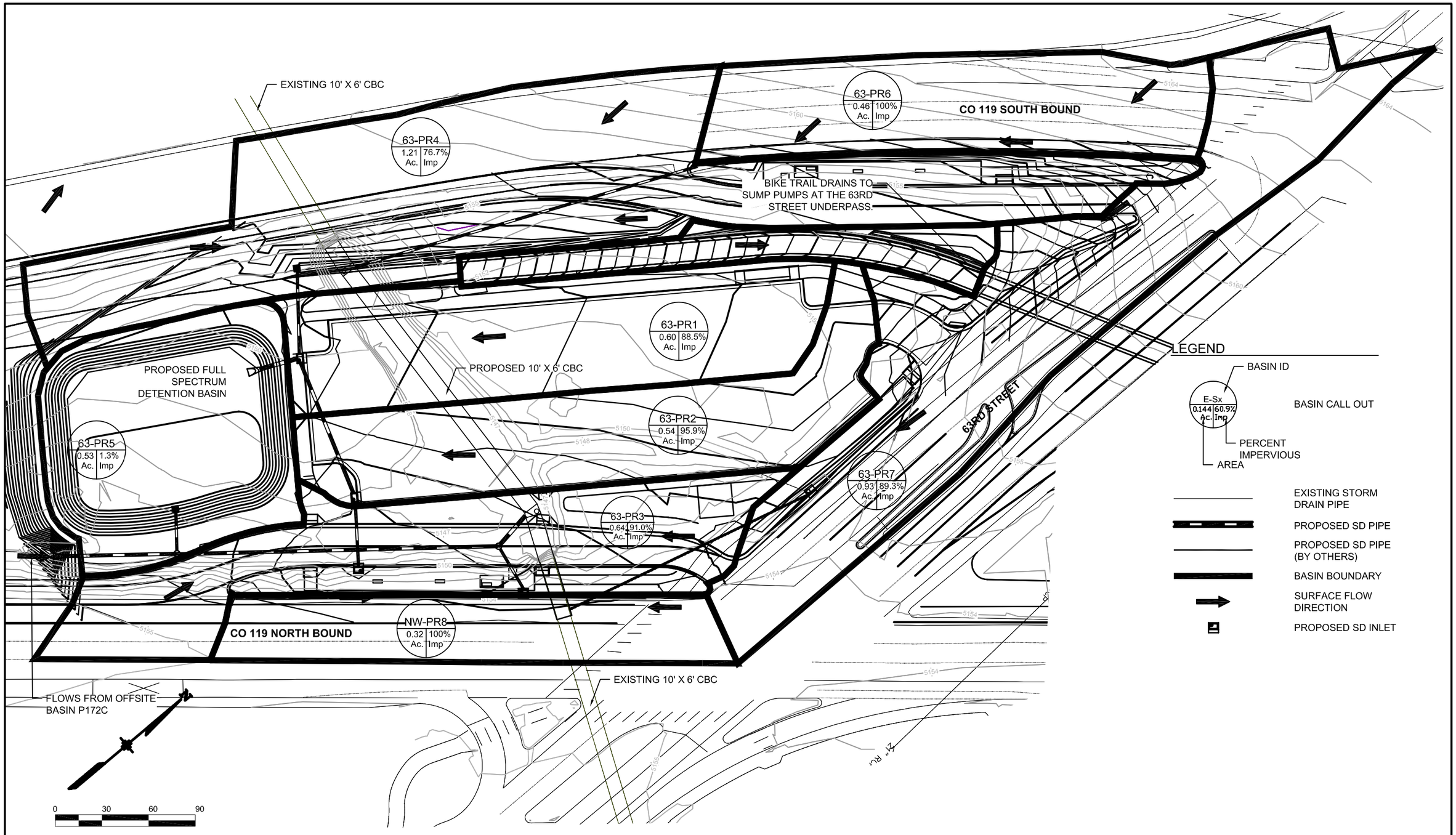
Print Date: $DATE$	Sheet Revisions			Colorado Department of Transportation		CO119 SAFETY & MOBILITY PROJECT NIWOT ROAD PARK-n-RIDE EXISTING DRAINAGE BASIN MAP	Project No./Code
File Name: $FILES$	Date:	Comments	Init.	1050 Lee Hill Road Boulder, CO 80302 Phone: 303-546-5676 FAX: 303-444-0751	No Revisions:		
Horiz. Scale: Vert. Scale: As Noted					Revised:	Designer: / Structure Numbers:	
Unit Information				Region 4 ALG	Void:	Detailer: / Sheet Subset: / Subset Sheets:	FIGURE 2
RTD							



	Print Date: $DATE$ File Name: $FILES$ Horiz. Scale: Vert. Scale: As Noted Unit Information RTD		Sheet Revisions Date: / Comments / Init.	Colorado Department of Transportation 1050 Lee Hill Road Boulder, CO 80302 Phone: 303-546-5676 FAX: 303-444-0751 Region 4 ALG	No Revisions: Revised: Void:	CO119 SAFETY & MOBILITY PROJECT NIWOT ROAD PARK-n-RIDE PROPOSED DRAINAGE BASIN MAP Designer: Detailer: Sheet Subset:	Project No./Code Structure Numbers Subset Sheets: FIGURE 3



	Print Date: $DATE$ File Name: $FILES$ Horiz. Scale: Vert. Scale: As Noted Unit Information RTD		Sheet Revisions Date: / Comments / Init.	Colorado Department of Transportation 1050 Lee Hill Road Boulder, CO 80302 Phone: 303-546-5676 FAX: 303-444-0751 Region 4 ALG	No Revisions: Revised: Void:	CO119 SAFETY & MOBILITY PROJECT 63RD STREET PARK-n-RIDE EXISTING DRAINAGE BASIN MAP Designer: Detailer: Sheet Subset: Structure Numbers Subset Sheets:	Project No./Code FIGURE 4



Print Date: $DATE$	Sheet Revisions			Colorado Department of Transportation		CO119 SAFETY & MOBILITY PROJECT 63RD STREET PARK-n-RIDE PROPOSED DRAINAGE BASIN MAP	Project No./Code
File Name: $FILES$	Date:	Comments	Init.	1050 Lee Hill Road Boulder, CO 80302 Phone: 303-546-5676 FAX: 303-444-0751	No Revisions:		
Horiz. Scale: Vert. Scale: As Noted					Revised:	Designer: / Detailer:	Structure Numbers
Unit Information				Region 4 ALG	Void:	Sheet Subset:	Subset Sheets: FIGURE 5

RTD

APPENDIX E

HYDROLOGIC CALCULATIONS

Calculation of Peak Runoff using Rational Method

Designer: Yong Song
Company: RTD
Date: 7/26/2022
Project: SH 119 BRT
Location: Niwot Road Station - RTD PnR

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$

$t_i = \frac{L_s}{60K\sqrt{S_i}} = \frac{L_s}{60V_s}$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum} = 5$ (urban)
$t_{minimum} = 10$ (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	0.79	1.07	1.35	1.81	2.23	2.69	3.98
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$

$Q(cfs) = CIA$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_t (ft/ft)	Overland Flow Time t_t (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
NW-EX1	4.54	C	46.1	0.35	0.41	0.47	0.58	0.62	0.67	0.73	125.00	5112.14	5109.00	0.025	10.27	500.00	5109.00	5103.50	0.011	7	0.73	11.35	21.62	23.30	21.62	1.49	2.02	2.55	3.42	4.21	5.08	7.51	2.37	3.77	5.45	8.96	11.87	15.51	25.02
NW-PR1	0.48	C	97.2	0.81	0.83	0.85	0.86	0.87	0.88	0.89	178.00	5109.99	5108.25	0.010	6.62	97.00	5108.25	5107.75	0.005	20	1.44	1.13	7.75	10.47	7.75	2.35	3.18	4.01	5.38	6.63	7.99	11.83	0.90	1.25	1.61	2.21	2.75	3.35	5.02
NW-PR2	0.55	C	86.2	0.71	0.74	0.77	0.80	0.82	0.84	0.86	127.00	5109.99	5108.16	0.014	6.54	69.00	5108.16	5107.80	0.005	20	1.44	0.80	7.33	12.10	7.33	2.39	3.24	4.09	5.48	6.75	8.14	12.05	0.92	1.30	1.71	2.40	3.02	3.72	5.65
NW-PR3	0.99	C	92.2	0.76	0.79	0.81	0.84	0.85	0.86	0.88	135.00	5112.13	5109.29	0.021	5.15	438.00	5109.29	5106.25	0.007	20	1.67	4.38	9.53	14.33	9.53	2.18	2.95	3.72	4.99	6.15	7.42	10.97	1.64	2.29	2.98	4.12	5.15	6.31	9.52
NW-PR4	0.46	C	100.0	0.83	0.85	0.87	0.88	0.89	0.89	0.90	138.00	5111.40	5109.20	0.016	4.55	238.00	5109.20	5107.55	0.007	20	1.67	2.38	6.93	11.07	6.93	2.44	3.30	4.16	5.58	6.88	8.30	12.28	0.94	1.30	1.67	2.27	2.82	3.43	5.13
NW-PR5 (DB)	0.50	C	20.9	0.14	0.21	0.29	0.44	0.50	0.57	0.65																													
NW-PR6	0.47	C	79.1	0.64	0.68	0.71	0.76	0.78	0.81	0.84	129.00	5111.40	5109.29	0.016	7.33	20.00	5109.29	5106.60	0.134	15	5.50	0.06	7.39	12.60	7.39	2.39	3.23	4.08	5.47	6.73	8.12	12.02	0.71	1.02	1.35	1.94	2.45	3.05	4.68
NW-PR7	0.54	C	95.9	0.80	0.82	0.84	0.86	0.87	0.88	0.89	90.00	5112.10	5109.60	0.028	3.47	335.00	5109.60	5107.47	0.006	20	1.59	3.50	6.97	12.82	6.97	2.44	3.29	4.16	5.57	6.87	8.28	12.25	1.05	1.46	1.89	2.59	3.23	3.93	5.91
NW-PR8	0.37	C	100.0	0.83	0.85	0.87	0.88	0.89	0.89	0.90	92.00	5110.82	5109.35	0.016	3.71	212.00	5109.35	5108.12	0.006	20	1.52	2.32	6.03	11.02	6.03	2.55	3.44	4.35	5.83	7.18	8.66	12.81	0.78	1.08	1.39	1.89	2.35	2.85	4.27

NIWOT ROAD P-n-R

EXISTING CONDITIONS DRAINAGE BASINS

Basin ID	Total Area (sq. ft.)	Total Area (acres)	Landscaped Area (sq. ft.)	Paved Area (sq. ft.)	% Landscaped Area	% Paved Area	Note
NW-EX1	197,881	4.543	106,687	91,194	53.9	46.1	

PROPOSED CONDITIONS DRAINAGE BASINS

Basin ID	Total Area (sq. ft.)	Total Area (acres)	Landscaped Area (sq. ft.)	Paved Area (sq. ft.)	% Landscaped Area	% Paved Area	Note
NW - PR1	20,680	0.475	577	20,103	2.8	97.2	
NW - PR2	23,799	0.546	3,282	20,517	13.8	86.2	
NW - PR3	43,043	0.988	3,354	39,689	7.8	92.2	
NW - PR4	20,175	0.463	0	20,175	0.0	100.0	
NW - PR5	21,911	0.503	17,336	4,575	79.1	20.9	
Total DB Contributing Basins	129,608	2.975	24,549	105,059	18.9	81.1	Excludes paved bike trail area (5960 sf) - which drains south to sump pumps near Niwot Road underpass
NW - PR6	20,256	0.465	4,230	16,026	20.9	79.1	
NW - PR7	23,605	0.542	972	22,633	4.1	95.9	
NW - PR8	16,086	0.369	0	16,086	0.0	100.0	
Total Niwot Basins	189,555	4.352	29,751	159,804	15.7	84.3	

