

***Proposed Retail/Drive-Thru
Address: TBD***

*Lot 2, Block 1, Horseshoe Ridge Subdivision, 1st Amendment
A Parcel of Land Located in the SE ¼ of Section 28, Township 6 South, Range
66 West of the 6th Principal Meridian
Town of Parker, County of Douglas, State of Colorado*

Final Drainage Report

***Prepared by: Brad Anderson
Reviewed by: Mike Beach, P.E.***

Date: May 28, 2019



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Project Location

Project Name: Retail/Drive-Thru

Location: Northwest corner of Pardee Street and Hess Road

Address: TBD

Parcels/Tax Lots: 2233-284-23-005

Zoning: PD Commercial (Horseshoe Ridge)

Site Area: Total = ±0.846 Acres

City, County, State: Town of Parker, Douglas County, Colorado

Governing Agency: Town of Parker

Design Criteria: “Storm Drainage and Environmental Criteria Manual”, Town of Parker, Colorado, Revised and Adopted February 2014

Engineer's Certification

This report for the stormwater design of the Propsoed Retail/Drive-Thru was prepared by me or under my direct supervision in accordance with the provisions of the Town of Parker Storm Drainage and Environmental Criteria Manual. I understand that the Town of Parker and its designated town authority do not and will not assume liability for drainage facilities designed by others.

Signature

Colorado P.E. License No.

Seal and Date

Section 1 – Project Overview

This report accompanies Civil Engineering Design plans to construct a new commercial Retail/Drive-Thru area within the Town of Parker.

The subject site (Lot 2, Block 1, as shown on the predeveloped basin drainage map, Appendix G) contains native grasses and is surrounded by public roads on the east and south, existing vacant lot to the north, and existing residential to the west. The property is 0.846-acres and has one allowed access point to the public right of way. The property is located in the northwest corner of the intersection of Pardee Street and Hess Road.

The proposed onsite improvements include rough grading to provide a building pad, construction of a new commercial building. Other improvements include asphalt parking, concrete sidewalks, landscaping, water and sewer connections, storm drainage management facility, and temporary & permanent erosion control facilities. A newly proposed stormwater detention pond will be installed in the southwest corner of the site adjacent to the planned outlet.

Section 2 – Pre-Developed Conditions

The site is located on FEMA MAP 08035C0182G and does not contain any mapped floodplain areas. (See Appendix A – FIRM Flood Plain Panel).

The subject lot was included in the original *Final Drainage Report for Horseshoe Subdivision prepared by Tetra Tech, September 2005 and Revised date of January 17, 2006*, for calculation purposes only. No stormwater facilities were constructed outside of the existing conveyance pipe that is located for this site to tie into at time of development.

Majority of the site slopes towards the east at roughly 1% to 10%. Current stormwater runoff would flow over the curb into the right of way of Pardee Street. The existing conveyance pipe under Hess Road was sized for this contributing subbasin.

The NRCS classifies soils on all of Lot 2 as Hydrologic Group “B”, with a very small portion of Group “C”. Since the majority of the site is Group “B”, the calculations for this type of soil were used per UDFCD Manual. See Appendix C for more NRCS information.

Existing conditions for the site show an overall percent imperviousness of 2.4%, an existing Conditions Basin Map is included in the Appendix. See Appendix E for the calculations.

Section 3 – Post-Developed Conditions

Site improvements will include, but are not limited to, constructing a new commercial retail building, asphalt parking lot, concrete sidewalks, landscaping, water and sewer connections, storm drainage facility improvements, and temporary & permanent erosion control facilities.

The post-developed drainage area for this site is roughly 0.846 acres. This new pond will be constructed to hold runoff from the proposed development.

The proposed subbasins have been analyzed and modeled as one subbasin due to all of the runoff will sheet flow and/or be conveyed to the proposed pond via curb and gutter or concrete pans: (See Appendix G for the Existing and Proposed Basin Maps).

Subbasin 1 – This 0.846-acre subbasin currently contains the building, asphalt parking, concrete sidewalks, concrete pans, landscaping, and the proposed detention facility. Roof drain lines from the building will be hard lined directly to the proposed on-site conveyance system. Runoff from this basin will flow primary from the northeast to the southwest via sheet flow and shallow concentrated flows. Flows will then be emptied into the proposed pond via curb scuppers and rip rap. The proposed detention pond will outlet the detained water via an existing outlet pipe under Hess Road. The outlet pipe will have a metered flow leaving the facility. The percent imperviousness for this basin is 68.2%.

Subbasin OS1 – This 0.056-acre subbasin contributes due to the proposed grading on the site. Since the existing site is fairly steep across it, it is necessary to keep the shared driveway included into this conveyance system. This subbasin contains asphaltic concrete and sidewalk areas. Runoff from this subbasin will be directed towards the northeast into an area inlet. Flows will then travel into the conveyance piping and eventually to the existing regional detention pond. The percent imperviousness for this basin is 90.0%.

Flow Rates/Conveyance Table:

Subbasin	Area (acres)	5-year Coeff.	5-year Developed Flow	10-year Coeff.	10-year Developed Flow	100-year Coeff.	100-year Developed Flow
1	0.846	0.57	2.1.	0.61	2.7	0.75	5.22
OS1	0.107	0.51	0.20	0.56	0.26	0.72	0.53

Precipitation data is obtained from the Storm Drainage and Environmental Criteria Manual from the Town of Parker.

TABLE 5.1
ONE-HOUR POINT RAINFALL

Frequency of Design Event (yr)	One-hour Point Rainfall, P ₁ (in)
2	0.99
5	1.39
10	1.64
25	1.98
50	2.31
100	2.60

Peak discharge flow rates from this project are included in the Appendix. All conveyance for the project is provided via overland flow and curb and gutter.

Section 4 - Hydrologic Calculations

Water Quality & Detention Design:

Stormwater quality treatment will be provided within the detention pond. An outlet structure will be required to outlet the WQCV at 40 hours drain time and at the release rates as required by the Town of Parker Storm Drainage and Environmental Criteria Manual. The detention volume above the WQCV will spill over the structure and will have a controlled outlet flow. Water quality and detention facilities will need to be constructed prior to or at the same time as the proposed infrastructure improvements on the overall site. Please see Appendix D and E for calculations.

Detention Pond Design:

The proposed detention pond will accommodate the proposed developed contributing area. The total contributing developed subbasin area is 0.846 acres, with an imperviousness of 68.2%. The proposed construction of the stormwater detention pond will also include the construction of a new outlet structure. Water from the pond will flow through the new outlet structure into an existing 18” stub pipe.

The historic peak 100-year runoff release rate is 2.9 cfs. The detention pond will release the detained runoff at a 100-year release rate of 0.7 cfs, (as shown in the UDFCD Spreadsheet, UD-Detention_V3.07). The calculated detention volume (including WQ) is 0.116 acre-ft. All calculations can be found in the Appendix section of this report.

