

FINAL DRAINAGE REPORT
FOR
PAINT BRUSH HILLS FILING NO. 14
EL PASO COUNTY, COLORADO

July 2020

Prepared for:

The Landhuis Company
212 N. Wahsatch Ave, Suite 301
Colorado Springs, CO 80903
(719) 635-3200

Prepared by:



102 E. Pikes Peak, 5th Floor
Colorado Springs, CO 80903
(719) 955-5485

Project #10-014
PCD Project # PPR

**FINAL DRAINAGE REPORT
FOR
PAINT BRUSH HILLS FILING NO. 14
DRAINAGE PLAN STATEMENTS**

ENGINEERS STATEMENT

The attached drainage plan and report was 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 omission on my part in preparing this report.

Virgil A. Sanchez, P.E. #37160
For and on Behalf of M&S Civil Consultants, Inc

DEVELOPER'S STATEMENT

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

BY: _____

TITLE: _____

DATE: _____

ADDRESS: The Landhuis Company
 212 N. Wahstach Ave, Suite 301
 Colorado Springs, CO 80903

EL PASO COUNTY'S STATEMENT

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

BY: _____ DATE: _____
 Jennifer Irvine, P.E.
 County Engineer/ECM Administrator

CONDITIONS

**FINAL DRAINAGE REPORT
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FINAL DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NO. 14

PURPOSE

This document is intended to serve as the Final Drainage Report for Paint Brush Hills Filing No. 14. The purpose of this document is to identify and analyze the on and offsite drainage patterns and to ensure that post development runoff is routed through the site safely and in a manner that satisfies the requirements set forth by the El Paso County Drainage Criteria Manual. The proposed principal use for the site consists of infrastructure typically associated with single family residential developments. The majority of the site will consist of asphalt, curb, landscaping and an existing storm water quality facility (Pond C) located near the southwest boundary of the site. This document is also intended to show some of Paint Brush Hills Filing No. 14 onsite drainage of approximately 6.72 acres, will not adversely affect the capacity of the existing storm water quality facility (Pond D) in the "Preliminary Drainage Report for Paint Brush Hills Filing 13E (PDRPBH-13E) (Pre-Development Grading Plan)", prepared by Classic Consulting Engineers and Surveyors, submitted on February 2018.

GENERAL LOCATION AND DESCRIPTION

Paint Brush Hills Filing No. 14 is located in the northeast quarter of Section 26, Township 12 South, Range 65 West of the 6th P.M. in El Paso County, Colorado. The parcel is bound to the north by existing single family residential Paint Brush Hills Filing No.3 and to the south by existing single family residential Paint Brush Hills Filing No. 12. An existing utility corridor and single family residential Paint Brush Hills Filing No. 13E is planned along the east boundary of the site. On the west property line are two rural and undeveloped parcels. Flows are directed south and southwest to an Extended Detention Basin (EDB) Pond C and subsequently to an existing swale tributary to the Falcon Drainage Basin. The site lies within the Falcon Drainage Basin.

The site consists of 88.631 acres which is presently undeveloped. Vegetation is sparse, consisting of native grasses with no trees onsite. The site has not experienced any overlot grading activities. Existing site terrain generally slopes from north to south at grade rates that vary between 1.0% and 4.0%.

The site is currently platted and zoned "RS-20,000 & RS-6000" for Residential Suburban. The proposed principal use for the site is single family residential. The majority of the lots shall consist of standard setbacks, landscaping and back and/or side lot swales typical for single family housing. An existing detention facility is located at the southwest boundary of the site and is to be upgraded upon development of the proposed Paint Brush Hills Filing No. 14 site.

SOILS

Soils for this project have been delineated by the map in the appendix, as Pring Coarse Sandy Loam (71) and is characterized as Hydrologic Soil Type "B". Soils in the study area are shown as mapped by S.C.S. in the "Soils Survey of El Paso County Area." Vegetation is sparse, consisting of native grasses and weeds.

HYDROLOGIC CALCULATIONS

Hydrologic calculations were performed using the El Paso County and City of Colorado Springs Storm Drainage Design Criteria manual and where applicable the Urban Storm Drainage Criteria Manual. The

Rational Method was used to estimate stormwater runoff anticipated from design storms with 5-year and 100-year recurrence intervals.

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. The relevant data sheets are included in the appendix of this report.

FLOODPLAIN STATEMENT

No portion of this site is within a designated F.E.M.A. floodplain as determined by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel No. 08041C0535 F, effective date March 17, 1997 and revised to reflect LOMR, 12-08-O579P, dated February 28, 2013. An annotated FIRM Panel is included in the Appendix.

DRAINAGE CRITERIA

This drainage analysis has been prepared in accordance with the current El Paso County Drainage Criteria Manual. Calculations were performed to determine runoff quantities for the 5-year and 100-year frequency storms for developed conditions using the Rational Method as required for basins having areas less than 100 acres.

FOUR STEP PROCESS

- Step1 Employ Runoff Reduction Practices** – Approx. 3.68 acres of proposed land (pervious surface) within the project has been set aside for an EDB facility. Also roof drains will be directed to landscaped areas to minimize direct connection of impervious surfaces.
- Step 2 Implement BMP's that provide a water quality capture volume with slow release** – An existing storm water quality facility will be re-designed to provide WQCV and Detention. The FSD outlet structure has been designed to drain the water quality event storm in 40 hours, while reducing the 100 year peak discharge. The development of this site is not anticipated to have negative effects on downstream drainageways.
- Step 3 Stabilize streams** – The site is not directly adjacent to any main branch within the Falcon Drainage Basin and Chico Creek receiving waters; however it does discharges into smaller up-gradient unnamed tributaries. A Full Spectrum Detention Pond is proposed to reduce peak discharge rates and provide water quality treatment. The WQCV will be released over a 40 hour period while larger event storms will be released in periods of times between 64-80 hours. The developed discharge from the site is anticipated to be less than existing and therefore is not anticipated to have negative effects on downstream drainage ways. A minor amount of frequent discharge to the downstream tributaries should be of benefit by providing water to existing wetlands vegetation which provides habitat and functions to stabilize the existing channel banks and channel bed.
- Step4 Consider site specific and other source control BMP's** – This submittal provides a final grading and erosion control plan with BMP's in place. The proposed project will use silt fence, a vehicle tracking control pad, concrete washout area, mulching and reseeded to mitigate the potential for erosion across the site.

EXISTING DRAINAGE CONDITIONS

The Paint Brush Hills Filing No. 14 site consists of 88.631 acres and is situated in the Falcon Drainage Basin with Chico Creek as receiving waters. This site was studied as part of the "Master Development

Drainage Plan for Falcon Hills Development (MDDP)” prepared by Kiowa Engineering Corporation, approved November 2002. More recently the site was studied in the “Final Drainage Report for Paint Brush Hills-Phase 2 (Filing No. 13,(FDRPBH-PH2-13))”, prepared by Classic Consulting Engineers and Surveyors, submitted on rev. June 2008.

Existing drainage of the onsite Paint Brush Hills Filing No. 14 site and offsite Paint Brush Hills Filing No. 3 is currently undeveloped and the terrain generally slopes from north to southwest at grade rates that vary between 1.0% and 4.0%. Existing natural drainage swales route flows to an existing detention facility (Pond C) constructed as part of the “Paint Brush Hills Filing No. 12”, see attached Historic Conditions Drainage Map from FDRPBH-PH2-13 and also refer to “Final Drainage Report for Paint Brush Hill Filing Nos. 10, 11 & 12 (FDRPBH-10,11,12)” prepared by Classic Consulting Engineers and Surveyors, rev. July 2003. See Historic Conditions Drainage Map in Drainage Maps section of this report. Offsite and onsite flows on Paint Brush Hills Filing No.14 are described as follows;

Historic Basin Descriptions

Basin OS-5, 46.1 acres, ($Q_5=35$ cfs, $Q_{100}=79.0$ cfs), consists of offsite existing Paint Brush Hills Filing No.3. Filing No.3 is a single family residential development with the average lot size of 3.5 acres. The percent impervious is approximately 11%. The west half of **Basin OS-5**, runoff enters the site as sheet flow. The east half of **Basin OS-5**, runoff is concentrated and enters the site as a swale.

Basin H-1, 92.3 acres, ($Q_5=42.0$ cfs, $Q_{100}=108.0$ cfs), consists of undeveloped Paint Brush Hills Filing No.14. The terrain generally slopes from north to southwest at grade rates that vary between 1.0% and 4.0%. Existing natural drainage swales route flows to an existing detention facility (Pond C). Historic cumulative flows, from **Basin OS-5** and **Basin H-1** are $Q_5=68.0$ cfs, $Q_{100}=169.0$ cfs. Runoff is released via an existing 48” RCP pipe to an existing swale.

PROPOSED DRAINAGE CHARACTERISTICS

General Concept Drainage Discussion

The following is a description of the offsite and onsite basins, offsite flows and the overall proposed drainage characteristics for the development of Paint Brush Hill Filing No. 14. These calculations have been provided to show that what is proposed will be adequate to convey flows when adjacent development occurs. Offsite **Basin ***OS-5** has been divided into 3 sub-basins as they pertain to the onsite proposed drainage characteristics. The following **Basin** description, **Design Points (DP)** and **Pipe Runs (PR)** were determined using the Rational Method since each individual basin is less than 100 acres and the combined acreage at any DP are also less than 130 acres. See drainage map in appendix for proposed conditions. This method offers a more conservative approach to sizing swales and storm drains. Development of this site will not adversely affect the surrounding development and is compliance with the M.D.D.P. approved for this site.

The * before a basin, design point and pipe run callout denotes previously studied in the "Final Drainage Report for Paint Brush Hills Filing 13E (PDRPBH-13E)", prepared by Classic Consulting Engineers and Surveyors, submitted on September 2018. The ** before a basin callout denotes a revision to PDRPBH13E. The *** before a basin callout denotes previously studied in the “Final Drainage Report for Paint Brush Hills-Phase 2 (Filing No. 13,(FDRPBH-PH2-13))”, prepared by Classic Consulting Engineers and Surveyors, submitted on rev. June 2008, specifically Basin ***OS-5. The # before a pipe run callout denotes, to be constructed with the Paint Brush Hills Filing No. 13E Street and Storm Sewer plans but the flows (slightly higher) have been adjusted per the Final Drainage Report for Paint Brush Hills Filing No. 14” prepared by MS Civil Consultants, dated July 2020.

Detailed Drainage Discussion

Basins Tributary to Detention Pond C

Basin OS5C, 29.0 acres, ($Q_5=25.5$ cfs, $Q_{100}=57.0$ cfs), consist of existing developed 3.5-acre properties and streets. Runoff produced by the offsite area, are routed via existing roadside swales to a larger swale that carries flows south to **DP3**.

Basin A, 0.52 acres, ($Q_5=0.4$ cfs, $Q_{100}=1.4$ cfs), consists of a proposed landscaped Tract. Cumulative developed flows within the **Basin A** and offsite **Basin OS5C** are routed as surface runoff via a proposed 4' wide swale to **DP3** ($Q_5=25.7$ cfs, $Q_{100}=58.1$ cfs). Surface runoff at **DP3** will be collected and conveyed via a 36" RCP FES and 36" RCP pipe (**PR2**) to **DP4**. In the event of clogging or total FES failure, flows at **DP3** will over top the embankment and be routed via a proposed 4' swale, within a 20' storm drainage easement to **DP4**.

Basin J, 7.19 acres, ($Q_5=5.6$ cfs, $Q_{100}=19.1$ cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP4** which will be collected by a proposed 15' Type R sump inlet. The intercepted flow ($Q_5=5.6$ cfs, $Q_{100}=19.1$ cfs) will combine with flows from **PR2** and be routed west via a 48" RCP pipe (**PR3**, $Q_5=30.4$ cfs, $Q_{100}=74.0$ cfs) to **PR5** ($Q_5=31.2$ cfs, $Q_{100}=76.0$ cfs). In the event of clogging or total inlet failure, flows at **DP4** will over top the high point and be routed via curb and gutter to **DP10**.

Basin K, 0.75 acres, ($Q_5=1.1$ cfs, $Q_{100}=2.7$ cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP5** which will be collected by a proposed 5' Type R sump inlet. The intercepted flow ($Q_5=1.1$ cfs, $Q_{100}=2.7$ cfs) will be routed west via an 18" RCP pipe (**PR4**, $Q_5=1.1$ cfs, $Q_{100}=2.7$ cfs) to **PR5** ($Q_5=31.2$ cfs, $Q_{100}=76.0$ cfs). In the event of clogging or total inlet failure, flows at **DP5** will over top the high point and be routed via curb and gutter to **DP10**.

Basin OS5B, 13.4 acres, ($Q_5=4.6$ cfs, $Q_{100}=25.8$ cfs), consist of existing developed 3.5-acre properties and streets. Runoff produced by the offsite area, will sheet flow onto **Basin D** which will be routed via side lot swales to **DP6**.

Basin D, 5.2 acres, ($Q_5=3.8$ cfs, $Q_{100}=14.0$ cfs), consists of a proposed single family residential lots. Cumulative developed flows within the **Basin D** and offsite **Basin OS5B** are routed as surface runoff via a proposed 4' wide swale to **DP6** ($Q_5=7.8$ cfs, $Q_{100}=37.7$ cfs). Surface runoff at **DP6** will be collected by a 3' x 8' CDOT Type D inlet. The intercepted flow ($Q_5=7.8$ cfs, $Q_{100}=37.7$ cfs) will be routed south via a 30" RCP pipe (**PR6**) to **DP7**. In the event of clogging or total inlet failure, flows at **DP6** will over top the embankment and be routed to **DP7**.

Basin E, 0.49 acres, ($Q_5=2.3$ cfs, $Q_{100}=4.1$ cfs), consists of a proposed local residential street. Surface runoff is routed via curb and gutter to **DP7** which will be collected by a proposed 5' Type R sump inlet. The intercepted flow ($Q_5=2.3$ cfs, $Q_{100}=4.1$ cfs) will combine with flows from **PR6** and be routed south via a 30" RCP pipe (**PR7**, $Q_5=9.2$ cfs, $Q_{100}=40.2$ cfs) to **PR9** ($Q_5=41.2$ cfs, $Q_{100}=117.8$ cfs). In the event of clogging or total inlet failure, flows at **DP7** will over top the high point and be routed via curb and gutter to **DP12**.

Basin F, 1.61 acres, ($Q_5=1.9$ cfs, $Q_{100}=5.4$ cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP8** which will be collected by a proposed 5' Type R sump inlet. The intercepted flow ($Q_5=1.9$ cfs, $Q_{100}=5.4$ cfs) will be routed west via an 18" RCP pipe (**PR8**, $Q_5=1.9$ cfs, $Q_{100}=5.4$ cfs) to **PR9** ($Q_5=41.2$ cfs, $Q_{100}=117.8$ cfs) .

In the event of clogging or total inlet failure, flows at **DP8** will over top the high point and be routed via curb and gutter to **DP12**.

Basin G, 12.2 acres, ($Q_5=14.0$ cfs, $Q_{100}=34.8$ cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP9** which will be collected by proposed dual 15' Type R at-grade inlets. The intercepted flow ($Q_5=7.0$ cfs, $Q_{100}=13.7$ cfs per side) will be routed south via 24" RCP pipe's (**PR10**, **PR11**, $Q_5=7.0$ cfs, $Q_{100}=13.7$ cfs per side) and will combine with **PR9** to **PR12** ($Q_5=53.9$ cfs, $Q_{100}=142.5$ cfs). In the event of clogging or total inlet failure, flows at **DP9** will be routed via curb and gutter to **DP15**.

Basin I, 12.7 acres, ($Q_5=14.5$ cfs, $Q_{100}=36.2$ cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP10** which will be collected by proposed dual 15' Type R at-grade inlets. The intercepted flow ($Q_5=7.3$ cfs, $Q_{100}=14.0$ cfs per side) will be routed west via a 18" RCP pipe (**PR13**, $Q_5=7.3$ cfs, $Q_{100}=14.0$ cfs) to **PR14**. Cumulative flows in a 30" RCP pipe (**PR14**, $Q_5=14.6$ cfs, $Q_{100}=27.9$ cfs) will be routed south to an existing 30" RCP pipe **PR#38** ($Q_5=14.6$ cfs, $Q_{100}=27.9$ cfs). In the event of clogging or total inlet failure, flows at **DP10** will be routed via curb and gutter to **DP11**. Pipe Run **PR#38** to be constructed as part of the Paint Brush Hills Filing No. 13E infrastructure.

Basin L, 3.37 acres, ($Q_5=3.8$ cfs, $Q_{100}=9.5$ cfs), consists of proposed single family residential lots and proposed local residential streets. Flowby from **DP10** and surface runoff from **Basin L** will be routed via curb and gutter to **DP11** ($Q_5=3.7$ cfs, $Q_{100}=17.0$ cfs) which will be collected by an existing 15' Type R at-grade inlet. The intercepted flow will be routed east via a 24" RCP pipe (**PR#15**, $Q_5=3.7$ cfs, $Q_{100}=13.5$ cfs) and then south to a planned 30" RCP pipe (**PR#16**, ($Q_5=17.4$ cfs, $Q_{100}=39.7$ cfs). In the event of clogging or total inlet failure, flows at **DP11** will be routed via curb and gutter to **DP15**. Pipe's **PR#15** and **PR#16** are to be constructed as part of the Paint Brush Hills Filing No. 13E infrastructure.

Basin *TT, 5.05 acres, ($Q_5=4.0$ cfs, $Q_{100}=13.0$ cfs), consists of proposed single family residential lots and proposed local residential streets. **Basin *TT** is to be constructed with Paint Brush Hills Filing No. 13E but surface runoff is to be captured and routed to Pond C. Surface runoff is routed via curb and gutter to **DP*37** ($Q_5=3.7$ cfs, $Q_{100}=13.0$ cfs) which will be collected by an existing 15' Type R at-grade inlet. The intercepted flow will be routed west via an existing 24" RCP pipe (**PR#39**, $Q_5=3.7$ cfs, $Q_{100}=11.5$ cfs). The combined flows from **PR#16** and **PR#39** will be routed west to a existing 36" RCP pipe (**PR#17**, $Q_5=20.8$ cfs, $Q_{100}=50.2$ cfs). In the event of clogging or total inlet failure, flows at **DP*37** will be routed via curb and gutter into the existing Paint Brush Hills Filing No. 12 subdivision. The combined flowby from **DP*37** and flow from **Basin *UU** is ($Q_5=1.0$ cfs, $Q_{100}=3.0$ cfs) and will be discussed in the Paint Brush Hills Filing No. 13E report. Pipe Run **PR#16** and **PR#39** to be constructed as part of the Paint Brush Hills Filing No. 13E infrastructure.

Basin H, 10.8 acres, ($Q_5=11.9$ cfs, $Q_{100}=29.7$ cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP12** which will be collected by proposed dual 15' Type R at-grade inlets. The intercepted flow ($Q_5=6.0$ cfs, $Q_{100}=12.4$ cfs per side) will be routed east via a 18" RCP pipe (**PR18**, $Q_5=6.0$ cfs, $Q_{100}=12.4$ cfs) and then south to a proposed 30" RCP pipe (**PR19**, ($Q_5=11.9$ cfs, $Q_{100}=24.8$ cfs). The combined flows from **PR17** and **PR19** will be routed west to a proposed 42" RCP pipe (**PR20**, $Q_5=32.4$ cfs, $Q_{100}=74.2$ cfs). The combined flows from **PR12** and **PR20** will be routed west to a proposed 54" RCP pipe (**PR21**, $Q_5=84.8$ cfs, $Q_{100}=213.4$ cfs). In the event of clogging or total inlet failure, flows at **DP12** will be routed via curb and gutter to **DP15**.

Basin M, 2.53 acres, ($Q_5=2.6$ cfs, $Q_{100}=7.8$ cfs), consists of proposed single family residential lots and proposed local residential streets. Flowby from **DP9**, **DP11**, **DP12** and surface runoff from **Basin M** will

be routed via curb and gutter to **DP13** ($Q_5=2.1$ cfs, $Q_{100}=21.3$ cfs). See **Basin C** for discussion of intercepted flow.

Basin OS5A, 3.7 acres, ($Q_5=1.5$ cfs, $Q_{100}=8.4$ cfs), consist of existing developed 3.5-acre properties and streets. Runoff produced by the offsite area, will sheet flow onto **Basin C** which will be routed via side lot swales and curb and gutter to **DP14**.

Basin C, 11.8 acres, ($Q_5=9.2$ cfs, $Q_{100}=28.6$ cfs), consists of proposed single family residential lots and proposed local residential streets. Surface runoff is routed via curb and gutter to **DP14** ($Q_5=10.3$ cfs, $Q_{100}=34.8$ cfs). The combined flows from **DP13** and **DP14** will be captured by proposed dual 20' Type R sump inlets at **DP15** ($Q_5=12.3$ cfs, $Q_{100}=55.4$ cfs). The intercepted flow will be routed south via a 30" RCP pipe (**PR22**, $Q_5=6.1$ cfs, $Q_{100}=27.7$ cfs per side) and then south to a proposed 36" RCP pipe (**PR23**, ($Q_5=12.3$ cfs, $Q_{100}=55.4$ cfs). The combined flows from **PR21** and **PR23** will be routed south to a proposed 60" RCP pipe (**PR24**, $Q_5=97.0$ cfs, $Q_{100}=268.2$ cfs) which will outfall into a proposed concrete lined forebay in Pond C.

Basin N, 9.02 acres, ($Q_5=6.2$ cfs, $Q_{100}=23.2$ cfs), consists of backyards of proposed single family residential lots, backyards of existing residential lots from Paint Brush Hills Filing No. 12 and existing Pond C. Surface runoff will sheet flow to **DP16** (existing **Pond C**). The cumulative flows from **Basin N** and **PR16** will outfall into the existing **Pond C** ($Q_5=102.2$ cfs, $Q_{100}=287.8$ cfs). The existing Pond C will require modifications in order to function as an Extended Detention Basin (EDB). These modifications will be addressed in the Street and Storm Sewer Construction drawings for Paint Brush Hills Filing No. 14. The proposed Detention Pond C functions to provide full spectrum detention and water quality for runoff calculated onsite and offsite flows. The pond is designed to treat approx 123.5 acres, and provide 1.724 ac-ft of water quality storage and 9.49 ac-ft of 100-year storage. The forebay, trickle channel micropool, outlet structure and pipe have been designed per the UDFCD manual and per the Detention Design-UD-Detention v3.05 workbook. The detention pond will be private and shall be maintained by the Paint Brush Hills Metropolitan District. Access shall be granted to the owner and El Paso County for access and maintenance of the private detention pond. A private maintenance agreement document shall accompany the submittal. In the event of clogging or total inlet failure, flows at **DP16** will over top the emergency spillway and outfall onto an existing swale, as it previously was designed. Per the Paint Brush Hills Filing No. 12 Construction Plans, an existing 20' x 20' rip rap pad ($D_{50} = 18"$) has been constructed and is in general conformance with the present release rate. The existing riprap pad will dissipate energy and prevent local scour at the outlet. The peak release rate from **Pond C** (**PR25**, $Q_5=3.6$ cfs and $Q_{100}=144.9$ cfs ~an existing 48" RCP) outfalls into an existing swale. The flows exiting the site do not exceed the flows as stated in the MDDP of $Q_5=22$ cfs and $Q_{100}=161$ cfs. Flows will not adversely affect the downstream infrastructure.

Basin Tributary to Adjacent Property to the West

Basin B, 9.16 acres, ($Q_5=6.2$ cfs, $Q_{100}=22.9$ cfs), consists of the backyards of proposed single family residential lots. Minimal improvements to the backyards will be implemented. Surface runoff will sheet flow west and follow historic drainage patterns to the adjacent property. Flows will not adversely affect the downstream infrastructure.

Basins Tributary to Adjacent Detention Pond D

As previously mentioned in the Purpose section of this report, approximately 6.72 acres of Paint Brush Hills Filing No. 14 runoff will be tributary to Paint Brush Hills Filing 13E (Pond D). The **Basin** description will show that the changes in drainage patterns will not adversely affect the capacity of the existing storm water quality facility (Pond D). The following descriptions are for **Basin **SS** and **Basin **OS1**. Refer to "Final Drainage Report for Paint Brush Hills Filing NO. 13E (PDRPBH-13E)" for

additional basin descriptions and proposed drainage map. Other than the basins describe below, the information provided (areas, C values, times of concentration, intensity) by the PDRPBH-13E report was used to quantify the flows in the proposed drainage spread sheets for **Design Point 34A**, ($Q_5=47$ cfs, $Q_{100}=155$ cfs) .

Basin **SS, 3.01 acres, ($Q_5=3.5$ cfs, $Q_{100}=9.7$ cfs), consists of a planned single family residential lots and proposed local residential streets. The developed flows within the **Basin **SS** are routed via curb and gutter to a planned 10' Type R sump inlet at **DP**34** ($Q_5=3.5$ cfs, $Q_{100}=9.7$ cfs). Due to changes in the grading and drainage patterns the acreage and surface runoff has been reduced from the PDRPBH-13E report. The combined flows from **DP*33** and **DP**34** ($Q_5=7.6$ cfs, $Q_{100}=21.4$ cfs) will be routed east, as planned in the PDRPBH-13E report, via a planned 24" RCP pipe and outlet into Basin OO (within an overhead electric utility easement). See the PDRPBH-13E report and construction plans, provided by Classic Engineers and Surveyors for details.

Basin **OS1, 4.44 acres, ($Q_5=4.9$ cfs, $Q_{100}=13.7$ cfs), consists of a planned single family residential lots and proposed local residential streets. The developed flows within the **Basin **OS1** are routed via curb and gutter to a planned 10' Type R sump inlet at **DP1** ($Q_5=4.9$ cfs, $Q_{100}=13.7$ cfs). Due to changes in the grading and drainage patterns the acreage and surface runoff has been increased from the PDRPBH-13E report. The flows from **DP1** will be routed east via a proposed 18" RCP pipe (**PR1**) and outlet into Basin OO (within an overhead electric utility easement). Caution will be taken working under the power lines and no amount of fill is anticipated as PR1 and outfall are installed. A rip rap apron will be constructed to dissipate energy and prevent local scour at the outlet. In the event of clogging or total inlet failure, flows at **DP1** will over top the curb and gutter and outfall into overhead electric utility easement. See Paint Brush Hills Filing No. 14 Street and Storm Sewer construction plans, provided by M&S Civil Consultants for details.

Basins **SS, **OS1, *DD1, *DD2, *EE, *FF, *GG, *HH, *II, *JJ, *KK, *RR and *OO are tributary to **DP **34A** ($Q_5=46.8$ cfs, $Q_{100}=155.2$ cfs). These flows are equivalent to the flows in the PDRPBH-13E report ($Q_5=47$ cfs, $Q_{100}=155$ cfs). Changes to grading and drainage patterns will not require additional changes to planned Pond D, other than the ones recommended by the PDRPBH-13E report, provided by Classic Engineers and Surveyors.

DETENTION POND PROVISIONS AND MAINTENANCE

Detention Pond C, has combined upstream developed runoff of $Q_5=102.2$ cfs and $Q_{100}=287.8$ cfs. The proposed Detention Pond functions to provide full spectrum detention and water quality for runoff calculated onsite. The pond is designed to treat approx 123.51 acres, and provide 1.724 ac-ft of water quality storage and 9.490 ac-ft of 100-year storage. The forebay, trickle channel micropool, outlet structure and pipe have been designed per the UDFCD manual and per the Detention Design-UD-Detention v3.07 workbook.

The detention ponds will be private and shall be maintained by the Paint Brush Hills Metropolitan District. Access shall be granted to the owner and El Paso County for access and maintenance of the private detention ponds. A private maintenance agreement documents shall accompany the submittal. In the event of clogging or total inlet failure, flows will over top the emergency spillway and outfall into an existing swale, Chico Creek are ultimate receiving waters. A rip rap apron will be revised and constructed to dissipate energy and prevent local scour at the outlet.

The water quality volume and 100-year volume required for the site has been determined using the guidelines set forth in the City of Colorado Springs/El Paso County Drainage Criteria Manual Chapter 6 - Volume II. Refer to the Detention Basin Design sheets located within the appendix of this report.

EROSION CONTROL

It is the policy of the El Paso County that we submit a grading and erosion control plan with the drainage report. Proposed erosion control blanket, silt fence, vehicle traffic control, and concrete washout area are proposed as erosion control measures.

CONSTRUCTION COST OPINION

Private Drainage Facilities NON-Reimbursable:

Item	Description	Quantity	Unit Cost	Cost
1.	18"RCP	151 LF	\$40 /LF	\$6,040.00
2.	24"RCP	46 LF	\$50 /LF	\$2,300.00
3.	30"RCP	354 LF	\$65 /LF	\$23,010.00
4.	36"RCP	340 LF	\$75 /LF	\$25,500.00
5.	42"RCP	261 LF	\$85 /LF	\$22,185.00
6.	48"RCP	2455 LF	\$150 /LF	\$368,250.00
7.	54"RCP	171 LF	\$200 /LF	\$34,200.00
8.	60"RCP	285 LF	\$250 /LF	\$71,250.00
9.	18"FES	1 EA	\$245 /EA	\$245.00
10.	36"FES	1 EA	\$775 /EA	\$775.00
11.	60"END TREATMENT	1 EA	\$15000/ /EA	\$15,000.00
	HEADWALL/W ING WALLS			
12.	5' TYPE R SUMP INLET	3 EA	\$4000 /EA	\$12,000.00
13.	10' TYPE R SUMP INLET	1 EA	\$4700 /EA	\$4,700.00
14.	15' TYPE R SUMP INLET	1 EA	\$6000 /EA	\$6,000.00
15.	15'TYPE R ATGRADE INLET	6 EA	\$6000 /EA	\$36,000.00
16.	3'x8' CDOT MOD TYPE D	1 EA	\$6000 /EA	\$6,000.00
17.	TYPE I MH	10 EA	\$6000 /EA	\$60,000.00
4.	EDB Pond	1 EA	\$20,000 /EA	\$20,000.00
5.	Pond Outlet MOD TYPE D	1 EA	\$15,000 /EA	\$15,000.00
6.	RIPRAP OUTFALL	490 SF	\$7 /SF	\$3,430.00
7.	SC250 Erosion Control Blanket	490 SY	\$12 /SY	\$5,880.00
Total \$				\$737,765.00

DRAINAGE & BRIDGE FEES

Drainage and Bridge Fees for the **Paint Brush Hills Filing No. 14** site are as follows:

	Acres	Imperviousness	Falcon Drainage Basin Fee		
2020 Drainage Fees:	123.51	x 40%	x \$30,807.00	=	\$1,521,989.03
2020 Bridge Fees:	123.51	x 40%	x \$4,232.00	=	\$209,077.73
Total					\$1,731,066.76

M &S Civil Consultants, Inc. (M &S) cannot and does not guarantee the construction cost will not vary from these opinions of probable costs. These opinions represent our best judgment as design professionals familiar with the construction industry and this development in particular. The above is only an estimate of the facility cost and drainage basin fee amounts in 2020.

SUMMARY

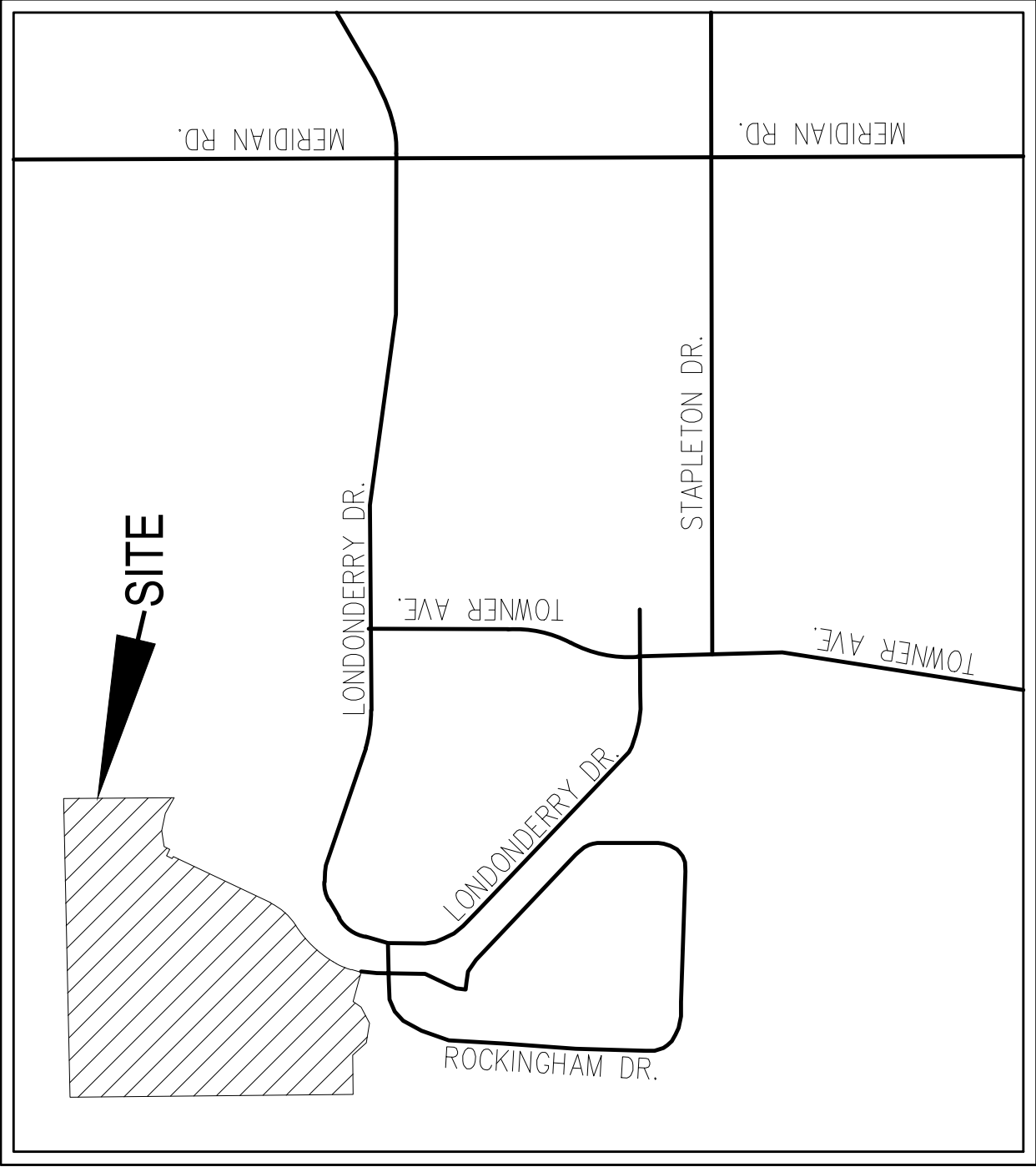
Development of the Paint Brush Hills Filing No. 14 site shall not adversely affect adjacent or downstream properties per this final drainage report. The proposed drainage facilities will adequately convey, detain and route runoff from tributary onsite and existing offsite flows to the Chico Creek receiving waters. All drainage facilities described herein and shown on the included drainage map are subject to change due to formal design considerations during the construction document preparation stage. Full Spectrum Detention and Water Quality Pond will be used to discharge developed flows into the Chico Creek receiving waters per the Urban Drainage criteria flow rates, which are at or less than the historic flow. Care will be taken to accommodate overland emergency flow routes on site and temporary drainage conditions. The development of the Paint Brush Hills Filing No. 14 project shall not adversely affect adjacent or downstream property.

REFERENCES

- 1.) "El Paso County and City of Colorado Springs Drainage Criteria Manual".
- 2.) "Urban Storm Drainage Criteria Manual"
- 3.) SCS Soils Map for El Paso County.
- 4.) Flood Insurance Rate Map (FIRM), Federal Emergency Management Agency, Effective date March 17, 1997.
- 5.) "Master Development Drainage Plan for Falcon Hills Development" prepared by Kiowa Engineering Corporation, approved November 2002.
- 6.) "Final Drainage Report for Paint Brush Hill Filing Nos. 10, 11 & 12" prepared by Classic Consulting Engineers and Surveyors, rev. July 2003.
- 7.) "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing No. 13)", prepared by Classic Consulting Engineers and Surveyors, submitted on rev. June 2008.
- 8.) "Final Drainage Report for Paint Brush Hills Filing 13E", prepared by Classic Consulting Engineers and Surveyors, submitted on September 2018.

