Revise to
Preliminary/Final
Drainage Report

FINAL DRAINAGE REPORT

FOR

PAINT BRUSH HILLS FILING NO. 14

EL PASO COUNTY, COLORADO

June 2018

Prepared for:

The Landhuis Company
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Prepared by:

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Project #10-014
PCD Project # PPR

SP206 & SF2024

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 master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

____
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 El Paso County Engineering Criteria Manual, as amended.

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

CONDITIONS

update to
preliminary/final
drainage report

FINAL DRAINAGE REPORT

FOR

PAINT BRUSH HILLS FILING NO. 14

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APPENDIX

FINAL DRAINAGE REPORT

FOR

insert "Preliminary and"

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.

Update reference to the current effective FIRM.

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

Update to match the four-step listed in ECM Appendix I Section I.7.2

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.

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 un-named tributaries. The developed discharge from the site is anticipated to be less that 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 reseeding 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=3.5 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.

Add narrative for basin H-5. It appears a portion of Filing 14 is within sub-basin H-5

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 ""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. 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.

Revise reference to "Final Drainage Report for Paint Brush Hills Filing 13E" dated Sep 2018.
See PCD File No SF189 for the approved report. Update any reference values that may have changed from the preliminary to the the final drainage report

Detailed Drainage Discussion

identify who' responsible for maintenance of the drainage swale.

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=25.2 cfs, Q_{100}=56.8 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 6' 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 24" 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 a planned 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 a proposed 15' Type R at-grade inlet. The intercepted flow (Q_5=3.7 cfs, Q_{100}=13.5 cfs) will be routed east via a 24" RCP pipe (**PR15,** 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 **PR15** and **PR#16** are to be constructed as part of the Paint Brush Hills Filing No. 13E infrastructure.

add the "#" sign for PR15

Basin *TT, 5.05 acres, (Q_5=3.7 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 a planned 15' Type R at-grade inlet. The intercepted flow (Q_5=3.7 cfs, Q_{100}=11.5 cfs) will be routed west via a 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 proposed 30" RCP pipe (**PR17,** 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}=5.5 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 (Q_5=6.2 cfs, Q_{100}=27.7 cfs per side) will be routed south via a 30" RCP pipe (**PR22,** Q_5=6.2 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**, Q5=3.6 cfs and Q100=144.9cfs ~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 Q5=22 cfs an[d Q100=161 cfs. Flows will not adversely affect] the downstream infrastructure.

100% of the development site must be treated for water quality. Provide permanent stormwater quality control measure for basin B.

Basin Tributary to Adjacent Property to the West

Basin B, 9.16 acres, (Q_5=6.2 cfs, Q_{100}=22.9.0 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 "Preliminary Drainage Report for Paint Brush Hills Filing NO. 13E (PDRPBH-13E)"

Update reference to the final drainage report for PBH Fil 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 24" 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 Q5=102.2 cfs and Q100=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	97	LF	$40	/LF	$3,880.00
2.	24"RCP	132	LF	$50	/LF	$6,600.00
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.	24"FES	1	EA	$350	/EA	$350.00
10.	36"FES	1	EA	$775	/EA	$775.00
11.	60"END TREATEMENT HEADWALL/W ING WALLS	1	EA	$15000/	/EA	$15,000.00
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 $	**$740,010.00**

Revise. Per the general description Fil 14 is only 88.63 ac.

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		
2018 Drainage Fees:	123.51	x	40%	x	$27,762.00	=	$1,371,553.85
2018 Bridge Fees:	123.51	x	40%	x	$3,814.00	=	$188,426.86
						Total	**$1,559,980.71**

Revise fees to the current 2020 fees.

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 2018.

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.

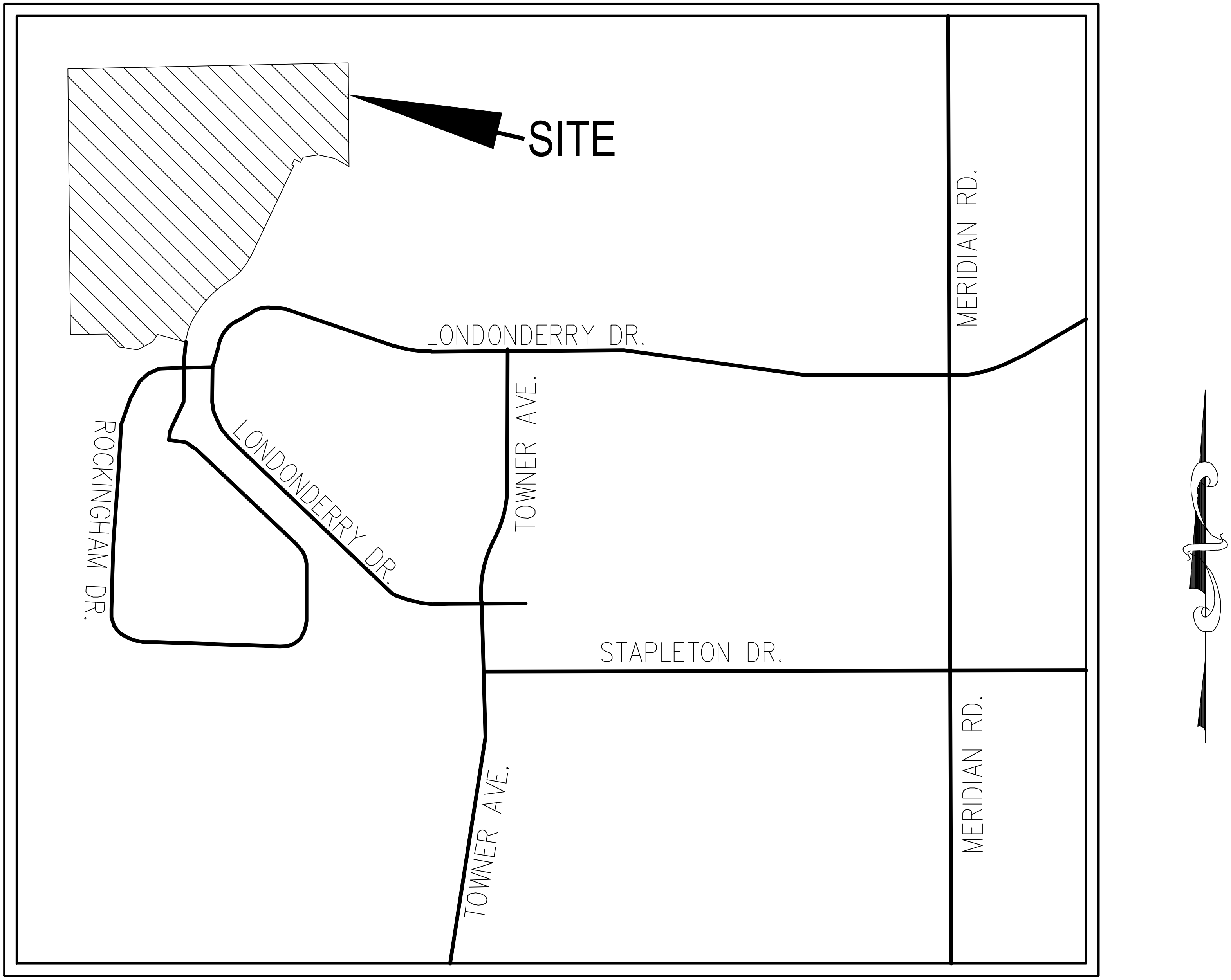
6.) “Final Drainage Report for Paint Brush Hill Filing Nos. 10, 11 & 12” prepared by Classic Consulting Engineers and Surveyors, rev. July 2003.

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.) “Preliminary Drainage Report for Paint Brush Hills Filing 13E (Pre-Development Grading Plan)”, prepared by Classic Consulting Engineers and Surveyors, submitted on February 2018.

