# FINAL DRAINAGE REPORT
# FOR
# ELECTRONIC STORAGE
# LOT 2 MOUNTAIN STATES PIPE AND SUPPLY
# 7765 ELECTRONIC DRIVE
# COLORADO SPRINGS, COLORADO

**JANUARY 2020**

Prepared For:
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TNE Job No. 1971.00
County Job No. ##########

PCD Filing No.:
PPR-20-020

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## DESIGN ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

_____ _____
Dane Frank, P.E. 50207 Date
On behalf of Terra Nova Engineering, Inc.

## OWNER/DEVELOPER'S STATEMENT:

I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

_____ _____
Authorized Signature Date

_____
Printed Name, Title

_____
Business Name

_____
Address

---

## EL PASO COUNTY:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ _____
Jennifer Irvine, P.E. Date
County Engineer / ECM Administrator

Conditions:

# FINAL DRAINAGE REPORT
# FOR
# ELECTRONIC STORAGE
# LOT 2 MOUNTAIN STATES PIPE AND SUPPLY
# 7765 ELECTRONIC DRIVE
# COLORADO SPRINGS, COLORADO

## PURPOSE

The purpose of this Final Drainage Report is to identify and analyze the proposed drainage patterns, determine proposed runoff quantities, size drainage structures for conveyance of developed runoff, and present solutions to drainage impacts on-site and off-site resulting from this development. The site has previously been platted and has previously been studied in:

"Preliminary and Final Drainage Report for TMC Design Corporation", dated December 2011, prepared by Stillwater Engineering

## GENERAL DESCRIPTION

This Final Drainage Report (FDR) is an analysis of approximately 2.25 acres of undeveloped land located at 7765 Electronic Drive. This site is being developed as a mini storage facility. The site is in the southeast quarter of Section 32, Township 13 South, Range 65 West of the 6$^{th}$ Principal Meridian within El Paso County. The parcels are bounded to the north by Electronic Drive, to the east by Marksheffel Road, to the south by LOT 6 AKERS ACRES SUB 1, EX THAT PT CONV TO COUNTY FOR R/W BY REC #210004057, and to the west by WLY 631.22 FT OF TRACT 5 AKERS ACRES SUB NO 1. (See vicinity map, Appendix).

The site lies within the Sand Creek Basin, with storm runoff draining from the southeast corner of the site, and flowing south, then west, before entering Sand Creek.

Soils for this project are delineated by the map in the appendix as Blakeland loamy sand (8), 1 to 9 percent slopes. Soils in the study area are shown as mapped by S.C.S. in the "Soils Survey of El Paso County Area" and contains soils of Hydrologic Group A.

The site is undeveloped with mostly grass and dirt surfaces, and a small number of trees. The site drains to the southeast, with an average slope of 6.1%.

**EXISTING DRAINAGE CONDITIONS**

The site is currently undeveloped and is open space. The site consists mostly of natural vegetative grass and weeds, with a small number of trees on the west side. There is also a small drainage swale on the south side of Electronic Drive, which is in the right of way.

The existing drainage basin and flow values are from the December 2011 Preliminary and Final Drainage Report. No significant drainage changes appear to have been made to the site since the time this report was prepared.

There are three drainage basins, one of which (Basin 2S) is entirely offsite, and one of which (Basin 3S) is partially offsite. See attached Existing Drainage Map (in appendix).

Basin P 1S is 2.66 acres and drains to Design Point 1 at the existing stormwater pond. Basin P 1S has flows of $Q_5$ = 4.08 cfs and $Q_{100}$ = 6.19 cfs.

Basin 2S is 5.49 acres and drains to Design Point 2 near the east end of Electronic Drive. Basin 2S has flows of $Q_5$ = 7.69 cfs and $Q_{100}$ = 11.67 cfs.

Basin 3S is 4.00 acres and drains to Design Point 3 at the southeast corner of the site. Basin 3S has flows of $Q_5$ = 5.60 cfs and $Q_{100}$ = 8.50 cfs.

**PROPOSED DRAINAGE CONDITIONS**

Runoff in the developed conditions consists of 10 basins; seven onsite basins and three offsite basins. Below is a description of the runoff in the developed conditions and how it will be safely routed, treated and detained. See appendix for calculations.

<u>Offsite Basins</u>

Basin OS-A is 0.44 acres and drains to Design Point A on the western edge of the site. Runoff

sheet flows onto the site from Basin OS-A. Basin OS-A has flows of $Q_5$ = 1.9 cfs and $Q_{100}$ = 3.9 cfs.

Basin OS-B is 1.38 acres and drains to Design Point B on the western edge of the site. Runoff sheet flows onto the site from Basin OS-B. Basin OS-B has flows of $Q_5$ = 5.5 cfs and $Q_{100}$ = 11.2 cfs.

Basin OS-C is 0.01 acres and drains to Design Point C on the north edge of the site. Runoff sheet flows onto the site from Basin OS-C. Basin OS-Ahas flows of $Q_5$ = 0.1 cfs and $Q_{100}$ = 0.1 cfs.

Onsite Basins

Basin PR-1 is 0.37 acres and drains to Design Point 1 at the northwest edge of the paved area onsite. Basin PR-1 has flows of $Q_5$ = 0.2 cfs and $Q_{100}$ = 1.1 cfs. Design Point 1 has combined flows of $Q_5$ = 2.0 cfs and $Q_{100}$ = 5.0 cfs.

Basin PR-2 is 0.62 acres and drains to Design Point 2 at the southeast edge of the paved area onsite. Basin PR-2 has flows of $Q_5$ = 0.2 cfs and $Q_{100}$ = 1.1 cfs. Design Point 1 has combined flows of $Q_5$ = 5.3 cfs and $Q_{100}$ = 11.6 cfs.

Basin PR-3 is 0.45 acres and drains to Design Point 3 at the southwest edge of the building roof. Basin PR-3 has flows of $Q_5$ = 2.3 cfs and $Q_{100}$ = 4.5 cfs.

Basin PR-4 is 0.32 acres and drains to Design Point 4 at the outlet of the onsite detention basin. Basin PR-4 has flows of $Q_5$ = 0.2 cfs and $Q_{100}$ = 1.2 cfs. Design Point 4 has combined flows of $Q_5$ = 7.8 cfs and $Q_{100}$ = 17.4 cfs.

Basin PR-5 is 0.34 acres and drains to Design Point 5 at the southeast corner of the site. This basin is undeveloped/landscaping area. Basin PR-1 has flows of $Q_5$ = 0.1 cfs and $Q_{100}$ = 1.0 cfs. Design Point 5 has combined flows of $Q_5$ = 5.6 cfs and $Q_{100}$ = 12.2 cfs.

Basin PR-6 is 0.03 acres and drains to Design Point 6 at the northeast corner of the site. This basin

is a landscaping area that flows offsite to the north. Basin PR-6 has flows of $Q_5$ = 0.0 cfs and $Q_{100}$ = 0.1 cfs.

Basin PR-7 is 0.13 acres and drains to Design Point 7 at the east edge of the site. This basin is landscaping area that sheet flows offsite to the adjacent lot. Basin PR-7 has flows of $Q_5$ = 0.1 cfs and $Q_{100}$ = 0.6 cfs.

At Design Point 4 the combined flow ($Q_5$=7.8 cfs and $Q_{100}$=17.4 cfs) of the development will be captured in a 0.243 acre-foot Extended Detention Basin. Runoff entering the pond on the northwest side will be routed through storm sewers into a 39 cu-ft concrete lined forebay with a 1.0 feet high concrete cutoff wall. A 3 inch notch in the wall drains the flow to a 1' concrete trickle channel, then the runoff is routed to the 3.0' deep micropool which has a 6" deep initial surcharge area. The 1.74 acres tributary to the EDB are 75% impervious. Based upon this we need a WQCV of 0.043 ac-ft, an EURV volume of 0.125 ac-ft and 100-year volume of 0.075 ac-ft for a total volume needed of 0.243 ac-ft. The bottom of the micropool elevation is at 6480.00 while the top of the ISV elevation is at 6483.00. The WQCV orifice starts at 6483.00 with 3 7/8 inch diameter holes spaced 12.90 inches apart. A 2'x2' outlet structure is set at 6486.23, which corresponds to the EURV elevation. The 100-year elevation tops out at 6487.07. A 12" HDPE outlet will release $Q_5$=0.1 cfs and $Q_{100}$=1.0 cfs discharge southeast, across two lots, and two an existing storm inlet.

In an effort to protect receiving water and as part of the "four-step process to minimize adverse impacts of urbanization" this site was analyzed in the following manner:

1. Reduce Runoff- The proposed impervious areas on the site are surrounded by landscaping and green space areas. Additionally, the new improvements and impervious areas on the site will be routed to a proposed private Extended Detention Basin. These items will reduce the volume of runoff using ponding and infiltration.
2. Stabilize Drainageways- There are no existing or proposed drainageways onsite. Additionally, the outflow of the Extended Detention Basin is carried by storm sewer until it connects with an existing public storm sewer system.
3. Provide Water Quality Capture Volume (WQCV)- The Extended Detention Basin has been sized and designed to sufficiently capture the required WQCV and slowly release it though

the three hole outlet, thereby allowing solids and contaminants to settle out.

4. Consider Need for Industrial and Commercial BMPs- The proposed development is an indoor mini storage facility; therefore, no BMPs have been proposed.

**HYDROLOGIC CALCULATIONS**

Hydrologic calculations were performed using the El Paso County Storm Drainage Design Criteria Manual - Volumes 1 & 2, latest editions. The Rational Method was used to estimate storm water runoff anticipated from design storms with 5-year and 100-year recurrence intervals. The Urban Drainage Criteria Manual was used to calculate the detention and water quality volume.

**HYDRAULIC CALCULATIONS**

Hydraulic calculations were estimated using the Manning's Formula and the methods described in the El Paso County Storm Drainage Design Criteria Manual – Volumes 1 & 2, latest editions. The pertinent data sheets are included in the appendix of this report.

A culvert is proposed at the entrance to the site. Design calculations have been included for the proposed culvert.

Street runoff capacity calculations for the onsite drive isles have been included.

**FLOODPLAIN STATEMENT**

No portion of this site is within a designated F.E.M.A. floodplain, as determined by Flood Insurance Rate Map No. 08041C0756 G, dated December 7, 2018 (see appendix).

**WATER QUALITY**

The proposed detention basin provides water quality treatment for the proposed development.

**CONSTRUCTION COST OPINION**

**Public Reimbursable**

None

**Public Non-Reimbursable**

| | | | |
|---|---|---|---|
| 1. 24" RCP | 50 LF | $ 78 | $ 3,900 |
| | | **Total** | **$ 3,900** |

**Private Non-Reimbursable**

| | | | |
|---|---|---|---|
| 1. 12" HDPE | 707 LF | $ 40 | $ 28,280 |
| 2. 15" HDPE | 82 LF | $ 45 | $ 3,690 |
| 3. 2'x2' Area Inlet | 1 EA | $ 3,000 | $ 3,000 |
| 4. 8' D-10-R Curb Inlet | 2 EA | $ 7,800 | $ 15,600 |
| 2. EDB | 1 EA | $ 60,000 | $ 60,000 |
| | | **Total** | **$ 110,570** |

**DRAINAGE FEES**

The site has previously been platted; therefore, no drainage fees are due.

**MAINTENANCE**

The Extended Detention Basin is private and will be maintained by the property owner. The proposed storm sewers are private and will be maintained by the property owner. The proposed culvert is public and will be maintained by the County.

**SUMMARY**

Development of this site will not adversely affect the surrounding development. This report is in general conformance with the previously approved reports which included this site. Site runoff and storm drain appurtenances from the Electronic Storage development will not adversely affect the downstream and surrounding developments and will be safely routed to the proposed extended detention basin and runoff reduced to the allowable pre-developed rates while slowly treating the water quality capture volume and in turn helping to stabilize the downstream stream and channel banks.

PREPARED BY:
**TERRA NOVA ENGINEERING, INC.**

Dane Frank, P.E.
Project Engineer

Jobs/1971.00/drainage/197100 FDR.doc

**BIBLIOGRAPHY**

El Paso County Drainage Criteria Manual-Volumes 1 & 2, latest edition

El Paso County Board Resolution No 15-042 (Adoption of Chapter 6 and Section 3.2.1 Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014, Hydrology and Full Spectrum Detention)

Preliminary and Final Drainage Report for TMC Design Corporation, dated December 2011, prepared by Stillwater Engineering

# VICINITY MAP

Google Maps

# Electronic Storage - Vicinity Map


North is up ^


Electronic Storage - Location Map
Image Dated Oct 2018
Electronic Dr
SITE
Marksheffel Rd
Google Earth
© 2018 Google
400 ft
N

# S.C.S. SOILS MAP


Map Scale: 1:970 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 10 20 40 60

Feet
0 45 90 180 270

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

## MAP LEGEND

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

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

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

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 8 | Blakeland loamy sand, 1 to 9 percent slopes | 4.6 | 97.6% |
| 10 | Blendon sandy loam, 0 to 3 percent slopes | 0.1 | 2.4% |
| **Totals for Area of Interest** | | **4.7** | **100.0%** |

# El Paso County Area, Colorado

## 8—Blakeland loamy sand, 1 to 9 percent slopes

### Map Unit Setting

*National map unit symbol:* 369v
*Elevation:* 4,600 to 5,800 feet
*Mean annual precipitation:* 14 to 16 inches
*Mean annual air temperature:* 46 to 48 degrees F
*Frost-free period:* 125 to 145 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Blakeland and similar soils:* 98 percent
*Minor components:* 2 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Blakeland

#### Setting

*Landform:* Hills, flats
*Landform position (three-dimensional):* Side slope, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from sedimentary rock and/or eolian deposits derived from sedimentary rock

#### Typical profile

*A - 0 to 11 inches:* loamy sand
*AC - 11 to 27 inches:* loamy sand
*C - 27 to 60 inches:* sand

#### Properties and qualities

*Slope:* 1 to 9 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Somewhat excessively drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 5 percent
*Available water storage in profile:* Low (about 4.5 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 6e
*Hydrologic Soil Group:* A
*Ecological site:* Sandy Foothill (R049BY210CO)
*Hydric soil rating:* No

**Minor Components**

**Other soils**

*Percent of map unit:* 1 percent
*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:* 1 percent
*Landform:* Depressions
*Hydric soil rating:* Yes

# Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

# El Paso County Area, Colorado

## 10—Blendon sandy loam, 0 to 3 percent slopes

### Map Unit Setting

*National map unit symbol:* 3671
*Elevation:* 6,000 to 6,800 feet
*Mean annual precipitation:* 14 to 16 inches
*Mean annual air temperature:* 46 to 48 degrees F
*Frost-free period:* 125 to 145 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Blendon and similar soils:* 98 percent
*Minor components:* 2 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Blendon

#### Setting

*Landform:* Terraces, alluvial fans
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Sandy alluvium derived from arkose

#### Typical profile

*A - 0 to 10 inches:* sandy loam
*Bw - 10 to 36 inches:* sandy loam
*C - 36 to 60 inches:* gravelly sandy loam