APPENDIX

VICINITY MAP

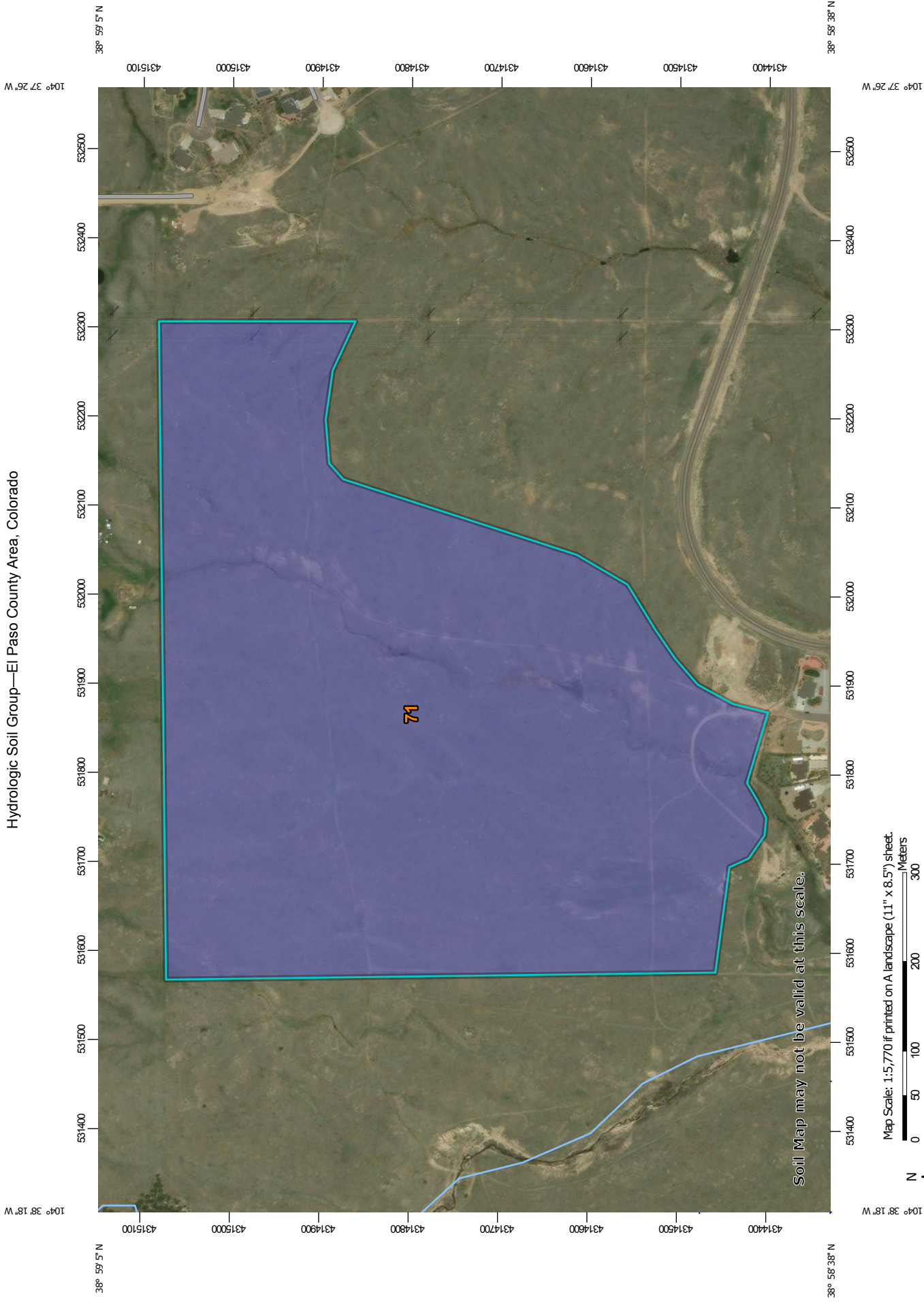


VICINITY MAP

N.T.S.

SOILS MAP

Hydrologic Soil Group—El Paso County Area, Colorado



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

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

C

C/D

D

Not rated or not available

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: [Web Soil Survey](#)

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 15, Oct 10, 2017

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

Date(s) aerial images were photographed: May 22, 2016—Mar 9, 2017

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
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	87.6	100.0%
Totals for Area of Interest			87.6	100.0%

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

FIRM PANEL W/ REVISED LOMR



Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT

COMMUNITY AND REVISION INFORMATION		PROJECT DESCRIPTION	BASIS OF REQUEST
COMMUNITY	El Paso County Colorado (Unincorporated Areas)	BRIDGE CHANNELIZATION CULVERT	FLOODWAY HYDRAULIC ANALYSIS NEW TOPOGRAPHIC DATA
	COMMUNITY NO.: 080059		
IDENTIFIER	Woodmen Road Widening Project -- Powers Boulevard to US-24	APPROXIMATE LATITUDE & LONGITUDE: 38.941, -104.693 SOURCE: Other DATUM: NAD 83	
ANNOTATED MAPPING ENCLOSURES		ANNOTATED STUDY ENCLOSURES	
TYPE: FIRM* NO.: 08041C0535F DATE: March 17, 1997 TYPE: FIRM* NO.: 08041C0575F DATE: March 17, 1997		DATE OF EFFECTIVE FLOOD INSURANCE STUDY: August 23, 1999 PROFILE(S): 204, 343, and 343(A) FLOODWAY DATA TABLE: TABLE 5	

Enclosures reflect changes to flooding sources affected by this revision.

* FIRM - Flood Insurance Rate Map; ** FBFM - Flood Boundary and Floodway Map; *** FHBM - Flood Hazard Boundary Map

FLOODING SOURCE(S) & REVISED REACH(ES)

See Page 2 for Additional Flooding Sources

Sand Creek - From approximately 615 feet downstream of East Woodmen Road to approximately 980 feet upstream of East Woodmen Road

SUMMARY OF REVISIONS

Flooding Source	Effective Flooding	Revised Flooding	Increases	Decreases
Sand Creek	Zone AE	Zone AE	YES	YES
	Zone X (shaded)	Zone X (shaded)	YES	YES
	BFEs	BFEs	YES	YES
	Floodway	Floodway	YES	YES

* BFEs - Base Flood Elevations

DETERMINATION

This document provides the determination from the Department of Homeland Security's Federal Emergency Management Agency (FEMA) regarding a request for a Letter of Map Revision (LOMR) for the area described above. Using the information submitted, we have determined that a revision to the flood hazards depicted in the Flood Insurance Study (FIS) report and/or National Flood Insurance Program (NFIP) map is warranted. This document revises the effective NFIP map, as indicated in the attached documentation. Please use the enclosed annotated map panels revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals in your community.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Information Exchange (FMIXESC) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the Engineering Library, 847 South Pickett Street, Alexandria, VA 22304-4605. Additional Information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

David N. Bascom, CFM, Program Specialist
Engineering Management Branch
Federal Insurance and Mitigation Administration

12-08-0579P

102-I-A-C



Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT (CONTINUED)

OTHER FLOODING SOURCES AFFECTED BY THIS REVISION

FLOODING SOURCE(S) & REVISED REACH(ES)

Sand Creek - From approximately 615 feet downstream of East Woodmen Road to approximately 980 feet upstream of East Woodmen Road
 East Fork Sand Creek - From approximately 1,260 feet downstream of East Woodmen Road to approximately 590 feet upstream of East Woodmen Road
 Unnamed Tributary to Black Squirrel Creek No. 2 - From approximately 330 feet downstream of Woodmen Road to approximately 760 feet upstream of Woodmen Road
 Falcon Basin Middle Tributary - From Woodmen Road to approximately 780 feet upstream of Woodmen Road

SUMMARY OF REVISIONS

Flooding Source	Effective Flooding	Revised Flooding	Increases	Decreases
Sand Creek	Zone X (unshaded)	Zone X (unshaded)	YES	YES
East Fork Sand Creek	Zone A	Zone A	YES	YES
	Zone X (unshaded)	Zone X (unshaded)	YES	YES
Unnamed Tributary to Black Squirrel Creek No. 2	Zone AE	Zone AE	YES	YES
	BFEs	BFEs	YES	YES
	Zone X (unshaded)	Zone X (unshaded)	YES	YES
Falcon Basin Middle Tributary	Zone A	Zone A	YES	YES
	Zone X (unshaded)	Zone X (unshaded)	YES	YES

* BFEs - Base Flood Elevations

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Information Exchange (FMIXESC) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the Engineering Library, 847 South Pickett Street, Alexandria, VA 22304-4605. Additional Information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

David N. Bascom, CFM, Program Specialist
 Engineering Management Branch
 Federal Insurance and Mitigation Administration



Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT (CONTINUED)

COMMUNITY INFORMATION

APPLICABLE NFIP REGULATIONS/COMMUNITY OBLIGATION

We have made this determination pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (P.L. 93-234) and in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, P.L. 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65. Pursuant to Section 1361 of the National Flood Insurance Act of 1968, as amended, communities participating in the NFIP are required to adopt and enforce floodplain management regulations that meet or exceed NFIP criteria. These criteria, including adoption of the FIS report and FIRM, and the modifications made by this LOMR, are the minimum requirements for continued NFIP participation and do not supersede more stringent State/Commonwealth or local requirements to which the regulations apply.

We provide the floodway designation to your community as a tool to regulate floodplain development. Therefore, the floodway revision we have described in this letter, while acceptable to us, must also be acceptable to your community and adopted by appropriate community action, as specified in Paragraph 60.3(d) of the NFIP regulations.

NFIP regulations Subparagraph 60.3(b)(7) requires communities to ensure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management ordinances; therefore, responsibility for maintenance of the altered or relocated watercourse, including any related appurtenances such as bridges, culverts, and other drainage structures, rests with your community. We may request that your community submit a description and schedule of maintenance activities necessary to ensure this requirement.

COMMUNITY REMINDERS

We based this determination on the 1-percent-annual-chance flood discharges computed in the FIS for your community without considering subsequent changes in watershed characteristics that could increase flood discharges. Future development of projects upstream could cause increased flood discharges, which could cause increased flood hazards. A comprehensive restudy of your community's flood hazards would consider the cumulative effects of development on flood discharges subsequent to the publication of the FIS report for your community and could, therefore, establish greater flood hazards in this area.

Your community must regulate all proposed floodplain development and ensure that permits required by Federal and/or State/Commonwealth law have been obtained. State/Commonwealth or community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction or may limit development in floodplain areas. If your State/Commonwealth or community has adopted more restrictive or comprehensive floodplain management criteria, those criteria take precedence over the minimum NFIP requirements.

We will not print and distribute this LOMR to primary users, such as local insurance agents or mortgage lenders; instead, the community will serve as a repository for the new data. We encourage you to disseminate the information in this LOMR by preparing a news release for publication in your community's newspaper that describes the revision and explains how your community will provide the data and help interpret the NFIP maps. In that way, interested persons, such as property owners, insurance agents, and mortgage lenders, can benefit from the information.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Information Exchange (FMIXESC) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the Engineering Library, 847 South Pickett Street, Alexandria, VA 22304-4605. Additional Information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

A handwritten signature in black ink, appearing to read "David N. Bascom".

David N. Bascom, CFM, Program Specialist
Engineering Management Branch
Federal Insurance and Mitigation Administration



Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT (CONTINUED)

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Jeanine D. Petterson
Director, Mitigation Division
Federal Emergency Management Agency, Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267
(303) 235-4830

STATUS OF THE COMMUNITY NFIP MAPS

We will not physically revise and republish the FIRM and FIS report for your community to reflect the modifications made by this LOMR at this time. When changes to the previously cited FIRM panel(s) and FIS report warrant physical revision and republication in the future, we will incorporate the modifications made by this LOMR at that time.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Information Exchange (FMIXESC) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the Engineering Library, 847 South Pickett Street, Alexandria, VA 22304-4605. Additional Information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

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David N. Bascom, CFM, Program Specialist
Engineering Management Branch
Federal Insurance and Mitigation Administration



Federal Emergency Management Agency
Washington, D.C. 20472

**LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)**

PUBLIC NOTIFICATION OF REVISION

PUBLIC NOTIFICATION

A notice of changes will be published in the *Federal Register*. This information will be published in your local newspaper on or about the dates listed below and through FEMA's Flood Hazard Mapping website at https://www.floodmaps.fema.gov/fhm/Scripts/bfe_main.asp.

LOCAL NEWSPAPER

Name: *The Gazette*

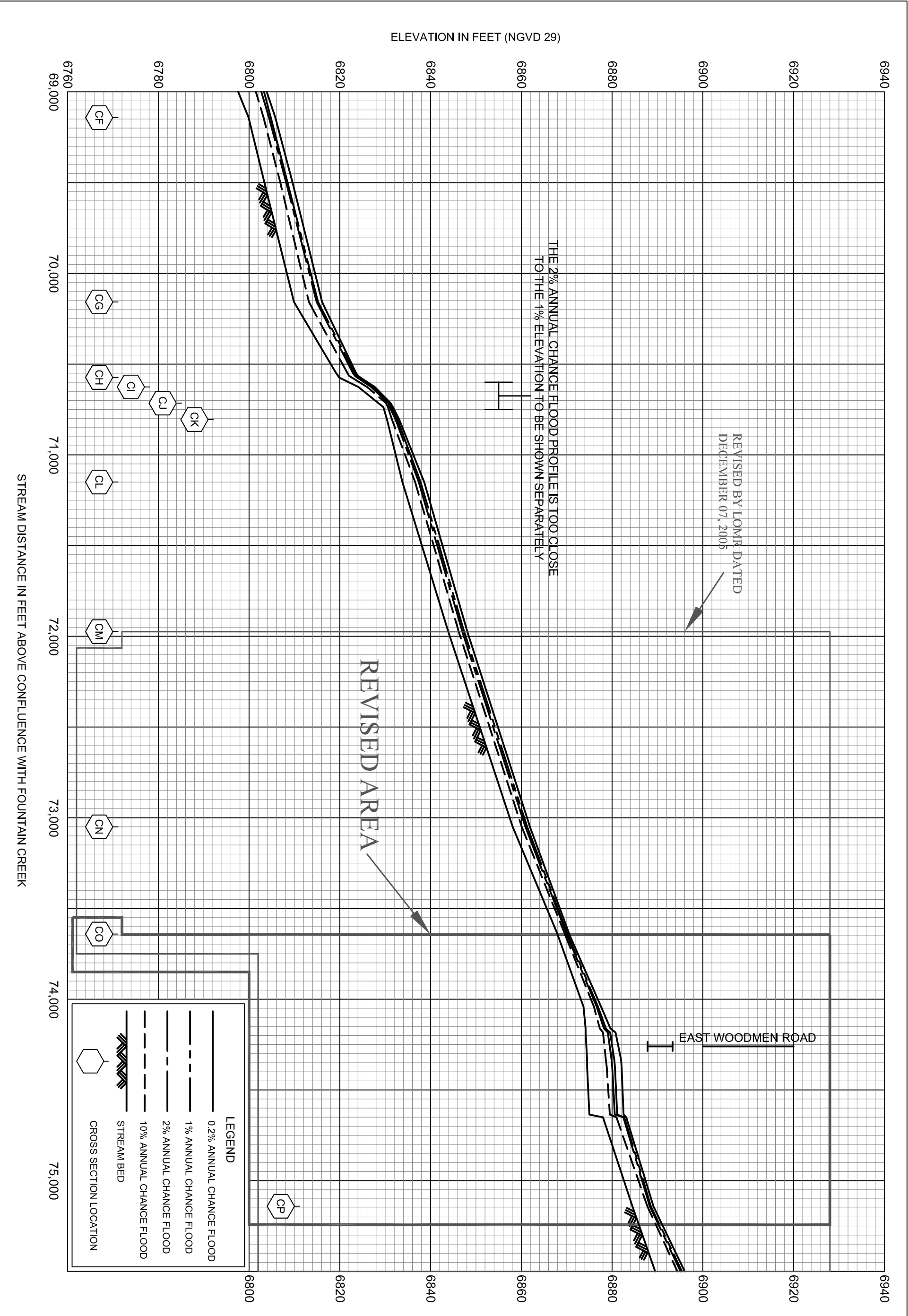
Dates: 10/24/2012 and 10/31/2012

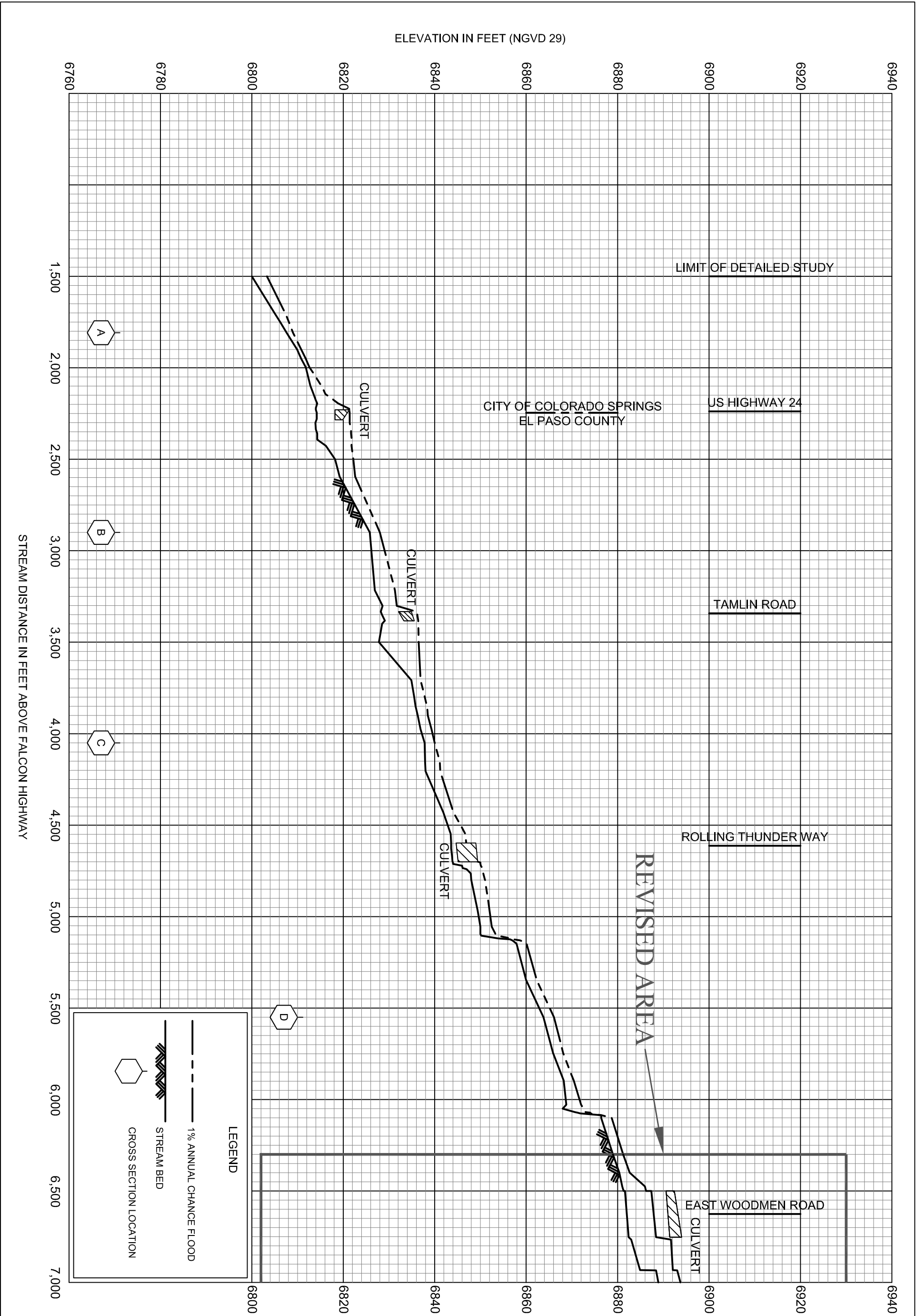
Within 90 days of the second publication in the local newspaper, a citizen may request that we reconsider this determination. Any request for reconsideration must be based on scientific or technical data. Therefore, this letter will be effective only after the 90-day appeal period has elapsed and we have resolved any appeals that we receive during this appeal period. Until this LOMR is effective, the revised flood hazard information presented in this LOMR may be changed.

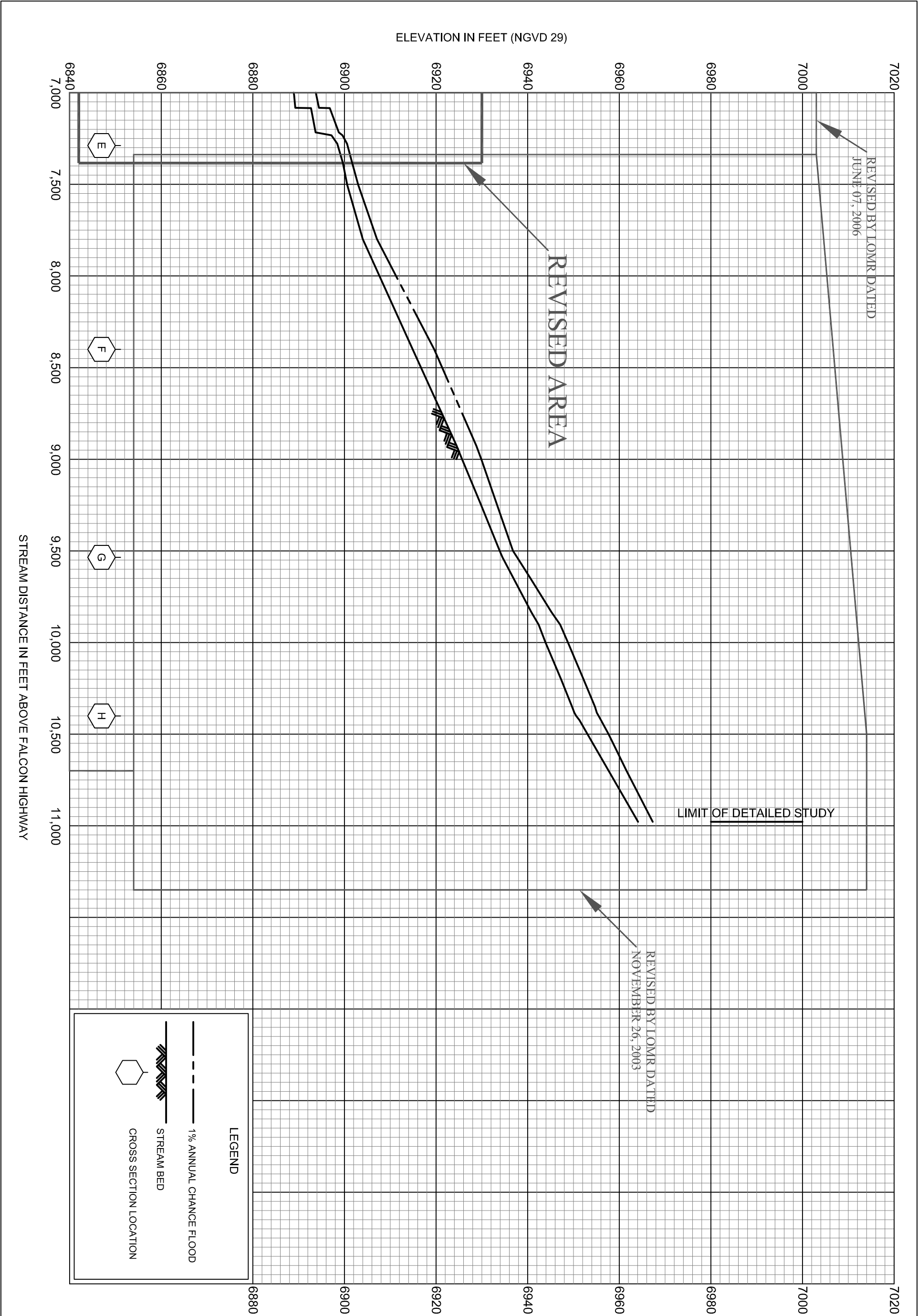
This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Information Exchange (FMIXESC) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the Engineering Library, 847 South Pickett Street, Alexandria, VA 22304-4605. Additional Information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

A handwritten signature in black ink, appearing to read "David N. Bascom".

David N. Bascom, CFM, Program Specialist
Engineering Management Branch
Federal Insurance and Mitigation Administration







Legend

1% annual chance (100-Year) Floodplain

1% annual chance (100-Year) Floodway

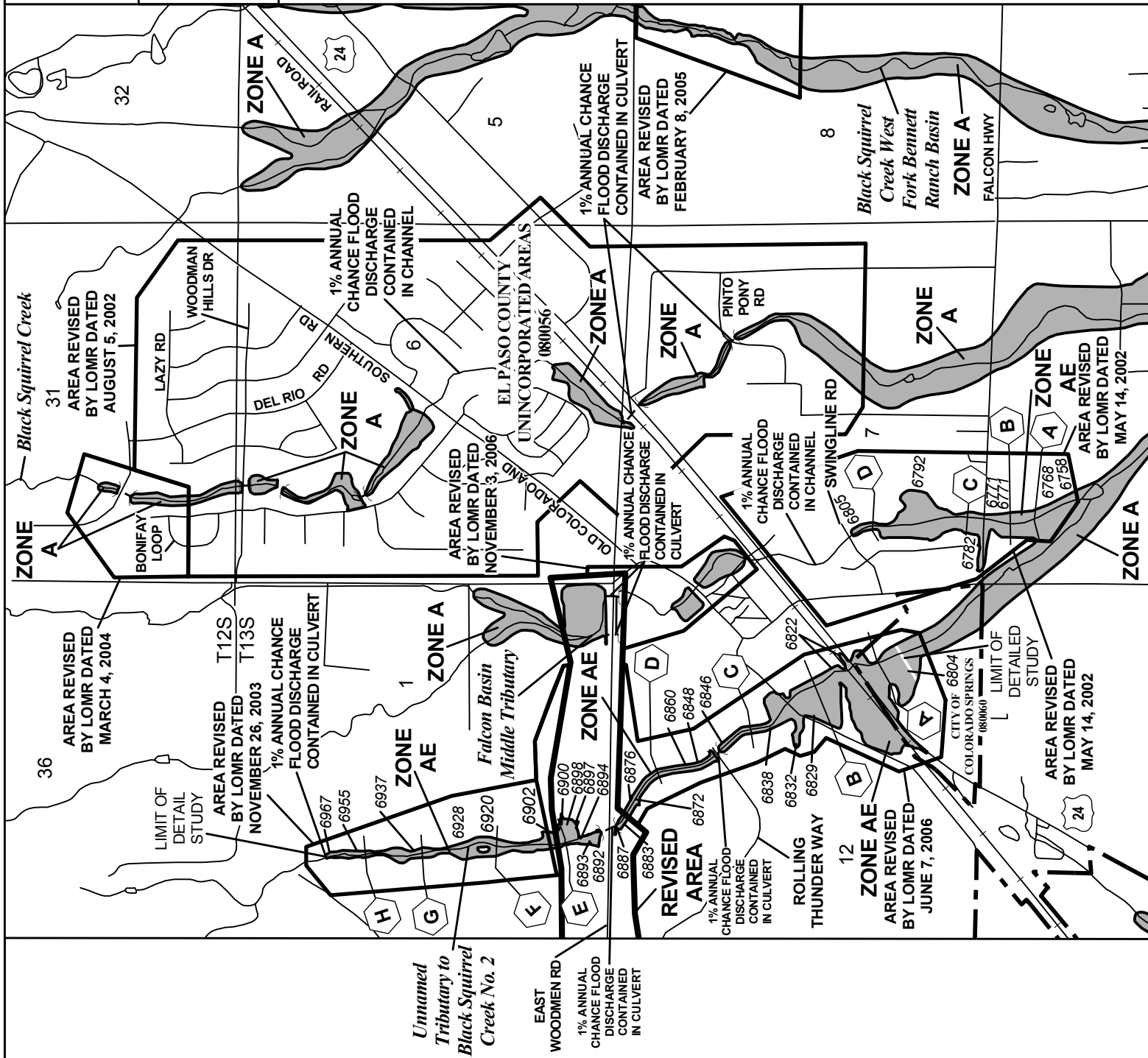
0.2% annual chance (500-Year) Floodplain

MAP SCALE 1" = 2000'

0 1000 2000

0 600 1200

FEET METERS



NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 575 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:
COMMUNITY

NUMBER PANEL SUFFIX

COLORADO, SPRINGS, CITY OF 080060 0575 F

EL PASO COUNTY, UNINCORPORATED AREAS 080069 0575 F

**REVISION TO
REFLECT LOMR
EFFECTIVE:
February 28, 2013**

MAP NUMBER
08041C0575 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

HYDROLOGIC CALCULATIONS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE CALCULATIONS
(Area Runoff Coefficient Summary)

BASIN	TOTAL AREA (Sq Ft)	TOTAL AREA (Acres)	IMPERVIOUS AREA/STREET			LANDSCAPED/UNDEVELOPED			RESIDENTIAL			WEIGHTED	
			AREA (Acres)	C ₅	C ₁₀₀	AREA (Acres)	C ₅	C ₁₀₀	AREA (Acres)	C ₅	C ₁₀₀	C ₅	C ₁₀₀
<i>*DD1</i>	387685	8.90	0.00	0.90	0.96	0.00	0.16	0.41	8.90	0.22	0.46	0.22	0.46
<i>*GG</i>	372875	8.56	0.00	0.90	0.96	0.00	0.16	0.41	8.56	0.22	0.46	0.22	0.46
<i>*FF</i>	52272	1.20	0.00	0.90	0.96	0.00	0.16	0.41	1.20	0.22	0.46	0.22	0.46
<i>*HH</i>	271815	6.24	0.00	0.90	0.96	0.00	0.16	0.41	6.24	0.30	0.50	0.30	0.50
<i>*II</i>	179032	4.11	0.00	0.90	0.96	0.00	0.16	0.41	4.11	0.30	0.50	0.30	0.50
<i>*DD2</i>	144184	3.31	0.00	0.90	0.96	0.00	0.16	0.41	3.31	0.30	0.50	0.30	0.50
<i>*KK</i>	22215	0.51	0.51	0.90	0.96	0.00	0.16	0.41	0.00	0.22	0.46	0.90	0.96
<i>*JJ</i>	40075	0.92	0.00	0.90	0.96	0.00	0.16	0.41	0.92	0.30	0.50	0.30	0.50
<i>*EE</i>	129373	2.97	0.00	0.90	0.96	0.00	0.16	0.41	2.97	0.30	0.50	0.30	0.50
<i>*RR</i>	182952	4.20	0.00	0.90	0.96	0.00	0.16	0.41	4.20	0.30	0.50	0.30	0.50
<i>**SS</i>	131167	3.01	0.00	0.90	0.96	0.00	0.16	0.41	3.01	0.30	0.50	0.30	0.50
<i>**OS1</i>	193584	4.44	0.00	0.90	0.96	0.00	0.16	0.41	4.44	0.30	0.50	0.30	0.50
<i>*OO</i>	1222298	28.06	0.00	0.90	0.96	28.06	0.16	0.41	0.00	0.22	0.46	0.16	0.41
<i>*LL</i>	101930	2.34	2.34	0.90	0.96	0.00	0.16	0.41	0.00	0.22	0.46	0.90	0.96
<i>*MM</i>	276607	6.35	0.00	0.90	0.96	0.00	0.16	0.41	6.35	0.30	0.50	0.30	0.50
<i>*TT</i>	219978	5.05	0.00	0.90	0.96	0.00	0.16	0.41	5.05	0.22	0.46	0.22	0.46
<i>*UU</i>	55321	1.27	0.00	0.90	0.96	1.27	0.16	0.41	0.00	0.22	0.46	0.16	0.41
<i>***OS-5</i>	2008124	46.10	0.00	0.90	0.96	0.00	0.16	0.41	46.10	0.30	0.40	0.30	0.40
<i>OSSA</i>	159430	3.66	0.00	0.90	0.96	0.00	0.16	0.41	3.66	0.11	0.37	0.11	0.37
<i>OSSB</i>	585306	13.44	0.00	0.90	0.96	0.00	0.16	0.41	13.44	0.11	0.37	0.11	0.37
<i>OSSC</i>	1263404	29.00	0.00	0.90	0.96	0.00	0.16	0.41	29.00	0.30	0.40	0.30	0.40
<i>A</i>	22798	0.52	0.01	0.90	0.96	0.51	0.16	0.41	0.00	0.22	0.46	0.18	0.42
<i>B</i>	399133	9.16	0.00	0.90	0.96	0.00	0.16	0.41	9.16	0.20	0.44	0.20	0.44
<i>C</i>	514010	11.80	0.00	0.90	0.96	0.00	0.16	0.41	11.80	0.26	0.48	0.26	0.48
<i>D</i>	226401	5.20	0.00	0.90	0.96	0.00	0.16	0.41	5.20	0.20	0.44	0.20	0.44
<i>E</i>	21364	0.49	0.49	0.90	0.96	0.00	0.16	0.41	0.00	0.20	0.44	0.90	0.96
<i>F</i>	70330	1.61	0.00	0.90	0.96	0.00	0.16	0.41	1.61	0.30	0.50	0.30	0.50
<i>G</i>	531342	12.20	0.00	0.90	0.96	0.00	0.16	0.41	12.20	0.35	0.52	0.35	0.52
<i>H</i>	469586	10.78	0.00	0.90	0.96	0.00	0.16	0.41	10.78	0.35	0.52	0.35	0.52
<i>I</i>	554956	12.74	0.00	0.90	0.96	0.00	0.16	0.41	12.74	0.35	0.52	0.35	0.52
<i>J</i>	313307	7.19	0.00	0.90	0.96	0.00	0.16	0.41	7.19	0.22	0.45	0.22	0.45
<i>K</i>	32632	0.75	0.00	0.90	0.96	0.00	0.16	0.41	0.75	0.36	0.54	0.36	0.54
<i>L</i>	146850	3.37	0.00	0.90	0.96	0.00	0.16	0.41	3.37	0.36	0.54	0.36	0.54
<i>M</i>	110207	2.53	0.00	0.90	0.96	0.00	0.16	0.41	2.53	0.27	0.48	0.27	0.48
<i>N</i>	392775	9.02	0.00	0.90	0.96	3.18	0.16	0.41	5.84	0.22	0.46	0.20	0.44

* Values taken from "Final Drainage Report for Paint Brush Hills Filing 13E" (*PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Sept 2018

** Revised from "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (**PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Feb 2018

*** "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing 13)" (FDRPBH-PH2-13) prepared by Classic Consulting Engineers and Surveyors, revised June 2008

Calculated by: GT

Date: 7/1/2020

Checked by: VAS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE CALCULATIONS
(Area Drainage Summary)

From Area Runoff Coefficient Summary				OVERLAND				STREET / CHANNEL FLOW				Time of Travel		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)	CHECK (min)	I ₅ (in/hr)	I ₁₀₀ (in/hr)	Q ₅ (c.f.s.)	Q ₁₀₀ (c.f.s.)
Proposed Area Drainage Summary																	
*DD1	8.90	0.22	0.46	0.22												6.0	22.0
*GG	8.56	0.22	0.46	0.22												6.0	22.0
*FF	1.20	0.22	0.46	0.22												0.8	3.0
*HH	6.24	0.30	0.50	0.30												6.0	18.0
*II	4.11	0.30	0.50	0.30												4.0	12.0
*DD2	3.31	0.30	0.50	0.30												4.0	10.0
*KK	0.51	0.90	0.96	0.90												2.0	4.0
*JJ	0.92	0.30	0.50	0.30												1.2	3.0
*EE	2.97	0.30	0.50	0.30												3.0	10.0
*RR	4.20	0.30	0.50	0.30												4.0	12.0
**SS	3.01	0.30	0.50	0.30	100	5	8.5	640	2.0%	2.8	3.8	12.3	14.1	3.8	6.4	3.5	9.7
**OS1	4.44	0.30	0.50	0.30	100	5	8.5	616	1.0%	2.0	5.1	13.6	14.0	3.7	6.2	4.9	13.7
*OO	28.06	0.16	0.41	0.16												12.0	51.0
*LL	2.34	0.90	0.96	0.90												7.0	19.0
*MM	6.35	0.30	0.50	0.30												4.0	7.0
*TT	5.05	0.22	0.46	0.22												4.0	13.0
*UU	1.27	0.16	0.41	0.16												1.0	3.0
***OS-5	46.10	0.30	0.40	0.30												14.0	32.0
OS5A	3.66	0.11	0.37	0.11	100	2	14.2	527	1.5%	1.8	4.8	19.0	13.5	3.7	6.2	1.5	8.4
OS5B	13.44	0.11	0.37	0.11	100	2	14.2	1684	1.5%	1.8	15.3	29.5	19.9	3.1	5.2	4.6	25.8
OS5C	29.00	0.30	0.40	0.30	100	2	11.5	2110	1.0%	2.0	17.6	29.1	22.3	2.9	4.9	25.5	57.0
A	0.52	0.18	0.42	0.18	100	5	9.8	569	4.3%	3.1	3.1	12.8	13.7	3.8	6.3	0.4	1.4
B	9.16	0.20	0.44	0.20	100	3	13.4	1063	3.2%	2.7	6.6	20.1	16.5	3.4	5.7	6.2	22.9
C	11.80	0.26	0.48	0.26	100	3	10.6	2030	2.6%	3.2	10.6	21.1	21.8	3.0	5.0	9.2	28.6
D	5.20	0.20	0.44	0.20	100	4	10.3	593	2.0%	2.1	4.7	14.9	13.9	3.6	6.1	3.8	14.0
E	0.49	0.90	0.96	0.90	10	0.2	0.9	471	2.0%	2.8	2.8	5.0	12.7	5.2	8.7	2.3	4.1
F	1.61	0.30	0.50	0.30	60	1.2	8.9	362	2.0%	2.8	2.1	11.0	12.3	4.0	6.7	1.9	5.4
G	12.20	0.35	0.52	0.35	100	2	10.8	1381	2.8%	3.3	6.9	17.7	18.2	3.3	5.5	14.0	34.8
H	10.78	0.35	0.52	0.35	100	2	10.8	1543	2.1%	2.9	8.9	19.6	19.1	3.2	5.3	11.9	29.7
I	12.70	0.35	0.52	0.35	100	2	10.8	1309	2.1%	2.9	7.5	18.3	17.8	3.3	5.5	14.5	36.2
J	7.19	0.22	0.45	0.22	100	2	12.6	799	1.9%	2.7	4.9	17.5	15.0	3.5	5.9	5.6	19.1
K	0.75	0.36	0.54	0.36	72	1.4	9.1	277	1.6%	2.5	1.8	10.9	11.9	4.0	6.7	1.1	2.7
L	3.37	0.36	0.54	0.36	75	1.5	9.2	1802	2.1%	2.9	10.4	19.6	20.4	3.1	5.2	3.8	9.5
M	2.53	0.27	0.48	0.27	100	2	11.9	318	2.1%	2.9	1.8	13.8	12.3	3.8	6.4	2.6	7.8
N	9.02	0.20	0.44	0.20	100	2	12.9	902	3.2%	3.6	4.2	17.1	15.6	3.5	5.8	6.2	23.2