The historic peak 100-year runoff release rate is 2.9 cfs. The detention pond will release the detained runoff at a 100-year release rate of 0.7 cfs, (as shown in the UDFCD Spreadsheet, UD-Detention_V3.07). The calculated detention volume (including WQ) is 0.116 acre-ft. All calculations can be found in the Appendix section of this report.

Section 5 – Design and Placement of Construction BMP's

Temporary Erosion and Sediment Control:

All erosion and sediment control measures shall be governed by the requirements of the Town of Parker. A combination of silt fence, temporary conveyance swales, slope protection, rock socks, constructions fences, and temporary sediment pond will be implemented to prevent offsite discharge of sediment. An engineered temporary erosion and sedimentation control plan was prepared to direct the contractor in complying with these requirements.

Temporary swales will be installed along the property lines at certain locations to prevent sediment laden storm water from discharging offsite. Temporary slope protection will be installed along permanent slopes equal to 3:1 horizontal to vertical. Slope protection may include surface roughening, temporary erosion control blankets or other approved equivalent.

A construction entrance will be installed at the proposed entrance. This construction entrance will be relocated as necessary to accommodate the proposed site improvements.

Permanent Erosion and Sediment Control:

Permanent erosion and sediment control will be provided onsite to minimize long term erosion impacts and minimize the amount of sediment that discharges offsite. All areas of the natural ground surface which are not covered in impervious surfaces will be resurfaced with landscaping or native vegetation. The owner will maintain the grounds to ensure there are no areas of erosion.

References

- *Town of Parker, "Storm Drainage and Environmental Criteria Manual", Revised February 2014.*
- *Urban Drainage & Flood Control District Drainage Criteria Manual*
- *FEMA Flood Insurance Rate Map, Community Panel #08035C0182G; March 16, 2016.*
- *USDA Natural Resources Conservation Service Web Soil Survey (WSS) aka NRCS Soils Map*
- *Survey prepared by PLS Group., dated 1/15/2019*
- *Final Drainage Report for Horseshoe Ridge Subdivision by Tetra Tech, Dated September 2005 and Revised date of January 17, 2006*

Appendix

Appendix A – FIRM Floodplain Panel

Appendix B – Vicinity Map

Appendix C – NRCS Soils Data

Appendix D – Criteria

Appendix E – Calculations

Appendix F – Detention Pond Volumes

Appendix G – Basin Map/Grading & Drainage Plan

Appendix A – FIRM Floodplain Panel

Site Location

NOTES TO USERS

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

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

Boundaries of the **Floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway width and other pertinent floodway data are provided in the Floodway Data table shown on this FIRM.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The horizontal datum was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

NOG Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov>.
Base map information shown on this FIRM was provided by the Douglas County GIS Department and the Town of Castle Rock GIS Department. Additional input was provided by the City of Lone Tree and Town of Parker. These data are current as of 2010.

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

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

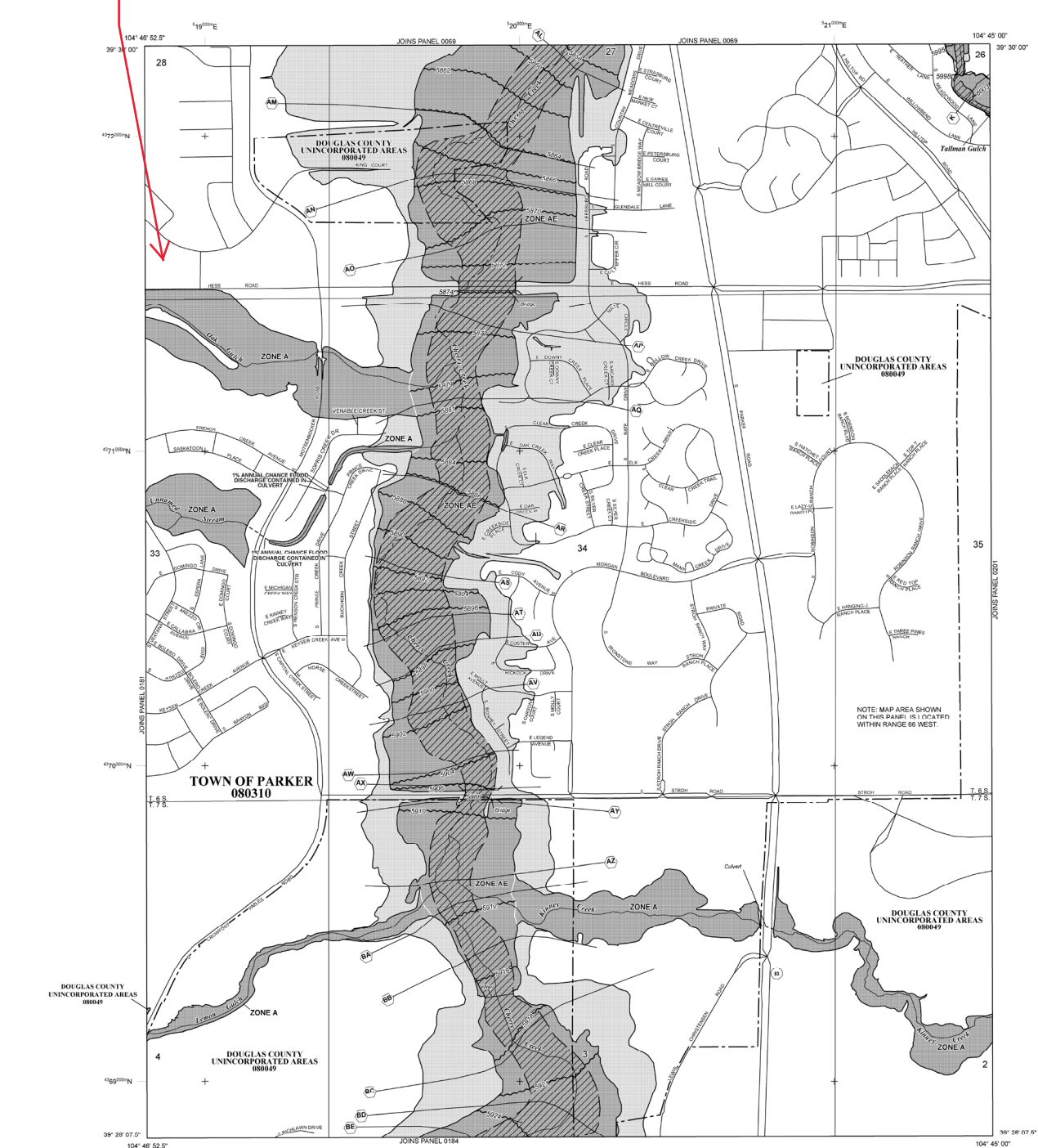
Based on updated topographic information, this map reflects more detailed and up-to-date stream channel configurations and floodplain delineations than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unretrofit streams may differ from what is shown on previous maps.

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

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

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have questions about this map, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/business/>.