#### Properties and qualities

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 2 percent
*Available water storage in profile:* Moderate (about 6.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 3e
*Hydrologic Soil Group:* B
*Ecological site:* Sandy Foothill (R049BY210CO)
*Hydric soil rating:* No

**Minor Components**

**Other soils**

*Percent of map unit:* 1 percent
*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:* 1 percent
*Landform:* Depressions
*Hydric soil rating:* Yes

# Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

# FEMA FIRM MAP

## NOTES TO USERS

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

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

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. Those differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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 in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

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

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

Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

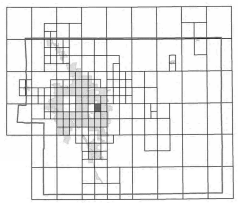
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

**El Paso County Vertical Datum Offset Table**

| Flooding Source | Vertical Datum Offset (ft) |
|---|---|

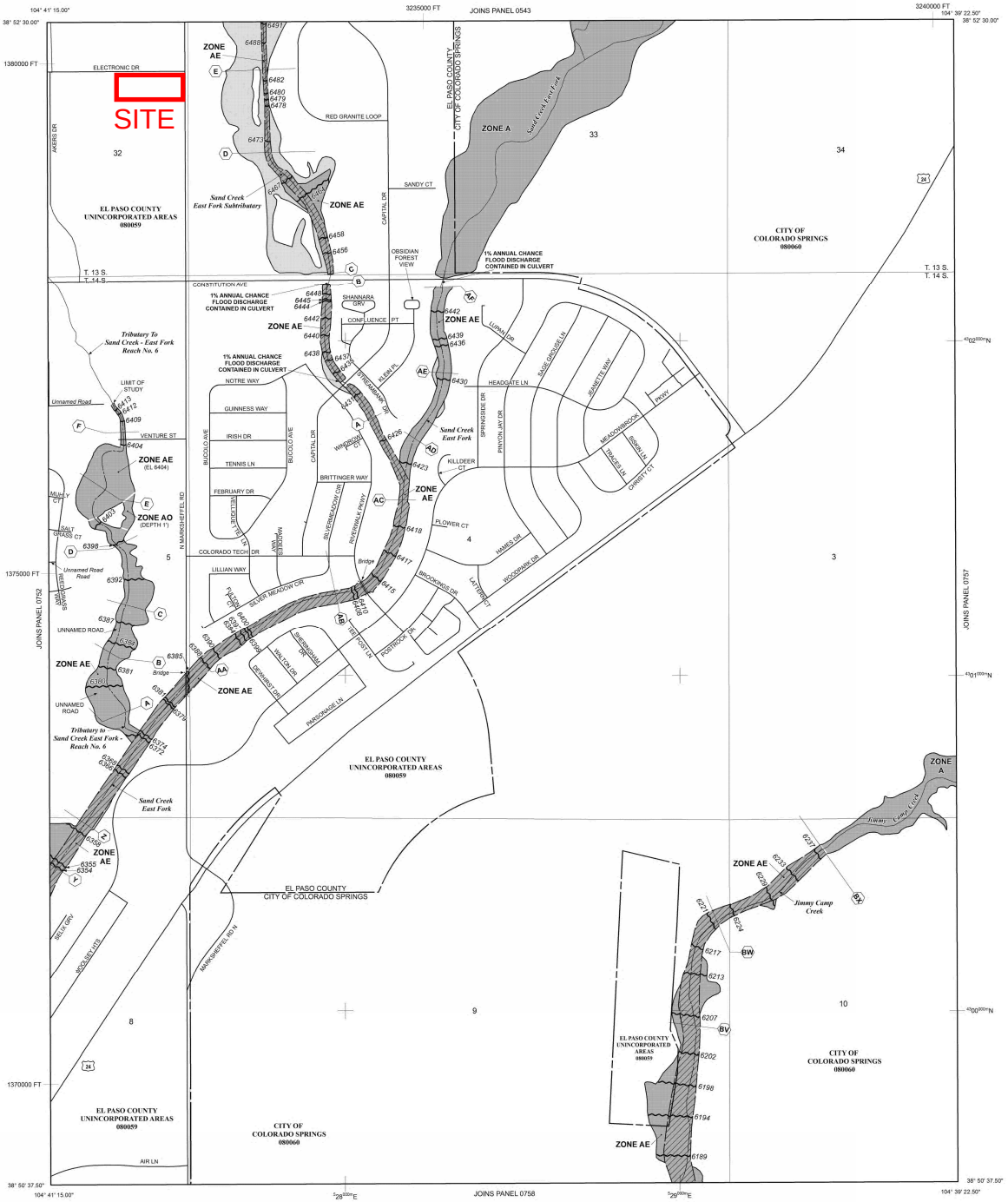
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

**Panel Location Map**



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.


**NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 13 SOUTH, RANGE 65 WEST, AND TOWNSHIP 14 SOUTH, RANGE 65 WEST.**

## LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

**ZONE A** No Base Flood Elevations determined.
**ZONE AE** Base Flood Elevations determined.
**ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
**ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
**ZONE AR** Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
**ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
**ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
**ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 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.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 Base Flood Elevation line and value; elevation in feet*
(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*
* Referenced to the North American Vertical Datum of 1988 (NAVD 88)
A — A Cross section line
23 — 23 Transect line
97° 07' 30.00" / 32° 22' 30.00" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4276000mN 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
**MARCH 17, 1997**

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
**DECEMBER 7, 2018** - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

**MAP SCALE 1" = 500'**

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

**PANEL 0756G**

NATIONAL FLOOD INSURANCE PROGRAM

# FIRM

**FLOOD INSURANCE RATE MAP**

**EL PASO COUNTY, COLORADO**
**AND INCORPORATED AREAS**

**PANEL 756 OF 1300**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| COLORADO SPRINGS, CITY OF | 080060 | 0756 | G |
| EL PASO COUNTY | 080059 | 0756 | 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.

**MAP NUMBER**
**08041C0756G**

**MAP REVISED**
**DECEMBER 7, 2018**

Federal Emergency Management Agency

# HYDROLOGIC CALCULATIONS

# *ELECTRONIC STORAGE*
# *(Area Runoff Coefficient Summary)*

## EXISTING CONDITIONS

| | | *STREETS / DEVELOPED* | | | *OVERLAND / UNDEVELOPED* | | | *WEIGHTED* | |
|---|---|---|---|---|---|---|---|---|---|
| **BASIN** | **TOTAL AREA** | **AREA** | **$C_5$** | **$C_{100}$** | **AREA** | **$C_5$** | **$C_{100}$** | **$C_5$** | **$C_{100}$** |
| | *(Acres)* | *(Acres)* | | | *(Acres)* | | | | |
| ***P 1S*** | 2.66 | | | | | | | | |
| ***2S*** | 5.49 | | | | | | | | |
| ***3S*** | 4.00 | | | | | | | | |

Note: Existing basin values are from previously approved report.

Calculated by: _____
Date: _____
Checked by: _____

## DEVELOPED CONDITIONS

| | | *STREETS / DEVELOPED* | | | *OVERLAND / UNDEVELOPED* | | | *WEIGHTED* | |
|---|---|---|---|---|---|---|---|---|---|
| **BASIN** | **TOTAL AREA** | **AREA** | **$C_5$** | **$C_{100}$** | **AREA** | **$C_5$** | **$C_{100}$** | **$C_5$** | **$C_{100}$** |
| | *(Acres)* | *(Acres)* | | | *(Acres)* | | | | |
| ***OS-A*** | 0.44 | 0.44 | 0.73 | 0.81 | 0.00 | 0.09 | 0.36 | 0.73 | 0.81 |
| ***OS-B*** | 1.38 | 1.38 | 0.73 | 0.81 | 0.00 | 0.09 | 0.36 | 0.73 | 0.81 |
| ***OS-C*** | 0.01 | 0.01 | 0.90 | 0.96 | 0.00 | 0.09 | 0.36 | 0.90 | 0.96 |
| ***PR-1*** | 0.37 | 0.00 | 0.90 | 0.96 | 0.37 | 0.09 | 0.36 | 0.09 | 0.36 |
| ***PR-2*** | 0.62 | 0.62 | 0.90 | 0.96 | 0.00 | 0.09 | 0.36 | 0.90 | 0.96 |
| ***PR-3*** | 0.45 | 0.45 | 0.90 | 0.96 | 0.00 | 0.09 | 0.36 | 0.90 | 0.96 |
| ***PR-4*** | 0.32 | 0.32 | 0.09 | 0.36 | 0.00 | 0.09 | 0.36 | 0.09 | 0.36 |
| ***PR-5*** | 0.34 | 0.34 | 0.09 | 0.36 | 0.00 | 0.09 | 0.36 | 0.09 | 0.36 |
| ***PR-6*** | 0.03 | 0.03 | 0.09 | 0.36 | 0.00 | 0.09 | 0.36 | 0.09 | 0.36 |
| ***PR-7*** | 0.13 | 0.13 | 0.20 | 0.44 | 0.00 | 0.09 | 0.36 | 0.20 | 0.44 |

Calculated by: DLF
Date: 1/10/2020
Checked by: LD

# *ELECTRONIC STORAGE*
# *AREA DRAINAGE SUMMARY*

## EXISTING CONDITIONS

| | | *WEIGHTED* | | *OVERLAND* | | | | *STREET / CHANNEL FLOW* | | | | $T_t$ | *INTENSITY* | | *TOTAL FLOWS* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BASIN** | **AREA TOTAL** *(Acres)* | $C_5$ | $C_{100}$ | $C_5$ | **Length** *(ft)* | **Height** *(ft)* | $T_C$ *(min)* | **Length** *(ft)* | **Slope** *(%)* | **Velocity** *(fps)* | $T_t$ *(min)* | **TOTAL** *(min)* | $I_5$ *(in/hr)* | $I_{100}$ *(in/hr)* | $Q_5$ *(c.f.s.)* | $Q_{100}$ *(c.f.s.)* |
| | | ** For Calcs See Runoff Summary* | | | | | | | | | | | | | | |
| ***P 1S*** | 2.66 | | | | | | | | | | | | | | **4.08** | **6.19** |
| ***2S*** | 5.49 | | | | | | | | | | | | | | **7.69** | **11.67** |
| ***3S*** | 4.00 | | | | | | | | | | | | | | **5.60** | **8.50** |

Note: Existing basin values are from previously approved report.

## DEVELOPED CONDITIONS

| | | *WEIGHTED* | | *OVERLAND* | | | | *STREET / CHANNEL FLOW* | | | | $T_t$ | *INTENSITY* | | *TOTAL FLOWS* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BASIN** | **AREA TOTAL** *(Acres)* | $C_5$ | $C_{100}$ | $C_5$ | **Length** *(ft)* | **Height** *(ft)* | $T_C$ *(min)* | **Length** *(ft)* | **Slope** *(%)* | **Velocity** *(fps)* | $T_t$ *(min)* | **TOTAL** *(min)* | $I_5$ *(in/hr)* | $I_{100}$ *(in/hr)* | $Q_5$ *(c.f.s.)* | $Q_{100}$ *(c.f.s.)* |
| | | ** For Calcs See Runoff Summary* | | | | | | | | | | | | | | |
| ***OS-A*** | 0.44 | 0.73 | 0.81 | 0.73 | 100 | 7.0 | 2.2 | 0 | 5.0% | 1.1 | 0.0 | 2.2 | 5.9 | 11.0 | **1.9** | **3.9** |
| ***OS-B*** | 1.38 | 0.73 | 0.81 | 0.73 | 300 | 21.0 | 3.5 | 0 | 5.0% | 1.1 | 0.0 | 3.5 | 5.4 | 10.0 | **5.5** | **11.2** |
| ***OS-C*** | 0.01 | 0.90 | 0.96 | 0.90 | 20 | 2.0 | 0.6 | 0 | 5.0% | 4.5 | 0.0 | 0.6 | 6.7 | 13.0 | **0.1** | **0.1** |
| ***PR-1*** | 0.37 | 0.09 | 0.36 | 0.09 | 100 | 6.0 | 6.4 | 0 | 5.0% | 4.5 | 0.0 | 6.4 | 4.7 | 8.4 | **0.2** | **1.1** |
| ***PR-2*** | 0.62 | 0.90 | 0.96 | 0.90 | 100 | 5.0 | 1.4 | 300 | 6.0% | 4.9 | 1.0 | 2.4 | 5.8 | 10.9 | **3.2** | **6.5** |
| ***PR-3*** | 0.45 | 0.90 | 0.96 | 0.90 | 100 | 0.5 | 2.9 | 0 | 5.0% | 4.5 | 0.0 | 2.9 | 5.6 | 10.4 | **2.3** | **4.5** |
| ***PR-4*** | 0.32 | 0.09 | 0.36 | 0.09 | 40 | 10.0 | 2.8 | 0 | 5.0% | 1.1 | 0.0 | 2.8 | 5.7 | 10.5 | **0.2** | **1.2** |
| ***PR-5*** | 0.34 | 0.09 | 0.36 | 0.09 | 100 | 5.0 | 6.8 | 0 | 5.0% | 1.1 | 0.0 | 6.8 | 4.6 | 8.2 | **0.1** | **1.0** |
| ***PR-6*** | 0.03 | 0.09 | 0.36 | 0.09 | 20 | 2.7 | 2.6 | 0 | 5.0% | 1.1 | 0.0 | 2.6 | 5.7 | 10.7 | **0.0** | **0.1** |
| ***PR-7*** | 0.13 | 0.20 | 0.44 | 0.20 | 20 | 1.2 | 3.0 | 0 | 5.0% | 1.1 | 0.0 | 3.0 | 5.6 | 10.4 | **0.1** | **0.6** |

Calculated by: DLF

Date: 1/10/2020

Checked by: LD

# *ELECTRONIC STORAGE*
# *PROPOSED SURFACE ROUTING SUMMARY*

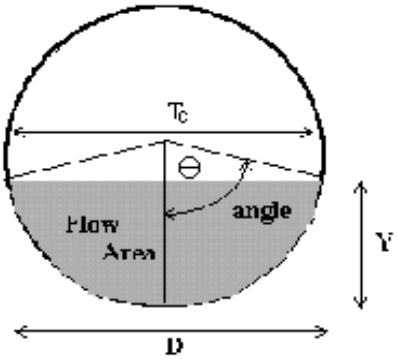
| *Design Point(s)* | *Contributing Basins* | *Area Ac* | *Flow* | |
|---|---|---|---|---|
| | | | $Q_5$ | $Q_{100}$ |
| ***A*** | **OS-A** | 0.44 | ***1.9*** | ***3.9*** |
| ***B*** | **OS-B** | 1.38 | ***5.5*** | ***11.2*** |
| ***C*** | **OS-C** | 0.01 | ***0.1*** | ***0.1*** |
| ***1*** | **OS-A, PR-1** | 0.81 | ***2.0*** | ***5.0*** |
| ***2*** | **OS-A, OS-C, PR-1, PR-2** | 1.44 | ***5.3*** | ***11.6*** |
| ***3*** | **PR-3** | 0.45 | ***2.3*** | ***4.5*** |
| ***4*** | **OS-A, OS-C, PR-1, PR-2, PR-3, PR-4** | 2.21 | ***7.8*** | ***17.4*** |
| ***5*** | **OS-B, PR-5** | 1.72 | ***5.6*** | ***12.2*** |
| ***6*** | **PR-6** | 0.03 | ***0.0*** | ***0.1*** |
| ***7*** | **PR-7** | 0.13 | ***0.1*** | ***0.6*** |