#REF!		#REF!
CA ₅	Basin	CA ₁₀₀
1.96	*DD1	4.09
1.88	*GG	3.94
0.26	*FF	0.55
1.87	*HH	3.12
1.23	*II	2.06
0.99	*DD2	1.66
0.46	*KK	0.49
0.28	*JJ	0.46
0.89	*EE	1.48
1.26	*RR	2.10
0.90	**SS	1.51
1.33	**OS1	2.22
4.49	*OO	11.50
2.11	*LL	2.25
1.91	*MM	3.18
1.11	*TT	2.32
0.20	*UU	0.52
13.83	***OS-5	18.44
0.40	OS5A	1.35
1.48	OS5B	4.97
8.70	OS5C	11.60
0.09	A	0.22
1.83	B	4.03
3.07	C	5.66
1.04	D	2.29
0.44	E	0.47
0.48	F	0.81
4.27	G	6.34
3.77	H	5.61
4.45	I	6.60
1.58	J	3.24
0.27	K	0.40
1.21	L	1.82
0.68	M	1.21
1.79	N	3.99

*Values taken from "Final Drainage Report for Paint Brush Hills Filing 13E" (**PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Sept 2018
 ** Revised from "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (**PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Feb 2018
 *** "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing 13)" (FDRPBH-PH2-13) prepared by Classic Consulting Engineers and Surveyors, revised June 2008

Calculated by: GT
 Date: 7/1/2020
 Checked by: VAS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE CALCULATIONS
(Basin Routing Summary)

From Area Runoff Coefficient Summary				OVERLAND				PIPE / CHANNEL FLOW				Time of Travel (T _t)		INTENSITY *		TOTAL FLOWS		COMMENTS
DESIGN POINT	CONTRIBUTING BASINS	CA _s	CA ₁₀₀	C _s	Length (ft)	Height (ft)	T _c (min)	Length (ft)	Slope (%)	Velocity (fps)	T _t (min)	TOTAL (min)	I _s (in/hr)	I ₁₀₀ (in/hr)	Q _s (c.f.s.)	Q ₁₀₀ (c.f.s.)		
PROPOSED DRAINAGE BASIN ROUTING SUMMARY																		
1	**OS1	1.33	2.22									13.6	3.7	6.2	4.9	13.7	PROP 10' SUMP TYPE R INLET REV **PDRPBH13E	
*33	*RR	1.26	2.10									14.9	3.5	5.9	4.4	12.4	W/18" RCP	
																	*10' SUMP TYPE R INLET	
																	*PDRPBH13E	
																	*W/18" RCP	
**34	**SS	0.90	1.51									12.3	3.8	6.4	3.5	9.7	*10' SUMP TYPE R INLET	
																	**PDRPBH13E	
																	**W/24" RCP	
**34.4	EX POND D DD1,DD2,EE,OO,RR,SS FF,GG,HH,II,JJ,KK,OS1	17.82	35.18									27.2	2.6	4.4	46.8	155.2	EX POND D	
																	*PDRPBH13E	
																	*Q _s = 47 cfs, *Q ₁₀₀ = 155 cfs	
3	A OSSC	0.09	0.22									22.3	2.9	4.9	25.7	58.1	PROP 36" RCP FES	
		8.70	11.60															
		8.79	11.82															
4	J	1.58	3.24									15.0	3.5	5.9	5.6	19.1	PROP 15' SUMP TYPE R INLET	
																	W/24" RCP	
5	K	0.27	0.40									10.9	4.0	6.7	1.1	2.7	PROP 5' SUMP TYPE R INLET	
																	W/18" RCP	
6	OS5B D	1.48	4.97									19.9	3.1	5.2	7.8	37.7	PROP 2.9x8.0' CDOT MOD TYPE D INLET	
		1.04	2.29														W/30" RCP	
		2.52	7.26															
7	E	0.44	0.47									5.0	5.2	8.7	2.3	4.1	PROP 5' SUMP TYPE R INLET	
																	W/30" RCP	
8	F	0.48	0.81									11.0	4.0	6.7	1.9	5.4	PROP 5' SUMP TYPE R INLET	
																	W/18" RCP	
9	G	4.27	6.34									18.2	3.2	5.4	13.8	34.4	PROP DUAL 15' AT-GRADE TYPE R INLET	
																	W/24" RCPS	
																	FLOWS SPLIT @ DP9	
10	I	4.45	6.60									17.8	3.3	5.5	14.5	36.2	PROP DUAL 15' AT-GRADE TYPE R INLET	
																	W/18" RCP & 30" RCP	
																	W/18" RCP & 30" RCP	
																	FLOWS SPLIT @ DP10	
11	L Flowby DP10	1.21	1.82									20.4	3.1	5.1	3.7	17.0	EX. 15' AT-GRADE TYPE R INLET	
		0.00	1.49														W/24" RCP	
		1.21	3.31															
*37	*TT	1.11	2.32									17.0	3.3	5.6	3.7	13.0	EX. 15' AT-GRADE TYPE R INLET	
																	W/24" RCP	
																	FLOWS SPLIT @ DP12	
12	H	3.77	5.61									19.1	3.2	5.3	11.9	29.7	PROP DUAL 15' AT-GRADE TYPE R INLET	
																	W/18" RCP & 30" RCP	
																	W/18" RCP & 30" RCP	
																	FLOWS SPLIT @ DP12	
13	M FLOWBY DP9 FLOWBY DP12 FLOWBY DP11	0.68	1.21									20.4	3.1	5.1	2.1	21.3	SEE DP15 FOR CUMMULATIVE FLOW	
		0.00	1.35															
		0.00	0.90															
		0.00	0.68															
		0.68	4.15															
14	C OSSA	3.07	5.66									21.8	3.0	5.0	10.3	34.8	SEE DP15 FOR CUMMULATIVE FLOW	
		0.40	1.35															
		3.47	7.02															
15	DP13 DP14	0.68	4.15									21.8	3.0	5.0	12.3	55.4	PROP DUAL 20' SUMP TYPE R INLET	
		3.47	7.02														W/30" & 36"RCP	
		4.15	11.16														FLOWS SPLIT @ DP15	
16	N PR24	1.79	3.99									22.3	2.9	4.9	102.2	287.8	EX. POND C	
		33.17	54.66															
		34.96	58.65															

* Values taken from "Final Drainage Report for Paint Brush Hills Filing 13E" (*PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated September 2018
** Revised from "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (*PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Feb 2018
*** "Final Drainage Report for Paint Brush Hills-Phase 2 (Filing 13)" (FDRPBH-PH2-13) prepared by Classic Consulting Engineers and Surveyors, revised June 2008

Calculated by: GT
Date: 7/1/2020
Checked by: VAS

PAINTBRUSH HILLS FILING NO. 14
FINAL DRAINAGE CALCULATIONS
(Storm Sewer Routing Summary)

PIPE RUN Point(s)	Contributing Pipes/Design Points	Equivalent CA ₅	Equivalent CA ₁₀₀	Maximum T _c	Intensity*		Flow		PIPE SIZE
					I ₅	I ₁₀₀	Q ₅	Q ₁₀₀	
*36	PDRPBH-13E DP33	1.26	2.10	14.9	3.5	5.9	4.4	12.4	*18" RCP
*37	DP**34, DP*33	2.16	3.61	14.9	3.5	5.9	7.6	21.4	*24" RCP
1	DP1	1.33	2.22	13.6	3.7	6.2	4.9	13.7	18" RCP
2	DP3	8.79	11.82	22.3	2.9	4.9	25.7	58.1	36" RCP
3	DP4, PR2	10.38	15.06	22.3	2.9	4.9	30.4	74.0	48" RCP
4	DP5	0.27	0.40	10.9	4.0	6.7	1.1	2.7	18" RCP
5	PR3, PR4	10.65	15.46	22.3	2.9	4.9	31.2	76.0	48" RCP
6	DP6	2.52	7.26	19.9	3.1	5.2	7.8	37.7	30" RCP
7	DP7, PR6	2.96	7.73	19.9	3.1	5.2	9.2	40.2	30" RCP
8	DP8	0.48	0.81	11.0	4.0	6.7	1.9	5.4	18" RCP
9	PR5, PR7, PR8	14.09	24.00	22.3	2.9	4.9	41.2	117.8	48" RCP
10	1/2 DP9 CAPTURE	2.17	2.52	18.2	3.2	5.4	7.0	13.7	24" RCP
11	1/2 DP9 CAPTURE	2.17	2.52	18.2	3.2	5.4	7.0	13.7	24" RCP
12	PR9, PR10, PR11	18.43	29.04	22.3	2.9	4.9	53.9	142.5	48" RCP
13	1/2 DP 10 CAPTURE	2.24	2.55	17.8	3.3	5.5	7.3	14.0	18" RCP
14	1/2 DP 10 CAPTURE, PR13	4.48	5.10	17.8	3.3	5.5	14.6	27.9	30" RCP
#38	PR14	4.48	5.10	17.8	3.3	5.5	14.6	27.9	*30" RCP
#15	DP 11 CAPTURE	1.22	2.63	20.4	3.1	5.1	3.7	13.5	*24" RCP
#16	#PR38, #PR15	5.70	7.73	20.4	3.1	5.1	17.4	39.7	*30" RCP
#39	DP*37	1.10	2.05	17.0	3.3	5.6	3.7	11.5	*24" RCP
#17	PR#16, PR#39	6.80	9.77	20.4	3.1	5.1	20.8	50.2	*36" RCP
18	1/2 DP12	1.89	2.34	19.1	3.2	5.3	6.0	12.4	18" RCP
19	1/2 DP12, PR18	3.78	4.68	19.1	3.2	5.3	11.9	24.8	30" RCP
20	PR#17, PR19	10.58	14.45	20.4	3.1	5.1	32.4	74.2	42" RCP
21	PR12, PR20	29.01	43.50	22.3	2.9	4.9	84.8	213.4	54" RCP
22	1/2 DP15	2.08	5.58	21.8	3.0	5.0	6.1	27.7	30" RCP
23	1/2 DP15, PR22	4.15	11.16	21.8	3.0	5.0	12.3	55.4	36" RCP
24	PR23, PR25	33.17	54.66	22.3	2.9	4.9	97.0	268.2	60" RCP
#25	DP 16	POND C OUTFALL RESTRICTED FLOW					3.6	144.9	EX 48" RCP

* Values taken from "Final Drainage Report for Paint Brush Hills Filing 13E" (*PDRPBH13E)

prepared by Classic Consulting Engineers and Surveyors, dated September 2018

Values adjusted from FDR PBH 14

DP - Design Point

EX - Existing Design Point

FB- Flow By from Design Point

INT- Intercepted Flow from Design Point

Calculated by: GT

Date: 7/1/2020

Checked by: VAS

HYDRAULIC CALCULATIONS / EDB WQCV CALCULATIONS

PAINTBRUSH HILLS FILING NO. 14

FINAL DRAINAGE REPORT

(CDOT Type R Inlet Calculations - Sump Condition)

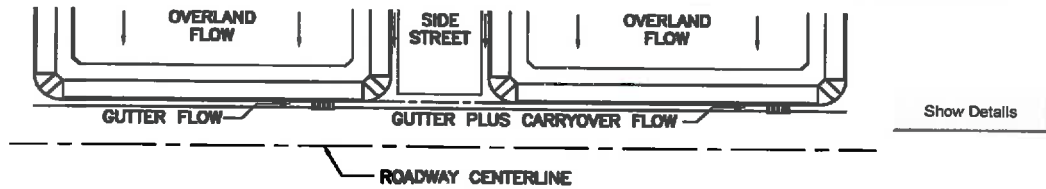
Urban Local Roadway-50' ROW-30' Pavement-6" Vertical Curb Maximum allowable depth for MINOR (0.43') & MAJOR (0.66') storm					
Inlet Length	Storm	Depth	Eqn. 7-31 $Q_m = C_w N_m L_e D^{3/2}$	Eqn. 7-32 $Q_o = C_o N_o (L_e H_c) (2g(D - 0.5H_c))^{1/2}$	Eqn. 7-29 $Q_m = C_m (Q_w Q_o)^{1/2}$
5	Q5	0.43	5.1	5.7	5.0
5	Q100	0.66	9.7	8.6	8.5
6	Q5	0.43	6.1	6.8	6.0
6	Q100	0.66	11.6	10.3	10.2
8	Q5	0.43	8.1	9.1	8.0
8	Q100	0.66	15.4	13.8	13.6
10	Q5	0.43	10.2	11.4	10.0
10	Q100	0.66	19.3	17.2	17.0
12	Q5	0.43	12.2	13.7	12.0
12	Q100	0.66	23.2	20.7	20.3
14	Q5	0.43	14.2	16.0	14.0
14	Q100	0.66	27.0	24.1	23.7
15	Q5	0.43	15.2	17.1	15.0
15	Q100	0.66	29.0	25.8	25.4
16	Q5	0.43	16.2	18.2	16.0
16	Q100	0.66	30.9	27.5	27.1
18	Q5	0.43	18.3	20.5	18.0
18	Q100	0.66	34.7	31.0	30.5
20	Q5	0.43	20.3	22.8	20.0
20	Q100	0.66	38.6	34.4	33.9

Table 7-7. Coefficients for various inlets in sumps

Inlet Type	Nw	Cw	No	Co	Cm
CDOT Type 13 Grate	0.7	3.3	0.43	0.6	0.93
Denver No. 16 Grate	0.73	3.6	0.31	0.6	0.9
Curb Opening for Type 13/No. 16 Combination	1	3.7	1	0.66	0.86
CDOT Type R Curb Opening	1	3.6	1	0.67	0.93

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP1



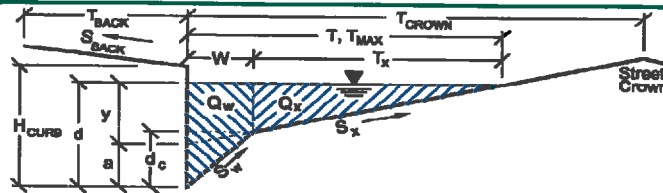
Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>4.9</u> cfs	Major Storm <u>13.7</u> cfs
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.			
Geographic Information: (Enter data in the blue cells):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Media	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D	← FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. ←
		Slope (ft/ft) <u> </u> Length (ft) <u> </u> Overland Flow = <u> </u> Channel Flow = <u> </u>	
Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + T_e) \cdot C_3$		Minor Storm Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u> Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u>0.0</u> cfs	Major Storm <u>0.0</u> cfs
		Total Design Peak Flow, Q = <u>4.9</u> cfs	<u>13.7</u> cfs

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

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14
SUMP INLET DP1



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)
Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK} = 8.0$ ft
 $S_{BACK} = 0.020$ ft/ft
 $n_{BACK} = 0.020$

$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 17.0$ ft
 $W = 2.00$ ft
 $S_X = 0.020$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_O = 0.000$ ft/ft
 $n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	17.0	17.0	ft
$d_{MAX} =$	5.6	7.9	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")
Gutter Depression ($d_c = (W \cdot S_X \cdot 12)$)
Water Depth at Gutter Flowline
Allowable Spread for Discharge outside the Gutter Section W ($T - W$)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
Discharge outside the Gutter Section W, carried in Section T_X
Discharge within the Gutter Section W ($Q_T - Q_X$)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
 $V \cdot d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
$y =$	4.08	4.08	inches
$d_c =$	2.0	2.0	inches
$a =$	1.51	1.51	inches
$d =$	5.59	5.59	inches
$T_X =$	15.0	15.0	ft
$E_o =$	0.350	0.350	
$Q_X =$	0.0	0.0	cfs
$Q_W =$	0.0	0.0	cfs
$Q_{BACK} =$	0.0	0.0	cfs
$Q_T =$	SUMP	SUMP	cfs
$V =$	0.0	0.0	fps
$V \cdot d =$	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})
Discharge within the Gutter Section W ($Q_d - Q_X$)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
 $V \cdot d$ Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm
Max Flow Based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
$T_{TH} =$	17.0	26.6	ft
$T_{XTH} =$	15.0	24.6	ft
$E_o =$	0.349	0.220	
$Q_{XTH} =$	0.0	0.0	cfs
$Q_X =$	0.0	0.0	cfs
$Q_W =$	0.0	0.0	cfs
$Q_{BACK} =$	0.0	0.0	cfs
$Q =$	0.0	0.0	cfs
$V =$	0.0	0.0	fps
$V \cdot d =$	0.0	0.0	
$R =$	SUMP	SUMP	
$Q_d =$	SUMP	SUMP	cfs
$d =$			inches
$d_{CROWN} =$			inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

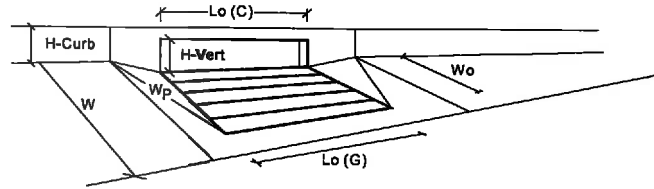
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

	Minor Storm	Major Storm	
$Q_{allow} =$	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14
Inlet ID = SUMP INLET DP1



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	Inches
N_o =	2.0	2	
Ponding Depth =	5.6	7.9	Inches

☒ Override Depths

	MINOR	MAJOR	
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	

	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	Inches
H_{throat} =	6.00	6.00	Inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	

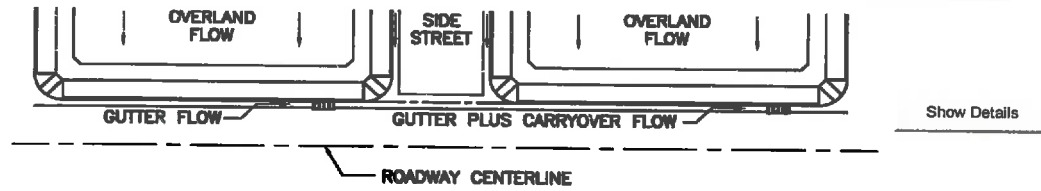
Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Q_a =	8.7	19.0	cfs
$Q_{PEAK REQUIRED}$ =	4.9	13.7	cfs

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: SUMP INLET DP**34



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street OR grass-lined channel):

*If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

Geographic Information: (Enter data in the blue cells):

Site Type: ☐ Site is Urban ☐ Site is Non-Urban

Flows Developed For: ☐ Street Inlets ☐ Area Inlets in a Median

Subcatchment Area = Acres
Percent Imperviousness = %
NRCS Soil Type = A, B, C, or D

Slope (ft/ft) Length (ft)
Overland Flow =
Channel Flow =

Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + T_e)^{C_3}$

Design Storm Return Period, T_r = years
Return Period One-Hour Precipitation, P_1 = inches
 C_1 =
 C_2 =
 C_3 =
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C_e =
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b = cfs

Minor Storm **Major Storm**

* Q_{Known} = 3.5 9.7 cfs

Total Design Peak Flow, Q = 3.5 9.7 cfs

← FILL IN THIS SECTION
OR...

← FILL IN THE SECTIONS
BELOW.

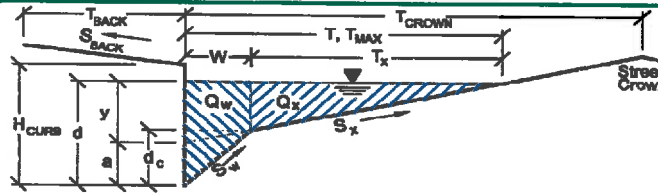
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

SUMP INLET DP**34



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK}	=	8.0	ft
S_{BACK}	=	0.020	ft/ft
n_{BACK}	=	0.020	

H_{CURB}	=	6.00	inches
T_{CROWN}	=	17.0	ft
W	=	2.00	ft
S_x	=	0.020	ft/ft
S_w	=	0.083	ft/ft
S_o	=	0.000	ft/ft
n_{STREET}	=	0.020	

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
T_{MAX}	=	17.0	ft
d_{MAX}	=	5.6	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Gutter Depression ($d_c - (W * S_x * 12)$)

Water Depth at Gutter Flowline

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Discharge outside the Gutter Section W, carried in Section T_x

Discharge within the Gutter Section W ($Q_T - Q_X$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	=	4.08	inches
d_c	=	2.0	inches
a	=	1.51	inches
d	=	5.59	inches
T_x	=	15.0	ft
E_o	=	0.350	
Q_X	=	0.0	cfs
Q_W	=	0.0	cfs
Q_{BACK}	=	0.0	cfs
Q_T	=	SUMP	cfs
V	=	0.0	fps
$V*d$	=	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

Discharge within the Gutter Section W ($Q_d - Q_X$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

Max Flow Based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T_{TH}	=	17.0	ft
T_{XTH}	=	15.0	ft
E_o	=	0.349	
Q_{XTH}	=	0.0	cfs
Q_X	=	0.0	cfs
Q_W	=	0.0	cfs
Q_{BACK}	=	0.0	cfs
Q	=	0.0	cfs
V	=	0.0	fps
$V*d$	=	0.0	
R	=	SUMP	
Q_d	=	SUMP	cfs
d	=		inches
d_{CROWN}	=		inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

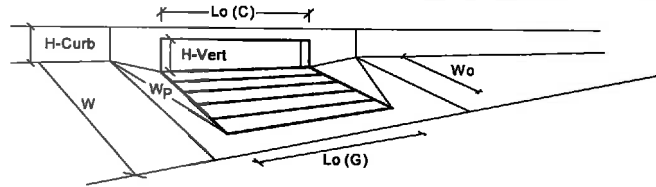
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

	Minor Storm	Major Storm	
Q_{allow}	=	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

Project = PAINT BRUSH HILLS FILING NO. 14
Inlet ID = SUMP INLET DP**34



Design Information (Input)

Type of Inlet
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')
Number of Unit Inlets (Grate or Curb Opening)
Water Depth at Flowline (outside of local depression)
Grate Information
Length of a Unit Grate
Width of a Unit Grate
Area Opening Ratio for a Grate (typical values 0.15-0.90)
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)
Grate Weir Coefficient (typical value 2.15 - 3.60)
Grate Orifice Coefficient (typical value 0.60 - 0.80)
Curb Opening Information
Length of a Unit Curb Opening
Height of Vertical Curb Opening in Inches
Height of Curb Orifice Throat in Inches
Angle of Throat (see USDCM Figure ST-5)
Side Width for Depression Pan (typically the gutter width of 2 feet)
Clogging Factor for a Single Curb Opening (typical value 0.10)
Curb Opening Weir Coefficient (typical value 2.3-3.7)
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

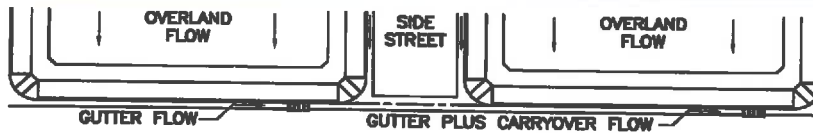
Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
θ_{local} =	3.00	3.00	inches
N_o =	2.0	2	
Ponding Depth =	5.6	7.9	inches
	<input checked="" type="checkbox"/> Override Depths		
	MINOR	MAJOR	
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
Q_a =	8.7	19.0	cfs
$Q_{PEAK REQUIRED}$ =	3.5	9.7	cfs

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: SUMP INLET DP4



Show Details

Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>5.6</u> cfs	Major Storm <u>19.1</u> cfs
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.			
Geographic Information: (Enter data in the blue cells):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
		Slope (ft/ft) Length (ft) Overland Flow = <u> </u> <u> </u> Channel Flow = <u> </u> <u> </u>	
Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + T_o)^{C_3}$			
		Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u>	
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u>			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u> </u>		Minor Storm <u>0.0</u> cfs	Major Storm <u>0.0</u> cfs
Total Design Peak Flow, Q = <u> </u>		Minor Storm <u>5.6</u> cfs	Major Storm <u>19.1</u> cfs

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

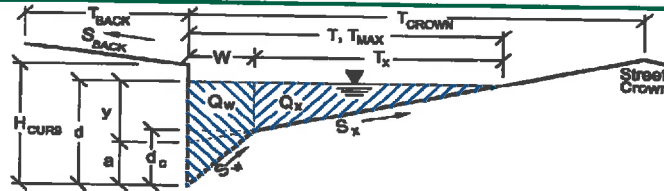
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

PAINT BRUSH HILLS FILING NO. 14

Inlet ID:

SUMP INLET DP4



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

T_{BACK}	8.0	ft
S_{BACK}	0.020	ft/ft
n_{BACK}	0.020	

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

H_{CURB}	6.00	inches
T_{CROWN}	17.0	ft

Distance from Curb Face to Street Crown

Gutter Width

W	2.00	ft
-----	------	----

Street Transverse Slope

S_X	0.020	ft/ft
-------	-------	-------

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

S_W	0.083	ft/ft
-------	-------	-------

Street Longitudinal Slope - Enter 0 for sump condition

S_0	0.000	ft/ft
-------	-------	-------

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

n_{STREET}	0.020	
--------------	-------	--

Max. Allowable Spread for Minor & Major Storm

	Minor Storm	Major Storm	
T_{MAX}	17.0	17.0	ft
d_{MAX}	5.6	7.9	inches

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Allow Flow Depth at Street Crown (leave blank for no)

☐ ☒ check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Gutter Depression ($d_c - (W * S_X * 12)$)

Water Depth at Gutter Flowline

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Discharge outside the Gutter Section W , carried in Section T_X

Discharge within the Gutter Section W ($Q_T - Q_X$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	4.08	4.08	inches
d_c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.59	5.59	inches
T_X	15.0	15.0	ft
E_0	0.350	0.350	
Q_X	0.0	0.0	cfs
Q_W	0.0	0.0	cfs
Q_{BACK}	0.0	0.0	cfs
Q_T	SUMP	SUMP	cfs
V	0.0	0.0	fps
$V*d$	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Theoretical Discharge outside the Gutter Section W , carried in Section T_{XTH}

Actual Discharge outside the Gutter Section W , (limited by distance T_{CROWN})

Discharge within the Gutter Section W ($Q_d - Q_X$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

Max Flow Based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T_{TH}	17.0	26.6	ft
T_{XTH}	15.0	24.6	ft
E_0	0.349	0.220	
Q_{XTH}	0.0	0.0	cfs
Q_X	0.0	0.0	cfs
Q_W	0.0	0.0	cfs
Q_{BACK}	0.0	0.0	cfs
Q	0.0	0.0	cfs
V	0.0	0.0	fps
$V*d$	0.0	0.0	
R	SUMP	SUMP	
Q_d	SUMP	SUMP	cfs
d			inches
d_{CROWN}			inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

	Minor Storm	Major Storm	
Q_{allow}	SUMP	SUMP	cfs

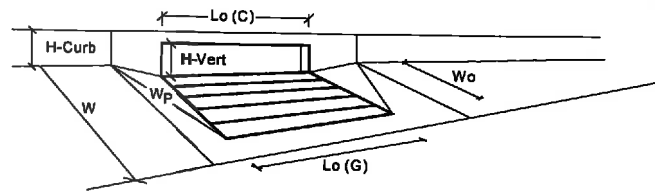
INLET IN A SUMP OR SAG LOCATION

Project =

PAINT BRUSH HILLS FILING NO. 14

Inlet ID =

SUMP INLET DP4



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

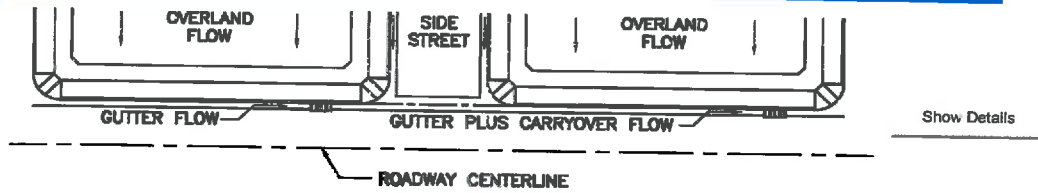
Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
N_o =	3.0	3	
Ponding Depth =	5.6	7.9	inches
<input checked="" type="checkbox"/> Override Depths			
	MINOR	MAJOR	
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
Q_a =	11.1	27.3	cfs
$Q_{PEAK REQUIRED}$ =	5.6	19.1	cfs

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: SUMP INLET DP5



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>1.1</u> cfs	Major Storm <u>2.7</u> cfs
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.			
Geographic Information: (Enter data in the blue cells):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Median	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D	← FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. ←
		Slope (ft/ft) Length (ft) Overland Flow = <u> </u> <u> </u> Channel Flow = <u> </u> <u> </u>	
Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + T_e) \wedge C_3$			
Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches		Minor Storm <u> </u>	Major Storm <u> </u>
C ₁ = <u> </u>		<u> </u>	<u> </u>
C ₂ = <u> </u>		<u> </u>	<u> </u>
C ₃ = <u> </u>		<u> </u>	<u> </u>
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C _s = <u> </u>		<u> </u>	<u> </u>
Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u> </u>		<u>0.0</u>	<u>0.0</u> cfs
Total Design Peak Flow, Q = <u> </u>		<u>1.1</u>	<u>2.7</u> cfs

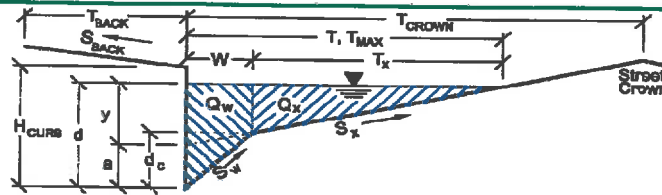
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

SUMP INLET DP5



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

T_{BACK}	=	8.0	ft
S_{BACK}	=	0.020	ft/ft
n_{BACK}	=	0.020	

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

H_{CURB}	=	6.00	inches
T_{CROWN}	=	17.0	ft
W	=	2.00	ft
S_X	=	0.020	ft/ft
S_W	=	0.083	ft/ft
S_0	=	0.000	ft/ft
n_{STREET}	=	0.020	

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
T_{MAX}	17.0	17.0	ft
d_{MAX}	5.6	7.9	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Gutter Depression ($d_c - (W * S_x * 12)$)

Water Depth at Gutter Flowline

Allowable Spread for Discharge outside the Gutter Section W (T - W)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Discharge outside the Gutter Section W, carried in Section T_X

Discharge within the Gutter Section W ($Q_T - Q_X$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	4.08	4.08	inches
d_c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.59	5.59	inches
T_X	15.0	15.0	ft
E_0	0.350	0.350	
Q_X	0.0	0.0	cfs
Q_W	0.0	0.0	cfs
Q_{BACK}	0.0	0.0	cfs
Q_T	SUMP	SUMP	cfs
V	0.0	0.0	fps
$V*d$	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section W (T - W)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X,TH}$

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

Discharge within the Gutter Section W ($Q_d - Q_X$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

Max Flow Based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T_{TH}	17.0	26.6	ft
$T_{X,TH}$	15.0	24.6	ft
E_0	0.349	0.220	
$Q_{X,TH}$	0.0	0.0	cfs
Q_X	0.0	0.0	cfs
Q_W	0.0	0.0	cfs
Q_{BACK}	0.0	0.0	cfs
Q	0.0	0.0	cfs
V	0.0	0.0	fps
$V*d$	0.0	0.0	
R	SUMP	SUMP	
Q_d	SUMP	SUMP	cfs
d			inches
d_{CROWN}			inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

	Minor Storm	Major Storm	
Q_{allow}	SUMP	SUMP	cfs

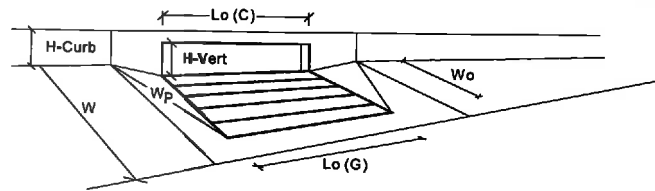
INLET IN A SUMP OR SAG LOCATION

Project =

PAINT BRUSH HILLS FILING NO. 14

Inlet ID =

SUMP INLET DP5



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

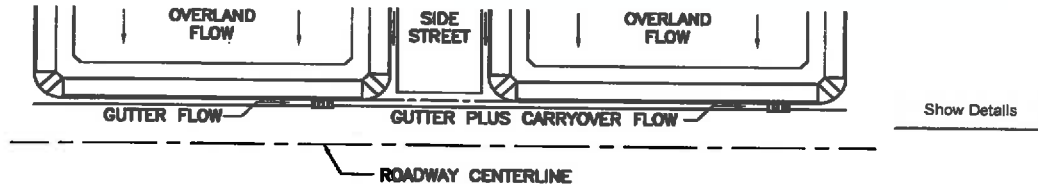
	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
N_o =	1.0	1	
Ponding Depth =	5.6	7.9	inches
	MINOR	MAJOR	<input checked="" type="checkbox"/> Override Depths
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Θ =	63.40	63.40	degrees
W_p =	2.00	2.50	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
Q_a =	4.6	9.1	cfs
$Q_{\text{PEAK REQUIRED}}$ =	1.1	2.7	cfs

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: SUMP INLET DP6



Design Flow: ONLY if already determined through other methods:
 (local peak flow for 1/2 of street OR grass-lined channel):

*If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.

Geographic Information: (Enter data in the blue cells):

Site Type: ☐ Site is Urban ☐ Site is Non-Urban

Flows Developed For: ☐ Street Inlets ☐ Area Inlets in a Medial

Subcatchment Area = Acres
 Percent Imperviousness = %
 NRCS Soil Type = A, B, C, or D

Slope (ft/ft) Length (ft)

Overland Flow =
 Channel Flow =

Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + 1.0) \cdot C_3$

Design Storm: Return Period, T_r = years
 Return Period One-Hour Precipitation, P_1 = inches
 C_1 =
 C_2 =
 C_3 =

User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =
 User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =

Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b = cfs

Total Design Peak Flow, Q = cfs

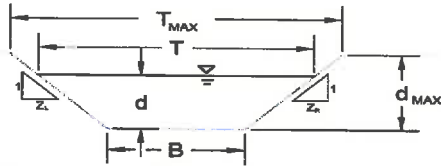
← FILL IN THIS SECTION
OR...

← FILL IN THE SECTIONS
BELOW.

AREA INLET IN A TRAPEZOIDAL GRASS-LINED CHANNEL

PAINT BRUSH HILLS FILING NO. 14

SUMP INLET DP6



Grass Type	Limiting Manning's n
A	0.06
B	0.04
C	0.033
D	0.03
E	0.024

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)

Manning's n (Leave cell D16 blank to manually enter an n value)

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

Soil Type	Max. Velocity (V _{max})	Max Froude No. (F _{max})
Sandy	5.0 fps	0.50
Non-Sandy	7.0 fps	0.80

A, B, C, D or E

E
n = see details below
S ₀ = 0.0132 ft/ft
B = 4.00 ft
Z1 = 3.00 ft/ft
Z2 = 3.00 ft/ft

Choose One:

- ☒ Sandy
☐ Non-Sandy

Max. Allowable Top Width of Channel for Minor & Major Storm

Max. Allowable Water Depth in Channel for Minor & Major Storm

	Minor Storm	Major Storm	
T _{MAX}	8.20	12.10	feet
d _{MAX}	0.52	1.01	feet

Maximum Channel Capacity Based On Allowable Top Width

Max. Allowable Top Width

Water Depth

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Max. Flow Based On Allowable Top Width

	Minor Storm	Major Storm	
T _{MAX}	8.20	12.10	ft
d	0.70	1.35	ft
A	4.27	10.87	sq ft
P	8.43	12.54	ft
R	0.51	0.87	ft
n	0.033	0.025	
V	3.35	6.14	fps
VR	1.69	5.32	ft ² /s
D	0.52	0.90	ft
Fr	0.82	1.14	
Q _T	14.28	66.68	cfs

Maximum Channel Capacity Based On Allowable Water Depth

Max. Allowable Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Max. Flow Based On Allowable Water Depth

	Minor Storm	Major Storm	
d _{MAX}	0.52	1.01	feet
T	7.12	10.06	feet
A	2.89	7.10	square feet
P	7.29	10.39	feet
R	0.40	0.68	feet
n	0.036	0.028	
V	2.53	4.79	fps
VR	1.01	3.27	ft ² /s
D	0.41	0.71	feet
Fr	0.70	1.01	
Q _d	7.33	34.02	cfs

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
Q _{allow}	7.33	34.02	cfs
d _{allow}	0.52	1.01	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n based on NRCS Vegetal Retardance

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

	Minor Storm	Major Storm	
Q _o	7.80	37.70	cfs
d	0.54	1.06	feet
T	7.21	10.35	feet
A	3.00	7.59	square feet
P	7.39	10.69	feet
R	0.41	0.71	feet
n	0.036	0.027	
V	2.60	4.96	fps
VR	1.06	3.53	ft ² /s
D	0.42	0.73	feet
Fr	0.71	1.02	

Warning 05

Warning 04

WARNING: MINOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'

WARNING: MAJOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'

AREA INLET IN A TRAPEZOIDAL GRASS-LINED CHANNEL

PAINT BRUSH HILLS FILING NO. 14
SUMP INLET DP6

Inlet Design Information (Input)

Type of Inlet Inlet Type = **CDOT Type D (In Series & Depressed)**

Angle of Inclined Grate (must be ≤ 30 degrees)

Width of Grate

Length of Grate

Open Area Ratio

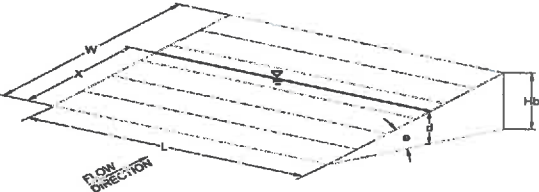
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



θ =	0.00	degrees
W =	3.00	feet
L =	6.00	feet
ARATIO =	0.70	
H _B =	0.00	feet
C ₁ =	0.38	
C _d =	0.72	
C _o =	0.48	
C _w =	1.53	

Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)

	MINOR	MAJOR
d =	1.54	2.06

Grate Capacity as a Weir

Submerged Side Weir Length

Inclined Side Weir Flow

Base Weir Flow

Interception without Clogging

Interception with Clogging

X =	6.00	6.00	feet
Q _{sw} =	30.59	47.48	cfs
Q _{sb} =	21.85	33.91	cfs
Q _{sl} =	83.04	128.87	cfs
Q _{sw} =	51.90	80.55	cfs

Grate Capacity as an Orifice

Interception without Clogging

Interception with Clogging

Q _{ol} =	58.77	69.20	cfs
Q _{os} =	37.35	43.25	cfs

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (> Q PEAK)

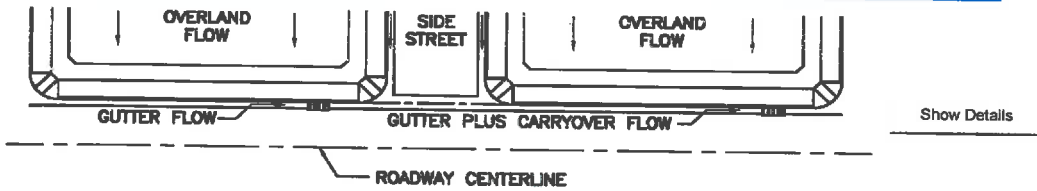
Q _a =	37.35	43.25	cfs
Bypassed Flow, Q _b =	0.00	0.00	cfs
Capture Percentage = Q _a /Q _a = C%	100	100	%

Warning 04: Froude No. exceeds USDCM Volume I recommendation.