Back up Calc for UD Detention

Proposed P-n-R Site

H (ft)	L (ft)	Slope (ft/ft)	LC (ft)
5.88	573	0.010	156

NOAA Atlas 14, Volume 8, Version 2
Location name: Longmont, Colorado, USA*
Latitude: 40.1019°, Longitude: -105.1769°
Elevation: 5108.03 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)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.218** (0.176-0.272)	**0.265** (0.213-0.331)	**0.359** (0.288-0.450)	**0.453** (0.361-0.571)	**0.608** (0.477-0.825)	**0.748** (0.565-1.02)	**0.904** (0.655-1.26)	**1.08** (0.744-1.54)	**1.34** (0.881-1.96)	**1.56** (0.985-2.27)
10-min	**0.319** (0.257-0.399)	**0.387** (0.312-0.485)	**0.525** (0.421-0.659)	**0.664** (0.529-0.836)	**0.891** (0.699-1.21)	**1.10** (0.827-1.49)	**1.32** (0.959-1.84)	**1.58** (1.09-2.26)	**1.96** (1.29-2.87)	**2.28** (1.44-3.33)
15-min	**0.389** (0.314-0.486)	**0.472** (0.380-0.591)	**0.640** (0.514-0.803)	**0.809** (0.645-1.02)	**1.09** (0.852-1.47)	**1.34** (1.01-1.82)	**1.61** (1.17-2.25)	**1.93** (1.33-2.75)	**2.39** (1.57-3.50)	**2.78** (1.76-4.06)
30-min	**0.529** (0.427-0.661)	**0.641** (0.516-0.802)	**0.867** (0.695-1.09)	**1.10** (0.872-1.38)	**1.47** (1.15-1.99)	**1.81** (1.37-2.46)	**2.18** (1.58-3.04)	**2.61** (1.80-3.73)	**3.24** (2.13-4.74)	**3.76** (2.38-5.50)
60-min	**0.652** (0.525-0.814)	**0.791** (0.637-0.990)	**1.07** (0.859-1.34)	**1.35** (1.08-1.71)	**1.81** (1.42-2.46)	**2.23** (1.68-3.03)	**2.69** (1.95-3.74)	**3.21** (2.21-4.58)	**3.98** (2.62-5.81)	**4.61** (2.92-6.74)
2-hr	**0.774** (0.629-0.958)	**0.941** (0.764-1.17)	**1.28** (1.03-1.59)	**1.61** (1.29-2.01)	**2.16** (1.71-2.89)	**2.65** (2.02-3.56)	**3.19** (2.33-4.40)	**3.81** (2.65-5.38)	**4.71** (3.13-6.82)	**5.46** (3.50-7.91)
3-hr	**0.847** (0.692-1.04)	**1.03** (0.841-1.27)	**1.40** (1.13-1.72)	**1.76** (1.42-2.18)	**2.34** (1.86-3.12)	**2.86** (2.19-3.83)	**3.44** (2.53-4.71)	**4.10** (2.87-5.75)	**5.05** (3.38-7.27)	**5.85** (3.77-8.42)
6-hr	**1.02** (0.840-1.24)	**1.23** (1.01-1.50)	**1.65** (1.35-2.02)	**2.05** (1.67-2.52)	**2.70** (2.16-3.55)	**3.28** (2.53-4.33)	**3.91** (2.90-5.29)	**4.62** (3.27-6.41)	**5.66** (3.83-8.05)	**6.52** (4.25-9.29)
12-hr	**1.27** (1.05-1.53)	**1.52** (1.26-1.83)	**2.00** (1.65-2.41)	**2.45** (2.01-2.98)	**3.17** (2.55-4.10)	**3.80** (2.95-4.94)	**4.48** (3.35-5.98)	**5.25** (3.74-7.18)	**6.35** (4.33-8.92)	**7.26** (4.78-10.2)
24-hr	**1.51** (1.26-1.80)	**1.84** (1.54-2.20)	**2.43** (2.03-2.92)	**2.97** (2.46-3.58)	**3.79** (3.05-4.80)	**4.47** (3.49-5.72)	**5.20** (3.91-6.82)	**5.99** (4.30-8.07)	**7.11** (4.89-9.85)	**8.01** (5.34-11.2)
2-day	**1.70** (1.44-2.01)	**2.14** (1.81-2.54)	**2.89** (2.42-3.43)	**3.53** (2.95-4.21)	**4.45** (3.59-5.52)	**5.18** (4.07-6.52)	**5.94** (4.50-7.66)	**6.74** (4.87-8.93)	**7.83** (5.43-10.7)	**8.68** (5.85-12.0)
3-day	**1.86** (1.58-2.18)	**2.31** (1.95-2.71)	**3.07** (2.59-3.61)	**3.72** (3.12-4.40)	**4.66** (3.77-5.74)	**5.41** (4.27-6.75)	**6.18** (4.70-7.92)	**6.99** (5.09-9.21)	**8.10** (5.66-11.0)	**8.97** (6.09-12.3)
4-day	**2.00** (1.70-2.33)	**2.43** (2.07-2.85)	**3.18** (2.69-3.73)	**3.82** (3.22-4.51)	**4.76** (3.87-5.84)	**5.51** (4.37-6.86)	**6.29** (4.81-8.03)	**7.11** (5.21-9.34)	**8.25** (5.79-11.1)	**9.14** (6.23-12.5)
7-day	**2.34** (2.00-2.71)	**2.75** (2.35-3.19)	**3.47** (2.96-4.04)	**4.10** (3.47-4.79)	**5.02** (4.13-6.12)	**5.77** (4.62-7.13)	**6.56** (5.06-8.31)	**7.39** (5.46-9.63)	**8.55** (6.06-11.5)	**9.47** (6.52-12.8)
10-day	**2.62** (2.25-3.02)	**3.04** (2.61-3.51)	**3.76** (3.22-4.35)	**4.39** (3.73-5.10)	**5.31** (4.38-6.43)	**6.06** (4.87-7.43)	**6.84** (5.31-8.61)	**7.67** (5.70-9.93)	**8.82** (6.29-11.8)	**9.74** (6.74-13.1)
20-day	**3.38** (2.93-3.86)	**3.86** (3.35-4.41)	**4.67** (4.03-5.35)	**5.36** (4.60-6.16)	**6.33** (5.26-7.54)	**7.10** (5.76-8.58)	**7.89** (6.18-9.79)	**8.71** (6.53-11.1)	**9.82** (7.07-12.9)	**10.7** (7.48-14.3)
30-day	**3.99** (3.48-4.52)	**4.56** (3.97-5.17)	**5.49** (4.77-6.25)	**6.27** (5.41-7.16)	**7.33** (6.11-8.64)	**8.15** (6.64-9.76)	**8.98** (7.06-11.0)	**9.81** (7.39-12.4)	**10.9** (7.91-14.2)	**11.8** (8.29-15.6)
45-day	**4.74** (4.15-5.33)	**5.44** (4.77-6.13)	**6.58** (5.74-7.43)	**7.49** (6.50-8.51)	**8.72** (7.29-10.2)	**9.65** (7.88-11.4)	**10.5** (8.33-12.8)	**11.4** (8.66-14.3)	**12.6** (9.16-16.3)	**13.4** (9.54-17.7)
60-day	**5.37** (4.72-6.02)	**6.20** (5.45-6.96)	**7.53** (6.59-8.47)	**8.59** (7.48-9.70)	**9.98** (8.36-11.6)	**11.0** (9.03-13.0)	**12.0** (9.51-14.5)	**13.0** (9.86-16.2)	**14.2** (10.4-18.2)	**15.1** (10.8-19.8)

[1] 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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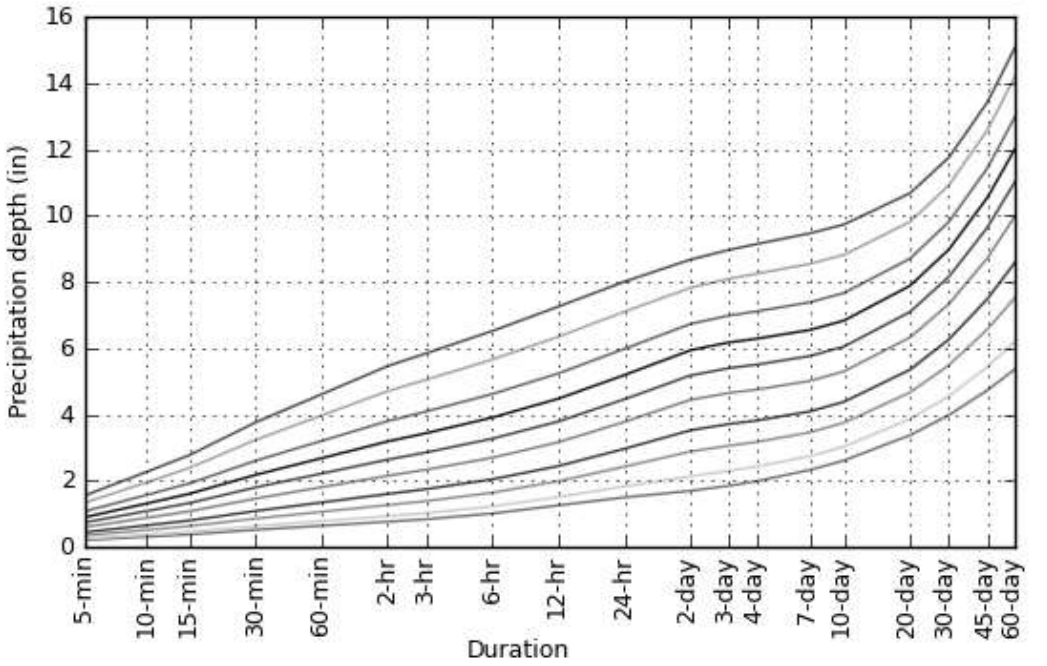
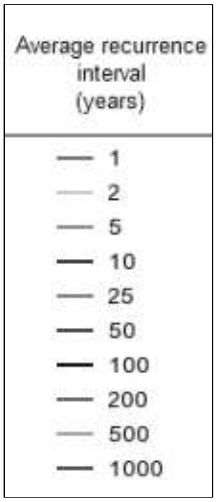
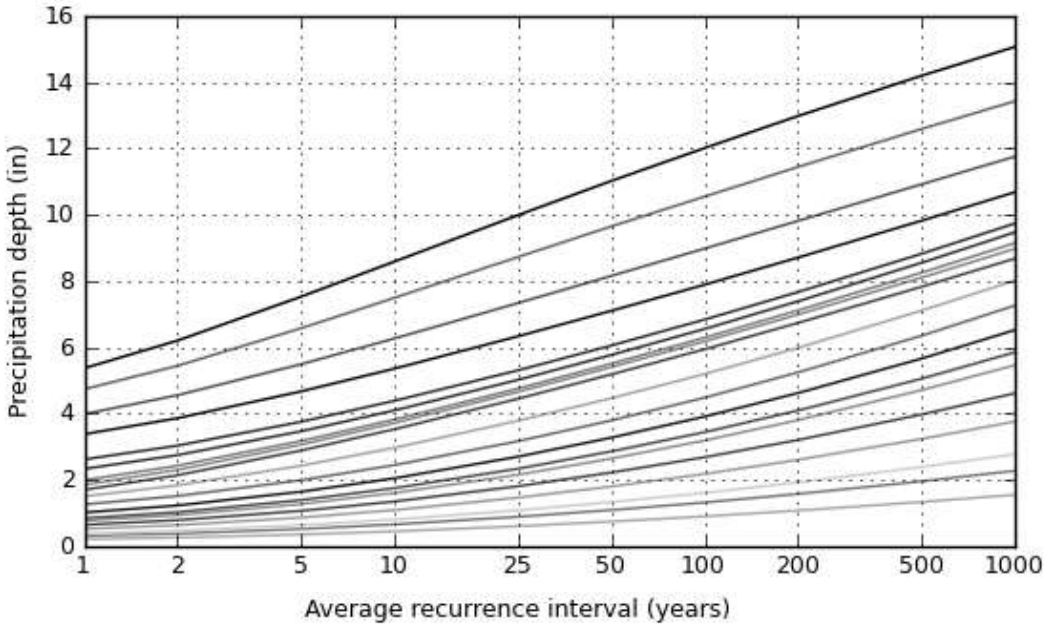
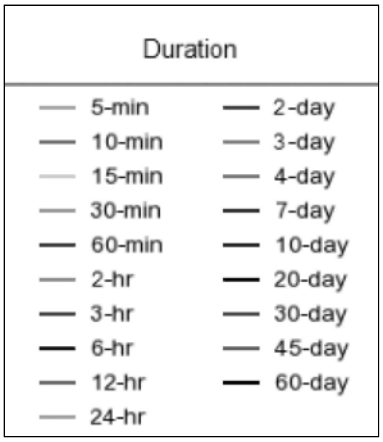
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 40.1019°, Longitude: -105.1769°









NOAA Atlas 14, Volume 8, Version 2

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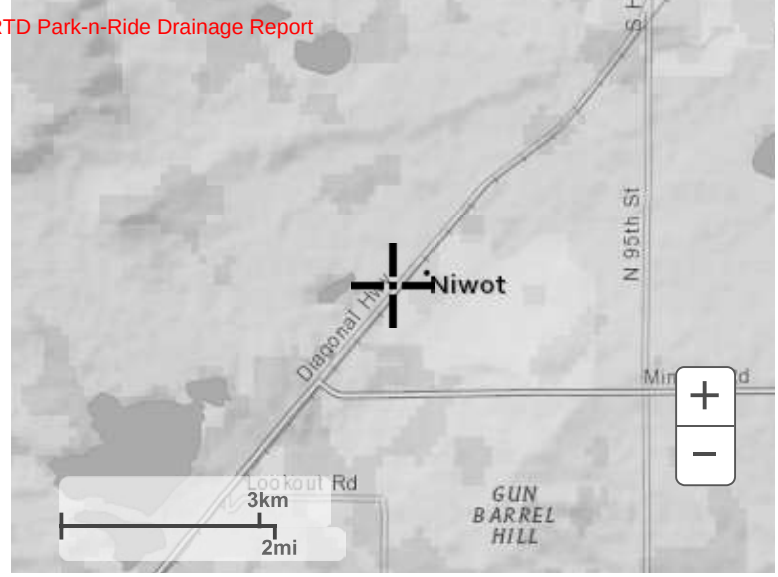
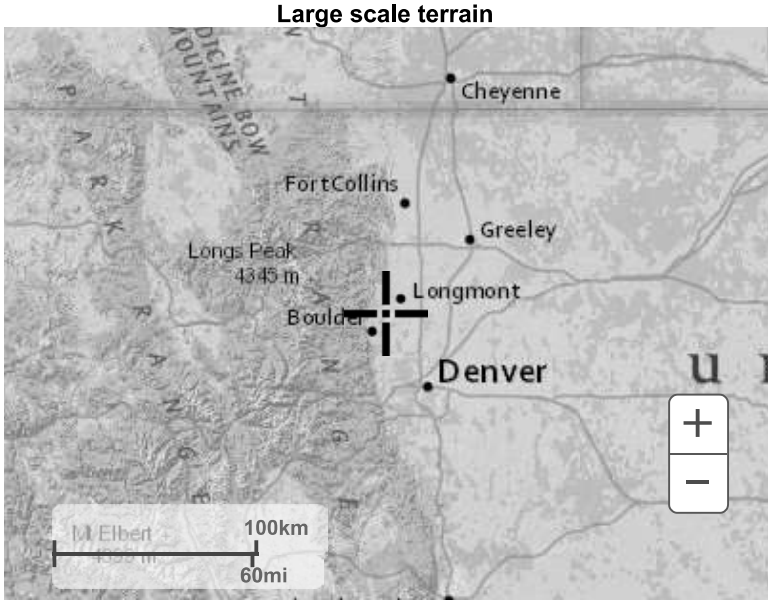
Maps & aerials