LEGEND

- SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**
- ZONE A**
No Base Flood Elevations determined.
- ZONE AE**
Base Flood Elevations determined.
Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- ZONE AO**
Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined; for areas of sheet flow flooding, velocities also determined.
- ZONE AR**
Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decreased. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
Areas to be protected from the 1% annual chance flood by a Federal flood protection system under construction; no base flood elevations determined.
- ZONE AV**
Coastal flood zone with velocity hazard (wave action); no base flood elevations determined.
- ZONE VE**
Coastal flood zone with velocity hazard (wave action); base flood elevations determined.
- FLOODWAY AREAS IN ZONE AE**
- OTHER FLOOD AREAS**
- ZONE X**
Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot and with drainage areas less than 1 square mile, and areas protected by levees from the 1% annual chance flood.
- OTHER AREAS**
- ZONE X**
Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D**
Areas in which flood hazards are undetermined, but possible.
- COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
- OTHERWISE PROTECTED AREAS (OPAs)**
- CBRS areas and OPAs** are normally located within or adjacent to Special Flood Hazard Areas.
- 1% Annual Chance Floodplain Boundary**
- 0.2% Annual Chance Floodplain Boundary**
- Floodway boundary**
- Zone D boundary**
- Zone D and OPA boundary**
- Boundary during Special Flood Hazard Area zone and boundary during Special Flood Hazard Area of different Special Flood Hazard zones, flood depths, or flood velocities.**
- Base Flood Elevation (no and velocity elevation in feet)**
- Base Flood Elevation value where uniform within zone; elevation in feet**

*Referenced to the North American Vertical Datum of 1988

- (A) Cross section line
- (B) Transsect line
- 45° 02' 00" 92° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) datum hemisphere
- 1000-meter horizontal Transverse Mercator grid values, zone 13
- 1000-meter horizontal Transverse Mercator grid values, zone 11
- BM5110 X Bench mark (see explanation in Notes to Users section of this FIRM panel)
- *M1.5 River Mile

Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

SEPTEMBER 30, 2020

EFFECTIVE DATES OF REVISIONS TO THIS PANEL

MARCH 16, 2018: To update corporate limits, to change base flood elevations, to add base flood elevations, to add special flood hazard areas, to update map format, to add roads and road names, to reflect updated topographic information, to incorporate previously issued letters of map revision.

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

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-435-6620.

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0182G

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

PANEL 182 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

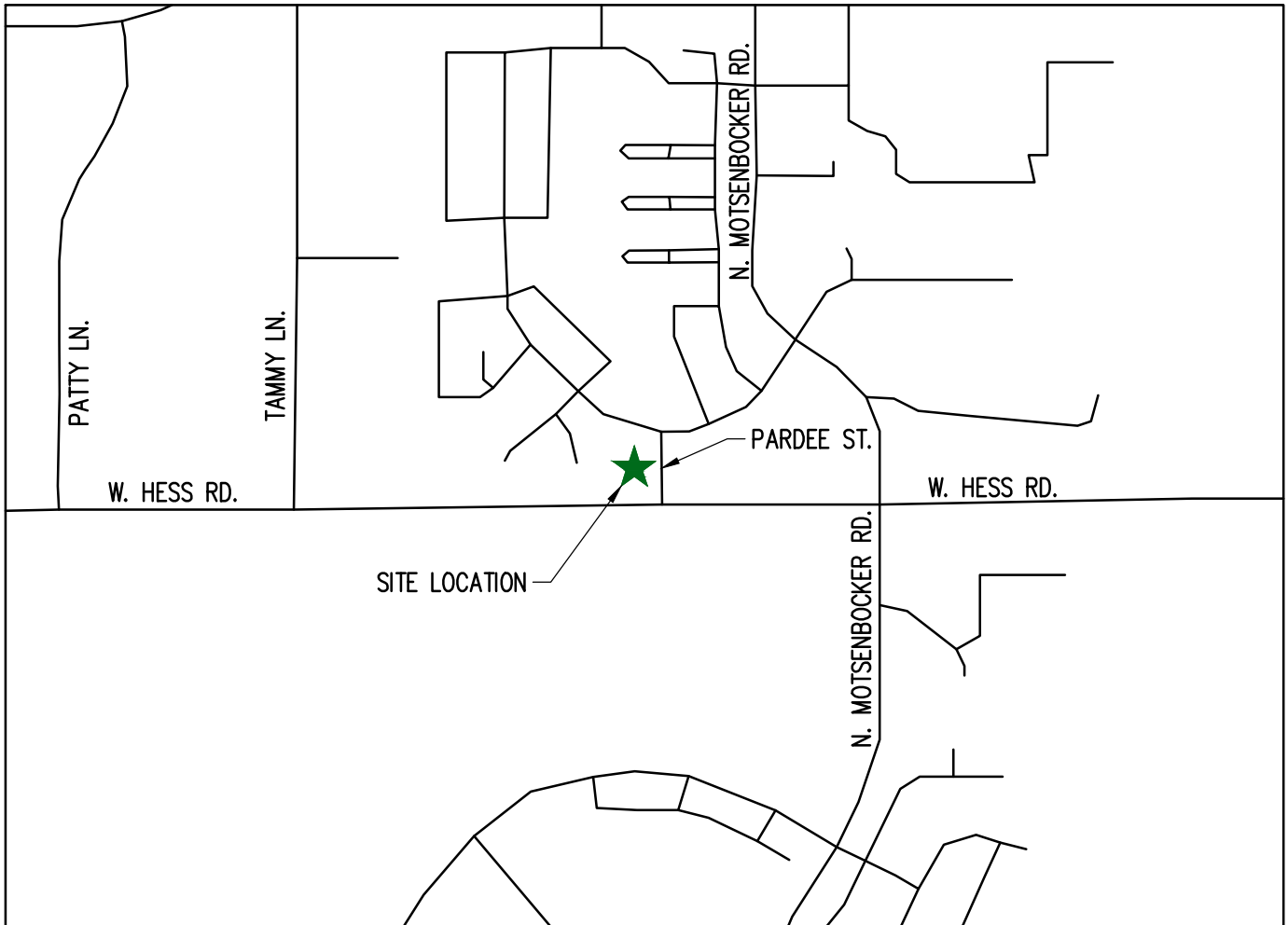
CONTAINS:	COMMUNITY	NUMBER	PANEL	SUFFIX
	DOUGLAS COUNTY	080049	0182G	G
	PARKER, TOWN OF	080310	0182G	G

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.