Warning 05: Depth (d) exceeds max allowable depth (dmax).

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: SUMP INLET DP7



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm 2.3 cfs	Major Storm 4.1 cfs
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.			
Geographic Information: (Enter data in the blue cells):			
Site Type: <input type="radio"/> Site Is Urban <input type="radio"/> Site Is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <input type="text"/> Acres Percent imperviousness = <input type="text"/> % NRCS Soil Type = <input type="text"/> A, B, C, or D	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
		Slope (ft/ft) Length (ft) Overland Flow = <input type="text"/> <input type="text"/> Channel Flow = <input type="text"/> <input type="text"/>	
Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + I_c) \cdot C_3$			
		Minor Storm Major Storm	
Design Storm Return Period, T_r = <input type="text"/> years Return Period One-Hour Precipitation, P_1 = <input type="text"/> inches C_1 = <input type="text"/> C_2 = <input type="text"/> C_3 = <input type="text"/>			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <input type="text"/> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 = <input type="text"/>			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b = <input type="text"/>		0.0 0.0 cfs	
Total Design Peak Flow, Q = <input type="text"/>		2.3 4.1 cfs	

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

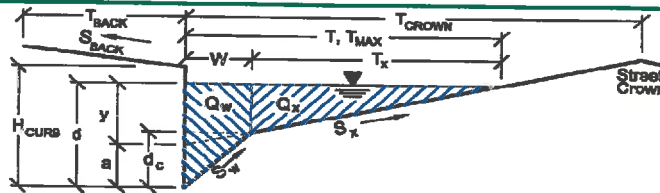
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

PAINT BRUSH HILLS FILING NO. 14

Inlet ID:

SUMP INLET DP7



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

$T_{BACK} = 8.0$ ft

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

$S_{BACK} = 0.020$ ft/ft

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

$H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

$T_{CROWN} = 17.0$ ft

Gutter Width

$W = 2.00$ ft

Street Transverse Slope

$S_x = 0.020$ ft/ft

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

$S_w = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

$S_o = 0.000$ ft/ft

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm Major Storm

$T_{MAX} = 17.0$ 17.0 ft

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

$d_{MAX} = 5.6$ 7.9 inches

Allow Flow Depth at Street Crown (leave blank for no)

☐ ☒ check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm

$y = 4.08$ 4.08 inches

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

$d_c = 2.0$ 2.0 inches

Gutter Depression ($d_c - (W * S_x * 12)$)

$a = 1.51$ 1.51 inches

Water Depth at Gutter Flowline

$d = 5.59$ 5.59 inches

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

$T_x = 15.0$ 15.0 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.350$ 0.350

Discharge outside the Gutter Section W, carried in Section T_x

$Q_x = 0.0$ 0.0 cfs

Discharge within the Gutter Section W ($Q_t - Q_x$)

$Q_w = 0.0$ 0.0 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0$ 0.0 cfs

Maximum Flow Based On Allowable Spread

$Q_t = \text{SUMP}$ SUMP cfs

Flow Velocity within the Gutter Section

$V = 0.0$ 0.0 fps

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

$V*d = 0.0$ 0.0

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Minor Storm Major Storm

$T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{XTH} = 15.0$ 24.6 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.349$ 0.220

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}

$Q_{XTH} = 0.0$ 0.0 cfs

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

$Q_x = 0.0$ 0.0 cfs

Discharge within the Gutter Section W ($Q_d - Q_x$)

$Q_w = 0.0$ 0.0 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0$ 0.0 cfs

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

$Q = 0.0$ 0.0 cfs

Average Flow Velocity Within the Gutter Section

$V = 0.0$ 0.0 fps

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

$V*d = 0.0$ 0.0

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

$R = \text{SUMP}$ SUMP

Max Flow Based on Allowable Depth (Safety Factor Applied)

$Q_d = \text{SUMP}$ SUMP cfs

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

$d =$ inches

Resultant Flow Depth at Street Crown (Safety Factor Applied)

$d_{CROWN} =$ inches

MINOR STORM Allowable Capacity Is based on Depth Criterion

MAJOR STORM Allowable Capacity Is based on Depth Criterion

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

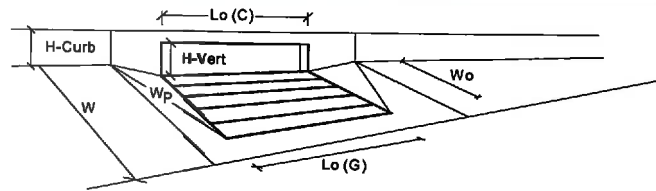
INLET IN A SUMP OR SAG LOCATION

Project =

PAINT BRUSH HILLS FILING NO. 14

Inlet ID =

SUMP INLET DP7



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

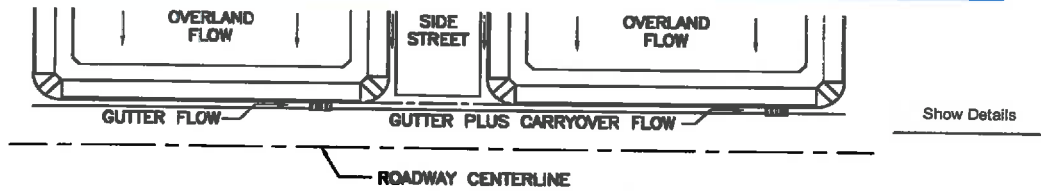
	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
N_o =	5.0	5	
Ponding Depth =	5.6	7.9	inches
			<input checked="" type="checkbox"/> Override Depths
	MINOR	MAJOR	
$L_o(G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r(G)$ =	N/A	N/A	
$C_w(G)$ =	N/A	N/A	
$C_o(G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o(C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
θ_{throat} =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r(C)$ =	0.10	0.10	
$C_w(C)$ =	3.60	3.60	
$C_o(C)$ =	0.67	0.67	
	MINOR	MAJOR	
Q_a =	18.8	46.2	cfs
$Q_{PEAK REQUIRED}$ =	2.3	4.1	cfs

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: SUMP INLET DP8



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{known} = <u>1.9</u> cfs	Major Storm <u>5.4</u> cfs
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.			
Geographic Information: (Enter data in the blue cells):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
		Slope (ft/ft) Length (ft) Overland Flow = <u> </u> <u> </u> Channel Flow = <u> </u> <u> </u>	
Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + I_c) \cdot C_3$			
		Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u>	
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C _s = <u> </u>			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u>0.0</u>		Minor Storm <u>0.0</u> cfs	Major Storm <u>0.0</u> cfs
Total Design Peak Flow, Q = <u>1.9</u>		<u>5.4</u> cfs	

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

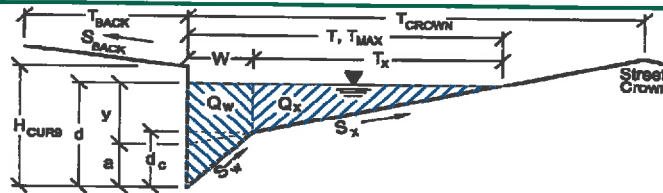
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

PAINT BRUSH HILLS FILING NO. 14

Inlet ID:

SUMP INLET DP8



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

$T_{BACK} = 8.0$ ft

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

$S_{BACK} = 0.020$ ft/ft

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

$H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

$T_{CROWN} = 17.0$ ft

Gutter Width

$W = 2.00$ ft

Street Transverse Slope

$S_x = 0.020$ ft/ft

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

$S_w = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

$S_o = 0.000$ ft/ft

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm Major Storm
 $T_{MAX} = 17.0 \quad 17.0$ ft

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

$d_{MAX} = 5.6 \quad 7.9$ inches

Allow Flow Depth at Street Crown (leave blank for no)

☐ ☒ check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm
 $y = 4.08 \quad 4.08$ inches

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

$d_c = 2.0 \quad 2.0$ inches

Gutter Depression ($d_c - (W * S_x * 12)$)

$a = 1.51 \quad 1.51$ inches

Water Depth at Gutter Flowline

$d = 5.59 \quad 5.59$ inches

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

$T_x = 15.0 \quad 15.0$ ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.350 \quad 0.350$

Discharge outside the Gutter Section W, carried in Section T_x

$Q_x = 0.0 \quad 0.0$ cfs

Discharge within the Gutter Section W ($Q_T - Q_x$)

$Q_w = 0.0 \quad 0.0$ cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0 \quad 0.0$ cfs

Maximum Flow Based On Allowable Spread

$Q_T = \text{SUMP} \quad \text{SUMP}$ cfs

Flow Velocity within the Gutter Section

$V = 0.0 \quad 0.0$ fps

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

$V*d = 0.0 \quad 0.0$

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Minor Storm Major Storm
 $T_{TH} = 17.0 \quad 26.6$ ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{XTH} = 15.0 \quad 24.6$ ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.349 \quad 0.220$

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}

$Q_{XTH} = 0.0 \quad 0.0$ cfs

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

$Q_x = 0.0 \quad 0.0$ cfs

Discharge within the Gutter Section W ($Q_d - Q_x$)

$Q_w = 0.0 \quad 0.0$ cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0 \quad 0.0$ cfs

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

$Q = 0.0 \quad 0.0$ cfs

Average Flow Velocity Within the Gutter Section

$V = 0.0 \quad 0.0$ fps

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

$V*d = 0.0 \quad 0.0$

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

$R = \text{SUMP} \quad \text{SUMP}$

Max Flow Based on Allowable Depth (Safety Factor Applied)

$Q_d = \text{SUMP} \quad \text{SUMP}$ cfs

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

$d = \quad \quad$ inches

Resultant Flow Depth at Street Crown (Safety Factor Applied)

$d_{CROWN} = \quad \quad$ inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

Minor Storm Major Storm
 $Q_{allow} = \text{SUMP} \quad \text{SUMP}$ cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

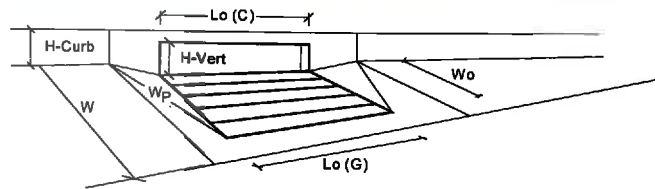
INLET IN A SUMP OR SAG LOCATION

Project =

PAINT BRUSH HILLS FILING NO. 14

Inlet ID =

SUMP INLET DP8



Design Information (Input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

	MINOR	MAJOR	
Inlet Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
N_o =	1.0	1	
Ponding Depth =	5.5	7.9	inches
<input checked="" type="checkbox"/> Override Depths			
	MINOR	MAJOR	
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_r (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_r (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
Q_a =	4.6	9.1	cfs
$Q_{PEAK REQUIRED}$ =	1.9	5.4	cfs

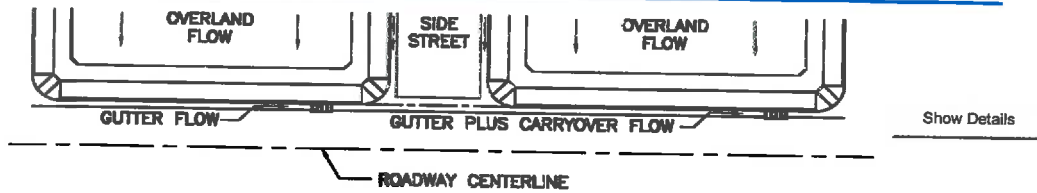
DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project:

PAINT BRUSH HILLS FILING NO. 14

Inlet ID:

AT-GRADE INLET DP9



Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street OR grass-lined channel):

***If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.**

Geographic Information: (Enter data in the blue cells):

Site Type: ☐ Site is Urban ☐ Site is Non-Urban

Flows Developed For: ☐ Street Inlets ☐ Area Inlets in a Medial

Subcatchment Area = Acres

Percent Imperviousness = %

NRCS Soil Type = A, B, C, or D

Slope (ft/ft) Length (ft)

Overland Flow =

Channel Flow =

Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + 1.0)^{C_3}$

Design Storm Return Period, T_r = years

Return Period One-Hour Precipitation, P_1 = inches

C_1 =

C_2 =

C_3 =

User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =

User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =

Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b = cfs

Total Design Peak Flow, Q = cfs

← FILL IN THIS SECTION
OR...

← FILL IN THE SECTIONS
BELOW.

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

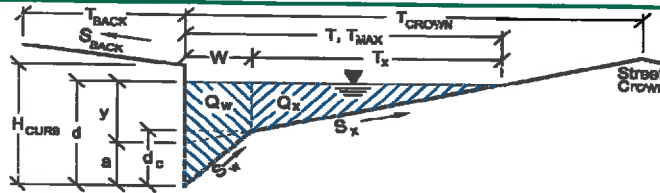
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

PAINT BRUSH HILLS FILING NO. 14

Inlet ID:

AT-GRADE INLET DP9



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

$T_{BACK} = 8.0$ ft

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

$S_{BACK} = 0.020$ ft/ft

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

$H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

$T_{CROWN} = 17.0$ ft

Gutter Width

$W = 2.00$ ft

Street Transverse Slope

$S_X = 0.020$ ft/ft

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

$S_W = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

$S_O = 0.018$ ft/ft

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm: $T_{MAX} = 17.0$ ft
Major Storm: $T_{MAX} = 17.0$ ft

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Minor Storm: $d_{MAX} = 5.6$ inches
Major Storm: $d_{MAX} = 7.9$ inches

Allow Flow Depth at Street Crown (leave blank for no)

☐ ☒ check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm: $y = 4.08$ inches
Major Storm: $y = 4.08$ inches

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Minor Storm: $d_c = 2.0$ inches
Major Storm: $d_c = 2.0$ inches

Gutter Depression ($d_c - (W * S_X * 12)$)

Minor Storm: $a = 1.51$ inches
Major Storm: $a = 1.51$ inches

Water Depth at Gutter Flowline

Minor Storm: $d = 5.59$ inches
Major Storm: $d = 5.59$ inches

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

Minor Storm: $T_X = 15.0$ ft
Major Storm: $T_X = 15.0$ ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Minor Storm: $E_o = 0.350$
Major Storm: $E_o = 0.350$

Discharge outside the Gutter Section W, carried in Section T_X

Minor Storm: $Q_X = 7.6$ cfs
Major Storm: $Q_X = 7.6$ cfs

Discharge within the Gutter Section W ($Q_T - Q_X$)

Minor Storm: $Q_W = 4.1$ cfs
Major Storm: $Q_W = 4.1$ cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Minor Storm: $Q_{BACK} = 0.0$ cfs
Major Storm: $Q_{BACK} = 0.0$ cfs

Maximum Flow Based On Allowable Spread

Minor Storm: $Q_T = 11.7$ cfs
Major Storm: $Q_T = 11.7$ cfs

Flow Velocity within the Gutter Section

Minor Storm: $V = 5.3$ fps
Major Storm: $V = 5.3$ fps

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

Minor Storm: $V*d = 2.5$
Major Storm: $V*d = 2.5$

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Minor Storm: $T_{TH} = 17.0$ ft
Major Storm: $T_{TH} = 26.6$ ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

Minor Storm: $T_{XTH} = 15.0$ ft
Major Storm: $T_{XTH} = 24.6$ ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Minor Storm: $E_o = 0.349$
Major Storm: $E_o = 0.220$

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}

Minor Storm: $Q_{XTH} = 7.6$ cfs
Major Storm: $Q_{XTH} = 28.4$ cfs

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

Minor Storm: $Q_X = 7.6$ cfs
Major Storm: $Q_X = 26.1$ cfs

Discharge within the Gutter Section W ($Q_d - Q_X$)

Minor Storm: $Q_W = 4.1$ cfs
Major Storm: $Q_W = 8.0$ cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Minor Storm: $Q_{BACK} = 0.0$ cfs
Major Storm: $Q_{BACK} = 1.4$ cfs

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Minor Storm: $Q = 11.7$ cfs
Major Storm: $Q = 35.5$ cfs

Average Flow Velocity Within the Gutter Section

Minor Storm: $V = 5.3$ fps
Major Storm: $V = 7.0$ fps

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

Minor Storm: $V*d = 2.5$
Major Storm: $V*d = 4.6$

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

Minor Storm: $R = 1.00$
Major Storm: $R = 0.91$

Max Flow Based on Allowable Depth (Safety Factor Applied)

Minor Storm: $Q_d = 11.7$ cfs
Major Storm: $Q_d = 32.2$ cfs

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Minor Storm: $d = 5.60$ inches
Major Storm: $d = 7.66$ inches

Resultant Flow Depth at Street Crown (Safety Factor Applied)

Minor Storm: $d_{CROWN} = 0.01$ inches
Major Storm: $d_{CROWN} = 2.07$ inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

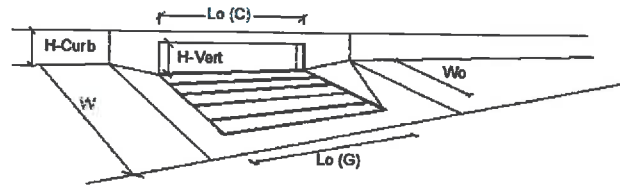
Minor Storm: $Q_{allow} = 11.7$ cfs
Major Storm: $Q_{allow} = 32.2$ cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

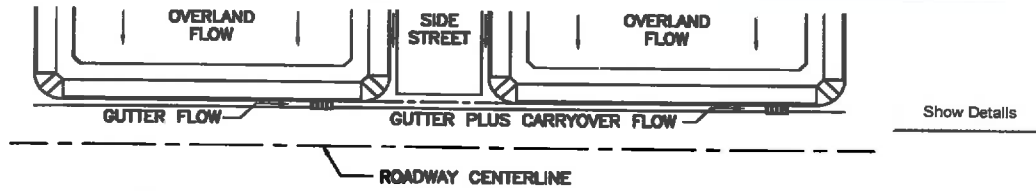
Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP9



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	Inches
Total Number of Units in the Inlet (Grate or Curb Opening)	N_o =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_{r-G} =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_{r-C} =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{maximum allowable from sheet 'Q-Allow'}$				
Total Inlet Interception Capacity	Q =	7.00	13.72	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	3.7	cfs
Capture Percentage = Q_i/Q_o =	$C\%$ =	100	78	%

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP10



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = 7.3 cfs	Major Storm 18.1 cfs
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.			
Geographic Information: (Enter data in the blue cells):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <input type="text"/> Acres Percent Imperviousness = <input type="text"/> % NRCS Soil Type = <input type="text"/> A, B, C, or D	← FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW.
		Slope (ft/ft) Length (ft) Overland Flow = <input type="text"/> <input type="text"/> Channel Flow = <input type="text"/> <input type="text"/>	
Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + 1.2) \cdot C_3$			
		Design Storm Return Period, T _r = <input type="text"/> years Return Period One-Hour Precipitation, P ₁ = <input type="text"/> inches C ₁ = <input type="text"/> C ₂ = <input type="text"/> C ₃ = <input type="text"/>	
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <input type="text"/> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <input type="text"/>			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <input type="text"/>		0.0	0.0 cfs
Total Design Peak Flow, Q = <input type="text"/>		7.3	18.1 cfs

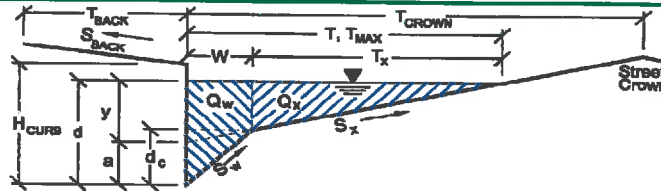
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

AT-GRADE INLET DP10



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T_{BACK}	8.0	ft
S_{BACK}	0.020	ft/ft
n_{BACK}	0.020	

H_{CURB}	6.00	inches
T_{CROWN}	17.0	ft
W	2.00	ft
S_x	0.020	ft/ft
S_w	0.083	ft/ft
S_o	0.016	ft/ft
n_{STREET}	0.020	

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
T_{MAX}	17.0	17.0	ft
d_{MAX}	5.6	7.9	inches
<input type="checkbox"/>	<input checked="" type="checkbox"/>		check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Gutter Depression ($d_c - (W * S_x * 12)$)

Water Depth at Gutter Flowline

Allowable Spread for Discharge outside the Gutter Section W (T - W)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Discharge outside the Gutter Section W, carried in Section T_x

Discharge within the Gutter Section W ($Q_T - Q_x$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	4.08	4.08	inches
d_c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.59	5.59	inches
T_x	15.0	15.0	ft
E_o	0.350	0.350	
Q_x	7.1	7.1	cfs
Q_w	3.8	3.8	cfs
Q_{BACK}	0.0	0.0	cfs
Q_T	11.0	11.0	cfs
V	5.0	5.0	fps
$V*d$	2.3	2.3	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section W (T - W)

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Theoretical Discharge outside the Gutter Section W, carried in Section T_{xTH}

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

Discharge within the Gutter Section W ($Q_d - Q_x$)

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

Max Flow Based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T_{TH}	17.0	26.6	ft
T_{xTH}	15.0	24.6	ft
E_o	0.349	0.220	
Q_{xTH}	7.2	26.8	cfs
Q_x	7.2	24.6	cfs
Q_w	3.9	7.5	cfs
Q_{BACK}	0.0	1.3	cfs
Q	11.0	33.4	cfs
V	5.0	6.6	fps
$V*d$	2.3	4.3	
R	1.00	1.00	
Q_d	11.0	33.3	cfs
d	5.60	7.90	inches
d_{CROWN}	0.01	2.30	inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

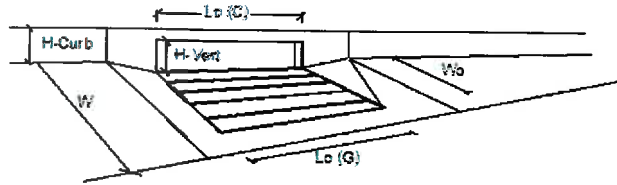
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

	Minor Storm	Major Storm	
Q_{allow}	11.0	33.3	cfs

INLET ON A CONTINUOUS GRADE

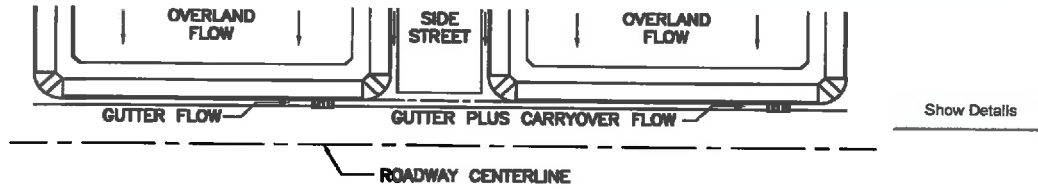
Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP10



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	N_o =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_r-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_r-C =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{maximum allowable from sheet 'Q-Allow'}$				
Total Inlet Interception Capacity	Q =	7.25	14.01	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	4.1	cfs
Capture Percentage = Q_d/Q_o =	$C\%$ =	100	77	%

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: AT-GRADE INLET DP11



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		*Q _{Known} = <input type="text" value="3.7"/> <input type="text" value="17.0"/> cfs	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.			
Geographic Information: (Enter data in the blue cells):			
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <input type="text"/> Acres Percent Imperviousness = <input type="text"/> % NRCS Soil Type = <input type="text"/> A, B, C, or D	
		Slope (ft/ft) <input type="text"/> Length (ft) <input type="text"/> Overland Flow = <input type="text"/> Channel Flow = <input type="text"/>	
Rainfall Information: Intensity I (inch/hr) = $C_1 \cdot P_1 / (C_2 + T_o)^{C_3}$			
		Design Storm Return Period, T_r = <input type="text"/> years Return Period One-Hour Precipitation, P_1 = <input type="text"/> inches C_1 = <input type="text"/> C_2 = <input type="text"/> C_3 = <input type="text"/> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <input type="text"/> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 = <input type="text"/> Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b = <input type="text" value="0.0"/> <input type="text" value="0.0"/> cfs	
		Total Design Peak Flow, Q = <input type="text" value="3.7"/> <input type="text" value="17.0"/> cfs	

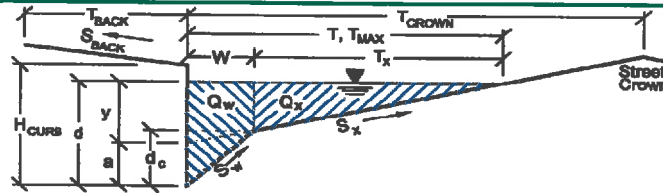
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

AT-GRADE INLET DP11



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

$T_{BACK} = 8.0$ ft

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

$S_{BACK} = 0.020$ ft/ft

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

$H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

$T_{CROWN} = 17.0$ ft

Gutter Width

$W = 2.00$ ft

Street Transverse Slope

$S_x = 0.020$ ft/ft

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

$S_w = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

$S_o = 0.014$ ft/ft

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

$T_{MAX} = 17.0$ Minor Storm 17.0 Major Storm ft

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

$d_{MAX} = 5.6$ 7.9 inches

Allow Flow Depth at Street Crown (leave blank for no)

☐ ☒ check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

$y = 4.08$ 4.08 inches

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

$d_c = 2.0$ 2.0 inches

Gutter Depression ($d_c - (W \cdot S_x \cdot 12)$)

$a = 1.51$ 1.51 inches

Water Depth at Gutter Flowline

$d = 5.59$ 5.59 inches

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

$T_x = 15.0$ 15.0 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.350$ 0.350

Discharge outside the Gutter Section W, carried in Section T_x

$Q_x = 6.7$ 6.7 cfs

Discharge within the Gutter Section W ($Q_T - Q_x$)

$Q_w = 3.6$ 3.6 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0$ 0.0 cfs

Maximum Flow Based On Allowable Spread

$Q_T = 10.3$ 10.3 cfs

Flow Velocity within the Gutter Section

$V = 4.7$ 4.7 fps

$V \cdot d$ Product: Flow Velocity times Gutter Flowline Depth

$V \cdot d = 2.2$ 2.2

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

$T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{XTH} = 15.0$ 24.6 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.349$ 0.220

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}

$Q_{XTH} = 6.7$ 25.0 cfs

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

$Q_x = 6.7$ 23.0 cfs

Discharge within the Gutter Section W ($Q_d - Q_x$)

$Q_w = 3.6$ 7.1 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0$ 1.2 cfs

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

$Q = 10.3$ 31.3 cfs

Average Flow Velocity Within the Gutter Section

$V = 4.7$ 6.1 fps

$V \cdot d$ Product: Flow Velocity Times Gutter Flowline Depth

$V \cdot d = 2.2$ 4.0

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

$R = 1.00$ 1.00

Max Flow Based on Allowable Depth (Safety Factor Applied)

$Q_d = 10.3$ 31.3 cfs

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

$d = 5.60$ 7.90 inches

Resultant Flow Depth at Street Crown (Safety Factor Applied)

$d_{CROWN} = 0.01$ 2.31 inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

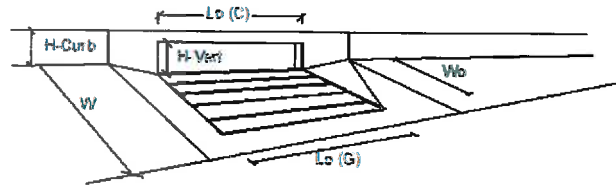
$Q_{allow} = 10.3$ 31.3 cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

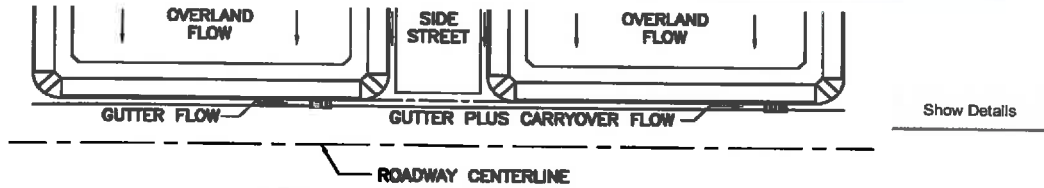
Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP11



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 's' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_rG =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_rC =	0.10	0.10	
Street Hydraulics: OK - $Q < \text{maximum allowable from sheet 'Q-Allow'}$				
Total Inlet Interception Capacity	Q_i =	3.70	13.51	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_o =	0.0	3.5	cfs
Capture Percentage = Q_i/Q_o =	C% =	100	79	%

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: AT-GRADE INLET "DP37"



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>3.7</u> cfs	Major Storm <u>13.0</u> cfs	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.	
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.					
Geographic Information: (Enter data in the blue cells):					
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D			
		Slope (ft/ft) <u> </u> Length (ft) <u> </u> Overland Flow = <u> </u> Channel Flow = <u> </u>			
Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + I_c) \wedge C_3$					
		Design Storm Return Period, T _r = <u> </u> years Return Period One-Hour Precipitation, P ₁ = <u> </u> inches C ₁ = <u> </u> C ₂ = <u> </u> C ₃ = <u> </u> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C ₅ = <u> </u>	Minor Storm <u> </u> <u> </u> <u> </u> <u> </u> <u> </u>	Major Storm <u> </u> <u> </u> <u> </u> <u> </u> <u> </u>	
		Bypass (Carry-Over) Flow from upstream Subcatchments, Q _b = <u>0.0</u> cfs	<u>0.0</u> cfs		
		Total Design Peak Flow, Q = <u>3.7</u> cfs	<u>13.0</u> cfs		

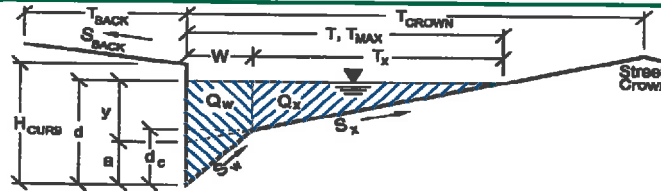
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

AT-GRADE INLET *DP37



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)
Height of Curb at Gutter Flow Line
Distance from Curb Face to Street Crown
Gutter Width
Street Transverse Slope
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
Street Longitudinal Slope - Enter 0 for sump condition
Manning's Roughness for Street Section (typically between 0.012 and 0.020)

T _{BACK}	8.0	ft
S _{BACK}	0.020	ft/ft
n _{BACK}	0.020	
H _{CURB}	6.00	inches
T _{CROWN}	17.0	ft
W	2.00	ft
S _X	0.020	ft/ft
S _W	0.083	ft/ft
S _O	0.014	ft/ft
n _{STREET}	0.020	

Max. Allowable Spread for Minor & Major Storm
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
T _{MAX}	17.0	17.0	ft
d _{MAX}	5.6	7.9	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")
Gutter Depression (d_c - (W * S_x * 12))
Water Depth at Gutter Flowline
Allowable Spread for Discharge outside the Gutter Section W (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
Discharge outside the Gutter Section W, carried in Section T_X
Discharge within the Gutter Section W (Q_T - Q_X)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Maximum Flow Based On Allowable Spread
Flow Velocity within the Gutter Section
V*d Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
y	4.08	4.08	inches
d _c	2.0	2.0	inches
a	1.51	1.51	inches
d	5.59	5.59	inches
T _X	15.0	15.0	ft
E _O	0.350	0.350	
Q _X	6.7	6.7	cfs
Q _W	3.6	3.6	cfs
Q _{BACK}	0.0	0.0	cfs
Q _T	10.3	10.3	cfs
V	4.7	4.7	fps
V*d	2.2	2.2	

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread
Theoretical Spread for Discharge outside the Gutter Section W (T - W)
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)
Theoretical Discharge outside the Gutter Section W, carried in Section T_{X TH}
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})
Discharge within the Gutter Section W (Q_d - Q_X)
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)
Total Discharge for Major & Minor Storm (Pre-Safety Factor)
Average Flow Velocity Within the Gutter Section
V*d Product: Flow Velocity Times Gutter Flowline Depth
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm
Max Flow Based on Allowable Depth (Safety Factor Applied)
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)
Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
T _{TH}	17.0	26.6	ft
T _{X TH}	15.0	24.6	ft
E _O	0.349	0.220	
Q _{X TH}	6.7	25.0	cfs
Q _X	6.7	23.0	cfs
Q _W	3.6	7.1	cfs
Q _{BACK}	0.0	1.2	cfs
Q	10.3	31.3	cfs
V	4.7	6.1	fps
V*d	2.2	4.0	
R	1.00	1.00	
Q _d	10.3	31.3	cfs
d	5.60	7.90	inches
d _{CROWN}	0.01	2.31	inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

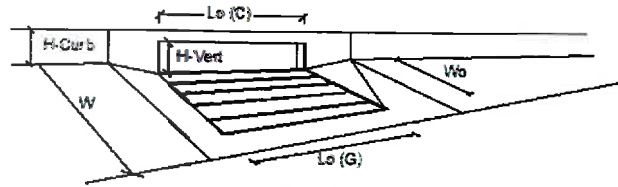
	Minor Storm	Major Storm	
Q _{allow}	10.3	31.3	cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

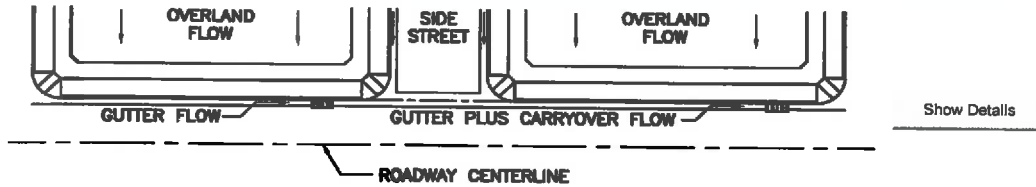
Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET "DP37"



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	N_o =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	$C_r\text{-}G$ =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	$C_r\text{-}C$ =	0.10	0.10	
Street Hydraulics: OK - $Q <$ maximum allowable from sheet 'Q-Allow'				
Total Inlet Interception Capacity	Q =	3.70	11.48	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	1.5	cfs
Capture Percentage = Q_i/Q_o =	$C\%$ =	100	88	%

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: AT-GRADE INLET DP12



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm *Q _{Known} = <u>6.0</u> cfs	Major Storm <u>14.9</u> cfs	← FILL IN THIS SECTION OR... ← FILL IN THE SECTIONS BELOW.
* If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.				
Geographic Information: (Enter data in the blue cells):				
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Medial	Subcatchment Area = <u> </u> Acres Percent Imperviousness = <u> </u> % NRCS Soil Type = <u> </u> A, B, C, or D		
		Slope (ft/ft) <u> </u> Length (ft) <u> </u> Overland Flow = <u> </u> Channel Flow = <u> </u>		
Rainfall Information: Intensity i (in/hr) = $C_1 \cdot P_1 / (C_2 + T_a)^{C_3}$				
		Design Storm Return Period, T_r = <u> </u> years Return Period One-Hour Precipitation, P_1 = <u> </u> inches C_1 = <u> </u> C_2 = <u> </u> C_3 = <u> </u> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <u> </u> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 = <u> </u> Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b = <u>0.0</u> cfs		
		Minor Storm Total Design Peak Flow, Q = <u>6.0</u> cfs	Major Storm <u>14.9</u> cfs	

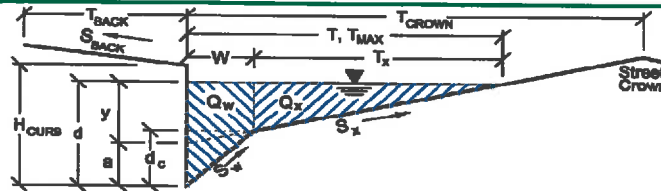
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
inlet ID:

PAINT BRUSH HILLS FILING NO. 14

AT-GRADE INLET DP12



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

$T_{BACK} = 8.0$ ft

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

$S_{BACK} = 0.020$ ft/ft

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

$H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

$T_{CROWN} = 17.0$ ft

Gutter Width

$W = 2.00$ ft

Street Transverse Slope

$S_x = 0.020$ ft/ft

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

$S_w = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

$S_o = 0.010$ ft/ft

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm Major Storm
 $T_{MAX} = 17.0$ 17.0 ft

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

$d_{MAX} = 5.6$ 7.9 inches

Allow Flow Depth at Street Crown (leave blank for no)

☐ ☒ check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm
 $y = 4.08$ 4.08 inches

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

$d_c = 2.0$ 2.0 inches

Gutter Depression ($d_c - (W * S_x * 12)$)

$a = 1.51$ 1.51 inches

Water Depth at Gutter Flowline

$d = 5.59$ 5.59 inches

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

$T_x = 15.0$ 15.0 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.350$ 0.350

Discharge outside the Gutter Section W, carried in Section T_x

$Q_x = 5.7$ 5.7 cfs

Discharge within the Gutter Section W ($Q_T - Q_x$)

$Q_w = 3.1$ 3.1 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0$ 0.0 cfs

Maximum Flow Based On Allowable Spread

$Q_T = 8.8$ 8.8 cfs

Flow Velocity within the Gutter Section

$V = 4.0$ 4.0 fps

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

$V*d = 1.9$ 1.9

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Minor Storm Major Storm
 $T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{X TH} = 15.0$ 24.6 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.349$ 0.220

Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X TH}$

$Q_{X TH} = 5.7$ 21.4 cfs

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

$Q_x = 5.7$ 19.6 cfs

Discharge within the Gutter Section W ($Q_d - Q_x$)

$Q_w = 3.1$ 6.0 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0$ 1.0 cfs

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

$Q = 8.8$ 26.7 cfs

Average Flow Velocity Within the Gutter Section

$V = 4.0$ 5.2 fps

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

$V*d = 1.9$ 3.4

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

$R = 1.00$ 1.00

Max Flow Based on Allowable Depth (Safety Factor Applied)

$Q_d = 8.8$ 26.7 cfs

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

$d = 5.60$ 7.90 inches

Resultant Flow Depth at Street Crown (Safety Factor Applied)

$d_{CROWN} = 0.01$ 2.31 inches

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

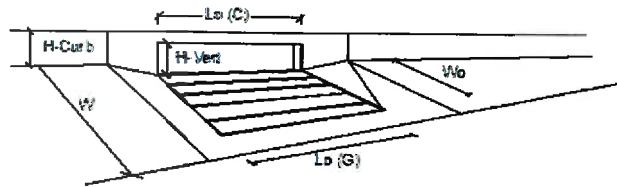
Minor Storm Major Storm
 $Q_{allow} = 8.8$ 26.7 cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

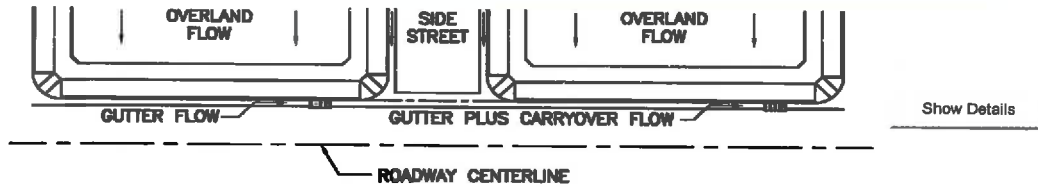
Project: PAINT BRUSH HILLS FILING NO. 14
Inlet ID: AT-GRADE INLET DP12



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	B _{LOCAL} =	3.0	3.0	inches	
Total Number of Units in the Inlet (Grate or Curb Opening)	N _o =	3	3		
Length of a Single Unit Inlet (Grate or Curb Opening)	L _o =	5.00	5.00	ft	
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W _o =	N/A	N/A	ft	
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C _r -G =	N/A	N/A		
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C _r -C =	0.10	0.10		
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'					
Total Inlet Interception Capacity	Q _i =	6.95	12.44	cfs	
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q _o =	0.0	2.4	cfs	
Capture Percentage = Q _i /Q _o =	C% =	100	84	%	

DESIGN PEAK FLOW FOR ONE-HALF OF STREET OR GRASS-LINED CHANNEL BY THE RATIONAL METHOD

Project: PAINT BRUSH HILLS FILING NO. 14
 Inlet ID: SUMP INLET DP15



Design Flow: ONLY if already determined through other methods: (local peak flow for 1/2 of street OR grass-lined channel):		Minor Storm 6.2	Major Storm 27.7	cfs
*If you enter values in Row 14, skip the rest of this sheet and proceed to sheet Q-Allow or Area Inlet.				
Geographic Information: (Enter data in the blue cells):				
Site Type: <input type="radio"/> Site is Urban <input type="radio"/> Site is Non-Urban	Flows Developed For: <input type="radio"/> Street Inlets <input type="radio"/> Area Inlets in a Median	Subcatchment Area = <input type="text"/> Acres Percent Imperviousness = <input type="text"/> % NRCS Soil Type = <input type="text"/> A, B, C, or D		
		Slope (ft/ft) <input type="text"/> Length (ft) <input type="text"/> Overland Flow = <input type="text"/> Channel Flow = <input type="text"/>		
Rainfall Information: Intensity I (in/hr) = $C_1 \cdot P_1 / (C_2 + 1.0) \wedge C_3$				
		Design Storm Return Period, T_r = <input type="text"/> years Return Period One-Hour Precipitation, P_1 = <input type="text"/> inches C_1 = <input type="text"/> C_2 = <input type="text"/> C_3 = <input type="text"/> User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C = <input type="text"/> User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 = <input type="text"/> Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b = <input type="text"/> 0.0 <input type="text"/> 0.0 cfs		
		Total Design Peak Flow, Q = <input type="text"/> 6.2 <input type="text"/> 27.7 cfs		

← FILL IN THIS SECTION
OR...