Calculated by: DLF
Date: 1/10/2020
Checked by: LD

# HYDRAULIC CALCULATIONS

# CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

**Project:** Electronic Storage
**Pipe ID:** Entrance Culvert




| **Design Information (Input)** | | | |
|---|---|---|---|
| Pipe Invert Slope | So = | 0.0200 | ft/ft |
| Pipe Manning's n-value | n = | 0.0130 | |
| Pipe Diameter | D = | 24.00 | inches |
| **Design discharge** | **Q =** | **5.00** | **cfs** |

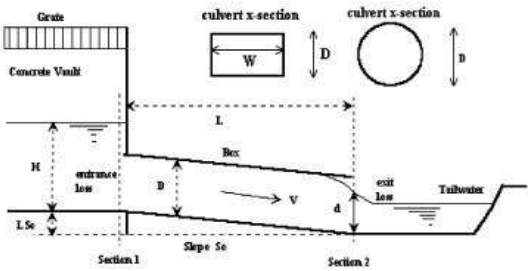
| **Full-flow Capacity (Calculated)** | | | |
|---|---|---|---|
| Full-flow area | Af = | 3.14 | sq ft |
| Full-flow wetted perimeter | Pf = | 6.28 | ft |
| Half Central Angle | Theta = | 3.14 | radians |
| Full-flow capacity | Qf = | 32.08 | cfs |

| **Calculation of Normal Flow Condition** | | | |
|---|---|---|---|
| Half Central Angle (0<Theta<3.14) | Theta = | 1.09 | radians |
| Flow area | An = | 0.67 | sq ft |
| Top width | Tn = | 1.77 | ft |
| Wetted perimeter | Pn = | 2.17 | ft |
| Flow depth | Yn = | 0.53 | ft |
| Flow velocity | Vn = | 7.42 | fps |
| Discharge | Qn = | 5.00 | cfs |
| Percent Full Flow | Flow = | 15.6% | of full flow |
| Normal Depth Froude Number | $Fr_n$ = | 2.12 | supercritical |

| **Calculation of Critical Flow Condition** | | | |
|---|---|---|---|
| Half Central Angle (0<Theta-c<3.14) | Theta-c = | 1.36 | radians |
| Critical flow area | Ac = | 1.15 | sq ft |
| Critical top width | Tc = | 1.95 | ft |
| Critical flow depth | Yc = | 0.79 | ft |
| Critical flow velocity | Vc = | 4.35 | fps |
| Critical Depth Froude Number | $Fr_c$ = | 1.00 | |

# CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

**Project:** Electronic Storage
**Basin ID:** Entrance Culvert
**Status:**




## Design Information (Input):

| | | | | |
|---|---|---|---|---|
| **Circular Culvert:** | Barrel Diameter in Inches | D = | 24 | inches |
| | Inlet Edge Type (choose from pull-down list) | | Grooved End with Headwall | |
| **OR:** | | | | |
| **Box Culvert:** | Barrel Height (Rise) in Feet | Height (Rise) = | | ft. |
| | Barrel Width (Span) in Feet | Width (Span) = | | ft. |
| | Inlet Edge Type (choose from pull-down list) | | Square Edge w/ 30-78 deg. Flared Wingwall | |
| | Number of Barrels | No = | 1 | |
| | Inlet Elevation at Culvert Invert | Inlet Elev = | 6497.5 | ft. elev. |
| | Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.) | Outlet Elev = | 6496.5 | ft. elev. |
| | Culvert Length in Feet | L = | 50 | ft. |
| | Manning's Roughness | n = | 0.013 | |
| | Bend Loss Coefficient | $K_b$ = | 0 | |
| | Exit Loss Coefficient | $K_x$ = | 1 | |

## Design Information (calculated):

| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.20 |
| Friction Loss Coefficient | $K_f$ = | 0.62 |
| Sum of All Loss Coefficients | $K_s$ = | 1.82 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.99 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | -0.0794 |

## Calculations of Culvert Capacity (output):

| Water Surface Elevation (ft., linked) | Tailwater Surface Elevation ft | Culvert Inlet-Control Flowrate cfs | Culvert Outlet-Control Flowrate cfs | Controlling Culvert Flowrate cfs (output) | Inlet Equation Used: | Flow Control Used |
|---|---|---|---|---|---|---|
| 6497.50 | | 0.00 | 0.00 | **0.00** | No Flow (WS < inlet) | N/A |
| 6497.75 | | 0.30 | 9.55 | **0.30** | Min. Energy. Eqn. | INLET |
| 6498.00 | | 1.30 | 10.21 | **1.30** | Min. Energy. Eqn. | INLET |
| 6498.25 | | 2.70 | 11.45 | **2.70** | Min. Energy. Eqn. | INLET |
| 6498.50 | | 4.60 | 13.23 | **4.60** | Min. Energy. Eqn. | INLET |
| 6498.75 | | 6.50 | 14.80 | **6.50** | Regression Eqn. | INLET |
| 6499.00 | | 8.90 | 16.20 | **8.90** | Regression Eqn. | INLET |
| 6499.25 | | 11.60 | 17.50 | **11.60** | Regression Eqn. | INLET |
| 6499.50 | | 14.30 | 18.72 | **14.30** | Regression Eqn. | INLET |
| 6499.75 | | 16.80 | 20.92 | **16.80** | Regression Eqn. | INLET |
| 6500.00 | | 19.10 | 22.91 | **19.10** | Regression Eqn. | INLET |
| 6500.25 | | 21.10 | 24.75 | **21.10** | Regression Eqn. | INLET |
| 6500.50 | | 23.00 | 26.46 | **23.00** | Regression Eqn. | INLET |
| 6500.75 | | 24.80 | 28.06 | **24.80** | Regression Eqn. | INLET |
| 6501.00 | | 26.40 | 29.58 | **26.40** | Regression Eqn. | INLET |
| 6501.25 | | 27.90 | 31.02 | **27.90** | Regression Eqn. | INLET |
| 6501.50 | | 29.40 | 32.39 | **29.40** | Regression Eqn. | INLET |
| 6501.75 | | 30.80 | 33.72 | **30.80** | Regression Eqn. | INLET |
| 6502.00 | | 32.10 | 35.00 | **32.10** | Regression Eqn. | INLET |
| 6502.25 | | 33.50 | 36.22 | **33.50** | Regression Eqn. | INLET |
| 6502.50 | | 34.70 | 37.42 | **34.70** | Regression Eqn. | INLET |
| 6502.75 | | 36.00 | 38.57 | **36.00** | Regression Eqn. | INLET |
| 6503.00 | | 37.20 | 39.69 | **37.20** | Regression Eqn. | INLET |
| 6503.25 | | 38.40 | 40.76 | **38.40** | Regression Eqn. | INLET |
| 6503.50 | | 39.50 | 41.83 | **39.50** | Regression Eqn. | INLET |
| 6503.75 | | 40.50 | 42.85 | **40.50** | Orifice Eqn. | INLET |
| 6504.00 | | 41.50 | 43.86 | **41.50** | Orifice Eqn. | INLET |
| 6504.25 | | 42.40 | 44.85 | **42.40** | Orifice Eqn. | INLET |
| 6504.50 | | 43.30 | 45.81 | **43.30** | Orifice Eqn. | INLET |
| 6504.75 | | 44.20 | 46.76 | **44.20** | Orifice Eqn. | INLET |

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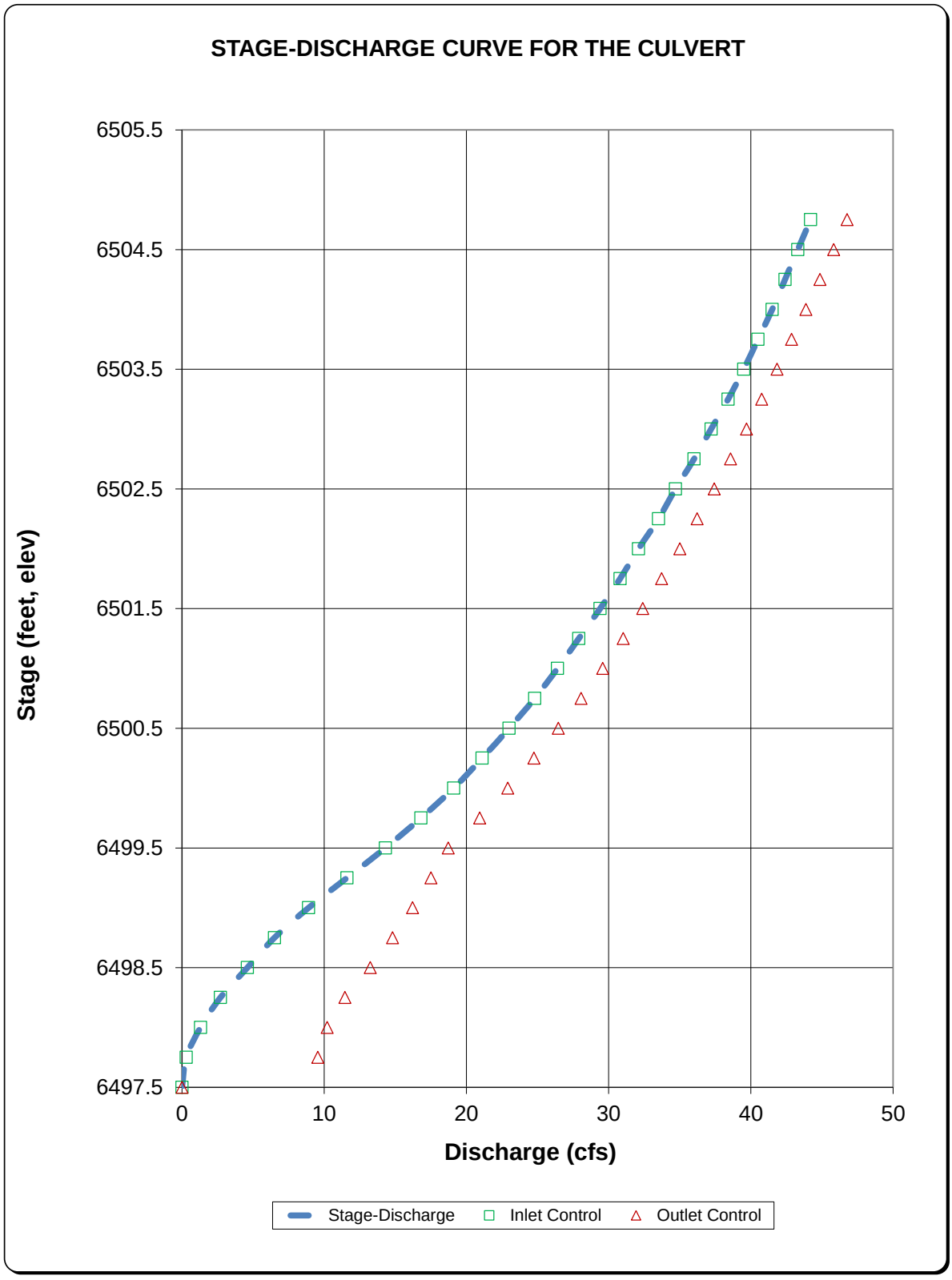
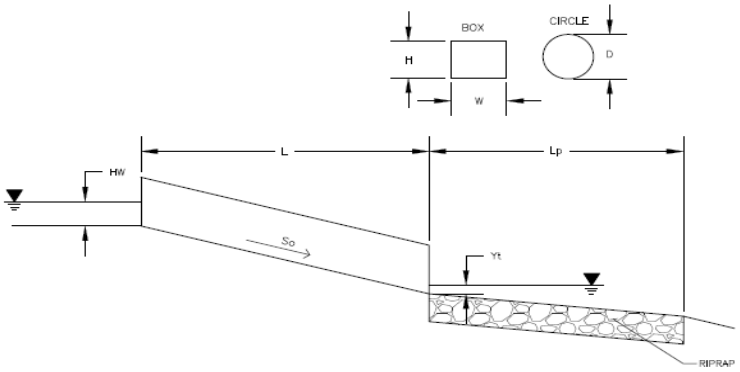
## CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

**Project:** Electronic Storage
**Basin ID:** Entrance Culvert



# Determination of Culvert Headwater and Outlet Protection

**Project:** Electronic Storage
**Basin ID:** Entrance Culvert




**Soil Type:**
Choose One:
(•) Sandy
( ) Non-Sandy

**Supercritical Flow! Using Da to calculate protection type.**

## Design Information (Input):

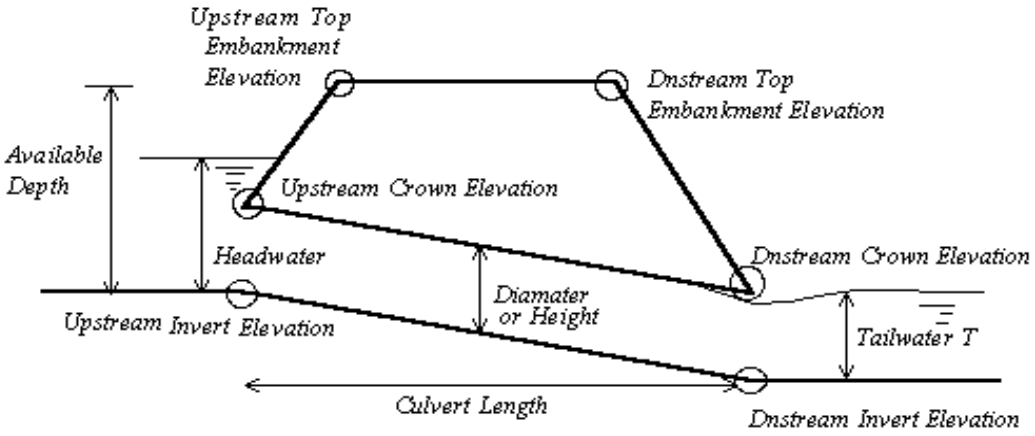
| | | | | |
|---|---|---|---|---|
| | Design Discharge | Q = | 5 | cfs |
| **Circular Culvert:** | | | | |
| | Barrel Diameter in Inches | D = | 24 | inches |
| | Inlet Edge Type (Choose from pull-down list) | | Square End with Headwall | |
| **Box Culvert:** | | | **OR** | |
| | Barrel Height (Rise) in Feet | Height (Rise) = | | ft |
| | Barrel Width (Span) in Feet | Width (Span) = | | ft |
| | Inlet Edge Type (Choose from pull-down list) | | | |
| | Number of Barrels | No = | 1 | |
| | Inlet Elevation | Elev IN = | 6497.5 | ft |
| | Outlet Elevation **OR** Slope | Elev OUT = | 6496.5 | ft |
| | Culvert Length | L = | 50 | ft |
| | Manning's Roughness | n = | 0.013 | |
| | Bend Loss Coefficient | $k_b$ = | 0 | |
| | Exit Loss Coefficient | $k_x$ = | 1 | |
| | Tailwater Surface Elevation | Elev $Y_t$ = | | ft |
| | Max Allowable Channel Velocity | V = | 5 | ft/s |