APPENDIX

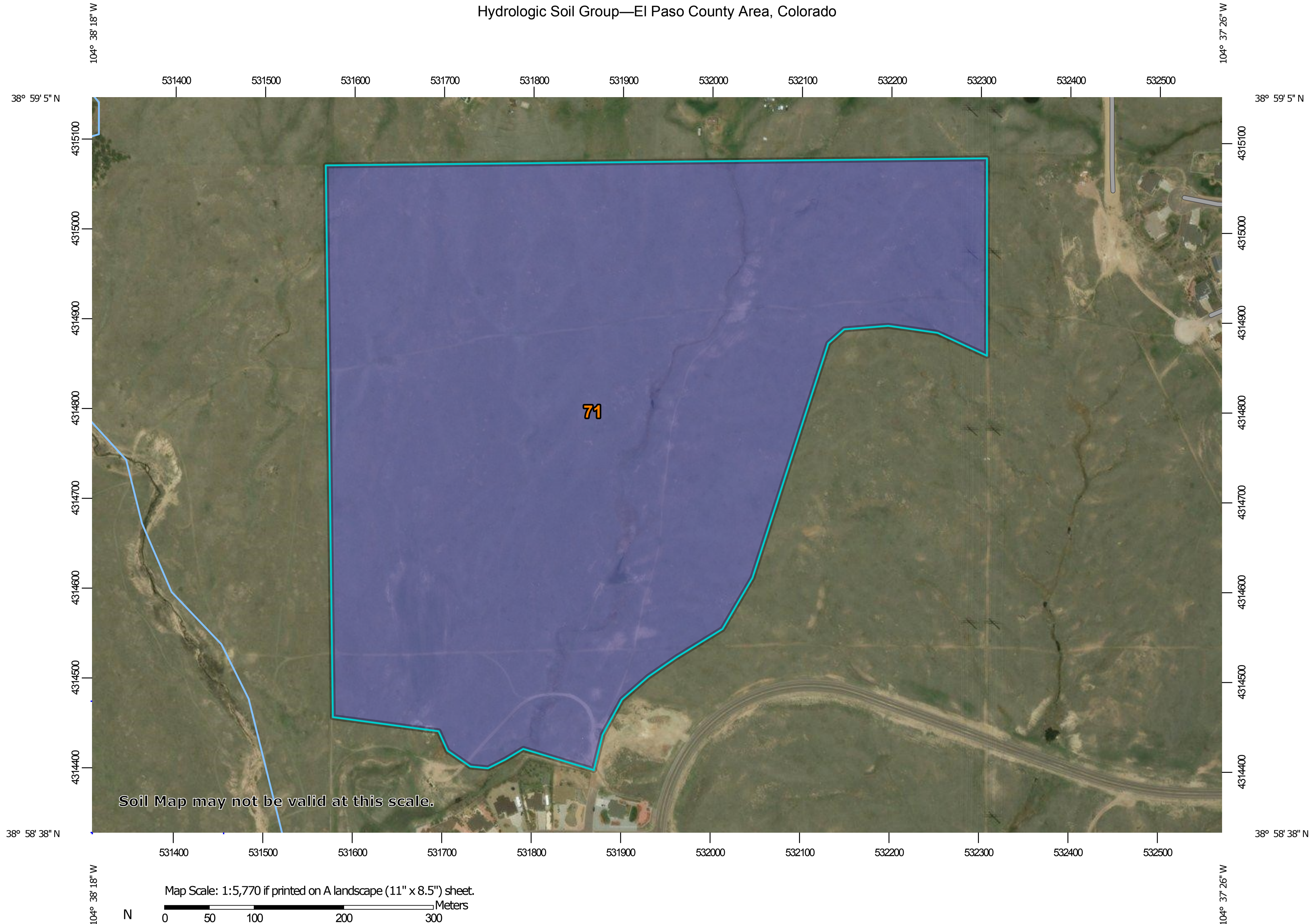
VICINITY MAP



VICINITY MAP

N.T.S.

SOILS MAP



Map Scale: 1:5,770 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 50, 100, 200, 300

Feet: 0, 250, 500, 1000, 1500

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

MAP LEGEND

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

Soils

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 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

Replace the firmette with the current effective FIRM

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) COMMUNITY NO.: 080059	BRIDGE CHANNELIZATION CULVERT	FLOODWAY HYDRAULIC ANALYSIS NEW TOPOGRAPHIC DATA
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

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)

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.

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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.

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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.

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.

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Engineering Management Branch
Federal Insurance and Mitigation Administration

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Sand Creek (cont'd)								
CA	65,292	164	427	6.1	6,748.7	6,748.7	6,749.4	0.7
CB	66,092	41	223	11.7	6,761.2	6,761.2	6,762.2	1.0
CC	66,247	90	270	9.6	6,773.6	6,773.6	6,773.7	0.1
CD	67,647	50	218	11.9	6,782.6	6,782.6	6,783.3	0.7
CE	68,297	65	284	8.8	6,793.9	6,793.9	6,794.4	0.5
CF	69,147	50	213	11.7	6,804.5	6,804.5	6,804.5	0.0
CG	70,157	50	213	11.7	6,815.1	6,815.1	6,815.3	0.2
CH	70,577	205	347	7.2	6,823.9	6,823.9	6,824.5	0.6
CI	70,627	180	267	9.4	6,826.7	6,826.7	6,827.7	1.0
CJ	70,727	210	340	7.3	6,831.1	6,831.1	6,831.1	0.0
CK	70,807	195	334	7.5	6,832.5	6,832.5	6,832.5	0.0
CL	71,162	90	255	9.8	6,838.0	6,838.0	6,839.0	1.0
CM	71,977	226	503	5.2	6,847.4	6,847.4	6,848.3	0.9
CN	73,052	174	328	7.9	6,861.1	6,861.1	6,861.2	0.1
CO	73,644	237	364	7.1	6,870.2	6,870.2	6,870.2	0.0
CP	75,142	196	345	7.5	6,888.6	6,888.6	6,888.6	0.0
CQ	76,161	109	283	9.2	6,903.5	6,903.5	6,903.7	0.2
CR	77,846	100	272	9.6	6,926.1	6,926.1	6,926.7	0.6
CS	79,187	117	287	9.1	6,944.1	6,944.1	6,944.1	0.0
CT	80,808	102	277	9.4	6,969.2	6,969.2	6,969.4	0.2

REVISED BY LOMR DATED
DECEMBER 07, 2005

REVISED AREA

1Feet Above Confluence With Fountain Creek

TABLE 5

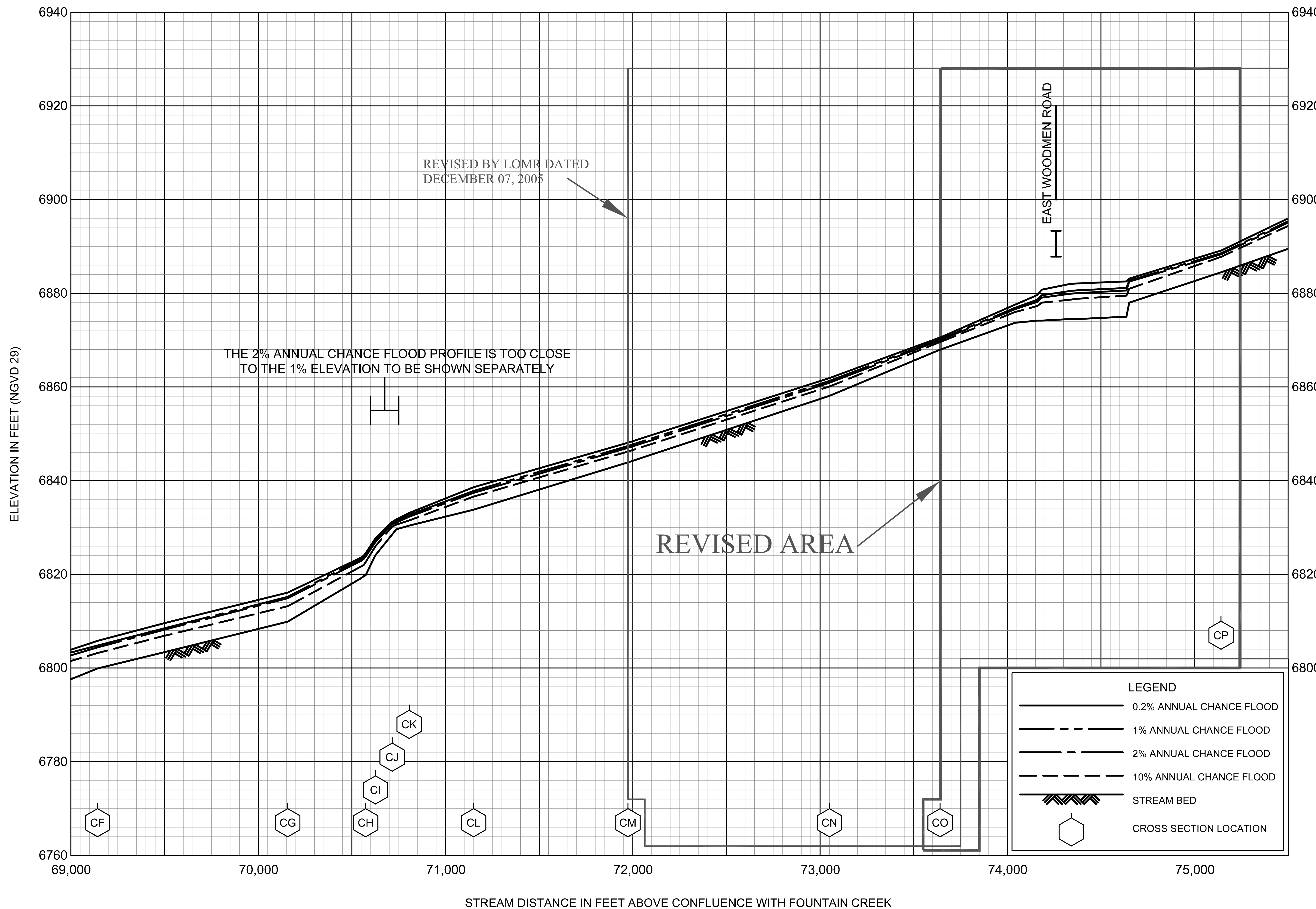
FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, CO
AND INCORPORATED AREAS