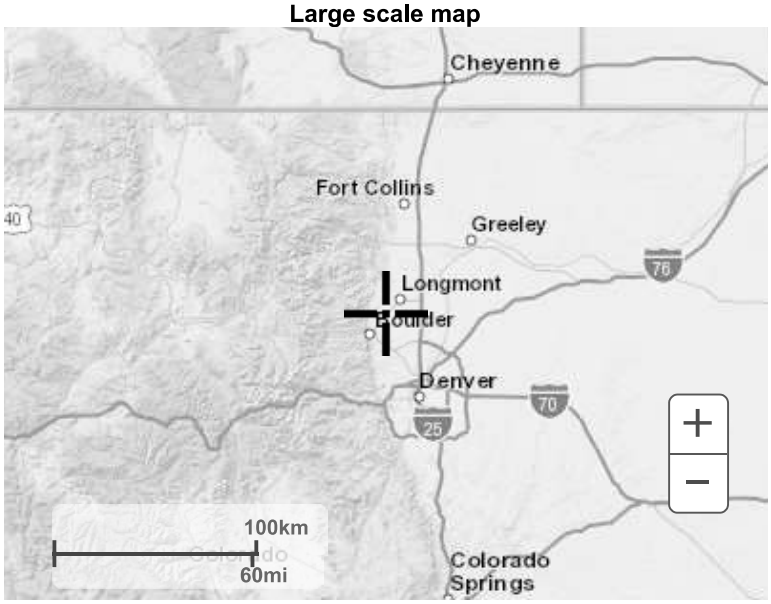
Small scale terrain



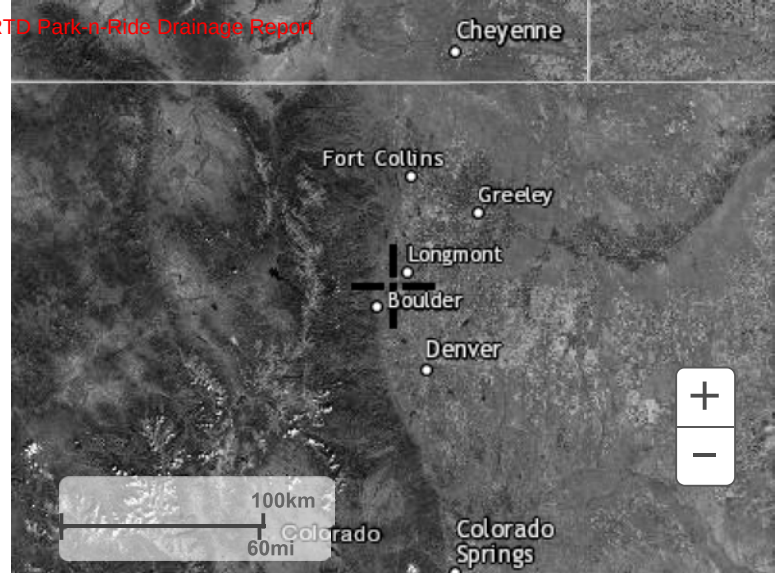
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Calculation of Peak Runoff using Rational Method

Designer: Yong Song
Company: RTD
Date: 7/27/2022
Project: SH 119 BRT
Location: 63rd Street Station - RTD PnR

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$

$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum} = 5$ (urban)
$t_{minimum} = 10$ (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	0.79	1.06	1.33	1.78	2.17	2.61	3.82
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$

$Q(cfs) = CIA$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
63-EX1	5.39	D	36.5	0.27	0.33	0.40	0.52	0.57	0.63	0.70	252.00	5165.20	5154.00	0.044	13.45	413.00	5154.00	5146.00	0.019	7	0.97	7.07	20.51	23.30	20.51	1.52	2.06	2.58	3.46	4.21	5.07	7.42	2.21	3.68	5.56	9.74	13.00	17.28	28.07
63-PR1	0.60	D	88.5	0.73	0.76	0.78	0.81	0.83	0.85	0.87	86.00	5156.29	5155.83	0.005	7.08	266.00	5155.83	5154.14	0.006	20	1.59	2.78	9.86	13.56	9.86	2.14	2.88	3.62	4.84	5.90	7.10	10.39	0.93	1.30	1.69	2.35	2.92	3.58	5.37
63-PR2	0.54	D	95.9	0.80	0.82	0.84	0.86	0.87	0.88	0.89	69.00	5156.81	5155.47	0.019	3.41	370.00	5155.47	5153.51	0.005	20	1.46	4.24	7.65	13.48	7.65	2.34	3.16	3.97	5.31	6.48	7.79	11.40	1.01	1.40	1.80	2.46	3.04	3.69	5.49
63-PR3	0.64	D	91.0	0.75	0.78	0.80	0.83	0.84	0.86	0.87	93.00	5155.48	5154.04	0.015	4.87	220.00	5154.04	5152.96	0.005	20	1.40	2.62	7.49	12.94	7.49	2.36	3.19	4.00	5.35	6.52	7.85	11.48	1.12	1.57	2.03	2.82	3.49	4.27	6.38
63-PR4	1.21	D	76.7	0.62	0.66	0.70	0.75	0.77	0.80	0.83	73.00	5162.13	5158.50	0.050	4.00	523.00	5158.50	5153.15	0.010	20	2.02	4.31	8.31	17.33	8.31	2.28	3.07	3.86	5.16	6.29	7.57	11.08	1.70	2.45	3.24	4.67	5.87	7.30	11.11
63-PR5 (DB)	0.53	D	1.3	0.01	0.05	0.14	0.33	0.40	0.49	0.59																													
63-PR6	0.46	D	100.0	0.83	0.85	0.87	0.88	0.89	0.89	0.90	74.00	5165.07	5161.25	0.052	2.26	283.00	5161.25	5157.53	0.013	20	2.29	2.06	4.32	10.79	5.00	2.66	3.60	4.51	6.04	7.36	8.85	12.96	1.03	1.41	1.81	2.46	3.02	3.66	5.42
63-PR7	0.93	D	89.3	0.73	0.76	0.79	0.82	0.83	0.85	0.87	262.00	5165.30	5155.91	0.036	6.47	267.00	5155.91	5153.67	0.008	20	1.83	2.43	8.90	13.08	8.90	2.22	3.00	3.76	5.04	6.14	7.38	10.81	1.52	2.13	2.76	3.84	4.76	5.83	8.74
63-PR8	0.32	D	100.0	0.83	0.85	0.87	0.88	0.89	0.89	0.90	45.00	5155.01	5154.45	0.012	2.82	180.00	5154.45	5153.89	0.004	20	1.30	2.31	5.13	11.01	5.13	2.65	3.57	4.48	6.00	7.31	8.79	12.87	0.70	0.97	1.24	1.68	2.07	2.51	3.71

63rd Street RTD P-n-R

EXISTING CONDITIONS DRAINAGE BASINS

Basin ID	Total Area (sq. ft.)	Total Area (acres)	Landscaped Area (sq. ft.)	Paved Area (sq. ft.)	% Landscaped Area	% Paved Area	Note
63-EX1	234,550	5.385	148,983	85,567	63.5	36.5	

PROPOSED CONDITIONS DRAINAGE BASINS

Basin ID	Total Area (sq. ft.)	Total Area (acres)	Landscaped Area (sq. ft.)	Paved Area (sq. ft.)	% Landscaped Area	% Paved Area	Note
63-PR1	25,970	0.596	2,986	22,984	11.5	88.5	
63-PR2	23,551	0.541	964	22,587	4.1	95.9	
63-PR3	27,663	0.635	2,484	25,179	9.0	91.0	
63-PR4	52,683	1.209	12,274	40,409	23.3	76.7	
63-PR5 (DB)	23,273	0.534	22,973	300	98.7	1.3	DB Basin
Total for Basins draining into DB	153,140	3.516	41,681	111,459	27.2	72.8	
		0.000					
63-PR6	20,156	0.463	0	20,156	0.0	100.0	
63-PR7	40,514	0.930	4,327	36,187	10.7	89.3	
63-PR8	13,884	0.319	0	13,884	0.0	100.0	
Total	227,694	5.227	46,008	181,686	20.2	79.8	Exclude bike trail area (8144 sf) which drains into sump pumps at 63rd Street underpass

Back up Calc for UD Detention

Proposed P-n-R Site

H (ft)	L (ft)	Slope (ft/ft)	LC (ft)
8.98	596	0.015	279

NOAA Atlas 14, Volume 8, Version 2
Location name: Boulder, Colorado, USA*
Latitude: 40.0742°, Longitude: -105.2073°
Elevation: 5151.67 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)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.213** (0.174-0.264)	**0.260** (0.212-0.322)	**0.354** (0.287-0.439)	**0.446** (0.359-0.556)	**0.595** (0.470-0.795)	**0.728** (0.553-0.975)	**0.876** (0.637-1.20)	**1.04** (0.720-1.46)	**1.29** (0.847-1.85)	**1.49** (0.943-2.14)
10-min	**0.312** (0.255-0.386)	**0.381** (0.310-0.472)	**0.518** (0.420-0.642)	**0.653** (0.526-0.814)	**0.872** (0.688-1.16)	**1.07** (0.810-1.43)	**1.28** (0.933-1.76)	**1.53** (1.06-2.14)	**1.88** (1.24-2.70)	**2.18** (1.38-3.13)
15-min	**0.381** (0.310-0.471)	**0.465** (0.379-0.576)	**0.631** (0.512-0.783)	**0.796** (0.641-0.992)	**1.06** (0.839-1.42)	**1.30** (0.988-1.74)	**1.57** (1.14-2.14)	**1.86** (1.29-2.61)	**2.30** (1.51-3.30)	**2.66** (1.68-3.82)
30-min	**0.521** (0.425-0.644)	**0.635** (0.516-0.785)	**0.859** (0.696-1.07)	**1.08** (0.871-1.35)	**1.45** (1.14-1.93)	**1.77** (1.34-2.37)	**2.13** (1.55-2.91)	**2.53** (1.75-3.55)	**3.13** (2.06-4.49)	**3.62** (2.29-5.20)
60-min	**0.645** (0.525-0.797)	**0.785** (0.639-0.971)	**1.06** (0.860-1.32)	**1.33** (1.07-1.66)	**1.78** (1.40-2.37)	**2.17** (1.65-2.90)	**2.61** (1.90-3.57)	**3.10** (2.14-4.34)	**3.82** (2.51-5.48)	**4.41** (2.79-6.34)
2-hr	**0.768** (0.631-0.941)	**0.935** (0.767-1.15)	**1.26** (1.03-1.55)	**1.59** (1.29-1.96)	**2.11** (1.68-2.78)	**2.57** (1.97-3.41)	**3.09** (2.26-4.18)	**3.66** (2.55-5.08)	**4.51** (3.00-6.41)	**5.21** (3.33-7.41)
3-hr	**0.844** (0.696-1.03)	**1.03** (0.844-1.25)	**1.38** (1.13-1.69)	**1.73** (1.41-2.12)	**2.28** (1.82-2.99)	**2.77** (2.13-3.65)	**3.32** (2.45-4.47)	**3.93** (2.76-5.42)	**4.82** (3.23-6.81)	**5.56** (3.58-7.87)
6-hr	**1.02** (0.851-1.24)	**1.23** (1.02-1.49)	**1.64** (1.35-1.98)	**2.03** (1.66-2.46)	**2.65** (2.13-3.43)	**3.19** (2.48-4.16)	**3.79** (2.82-5.05)	**4.46** (3.16-6.09)	**5.43** (3.68-7.61)	**6.24** (4.07-8.75)
12-hr	**1.28** (1.07-1.53)	**1.53** (1.28-1.83)	**2.00** (1.67-2.40)	**2.45** (2.03-2.95)	**3.15** (2.55-4.03)	**3.76** (2.94-4.84)	**4.43** (3.32-5.83)	**5.17** (3.69-6.98)	**6.23** (4.26-8.63)	**7.11** (4.69-9.89)
24-hr	**1.53** (1.29-1.81)	**1.86** (1.57-2.21)	**2.47** (2.07-2.93)	**3.01** (2.51-3.60)	**3.83** (3.10-4.81)	**4.52** (3.55-5.72)	**5.25** (3.96-6.81)	**6.04** (4.35-8.04)	**7.15** (4.93-9.78)	**8.05** (5.37-11.1)
2-day	**1.72** (1.46-2.01)	**2.17** (1.85-2.55)	**2.95** (2.49-3.47)	**3.61** (3.04-4.27)	**4.56** (3.69-5.61)	**5.31** (4.19-6.62)	**6.09** (4.63-7.77)	**6.90** (5.01-9.05)	**8.01** (5.56-10.8)	**8.87** (5.99-12.1)
3-day	**1.87** (1.60-2.18)	**2.34** (1.99-2.73)	**3.13** (2.66-3.66)	**3.81** (3.21-4.47)	**4.77** (3.89-5.83)	**5.54** (4.40-6.86)	**6.34** (4.85-8.05)	**7.17** (5.24-9.35)	**8.31** (5.81-11.1)	**9.20** (6.25-12.5)
4-day	**2.02** (1.73-2.34)	**2.47** (2.11-2.87)	**3.24** (2.76-3.77)	**3.90** (3.30-4.57)	**4.86** (3.98-5.93)	**5.64** (4.50-6.96)	**6.45** (4.95-8.15)	**7.29** (5.35-9.48)	**8.46** (5.95-11.3)	**9.38** (6.41-12.7)
7-day	**2.38** (2.05-2.74)	**2.80** (2.41-3.23)	**3.52** (3.02-4.07)	**4.16** (3.55-4.83)	**5.10** (4.22-6.18)	**5.87** (4.73-7.21)	**6.69** (5.18-8.41)	**7.55** (5.60-9.76)	**8.76** (6.23-11.6)	**9.72** (6.70-13.1)
10-day	**2.68** (2.32-3.08)	**3.10** (2.68-3.55)	**3.81** (3.28-4.39)	**4.45** (3.81-5.14)	**5.38** (4.47-6.48)	**6.15** (4.97-7.50)	**6.96** (5.42-8.70)	**7.82** (5.83-10.0)	**9.02** (6.45-11.9)	**9.98** (6.92-13.3)
20-day	**3.47** (3.03-3.94)	**3.95** (3.44-4.49)	**4.76** (4.13-5.42)	**5.45** (4.70-6.23)	**6.43** (5.37-7.62)	**7.21** (5.87-8.66)	**8.01** (6.30-9.87)	**8.85** (6.66-11.2)	**9.99** (7.21-13.0)	**10.9** (7.64-14.4)
30-day	**4.09** (3.59-4.62)	**4.67** (4.09-5.27)	**5.61** (4.89-6.35)	**6.40** (5.54-7.27)	**7.47** (6.25-8.76)	**8.30** (6.79-9.88)	**9.14** (7.21-11.2)	**9.98** (7.54-12.5)	**11.1** (8.06-14.3)	**11.9** (8.45-15.7)
45-day	**4.87** (4.29-5.46)	**5.59** (4.92-6.28)	**6.74** (5.91-7.59)	**7.68** (6.69-8.68)	**8.93** (7.49-10.4)	**9.86** (8.09-11.6)	**10.8** (8.54-13.0)	**11.7** (8.86-14.5)	**12.8** (9.36-16.4)	**13.7** (9.74-17.9)
60-day	**5.53** (4.89-6.18)	**6.39** (5.64-7.14)	**7.74** (6.80-8.67)	**8.82** (7.71-9.93)	**10.2** (8.61-11.8)	**11.3** (9.29-13.2)	**12.3** (9.78-14.8)	**13.3** (10.1-16.5)	**14.5** (10.6-18.5)	**15.4** (11.0-20.1)