## Required Protection (Output):

| | | | |
|---|---|---|---|
| Tailwater Surface Height | $Y_t$ = | 0.80 | ft |
| Flow Area at Max Channel Velocity | $A_t$ = | 1.00 | $ft^2$ |
| Culvert Cross Sectional Area Available | A = | 3.14 | $ft^2$ |
| Entrance Loss Coefficient | $k_e$ = | 0.50 | |
| Friction Loss Coefficient | $k_f$ = | 0.62 | |
| Sum of All Losses Coefficients | $k_s$ = | 2.12 | ft |
| Culvert Normal Depth | $Y_n$ = | 0.53 | ft |
| Culvert Critical Depth | $Y_c$ = | 0.79 | ft |
| Tailwater Depth for Design | d = | 1.39 | ft |
| Adjusted Diameter **OR** Adjusted Rise | $D_a$ = | 1.27 | ft |
| Expansion Factor | 1/(2*tan(Θ)) = | 6.70 | |
| Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$) | Q/D^2.5 = | 0.88 | $ft^{0.5}/s$ |
| Froude Number | Fr = | 2.12 | **Supercritical!** |
| Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise | Yt/D = | 0.63 | |
| Inlet Control Headwater | $HW_I$ = | 1.09 | ft |
| Outlet Control Headwater | $HW_O$ = | 0.48 | |
| **Design Headwater Elevation** | **HW =** | **6,498.59** | **ft** |
| **Headwater/Diameter OR Headwater/Rise Ratio** | **HW/D =** | **0.55** | |
| Minimum Theoretical Riprap Size | $d_{50}$ = | 2 | in |
| Nominal Riprap Size | $d_{50}$ = | 6 | in |
| **UDFCD Riprap Type** | **Type =** | **VL** | |
| **Length of Protection** | **$L_p$ =** | **6** | **ft** |
| **Width of Protection** | **T =** | **3** | **ft** |

# Vertical Profile for the Culvert

**Project =** Electronic Storage
**Box ID =** Entrance Culvert




| **Culvert Information (Input)** | | | |
|---|---|---|---|
| Barrel Diameter or Height | D or H = | 24.00 | inches |
| Barrel Length | L = | 50.00 | ft |
| Barrel Invert Slope | So = | 0.0200 | ft/ft |
| Downstream Invert Elevation | EDI = | 6496.50 | ft |
| Downstream Top Embankment Elevation | EDT = | 6499.50 | ft |
| Upstream Top Embankment Elevation | EUT = | 6501.00 | ft |
| Design Headwater Depth (not elev.) | Hw = | 1.09 | ft |
| Tailwater Depth (not elev.) | Yt = | 1.39 | ft |

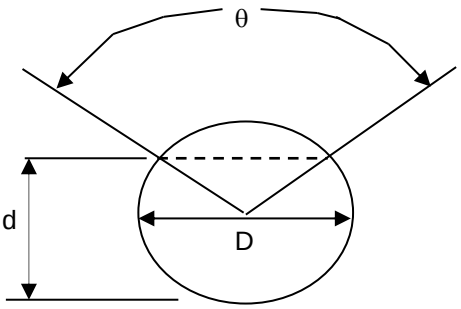
| **Culvert Hydraulics (Calculated)** | | | |
|---|---|---|---|
| Available Headwater Depth | HW-a = | 3.50 | ft |
| Design Hw/D ratio | Hw/D = | 0.55 | |
| **Culvert Vertical Profile** | | | |
| Upstream Invert Elevation | EUI = | 6497.50 | ft |
| Upstream Crown Elevation | EUC = | 6499.50 | ft |
| Upstream Soil Cover Depth | Upsoil = | 1.50 | ft |
| Downstream Invert Elevation | EDI = | 6496.50 | ft |
| Downstream Crown Elevation | EDC = | 6498.50 | ft |
| Downstream Soil Cover Depth | Dnsoil = | 1.00 | ft |

**MANNING'S EQUATION FOR PIPE FLOW**

| | | | |
|---|---|---|---|
| Project: | Electronic Storage | Location: | Roof Drains Storm Pipe (Need Q=4.5 cfs) |
| By: | Dane Frank | Date: | 1/13/2020 |
| Chk. By: | | Date: | |

mdo version 12.8.00

Clear Data Entry Cells




INPUT

| | | |
|---|---|---|
| D= | 12 | inches |
| d= | 12 | inches |
| n= | 0.012 | mannings coeff |
| θ= | 0.0 | degrees |
| S= | 0.1 | slope in/in |

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

Q=V x A

| Solution to Mannings Equation | | | | |
|---|---|---|---|---|
| Area,ft$^2$ | Wetted Perimeter, ft | Hydraulic Radius, ft | velocity ft/s | flow, cfs |
| 0.79 | 3.14 | 0.25 | 15.54 | 12.20 |

| Manning's n-values | |
|---|---|
| PVC | 0.01 |
| PE (<9"dia) | 0.015 |
| PE (>12"dia) | 0.02 |
| PE(9-12"dia) | 0.017 |
| CMP | 0.025 |
| ADS N12 | 0.012 |
| HCMP | 0.023 |
| Conc | 0.013 |

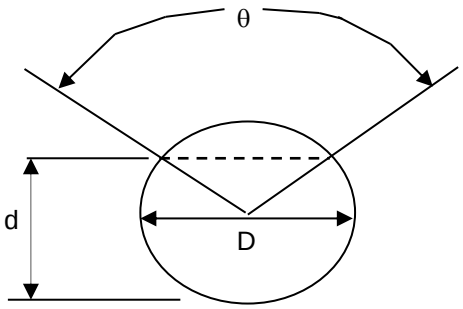
Created by: Mike O'Shea

**MANNING'S EQUATION FOR PIPE FLOW**

| | | | |
|---|---|---|---|
| Project: | Electronic Storage | Location: | SW Pond Inlet ST Pipe (Need Q=10.3 cfs) |
| By: | Dane Frank | Date: | 1/13/2020 |
| Chk. By: | | Date: | |

mdo version 12.8.00

Clear Data Entry Cells




INPUT

| | | |
|---|---|---|
| D= | 15 | inches |
| d= | 15 | inches |
| n= | 0.012 | mannings coeff |
| θ= | 0.0 | degrees |
| S= | 0.049 | slope in/in |

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

Q=V x A

| Solution to Mannings Equation | | | | |
|---|---|---|---|---|
| Area,ft$^2$ | Wetted Perimeter, ft | Hydraulic Radius, ft | velocity ft/s | flow, cfs |
| 1.23 | 3.93 | 0.31 | 12.62 | 15.49 |

| Manning's n-values | |
|---|---|
| PVC | 0.01 |
| PE (<9"dia) | 0.015 |
| PE (>12"dia) | 0.02 |
| PE(9-12"dia) | 0.017 |
| CMP | 0.025 |
| ADS N12 | 0.012 |
| HCMP | 0.023 |
| Conc | 0.013 |

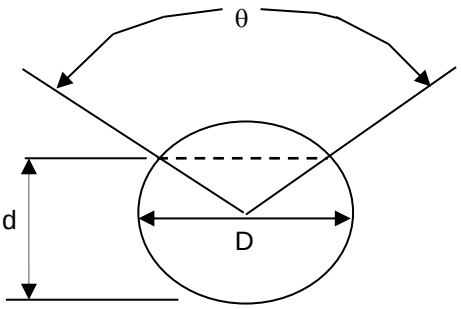
Created by: Mike O'Shea

**MANNING'S EQUATION FOR PIPE FLOW**

| | | | |
|---|---|---|---|
| Project: | Electronic Storage | Location: | NE Pond Inlet ST Pipe (Need Q=5.8 cfs) |
| By: | Dane Frank | Date: | 1/13/2020 |
| Chk. By: | | Date: | |

mdo version 12.8.00

Clear Data Entry Cells




INPUT

| | | |
|---|---|---|
| D= | 12 | inches |
| d= | 12 | inches |
| n= | 0.012 | mannings coeff |
| θ= | 0.0 | degrees |
| S= | 0.049 | slope in/in |

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

Q=V x A

| Solution to Mannings Equation | | | | |
|---|---|---|---|---|
| Area,ft$^2$ | Wetted Perimeter, ft | Hydraulic Radius, ft | velocity ft/s | flow, cfs |
| 0.79 | 3.14 | 0.25 | 10.88 | 8.54 |

| Manning's n-values | |
|---|---|
| PVC | 0.01 |
| PE (<9"dia) | 0.015 |
| PE (>12"dia) | 0.02 |
| PE(9-12"dia) | 0.017 |
| CMP | 0.025 |
| ADS N12 | 0.012 |
| HCMP | 0.023 |
| Conc | 0.013 |

Created by: Mike O'Shea

**MANNING'S EQUATION for OPEN CHANNEL FLOW**

**Project:** **Electronic Storage** Location: NW of Bldg Capacity (Need 3cfs)

By: Dane Frank Date: 1/13/2020

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

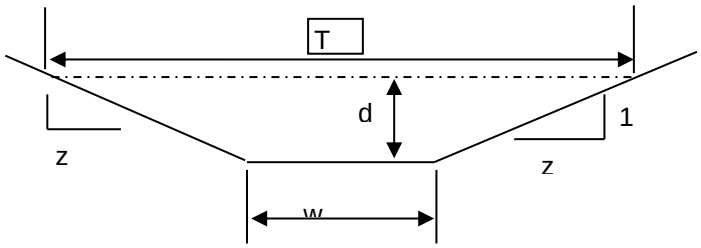
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient




$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

| INPUT | |
|---|---|
| z (sideslope)= | 25 |
| z (sideslope)= | 50 |
| b (btm width, ft)= | 0 |
| d (depth, ft)= | 0.6 |
| S (slope, ft/ft) | 0.005 |
| $n_{low}$ = | 0.013 |
| $n_{high}$ = | 0.013 |

Clear Data Entry Cells

| | | | | Low N | | High N | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth, ft | Area, sf | Wetted Perimeter, ft | Hydraulic Radius, ft | Velocity, fps | Flow, cfs | Velocity, fps | Flow, cfs | | |
| 0.6 | 13.50 | 45.02 | 0.30 | 3.62110768 | 48.885 | 3.621108 | 48.885 | T = | 45 |
| | | | | | | | | Dm = | 0.300 |
| | | | | Sc low = | 0.0037 | Sc high = | 0.0037 | | |
| | | | | .7 Sc | 1.3 Sc | .7 Sc | 1.3 Sc | | |
| | | | | 0.0026 | 0.0048 | 0.0026 | 0.0048 | | |

$s_c$ = critical slope ft / ft

T = top width of the stream

$d_m$ = a/T = mean depth of flow

Created by: Mike O'Shea

**MANNING'S EQUATION for OPEN CHANNEL FLOW**

**Project:** **Electronic Storage** Location: NE of Bldg Capacity (Need 5.8 cfs)

By: Dane Frank Date: 1/13/2020

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

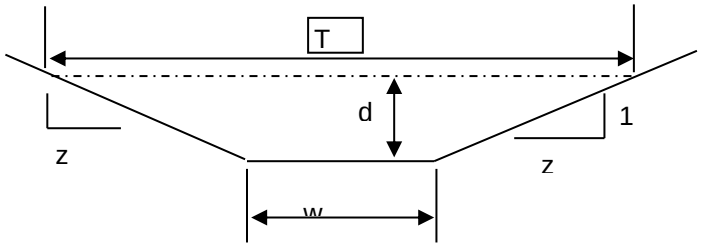
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient




$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

| INPUT | |
|---|---|
| z (sideslope)= | 25 |
| z (sideslope)= | 25 |
| b (btm width, ft)= | 0 |
| d (depth, ft)= | 0.6 |
| S (slope, ft/ft) | 0.1 |
| $n_{low}$ = | 0.013 |
| $n_{high}$ = | 0.013 |

Clear Data Entry Cells

| | | | | Low N | | High N | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth, ft | Area, sf | Wetted Perimeter, ft | Hydraulic Radius, ft | Velocity, fps | Flow, cfs | Velocity, fps | Flow, cfs | | |
| 0.6 | 9.00 | 30.02 | 0.30 | 16.1897726 | 145.708 | 16.18977 | 145.708 | T = | 30 |
| | | | | | | | | Dm = | 0.300 |
| | | | | Sc low = | 0.0037 | Sc high = | 0.0037 | | |
| | | | | .7 Sc | 1.3 Sc | .7 Sc | 1.3 Sc | | |
| | | | | 0.0026 | 0.0048 | 0.0026 | 0.0048 | | |

$s_c$ = critical slope ft / ft

T = top width of the stream

$d_m$ = a/T = mean depth of flow

Created by: Mike O'Shea

**MANNING'S EQUATION for OPEN CHANNEL FLOW**

**Project:** **Electronic Storage** Location: SE of Bldg Capacity (Need 5.8 cfs)

By: Dane Frank Date: 1/13/2020

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

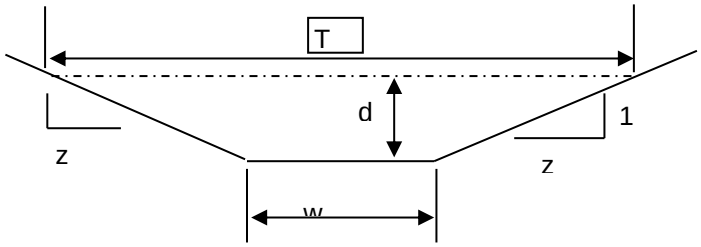
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient




$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

| INPUT | |
|---|---|
| z (sideslope)= | 50 |
| z (sideslope)= | 0 |
| b (btm width, ft)= | 0 |
| d (depth, ft)= | 0.5 |
| S (slope, ft/ft) | 0.01 |
| $n_{low}$ = | 0.013 |
| $n_{high}$ = | 0.013 |

Clear Data Entry Cells

| | | | | Low N | | High N | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth, ft | Area, sf | Wetted Perimeter, ft | Hydraulic Radius, ft | Velocity, fps | Flow, cfs | Velocity, fps | Flow, cfs | | |
| 0.5 | 6.25 | 25.50 | 0.25 | 4.47601532 | 27.9751 | 4.476015 | 27.9751 | T = | 25 |
| | | | | | | | | Dm = | 0.250 |
| | | | | Sc low = | 0.0040 | Sc high = | 0.0040 | | |
| | | | | .7 Sc | 1.3 Sc | .7 Sc | 1.3 Sc | | |
| | | | | 0.0028 | 0.0052 | 0.0028 | 0.0052 | | |

$s_c$ = critical slope ft / ft

T = top width of the stream

$d_m$ = a/T = mean depth of flow

Created by: Mike O'Shea

**MANNING'S EQUATION for OPEN CHANNEL FLOW**

| | | | | |
|---|---|---|---|---|
| **Project:** | **Electronic Storage** | Location: | SW of Bldg Capacity (Need 5.8 cfs) | |
| By: | Dane Frank | Date: | 1/13/2020 | |
| Chk By: | | Date: | | version 12-2004 |