FLOODWAY DATA

REVISION TO REFLECT LOMR EFFECTIVE: February 28, 2013

SAND CREEK



FLOOD PROFILES

SAND CREEK

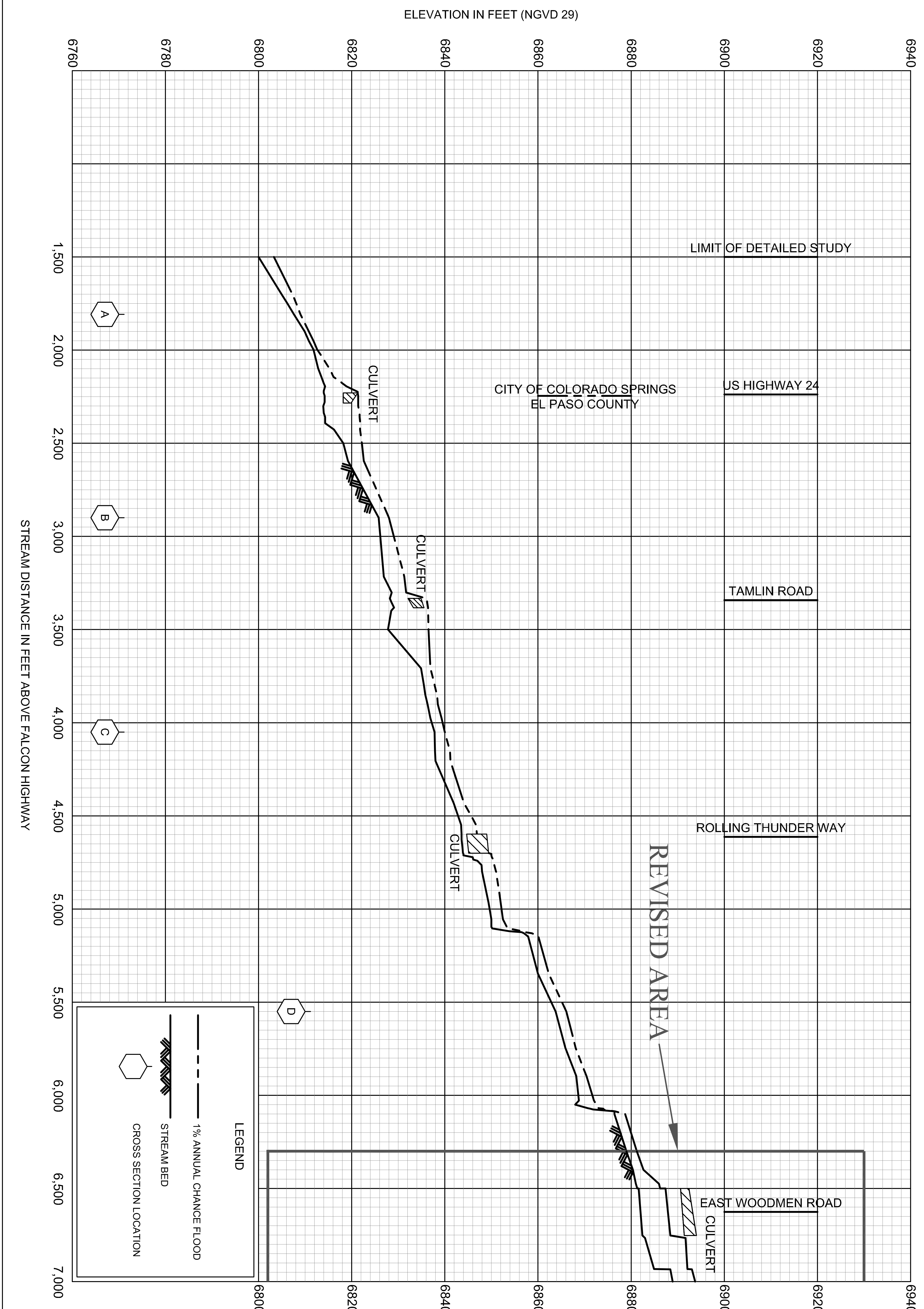
REVISION TO REFLECT LOMR EFFECTIVE: February 28, 2013

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, CO

AND INCORPORATED AREAS

204P



343P(a)