[1] 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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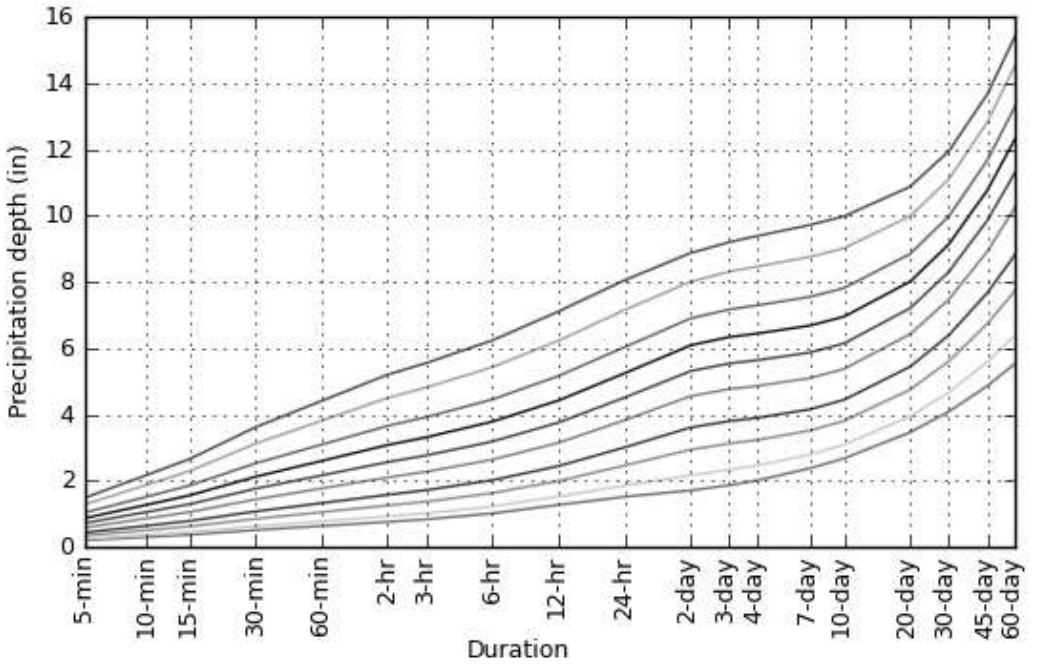
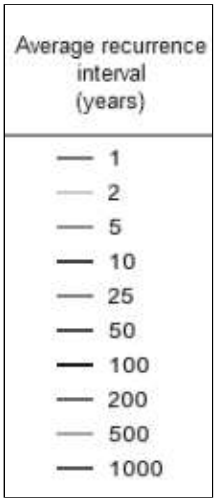
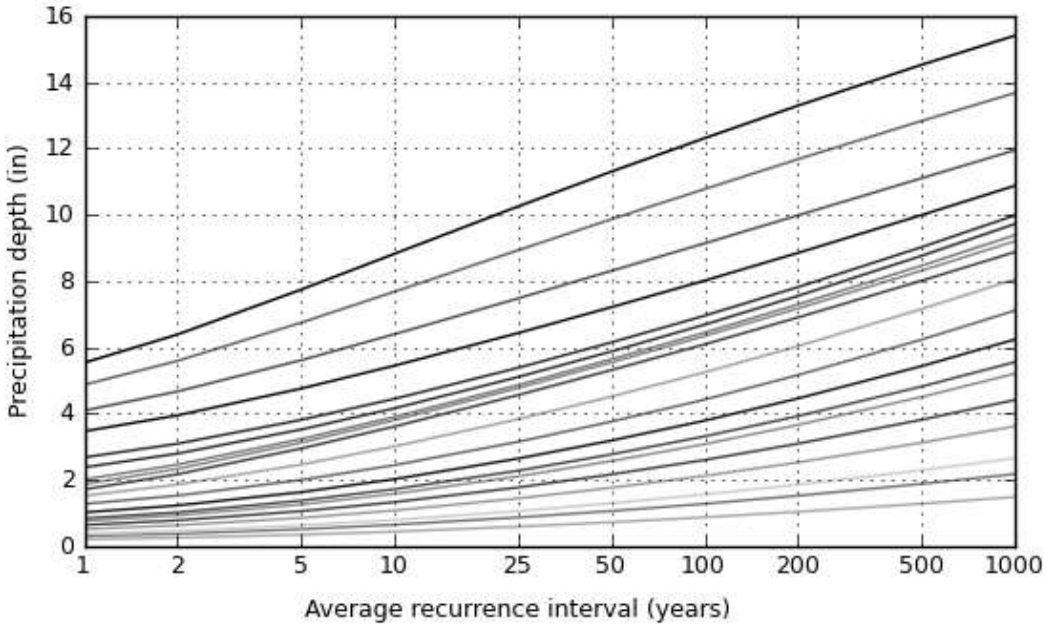
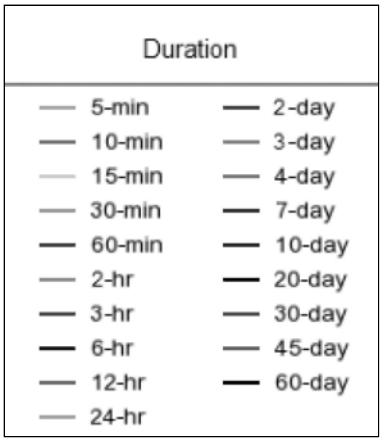
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 40.0742°, Longitude: -105.2073°









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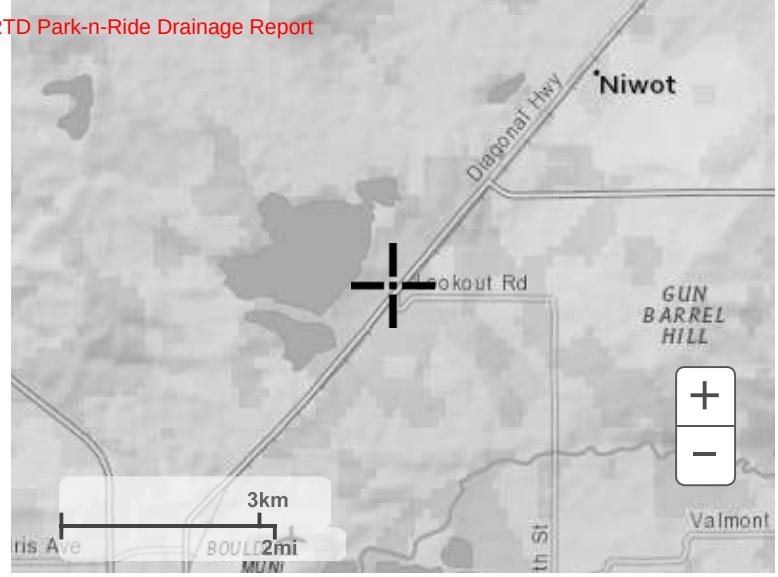
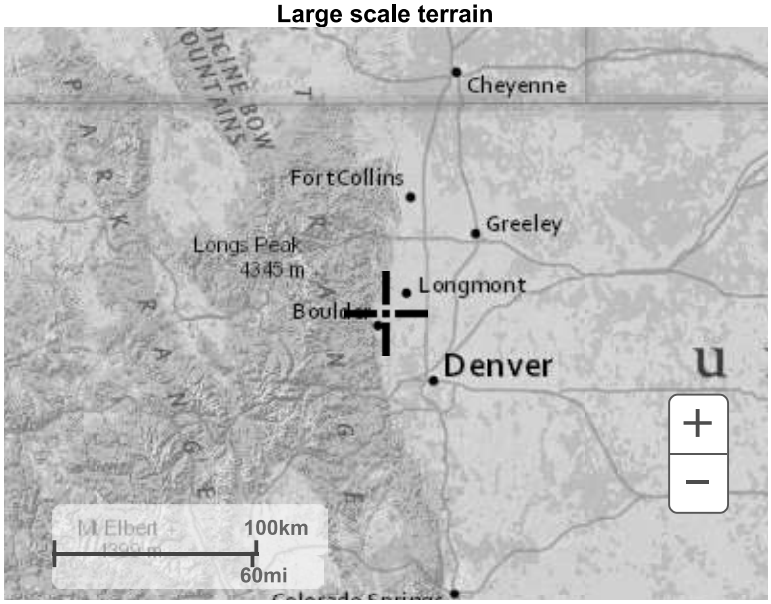
Maps & aerials

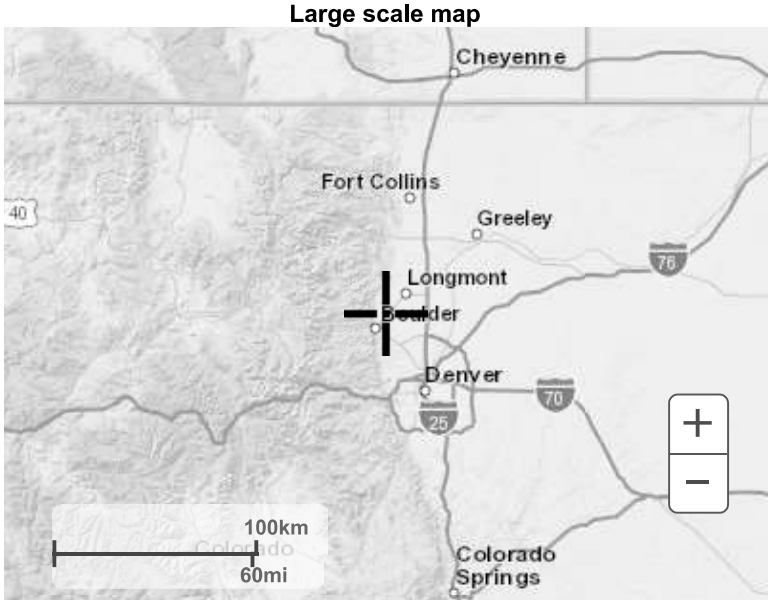
Small scale terrain



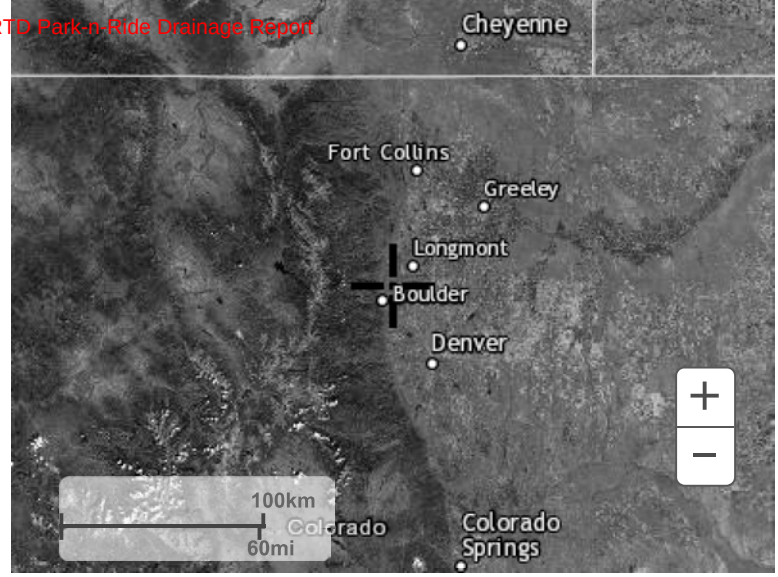
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
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Silver Spring, MD 20910
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Disclaimer

APPENDIX F

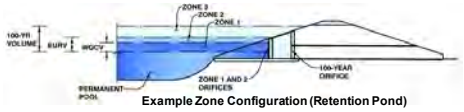
DETENTION BASIN DESIGN CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: SH119 BRT - Niwot Road Station PnR

Basin ID: Proposed Condition Basins PR1 thru PR5



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	2.98	acres
Watershed Length =	573	ft
Watershed Length to Centroid =	156	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	81.10%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.083	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.237	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.79 in.) =	0.141	acre-feet	0.79 inches
5-yr Runoff Volume (P1 = 1.07 in.) =	0.202	acre-feet	1.07 inches
10-yr Runoff Volume (P1 = 1.35 in.) =	0.269	acre-feet	1.35 inches
25-yr Runoff Volume (P1 = 1.81 in.) =	0.386	acre-feet	1.81 inches
50-yr Runoff Volume (P1 = 2.23 in.) =	0.491	acre-feet	2.23 inches
100-yr Runoff Volume (P1 = 2.69 in.) =	0.609	acre-feet	2.69 inches
500-yr Runoff Volume (P1 = 3.98 in.) =	0.935	acre-feet	3.98 inches
Approximate 2-yr Detention Volume =	0.143	acre-feet	
Approximate 5-yr Detention Volume =	0.208	acre-feet	
Approximate 10-yr Detention Volume =	0.260	acre-feet	
Approximate 25-yr Detention Volume =	0.323	acre-feet	
Approximate 50-yr Detention Volume =	0.362	acre-feet	
Approximate 100-yr Detention Volume =	0.411	acre-feet	

Define Zones and Basin Geometry

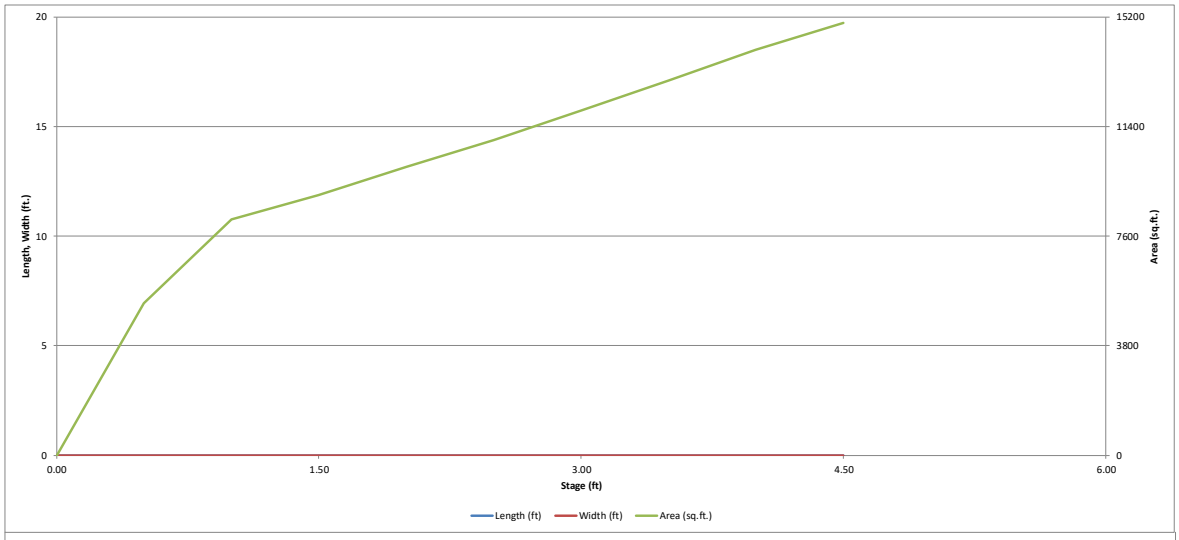
Zone 1 Volume (WQCV) =	0.083	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.154	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.174	acre-feet
Total Detention Basin Volume =	0.411	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