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

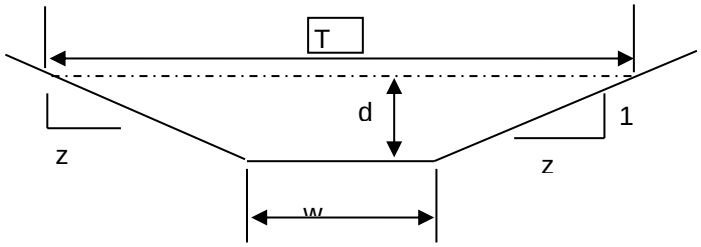
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient




$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

| INPUT | |
|---|---|
| z (sideslope)= | 25 |
| z (sideslope)= | 0 |
| b (btm width, ft)= | 0 |
| d (depth, ft)= | 0.5 |
| S (slope, ft/ft) | 0.1 |
| $n_{low}$ = | 0.013 |
| $n_{high}$ = | 0.013 |

Clear Data Entry Cells

| | | | | Low N | | High N | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth, ft | Area, sf | Wetted Perimeter, ft | Hydraulic Radius, ft | Velocity, fps | Flow, cfs | Velocity, fps | Flow, cfs | | |
| 0.5 | 3.13 | 13.01 | 0.24 | 13.967008 | 43.6469 | 13.96701 | 43.6469 | T = | 12.5 |
| | | | | | | | | Dm = | 0.250 |
| | | | | Sc low = | 0.0041 | Sc high = | 0.0041 | | |
| | | | | .7 Sc | 1.3 Sc | .7 Sc | 1.3 Sc | | |
| | | | | 0.0029 | 0.0054 | 0.0029 | 0.0054 | | |

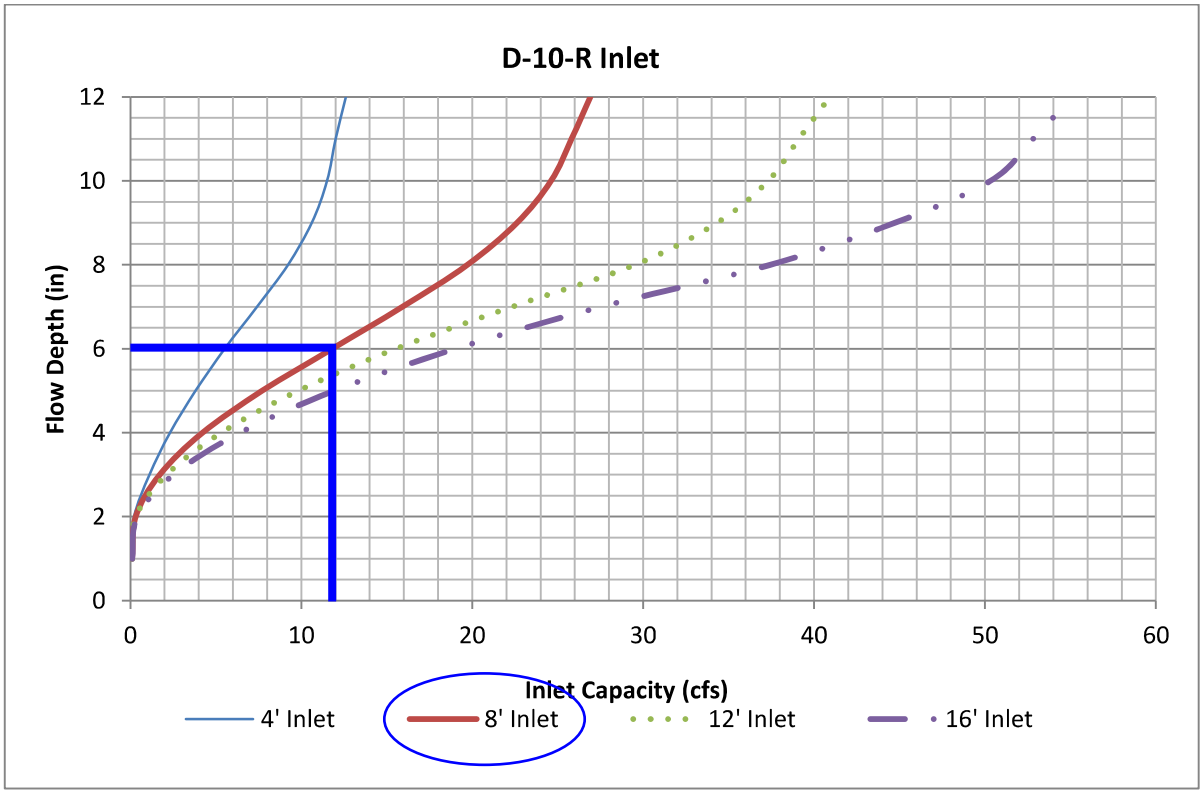
$s_c$ = critical slope ft / ft

T = top width of the stream

$d_m$ = a/T = mean depth of flow

Created by: Mike O'Shea

**Figure 8-12. Inlet Capacity Chart Sump Conditions, Curb Opening (D-10-R) Inlet**



# DETENTION CALCULATIONS

# Stormwater Detention and Infiltration Design Data Sheet

Workbook Protected  Worksheet Protected

**Stormwater Facility Name:** **Electronic Storage EDB**

**Facility Location & Jurisdiction:** **7765 Electronic Drive, El Paso County**

**User Input: Watershed Characteristics**

| | | |
|---|---|---|
| Watershed Slope = | 0.060 | ft/ft |
| Watershed Length = | 340 | ft |
| Watershed Area = | 1.74 | acres |
| Watershed Imperviousness = | 75.0% | percent |
| Percentage Hydrologic Soil Group A = | 98.0% | percent |
| Percentage Hydrologic Soil Group B = | 2.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |

Location for 1-hr Rainfall Depths (use dropdown): User Input

WQCV Treatment Method = Extended Detention

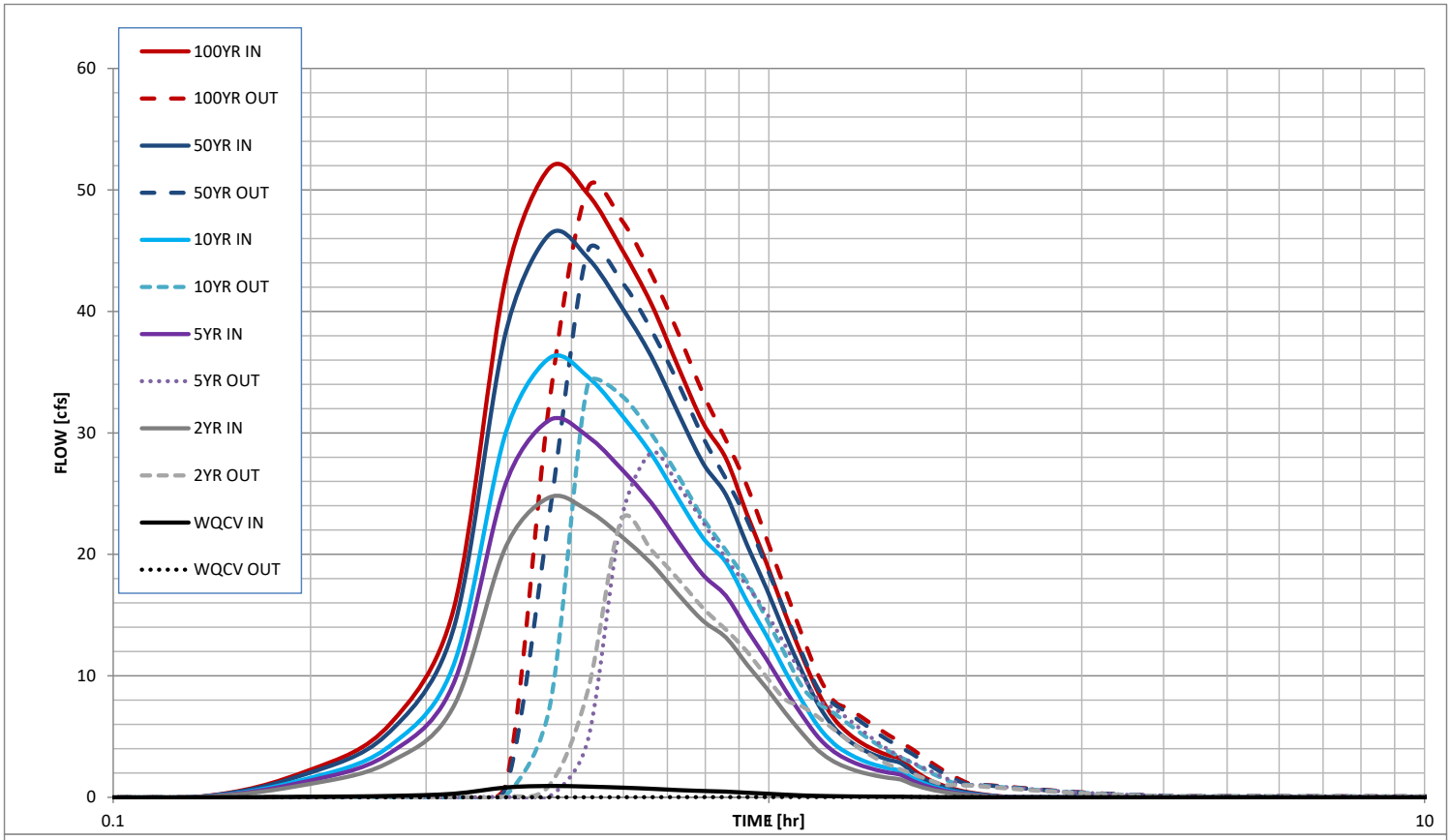
| User Defined Stage [ft] | User Defined Area [ft^2] | User Defined Stage [ft] | User Defined Discharge [cfs] |
|---|---|---|---|
| 0.00 | 1,219 | 0.00 | 0.00 |
| 1.00 | 1,835 | 1.00 | 0.02 |
| 1.20 | 1,959 | 1.20 | 0.03 |
| 2.00 | 2,457 | 2.00 | 0.05 |
| 3.00 | 3,309 | 3.00 | 0.08 |
| 3.23 | 3,504 | 3.23 | 0.09 |
| 4.00 | 4,155 | 4.00 | 1.01 |
| 4.07 | 4,230 | 4.07 | 1.01 |
| 5.00 | 5,226 | 5.00 | 8.12 |
| 6.00 | 6,296 | 6.00 | 55.23 |
| 7.00 | 7,367 | 7.00 | 155.47 |
| 8.00 | 8,886 | 8.00 | 319.62 |

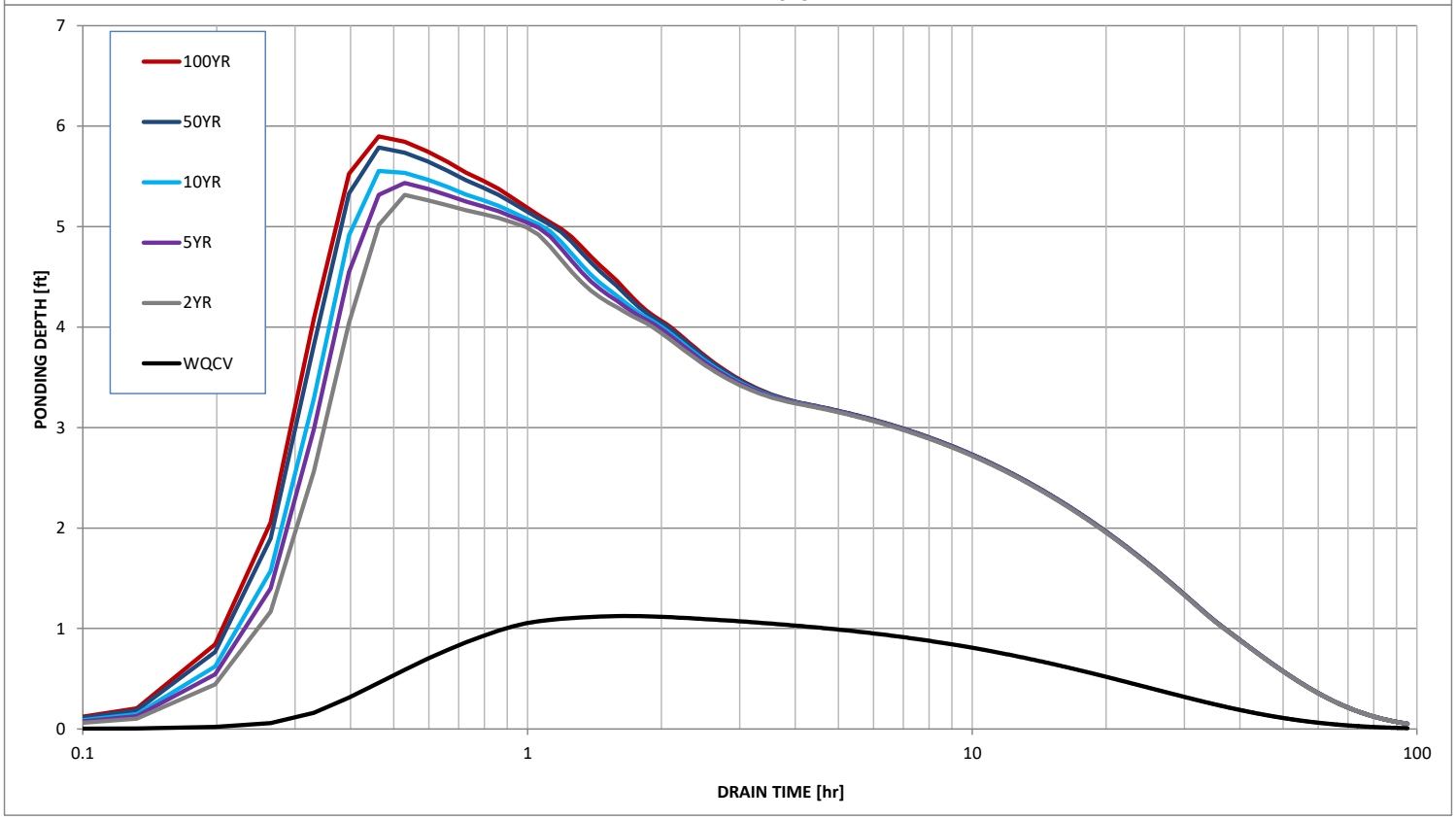
**After completing and printing this worksheet to a pdf, go to:**
**https://maperture.digitaldataservices.com/gvh/?viewer=cswdif**
**create a new stormwater facility, and**
**attach the pdf of this worksheet to that record.**

**Routed Hydrograph Results**

| Design Storm Return Period = | WQCV | 2 Year | 5 Year | 10 Year | 50 Year | 100 Year | |
|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth = | 0.53 | 1.19 | 1.50 | 1.75 | 2.25 | 2.52 | in |
| Calculated Runoff Volume = | 0.043 | 0.117 | 0.152 | 0.184 | 0.255 | 0.298 | acre-ft |
| OPTIONAL Override Runoff Volume = | | 1.19 | 1.50 | 1.75 | 2.25 | 2.52 | acre-ft |
| Inflow Hydrograph Volume = | 0.043 | 1.189 | 1.500 | 1.750 | 2.250 | 2.519 | acre-ft |
| Time to Drain 97% of Inflow Volume = | 65.6 | 36.4 | **32.0** | 29.1 | 24.1 | 21.8 | hours |
| Time to Drain 99% of Inflow Volume = | 84.3 | 58.3 | 53.9 | 51.0 | 46.1 | **43.9** | hours |
| Maximum Ponding Depth = | 1.12 | 5.32 | 5.43 | 5.55 | 5.79 | 5.90 | ft |
| Maximum Ponded Area = | 0.04 | 0.13 | 0.13 | 0.13 | 0.14 | **0.14** | acres |
| Maximum Volume Stored = | 0.040 | 0.382 | 0.398 | 0.413 | 0.445 | 0.461 | acre-ft |