FEDERAL EMERGENCY MANAGEMENT AGENCY

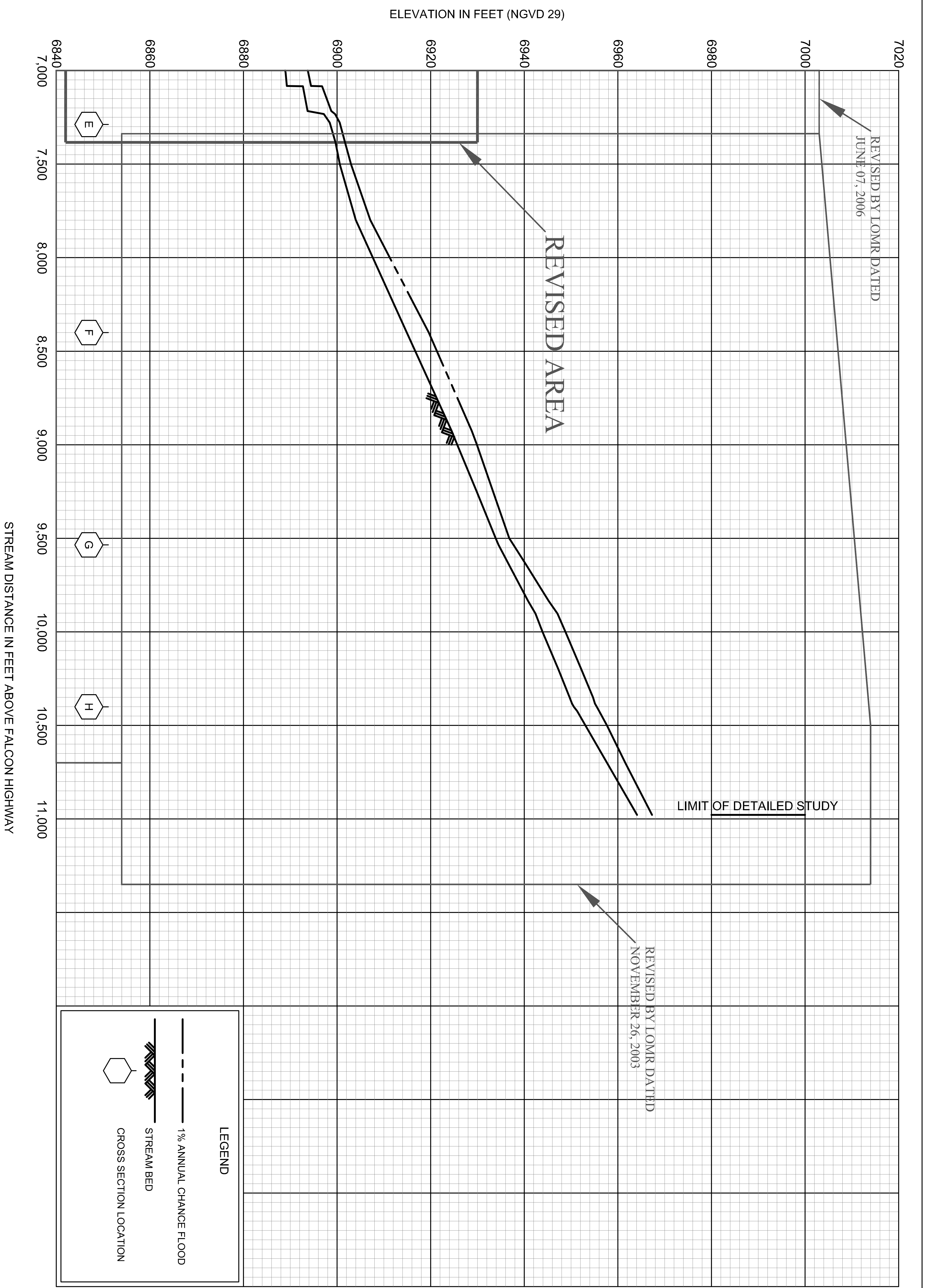
EL PASO COUNTY, CO

AND INCORPORATED AREAS

REVISION TO REFLECT LOMR EFFECTIVE: February 28, 2013

FLOOD PROFILES

UNNAMED TRIBUTARY TO BLACK SQUIRREL CREEK NO.2



FEDERAL EMERGENCY MANAGEMENT AGENCY

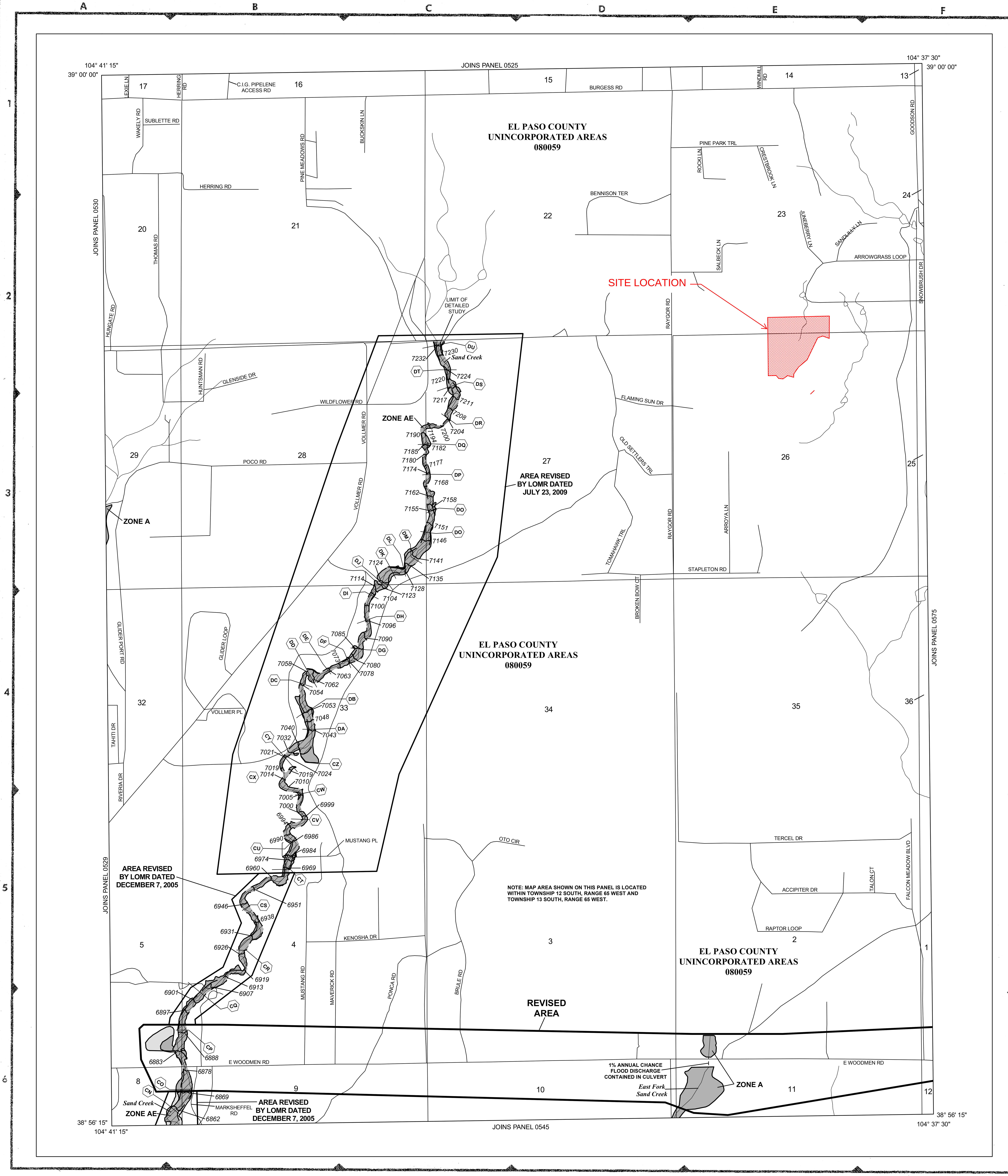
EL PASO COUNTY, CO

AND INCORPORATED AREAS

REVISION TO REFLECT LOMR EFFECTIVE: February 28, 2013

FLOOD PROFILES

UNNAMED TRIBUTARY TO BLACK SQUIRREL CREEK NO.2



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

- **ZONE A** No base flood elevations determined.
- **ZONE AE** Base flood elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- **ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE A99** To be protected from 100 year flood by Federal flood protection system under construction; no base elevations determined.
- **ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- **ZONE VE** Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- **ZONE X** Areas of 500-year flood; areas of 100 year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside 500-year floodplain.
- **ZONE D** Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 — Identified 1990 — Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

- Flood Boundary
- Floodway Boundary
- Zone D Boundary
- Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.
- ~513~ Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.
- (D)——(D) Cross Section Line
- (EL 987) Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.
- RM7 × Elevation Reference Mark
- • M2 River Mile
- 97°07'30", 32°22'30" Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

Coastal base flood elevations apply only landward of 0.0 NGVD, and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of Special Flood Hazard (100-year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

This map may incorporate approximate boundaries of Coastal Barrier Resource System Units and/or Otherwise Protected Areas established under the Coastal Barrier Improvement Act of 1990 (PL 101-591).

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels and base map source see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Map Index

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

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE DATE shown on this map to determine when actuarial rates apply to structures in zones where elevations or depths have been established.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE IN FEET
1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 535 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

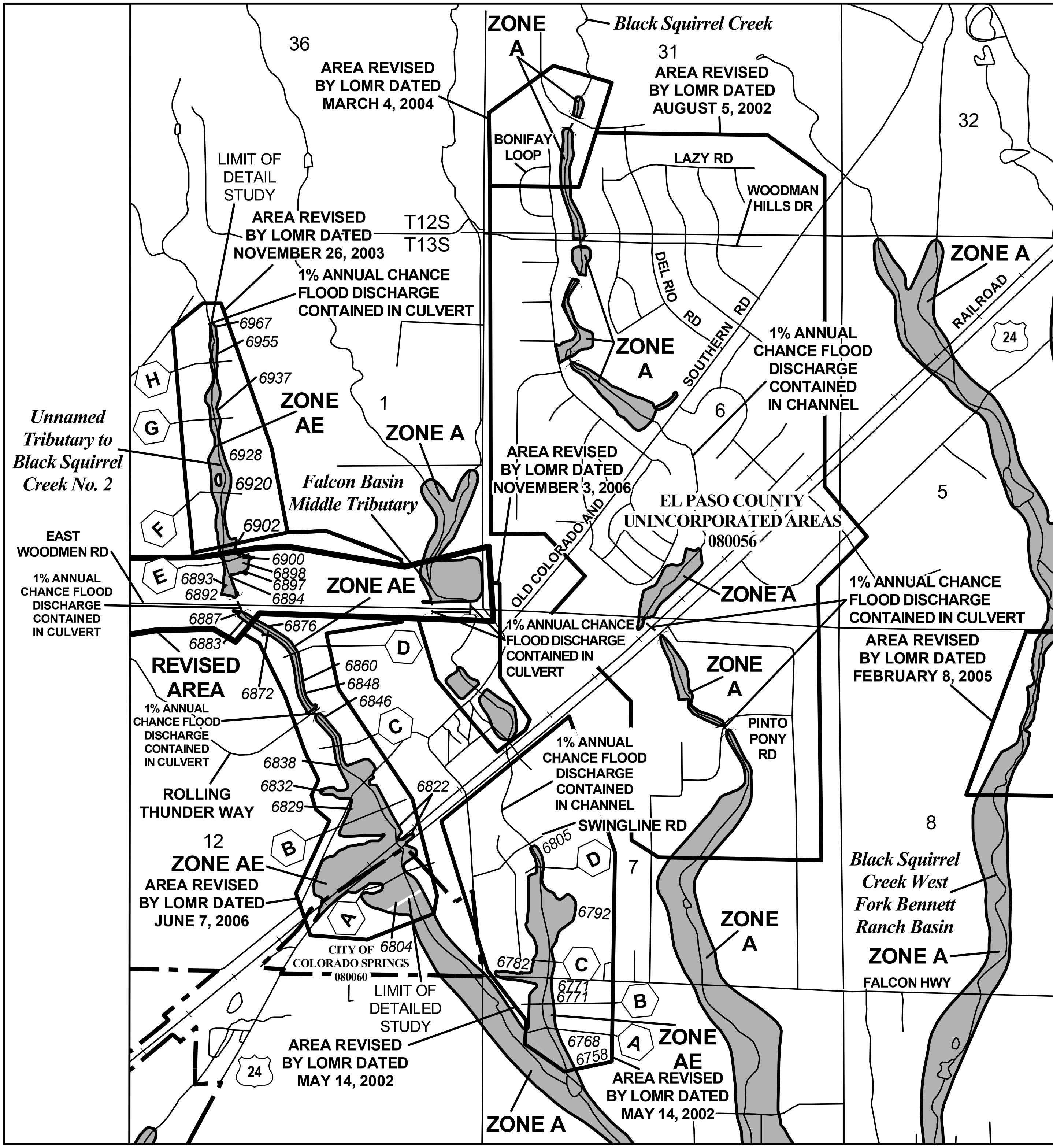
COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0535	F

REVISION TO REFLECT LOMR EFFECTIVE: February 28, 2013

MAP NUMBER
08041C0535 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency



Legend

1% annual chance (100-Year) Floodplain

1% annual chance (100-Year) Floodway

0.2% annual chance (500-Year) Floodplain

MAP SCALE 1" = 2000'

1000 0 2000 FEET

600 0 600 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	080059	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)

			IMPERVIOUS AREA/STREET			LANDSCAPED/UNDEVELOPED			RESIDENTIAL			WEIGHTED	
BASIN	TOTAL AREA (Sq Ft)	TOTAL AREA (Acres)	AREA (Acres)	C_5	C_{100}	AREA (Acres)	C_5	C_{100}	AREA (Acres)	C_5	C_{100}	C_5	C_{100}
*DD1	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
*GG	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
*FF	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
*HH	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
*II	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
*DD2	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
*KK	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
*JJ	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
*EE	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
*RR	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
**SS	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
**OS1	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
*OO	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
*LL	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
*MM	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
*TT	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
*UU	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
***OS-5	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
OS5A	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
OS5B	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
OS5C	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
A	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
B	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
C	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
D	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
E	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
F	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
G	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
H	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	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
J	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
K	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
L	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
M	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
N	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 "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (*PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Feb 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: 5/18/2018
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} (From DCM Table 5-1)	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	16.0
*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												7.6	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