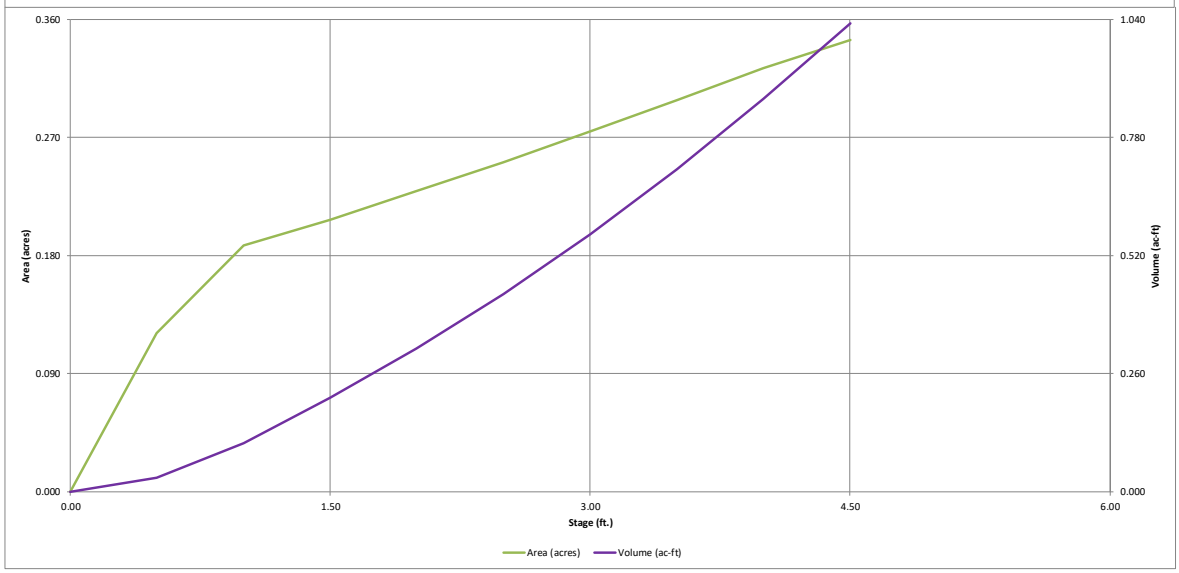
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
	--	0.50	--	--	--	5,274	0.121	1,318	0.030
	--	1.00	--	--	--	8,182	0.188	4,682	0.107
	--	1.50	--	--	--	9,034	0.207	8,986	0.206
	--	2.00	--	--	--	9,992	0.229	13,743	0.315
	--	2.50	--	--	--	10,930	0.251	18,973	0.436
	--	3.00	--	--	--	11,957	0.274	24,695	0.567
	--	3.50	--	--	--	13,000	0.298	30,934	0.710
	--	4.00	--	--	--	14,063	0.323	37,700	0.865
	--	4.50	--	--	--	15,000	0.344	44,966	1.032

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



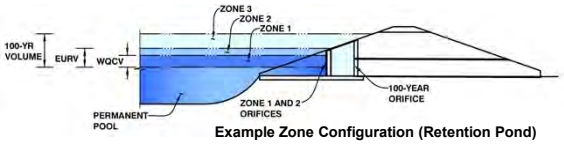


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: SH119 BRT - Niwot Road Station PnR

Basin ID: Proposed Condition Basins PR1 thru PR5



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.87	0.083	Orifice Plate
Zone 2 (EURV)	1.65	0.154	Orifice Plate
Zone 3 (100-year)	2.41	0.174	Weir&Pipe (Restrict)
Total (all zones)		0.411	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.944E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.65	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.00	sq. inches (diameter = 1-1/8 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.70	1.40					
Orifice Area (sq. inches)	1.00	1.00	1.00					

	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)

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

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.70	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.41	N/A	feet
Overflow Weir Front Edge Length =	2.92	N/A	feet	Overflow Weir Slope Length =	2.92	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	9.51	N/A	
Horiz. Length of Weir Sides =	2.83	N/A	feet	Overflow Grate Open Area w/o Debris =	5.93	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	2.96	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.62	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.34	N/A	feet
Restrictor Plate Height Above Pipe Invert =	6.90		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.34	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.70	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.52	feet
Spillway Crest Length =	10.00	feet	Stage at Top of Freeboard =	4.22	feet
Spillway End Slopes =	0.00	H:V	Basin Area at Top of Freeboard =	0.33	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.94	acre-ft

Calculated Parameters for Spillway

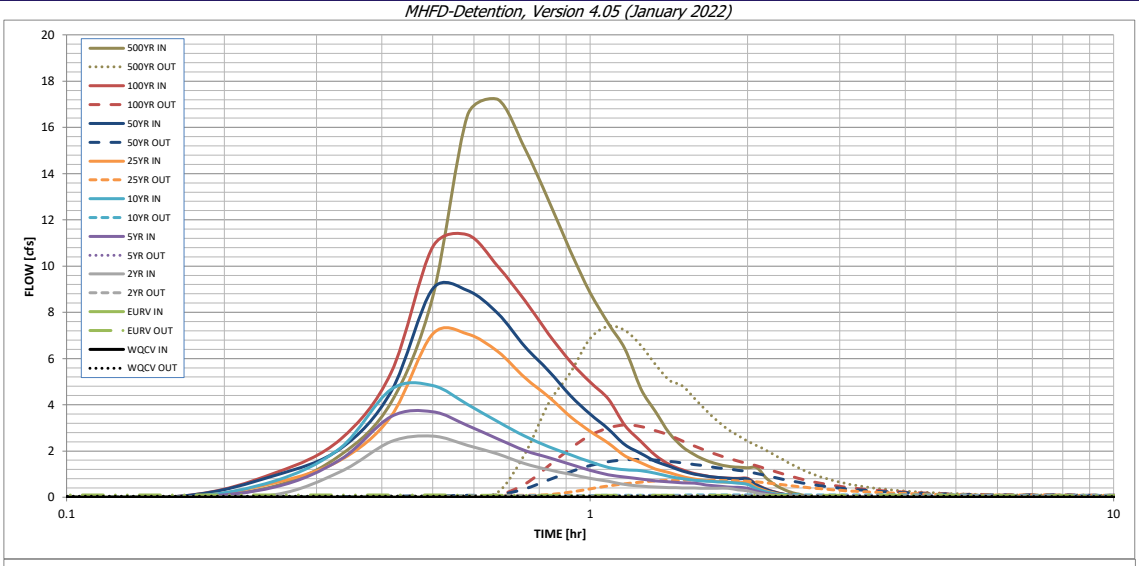
Routed Hydrograph Results

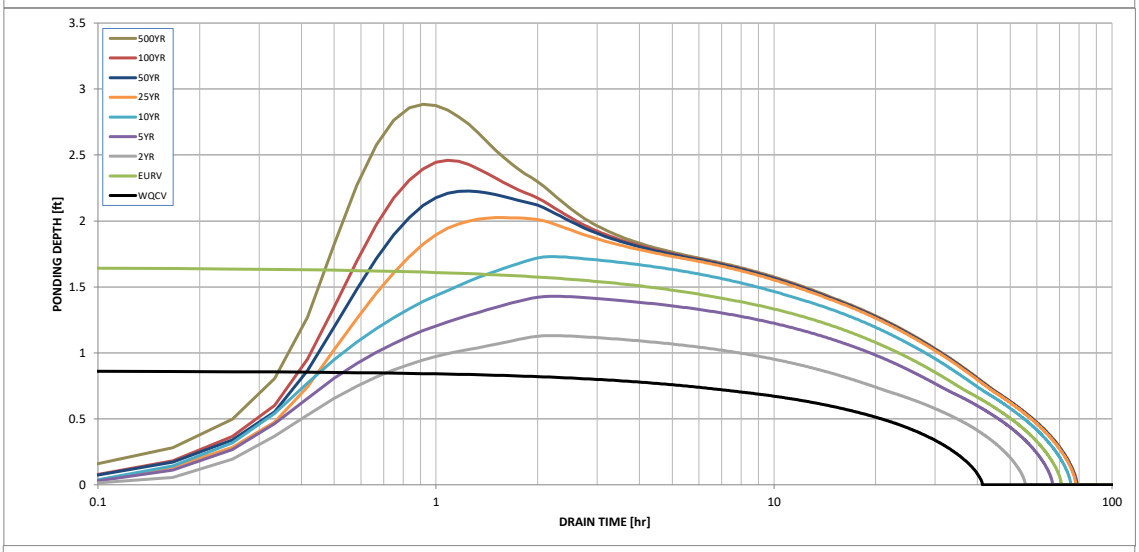
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

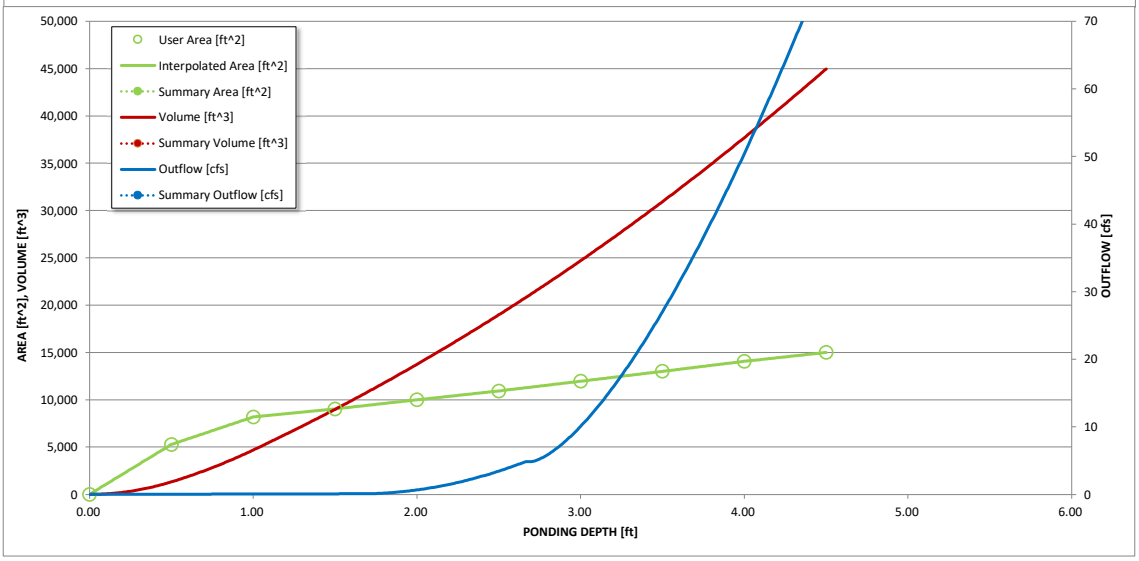
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.79	1.07	1.35	1.81	2.23	2.69	3.98
CUHP Runoff Volume (acre-ft) =	0.083	0.237	0.141	0.202	0.269	0.386	0.491	0.609	0.935
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.141	0.202	0.269	0.386	0.491	0.609	0.935
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.2	0.8	2.3	3.4	4.7	8.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.08	0.28	0.79	1.16	1.59	2.73
Peak Inflow Q (cfs) =	N/A	N/A	2.6	3.7	4.8	7.1	9.0	11.3	17.2
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.1	0.7	1.6	3.1	7.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.1	0.3	0.5	0.7	0.9
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.1	0.3	0.5	0.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	64	51	61	68	68	67	65	59
Time to Drain 99% of Inflow Volume (hours) =	**40**	68	53	64	72	74	73	73	70
Maximum Ponding Depth (ft) =	0.87	1.65	1.13	1.43	1.73	2.03	2.23	2.46	2.88
Area at Maximum Ponding Depth (acres) =	0.17	0.21	0.19	0.20	0.22	0.23	0.24	0.25	0.27
Maximum Volume Stored (acre-ft) =	0.084	0.238	0.132	0.190	0.253	0.320	0.367	0.426	0.534

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	0.06	0.06	0.48
	0:15:00	0.00	0.00	0.11	0.44	0.71	0.63	0.95	1.05	1.82
	0:20:00	0.00	0.00	1.10	1.63	2.13	1.61	2.10	2.51	4.10
	0:25:00	0.00	0.00	2.41	3.49	4.66	3.51	4.56	5.39	8.66
	0:30:00	0.00	0.00	2.65	3.70	4.83	7.06	9.02	10.83	16.53
	0:35:00	0.00	0.00	2.25	3.10	4.01	7.06	8.94	11.35	17.20
	0:40:00	0.00	0.00	1.87	2.52	3.26	6.30	7.94	9.99	15.10
	0:45:00	0.00	0.00	1.45	2.02	2.65	5.17	6.52	8.51	12.84
	0:50:00	0.00	0.00	1.19	1.71	2.19	4.35	5.47	7.06	10.66
	0:55:00	0.00	0.00	1.00	1.42	1.84	3.49	4.40	5.86	8.85
	1:00:00	0.00	0.00	0.82	1.17	1.53	2.85	3.60	4.98	7.52
	1:05:00	0.00	0.00	0.69	0.97	1.29	2.34	2.96	4.25	6.41
	1:10:00	0.00	0.00	0.55	0.87	1.18	1.79	2.27	3.10	4.71
	1:15:00	0.00	0.00	0.48	0.79	1.15	1.49	1.90	2.42	3.71
	1:20:00	0.00	0.00	0.44	0.71	1.04	1.23	1.56	1.81	2.78
	1:25:00	0.00	0.00	0.42	0.66	0.90	1.06	1.35	1.42	2.19
	1:30:00	0.00	0.00	0.41	0.63	0.81	0.90	1.14	1.18	1.84
	1:35:00	0.00	0.00	0.40	0.61	0.74	0.79	1.00	1.02	1.59
	1:40:00	0.00	0.00	0.39	0.53	0.70	0.72	0.91	0.92	1.44
	1:45:00	0.00	0.00	0.39	0.48	0.67	0.68	0.85	0.86	1.34
	1:50:00	0.00	0.00	0.39	0.45	0.65	0.65	0.82	0.83	1.30
	1:55:00	0.00	0.00	0.32	0.42	0.61	0.63	0.80	0.82	1.28
	2:00:00	0.00	0.00	0.28	0.39	0.55	0.63	0.79	0.82	1.28
	2:05:00	0.00	0.00	0.18	0.26	0.36	0.41	0.52	0.54	0.85
	2:10:00	0.00	0.00	0.12	0.17	0.24	0.27	0.34	0.36	0.56
	2:15:00	0.00	0.00	0.08	0.11	0.15	0.17	0.22	0.23	0.36
	2:20:00	0.00	0.00	0.04	0.06	0.09	0.11	0.14	0.14	0.22
	2:25:00	0.00	0.00	0.03	0.04	0.05	0.07	0.08	0.09	0.13
	2:30:00	0.00	0.00	0.01	0.02	0.03	0.03	0.04	0.05	0.07
	2:35:00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