# Stormwater Detention and Infiltration Design Data Sheet



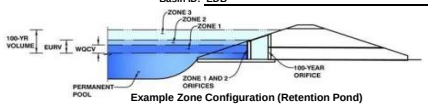



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

**UD-Detention, Version 3.07 (February 2017)**

**Project:** Electronic Storage

**Basin ID:** EDB




**Example Zone Configuration (Retention Pond)**

## Required Volume Calculation

| | | | |
|---|---|---|---|
| Selected BMP Type = | EDB | | |
| Watershed Area = | 1.74 | acres | |
| Watershed Length = | 340 | ft | |
| Watershed Slope = | 0.060 | ft/ft | |
| Watershed Imperviousness = | 75.00% | percent | |
| Percentage Hydrologic Soil Group A = | 98.0% | percent | |
| Percentage Hydrologic Soil Group B = | 2.0% | percent | |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent | |
| Desired WQCV Drain Time = | 40.0 | hours | |
| Location for 1-hr Rainfall Depths = | Denver - Capitol Building | | |
| Water Quality Capture Volume (WQCV) = | 0.043 | acre-feet | Optional User Override 1-hr Precipitation |
| Excess Urban Runoff Volume (EURV) = | 0.168 | acre-feet | |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.117 | acre-feet | 1.19 inches |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 0.152 | acre-feet | 1.50 inches |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 0.184 | acre-feet | 1.75 inches |
| 25-yr Runoff Volume (P1 = 2 in.) = | 0.219 | acre-feet | 2.00 inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 0.255 | acre-feet | 2.25 inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 0.298 | acre-feet | 2.52 inches |
| 500-yr Runoff Volume (P1 = 3 in.) = | 0.377 | acre-feet | 3.00 inches |
| Approximate 2-yr Detention Volume = | 0.110 | acre-feet | |
| Approximate 5-yr Detention Volume = | 0.144 | acre-feet | |
| Approximate 10-yr Detention Volume = | 0.172 | acre-feet | |
| Approximate 25-yr Detention Volume = | 0.205 | acre-feet | |
| Approximate 50-yr Detention Volume = | 0.224 | acre-feet | |
| Approximate 100-yr Detention Volume = | 0.243 | acre-feet | |

## Stage-Storage Calculation

| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 0.043 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 0.125 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 0.075 | acre-feet |
| Total Detention Basin Volume = | 0.243 | 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 = 0.25 ft

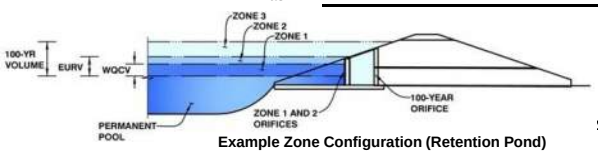
| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area (ft^2) | Optional Override Area (ft^2) | Area (acre) | Volume (ft^3) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Top of Micropool** | -- | 0.00 | -- | -- | -- | 1,219 | 0.028 | | |
| | -- | 0.25 | -- | -- | -- | 1,375 | 0.032 | 310 | 0.007 |
| | -- | 0.50 | -- | -- | -- | 1,530 | 0.035 | 672 | 0.015 |
| | -- | 0.75 | -- | -- | -- | 1,686 | 0.039 | 1,072 | 0.025 |
| | -- | 1.00 | -- | -- | -- | 1,841 | 0.042 | 1,512 | 0.035 |
| **Top of WQCV** | -- | 1.25 | -- | -- | -- | 1,997 | 0.046 | 1,990 | 0.046 |
| | -- | 1.50 | -- | -- | -- | 2,152 | 0.049 | 2,507 | 0.058 |
| | -- | 1.75 | -- | -- | -- | 2,308 | 0.053 | 3,063 | 0.070 |
| | -- | 2.00 | -- | -- | -- | 2,463 | 0.057 | 3,657 | 0.084 |
| | -- | 2.25 | -- | -- | -- | 2,675 | 0.061 | 4,324 | 0.099 |
| | -- | 2.50 | -- | -- | -- | 2,886 | 0.066 | 5,019 | 0.115 |
| | -- | 2.75 | -- | -- | -- | 3,098 | 0.071 | 5,767 | 0.132 |
| | -- | 3.00 | -- | -- | -- | 3,309 | 0.076 | 6,568 | 0.151 |
| **Top of EURV** | -- | 3.25 | -- | -- | -- | 3,521 | 0.081 | 7,422 | 0.170 |
| | -- | 3.50 | -- | -- | -- | 3,732 | 0.086 | 8,328 | 0.191 |
| | -- | 3.75 | -- | -- | -- | 3,944 | 0.091 | 9,288 | 0.213 |
| | -- | 4.00 | -- | -- | -- | 4,155 | 0.095 | 10,300 | 0.236 |
| **Top of 100 YR** | -- | 4.25 | -- | -- | -- | 4,423 | 0.102 | 11,372 | 0.261 |
| | -- | 4.50 | -- | -- | -- | 4,690 | 0.108 | 12,511 | 0.287 |
| | -- | 4.75 | -- | -- | -- | 4,958 | 0.114 | 13,717 | 0.315 |
| | -- | 5.00 | -- | -- | -- | 5,226 | 0.120 | 14,990 | 0.344 |
| | -- | 5.25 | -- | -- | -- | 5,493 | 0.126 | 16,330 | 0.375 |
| | -- | 5.50 | -- | -- | -- | 5,761 | 0.132 | 17,737 | 0.407 |
| | -- | 5.75 | -- | -- | -- | 6,028 | 0.138 | 19,210 | 0.441 |
| | -- | 6.00 | -- | -- | -- | 6,296 | 0.145 | 20,751 | 0.476 |
| | -- | 6.25 | -- | -- | -- | 6,564 | 0.151 | 22,358 | 0.513 |
| | -- | 6.50 | -- | -- | -- | 6,831 | 0.157 | 24,033 | 0.552 |
| | -- | 6.75 | -- | -- | -- | 7,099 | 0.163 | 25,774 | 0.592 |
| | -- | 7.00 | -- | -- | -- | 7,367 | 0.169 | 27,582 | 0.633 |
| | -- | 7.25 | -- | -- | -- | 7,634 | 0.175 | 29,457 | 0.676 |
| | -- | 7.50 | -- | -- | -- | 7,902 | 0.181 | 31,399 | 0.721 |
| | -- | 7.75 | -- | -- | -- | 8,169 | 0.188 | 33,408 | 0.767 |
| **Top of Berm** | -- | 8.00 | -- | -- | -- | 8,886 | 0.204 | 35,540 | 0.816 |

# Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

**Project:** Electronic Storage

**Basin ID:** EDB




Example Zone Configuration (Retention Pond)

| | Stage (ft) | Zone Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 1.20 | 0.043 | Orifice Plate |
| Zone 2 (EURV) | 3.23 | 0.125 | Orifice Plate |
| Zone 3 (100-year) | 4.07 | 0.075 | Weir&Pipe (Rect.) |
| | | 0.243 | 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 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)**

| | | | | | |
|---|---|---|---|---|---|
| Invert of Lowest Orifice = | 0.00 | ft (relative to basin bottom at Stage = 0 ft) | WQ Orifice Area per Row = | 4.167E-03 | $ft^2$ |
| Depth at top of Zone using Orifice Plate = | 3.23 | ft (relative to basin bottom at Stage = 0 ft) | Elliptical Half-Width = | N/A | feet |
| Orifice Plate: Orifice Vertical Spacing = | 12.90 | inches | Elliptical Slot Centroid = | N/A | feet |
| Orifice Plate: Orifice Area per Row = | 0.60 | sq. inches (diameter = 7/8 inch) | 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 | 1.08 | 2.15 | | | | | |
| Orifice Area (sq. inches) | 0.60 | 0.60 | 0.60 | | | | | |

| | 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) and Grate (Flat or Sloped)**

| | Zone 3 Weir | Not Selected | | | Zone 3 Weir | Not Selected | |
|---|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | 3.23 | N/A | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | 3.23 | N/A | feet |
| Overflow Weir Front Edge Length = | 2.00 | N/A | feet | Over Flow Weir Slope Length = | 2.00 | N/A | feet |
| Overflow Weir Slope = | 0.00 | N/A | H:V (enter zero for flat grate) | Grate Open Area / 100-yr Orifice Area = | 27.94 | N/A | should be ≥ 4 |
| Horiz. Length of Weir Sides = | 2.00 | N/A | feet | Overflow Grate Open Area w/o Debris = | 2.80 | N/A | $ft^2$ |
| Overflow Grate Open Area % = | 70% | N/A | %, grate open area/total area | Overflow Grate Open Area w/ Debris = | 1.40 | 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 Rectangular | Not Selected | | | Zone 3 Rectangular | Not Selected | |
|---|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | 0.50 | N/A | ft (distance below basin bottom at Stage = 0 ft) | Outlet Orifice Area = | 0.10 | N/A | $ft^2$ |
| Rectangular Orifice Width = | 3.90 | N/A | inches | Outlet Orifice Centroid = | 0.15 | N/A | feet |
| Rectangular Orifice Height = | 3.70 | | inches | Half-Central Angle of Restrictor Plate on Pipe = | N/A | N/A | radians |

**Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate**

**User Input: Emergency Spillway (Rectangular or Trapezoidal)**

| | | | | | |
|---|---|---|---|---|---|
| Spillway Invert Stage= | 4.50 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 0.46 | feet |
| Spillway Crest Length = | 5.00 | feet | Stage at Top of Freeboard = | 5.96 | feet |
| Spillway End Slopes = | 4.00 | H:V | Basin Area at Top of Freeboard = | 0.14 | acres |
| Freeboard above Max Water Surface = | 1.00 | feet | | | |