FEDERAL EMERGENCY MANAGEMENT AGENCY

MAP NUMBER
0803C0182G
MAP REVISED
MARCH 16, 2016

Appendix B – Vicinity Map



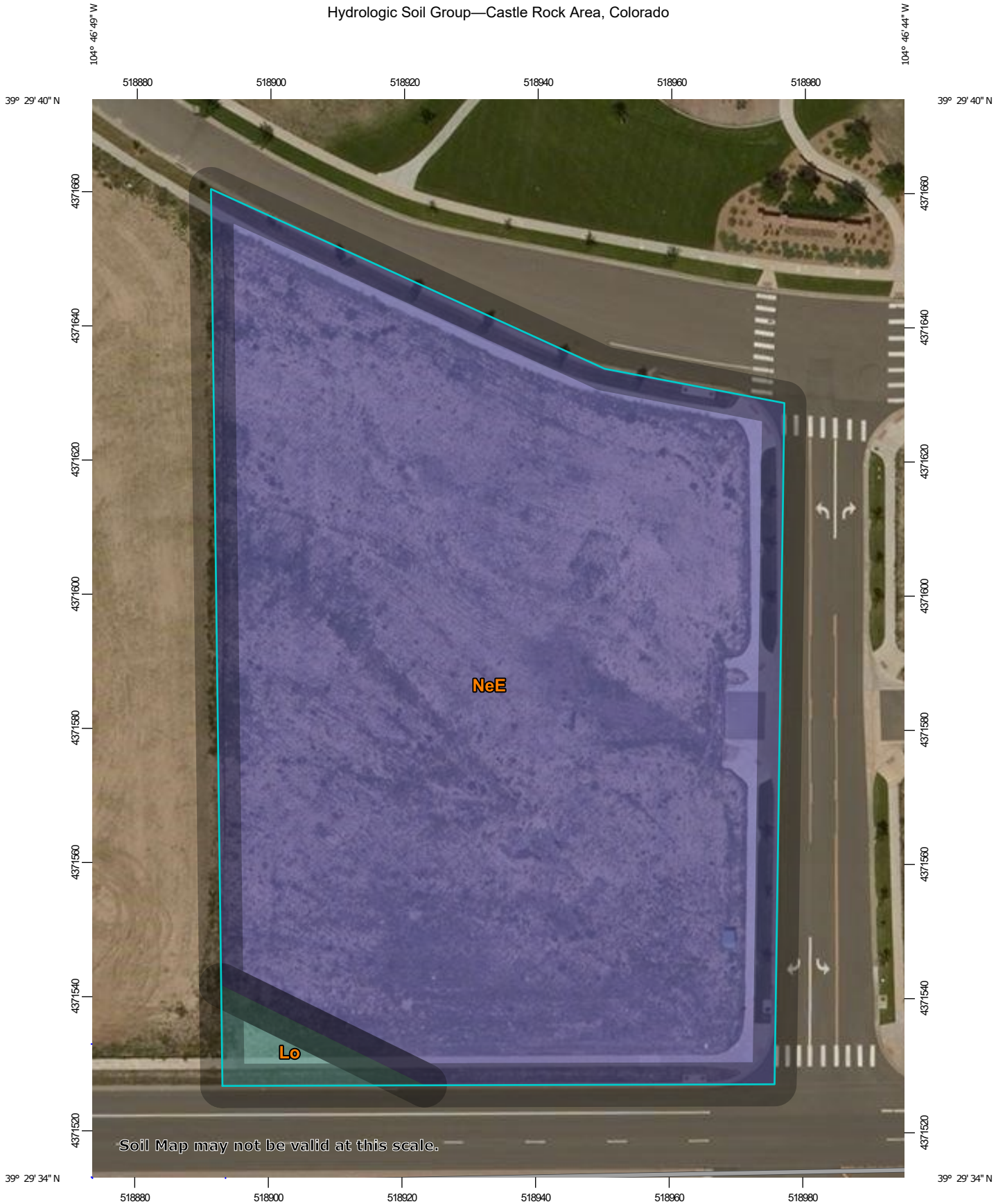
SCALE 1:1000

VICINITY MAP

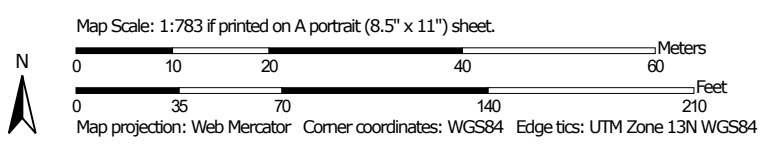


Appendix C – NRCS Soils Data

Hydrologic Soil Group—Castle Rock Area, Colorado




Soil Map may not be valid at this scale.



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: Castle Rock Area, Colorado
 Survey Area Data: Version 11, Sep 10, 2018

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Lo	Loamy alluvial land	C	0.1	2.3%
NeE	Newlin gravelly sandy loam, 8 to 30 percent slopes	B	2.3	97.7%
Totals for Area of Interest			2.4	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 – Criteria

UDFCD Intensity-Duration Calculations:

Equation 5-1

$$I = (28.5 * P1) / ((10 + Tc)^{0.786})$$

Where: I = rainfall intensity (inches per hour)
P1 = 1-hour point rainfall depth (inches)
Tc = Time of Concentration (minutes)

Duration	P1	5	10	15	20	25	30	Tc	Rainfall
2-year	0.99	3.36	2.68	2.25	1.95	1.73	1.55		Enter Td
5-year	1.39	4.71	3.76	3.16	2.73	2.42	2.18		Enter Td
10-year	1.64	5.56	4.44	3.72	3.23	2.86	2.57		Enter Td
100-year	2.6	8.82	7.03	5.90	5.11	4.53	4.08		Enter Td

Notes:

Visit NOAA Atlas 14 to obtain 1-hour point rainfall depths (P1)

https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

5. HYDROLOGIC CRITERIA

5.1 INTRODUCTION

This section presents the criteria and methodology for determining storm runoff design peaks and volumes to be used in the Town of Parker for preparation of storm drainage plans and facility design. In general, hydrologic analysis of the initial and major storm events for both the historic and fully developed site conditions is required. In addition to the hydrologic analysis for a site, a hydrologic analysis should be performed for all off site basins that impact the proposed site. The Town of Parker adopts procedures prescribed by the Urban Drainage and Flood Control District (UDFCD) for performing hydrologic analysis. These procedures may be found in the Rainfall and Runoff sections of the MANUAL. Standards and technical criteria found in the MANUAL should be followed except where superseded by specific requirements of this manual.

5.2 DESIGN RAINFALL

For any storm runoff technique, design rainfall must first be established. The design rainfall data to be used for the Town of Parker were obtained from NOAA Atlas 2, Precipitation– Frequency Atlas of the Western United States, Volume III– Colorado. The design storm events developed and utilized are the same as those used by UDFCD.

The one-hour point rainfall depths for different frequency events are shown in Table 5.1 herein. Rainfall intensity as a function of the one-hour point rainfall and the time of concentration can be approximated by the following equation which appears in the MANUAL as Equation RA-5.

$$I = (28.5P_1)/(10+t_c)^{0.786}$$

Where, I = rainfall intensity (in/hr)
 P_1 = one-hour point rainfall depth (in)
 t_c = time of concentration (min)

Graphical presentation of the equation is shown as the Time-Intensity-Frequency curves in Figure 5.1 herein. Rainfall intensity for use in the Rational Method may be taken from Figure 5.1 or calculated using the equation.