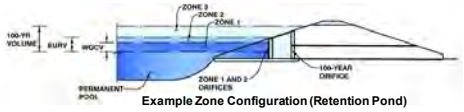
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: SH119 BRT - 63rd Street Station PnR

Basin ID: RTD PnR Onsite Full Spectrum Detention Basin (63-PR1 thru 63-PR5)



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	3.52	acres
Watershed Length =	596	ft
Watershed Length to Centroid =	279	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	72.80%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.084	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.250	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.79 in.) =	0.148	acre-feet	0.79 inches
5-yr Runoff Volume (P1 = 1.06 in.) =	0.215	acre-feet	1.06 inches
10-yr Runoff Volume (P1 = 1.33 in.) =	0.288	acre-feet	1.33 inches
25-yr Runoff Volume (P1 = 1.78 in.) =	0.425	acre-feet	1.78 inches
50-yr Runoff Volume (P1 = 2.17 in.) =	0.541	acre-feet	2.17 inches
100-yr Runoff Volume (P1 = 2.61 in.) =	0.677	acre-feet	2.61 inches
500-yr Runoff Volume (P1 = 3.82 in.) =	1.040	acre-feet	3.82 inches
Approximate 2-yr Detention Volume =	0.148	acre-feet	
Approximate 5-yr Detention Volume =	0.220	acre-feet	
Approximate 10-yr Detention Volume =	0.272	acre-feet	
Approximate 25-yr Detention Volume =	0.338	acre-feet	
Approximate 50-yr Detention Volume =	0.376	acre-feet	
Approximate 100-yr Detention Volume =	0.433	acre-feet	

Define Zones and Basin Geometry

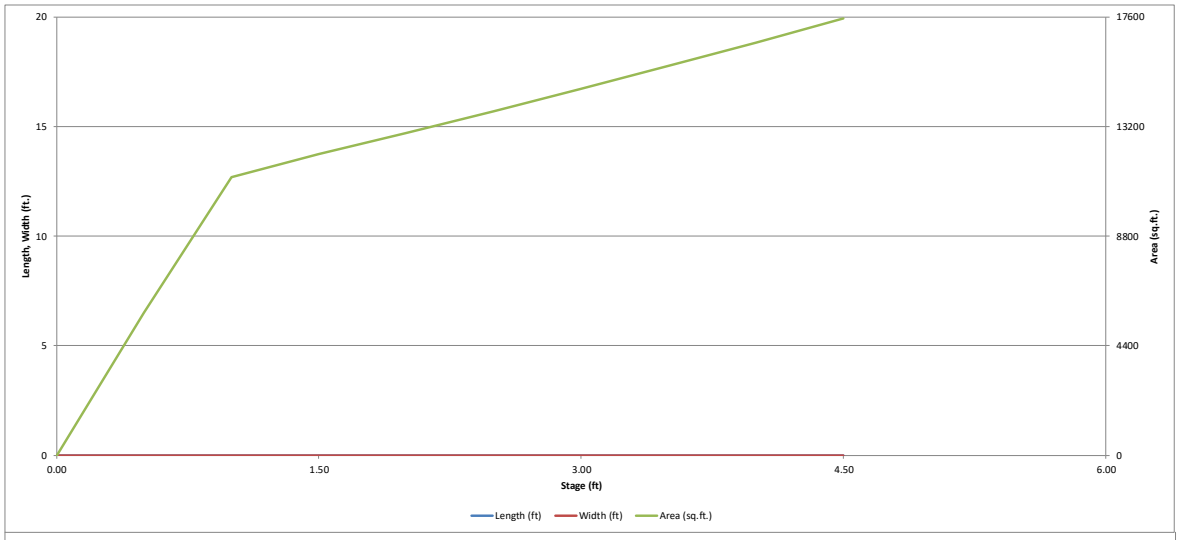
Zone 1 Volume (WQCV) =	0.084	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.165	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.183	acre-feet
Total Detention Basin Volume =	0.433	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

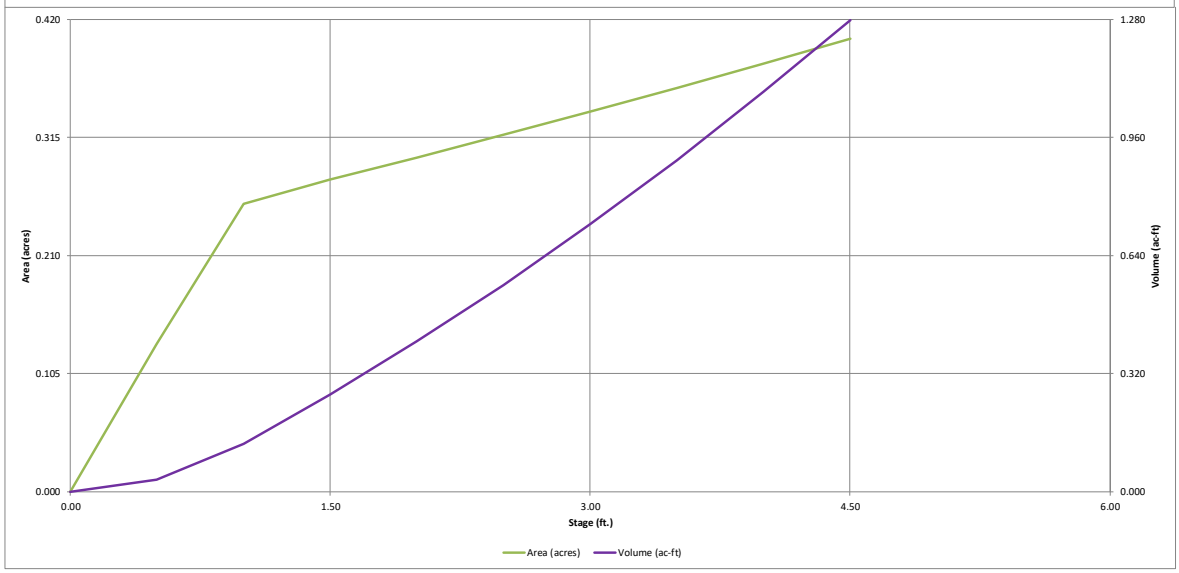
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
	--	0.50	--	--	--	5,713	0.131	1,428	0.033
	--	1.00	--	--	--	11,156	0.256	5,645	0.130
	--	1.50	--	--	--	12,100	0.278	11,459	0.263
	--	2.00	--	--	--	12,946	0.297	17,721	0.407
	--	2.50	--	--	--	13,816	0.317	24,411	0.560
	--	3.00	--	--	--	14,712	0.338	31,543	0.724
	--	3.50	--	--	--	15,633	0.359	39,129	0.898
	--	4.00	--	--	--	16,580	0.381	47,183	1.083
	--	4.50	--	--	--	17,552	0.403	55,716	1.279

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



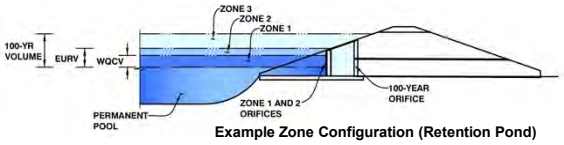


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: SH119 BRT - 63rd Street Station PnR

Basin ID: RTD PnR Onsite Full Spectrum Detention Basin (63-PR1 thru 63-PR5)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.81	0.084	Orifice Plate
Zone 2 (EURV)	1.46	0.165	Orifice Plate
Zone 3 (100-year)	2.09	0.183	Weir&Pipe (Restrict)
Total (all zones)		0.433	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	7.292E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.46	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.05	sq. inches (diameter = 1-1/8 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.70	1.40					
Orifice Area (sq. inches)	1.05	1.05	1.05					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.21	N/A	feet
Overflow Weir Front Edge Length =	2.92	N/A	feet	Overflow Weir Slope Length =	2.92	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.51	N/A	
Horiz. Length of Weir Sides =	2.83	N/A	feet	Overflow Grate Open Area w/o Debris =	5.93	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	2.96	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.70	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.36	N/A	feet
Restrictor Plate Height Above Pipe Invert =	7.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.40	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.53	feet
Spillway Crest Length =	10.00	feet	Stage at Top of Freeboard =	4.03	feet
Spillway End Slopes =	0.00	H:V	Basin Area at Top of Freeboard =	0.38	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.09	acre-ft

Calculated Parameters for Spillway

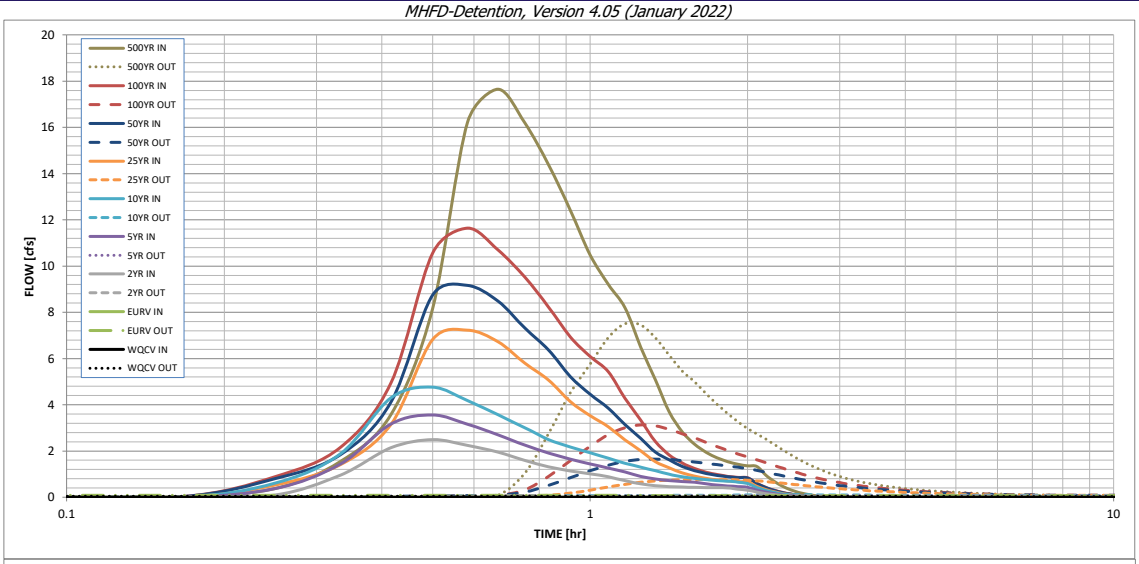
Routed Hydrograph Results

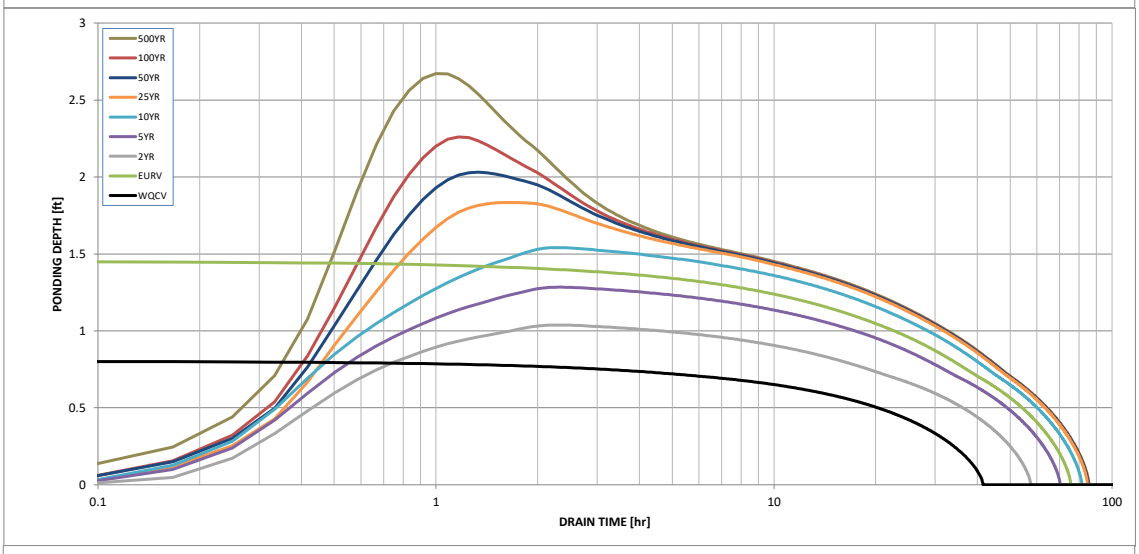
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