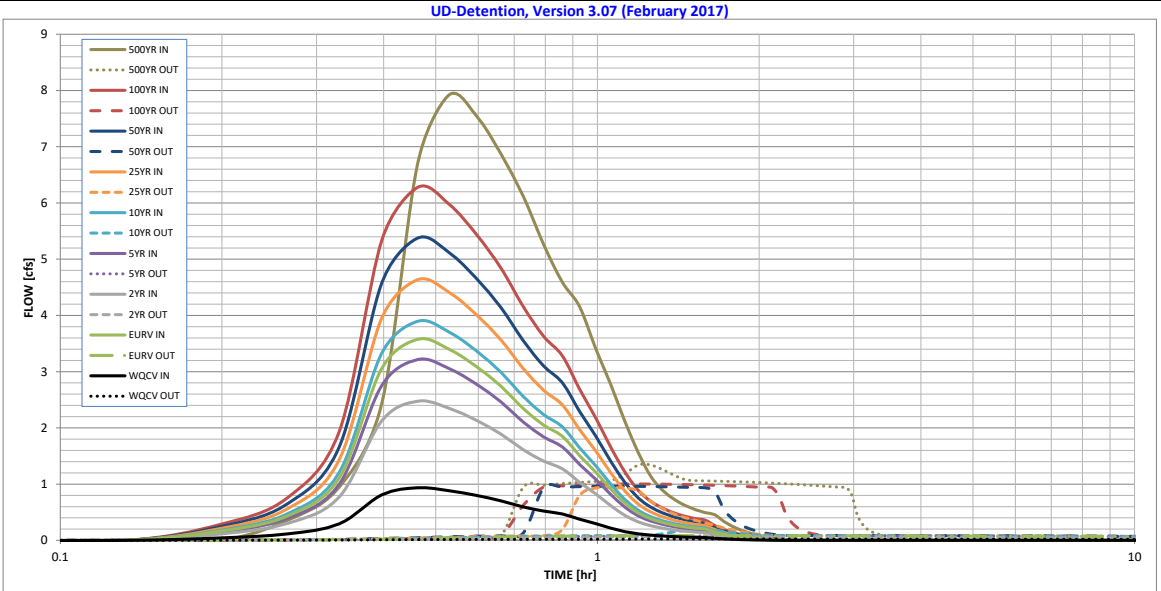
**Calculated Parameters for Spillway**

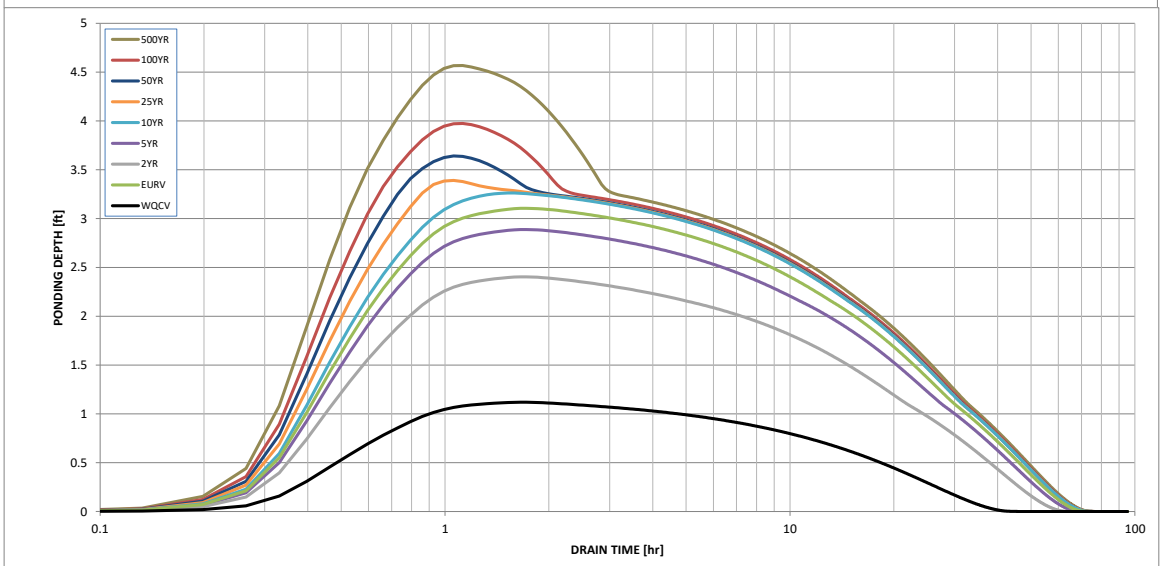
**Routed Hydrograph Results**

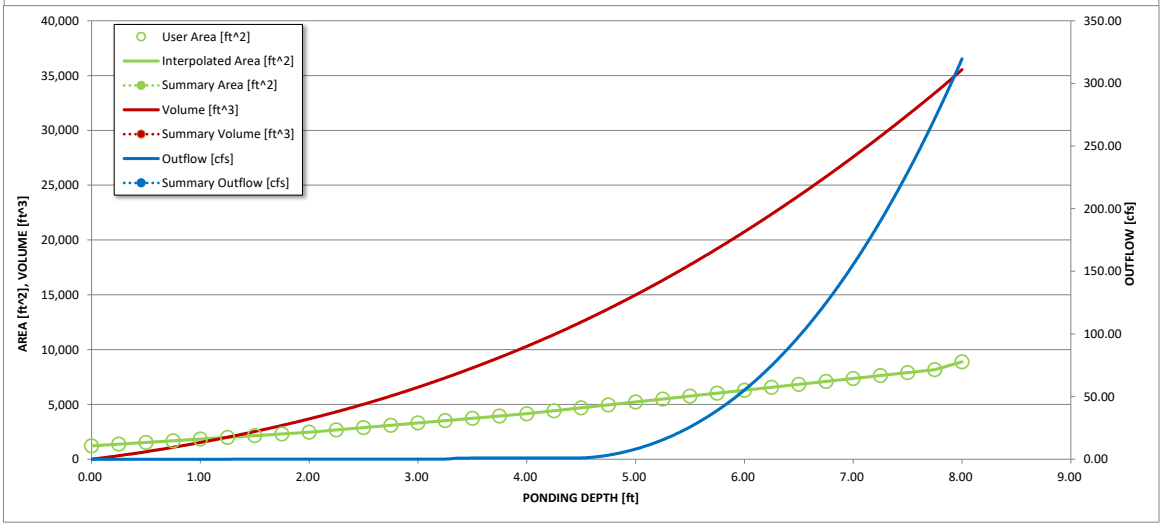
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | 0.53 | 1.07 | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 3.00 |
| Calculated Runoff Volume (acre-ft) = | 0.043 | 0.168 | 0.117 | 0.152 | 0.184 | 0.219 | 0.255 | 0.298 | 0.377 |
| OPTIONAL Override Runoff Volume (acre-ft) = | | | | | | | | | |
| Inflow Hydrograph Volume (acre-ft) = | 0.043 | 0.168 | 0.116 | 0.151 | 0.183 | 0.219 | 0.254 | 0.297 | 0.376 |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.05 | 0.27 | 0.64 | 1.32 |
| Predevelopment Peak Q (cfs) = | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.5 | 1.1 | 2.3 |
| Peak Inflow Q (cfs) = | 0.9 | 3.6 | 2.5 | 3.2 | 3.9 | 4.6 | 5.4 | 6.3 | 7.9 |
| Peak Outflow Q (cfs) = | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.9 | 1.0 | 1.0 | 1.3 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 6.4 | 5.4 | 10.4 | 2.0 | 0.9 | 0.6 |
| Structure Controlling Flow = | Plate | Plate | Plate | Plate | Overflow Grate 1 | Outlet Plate 1 | Outlet Plate 1 | Outlet Plate 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | 0.0 | 0.3 | 0.3 | 0.3 | 0.3 |
| 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) = | 37 | 58 | 52 | 56 | 59 | 57 | 56 | 55 | 53 |
| Time to Drain 99% of Inflow Volume (hours) = | **40** | 64 | 57 | 62 | 65 | 64 | 64 | 63 | 63 |
| Maximum Ponding Depth (ft) = | 1.12 | 3.11 | 2.40 | 2.89 | 3.26 | 3.39 | 3.64 | 3.97 | 4.57 |
| Area at Maximum Ponding Depth (acres) = | 0.04 | 0.08 | 0.06 | 0.07 | 0.08 | 0.08 | 0.09 | 0.09 | 0.11 |
| Maximum Volume Stored (acre-ft) = | 0.040 | 0.158 | 0.109 | 0.142 | 0.171 | 0.182 | 0.203 | 0.234 | 0.294 |

# 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 | | | |

**MANNING'S EQUATION for OPEN CHANNEL FLOW**

| | | | | |
|---|---|---|---|---|
| **Project:** | **Electronic Storage** | Location: | Forebay Notch - Q=7.9 cfs * 2% = 0.16 cfs | |
| By: | Dane Frank | Date: | 1/13/2020 | |
| Chk By: | | Date: | | version 12-2004 |

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

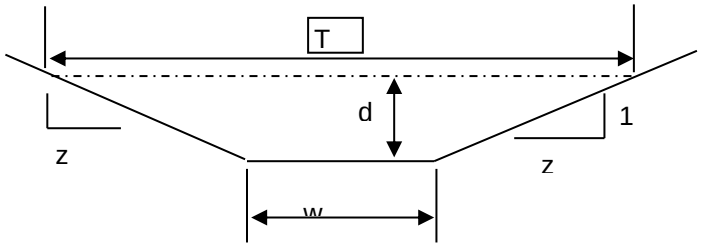
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient




$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

| INPUT | |
|---|---|
| z (sideslope)= | 0 |
| z (sideslope)= | 0 |
| b (btm width, ft)= | 0.13 |
| d (depth, ft)= | 1 |
| S (slope, ft/ft) | 0.005 |
| $n_{low}$ = | 0.013 |
| $n_{high}$ = | 0.013 |

Clear Data Entry Cells

| | | | | Low N | | High N | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth, ft | Area, sf | Wetted Perimeter, ft | Hydraulic Radius, ft | Velocity, fps | Flow, cfs | Velocity, fps | Flow, cfs | | |
| 1 | 0.13 | 2.13 | 0.06 | 1.25284058 | 0.16287 | 1.252841 | 0.16287 | T = | 0.13 |
| | | | | | | | | Dm = | 1.000 |
| | | | | Sc low = | 0.1024 | Sc high = | 0.1024 | | |
| | | | | .7 Sc | 1.3 Sc | .7 Sc | 1.3 Sc | | |
| | | | | 0.0717 | 0.1331 | 0.0717 | 0.1331 | | |

$s_c$ = critical slope ft / ft

T = top width of the stream

$d_m$ = a/T = mean depth of flow

Created by: Mike O'Shea

**MANNING'S EQUATION for OPEN CHANNEL FLOW**

**Project:** **Electronic Storage** Location: EDB Trickle Channels (need Q= 0.16 cfs)

By: Dane Frank Date: 1/13/2020

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

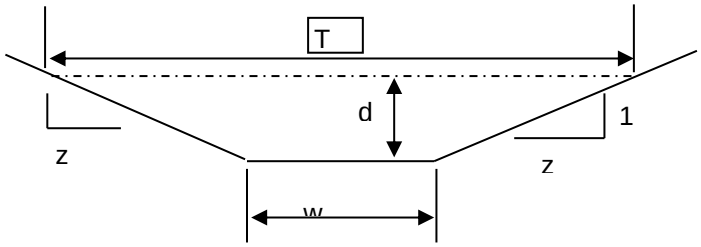
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient




$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

| INPUT | |
|---|---|
| z (sideslope)= | 0 |
| z (sideslope)= | 0 |
| b (btm width, ft)= | 0.21 |
| d (depth, ft)= | 0.5 |
| S (slope, ft/ft) | 0.005 |
| $n_{low}$ = | 0.013 |
| $n_{high}$ = | 0.013 |

Clear Data Entry Cells

| | | | | Low N | | High N | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth, ft | Area, sf | Wetted Perimeter, ft | Hydraulic Radius, ft | Velocity, fps | Flow, cfs | Velocity, fps | Flow, cfs | | |
| 0.5 | 0.11 | 1.21 | 0.09 | 1.58414291 | 0.16634 | 1.584143 | 0.16634 | T = | 0.21 |
| | | | | | | | | Dm = | 0.500 |
| | | | | Sc low = | 0.0320 | Sc high = | 0.0320 | | |
| | | | | .7 Sc | 1.3 Sc | .7 Sc | 1.3 Sc | | |
| | | | | 0.0224 | 0.0416 | 0.0224 | 0.0416 | | |

$s_c$ = critical slope ft / ft

T = top width of the stream

$d_m$ = a/T = mean depth of flow

Created by: Mike O'Shea

# *FORBAY VOLUMES*

## FORBAY VOLUME

Required Forbay Volume = 1% of WQCV

| | | |
|---|---|---|
| WQCV = | 0.043 | ac-ft |
| WQCV = | 1,873 | cu-ft |
| 1% of WQCV = | 19 | cu-ft |

| *ELEV* | *AREA* | *AREA AVG.* | *DELTA ELEV.* | *VOLUME* | *VOLUME TOTAL* |
|---|---|---|---|---|---|
| 6483.00 | 39 | | | | |
| | | 39 | 1 | 39 | |
| 6484.00 | 39 | | | | 39 |

| | | |
|---|---|---|
| Design Volume: | 39 | cu-ft |
| | 0.001 | ac-ft |

# DRAINAGE MAPS

# ELECTRONIC STORAGE
## SITE DEVELOPMENT PLAN
# EXISTING DRAINAGE MAP
## MARCH 2020

**BASIN SUMMARY**

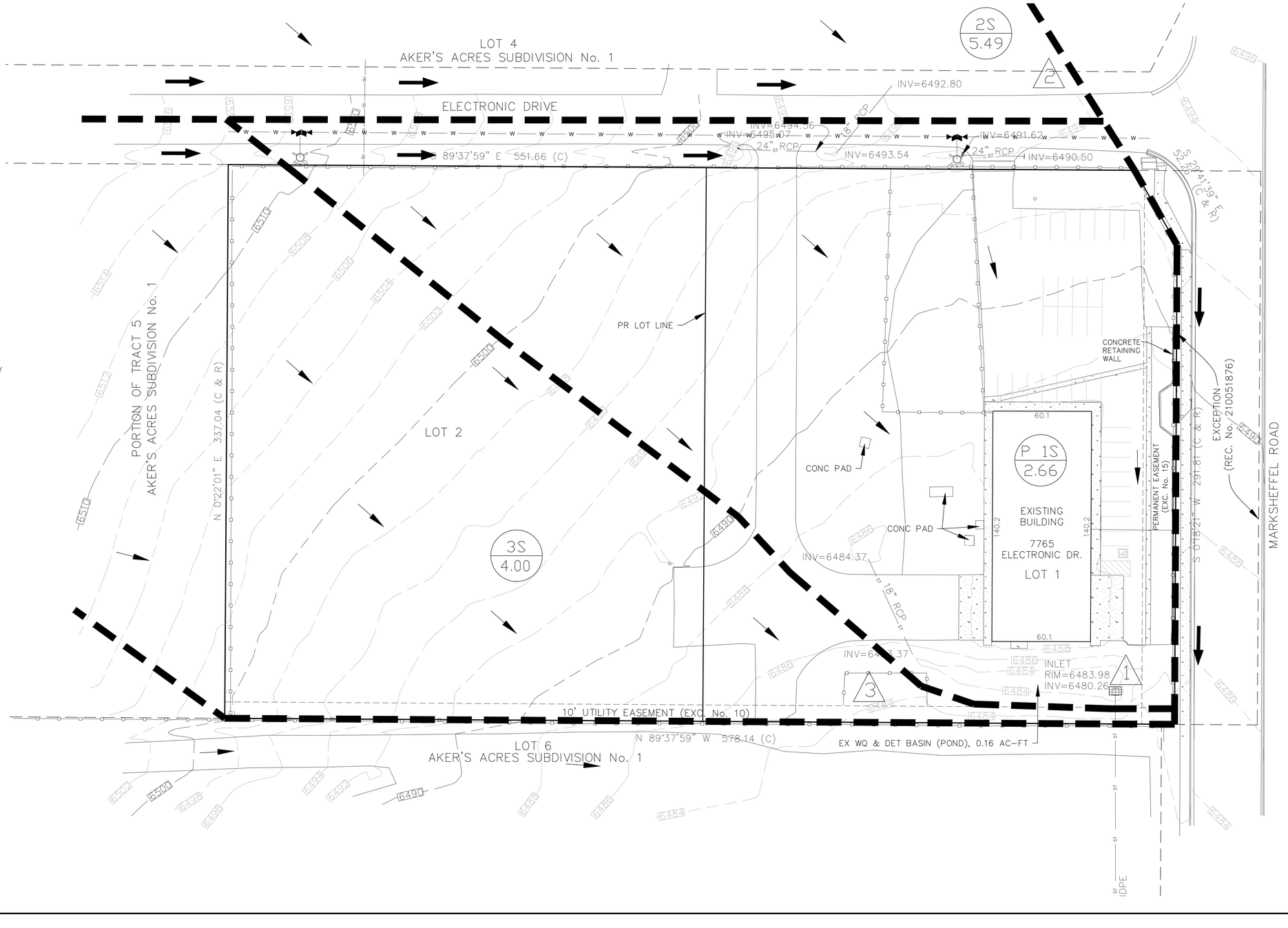
| DESIGN POINT | BASIN | AREA (ACRES) | FLOW 5 YR (cfs) | FLOW 100 YR (cfs) |
|---|---|---|---|---|
| 1 | P 1S | 2.66 | 4.08 | 6.19 |
| 2 | 2S | 5.49 | 7.69 | 11.67 |
| 3 | 3S | 4.00 | 5.60 | 8.50 |

**LEGEND**

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 1' CONTOUR
- EXISTING 10' CONTOUR
- GROUND SURFACE FLOW DIRECTION
- ROAD AND DITCH FLOW DIRECTION
- CHAIN-LINK FENCE

**NOTES**

1. ALL FEATURE SHOWN ARE EXISTING.
2. THE DRAINAGE BASINS FLOW VALUES SHOWN ARE FROM THE PRELIMINARY AND FINAL DRAINAGE REPORT FOR TMC DESIGN CORPORATION, DATED DECEMBER 2011, PREPARED BY STILLWATER ENGINEERING. NO SIGNIFICANT DRAINAGE CHANGES APPEAR TO HAVE BEEN MADE TO THE SITE SINCE THE TIME THIS REPORT WAS PREPARED.

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**REVISIONS**

| NO. | DESCRIPTION | DATE |
|---|---|---|
| | | |

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**ELECTRONIC STORAGE**

SITE DEVELOPMENT PLAN
EXISTING DRAINAGE MAP

| | |
|---|---|
| DESIGNED BY | DLF |
| DRAWN BY | DLF |
| CHECKED BY | LD |
| H-SCALE | AS SHOWN |
| V-SCALE | N/A |
| JOB NO. | 1971.00 |
| DATE ISSUED | 03/23/20 |
| SHEET NO. | 1 OF 3 |

# ELECTRONIC STORAGE
## SITE DEVELOPMENT PLAN
# PROPOSED DRAINAGE MAP
## MARCH 2020

NOTE TO REVIEWER: THE POND OUTLET STORM PIPE WILL NEED A DRAINAGE EASEMENT ONCE IT LEAVES THE LOT. THIS WILL BE ADDED FOLLOWING THE FIRST REVIEW.