TABLE 5.1
ONE-HOUR POINT RAINFALL

Frequency of Design Event (yr)	One-hour Point Rainfall, P_1 (in)
2	0.99
5	1.39
10	1.64
25	1.98
50	2.31
100	2.60

5.3 FLOOD HYDROLOGY OVERVIEW

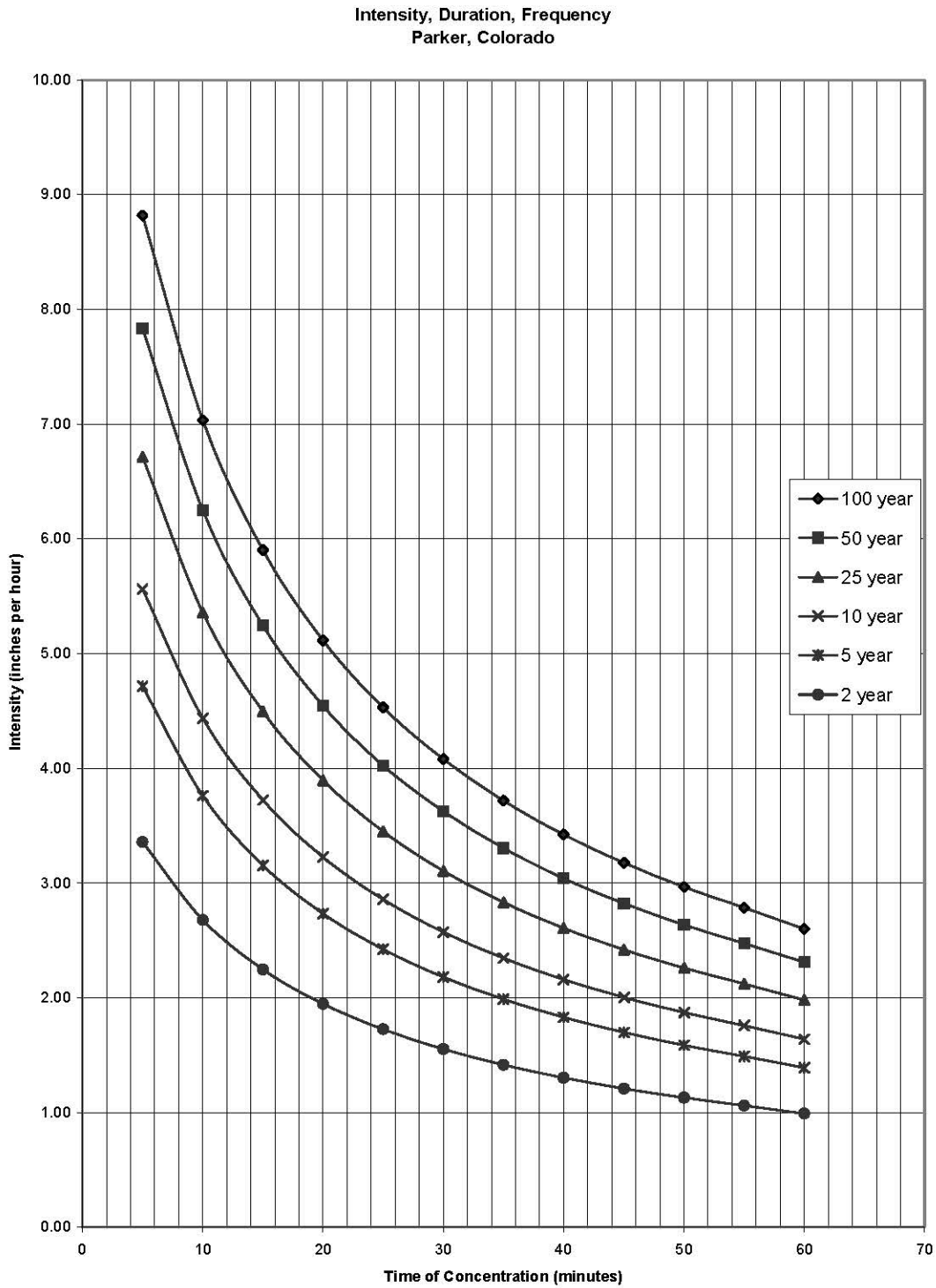
Various methods exist to determine appropriate flood peaks or hydrographs for storm drainage planning and design. Methods for determining flood peaks or hydrographs are the Rational Method, the Colorado Urban Hydrograph Procedure (CUHP), and Urban Drainage Stormwater Management (UDSWM) model. The Town of Parker discourages the use of computer models other than CUHP and UDSWM since these programs are preferred, if not required, by UDFCD for studies involving major drainageways where UDFCD approval is sought or where maintenance eligibility is requested.

The three methods are briefly described in this section, and a discussion of their applicability to the Town of Parker is discussed. UDSWM is mostly used to combine and route the hydrographs generated using CUHP.

In general, the Rational Method is the most widely used and accepted technique for determining peak flows in urban areas for small basins. Within the constraints outlined in the MANUAL, use of the Rational Method provides a relatively simple but effective way to analyze storm runoff.

CUHP is somewhat more complicated than the Rational Method. It allows a manual computation of a runoff hydrograph which may be used for further hydraulic routing through channels and/or detention ponds. Historically, CUHP is best used in urban areas for which runoff coefficients have been derived. However, recent improvements by UDFCD include consideration for different soil types, thus CUHP is now more applicable to rural areas. The reader is referred to UDFCD for the latest version of CUHP.

UDSWM is a computer model that generates runoff hydrographs and routes and combines these hydrographs. UDSWM is a modified version of the Runoff Block of the Environmental Protection Agency's Storm Water Management Model (SWMM). It has been modified to be used in conjunction with CUHP. Table 5.2 herein provides guidance on selecting the appropriate method for a given project.



**FIGURE 5.1
RAINFALL INTENSITY VERSUS DURATION CURVES FOR PARKER, COLORADO**

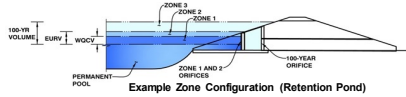
Appendix E – Calculations

Appendix F – Detention Pond Volumes

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: **TLE Parker**
Basin ID: **NORTH POND**



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	0.85	acres
Watershed Length =	330	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	67.47%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	97.7%	percent
Percentage Hydrologic Soil Groups C/D =	2.3%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Parker - Town Hall	
Water Quality Capture Volume (WQCV) =	0.019	acre-feet
Excess Urban Runoff Volume (EURV) =	0.062	acre-feet
2-yr Runoff Volume (P1 = 0.99 in.) =	0.043	acre-feet
5-yr Runoff Volume (P1 = 1.39 in.) =	0.064	acre-feet
10-yr Runoff Volume (P1 = 1.64 in.) =	0.083	acre-feet
25-yr Runoff Volume (P1 = 1.98 in.) =	0.111	acre-feet
50-yr Runoff Volume (P1 = 2.31 in.) =	0.134	acre-feet
100-yr Runoff Volume (P1 = 2.6 in.) =	0.159	acre-feet
500-yr Runoff Volume (P1 = 3.08 in.) =	0.199	acre-feet
Approximate 2-yr Detention Volume =	0.040	acre-feet
Approximate 5-yr Detention Volume =	0.060	acre-feet
Approximate 10-yr Detention Volume =	0.077	acre-feet
Approximate 25-yr Detention Volume =	0.088	acre-feet
Approximate 50-yr Detention Volume =	0.095	acre-feet
Approximate 100-yr Detention Volume =	0.102	acre-feet