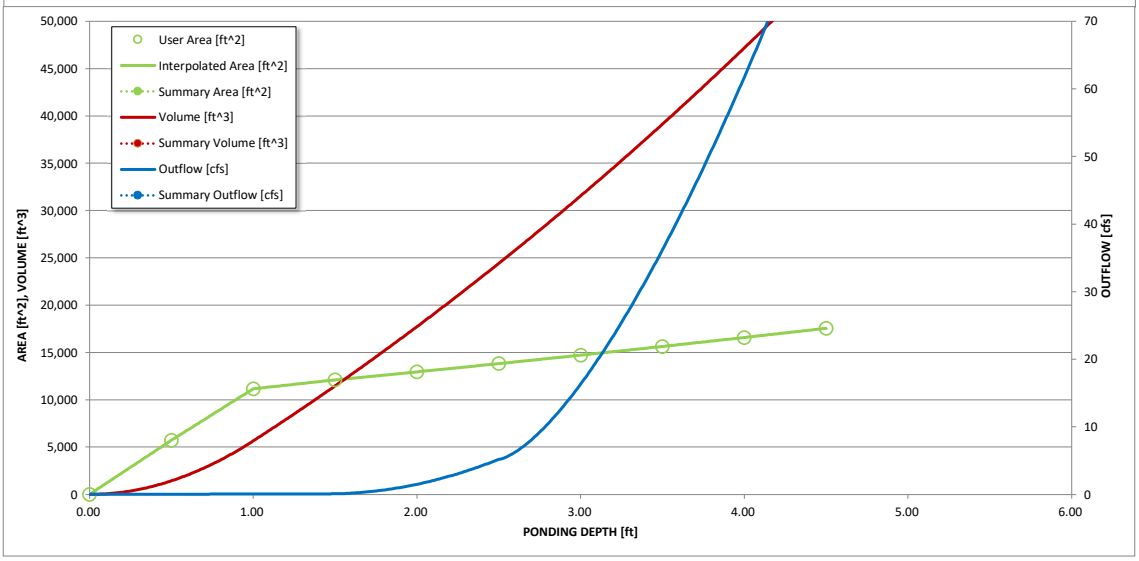
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.79	1.06	1.33	1.78	2.17	2.61	3.82
CUHP Runoff Volume (acre-ft) =	0.084	0.250	0.148	0.215	0.288	0.425	0.541	0.677	1.040
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.148	0.215	0.288	0.425	0.541	0.677	1.040
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.2	0.8	2.4	3.5	5.0	8.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.06	0.24	0.69	1.00	1.41	2.39
Peak Inflow Q (cfs) =	N/A	N/A	2.5	3.6	4.8	7.2	9.2	11.6	17.7
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.1	0.8	1.6	3.1	7.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.1	0.3	0.5	0.6	0.9
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.1	0.3	0.5	0.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	69	53	64	74	74	73	70	65
Time to Drain 99% of Inflow Volume (hours) =	**40**	73	55	68	78	80	80	79	77
Maximum Ponding Depth (ft) =	0.81	1.46	1.04	1.28	1.54	1.83	2.03	2.26	2.67
Area at Maximum Ponding Depth (acres) =	0.21	0.28	0.26	0.27	0.28	0.29	0.30	0.31	0.32
Maximum Volume Stored (acre-ft) =	0.085	0.252	0.137	0.203	0.274	0.357	0.416	0.485	0.615

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	0.03	0.03	0.38
	0:15:00	0.00	0.00	0.09	0.38	0.61	0.53	0.80	0.88	1.54
	0:20:00	0.00	0.00	0.96	1.44	1.88	1.42	1.84	2.16	3.59
	0:25:00	0.00	0.00	2.14	3.17	4.30	3.16	4.12	4.96	8.17
	0:30:00	0.00	0.00	2.49	3.56	4.76	6.82	8.75	10.57	16.23
	0:35:00	0.00	0.00	2.24	3.16	4.18	7.22	9.16	11.64	17.66
	0:40:00	0.00	0.00	1.96	2.70	3.57	6.73	8.49	10.70	16.19
	0:45:00	0.00	0.00	1.59	2.26	3.01	5.80	7.32	9.52	14.38
	0:50:00	0.00	0.00	1.32	1.92	2.50	5.06	6.37	8.23	12.41
	0:55:00	0.00	0.00	1.14	1.65	2.17	4.14	5.22	6.94	10.48
	1:00:00	0.00	0.00	1.01	1.45	1.92	3.53	4.45	6.09	9.20
	1:05:00	0.00	0.00	0.89	1.26	1.69	3.05	3.85	5.43	8.20
	1:10:00	0.00	0.00	0.71	1.09	1.47	2.48	3.14	4.28	6.49
	1:15:00	0.00	0.00	0.58	0.91	1.30	2.00	2.54	3.33	5.08
	1:20:00	0.00	0.00	0.50	0.79	1.15	1.54	1.95	2.41	3.69
	1:25:00	0.00	0.00	0.46	0.72	0.99	1.27	1.62	1.83	2.83
	1:30:00	0.00	0.00	0.44	0.68	0.89	1.05	1.34	1.47	2.29
	1:35:00	0.00	0.00	0.43	0.65	0.81	0.91	1.15	1.25	1.95
	1:40:00	0.00	0.00	0.42	0.58	0.76	0.81	1.03	1.09	1.70
	1:45:00	0.00	0.00	0.41	0.53	0.72	0.75	0.95	0.98	1.54
	1:50:00	0.00	0.00	0.41	0.49	0.70	0.71	0.89	0.91	1.43
	1:55:00	0.00	0.00	0.35	0.46	0.66	0.68	0.85	0.86	1.36
	2:00:00	0.00	0.00	0.31	0.43	0.59	0.66	0.83	0.84	1.33
	2:05:00	0.00	0.00	0.22	0.31	0.42	0.47	0.59	0.60	0.95
	2:10:00	0.00	0.00	0.16	0.22	0.30	0.33	0.42	0.43	0.68
	2:15:00	0.00	0.00	0.11	0.15	0.21	0.23	0.29	0.30	0.48
	2:20:00	0.00	0.00	0.07	0.10	0.14	0.16	0.20	0.21	0.32
	2:25:00	0.00	0.00	0.05	0.07	0.09	0.11	0.13	0.14	0.21
	2:30:00	0.00	0.00	0.03	0.04	0.06	0.07	0.09	0.09	0.14
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	2:40:00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04
	2:45:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

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

APPENDIX G

STORM DRAIN SYSTEM CALCULATIONS

NIWOT ROAD P-n-R

STORM DRAIN SYSTEM DESIGN FLOW RATES

FINAL DEVELOPED HYDROLOGIC CONDITIONS

Storm Drain Inlets

Contributing Basins to SD Inlet	SD Inlet ID	Computed Q100 (cfs)	Inlet Capacity (cfs)	Proposed Inlet	Comments
NW-PR1 (Sump)	IN 1	3.4	5.4	5' Type R Inlet	Max Depth = 6 inches
NW-PR2 (Sump)	IN 2	3.7	5.4	5' Type R Inlet	Max Depth = 6 inches
NW-PR3 (Sump)	IN 3	6.3	8.3	10' Type R Inlet	Max Depth = 6 inches
NW-PR4 (Sump)	IN 4	3.4	5.4	5' Type R Inlet	Max Depth = 6 inches
NW-PR7 (Continuous)	IN 5	3.9	3.8	10' Type R Inlet	99% Capture

Storm Drain Pipes

Contributing Basins to SD Pipe	Upstream Node	Downstream Node	Computed Q100 (cfs)	Length (ft)	Slope (ft/ft)	Pipe Size (inch)*	Comments
NW-PR6	FES1	MH1	3.1	55.0	0.027	18 inch RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs
18" RCP under Niwot, NW-PR6	MH1	MH2, MH3	16.6	362.0	0.004	30 inch RCP	30" RCP @ 0.4% FF Cap = 25.9 cfs
18" RCP under Niwot, NW-PR6, DB Outflow	MH3	FES2	21.0	25.0	0.008	30 inch RCP	30" RCP @ 0.4% FF Cap = 25.9 cfs
NW-PR2	IN2	IN1	3.7	150.0	0.005	18 inch RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs
NW-PR4	IN4	IN1	3.4	85.0	0.005	18 inch RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs
NW-PR1, NW-PR2, NW-PR4	IN1	DB	10.5	15.0	0.013	24 inch RCP	24" RCP @ 0.5% FF Cap = 16 cfs
NW-PR7	IN5	MH-O	3.9	10.0	0.005	18 inch RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs
NW-PR3	IN3	DB	6.3	90.0	0.003	24 inch RCP	24" RCP @ 0.3% FF Cap = 12 cfs

* Pipe culvert size approximated based on Bently Flowmaster normal depth flowing-full (FF) capacity

18" RCP under Niwot	Length (ft)	H(ft)	Slope (ft/ft)	Q full (cfs)
Existing culvert under Niwot Road	136	2.17	0.016	13.5

63rd Street P-n-R

STORM DRAIN SYSTEM DESIGN

PROPOSED HYDROLOGIC CONDITIONS

Storm Drain Inlets

Contributing Basins to SD Inlet	SD Inlet ID	Computed Q100 (cfs)	Inlet Capacity (cfs)	Proposed Inlet	Comments
63-PR1 (Sump)	IN 1	3.6	5.4	5' Type R Inlet	Max Depth = 6 inches
63-PR2 (Sump)	IN 2	3.7	5.4	5' Type R Inlet	Max Depth = 6 inches
63-PR3 (Sump)	IN 3	4.3	5.4	5' Type R Inlet	Max Depth = 6 inches
63-PR4 (Area Inlet)	IN 4	7.3	8.3	CDOT Type C	
63-PR6 (Continuous)	IN 5	3.7	4.0	10' Type R Inlet	99% Capture
63-PR8 (Sump)	IN 6	2.5	5.4	5' Type R Inlet	Max Depth = 6 inches
63-PR7*	IN 7	5.8			

* For SD Inlet and pipe design for Basin 63-PR7, refer to CO 119 Safety and Mobility Improvements Project, Preliminary Drainage Report, August 2022.

Storm Drain Pipes

Contributing Basins to SD Pipe	Upstream Node	Downstream Node	Computed Q100 (cfs)	Length (ft)	Slope (ft/ft)	Pipe Size (inch)*	Comments
offsite CDOT Median Area (Muller Basin P172C**)	FES 1	MH 1	11.9	75.0	0.005	24" RCP	24" RCP @ 0.5% FF Cap = 16 cfs
DB Outflow	DB Out	MH 1	3.1	30.0	0.005	18" RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs
P172C, DB Outflow	MH 1	MH 2	15.0	207.0	0.005	24" RCP	24" RCP @ 0.5% FF Cap = 16 cfs
63-PR8	IN 6	MH 2	2.5	35.0	0.086	18" RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs
P172C, DB Outflow, 63-PR8	MH 2	CBC	17.5	28.0	0.005	30" RCP	30" RCP @ 0.4% FF Cap = 25.9 cfs
63-PR3	IN 3	IN 2	4.3	45.0	0.005	18" RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs
63-PR3, 63-PR2	IN 2	IN 1	8.0	95.0	0.005	24" RCP	24" RCP @ 0.5% FF Cap = 16 cfs
63-PR4	IN 4	IN 1	7.3	55.0	0.005	18" RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs
63-PR1, 63-PR2, 63-PR3, 63-PR4	IN 1	DB In	18.9	35.0	0.005	30" RCP	30" RCP @ 0.4% FF Cap = 25.9 cfs
63-PR6	IN 5	CBC	3.7	230.0	0.022	18" RCP	18" RCP @ 0.5% FF Cap = 7.4 cfs

* Pipe culvert size approximated based on Bently Flowmaster normal depth flowing-full (FF) capacity

** Basin P172C - refer to CO 119 Safety and Mobility Improvements Project, Preliminary Drainage Report, August 2022.

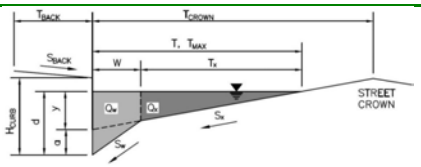
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: **SH 119 BRT - RTD P-n-R**

Inlet ID: **Type R Sump 5 Cap**



Gutter Geometry:

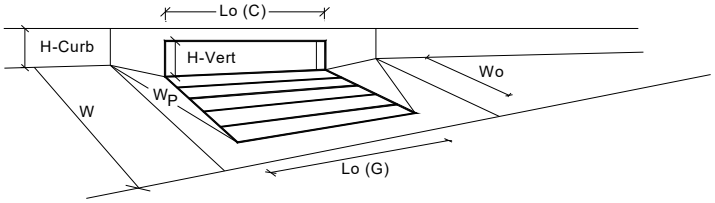
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	6.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	0.77	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.4**	**5.4**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.0	4.0	cfs

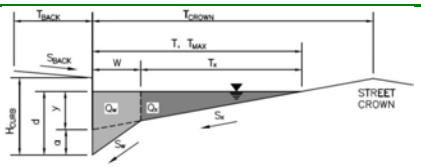
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: **SH119 BRT - RTD P-n-R**

Inlet ID: **Type R Sump 10 Cap**



Gutter Geometry:

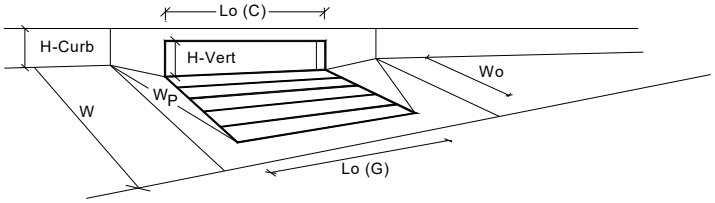
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	6.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



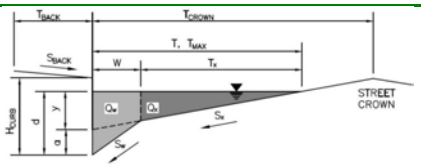
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.57	0.57	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	0.93	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**8.3**	**8.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.0	8.0	cfs

MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: SH 119 BRT - RTD P-n-R
Inlet ID: Type R Cont Cap



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	6.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.005	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

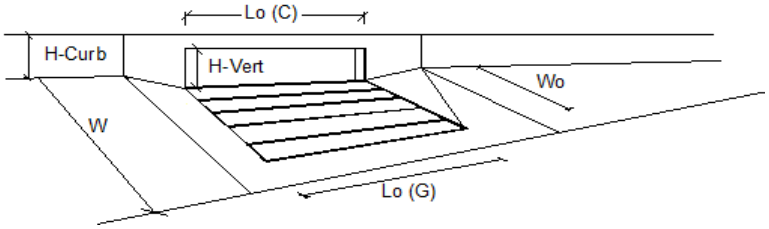
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**9.7**	**9.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

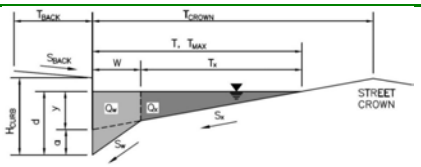
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.0**	**3.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**99**	**%**

MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: SH 119 BRT - RTD P-n-R
Inlet ID: Type R Cont Cap



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	6.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.013	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