**BASIN SUMMARY**

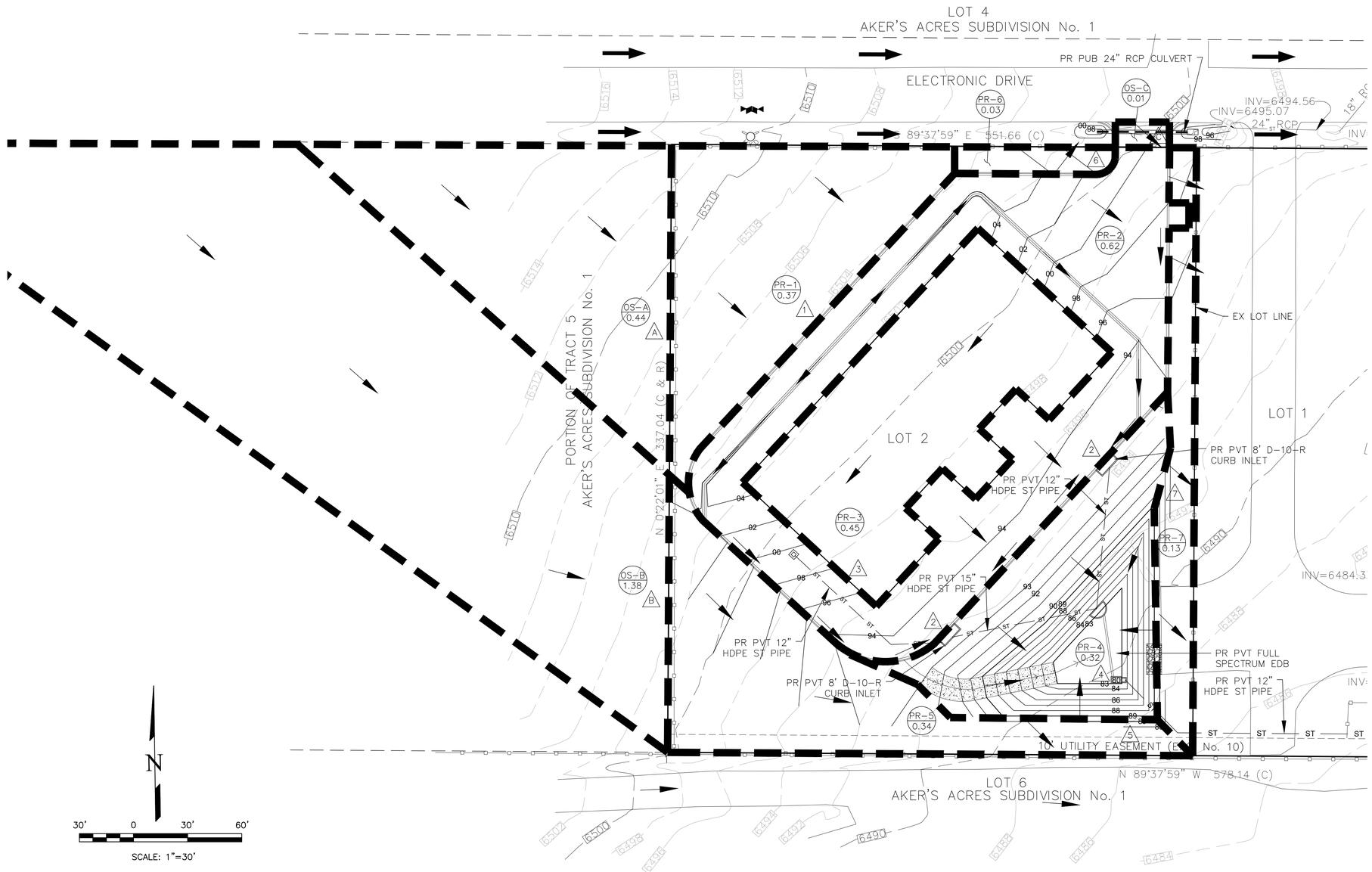
| DESIGN POINT | BASIN | AREA (ACRES) | FLOW 5 YR (cfs) | FLOW 100 YR (cfs) |
|---|---|---|---|---|
| A | OS-A | 0.44 | 1.9 | 3.9 |
| B | OS-B | 1.38 | 5.5 | 11.2 |
| C | OS-C | 0.01 | 0.1 | 0.1 |
| 1 | PR-1 | 0.37 | 0.2 | 1.1 |
| 2 | PR-2 | 0.62 | 3.2 | 6.5 |
| 3 | PR-3 | 0.45 | 2.3 | 4.5 |
| 4 | PR-4 | 0.32 | 0.2 | 1.2 |
| 5 | PR-5 | 0.34 | 0.1 | 1.0 |
| 6 | PR-6 | 0.03 | 0.0 | 0.1 |
| 7 | PR-7 | 0.13 | 0.1 | 0.6 |

**DESIGN POINT SUMMARY**

| DESIGN POINT | CONTRIBUTING BASINS | AREA (ACRES) | FLOW 5 YR (cfs) | FLOW 100 YR (cfs) |
|---|---|---|---|---|
| A | OS-A | 0.44 | 1.9 | 3.9 |
| B | OS-B | 1.38 | 5.5 | 11.2 |
| C | OS-C | 0.01 | 0.1 | 0.1 |
| 1 | OS-A,PR-1 | 0.81 | 2.0 | 5.0 |
| 2 | OS-A,OS-C,PR-1,PR-2 | 1.44 | 5.3 | 11.6 |
| 3 | PR-3 | 0.45 | 2.3 | 4.5 |
| 4 | OS-A,OS-C,PR-1,PR-2, PR-3,PR-4 | 2.21 | 7.8 | 17.4 |
| 5 | OS-B,PR-5 | 1.72 | 5.6 | 12.2 |
| 6 | PR-6 | 0.03 | 0.0 | 0.1 |
| 7 | PR-7 | 0.13 | 0.1 | 0.6 |

**LEGEND**

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 1' CONTOUR
- EXISTING 10' CONTOUR
- GROUND SURFACE FLOW DIRECTION
- ROAD AND DITCH FLOW DIRECTION
- CHAIN-LINK FENCE






REVISIONS

| NO. | DESCRIPTION | DATE |
|---|---|---|

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www.tnesinc.com

ELECTRONIC STORAGE

PROPOSED DRAINAGE MAP
PROPOSED DRAINAGE MAP

| | |
|---|---|
| DESIGNED BY | DLF |
| DRAWN BY | DLF |
| CHECKED BY | LD |
| H-SCALE | AS SHOWN |
| V-SCALE | N/A |
| JOB NO. | 1971.00 |
| DATE ISSUED | 03/23/20 |
| SHEET NO. | 2 OF 3 |

# ELECTRONIC STORAGE
## SITE DEVELOPMENT PLAN
# PROPOSED DRAINAGE MAP
## MARCH 2020

FOR REFERENCE ONLY
NOT FOR CONSTRUCTION

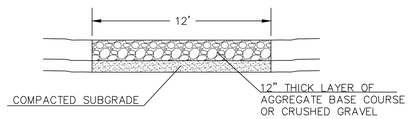
**LEGEND**

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 1' CONTOUR
- EXISTING 10' CONTOUR
- GROUND SURFACE FLOW DIRECTION
- ROAD AND DITCH FLOW DIRECTION
- CHAIN-LINK FENCE

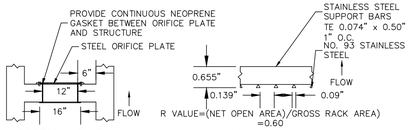
N

30' 0 30' 60'

SCALE: 1"=30'

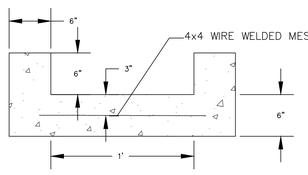



**12' MAINTENANCE ACCESS ROAD SECTION**
NOT TO SCALE

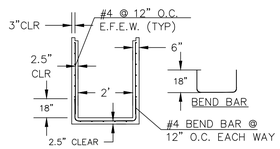



**SECTION B–B**
NOT TO SCALE

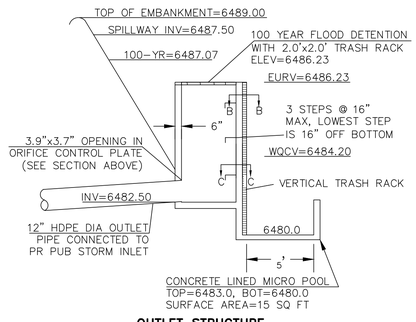
**SECTION C–C**
NOT TO SCALE



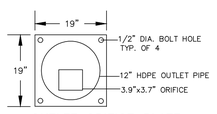

**1' CONCRETE TRICKLE CHANNEL**
NOT TO SCALE



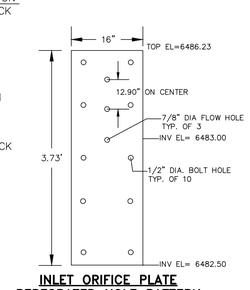

**2'x2' OUTLET BOX STRUCTURAL DETAIL**
NOT TO SCALE



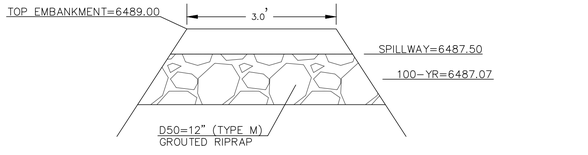

**OUTLET STRUCTURE**
NOT TO SCALE

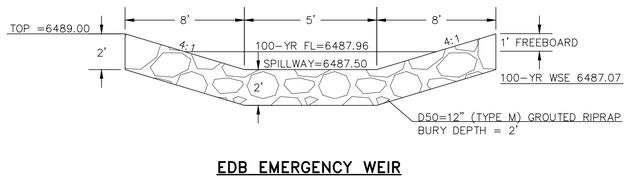



**OUTLET ORIFICE PLATE**
NOT TO SCALE

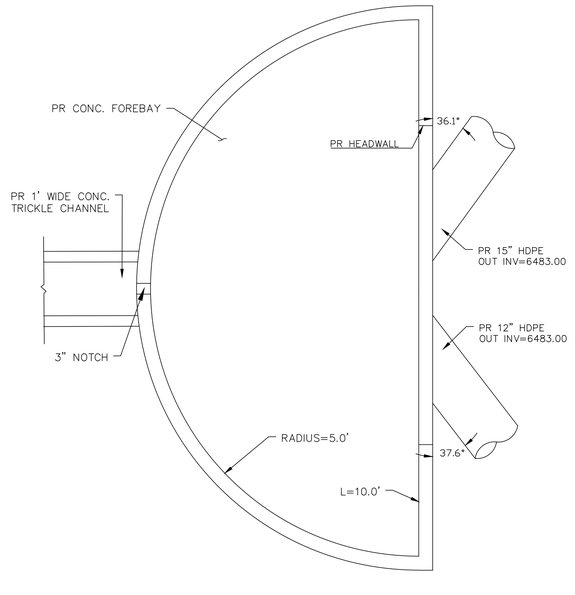



**INLET ORIFICE PLATE**
**PERFORATED HOLE PATTERN**
NOT TO SCALE

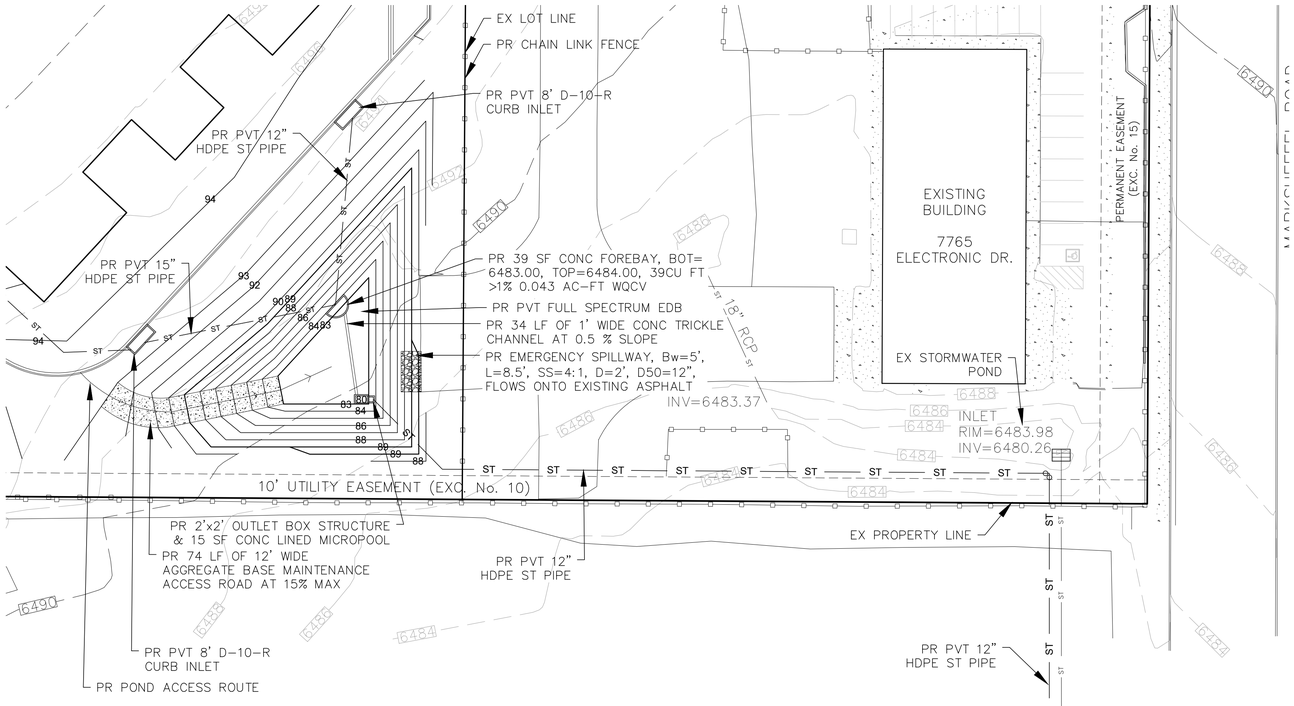


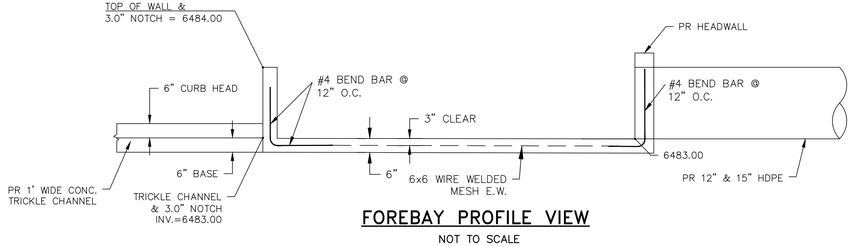

**EDB EMERGENCY WEIR**
NOT TO SCALE




**FOREBAY PLAN VIEW**
NOT TO SCALE




NOTE TO REVIEWER: THE POND OUTLET STORM PIPE WILL NEED A DRAINAGE EASEMENT ONCE IT LEAVES THE LOT. THIS WILL BE ADDED FOLLOWING THE FIRST REVIEW.




**FOREBAY PROFILE VIEW**
NOT TO SCALE

| REVISIONS | | |
|---|---|---|
| NO. | DESCRIPTION | DATE |

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ELECTRONIC STORAGE

PROPOSED DRAINAGE MAP
PROPOSED DRAINAGE MAP

| | |
|---|---|
| DESIGNED BY | DLF |
| DRAWN BY | DLF |
| CHECKED BY | LD |
| H-SCALE | AS SHOWN |
| V-SCALE | N/A |
| JOB NO. | 1971.00 |
| DATE ISSUED | 03/23/20 |
| SHEET NO. | 3 OF 3 |

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