Optional User Override 1-hr Precipitation	0.99	inches
	1.39	inches
	1.64	inches
	1.98	inches
	2.31	inches
	2.60	inches
		inches

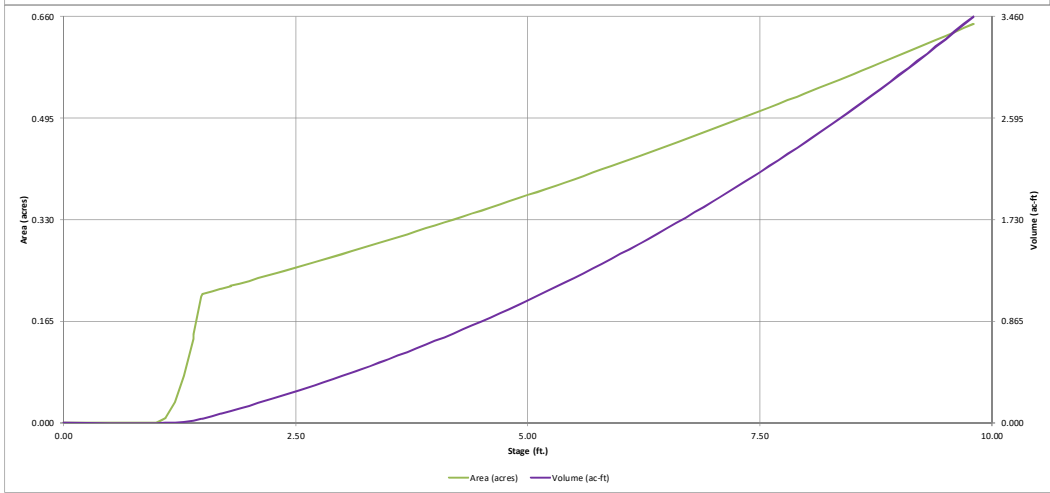
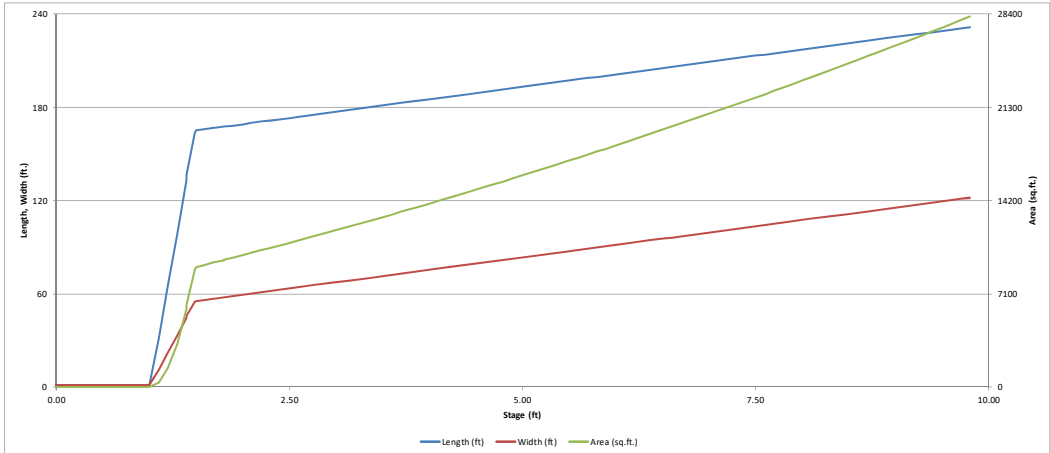
Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.019	acre-feet
Zone 2 Volume (10-year - Zone 1) =	0.059	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.025	acre-feet
Total Detention Basin Volume =	0.102	acre-feet
Initial Surcharge Volume (SV) =	1	ft ³
Initial Surcharge Depth (SD) =	0.50	ft
Total Available Detention Depth (H _{total}) =	1.80	ft
Depth of Trickle Channel (H _{TC}) =	0.50	ft
Slope of Trickle Channel (S _{TC}) =	0.003	ft/ft
Slopes of Main Basin Sides (S _{main}) =	4	H:V
Basin Length-to-Width Ratio (R _{basin}) =	3	
Initial Surcharge Area (A _{sv}) =	2	ft ²
Surcharge Volume Length (L _{sv}) =	1.4	ft
Surcharge Volume Width (W _{sv}) =	1.4	ft
Depth of Basin Floor (H _{basin}) =	0.49	ft
Length of Basin Floor (L _{basin}) =	165.0	ft
Width of Basin Floor (W _{basin}) =	55.3	ft
Area of Basin Floor (A _{basin}) =	9,126	ft ²
Volume of Basin Floor (V _{basin}) =	1,498	ft ³
Depth of Main Basin (H _{main}) =	0.32	ft
Length of Main Basin (L _{main}) =	167.5	ft
Width of Main Basin (W _{main}) =	57.8	ft
Area of Main Basin (A _{main}) =	9,688	ft ²
Volume of Main Basin (V _{main}) =	2,963	ft ³
Calculated Total Basin Volume (V _{total}) =	0.102	acre-feet