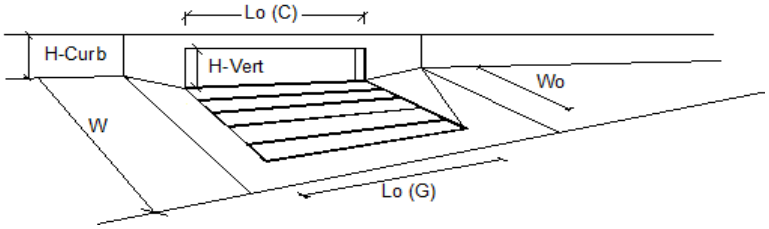
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**15.4**	**15.4**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)

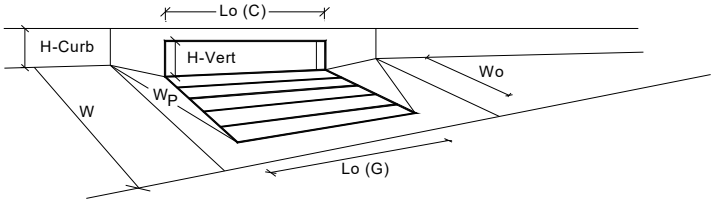


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.0**	**4.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**99**	**%**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type C Grate		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	8.00	8.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	7.8	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	2.92	2.92	feet
Width of a Unit Grate	W_o =	2.92	2.92	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.70	0.70	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	2.41	2.41	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.67	0.67	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	N/A	N/A	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.802	0.954	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.95	1.00	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**6.0**	**8.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.0	8.0	cfs

Worksheet for 18 inch under Niwot

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01600	ft/ft
Normal Depth	1.50	ft
Diameter	1.50	ft

Results

Discharge	13.29	ft^3/s
Flow Area	1.77	ft^2
Wetted Perimeter	4.71	ft
Hydraulic Radius	0.38	ft
Top Width	0.00	ft
Critical Depth	1.36	ft
Percent Full	100.0	%
Critical Slope	0.01400	ft/ft
Velocity	7.52	ft/s
Velocity Head	0.88	ft
Specific Energy	2.38	ft
Froude Number	0.00	
Maximum Discharge	14.29	ft^3/s
Discharge Full	13.29	ft^3/s
Slope Full	0.01600	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

Worksheet for 18 inch under Niwot

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.36	ft
Channel Slope	0.01600	ft/ft
Critical Slope	0.01400	ft/ft

Worksheet for 18 inch RCP 0.5 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.50	ft
Diameter	1.50	ft

Results

Discharge	7.43	ft³/s
Flow Area	1.77	ft²
Wetted Perimeter	4.71	ft
Hydraulic Radius	0.38	ft
Top Width	0.00	ft
Critical Depth	1.06	ft
Percent Full	100.0	%
Critical Slope	0.00703	ft/ft
Velocity	4.20	ft/s
Velocity Head	0.27	ft
Specific Energy	1.77	ft
Froude Number	0.00	
Maximum Discharge	7.99	ft³/s
Discharge Full	7.43	ft³/s
Slope Full	0.00500	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

Worksheet for 18 inch RCP 0.5 Percent Slope

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.06	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00703	ft/ft

Worksheet for 24 inch RCP 0.5 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	2.00	ft
Diameter	2.00	ft

Results

Discharge	16.00	ft³/s
Flow Area	3.14	ft²
Wetted Perimeter	6.28	ft
Hydraulic Radius	0.50	ft
Top Width	0.00	ft
Critical Depth	1.44	ft
Percent Full	100.0	%
Critical Slope	0.00662	ft/ft
Velocity	5.09	ft/s
Velocity Head	0.40	ft
Specific Energy	2.40	ft
Froude Number	0.00	
Maximum Discharge	17.21	ft³/s
Discharge Full	16.00	ft³/s
Slope Full	0.00500	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

Worksheet for 24 inch RCP 0.5 Percent Slope

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.44	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00662	ft/ft

Worksheet for 24 inch RCP 0.3 percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00300	ft/ft
Normal Depth	2.00	ft
Diameter	2.00	ft

Results

Discharge	12.39	ft^3/s
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Hydraulic Radius	0.50	ft
Top Width	0.00	ft
Critical Depth	1.27	ft
Percent Full	100.0	%
Critical Slope	0.00567	ft/ft
Velocity	3.94	ft/s
Velocity Head	0.24	ft
Specific Energy	2.24	ft
Froude Number	0.00	
Maximum Discharge	13.33	ft^3/s
Discharge Full	12.39	ft^3/s
Slope Full	0.00300	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

Worksheet for 24 inch RCP 0.3 percent Slope

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.27	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00567	ft/ft

Worksheet for 30 inch RCP 0.4 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00400	ft/ft
Normal Depth	2.50	ft
Diameter	2.50	ft

Results

Discharge	25.94	ft^3/s
Flow Area	4.91	ft^2
Wetted Perimeter	7.85	ft
Hydraulic Radius	0.63	ft
Top Width	0.00	ft
Critical Depth	1.74	ft
Percent Full	100.0	%
Critical Slope	0.00583	ft/ft
Velocity	5.28	ft/s
Velocity Head	0.43	ft
Specific Energy	2.93	ft
Froude Number	0.00	
Maximum Discharge	27.90	ft^3/s
Discharge Full	25.94	ft^3/s
Slope Full	0.00400	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

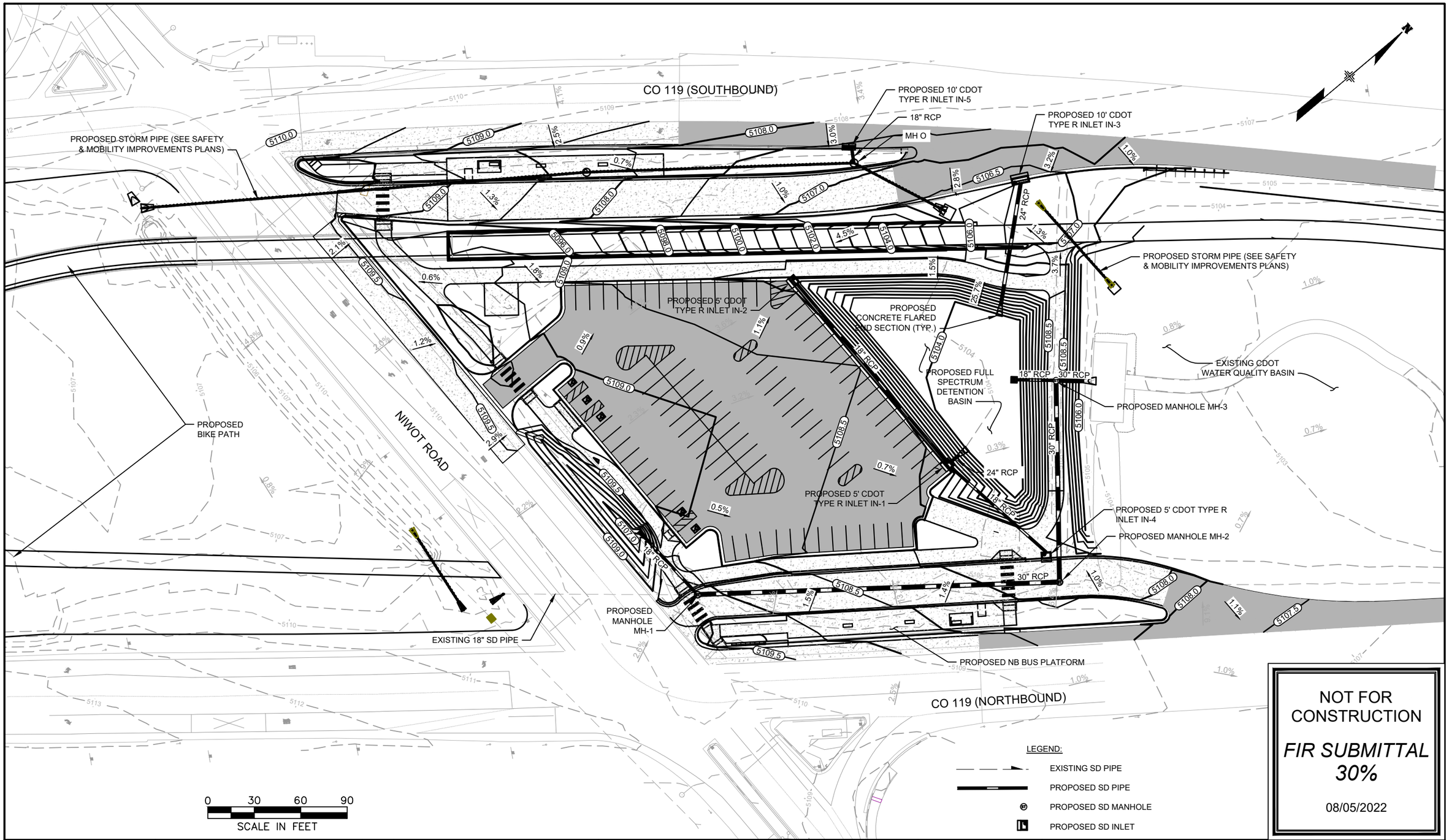
Worksheet for 30 inch RCP 0.4 Percent Slope

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	2.50	ft
Critical Depth	1.74	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.00583	ft/ft

APPENDIX H

FIR DRAINAGE PLANS



All seals for this set of drawings are applied to the cover page(s)

Print Date: 8/4/2022
File Name: CO119 BRT Niwot_DRAINAGE.dwg
Horiz. Scale: As Noted Vert. Scale: As Noted
Unit Information

RTD

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
1050 Lee Hill Road
Boulder, CO 80302
Phone: 303-546-5676
FAX: 303-444-0751
Region 4 ALG

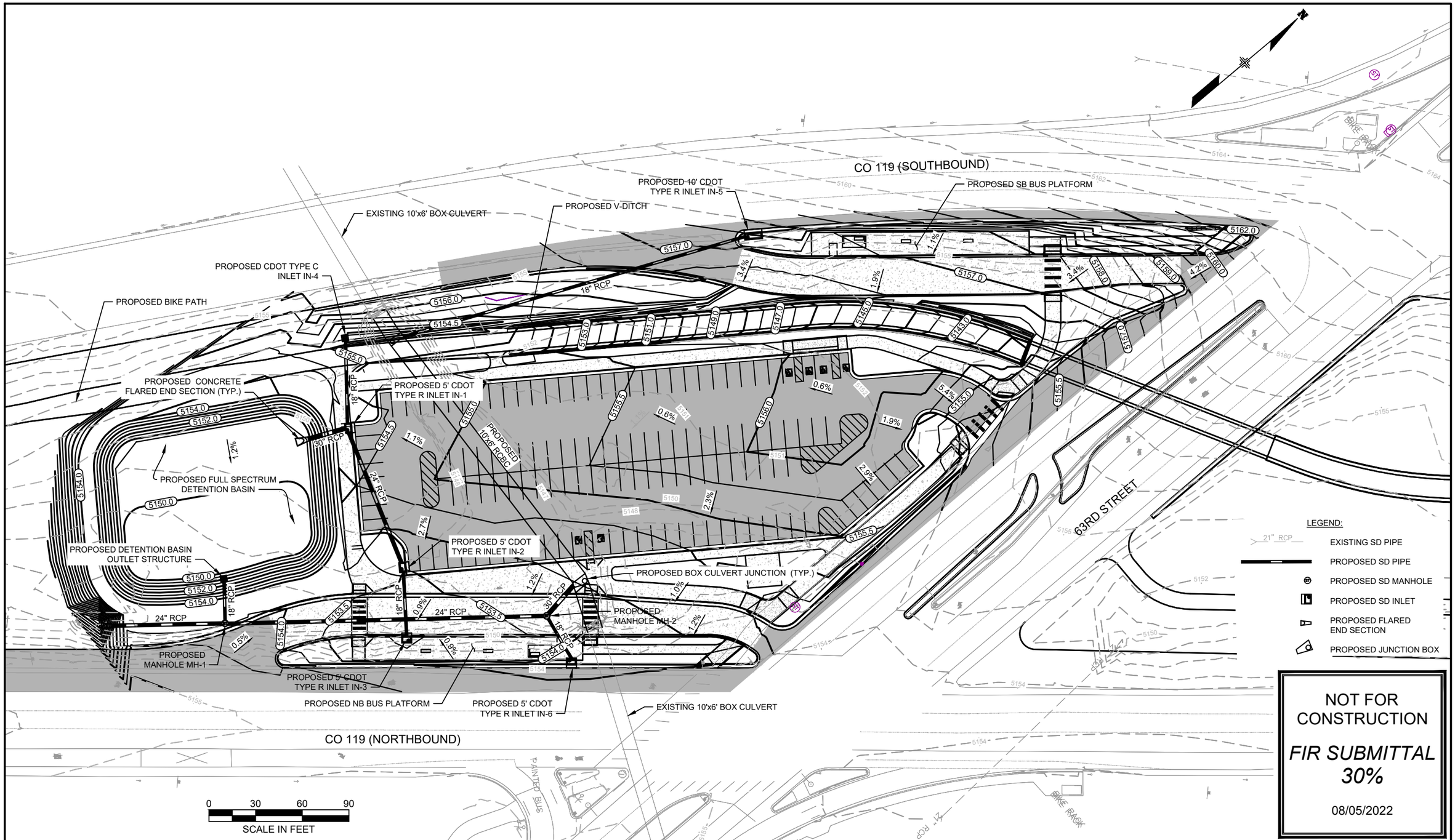
As Constructed
No Revisions:
Revised:
Void:

CO119 MOBILITY
NIWOT ROAD PARK-n-RIDE
DRAINAGE PLAN

Designer: FBT
Detailer: AM
Sheet Subset: RTD
Structure Numbers
Subset Sheets: 15 of 16

Project No./Code
21497

Sheet Number C-009



NOT FOR CONSTRUCTION

FIR SUBMITTAL 30%

08/05/2022

All seals for this set of drawings are applied to the cover page(s)

Print Date: 8/4/2022
File Name: C0119 BRT 63rd_DRAINAGE.dwg
Horiz. Scale: As Noted Vert. Scale: As Noted
Unit Information

RTD

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
1050 Lee Hill Road
Boulder, CO 80302
Phone: 303-546-5676
FAX: 303-444-0751
Region 4 ALG

As Constructed
No Revisions:
Revised:
Void:

C0119 MOBILITY
63RD STREET PARK-n-RIDE
DRAINAGE PLAN

Designer: FBT
Detailer: AM
Sheet Subset: RTD
Structure Numbers:
Subset Sheets: 9 of 16

Project No./Code
21497

Sheet Number C-003

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