*Values taken from "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (*PDRPBH13E) prepared by Classic Consulting Engineers and Surveyors, dated Feb 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: 5/21/2018
ked by: VAS

#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

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		
DESIGN POINT	CONTRIBUTING BASINS	CA_5	CA_{100}	C_5	Length (ft)	Height (ft)	T_C (min)	Length (ft)	Slope (%)	Velocity (fps)	T_t (min)	TOTAL (min)	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (c.f.s.)	Q_{100} (c.f.s.)	COMMENTS
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 W/18" RCP
**33*	*RR	1.26	2.10									14.9	3.5	5.9	*4.4*	*12.4*	*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
***34A*	EX POND D DD1,DD2,EE,OO,RR,SS FF,GG,HH,II,JJ,KK,OS1	17.93	35.18									37.2	2.6	4.4	*46.8*	*155.2*	EX POND D *PDRPBH13E *Q_5 = 47 cfs, *Q_{100} = 155 cfs
3	A OS5C	0.09 8.70 8.79	0.22 11.60 11.82									22.3	2.9	4.9	*25.7*	*58.1*	PROP 36" RCP FES
4	J	1.56	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 1.04 2.52	4.97 2.29 7.26									19.9	3.1	5.2	*7.8*	*37.7*	PROP 2.9'-8.0' CDOT MOD TYPE D INLET W/30" RCP
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 FLOWS SPLIT @ DP10
11	L Flowby DP10	1.21 0.00 1.21	1.82 1.49 3.31									20.4	3.1	5.1	*3.7*	*17.0*	PROP. 15' AT-GRADE TYPE R INLET W/24" RCP
**37*	*TT	1.11	2.12									17.0	3.3	5.6	*3.7*	*13.0*	PROP DUAL 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 FLOWS SPLIT @ DP12
13	M FLOWBY DP9 FLOWBY DP12 FLOWBY DP11	0.68 0.00 0.00 0.00 0.68	1.21 1.35 0.90 0.68 4.15									20.4	3.1	5.1	*2.1*	*21.3*	SEE DP15 FOR CUMMULATIVE FLOW
14	C OS5A	3.07 0.40 3.47	5.66 1.36 7.02									21.8	3.0	5.0	*10.3*	*34.8*	SEE DP15 FOR CUMMULATIVE FLOW
15	DP13 DP14	0.68 3.47 4.15	4.15 7.02 11.16									21.8	3.0	5.0	*12.3*	*55.4*	PROP DUAL 20' SUMP TYPE R INLET W/30" & 36"RCP FLOWS SPLIT @ DP15
16	N PR24	1.79 33.17 34.96	3.99 54.66 58.65									22.3	2.9	4.9	*102.2*	*287.8*	EX. POND C

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

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**** "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: 5/21/2018
Checked by: VAS

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

PIPE RUN	Contributing Pipes/Design Points	Equivalent CA_5	Equivalent CA_{100}	Maximum T_C	Intensity* I_5	I_{100}	Flow Q_5	Q_{100}	PIPE SIZE
*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	**30" 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	PR17, 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 "Preliminary Drainage Report for Paint Brush Hills Filing 13E" (*PDRPBHI3E) prepared by Classic Consulting Engineers and Surveyors, dated February 2018*

 # Values adjusted from FDRPBH-PH2-13

DP - Design Point
EX - Existing Design Point

FB- Flow By from Design Point
INT- Intercepted Flow from Design Point

Calculated by: GT
Date: 5/24/2018
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	Eqn. 7-32	Eqn. 7-29
			$Q_w=C_wN_wL_eD^{3/2}$	$Q_o=C_oN_o(L_eH_c)(2g(D-0.5H_c))^{1/2}$	$Q_m=C_m(Q_wQ_o)^{1/2}$
5	Q_5	0.43	5.1	5.7	5.0
5	Q_{100}	0.66	9.7	8.6	8.5
6	Q_5	0.43	6.1	6.8	6.0
6	Q_{100}	0.66	11.6	10.3	10.2
8	Q_5	0.43	8.1	9.1	8.0
8	Q_{100}	0.66	15.4	13.8	13.6
10	Q_5	0.43	10.2	11.4	10.0
10	Q_{100}	0.66	19.3	17.2	17.0
12	Q_5	0.43	12.2	13.7	12.0
12	Q_{100}	0.66	23.2	20.7	20.3
14	Q_5	0.43	14.2	16.0	14.0
14	Q_{100}	0.66	27.0	24.1	23.7
15	Q_5	0.43	15.2	17.1	15.0
15	Q_{100}	0.66	29.0	25.8	25.4
16	Q_5	0.43	16.2	18.2	16.0
16	Q_{100}	0.66	30.9	27.5	27.1
18	Q_5	0.43	18.3	20.5	18.0
18	Q_{100}	0.66	34.7	31.0	30.5
20	Q_5	0.43	20.3	22.8	20.0
20	Q_{100}	0.66	38.6	34.4	33.9

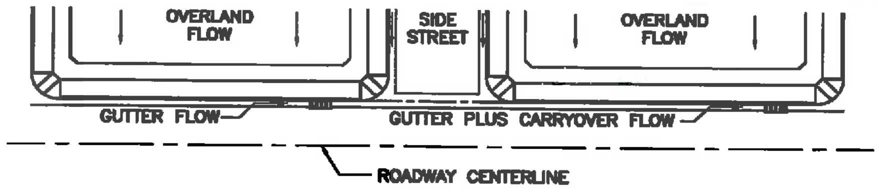
Table 7-7. Coefficients for various inlets in sumps

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

Worksheet Protected

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



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	Major Storm	
*Q_{Known} =	4.9	13.7	cfs

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

<-- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <--

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) * C_3$

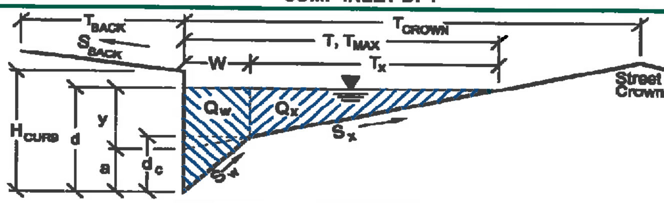
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	4.9	13.7	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 DP1



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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	**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

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	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 =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**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

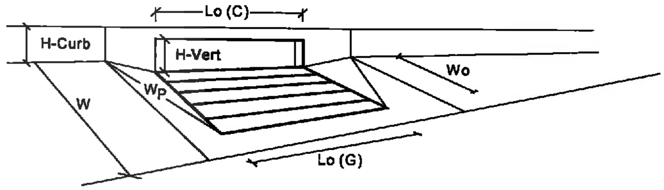
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	cfs

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 DP1



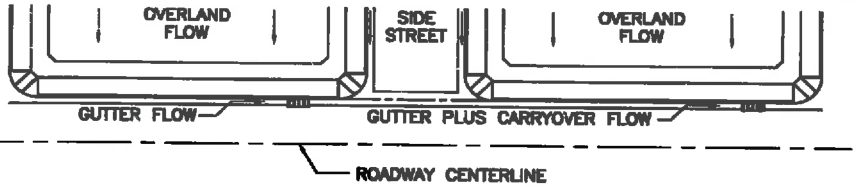
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2.0	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	8.7	19.0	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.9	13.7	cfs

Worksheet Protected

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



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	$*Q_{Known}$ =	3.5	9.7	cfs

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

←--- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. ←---

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)$ ^ C_3

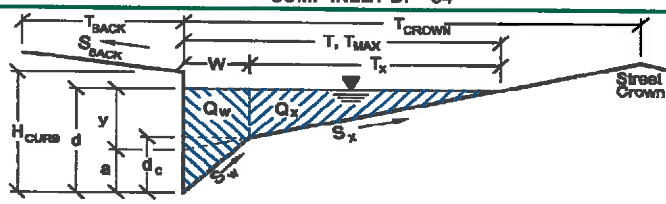
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	3.5	9.7	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 DP**34



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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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		Minor Storm	Major Storm	
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 * 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 =	**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		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X TH}$	$Q_{X TH}$ =	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 =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**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	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	cfs

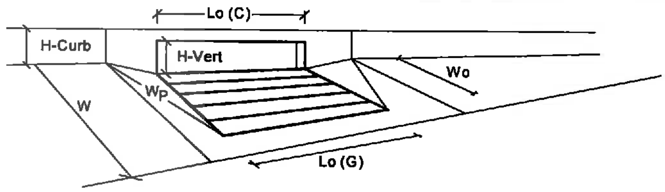
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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 DP**34

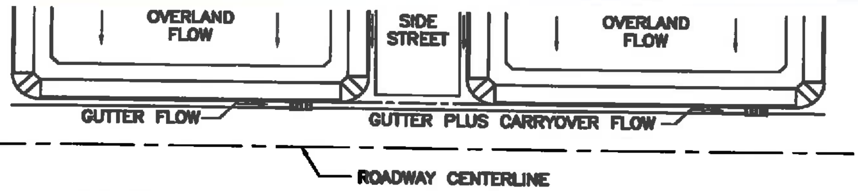


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2.0	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	8.7	19.0	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.5	9.7	cfs