Depth Increment =	0.1								
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									
ISV	0.50		1.4	1.4	2		0.000	1	0.000
	0.60		1.4	1.4	2		0.000	1	0.000
	0.70		1.4	1.4	2		0.000	1	0.000
	0.80		1.4	1.4	2		0.000	2	0.000
	0.90		1.4	1.4	2		0.000	2	0.000
	1.00		1.4	1.4	2		0.000	2	0.000
	1.10		31.8	11.4	363		0.008	14	0.000
	1.20		65.5	22.5	1,476		0.034	100	0.002
	1.30		99.2	33.6	3,338		0.077	334	0.008
	1.40		133.0	44.7	5,950		0.137	792	0.018
Zone 1 (WQCV)	1.40		136.3	45.9	6,253		0.144	853	0.020
Floor	1.49		163.3	54.7	8,942		0.205	1,458	0.033
	1.50		165.1	55.3	9,135		0.210	1,548	0.036
	1.60		165.9	56.1	9,312		0.214	2,470	0.057
Zone 2 (10-year)	1.69		166.7	56.9	9,490		0.218	3,411	0.078
	1.70		166.7	56.9	9,490		0.218	3,411	0.078
	1.80		167.5	57.7	9,670		0.222	4,369	0.100
Zone 3 (100-year)	1.80		167.5	57.8	9,688		0.222	4,465	0.103
	1.90		168.3	58.5	9,851		0.226	5,345	0.123
	2.00		169.1	59.3	10,033		0.230	6,339	0.146
	2.10		169.9	60.2	10,234		0.235	7,453	0.171
	2.20		170.7	61.0	10,419		0.239	8,486	0.195
	2.30		171.5	61.8	10,605		0.243	9,537	0.219
	2.40		172.3	62.6	10,793		0.248	10,607	0.244
	2.50		173.1	63.4	10,981		0.252	11,696	0.268
	2.60		173.9	64.2	11,171		0.256	12,803	0.294
	2.70		174.7	65.0	11,362		0.261	13,930	0.320
	2.80		175.5	65.8	11,555		0.265	15,076	0.346
	2.90		176.3	66.6	11,748		0.270	16,241	0.373
	3.00		177.1	67.4	11,943		0.274	17,426	0.400
	3.10		177.9	68.2	12,140		0.279	18,630	0.428
	3.20		178.7	69.0	12,337		0.283	19,854	0.456
	3.30		179.5	69.8	12,536		0.288	21,097	0.484
	3.40		180.3	70.6	12,736		0.292	22,361	0.513
	3.50		181.1	71.4	12,938		0.297	23,644	0.543
	3.60		181.9	72.2	13,140		0.302	24,948	0.573
	3.70		182.7	73.0	13,344		0.306	26,273	0.603
	3.80		183.5	73.8	13,550		0.311	27,617	0.634
	3.90		184.3	74.6	13,756		0.316	28,983	0.665
	4.00		185.1	75.4	13,964		0.321	30,369	0.697
	4.10		185.9	76.2	14,173		0.325	31,775	0.729
	4.20		186.7	77.0	14,383		0.330	33,203	0.762
	4.30		187.5	77.8	14,595		0.335	34,652	0.796
	4.40		188.3	78.6	14,808		0.340	36,122	0.829
	4.50		189.1	79.4	15,022		0.345	37,614	0.863
	4.60		189.9	80.2	15,238		0.350	39,127	0.898
	4.70		190.7	81.0	15,454		0.355	40,661	0.933
	4.80		191.5	81.8	15,672		0.360	42,218	0.969
	4.90		192.3	82.6	15,892		0.365	43,796	1.005
	5.00		193.1	83.4	16,112		0.370	45,396	1.042
	5.10		193.9	84.2	16,334		0.375	47,018	1.079
	5.20		194.7	85.0	16,557		0.380	48,663	1.117
	5.30		195.5	85.8	16,782		0.385	50,330	1.155
	5.40		196.3	86.6	17,008		0.390	52,019	1.194
	5.50		197.1	87.4	17,236		0.395	53,731	1.234
	5.60		197.9	88.2	17,463		0.401	55,466	1.273
	5.70		198.7	89.0	17,693		0.406	57,224	1.314
	5.80		199.5	89.8	17,923		0.411	59,005	1.355
	5.90		200.3	90.6	18,156		0.417	60,809	1.396
	6.00		201.1	91.4	18,389		0.422	62,636	1.438
	6.10		201.9	92.2	18,624		0.428	64,487	1.480
	6.20		202.7	93.0	18,860		0.433	66,361	1.523
	6.30		203.5	93.8	19,097		0.438	68,259	1.567
	6.40		204.3	94.6	19,335		0.444	70,180	1.611
	6.50		205.1	95.4	19,575		0.449	72,126	1.656
	6.60		205.9	96.2	19,816		0.455	74,095	1.701
	6.70		206.7	97.0	20,059		0.460	76,089	1.747
	6.80		207.5	97.8	20,302		0.466	78,107	1.793
	6.90		208.3	98.6	20,547		0.472	80,150	1.840
	7.00		209.1	99.4	20,793		0.477	82,217	1.887
	7.10		209.9	100.2	21,041		0.483	84,308	1.935
	7.20		210.7	101.0	21,290		0.489	86,425	1.984
	7.30		211.5	101.8	21,540		0.494	88,566	2.033
	7.40		212.3	102.6	21,791		0.500	90,733	2.083
	7.50		213.1	103.4	22,044		0.506	92,924	2.133
	7.60		213.9	104.2	22,298		0.512	95,142	2.184
	7.70		214.7	105.0	22,553		0.518	97,384	2.236
	7.80		215.5	105.8	22,809		0.524	99,652	2.288
	7.90		216.3	106.6	23,067		0.530	101,946	2.340
	8.00		217.1	107.4	23,326		0.535	104,268	2.394
	8.10		217.9	108.2	23,586		0.541	106,611	2.447
	8.20		218.7	109.0	23,848		0.547	108,983	2.502
	8.30		219.5	109.8	24,111		0.554	111,381	2.557
	8.40		220.3	110.6	24,376		0.560	113,805	2.613
	8.50		221.1	111.4	24,640		0.566	116,256	2.669
	8.60		221.9	112.2	24,907		0.572	118,733	2.726
	8.70		222.7	113.0	25,175		0.578	121,237	2.783
	8.80		223.5	113.8	25,444		0.584	123,768	2.841
	8.90		224.3	114.6	25,715		0.590	126,326	2.900
	9.00		225.1	115.4	25,986		0.597	128,911	2.959
	9.10		225.9	116.2	26,260		0.603	131,523	3.019
	9.20		226.7	117.0	26,534		0.609	134,163	3.080

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

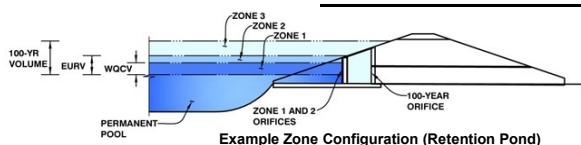


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: _____

Basin ID: _____



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.40	0.019	Orifice Plate
Zone 2 (10-year)	1.69	0.059	Circular Orifice
Zone 3 (100-year)	1.80	0.025	Weir&Pipe (Circular)
		0.102	Total

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft ²
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.40	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	0.15	sq. inches (diameter = 7/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.007E-03	ft ²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft ²

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							
Orifice Area (sq. inches)	0.15							
	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.40	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	1.70	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	0.75	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.00	N/A	ft ²
Vertical Orifice Centroid =	0.03	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.70	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	30%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H ₁ =	2.70	N/A	feet
Over Flow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	84.67	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	11.54	N/A	ft ²
Overflow Grate Open Area w/ Debris =	8.08	N/A	ft ²

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

	Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	5.00	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Circular	Not Selected	
Outlet Orifice Area =	0.14	N/A	ft ²
Outlet Orifice Centroid =	0.21	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