← FILL IN THE SECTIONS
BELOW.

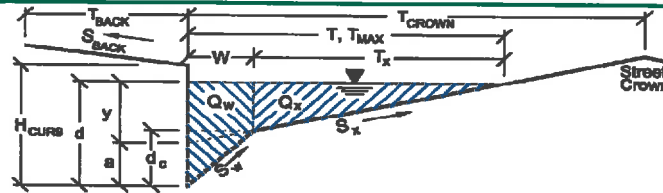
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project:
Inlet ID:

PAINT BRUSH HILLS FILING NO. 14

SUMP INLET DP15



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb

$T_{BACK} = 8.0$ ft

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

$S_{BACK} = 0.020$ ft/ft

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$n_{BACK} = 0.020$

Height of Curb at Gutter Flow Line

$H_{CURB} = 6.00$ inches

Distance from Curb Face to Street Crown

$T_{CROWN} = 17.0$ ft

Gutter Width

$W = 2.00$ ft

Street Transverse Slope

$S_x = 0.020$ ft/ft

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

$S_w = 0.083$ ft/ft

Street Longitudinal Slope - Enter 0 for sump condition

$S_o = 0.000$ ft/ft

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$n_{STREET} = 0.020$

Max. Allowable Spread for Minor & Major Storm

Minor Storm Major Storm

$T_{MAX} = 17.0$ 17.0 ft

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

$d_{MAX} = 5.6$ 7.9 inches

Allow Flow Depth at Street Crown (leave blank for no)

☐ ☒ check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread

Water Depth without Gutter Depression (Eq. ST-2)

Minor Storm Major Storm

$y = 4.08$ 4.08 inches

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

$d_c = 2.0$ 2.0 inches

Gutter Depression ($d_c - (W * S_x * 12)$)

$a = 1.51$ 1.51 inches

Water Depth at Gutter Flowline

$d = 5.59$ 5.59 inches

Allowable Spread for Discharge outside the Gutter Section W ($T - W$)

$T_x = 15.0$ 15.0 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.350$ 0.350

Discharge outside the Gutter Section W, carried in Section T_x

$Q_x = 0.0$ 0.0 cfs

Discharge within the Gutter Section W ($Q_T - Q_x$)

$Q_w = 0.0$ 0.0 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0$ 0.0 cfs

Maximum Flow Based On Allowable Spread

$Q_T = \text{SUMP}$ SUMP cfs

Flow Velocity within the Gutter Section

$V = 0.0$ 0.0 fps

$V*d$ Product: Flow Velocity times Gutter Flowline Depth

$V*d = 0.0$ 0.0

Maximum Capacity for 1/2 Street based on Allowable Depth

Theoretical Water Spread

Minor Storm Major Storm

$T_{TH} = 17.0$ 26.6 ft

Theoretical Spread for Discharge outside the Gutter Section W ($T - W$)

$T_{XTH} = 15.0$ 24.6 ft

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

$E_o = 0.349$ 0.220

Theoretical Discharge outside the Gutter Section W, carried in Section T_{XTH}

$Q_{XTH} = 0.0$ 0.0 cfs

Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})

$Q_x = 0.0$ 0.0 cfs

Discharge within the Gutter Section W ($Q_d - Q_x$)

$Q_w = 0.0$ 0.0 cfs

Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)

$Q_{BACK} = 0.0$ 0.0 cfs

Total Discharge for Major & Minor Storm (Pre-Safety Factor)

$Q = 0.0$ 0.0 cfs

Average Flow Velocity Within the Gutter Section

$V = 0.0$ 0.0 fps

$V*d$ Product: Flow Velocity Times Gutter Flowline Depth

$V*d = 0.0$ 0.0

Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm

$R = \text{SUMP}$ SUMP

Max Flow Based on Allowable Depth (Safety Factor Applied)

$Q_d = \text{SUMP}$ SUMP cfs

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

$d =$ inches

Resultant Flow Depth at Street Crown (Safety Factor Applied)

$d_{CROWN} =$ inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

Minor Storm Major Storm
 $Q_{allow} = \text{SUMP}$ SUMP cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

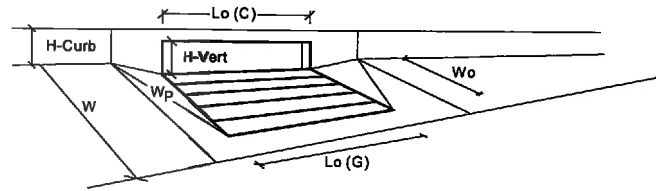
INLET IN A SUMP OR SAG LOCATION

Project =

PAINT BRUSH HILLS FILING NO. 14

Inlet ID =

SUMP INLET DP15



Design Information (input)

Type of Inlet

Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')

Number of Unit Inlets (Grate or Curb Opening)

Water Depth at Flowline (outside of local depression)

Grate Information

Length of a Unit Grate

Width of a Unit Grate

Area Opening Ratio for a Grate (typical values 0.15-0.90)

Clogging Factor for a Single Grate (typical value 0.50 - 0.70)

Grate Weir Coefficient (typical value 2.15 - 3.60)

Grate Orifice Coefficient (typical value 0.60 - 0.80)

Curb Opening Information

Length of a Unit Curb Opening

Height of Vertical Curb Opening in Inches

Height of Curb Orifice Throat in Inches

Angle of Throat (see USDCM Figure ST-5)

Side Width for Depression Pan (typically the gutter width of 2 feet)

Clogging Factor for a Single Curb Opening (typical value 0.10)

Curb Opening Weir Coefficient (typical value 2.3-3.7)

Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)

Total Inlet Interception Capacity (assumes clogged condition)

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

MINOR MAJOR

Inlet Type = CDOT Type R Curb Opening

B_{local} = 3.00 3.00 inches

N_o = 4.0 4

Ponding Depth = 5.8 7.9 inches

☒ Override Depths

MINOR MAJOR

$L_o (G)$ = N/A N/A feet

W_o = N/A N/A feet

A_{ratio} = N/A N/A

$C_r (G)$ = N/A N/A

$C_w (G)$ = N/A N/A

$C_o (G)$ = N/A N/A

MINOR MAJOR

$L_o (C)$ = 5.00 5.00 feet

H_{vert} = 6.00 6.00 inches

H_{throat} = 6.00 6.00 inches

Theta = 63.40 63.40 degrees

W_p = 2.00 2.00 feet

$C_r (C)$ = 0.10 0.10

$C_w (C)$ = 3.60 3.60

$C_o (C)$ = 0.67 0.67

MINOR MAJOR

Q_a = 15.0 36.7 cfs

$Q_{PEAK REQUIRED}$ = 6.2 27.7 cfs

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Partially Full Pipe Flow Calculator and Equations

[Fluid Flow Table of Contents](#) | [Hydraulic and Pneumatic Knowledge](#)
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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

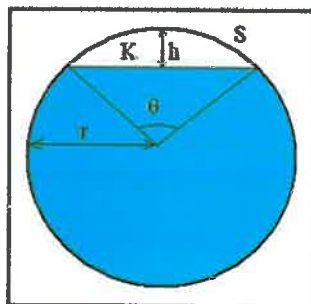
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) \cdot 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) \cdot 0.5$ (for $0.5 \leq y/D \leq 1$)

PR * 37

$Q_{100} = 21.4 \text{ cfs}$

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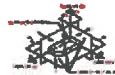
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Ultimate - GD&T Wall Chart
ASME Y14.5-2009 Standard
Laminated, 24" x 36" - Awesome!



Partially Full Pipe Flow Calculator and Equations

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = 18 in
Depth of flow, y = 17 in

(must have $y \geq D/2$)

Full Pipe Manning roughness, n_{full} = 0.013
Channel bottom slope, S = 0.016 ft/ft

Calculations

n/n_{full} = 1.027777
Partially Full Manning roughness, n = 0.013

Calculations

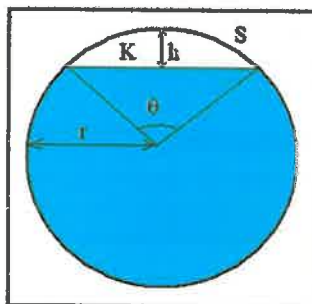
Pipe Diameter, D = 1.5 ft
Pipe Radius, r = 0.75 ft

Circ. Segment Height, h = 0.083 ft

Central Angle, θ = 0.95 radians
Cross-Sect. Area, A = 1.73 ft²

Wetted Perimeter, P = 4.0 ft
Hydraulic Radius, R = 0.43 ft
Discharge, Q = 13.94 cfs
Ave. Velocity, V = 8.06 ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ = 97.8%



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 1
 $Q_{100} = 13.7 \text{ cfs}$

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Partially Full Pipe Flow Calculator and Equations

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

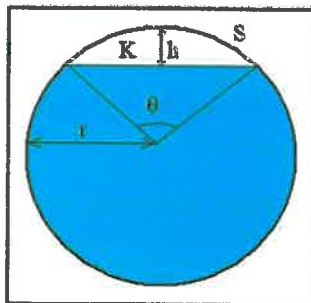
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Section, Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 2

$Q_{100} = 58.1 \text{ cfs}$

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Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

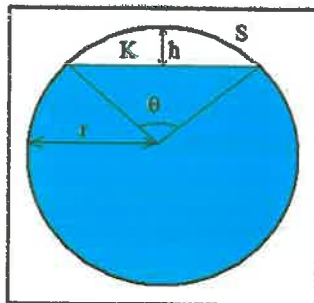
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Section. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 3

$$Q_{100} = 74.0 \text{ cfs}$$

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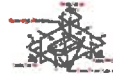
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = 18 in
Depth of flow, y = 8 in

(must have $y \geq D/2$)

Full Pipe Manning roughness, n_{full} = 0.013
Channel bottom slope, S = 0.01 ft/ft

Calculations

n/n_{full} = 1.277777
Partially Full Manning roughness, n = 0.017

Calculations

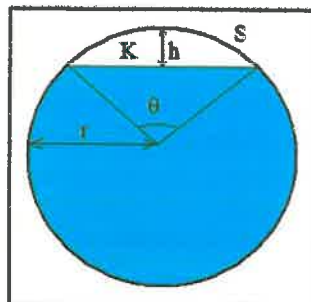
Pipe Diameter, D = 1.5 ft
Pipe Radius, r = 0.75 ft

Circ. Segment Height, h = 0.833 ft

Central Angle, θ = 3.36 radians
Cross-Sect. Area, A = 0.76 ft²

Wetted Perimeter, P = 2.2 ft
Hydraulic Radius, R = 0.35 ft
Discharge, Q = 3.36 cfs
Ave. Velocity, V = 4.43 ft/sec

pipe % full $[(A/A_{full}) \cdot 100\%]$ = 42.9%



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r \cdot \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) \cdot 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 4

$Q_{100} = 2.7 \text{ cfs}$

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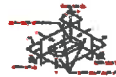
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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

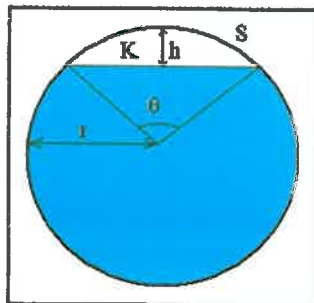
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$R = A/P$$

$$R = A/P$$

$$(Manning Equation)$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

P

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR5

$Q_{100} = 76.085$

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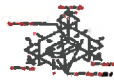
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

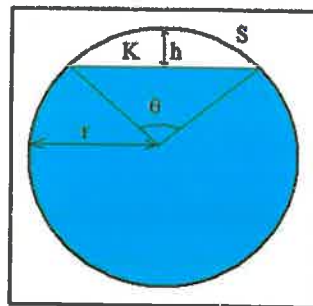
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 6

$Q_{100} = 37.7$ cfs

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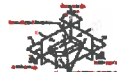
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

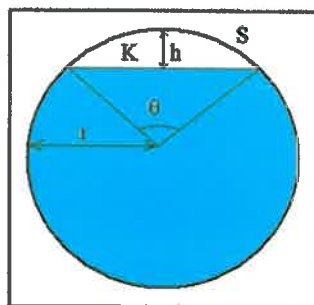
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 7
 $Q_{100} = 40.2 \text{ cfs}$

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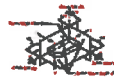
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II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

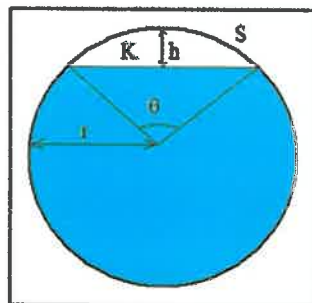
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$\text{(hydraulic radius)}$$

$$R = A/P$$

$$\text{(Manning Equation)}$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

$$\text{Equation used for } n/n_{full}: n/n_{full} = 1.25 - (y/D - 0.5) * 0.5 \quad (\text{for } 0.5 \leq y/D \leq 1)$$

PRB

$$Q_{100} = 5.4 \text{ cfs}$$

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Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

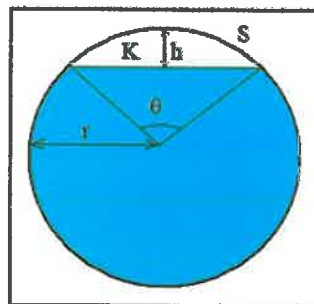
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$(\text{hydraulic radius})$$

$$R = A/P$$

$$(\text{Manning Equation})$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$\text{Equation used for } n/n_{full}: n/n_{full} = 1.25 - (y/D - 0.5) * 0.5 \quad (\text{for } 0.5 \leq y/D \leq 1)$$

PR 9

$$Q_{100} = 117.8 \text{ cfs}$$

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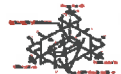
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II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in
(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations
 n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

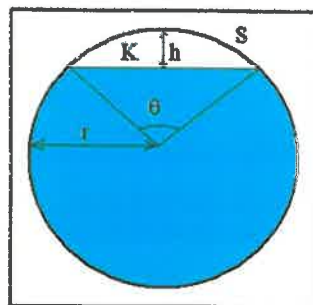
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 \cdot (y/D - 0.5)^{0.5}$ (for $0.5 \leq y/D \leq 1$)

PR 10 & PR 11

$Q_{100} = 34.4$ cfs FLOWS SPLIT @ DP 9

FLOWS CAPTURED $Q_{100} = 13.65$ cfs PER SIDE

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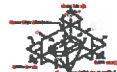
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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

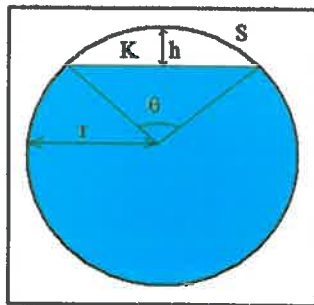
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full [(A/A_{full})*100%] =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$ (for $0.5 \leq y/D \leq 1$)

PR 12

$Q_{100} = 142.5 \text{ cfs}$

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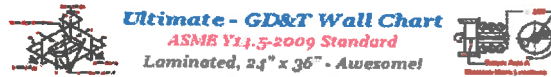
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = 18 in
Depth of flow, y = 17 in
(must have $y \geq D/2$)

Full Pipe Manning roughness, n_{full} = 0.013
Channel bottom slope, S = 0.016 ft/ft

Calculations

n/n_{full} = 1.027777
Partially Full Manning roughness, n = 0.013

Calculations

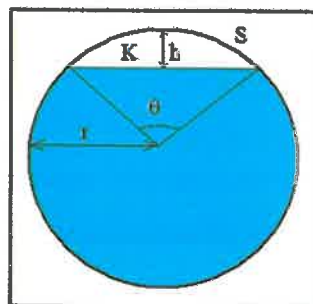
Pipe Diameter, D = 1.5 ft
Pipe Radius, r = 0.75 ft

Circ. Segment Height, h = 0.083 ft

Central Angle, θ = 0.95 radians
Cross-Sect. Area, A = 1.73 ft²

Wetted Perimeter, P = 4.0 ft
Hydraulic Radius, R = 0.43 ft
Discharge, Q = 13.94 cfs
Ave. Velocity, V = 8.06 ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ = 97.8%



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 13

$Q_{100} = 14.0 \text{ cfs}$

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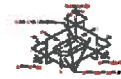
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in
(must have $y \geq D/2$)

Full Pipe Manning roughness, n_{full} =
Channel bottom slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning roughness, n =

Calculations

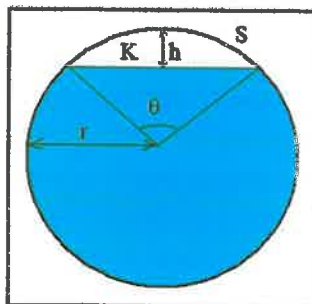
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$(\text{hydraulic radius})$$

$$R = A/P$$

$$(\text{Manning Equation})$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 14

Q₁₀₀ = 27.9 cfs

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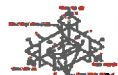
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II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

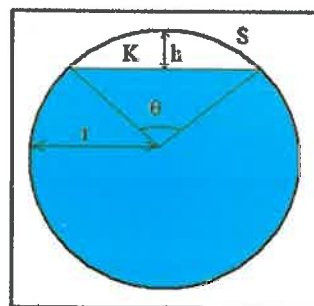
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Section Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

* PR 38

$Q_{100} = 27.9 \text{ cfs}$

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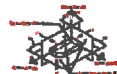
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II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

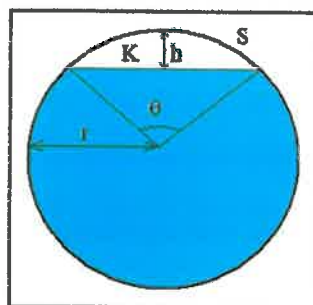
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$R = A/P$$

$$R = A/P$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$P =$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$\text{Equation used for } n/n_{full}: n/n_{full} = 1.25 \cdot (y/D - 0.5)^{0.5} \quad (\text{for } 0.5 \leq y/D \leq 1)$$

PR 15

CAPTURED $Q_{100} = 13.5$ cfs

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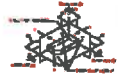
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in
(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

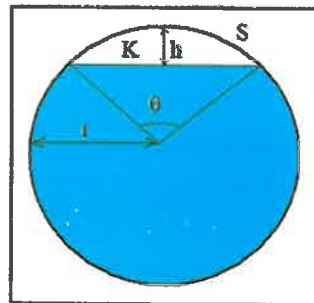
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$(hydraulic\ radius)$$

$$R = A/P$$

$$(Manning\ Equation)$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 16

$Q_{100} = 39.7$ cfs

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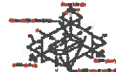
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations
 n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

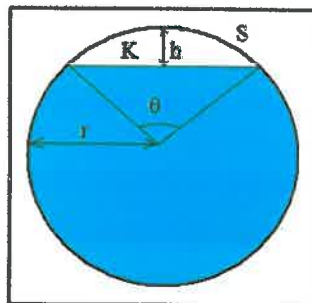
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Section. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$\text{(hydraulic radius)}$$

$$R = A/P$$

$$\text{(Manning Equation)}$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$\text{Equation used for } n/n_{full}: n/n_{full} = 1.25 - (y/D - 0.5) * 0.5 \quad (\text{for } 0.5 \leq y/D \leq 1)$$

* PR 39

CAPTURED $Q_{100} = 11.5 \text{ cfs}$

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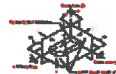
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II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

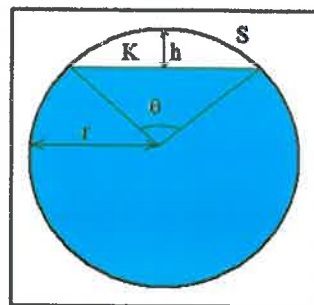
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) \cdot 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r\theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) \cdot 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 17

$Q_{100} = 50.2$ cfs

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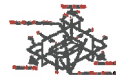
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Laminated, 24" x 36" - Awesome!



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for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = 18 in
Depth of flow, y = 17 in
(must have $y \geq D/2$)

Full Pipe Manning roughness, n_{full} = 0.013
Channel bottom slope, S = 0.013 ft/ft

Calculations

n/n_{full} = 1.027777
Partially Full Manning roughness, n = 0.013

Calculations

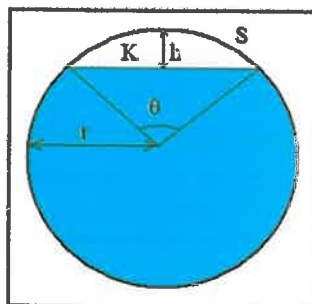
Pipe Diameter, D = 1.5 ft
Pipe Radius, r = 0.75 ft

Circ. Segment Height, h = 0.083 ft

Central Angle, θ = 0.95 radians
Cross-Sect. Area, A = 1.73 ft²

Wetted Perimeter, P = 4.0 ft
Hydraulic Radius, R = 0.43 ft
Discharge, Q = 12.57 cfs
Ave. Velocity, V = 7.27 ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ = 97.8%



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 18

$Q_{100} = 12.4 \text{ cfs}$

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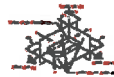
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Partially Full Pipe Flow Calculator and Equations

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This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in
(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

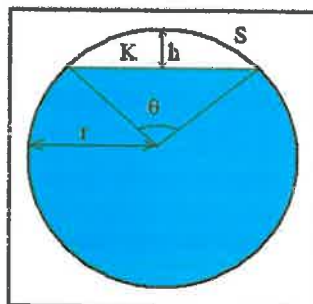
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 19

$Q_{100} = 24.8 \text{ cfs}$

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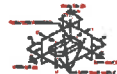
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

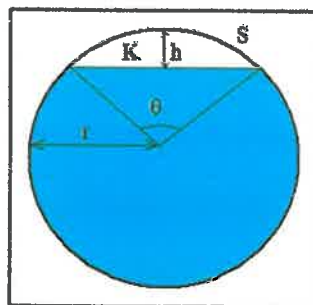
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 \cdot (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 20

$$Q_{100} = 74.2 \text{ cfs}$$

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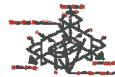
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

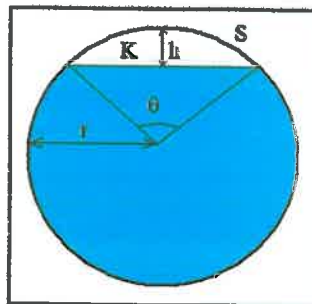
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 21

$Q_{100} = 213.4 \text{ cfs}$

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

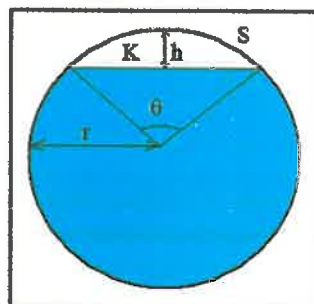
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 22

$Q_{100} = 27.7 \text{ cfs}$

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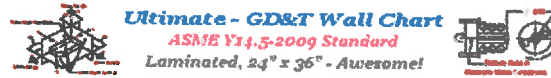
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

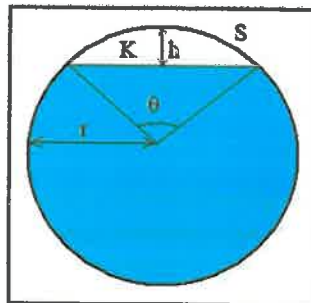
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, α = radians
Cross-Section. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 23

$Q_{100} = 55.4 \text{ cfs}$

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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in
(must have $y \geq D/2$)

Full Pipe Manning roughness, n_{full} =
Channel bottom slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning roughness, n =

Calculations

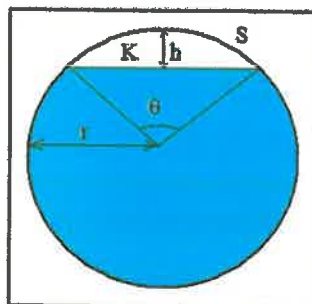
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) \cdot 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

(hydraulic radius)

$$R = A/P$$

(Manning Equation)

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

P

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r \cdot \theta$$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) \cdot 0.5$ (for $0.5 \leq y/D \leq 1$)

PR 24

$Q_{100} = 268.2$ cfs

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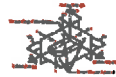
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Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = in
Depth of flow, y = in

(must have $y \geq D/2$)

Full Pipe Manning
roughness, n_{full} =
Channel bottom
slope, S = ft/ft

Calculations

n/n_{full} =
Partially Full Manning
roughness, n =

Calculations

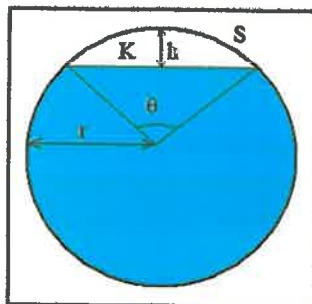
Pipe Diameter, D = ft
Pipe Radius, r = ft

Circ. Segment Height, h = ft

Central Angle, θ = radians
Cross-Sect. Area, A = ft²

Wetted Perimeter, P = ft
Hydraulic Radius, R = ft
Discharge, Q = cfs
Ave. Velocity, V = ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ =



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$r = D/2$$

$$h = 2r - y$$

$$(\text{hydraulic radius})$$

$$R = A/P$$

$$(\text{Manning Equation})$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

$$V = Q/A$$

P

$$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$\text{Equation used for } n/n_{full}: n/n_{full} = 1.25 - (y/D - 0.5) * 0.5 \quad (\text{for } 0.5 \leq y/D \leq 1)$$

PR 25

Q₁₀₀ = 144.9 cfs

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Line No.	Line ID	Line Size (in)	Line Type	Junct Type	J-Loss Coeff	n-val Pipe	Flow Rate (cfs)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Minor Loss (ft)	HGL Jnct (ft)	Vel Ave (ft/s)	Line Length (ft)	Rim-Hw (ft)
1	Storm 1	60	Cir	MH	0.99 z	0.013	268.20	7192.00	7202.30	3.53	7198.00	7206.83	3.17	7206.83	14.01	292.040	5.17
2	Storm 1	36	Cir	Generic	0.50	0.013	55.40	7204.30	7204.67	4.12	7209.07	7209.13	0.48	7209.61	7.84	8.980	1.79
3	Storm 1	30	Cir	Generic	1.00	0.013	27.70	7205.17	7206.94	5.01	7210.07	7210.23	0.50	7210.73	5.64	35.350	0.67
4	Storm 2	54	Cir	MH	1.00 z	0.013	213.40	7202.80	7205.94	1.73	7207.23	7210.06	3.05	7210.06	13.73	181.630	3.94
5	Storm 2	42	Cir	MH	1.00 z	0.013	74.20	7206.94	7212.65	2.19	7212.18	7215.34	n/a	7215.34	8.52	261.291	4.66
6	Storm 2	30	Cir	MH	1.00 z	0.013	50.20	7213.65	7217.78	2.56	7215.34	7220.08	n/a	7220.08	12.40	161.162	3.72
7	Storm 2	24	Cir	Generic	1.00	0.013	11.50	7218.58	7219.65	3.74	7221.62	7221.65	0.21	7221.86	3.66	28.586	2.22
8	Storm 3	48	Cir	MH	0.89 z	0.013	142.50	7206.44	7208.80	1.62	7211.10	7212.33	2.04	7212.33	11.74	145.400	3.83
9	Storm 3	48	Cir	MH	0.15 z	0.013	117.80	7209.10	7217.15	1.85	7213.25	7220.42	n/a	7220.42	10.05	435.420	3.58
10	Storm 3	48	Cir	MH	0.15 z	0.013	117.80	7217.45	7225.32	1.81	7220.84	7228.59	n/a	7228.59	10.55	435.420	3.87
11	Storm 3	48	Cir	MH	0.15 z	0.013	117.80	7225.63	7240.60	4.41	7229.01	7243.87	n/a	7243.87	10.56	339.480	3.88
12	Storm 3	48	Cir	MH	1.00 z	0.013	117.80	7240.90	7246.33	1.60	7244.29	7249.60	n/a	7249.60	10.55	339.480	6.89
13	Storm 3	48	Cir	MH	0.92	0.013	117.80	7246.63	7247.95	0.59	7250.25	7251.57	1.39	7252.96	9.84	224.160	2.30
14	Storm 3	48	Cir	MH	0.88	0.013	76.00	7248.25	7251.43	0.64	7253.90	7255.16	0.53	7255.69	6.14	497.380	2.77
15	Storm 3	18	Cir	Generic	1.00	0.013	2.70	7254.23	7254.75	4.89	7256.25	7256.25	0.04	7256.29	1.53	10.640	2.36
16	Storm 3_Lat 1	24	Cir	None	0.89	0.013	13.70	7211.10	7211.21	2.51	7214.33	7214.34	0.26	7214.60	4.36	4.375	1.86
17	Storm 3_Lat 1	24	Cir	Generic	1.00	0.013	13.70	7211.21	7211.41	2.50	7214.60	7214.63	0.30	7214.93	4.36	8.000	1.32
18	Storm 3_Lat 2	24	Cir	Generic	1.00	0.013	13.70	7211.10	7211.91	2.50	7214.33	7214.44	0.30	7214.74	4.36	32.420	1.60
19	Storm 3_Lat 3	30	Cir	Generic	0.72	0.013	40.20	7249.75	7250.36	2.02	7253.42	7253.71	0.75	7254.47	8.19	30.230	0.79
20	Storm 3_Lat 3	30	Cir	Generic	1.00	0.013	37.70	7250.66	7250.75	2.00	7254.59	7254.63	0.92	7255.55	7.68	4.500	0.35
21	Storm 3_Lat 4	18	Cir	None	0.89	0.013	5.40	7250.75	7250.97	5.03	7254.32	7254.33	0.13	7254.46	3.06	4.380	1.07
22	Storm 3_Lat 4	18	Cir	Generic	1.00	0.013	5.40	7250.97	7251.37	5.00	7254.46	7254.48	0.15	7254.63	3.06	8.000	0.52
23	Storm 4	48	Cir	Generic	1.23 z	0.013	74.00	7251.73	7251.99	0.75	7255.71	7254.59	1.40	7254.59	7.22	34.736	3.70

Project File: Storm Main System.stm

Number of lines: 32

Date: 6/13/2018

NOTES: ** Critical depth

Line No.	Line ID	Line Size (in)	Line Type	Junct Type	J-Loss Coeff	n-val Pipe	Flow Rate (cfs)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Minor Loss (ft)	HGL Jnct (ft)	Vel Ave (ft/s)	Line Length (ft)	Rim-Hw (ft)
24	Storm 4	36	Cir	None	0.89 z	0.013	58.10	7252.99	7255.10	0.83	7255.34	7257.57	1.21	7257.57	9.56	254.990	5.94
25	Storm 4	36	Cir	Hdwall	1.00 z	0.013	58.10	7255.10	7255.80	0.83	7257.87	7258.27	1.36	7258.27	8.93	84.027	-2.46
26	Storm 5	24	Cir	Generic	1.50 z	0.013	24.80	7214.15	7215.74	2.83	7215.73	7217.50	1.68	7217.50	8.90	56.270	2.89
27	Storm 5	18	Cir	Generic	1.00 z	0.013	12.40	7216.24	7217.30	3.00	7217.85	7218.63 j	n/a	7218.63	7.25	35.330	1.76
28	Storm Planned	30	Cir	MH	1.00 z	0.013	39.70	7218.08	7219.19	1.83	7220.82	7221.31 j	n/a	7221.31	8.52	60.570	3.22
29	Storm Planned	30	Cir	MH	1.00 z	0.013	27.90	7219.49	7223.85	1.50	7222.05	7225.65 j	n/a	7225.65	6.53	290.660	3.30
30	Storm 6	24	Cir	Generic	1.00	0.013	13.50	7219.99	7220.09	1.94	7222.27	7222.29	0.29	7222.57	4.30	5.130	1.93
31	Storm 7	30	Cir	Generic	1.46 z	0.013	27.90	7224.15	7224.80	1.01	7225.99	7226.60 j	n/a	7226.60	7.28	64.530	3.04
32	Storm 7	18	Cir	Generic	1.00	0.013	14.00	7225.80	7226.34	1.48	7227.30	7227.95	0.98	7228.92	7.92	36.470	0.85