Worksheet Protected

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:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	$^*Q_{Known}$ =	5.6	19.1	cfs

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

<-- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <--

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

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

Site Type:
- O Site is Urban
- O Site is Non-Urban

Flows Developed For:
- O Street Inlets
- O Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

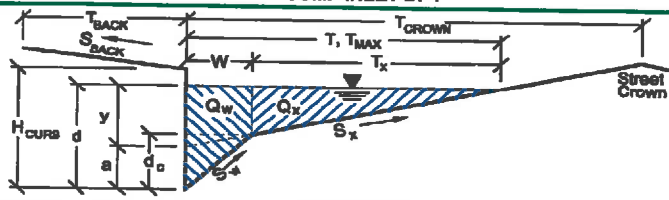
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	5.6	19.1	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 DP4



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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	**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

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	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 ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**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} =	**SUMP**	**SUMP**	**cfs**

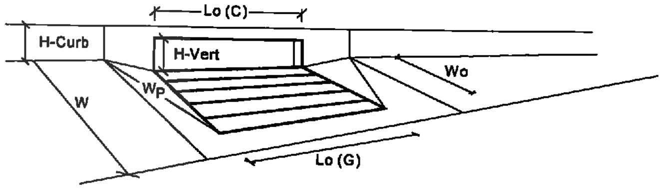
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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 DP4

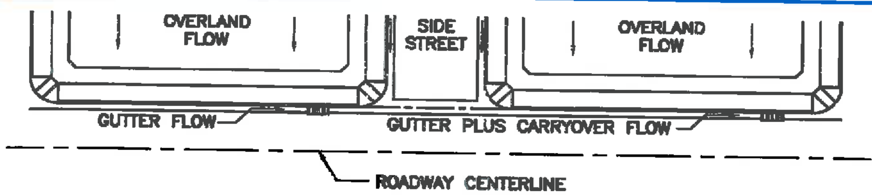


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	3.0	3	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	11.1	27.3	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	5.6	19.1	cfs

Worksheet Protected

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



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	Major Storm	
*Q_{Known} =	1.1	2.7	cfs

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

<--- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <---

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

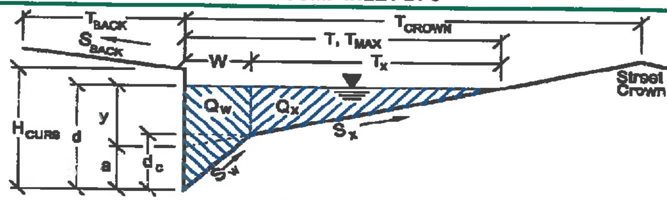
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	1.1	2.7	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 DP5



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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	**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

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	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 ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**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	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	cfs

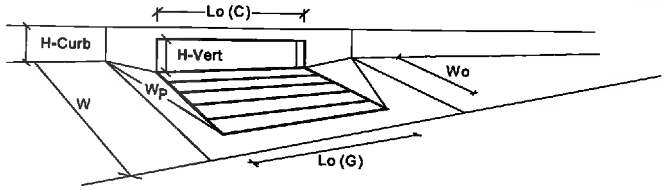
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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 DP5

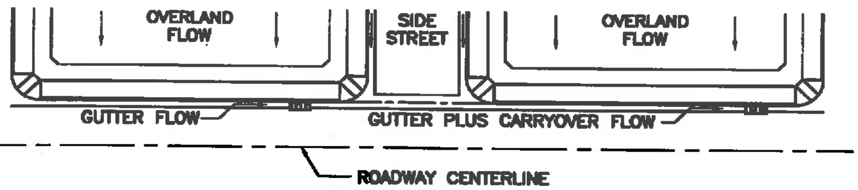


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1.0	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	4.6	9.1	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.1	2.7	cfs

Worksheet Protected

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



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	$*Q_{Known}$ =	7.8	37.7	cfs

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

<--- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <---

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

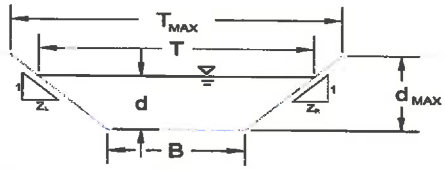
Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)$ ^ C_3

	Minor Storm	Major Storm	
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 =	0.0	0.0	cfs
Total Design Peak Flow, Q =	7.8	37.7	cfs

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)	A, B, C, D or E	E	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0132	ft/ft
Bottom Width	B =	4.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft

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

Choose One:
- (●) Sandy
- ( ) Non-Sandy

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	8.20	12.10	feet
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	0.52	1.01	feet

Maximum Channel Capacity Based On Allowable Top Width

		Minor Storm	Major Storm	
Max. Allowable Top Width	T_{MAX} =	8.20	12.10	ft
Water Depth	d =	0.70	1.35	ft
Flow Area	A =	4.27	10.87	sq ft
Wetted Perimeter	P =	8.43	12.54	ft
Hydraulic Radius	R =	0.51	0.87	ft
Manning's n based on NRCS Vegetal Retardance	n =	0.033	0.025	
Flow Velocity	V =	3.35	6.14	fps
Velocity-Depth Product	VR =	1.69	5.32	ft^2/s
Hydraulic Depth	D =	0.52	0.90	ft
Froude Number	Fr =	0.82	1.14	
Max. Flow Based On Allowable Top Width	Q_T =	14.28	66.68	cfs

Maximum Channel Capacity Based On Allowable Water Depth

		Minor Storm	Major Storm	
Max. Allowable Water Depth	d_{MAX} =	0.52	1.01	feet
Top Width	T =	7.12	10.06	feet
Flow Area	A =	2.89	7.10	square feet
Wetted Perimeter	P =	7.29	10.39	feet
Hydraulic Radius	R =	0.40	0.68	feet
Manning's n based on NRCS Vegetal Retardance	n =	0.036	0.028	
Flow Velocity	V =	2.53	4.79	fps
Velocity-Depth Product	VR =	1.01	3.27	ft^2/s
Hydraulic Depth	D =	0.41	0.71	feet
Froude Number	Fr =	0.70	1.01	
Max. Flow Based On Allowable Water Depth	Q_d =	7.33	34.02	cfs

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	7.33	34.02	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	0.52	1.01	ft

Water Depth in Channel Based On Design Peak Flow

			Minor Storm	Major Storm	
	Design Peak Flow	Q_o =	7.80	37.70	cfs
Warning 05	**Water Depth**	d =	0.54	1.06	feet
	Top Width	T =	7.21	10.35	feet
	Flow Area	A =	3.00	7.59	square feet
	Wetted Perimeter	P =	7.39	10.69	feet
	Hydraulic Radius	R =	0.41	0.71	feet
	Manning's n based on NRCS Vegetal Retardance	n =	0.036	0.027	
	Flow Velocity	V =	2.60	4.96	fps
	Velocity-Depth Product	VR =	1.06	3.53	ft^2/s
	Hydraulic Depth	D =	0.42	0.73	feet
Warning 04	Froude Number	Fr =	0.71	1.02	

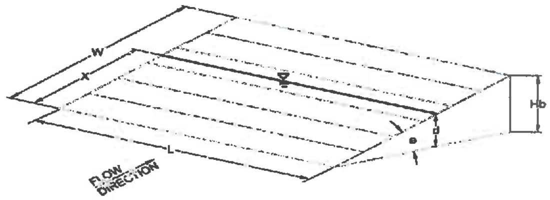
WARNING: MINOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'
WARNING: MAJOR STORM max. allowable capacity is less than flow given on sheet 'Q-Peak'

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)	θ =	0.00	degrees
Width of Grate	W =	3.00	feet
Length of Grate	L =	6.00	feet
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	feet
Clogging Factor	C_f =	0.38	
Grate Discharge Coefficient	C_d =	0.72	
Orifice Coefficient	C_o =	0.48	
Weir Coefficient	C_w =	1.53	

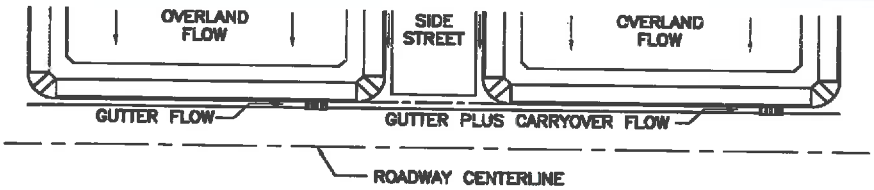
		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.54	2.06	
Grate Capacity as a Weir				
Submerged Side Weir Length	X =	6.00	6.00	feet
Inclined Side Weir Flow	Q_{ws} =	30.59	47.48	cfs
Base Weir Flow	Q_{wb} =	21.85	33.91	cfs
Interception without Clogging	Q_{wi} =	83.04	128.87	cfs
Interception with Clogging	Q_{wa} =	51.90	80.55	cfs
Grate Capacity as an Orifice				
Interception without Clogging	Q_{oi} =	59.77	69.20	cfs
Interception with Clogging	Q_{oa} =	37.35	43.25	cfs
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	37.35	43.25	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (> Q PEAK) — Bypassed Flow, Q_b =		0.00	0.00	cfs
Capture Percentage = Q_a/Q_o = C%		100	100	%

Warning 04: Froude No. exceeds USDCM Volume I recommendation.
Warning 05: Depth (d) exceeds max allowable depth (dmax).