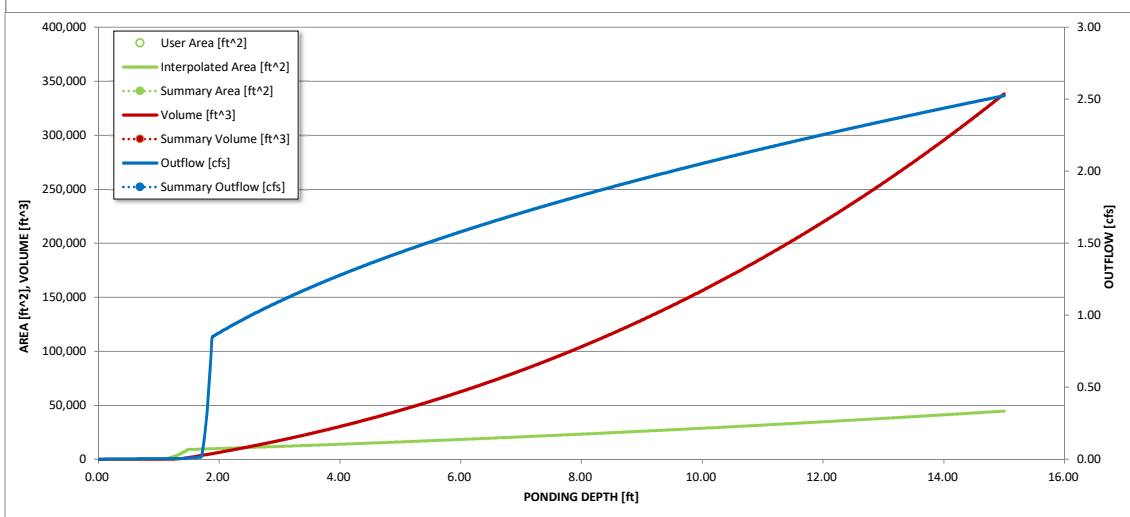
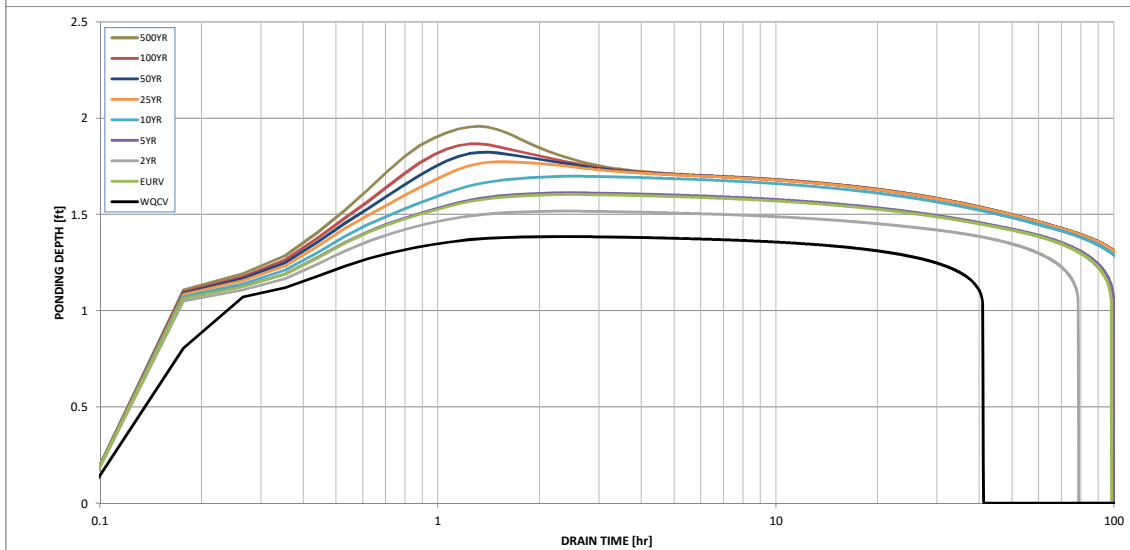
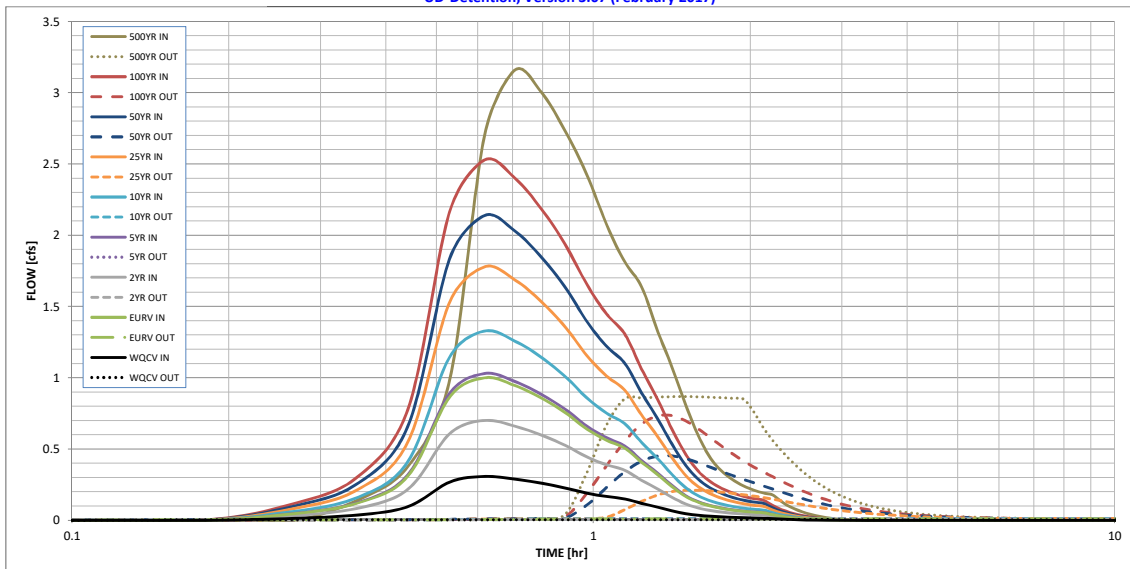
Spillway Design Flow Depth =		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres

Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	0.53	1.07	0.99	1.39	1.64	1.98	2.31	2.60	3.08
Calculated Runoff Volume (acre-ft) =	0.019	0.062	0.043	0.064	0.083	0.111	0.134	0.159	0.199
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.019	0.062	0.043	0.064	0.082	0.111	0.134	0.159	0.199
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.17	0.61	0.88	1.19	1.68
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.5	0.7	1.0	1.4
Peak Inflow Q (cfs) =	0.3	1.0	0.7	1.0	1.3	1.8	2.1	2.5	3.2
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.7	0.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.09	0.4	0.6	0.7	0.6
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.0	0.0	0.1	0.1
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) =	40	94	76	96	112	113	112	110	108
Time to Drain 99% of Inflow Volume (hours) =	41	97	78	99	115	118	118	118	117
Maximum Ponding Depth (ft) =	1.38	1.60	1.52	1.61	1.70	1.77	1.82	1.87	1.96
Area at Maximum Ponding Depth (acres) =	0.13	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.23
Maximum Volume Stored (acre-ft) =	0.017	0.059	0.040	0.061	0.078	0.096	0.107	0.116	0.136

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Appendix G – Basin Map/Grading and Drainage Plan