Project File: Storm Main System.stm

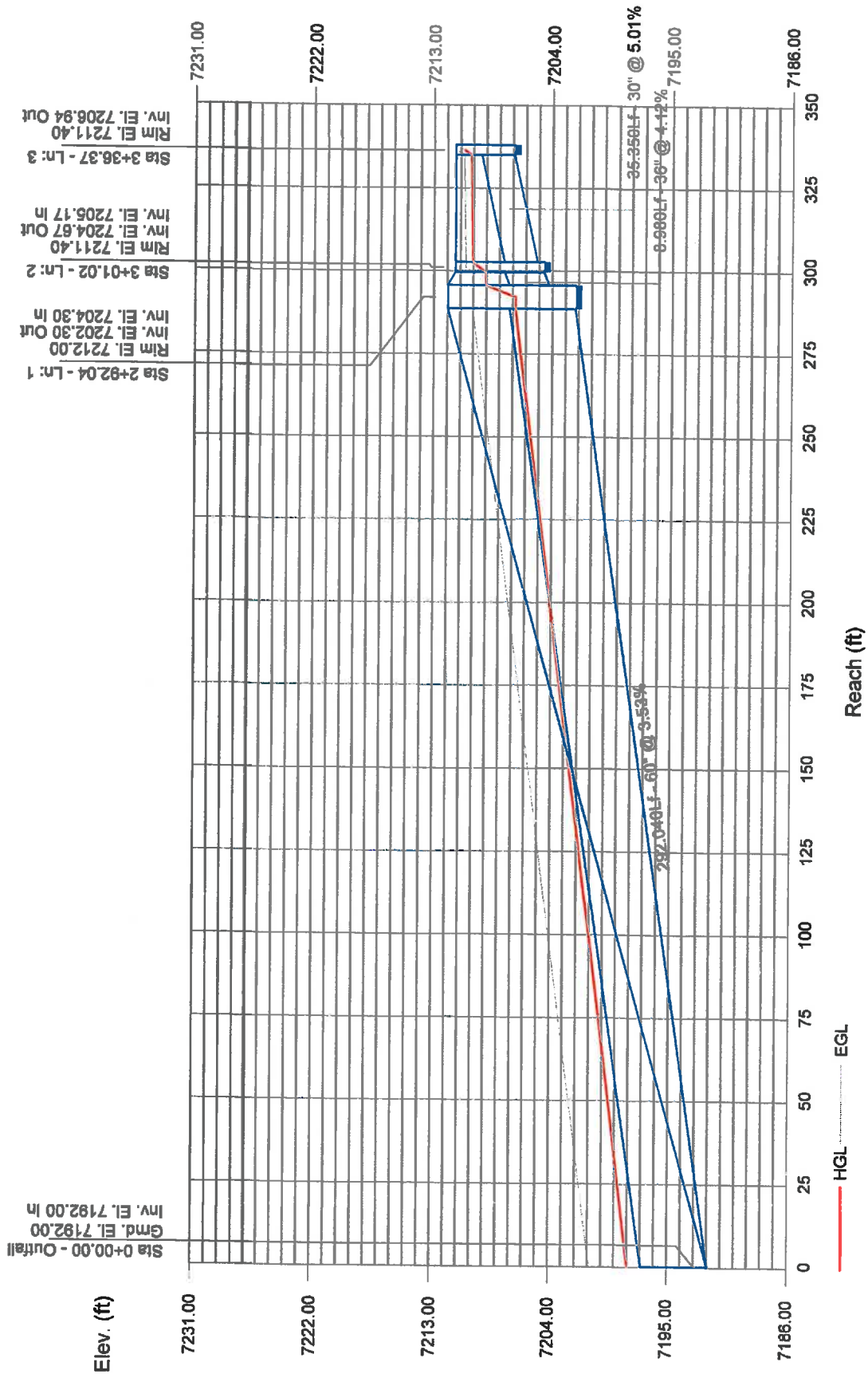
Number of lines: 32

Date: 6/13/2018

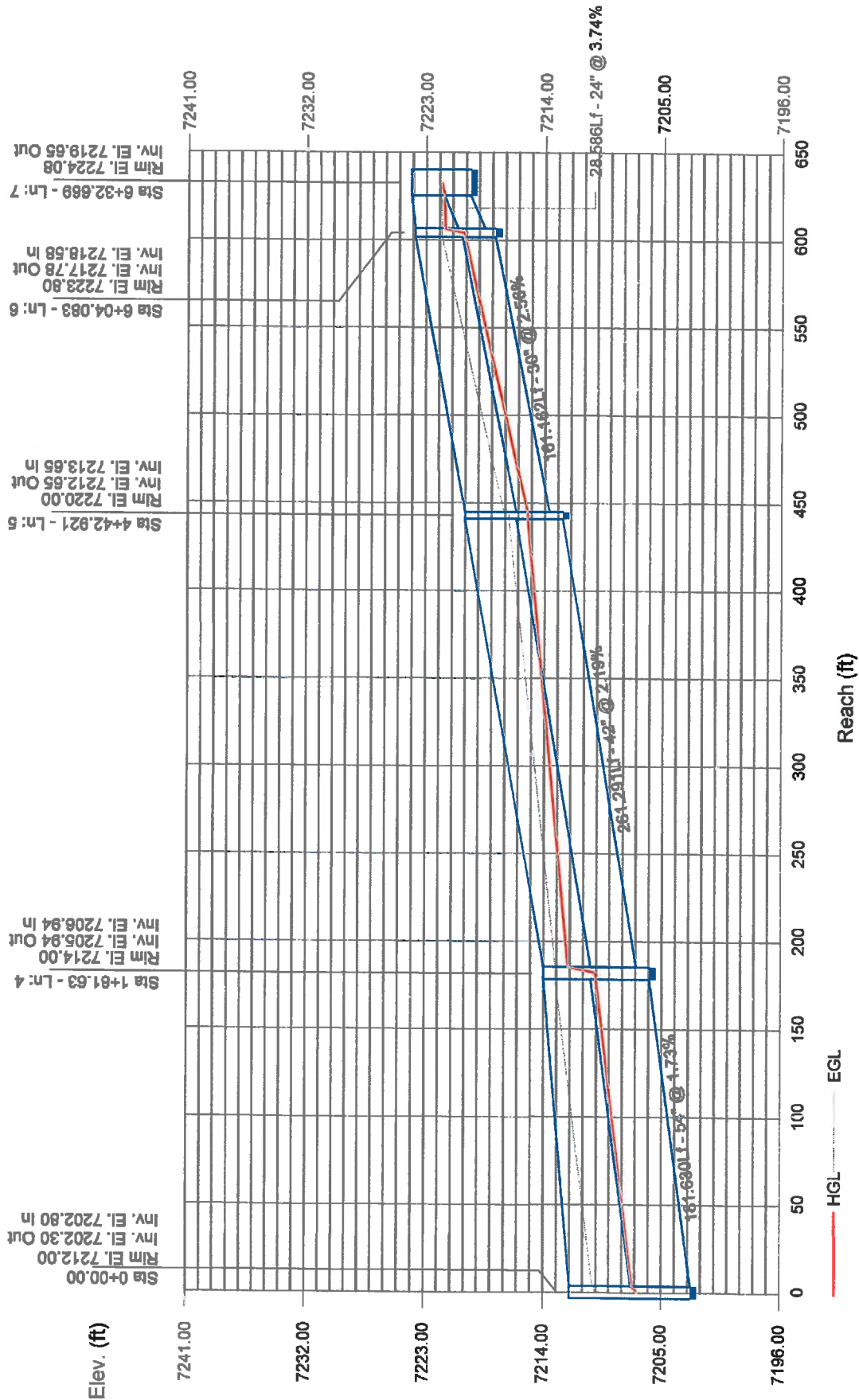
NOTES: ** Critical depth

Line No.	Line ID	Line Size (in)	Line Type	Junct Type	J-Loss Coeff	n-val Pipe	Flow Rate (cfs)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Minor Loss (ft)	HGL Jnct (ft)	Vel Ave (ft/s)	Line Length (ft)	Rim-Hw (ft)
1	Storm 8	18	Cir	Generic	1.25 z	0.013	13.50	7248.00	7249.01	1.70	7249.21	7250.38	n/a	7250.38	8.41	59.460	2.27
Paint Brush Hills Filing 14																	
														Number of lines: 1		Date: 6/13/2018	
NOTES: ** Critical depth																	