Worksheet Protected

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



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel): $^*Q_{Known}$ =	2.3	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.

<--- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <---

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

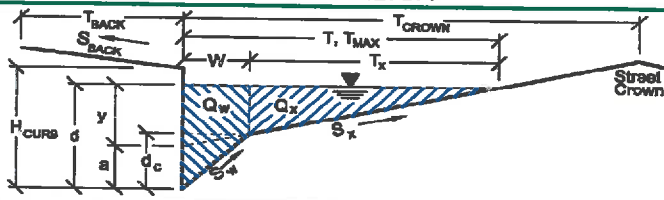
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	**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

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	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 ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**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	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

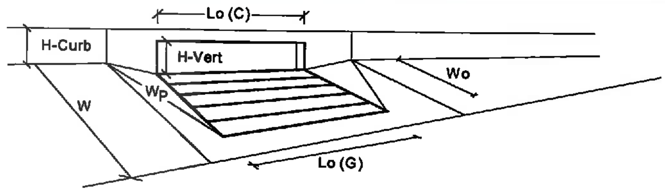
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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

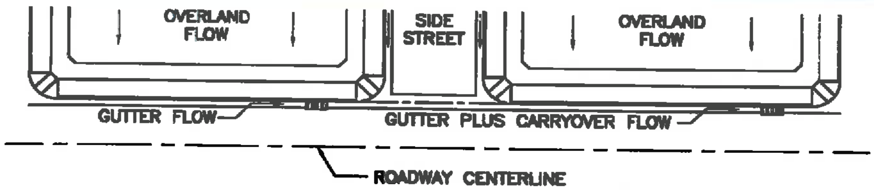


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	5.0	5	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	18.8	46.2	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.3	4.1	cfs

Worksheet Protected

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



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel): *Q_{Known} =	1.9	5.4	cfs

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

← FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. ←

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

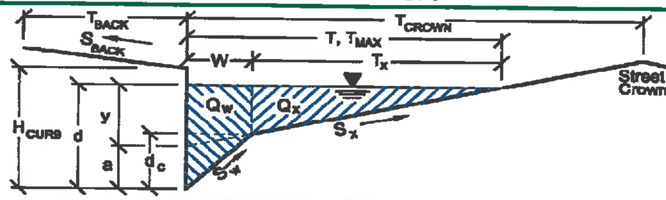
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	1.9	5.4	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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	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

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	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 ≥ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	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

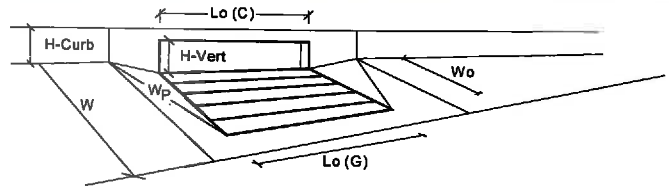
		Minor Storm	Major Storm	
	Q_{allow} =	SUMP	SUMP	cfs

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 DP8

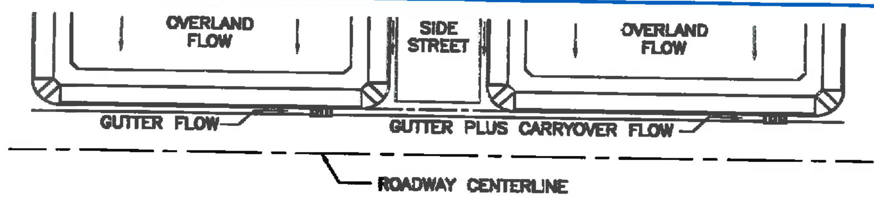


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1.0	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	4.6	9.1	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.9	5.4	cfs

Worksheet Protected

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



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	*Q_{Known} =	7.0	17.4	cfs

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

← FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. ←

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

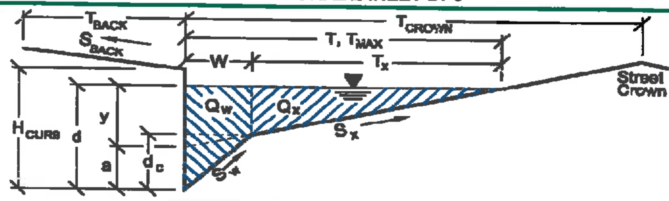
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	7.0	17.4	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: 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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	7.6	7.6	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	4.1	4.1	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 =	**11.7**	**11.7**	**cfs**
Flow Velocity within the Gutter Section	V =	5.3	5.3	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.5	2.5	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	7.6	28.4	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	7.6	26.1	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	4.1	8.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	1.4	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	11.7	35.5	cfs
Average Flow Velocity Within the Gutter Section	V =	5.3	7.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.5	4.6	
Slope-Based Depth Safety Reduction Factor for Major & Minor ($d \geq 6"$) Storm	R =	1.00	0.91	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**11.7**	**32.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.60	7.66	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.01	2.07	inches

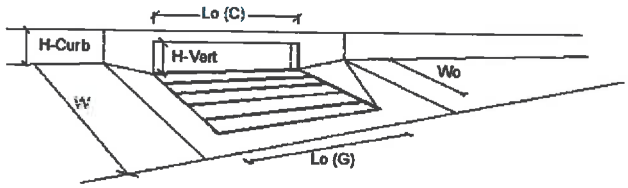
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**11.7**	**32.2**	**cfs**

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

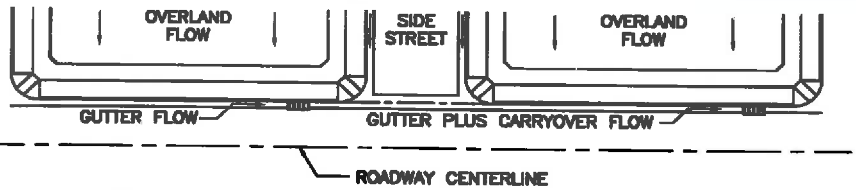


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate 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_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
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_a/Q_o =	C% =	100	79	%

Worksheet Protected

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



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	Major Storm	
$^*Q_{Known}$ =	7.3	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.

<--- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <---

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

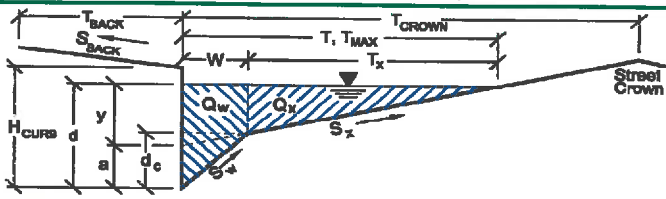
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	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: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: AT-GRADE INLET DP10



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 =	0.016	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	7.1	7.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.8	3.8	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 =	**11.0**	**11.0**	cfs
Flow Velocity within the Gutter Section	V =	5.0	5.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.3	2.3	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	7.2	26.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	7.2	24.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.9	7.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	1.3	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	11.0	33.4	cfs
Average Flow Velocity Within the Gutter Section	V =	5.0	6.6	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.3	4.3	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**11.0**	**33.3**	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	2.30	inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	11.0	33.3	cfs

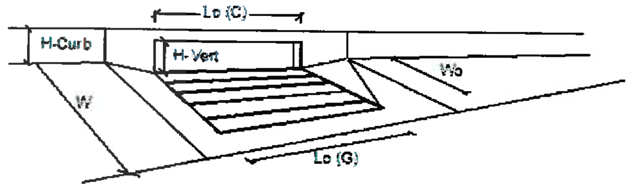
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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 DP10



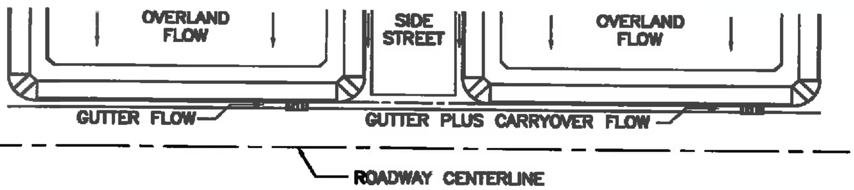
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate 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_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
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_a/Q_o =	C% =	100	77	%

Worksheet Protected

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



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	Major Storm	
*Q_{Known} =	3.7	17.0	cfs

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

← FILL IN THIS SECTION OR...

← FILL IN THE SECTIONS BELOW.