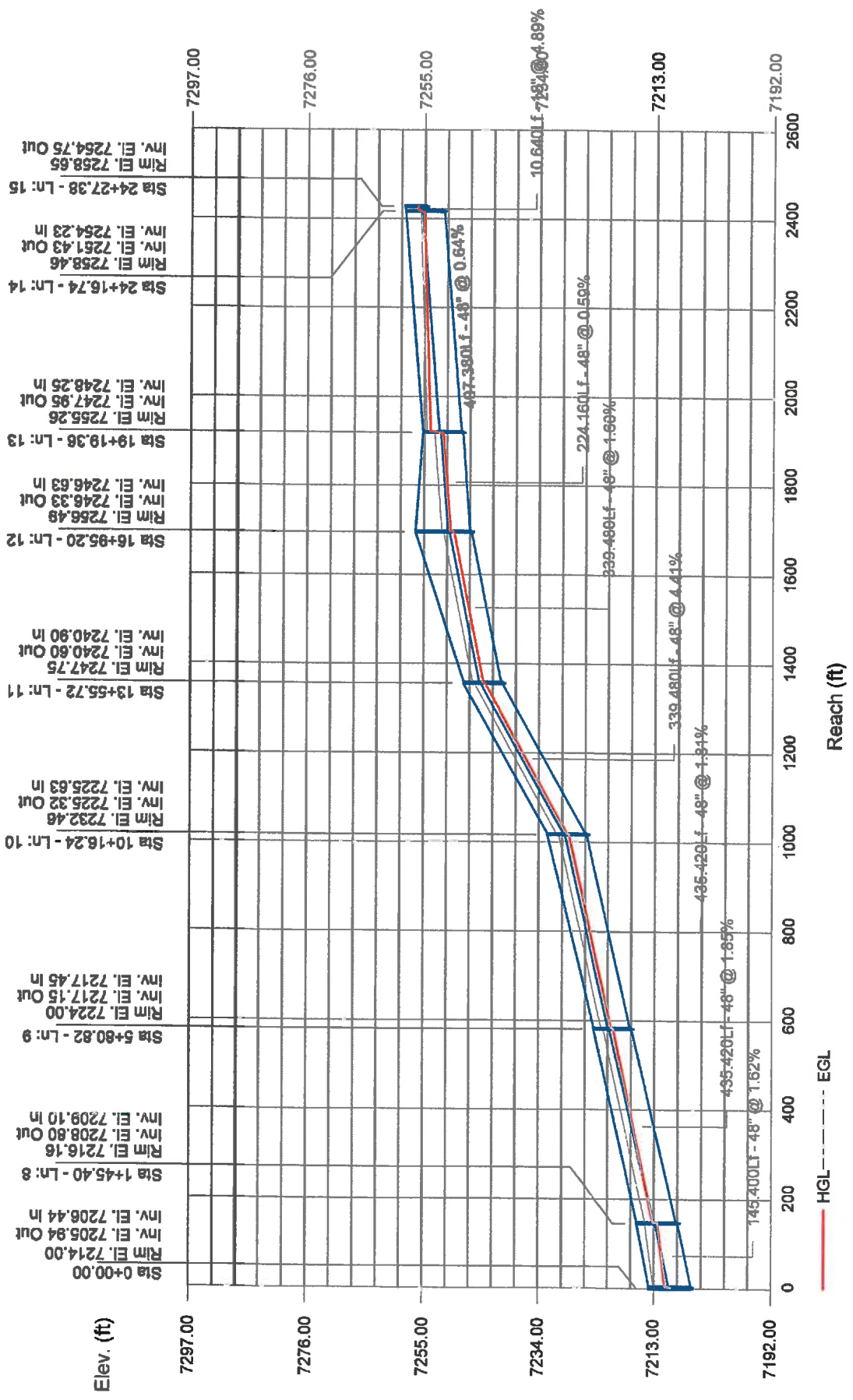
STORM 1



STORM 2



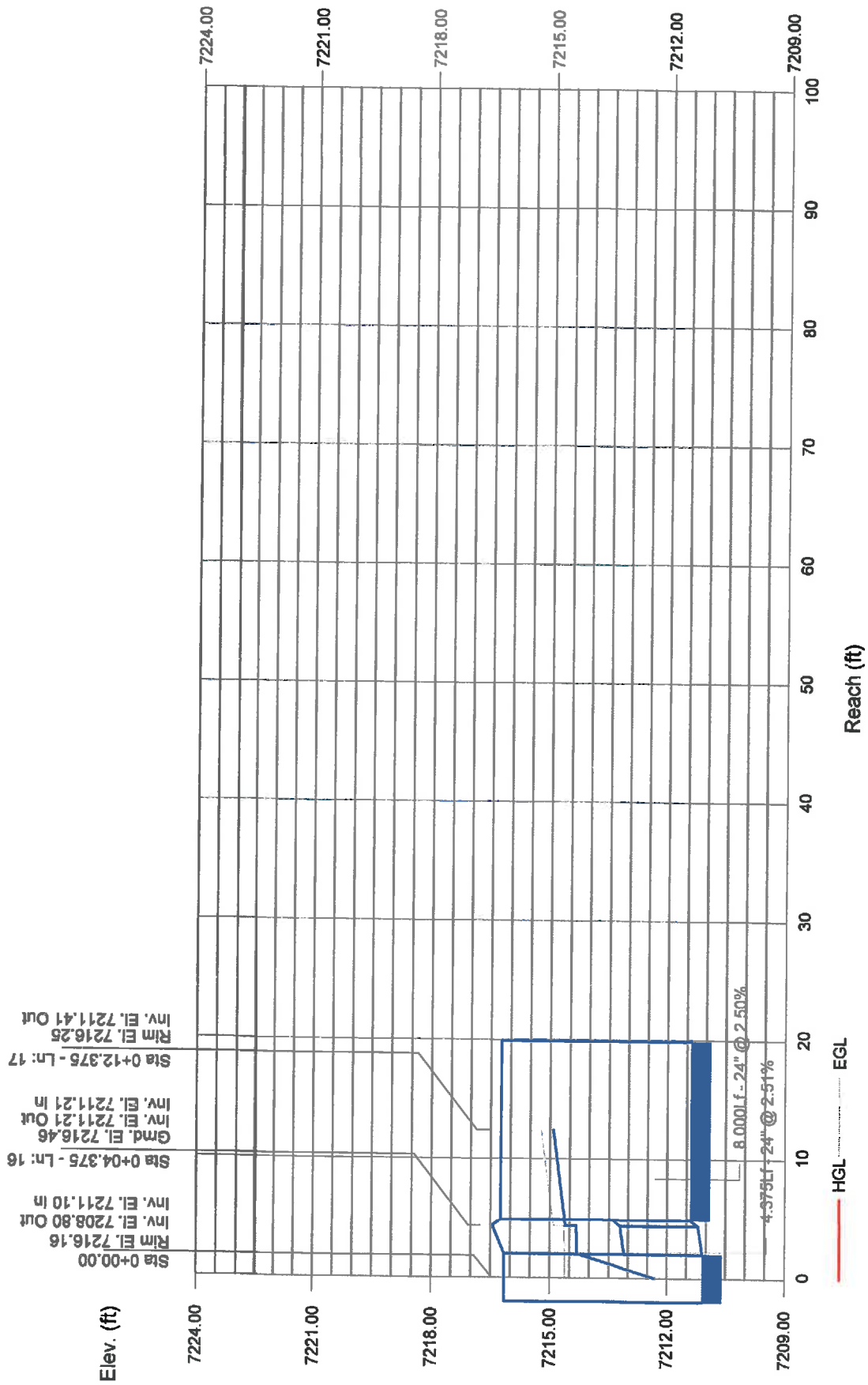
STORM 3



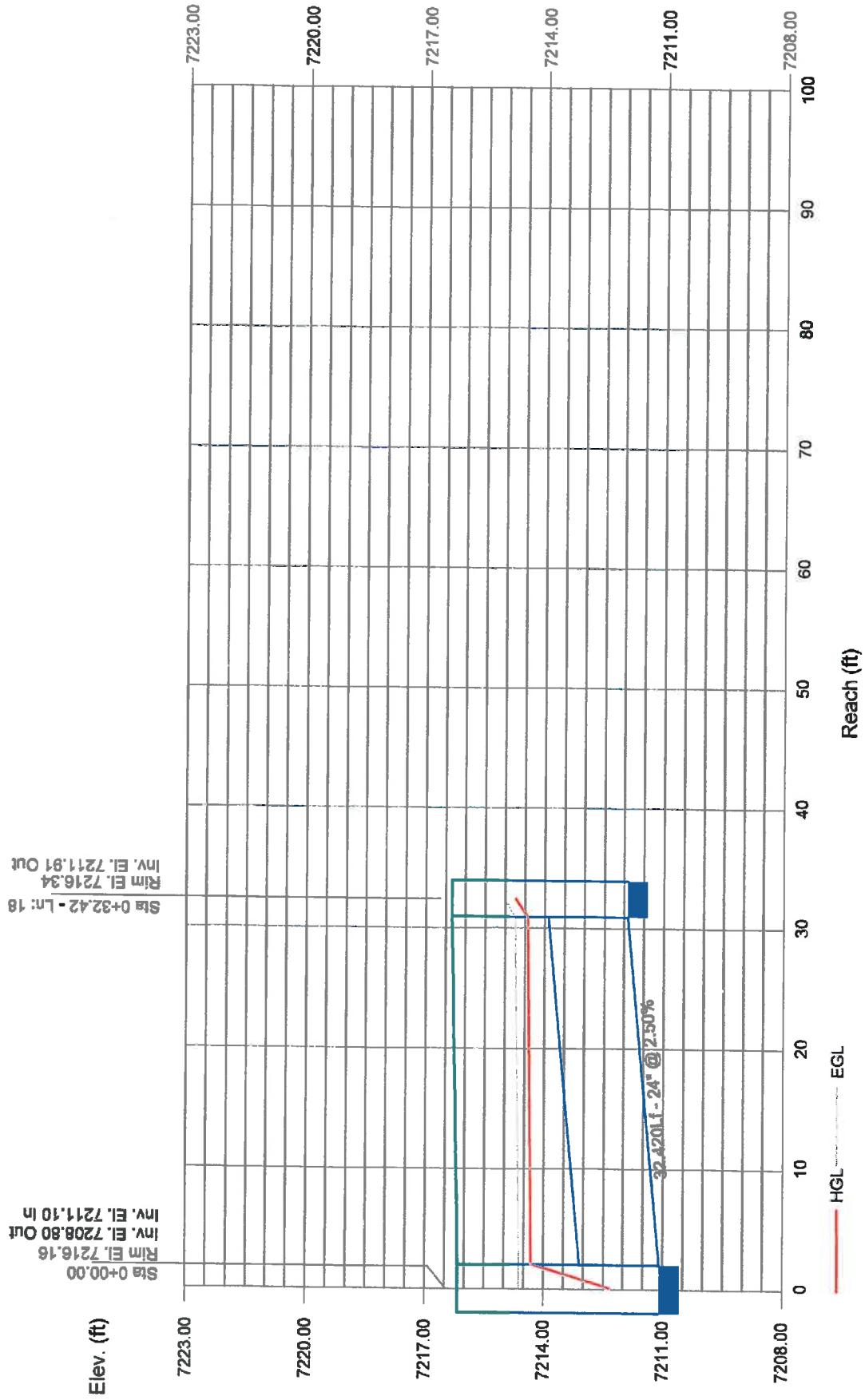
Storm Sewer Profile

Proj. file: Storm Main System.stm

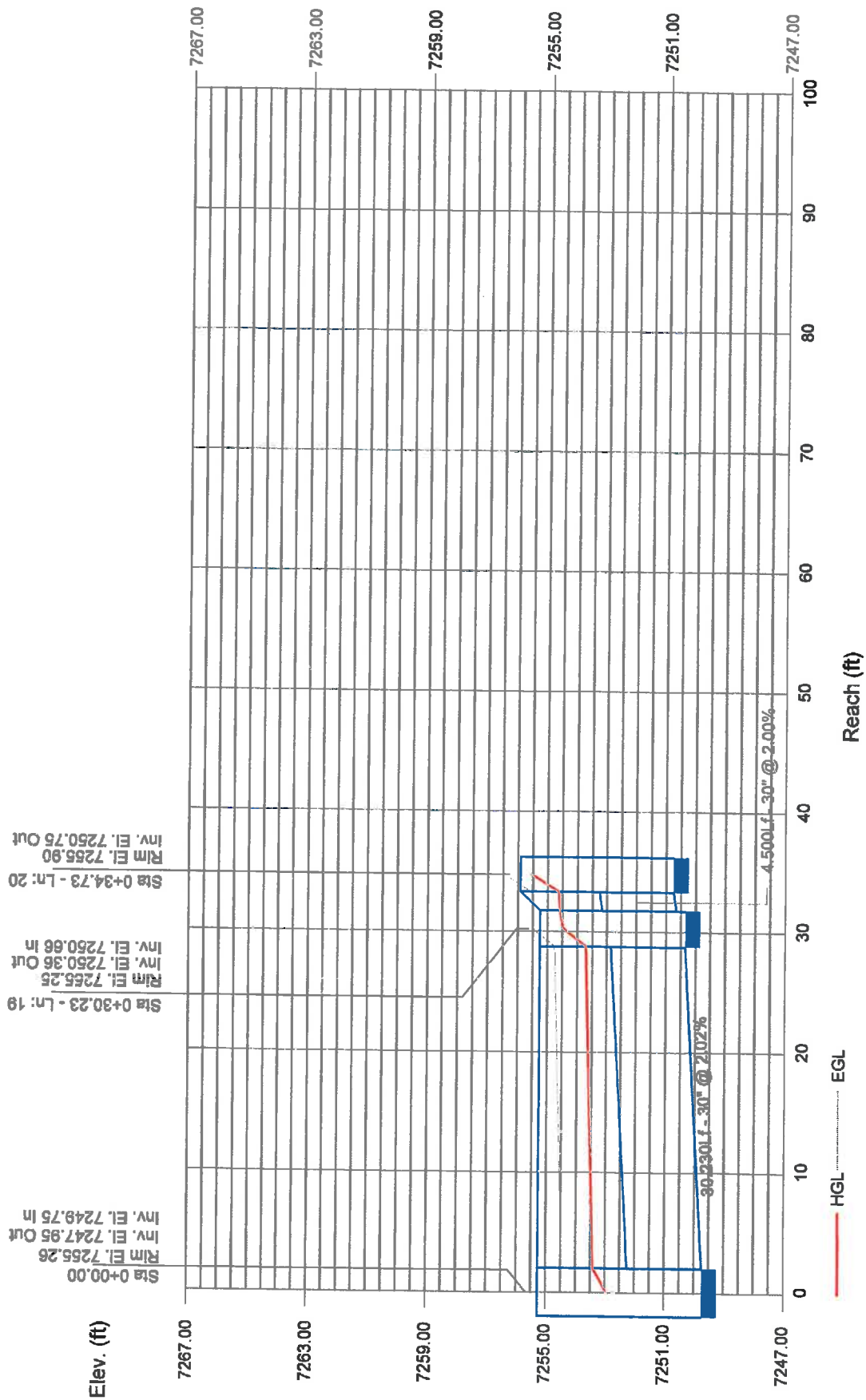
STORM 3 LAT 1



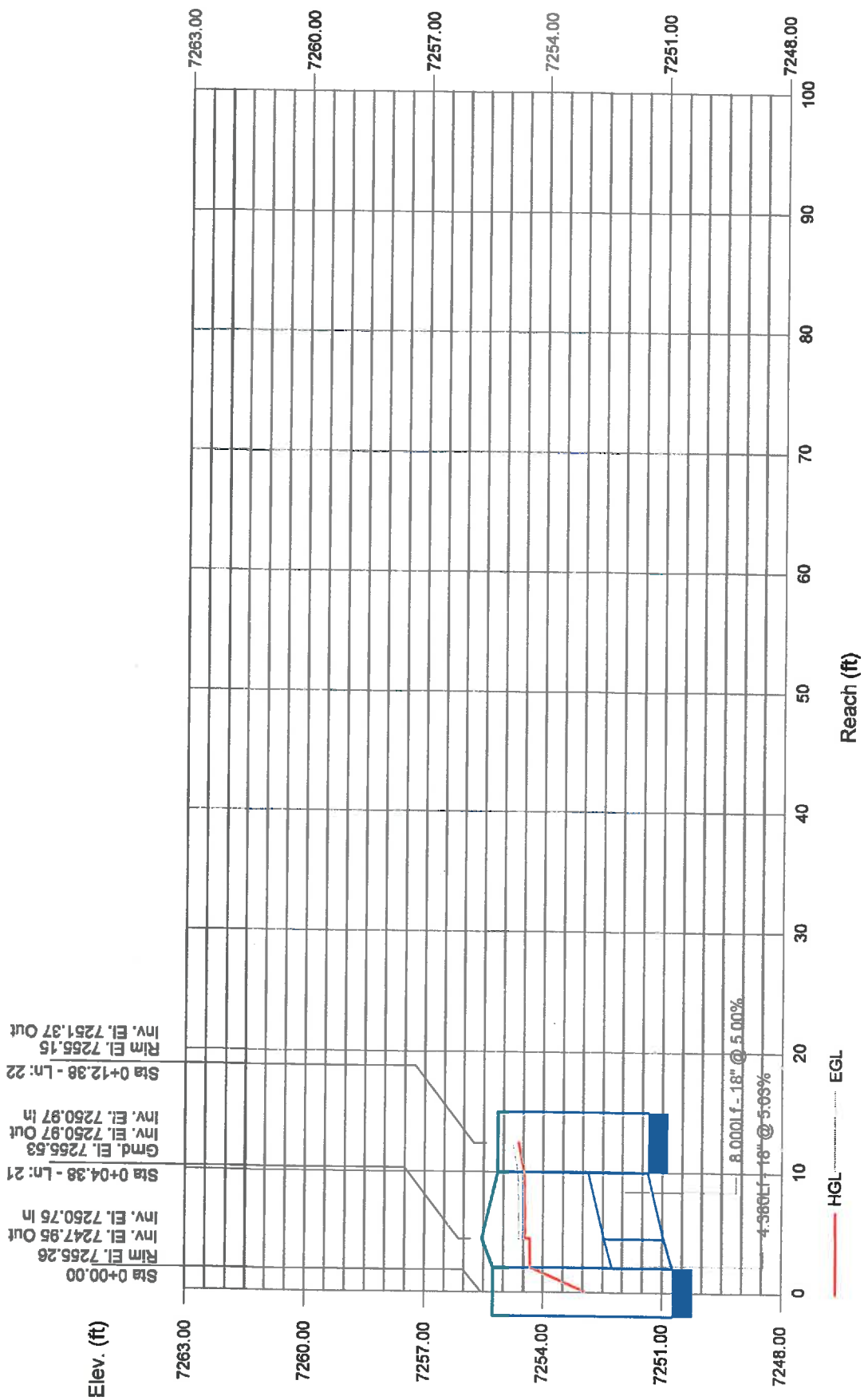
STORM 3 LAT 2



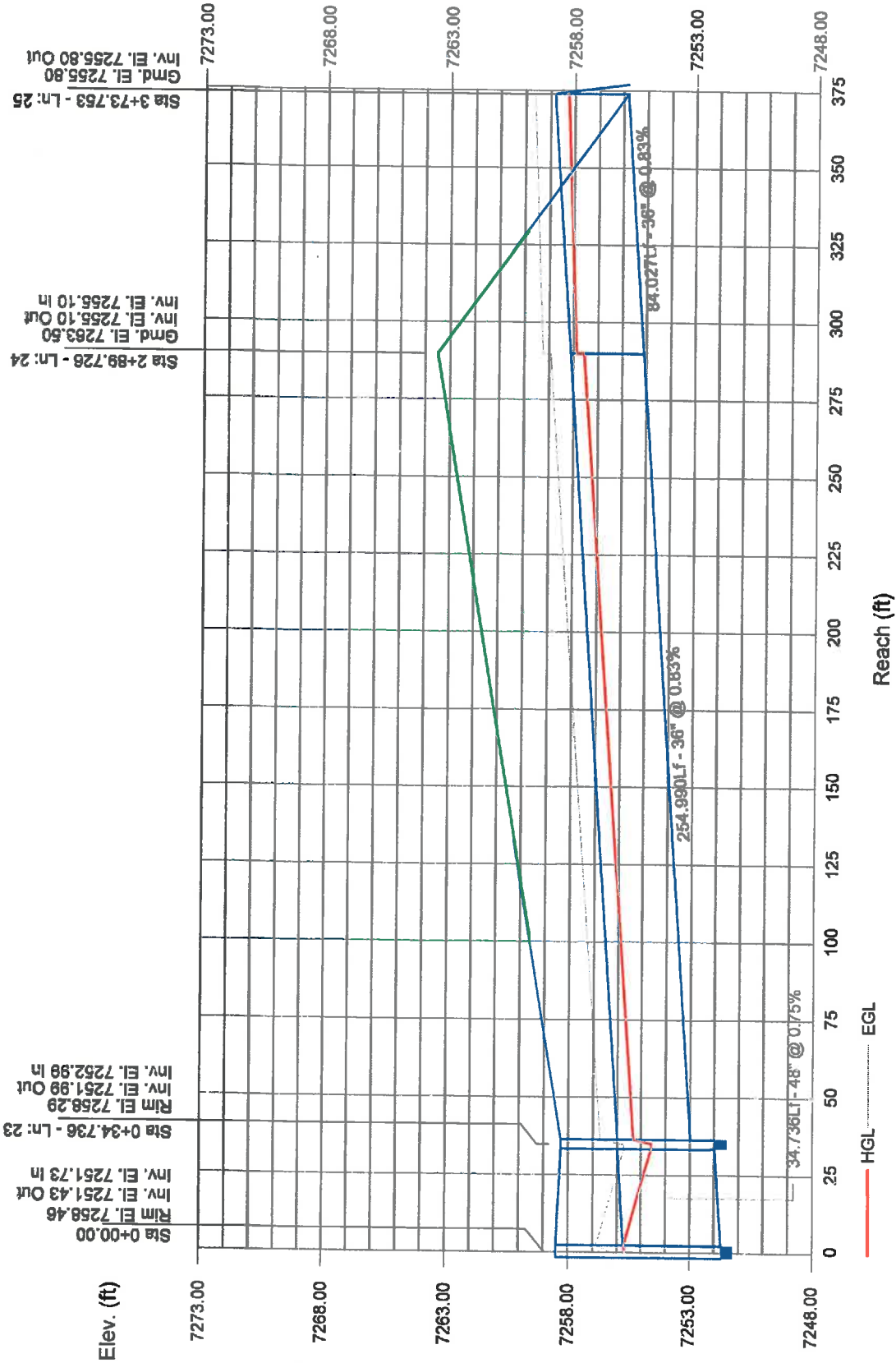
STORM 3 LAT 3



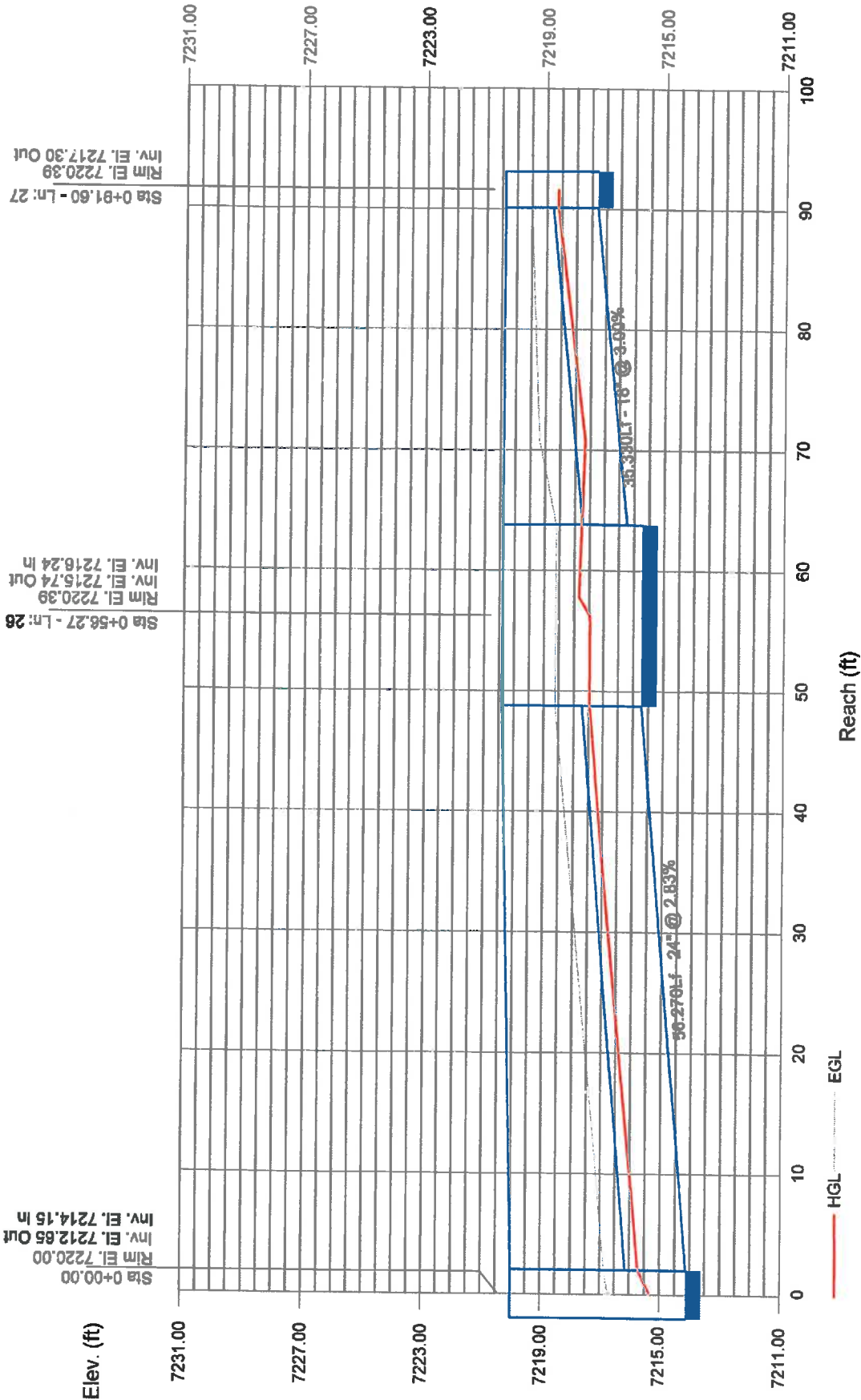
STORM 3 LAT 4



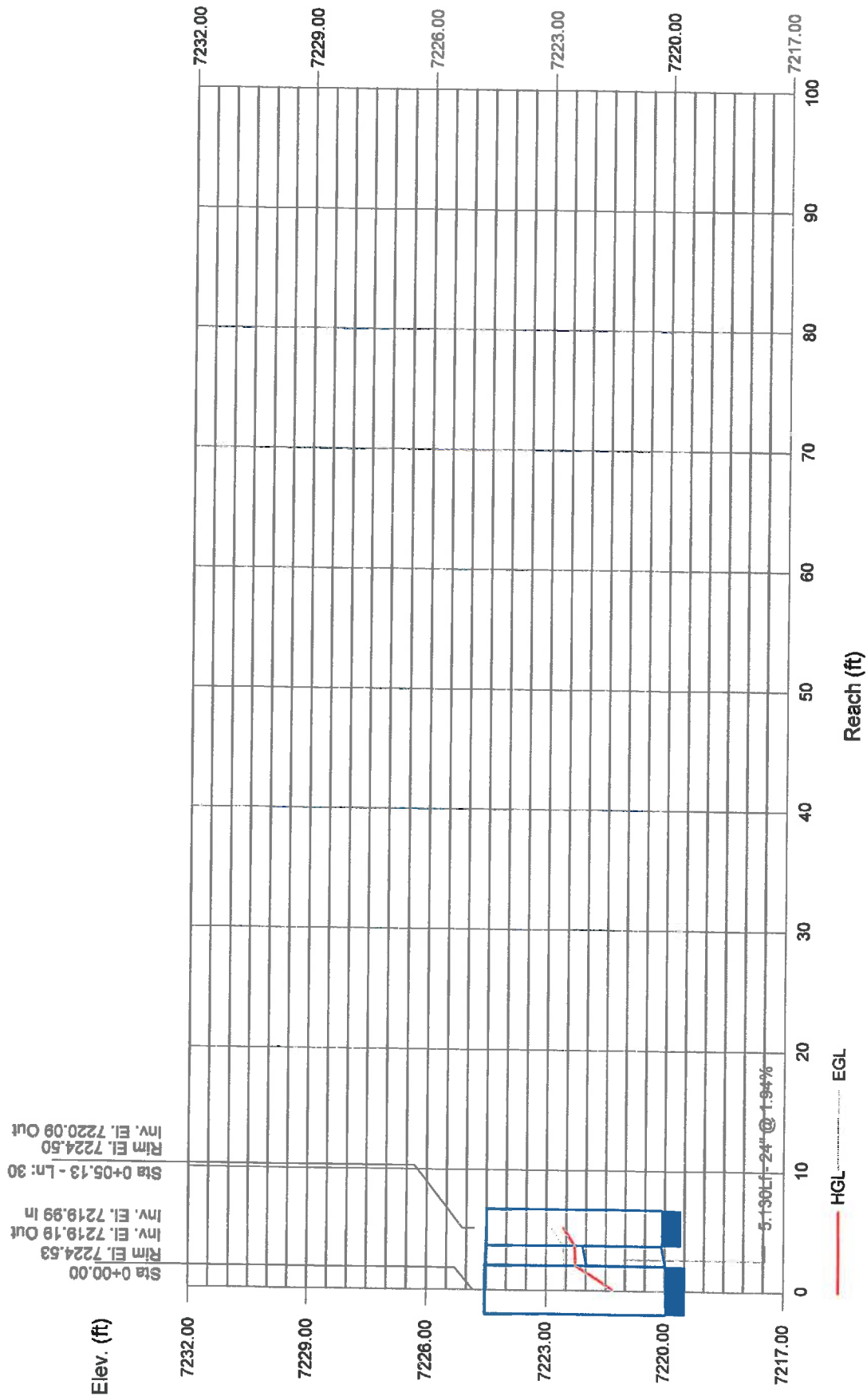
STORM 4



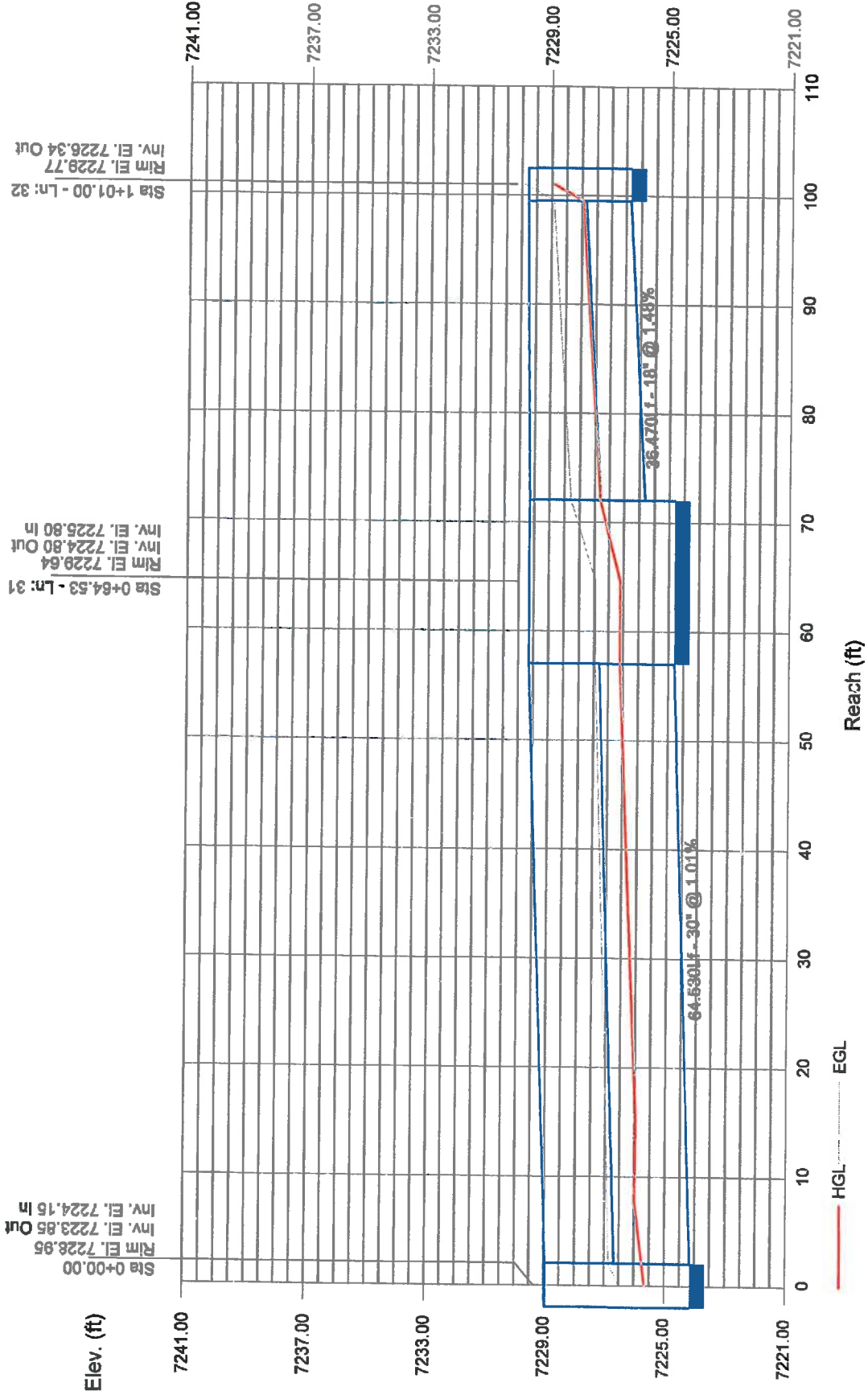
STORM 5



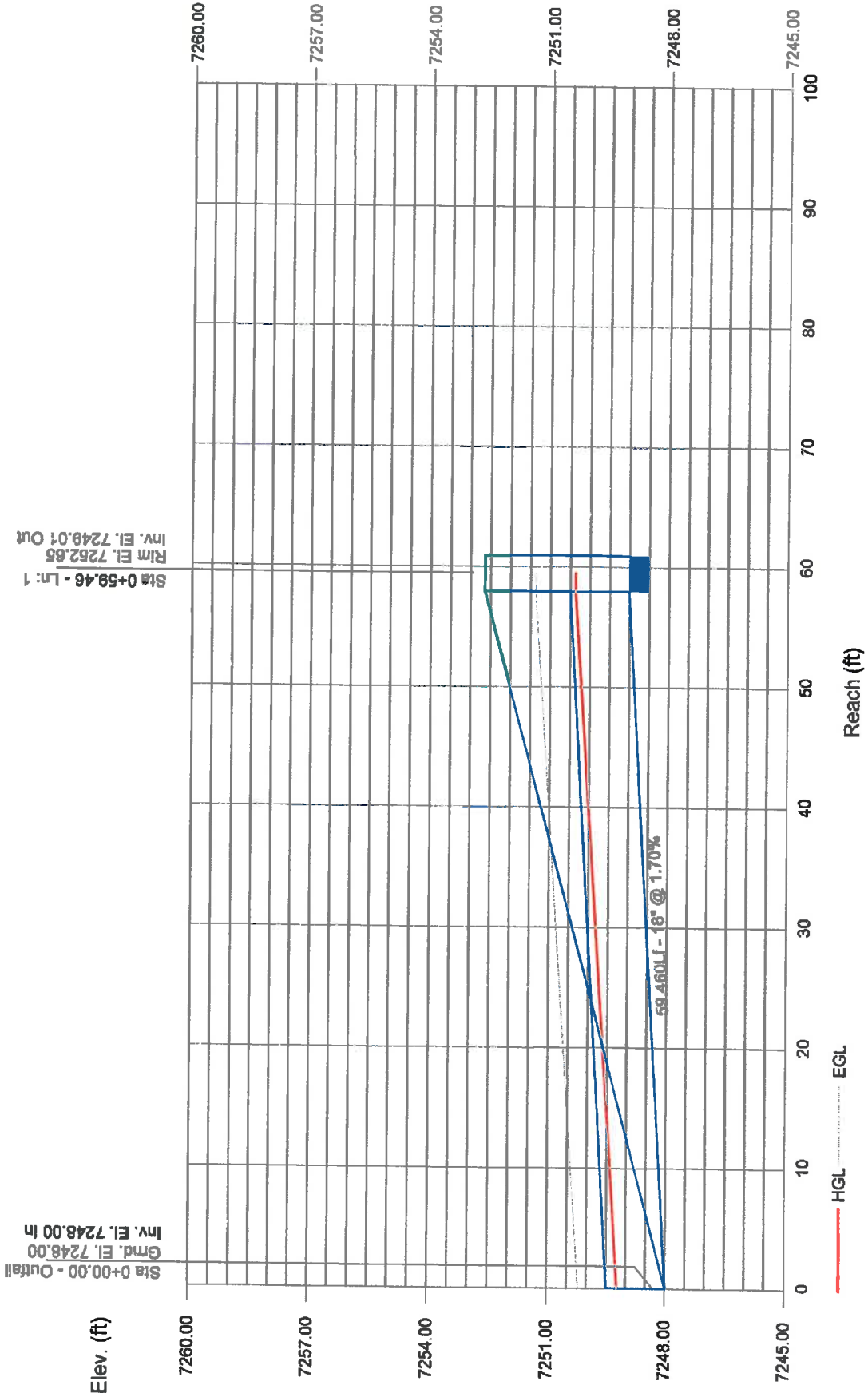
STORM 6



STORM 7



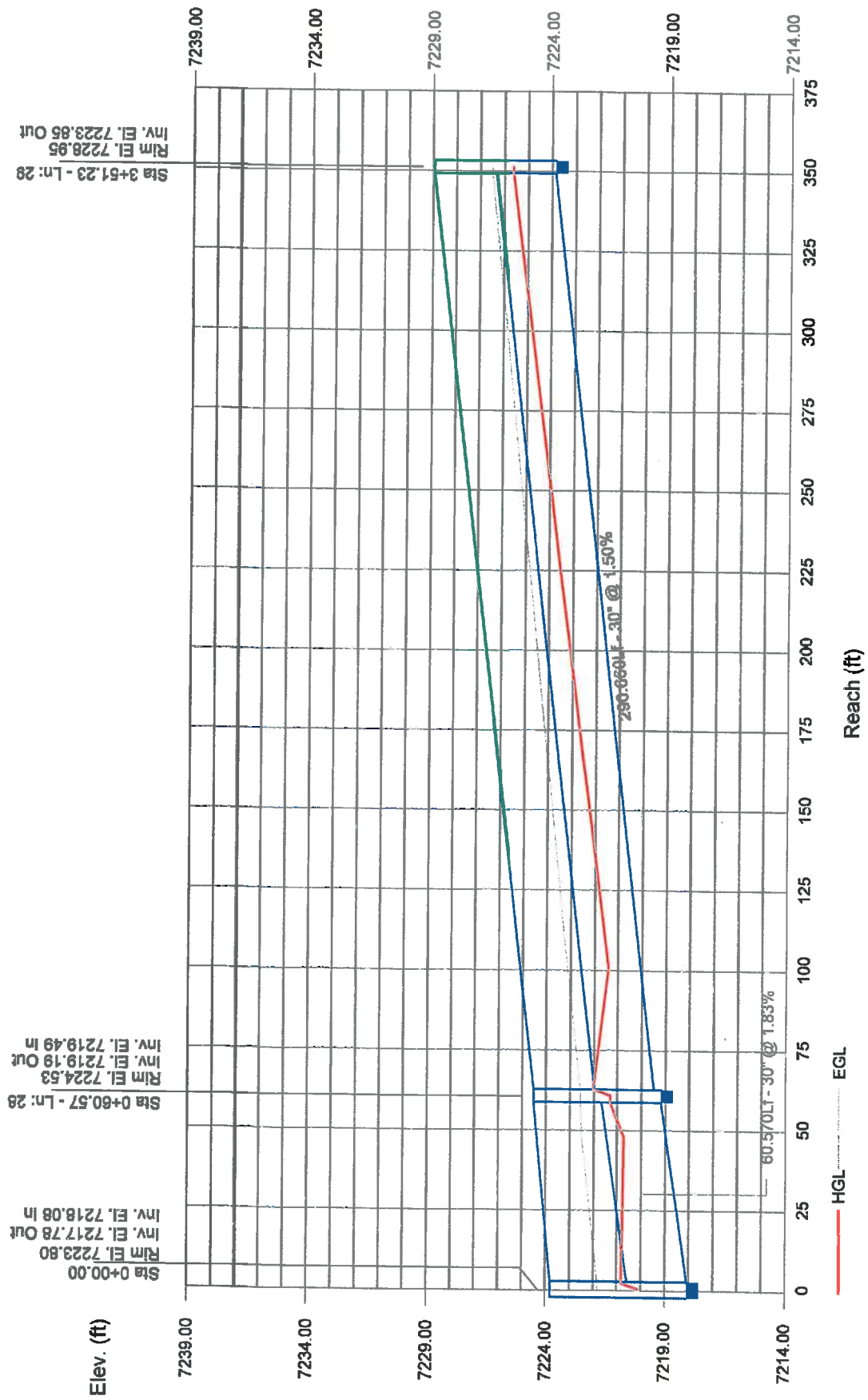
STORM 8



Storm Sewer Profile

Proj. file: Storm Main System.stm

STORM PLANNED



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Paint Brush Hills Filling No. 14

Basin ID: Full Spectrum Detention Pond C



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB
Watershed Area =	123.51 acres
Watershed Length =	3,440 ft
Watershed Slope =	0.025 %
Watershed Imperviousness =	40.00% percent
Percentage Hydrologic Soil Group A =	0.0% percent
Percentage Hydrologic Soil Group B =	100.0% percent
Percentage Hydrologic Soil Group C/D =	0.0% percent
Detained WQCV Drain Time =	40.0 hours

Location for 1-hr Rainfall Depths = User Input

Water Quality Capture Volume (WQCV) =	1,851 acre-feet
Excess Urban Runoff Volume (EURV) =	5,188 acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	4,092 acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	5,690 acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	8,084 acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	12,163 acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	14,895 acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	18,488 acre-feet
Approximate 2-yr Detention Volume =	3,825 acre-feet
Approximate 5-yr Detention Volume =	5,342 acre-feet
Approximate 10-yr Detention Volume =	7,351 acre-feet
Approximate 25-yr Detention Volume =	8,219 acre-feet
Approximate 50-yr Detention Volume =	8,824 acre-feet
Approximate 100-yr Detention Volume =	9,881 acre-feet

Optional User Override
1-hr Precipitation

1.19
1.50
1.75
2.00
2.25
2.52

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	7190.09	0.00	-	-	-	200	0.005	277	0.006
	7191	0.91	-	-	-	419	0.010	277	0.006
	7192	2.00	-	-	-	9,716	0.223	5,708	0.131
	7193.00	3.00	-	-	-	49,588	1.138	35,457	0.814
	7194.00	4.00	-	-	-	71,735	1.647	96,118	2.207
	7195.00	5.00	-	-	-	76,385	1.753	170,168	3.907
	7196.00	6.00	-	-	-	81,024	1.860	248,863	5.713
	7197.00	7.00	-	-	-	85,770	1.968	332,260	7.628
	7198.00	8.00	-	-	-	90,627	2.081	420,458	9.652
	7199	9.00	-	-	-	98,822	2.269	515,183	11.827
		10.00	-	-	-	105,781	2.428	617,484	14.175

Stage-Storage Calculation

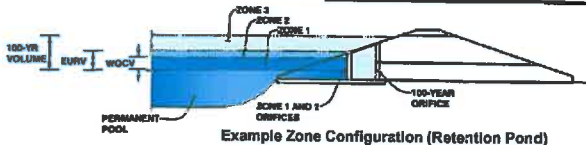
Zone 1 Volume (WQCV) =	1,851 acre-feet
Zone 2 Volume (EURV - Zone 1) =	3,337 acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	4,893 acre-feet
Total Detention Basin Volume =	9,881 acre-feet
Initial Surge Volume (ISV) =	user ft ³
Initial Surge Depth (ISD) =	user ft
Total Available Detention Depth (H _{total}) =	user ft
Depth of Trickle Channel (H _{TC}) =	user ft
Slope of Trickle Channel (S _{TC}) =	user H:V
Slopes of Main Basin Sides (S _{basin}) =	user H:V
Basin Length-to-Width Ratio (R _{LW}) =	user

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: The Sands

Basin ID: FSD Pond C



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.78	1.851	Orifice Plate
Zone 2 (EURV)	5.72	3.337	Orifice Plate
Zone 3 (100-year)	8.11	4.693	Weir & Pipe (Restrict)
		9.881	Total

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area = ft²
Underdrain Orifice Centroid = 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 = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = inches
Orifice Plate: Orifice Area per Row = inches

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
Elliptical Half-Width = feet
Elliptical Slot Centroid = feet
Elliptical Slot Area = ft²

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	1.91	3.81					
Orifice Area (sq. inches)	6.52	6.52	12.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter = inches

Calculated Parameters for Vertical Orifice

Vertical Orifice Area = ft²
Vertical Orifice Centroid = feet

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

Overflow Weir Front Edge Height, H_o = ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = feet
Overflow Weir Slope = H:V (enter zero for flat grate)
Horiz. Length of Weir Sides = feet
Overflow Grate Open Area % = %
Debris Clogging % = %

Calculated Parameters for Overflow Weir

Height of Grate Upper Edge, H₁ = feet
Over Flow Weir Slope Length = feet
Grate Open Area / 100-yr Orifice Area = should be ≥ 4
Overflow Grate Open Area w/o Debris = ft²
Overflow Grate Open Area w/ Debris = ft²

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

Depth to Invert of Outlet Pipe = ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = inches
Restrictor Plate Height Above Pipe Invert = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Outlet Orifice Area = ft²
Outlet Orifice Centroid = feet
Half-Central Angle of Restrictor Plate on Pipe = 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

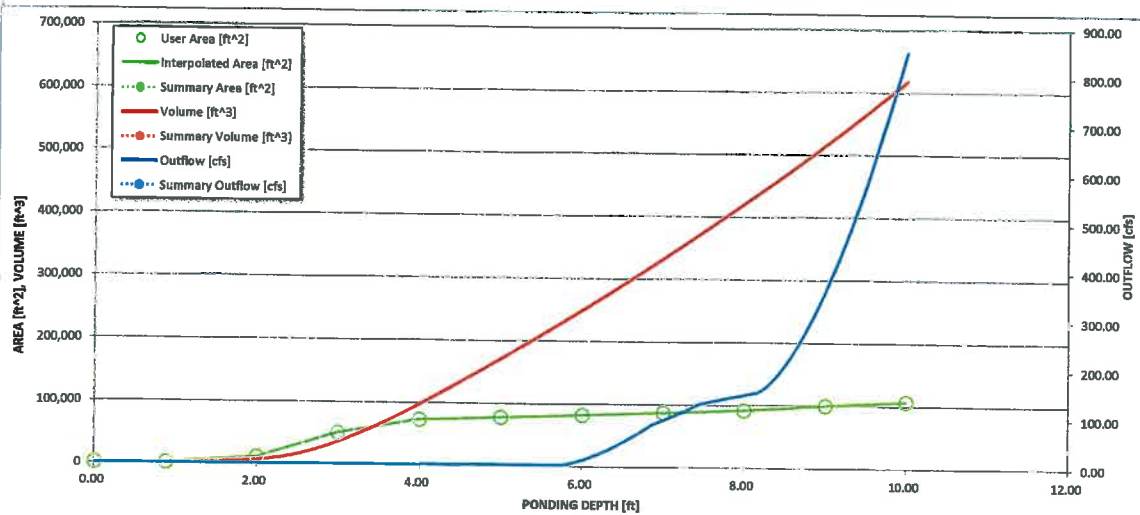
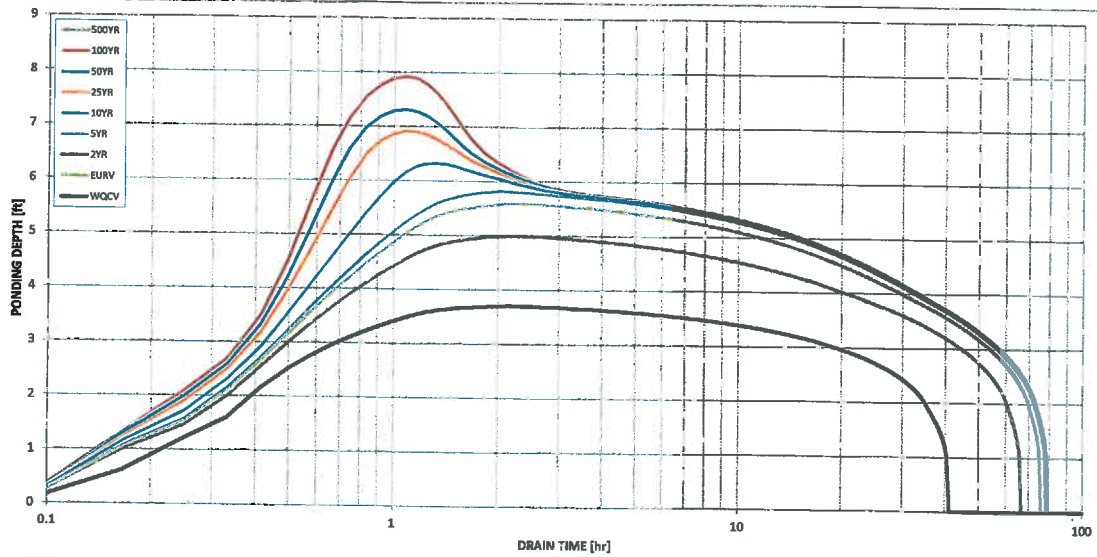
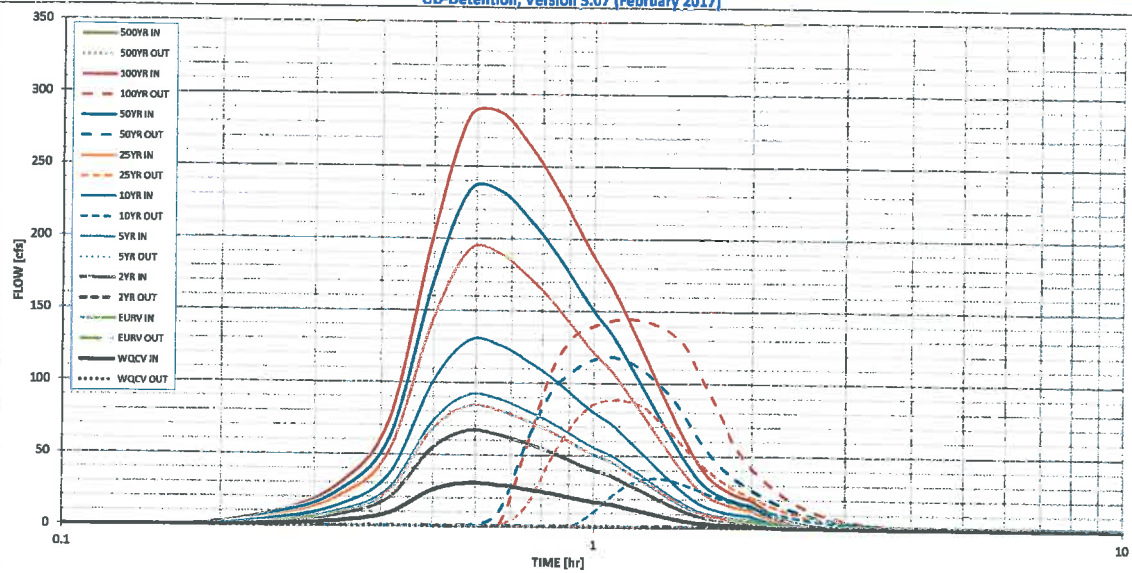
Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres

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	1.19	1.50	1.75	2.00	2.25	2.52	0.00
Calculated Runoff Volume (acre-ft) =	1.851	5.188	4.092	5.690	8.084	12.153	14.895	18.488	0.000
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	1.851	5.188	4.094	5.686	8.085	12.153	14.906	18.501	#N/A
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.20	0.67	0.92	1.24	0.00
Predevelopment Peak Q (cfs) =	0.0	0.0	1.5	2.6	24.9	82.4	113.9	153.3	0.0
Peak Inflow Q (cfs) =	30.5	89.9	66.6	91.9	129.4	192.1	233.6	287.8	#N/A
Peak Outflow Q (cfs) =	0.7	1.5	1.3	3.6	34.4	88.7	118.3	144.9	#N/A
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.4	1.4	1.1	1.0	0.9	#N/A
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	#N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	1.0	2.6	3.5	4.3	#N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	#N/A
Time to Drain 97% of Inflow Volume (hours) =	38	69	61	71	70	67	65	63	#N/A
Time to Drain 99% of Inflow Volume (hours) =	40	73	64	76	75	74	73	72	#N/A
Maximum Ponding Depth (ft) =	3.70	5.59	4.99	5.82	6.33	6.91	7.32	7.92	#N/A
Area at Maximum Ponding Depth (acres) =	1.49	1.82	1.75	1.84	1.89	1.96	2.00	2.07	#N/A
Maximum Volume Stored (acre-ft) =	1.724	4.945	3.892	5.365	6.317	7.435	8.247	9.490	#N/A

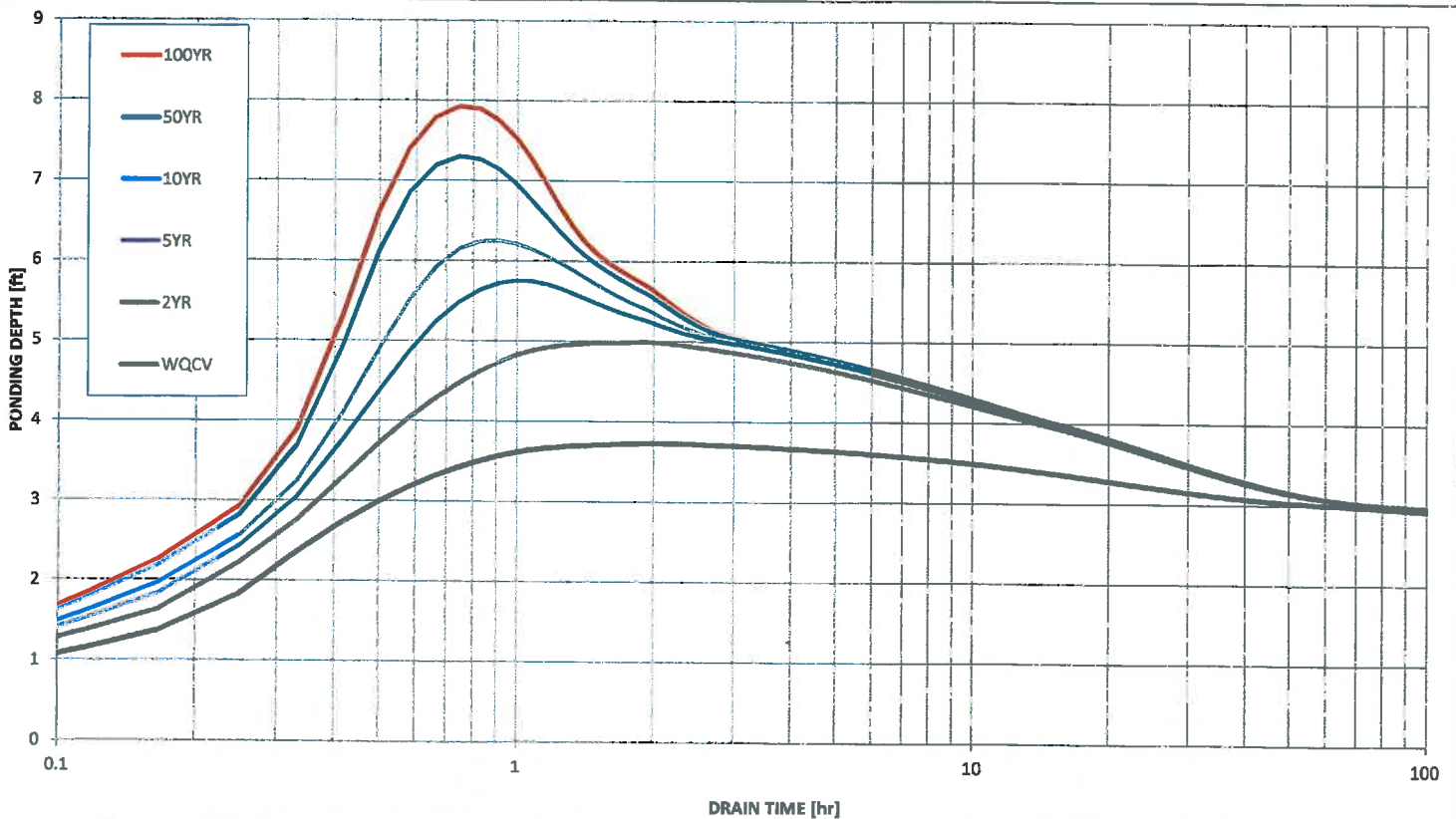
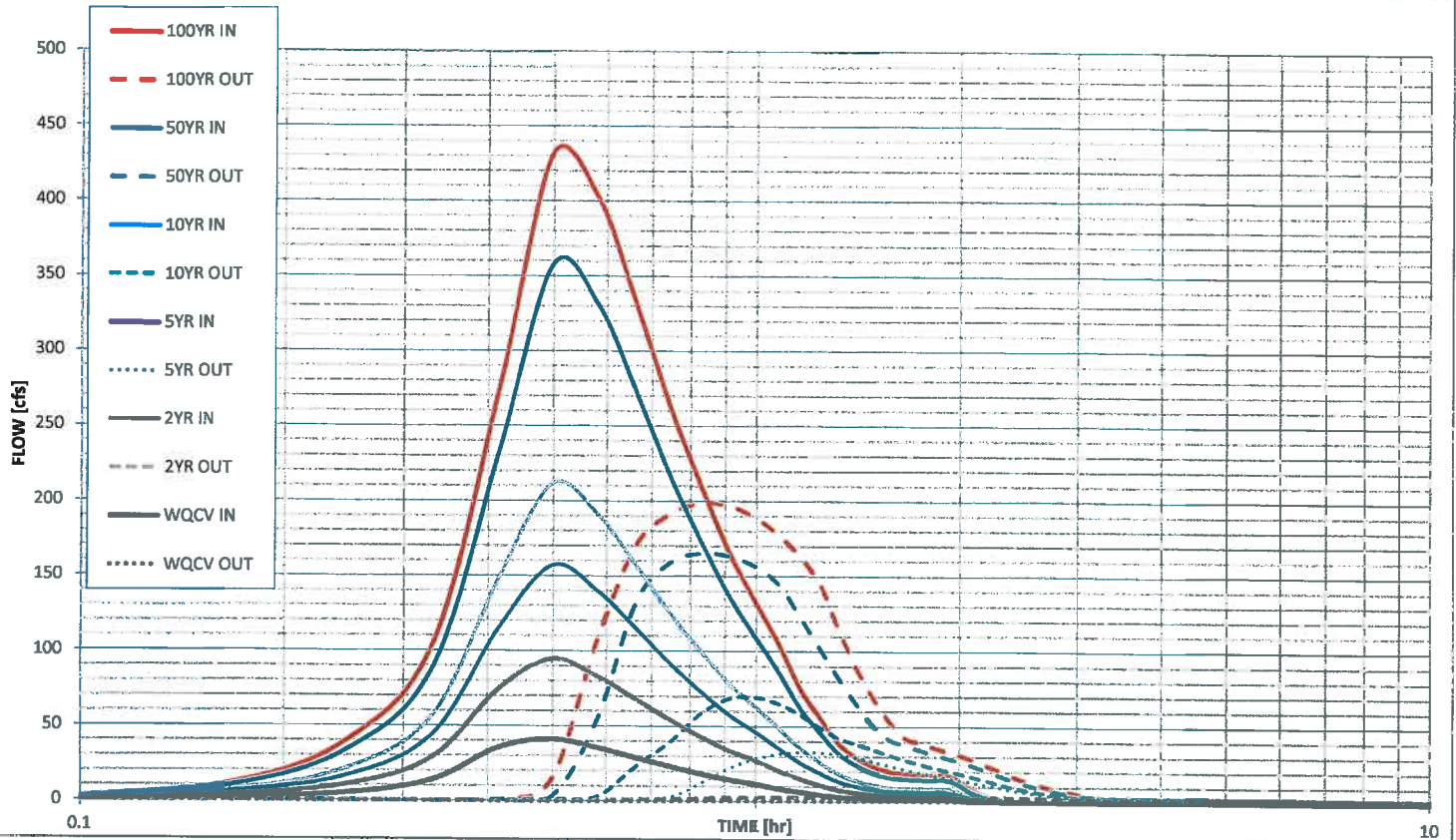
Detention Basin Outlet Structure Design

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			

Stormwater Detention and Infiltration Design Data Sheet



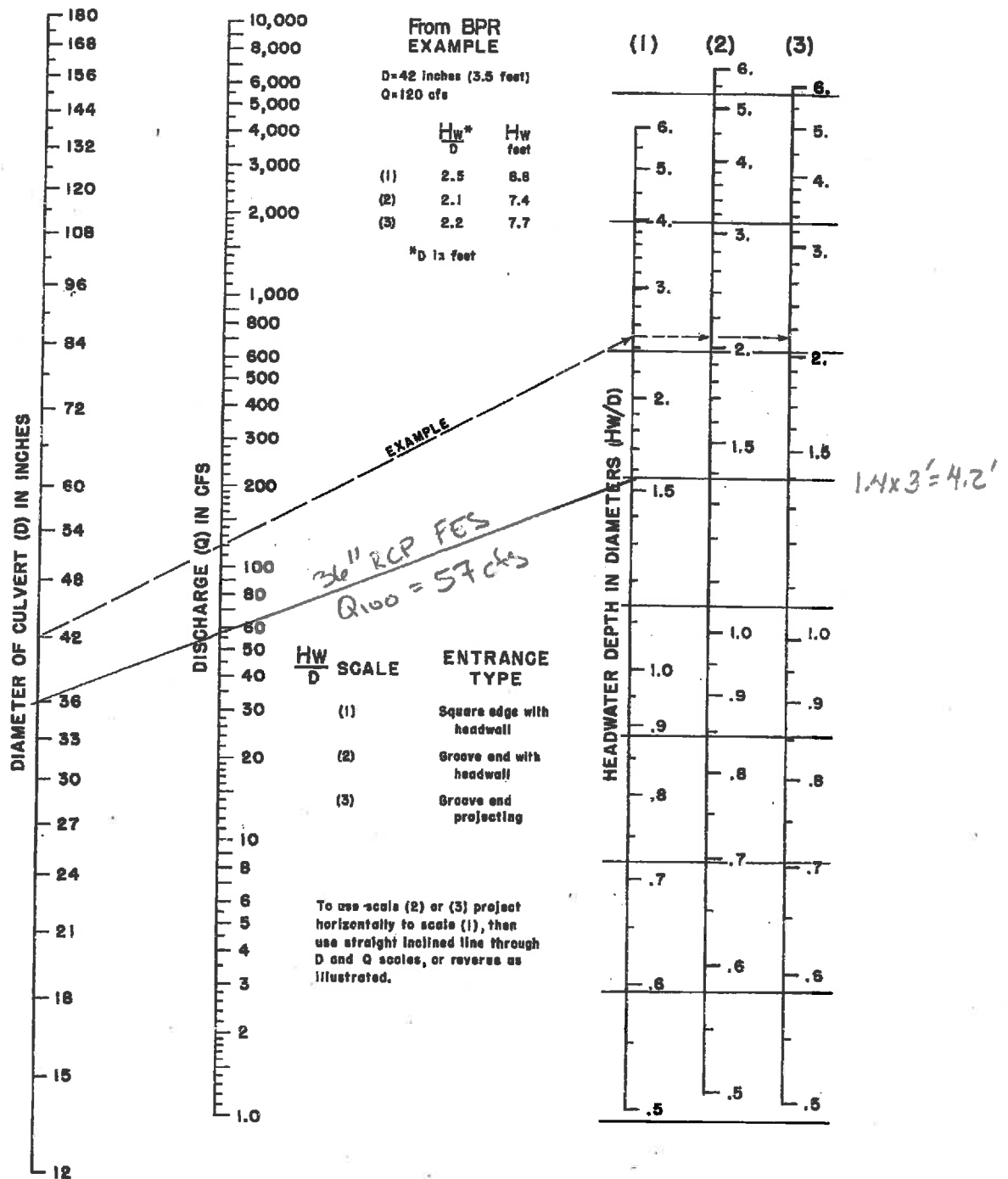


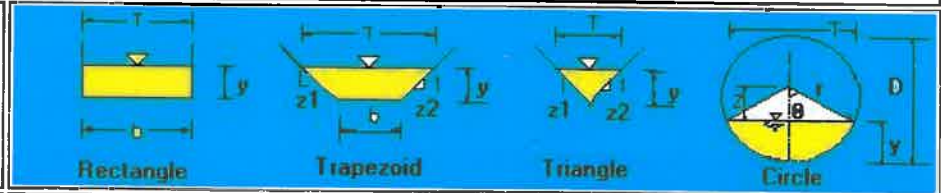
Figure CU-9—Inlet Control Nomograph—Example

DP 3 Q₁₀₀ = 57 cfs

The open channel flow calculator

Select Channel Type:

Rectangle ▾



Velocity(V)&Discharge(Q) ▾

Select unit system: Feet(ft) ▾

Channel slope: 0.005

ft/ft

Water depth(y): 0.5

ft

Bottom W(b)

2

ft

Flow velocity 3.8858

ft/s

LeftSlope (Z1): 0 to 1 (H:V)

RightSlope (Z2): 0

to 1 (H:V)

Flow discharge 3.8858

ft³/s

Input n value 0.013 or select n

Calculate!

Status: Calculation finished

Reset

Wetted perimeter 3

ft

Flow area 1

ft²

Top width(T) 2

ft

Specific energy 0.73

ft

Froude number 0.97

Flow status Subcritical flow

Critical depth 0.49

ft

Critical slope 0.0053

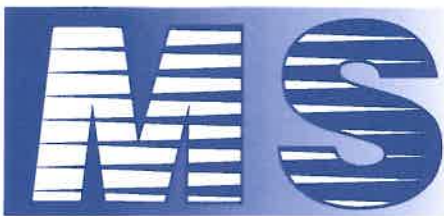
ft/ft

Velocity head 0.23

ft

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Low Flow TRICKLE CHANNEL



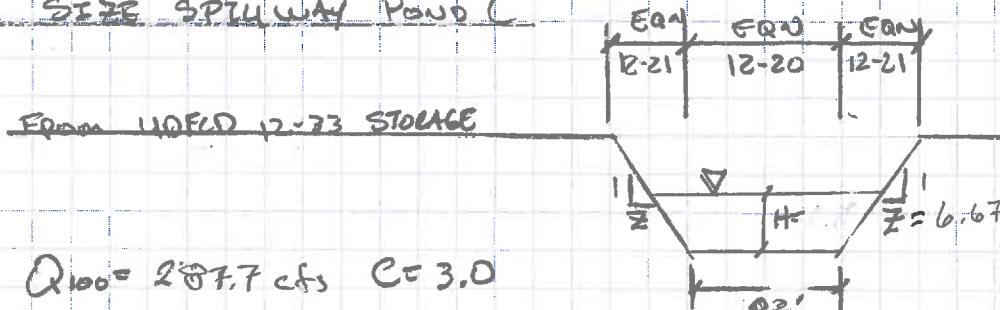
CIVIL CONSULTANTS, INC.

20 BOULDER CRESCENT, STE 110
COLORADO SPRINGS, CO 80903
(719) 955-5485

PROJECT: 10-014 PAINT BRUSH HILLS FILLING 14

DATE: 5-31-2018

SIZE SPILLWAY Pond C



$$Q_{100} = 287.7 \text{ cfs} \quad C = 3.0$$

$$\text{EQN 12-20} \quad Q = CLH^{1.5} \quad Q = 3.0 (83') (1.0)^{1.5} = 249 \text{ cfs}$$

$$\text{EQN 12-21} \quad Q = CBH^{2.5} \quad Q = 3.0 (6.7) (1.0)^{2.5} = 20.1 \text{ cfs}$$

$$Q_{\text{TOTAL}} = 249 \text{ cfs} + 2(20.1 \text{ cfs}) = 289.2 \text{ cfs} \geq 287.7 \text{ cfs} \quad \text{OK}$$

Pond C Surface Vol.

$$\text{ACRES} = 123.51 \text{ ACRES} \quad \text{WATER SHED IMPERVIOUS} = 40\%$$

$$\text{TRIBUTARY IMPERVIOUS AREA} = 123.51 \times 40\% = 49.40 \text{ ACRES}$$

$$\text{FROM FIG 1 MICROPOOL AREA} = 200 \text{ SQ FT} \approx 200 \text{ SQ FT ACTUAL}$$

MINIMUM FOREBAY VOLUME

$$3\% \text{ OF WQEV} \quad 3\% \times 1.724 \text{ AC-FT} = 0.052 \text{ AC-FT} \times 43560 \frac{\text{cu-ft}}{\text{AC-FT}} = 2252.92 \text{ cu-ft}$$

$$2253 \text{ cu-ft} \div 1.5 \text{ ft} = 1502 \text{ SQ FT} \leq 1522 \text{ SQ FT} \quad \text{OK}$$

FOREBAY RELEASE & CONFIGURATION

$$\text{PEAK 100-YR DISCHARGE } Q_{100} = 142.6 \text{ cfs} \times 2\% \text{ EFFICIENCY} = 2.85 \text{ cfs}$$

$$\text{WEIR EQN } Q = CLH^{3/2} \quad C = 3.0 \quad \text{FOREBAY } 1.5 \text{ FT DEEP}$$

$$Q = 3.0 (0.52') (1.5)^{3/2} = 2.87 \text{ cfs} \geq 2.85 \text{ cfs} \quad \text{OK}$$

TRICKLE CHANNEL CAPACITY

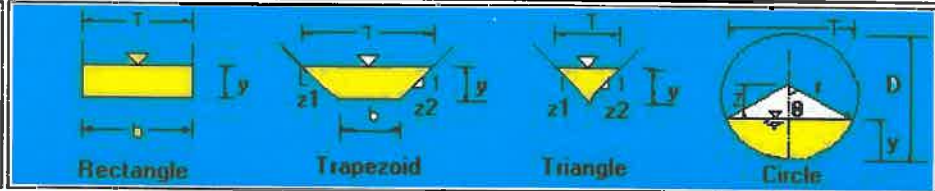
SEE OPEN CHANNEL FLOW CALCULATOR SHEET

LOW FLOW CHANNEL 6" H x 2' WIDE @ 0.5% SLOPE

The open channel flow calculator

Select Channel Type:

Trapezoid ▾



Velocity(V)&Discharge(Q) ▾

Select unit system: Feet(ft) ▾

Channel slope: 0.25

ft/ft

Water depth(y): 0.465

ft

Bottom width(b) 83

ft

Flow velocity 7.3195

ft/s

LeftSlope (Z1): 4 to 1 (H:V)

RightSlope (Z2): 4

to 1 (H:V)

Flow discharge 288.8258

ft³/s

Input n value 0.06 or select n

Calculate!

Status: Calculation finished

Reset

Wetted perimeter 86.83

ft

Flow area 39.46

ft²

Top width(T) 86.72

ft

Specific energy 1.3

ft

Froude number 1.91

Flow status Supercritical flow

Critical depth 0.72

ft

Critical slope 0.059

ft/ft

Velocity head 0.83

ft

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POND C SPILLWAY RUNDOWN



Material and Performance Specification Sheet

North American Green
14649 Highway 41 North
Evansville, IN 47725
800-772-2040
FAX: 812-867-0247
www.nagreen.com

A **tensar** Company

SC250 Turf Reinforcement Mat

The composite turf reinforcement mat (C-TRM) shall be a machine-produced mat of 70% straw and 30% coconut fiber matrix incorporated into a permanent three-dimensional turf reinforcement matting. The matrix shall be evenly distributed across the entire width of the matting and stitch bonded between a heavy duty UV stabilized netting with 0.50 x 0.50 inch (1.27 x 1.27 cm) openings, an ultra heavy UV stabilized, dramatically corrugated (crimped) intermediate netting with 0.5 x 0.5 inch (1.27 x 1.27 cm) openings, and covered by an heavy duty UV stabilized nettings with 0.50 x 0.50 inch (1.27 x 1.27 cm) openings. The middle corrugated netting shall form prominent closely spaced ridges across the entire width of the mat. The three nettings shall be stitched together on 1.50 inch (3.81cm) centers with UV stabilized polypropylene thread to form a permanent three-dimensional turf reinforcement matting.

The SC250 shall meet requirements established by the Erosion Control Technology Council (ECTC) Specification and the US Department of Transportation, Federal Highway Administration's (FHWA) *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-03 Section 713.18 as a type 5A, B, and C Permanent Turf Reinforcement Mat.*

Installation staple patterns shall be clearly marked on the turf reinforcement matting with environmentally safe paint. All mats shall be manufactured with a colored thread stitched along both outer edges (approximately 2-5 inches [5-12.5 cm] from the edge) as an overlap guide for adjacent mats.

Material Content		
Matrix	70% Straw / 30% Coconut fibers	0.35 lbs/yd ² (0.19 kg/m ²) / 0.15 lbs/yd ² (0.08 kg/m ²)
Nettings	Top and Bottom, UV stabilized Polypropylene	5 lb/1000 ft ² (2.44 kg/100 m ²)
	Middle, corrugated UV stabilized Polypropylene	24 lb/1000 ft ² (11.7 kg/100 m ²)
Thread	Polypropylene, UV stabilized	

SC250 is available in the following roll sizes:

Width	6.5 ft (2.0 m)
Length	55.5 ft (16.9 m)
Weight ± 10%	34 lbs (15.42 kg)
Area	40.0 yd ² (33.4 m ²)

Index Value Properties:

Property	Test Method	Typical	Net Only
Thickness	ASTM D6525	0.72 in (18.3 mm)	0.48 in
Resiliency	ASTM 6524	95.2%	—
Density	ASTM D792	0.53 oz/in ³	—
Mass/Unit Area	ASTM 6566	17.88 oz/yd ² (606 g/m ²)	—
Porosity	ECTC Guidelines	99%	—
Stiffness	ASTM D1388	222.65 oz-in	—
Light Penetration	ECTC Guidelines	8.9%	—
UV Stability	ASTM D4355/ 1000 hr	100%	100%
Tensile Strength MD	ASTM D6818	620 lbs/ft (9.05 kN/m)	655 lbs/ft
Elongation MD	ASTM D6818	35%	25%
Tensile Strength TD	ASTM D6818	737 lbs/ft (10.75 kN/m)	666 lbs/ft
Elongation TD	ASTM D6818	16%	16%

Bench Scale Testing* (NTPEP):

Test Method	Parameters	Results
ECTC Method 2 Rainfall	50 mm (2 in)/hr for 30 min	SLR** = 18.25
	100mm (4 in)/hr for 30 min	SLR** = 20.97
	150 mm (6 in)/hr for 30 min	SLR** = 22.74
ECTC Method 3 Shear Resistance	Shear at 0.50 inch soil loss	7.7 lbs/ft ²
ECTC Method 4 Germination	Top Soil, Fescue, 21 day incubation	523% improvement of biomass

* Bench Scale tests should not be used for design purposes

** Soil Loss Ratio = Soil loss with Bare Soil/Soil Loss with RECP (soil loss is based on regression analysis)

Updated 3/09

Performance Design Values:

Maximum Permissible Shear Stress		
	Short Duration	Long Duration
Phase 1 Unvegetated	3.0 lbs/ft ² (144 Pa)	2.5 lbs/ft ² (120 Pa)
Phase 2 Partially Veg.	8.0 lbs/ft ² (383 Pa)	8.0 lbs/ft ² (383 Pa)
Phase 3 Fully Veg.	10.0 lbs/ft ² (480 Pa)	8.0 lbs/ft ² (383 Pa)
Velocity Unveg	9.5 ft/s (2.9 m/s)	
Velocity Veg.	15 ft/s (4.6 m/s)	

Slope Design Data: C Factors			
	Slope Gradients (S)		
Slope Length (L)	≤ 3:1	3:1 – 2:1	≥ 2:1
≤ 20 ft (6 m)	0.0010	0.0209	0.0507
20-50 ft	0.0081	0.0266	0.0574
≥ 50 ft (15.2 m)	0.0455	0.0555	0.081

Roughness Coefficients- Unveg.	
Flow Depth	Manning's n
≤ 0.50 ft (0.15 m)	0.040
0.50 – 2.0 ft	0.040 – 0.012
≥ 2.0 ft (0.60 m)	0.011

Product Participant of:





PROJECT: PAINT BRUSH HILLS FILLING No. 14

DATE: 6-12-18

LOW TAILWATER REPPAP BASIN PIPE RUN #1

$$Q_{100} = 13.7 \text{ cfs} \quad 24" \text{ RCP}$$

PER FIGURE 9-37 LOW TAILWATER REPPAP BASIN (UDFCD)
FOR 24" PIPE REPPAP BASIN 15' L x 10' W

PER FIGURE 9-38 REPPAP BASIN PROTECTION (UDFCD)

Y_t/D ASSUMED 0.4

$$Q/D^{1.5} = 13.7/2^{1.5} = 4.84$$

FROM FIGURE 9-38 TYPE L REPPAP $D_{50} = 9"$

$$2D_{50} = 2(9") = \underline{18" \text{ THICK}}$$

LOW TAILWATER REPPAP BASIN PIPE RUN #25

$$Q_{100} = 144.9 \text{ cfs} \quad 48" \text{ RCP}$$

PER FIG 9-37 LOW TAILWATER REPPAP BASIN (UDFCD)
FOR 48" PIPE REPPAP BASIN 24' L x 19' W

PER FIGURE 9-38 REPPAP BASIN PROTECTION (UDFCD)

Y_t/D ASSUMED 0.4

$$Q/D^{1.5} = 144.9/4^{1.5} = 18.11$$

FROM FIGURE 9-38 TYPE H $D_{50} = 18"$

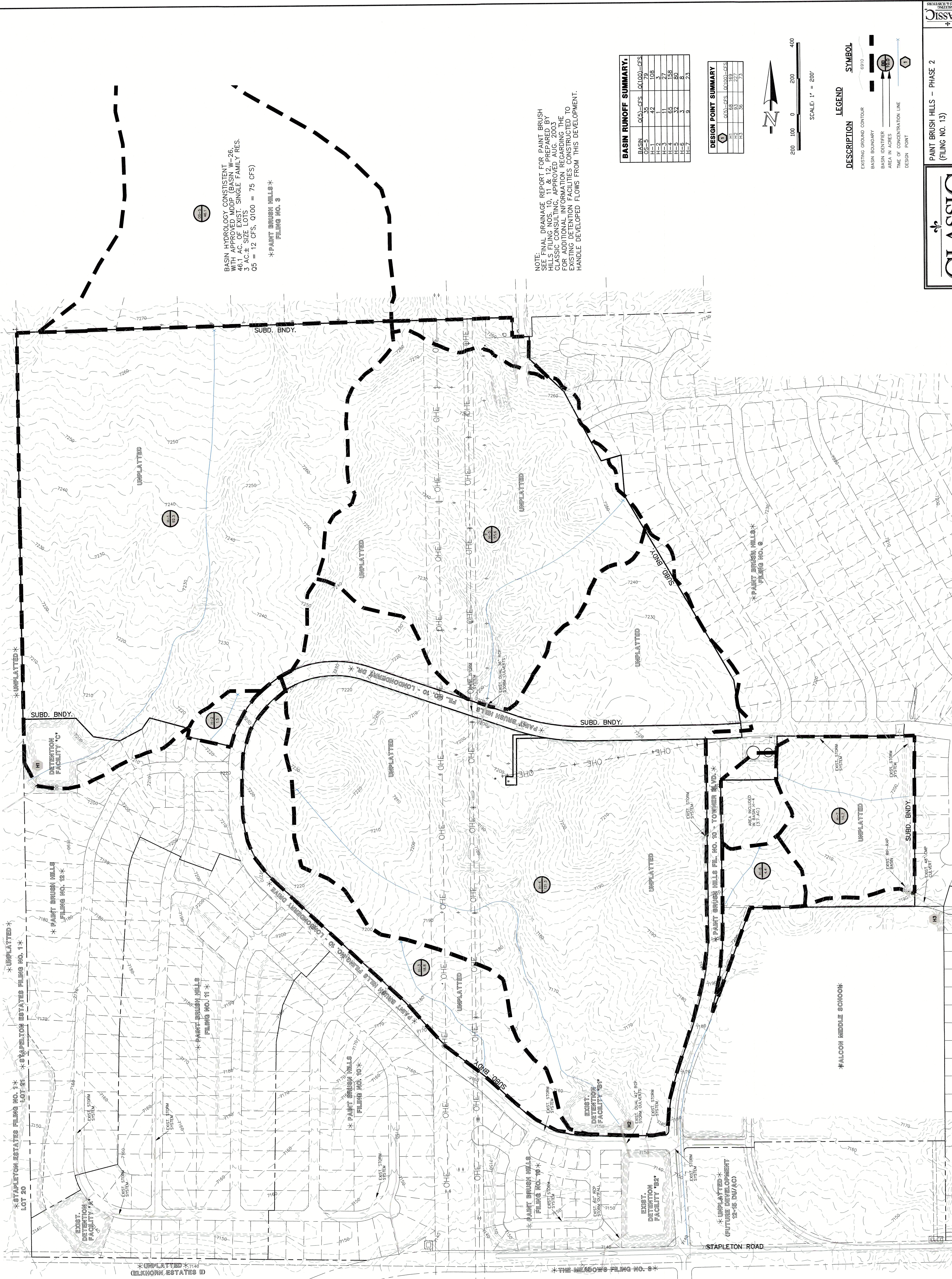
$$2D_{50} = 2(18") = \underline{36" \text{ THICK}}$$

PER "PAINT BRUSH HILLS FILLING 12" CONSTRUCTION PLANS

EXISTING REPPAP FOR OUTFALL 20' x 20' x 3' THICK ($D_{50} = 18"$)

EXISTING REPPAP PAD IS IN CONFORMANCE

**PROPOSED AND EXISTING DRAINAGE MAP
& REFERENCE MAPS**



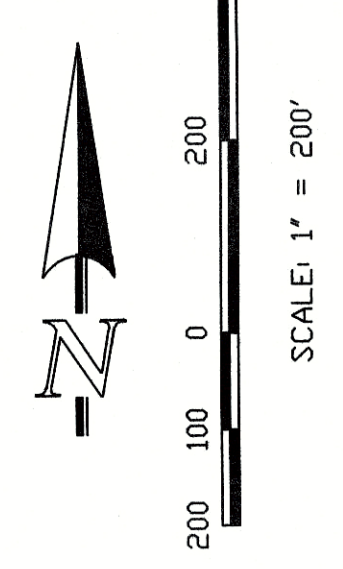
BASIN HYDROLOGY CONSTANT
WITH APPROVED MDDP (BASIN W-26,
46.1 AC OF EXIST. SINGLE FAMILY RES.
3 AC.± SIZE LOTS
Q5 = 12 CFS, Q100 = 75 CFS)

PAINT BRUSH HILLS
FILING NO. 3

NOTE:
SEE FINAL DRAINAGE REPORT FOR PAINT BRUSH
HILLS FILING NOS. 10, 11 & 12, PREPARED BY
CLASSIC CONSULTING, APPROVED AUG. 2008
FOR ADDITIONAL INFORMATION REGARDING THE
EXISTING DETENTION FACILITIES AND THE
HANDLE DEVELOPED FLOWS FROM THIS DEVELOPMENT.

BASIN RUNOFF SUMMARY.		
BASIN	Q(5)-CFS	Q(100)-CFS
OS-5	35	79
H-1	42	108
H-2	11	27
H-4	65	158
H-5	32	80
H-7	9	23

DESIGN POINT SUMMARY		
DESIGN POINT	Q(5)-CFS	Q(100)-CFS
1	83	207
2	93	227
3	113	286



DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
BASIN BOUNDARY	---
BASIN IDENTIFIER	○
AREA IN ACRES	100
TIME OF CONCENTRATION LINE	---
DESIGN POINT	△

CLASSICSM
CONSULTING
ENGINEERS & SURVEYORS

6335 Corporate Drive, Suite 101
Colorado Springs, Colorado 80919
(719) 785-0790
(719) 785-0798 (fax)

PAINT BRUSH HILLS – PHASE 2
(FILING NO. 13)

FINAL DRAINAGE REPORT
HISTORIC CONDITIONS DRAINAGE MAP

DESIGNED BY: MAM
DRAWN BY: MAM
CHECKED BY: (V)
DATE: 8/20/12
SCALE: (H) 1"= 200'
SHEET 1 OF 2
JOB NO.: 2053.21

FINAL DRAINAGE REPORT - BASIN RUNOFF SUMMARY																		
BASIN	CA(2)	WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY			TOTAL FLOWS		
		CA(5)	CA(100)	Q(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (ft/s)	Tc (min)		TOTAL (cfs)	I(2) (cfs/ft)	I(5) (cfs/ft)	I(100) (cfs/ft)	Q(2) (cfs)	Q(100) (cfs)
DD1	1.34	1.96	4.09	0.22	180	4	18.4	650	3.0%	6.1	1.8	18.2	2.58	3.23	5.43	3	6	22
DD2	0.76	0.99	1.66	0.30	130	2.6	13.1	450	3.0%	6.1	1.2	14.3	2.87	3.59	6.02	2	4	10
EE	0.68	0.89	1.49	0.30	50	1	8.1	1300	3.0%	6.1	3.6	11.7	3.11	3.89	6.54	2	3	10
FF	0.18	0.26	0.55	0.22	250	6	18.8	300	1.3%	4.0	1.3	20.1	2.47	3.08	5.18	0.4	0.8	3
GG	1.28	1.88	3.94	0.22	180	6	14.3	900	3.0%	6.1	2.5	16.8	2.68	3.35	5.62	3	6	22
HH	1.44	1.87	3.12	0.30	120	2.4	12.6	750	1.9%	4.3	2.9	15.5	2.77	3.47	5.83	4	6	18
I	0.95	1.23	2.06	0.30	150	3	14.1	360	1.9%	4.3	1.4	15.4	2.78	3.48	5.84	3	4	12
J	0.21	0.28	0.46	0.30	50	1	8.1	350	1.9%	4.3	1.4	9.5	3.36	4.21	7.07	0.7	1.2	3
KK	0.45	0.46	0.49	0.08	20	1	4.8	400	1.9%	4.3	1.6	6.4	3.83	4.80	8.05	2	2	4
LL	2.08	2.11	2.25	0.08	150	4	16.3	350	1.3%	4.0	1.5	17.8	2.61	3.27	5.48	5	7	12
MM	1.46	1.91	3.18	0.30	130	2.6	13.1	820	4.0%	7.0	1.2	14.3	2.87	3.59	6.02	4	7	19
NN	Not Used																	
OO	1.96	4.49	11.50	0.16	300	10	19.8	2200	2.0%	4.9	7.4	27.2	2.11	2.63	4.41	4	12	51
PP	0.43	0.63	1.20	0.16	300	10	19.8					19.8	2.48	3.11	5.22	1	2	6
QQ	0.78	1.01	1.69	0.30	150	3	14.1	1300	2.0%	4.9	4.4	18.5	2.57	3.21	5.39	2	3	9
RR	0.97	1.26	2.10	0.30	150	3	14.1	250	2.0%	4.9	0.8	14.9	2.82	3.53	5.69	3	4	12
SS	0.69	0.90	1.51	0.30	150	3	14.1	400	2.0%	4.9	1.3	15.4	2.78	3.48	5.84	2	3	9
TT	0.76	1.11	2.32	0.22	150	3	15.5	450	2.0%	4.9	1.5	17.0	2.66	3.33	5.60	2	4	13
UU	0.19	0.28	0.58	0.22	150	3	15.5	150	2.0%	4.9	0.5	16.0	2.74	3.43	5.75	1	1	3
VV	0.14	0.14	0.16	0.22	20	0.5	5.3					5.3	4.06	5.10	8.95	0.6	0.7	1.4
OS-1	1.02	1.33	2.22	0.30	150	3	14.1	450	3.9%	6.5	1.1	15.2	2.80	3.50	5.87	3	5	17
OS-2	2.09	2.73	4.55	0.30	150	3	14.1	1200	3.0%	6.1	3.4	17.5	2.63	3.29	5.52	6	9	25
OS-3	0.83	1.08	1.80	0.30	50	1	8.1	1100	3.0%	6.1	3.0	11.1	3.17	3.97	6.66	3	4	12

NOTES:
THIS MAP IS FOR DRAINAGE PURPOSES ONLY.
SEE GRADING PLAN FOR APPROPRIATE GRADING INFORMATION.

SCALE: 1" = 200'

POND D DESIGN DATA:
(SEE UD DETENTION WORKSHEET)

TRIBUTARY ACREAGE = 75.03 AC. @ 27% IMP
WQCV REQ. = 0.88 AC-FT
EURV REQ. = 2.06 AC-FT

RELEASE:
Q5 = 0.6 cfs @ WSE = 7203.84 (2.14 AC-FT)
Q100 = 64 cfs @ WSE = 7205.77 (5.94 AC-FT)

EMERGENCY SPILLWAY ELEV. = 7206.00
EMERGENCY OVERFLOW ELEV. = 7206.94
TOP OF EMBANKMENT ELEV. = 7208.00

POND D STRUCTURE DESIGN DATA:
PIPE RUN 35 - 36" RCP (21.54 AC. @ 34% IMP.)
FOREBAY DESIGN:
261 CF REQ. - 268 CF PROVIDED W/18 IN. DEPTH & 6 IN. NOTCH

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
1-800-922-1987
CITY OF COLORADO SPRINGS DEPT. OF UTILITIES
GAS, ELECTRIC, WATER AND WASTEWATER

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE
SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR
SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING
UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL
BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH
MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND
PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE
1	REVISED PER COUNTY COMMENTS	9-18-18
2	REVISED PER COUNTY COMMENTS	10-18-18

REVIEW:
PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF
CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, COLORADO P.E. #37155 DATE

CLASSIC
CONSULTING
ENGINEERS & SURVEYORS

619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903

(719)785-0790
(719)785-0799 (Fax)

PAINT BRUSH HILLS
FILING NO. 13E
FINAL DRAINAGE REPORT
PROPOSED CONDITIONS DRAINAGE MAP

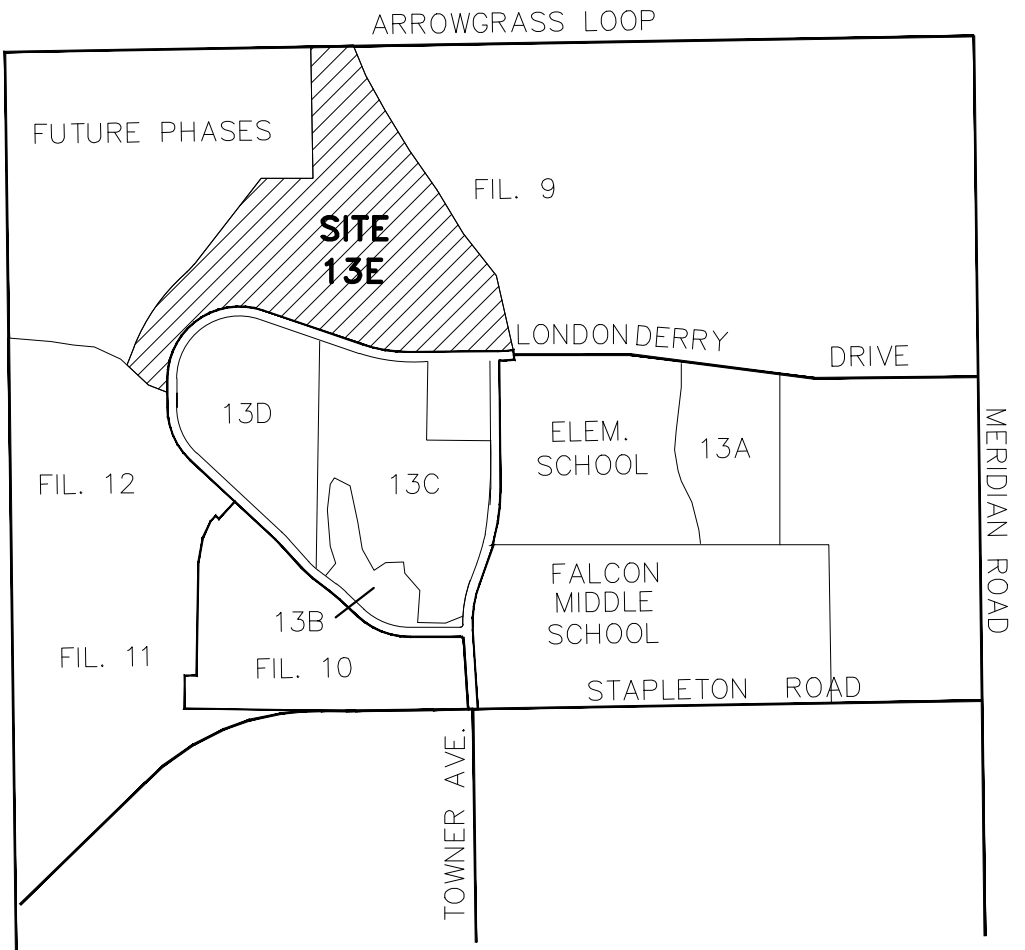
DESIGNED BY: MAW SCALE: DATE: 2/12/18
DRAWN BY: MAW (H) 1" = 200' SHEET 2 OF 2
CHECKED BY: (V) 1" = N/A JOB NO.: 2053.50

DESCRIPTION	LEGEND	SYMBOL
EXISTING GROUND CONTOUR	6910	
PROPOSED FINISHED CONTOUR	6910	
BASIN BOUNDARY		
DESIGN POINT		3
BASIN IDENTIFIER		BB
AREA IN ACRES		10.0
EXISTING DIRECTION OF FLOW		
PROPOSED DIRECTION OF FLOW		
PROPOSED STORM SEWER		
PROPOSED STORM SEWER INLETS		
STORM PIPE RUN SIZING		20
TIME OF CONCENTRATION		

FINAL DRAINAGE REPORT - SURFACE ROUTING SUMMARY									
Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Inlet Size
					I(5)	I(100)	Q(5)	Q(100)	
24	DD1	1.96	4.09	18.2	3.23	5.43	6	22	15" Type R At-Grade
25	DD2, DD1 Flowby	0.99	3.01	18.7	3.19	5.36	3	16	10" Type R Sump
26	EE	0.89	1.49	11.7	3.89	6.54	3	10	9" Type R Sump
27	GG, FF	2.15	4.49	20.1	3.08	5.18	7	23	10" Type R Sump
28	HH	1.87	3.12	15.5	3.47	5.83	6	18	10" Type R Sump
29	II, KK	1.69	2.54	15.4	3.48	5.84	6	15	10" Type R Sump
30	JJ	0.28	0.46	9.5	4.21	7.07	1	3	9" Type R Sump
31	LL, MM	4.01	5.42	17.8	3.27	5.48	13	30	Ex. 12" Type R
32	Not Used								
33	RR	1.26	2.10	14.9	3.53	5.93	4	12	9" Type R Sump
34	SS	0.90	1.51	15.4	3.48	5.84	3	9	10" Type R Sump
34A	Total Inflow to Pond D (See UD Detention Worksheet)							36	155
35	OS-2	2.73	4.55	17.5	3.29	5.52	9	25	15" Type R Future At-grade Inlet
36	OS-3	1.08	1.80	11.1	3.97	6.66	4	12	15" Type R Future At-grade Inlet
37	TT	1.11	2.32	17.0	3.33	5.60	4	13	15" Type R At-Grade
38 (Ultimate)	QQ and DP-35 and DP-36 Flow-by	1.17	3.69	18.0	3.25	5.45	4	20	15" Type R At-Grade
38 (Interim)	Portion of Basin QQ (40%)	0.40	0.67	10.0	4.13	6.93	2	5	15" Type R At-Grade
39	UU, WW	0.42	0.75	16.0	3.43	5.75	1	4	
	Northerly Forebay (PR-28, PR-37, OS-1, OS-3)	10.93	22.26	27.2	2.63	4.41	29	98	

FINAL DRAINAGE REPORT - PIPE ROUTING SUMMARY									
Pipe Run	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Velocity (ft/sec)
					I(5)	I(100)	Q(5)	Q(100)	
25	DP24 Pickup	1.96	2.74	18.2	3.23	5.43	6	15	24" RCP 10.6
26	DP25	0.99	3.01	18.7	3.19	5.36	3	16	24" RCP 7.8
27	PR25, PR26	2.95	5.75	18.9	3.18	5.33	9	31	30" RCP 9.2
28	DP26, PR27	3.84	7.23	19.2	3.15	5.29	12	38	30" RCP 16.4
29	DP27	2.15	4.49	20.1	3.08	5.18	7	23	30" RCP 8.6
30	DP28	1.87	3.12	15.5	3.47	5.83	6	18	24" RCP 8.0
31	PR29, PR30	4.02	7.61	20.6	3.05	5.11	12	39	36" RCP 9.8
32	DP29	1.69	2.54	15.4	3.48	5.84	6	15	24" RCP 7.7
33	DP30	0.28	0.46	9.5	4.21	7.07	1	3	18" RCP 5.1
34	PR32, PR33	1.97	3.00	15.6	3.46	5.81	7	17	30" RCP 8.0
35	PR31, PR34	5.99	10.61	21.3	3.00	5.03	18	53	36" RCP 9.5
36	DP33	1.26	2.10	14.9	3.53	5.93	4	12	24" RCP 7.3
37	DP34, PR36	2.16	3.61	15.7	3.45	5.79	7	21	24" RCP 8.2
38	Pick-up from Future At-grade inlets at DP-35 and DP-36	3.65	4.34	17.5	3.29	5.52	12	24	30" RCP 9.9
39	Pick-up from DP-38	1.17	2.55	18.0	3.25	5.45	4	14	24" RCP 9.9
40	PR-38, PR-39	4.82	6.89	18.0	3.25	5.45	16	38	30" RCP 13.1
41	Pick-up from DP-37	1.11	2.07	17.0	3.33	5.60	4	12	24" RCP 13.4
42 (Ultimate)	PR-40, PR-41	6.43	9.25	18.0	3.25	5.45	21	50	36" RCP 14.9
42 (Interim)	Collected flows from 15" at-grade inlets at Design Points 37 & 38	1.52	2.74	17.0	3.33	5.60	5	15	36" RCP 7.7

FLOOD PLAIN STATEMENT:
NO PORTION OF THIS SITE IS LOCATED WITHIN A FEMA FLOODPLAIN AS DETERMINED BY THE
FLOOD INSURANCE RATE MAPS (F.I.R.M.) MAP NUMBERS 0803C 0535F AND 0804C 0575,
WITH EFFECTIVE DATES OF MARCH 17, 1997 (SEE APPENDIX).



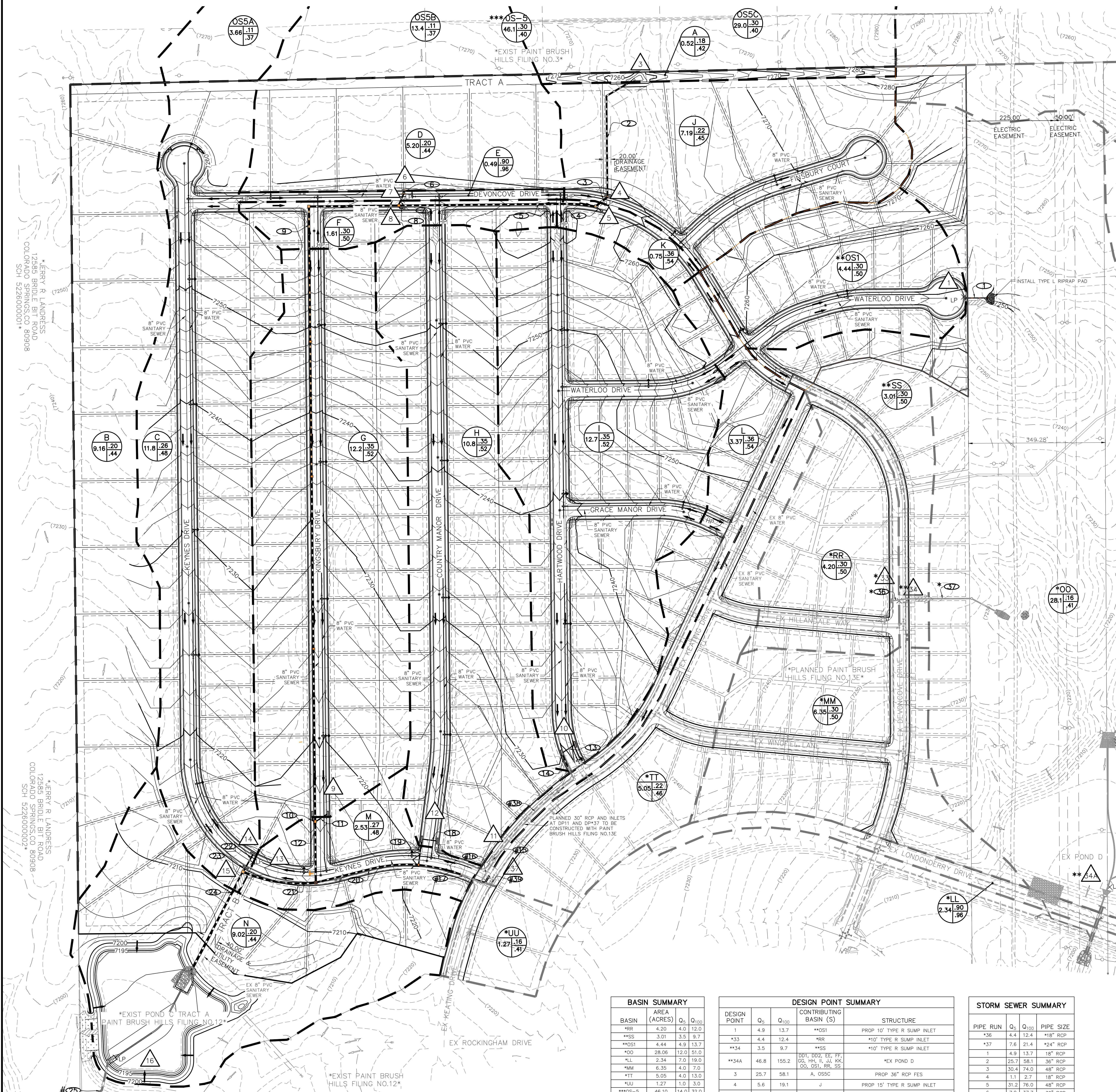
VICINITY MAP
N.T.S.

PAINT BRUSH HILLS FILING NO. 14

COUNTY OF EL PASO, STATE OF COLORADO

PROPOSED DRAINAGE MAP

JULY 2020



POND C EDB SUMMARY

EPC/URBAN DRAINAGE EDB	
WQ WATER SURFACE ELEV	7193.79
WQ VOLUME	1.724 AC-FT
EURV WATER SURFACE ELEV	7195.68
EURV VOLUME	4.945 AC-FT
100-YR WATER SURFACE ELEV	7198.00
100-YR VOLUME	9.490 AC-FT
SPILLWAY CREST ELEV	7198.00
TOP OF EMBANKMENT ELEV	7200.00
100-YR INFLOW	287.8 CFS
100-YR RELEASE	144.9 CFS

BASIN SUMMARY			
BASIN	AREA (ACRES)	Q ₅	Q ₁₀₀
**RR	4.20	4.0	12.0
**SS	3.01	3.5	9.7
**OSI	4.44	4.9	13.7
**O	28.06	12.0	51.0
*L	2.26	2.3	19.0
*M	3.55	3.0	10.0
*T1	4.05	4.0	13.0
*U1	1.27	1.0	3.0
**OS5=5	4.61	14.0	32.0
OS5A	36.10	14.0	32.0
OS5B	13.44	4.6	25.8
OS5C	29.00	25.5	57.0
A	0.52	1.8	4.2
B	9.16	8.2	22.6
C	11.80	9.2	28.9
D	5.20	3.8	14.0
E	0.49	2.3	4.1
F	1.61	1.9	5.4
G	12.20	14.0	34.8
H	10.78	11.9	29.7
I	12.70	14.3	36.2
J	7.19	5.6	19.1
K	0.75	1.1	2.7
L	3.37	3.8	9.5
M	2.53	2.6	7.8
N	9.02	6.2	23.2