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

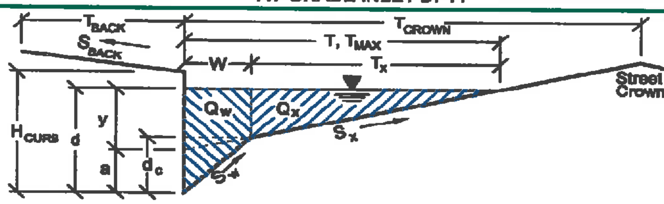
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	3.7	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: PAINT BRUSH HILLS FILING NO. 14

Inlet ID: 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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	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*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.2	2.2	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	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*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.2	4.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 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	Major Storm	
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

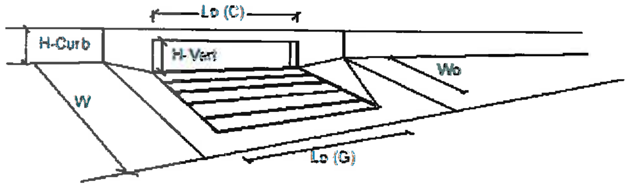
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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

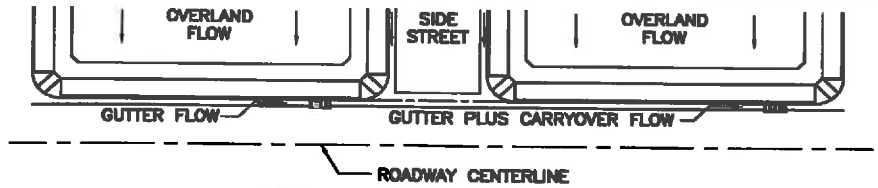


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate 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_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	3.70	13.51	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	3.5	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	79	%

Worksheet Protected

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



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel):	$^*Q_{Known}$ =	3.7	13.0	cfs

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

← FILL IN THIS SECTION OR...

← FILL IN THE SECTIONS BELOW.

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

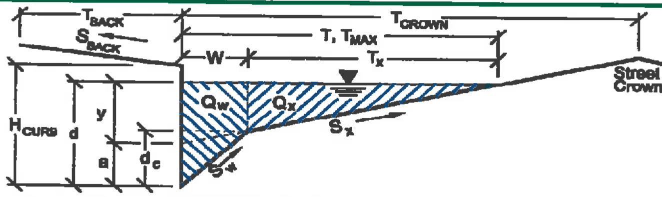
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	3.7	13.0	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: AT-GRADE INLET *DP37



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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	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*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.2	2.2	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\,TH}$	$Q_{X\,TH}$ =	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*d Product: Flow Velocity Times Gutter Flowline Depth	V*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

		Minor Storm	Major Storm	
	Q_{allow} =	**10.3**	**31.3**	cfs

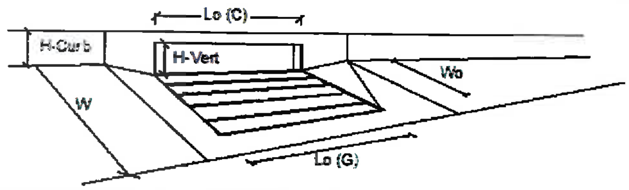
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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

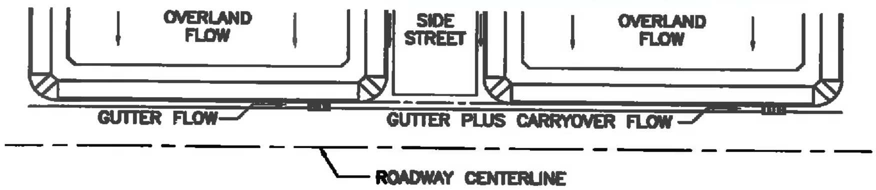


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate 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_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
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_a/Q_o =	C% =	100	88	%

Worksheet Protected

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



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel): *Q_{Known} =	6.0	14.9	cfs

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

<--- FILL IN THIS SECTION OR...

FILL IN THE SECTIONS BELOW. <---

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

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

Site Type:
- ○ Site is Urban
- ○ Site is Non-Urban

Flows Developed For:
- ○ Street Inlets
- ○ Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

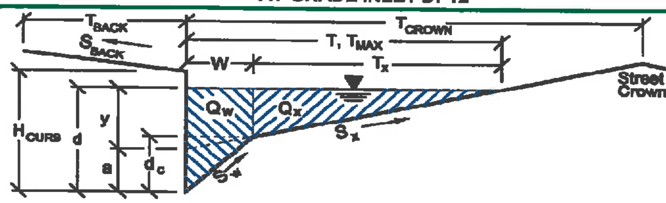
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	6.0	14.9	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: 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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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		Minor Storm	Major Storm	
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 * 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		Minor Storm	Major Storm	
Theoretical Water Spread	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 ≥ 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	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	8.8	26.7	cfs

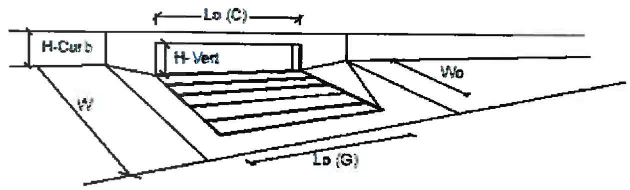
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

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

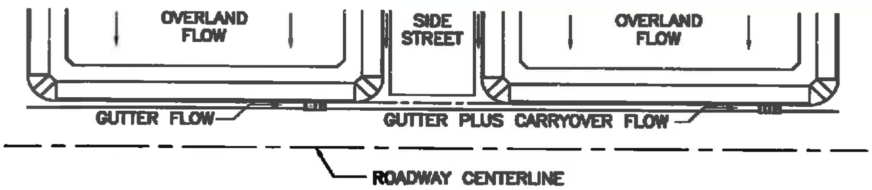


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate 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_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	5.95	12.44	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	2.4	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	84	%

Worksheet Protected

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



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street OR grass-lined channel): *Q_{Known} =	6.2	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.

← FILL IN THIS SECTION OR...

← FILL IN THE SECTIONS BELOW.

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

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

Site Type:
- O Site is Urban
- O Site is Non-Urban

Flows Developed For:
- O Street Inlets
- O Area Inlets in a Median

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

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

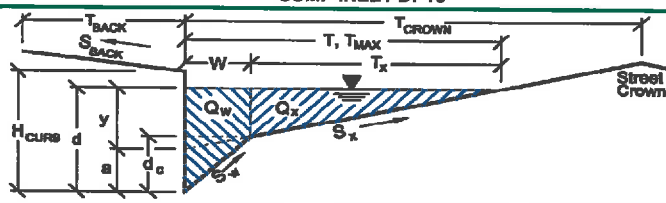
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =	0.0	0.0	cfs
Total Design Peak Flow, Q =	6.2	27.7	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 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	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & 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

		Minor Storm	Major Storm	
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 * 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 =	**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

		Minor Storm	Major Storm	
Theoretical Water Spread	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 $T_{X\ TH}$	$Q_{X\ TH}$ =	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 =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**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

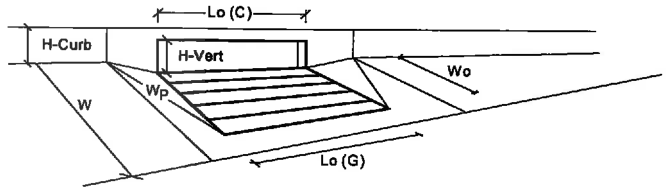
		Minor Storm	Major Storm	
	Q_{allow} =	**SUMP**	**SUMP**	cfs

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)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	4.0	4	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.6	7.9	inches ☑ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	15.0	36.7	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	6.2	27.7	cfs

Partially Full Pipe Flow Calculator and Equations

Fluid Flow Table of Contents | Hydraulic and Pneumatic Knowledge
Fluid Power Equipment

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 =	24	in
Depth of flow, y =	21	in

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

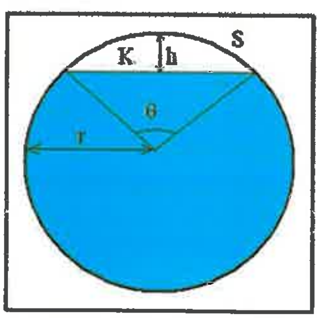
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.0625
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	2	ft
Pipe Radius, r =	1	ft
Circ. Segment Height, h =	0.250	ft
Central Angle, q =	1.45	radians
Cross-Sect. Area, A =	2.91	ft^2
Wetted Perimeter, P =	4.8	ft
Hydraulic Radius, R =	0.60	ft
Discharge, Q =	22.43	cfs
Ave. Velocity, V =	7.70	ft/sec
pipe % full [$(A/A_{full})*100\%$] =	92.8%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

$r = D/2$

$h = 2r - y$

(hydraulic radius)

$R = A/P$

(Manning Equation)

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

$V = Q/A$ 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 $0.5 \leq y/D \leq 1$)

PR * 37
$Q_{100} = 21.4$ cfs

Partially Full Pipe Flow Calculator and Equations

Fluid Flow Table of Contents | Hydraulic and Pneumatic Knowledge
Fluid Power Equipment

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

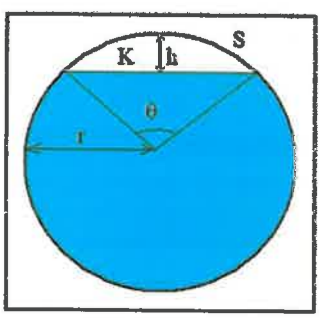
Pipe Diameter, D =	18	in
Depth of flow, y =	17	in
(must have $y \geq D/2$)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.016	ft/ft

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, q =	0.95	radians
Cross-Sect. Area, A =	1.73	ft^2
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)

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

$V = Q/A$ 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 $0.5 \leq y/D \leq 1$)

PR 1
Q_{100} = 13.7 cfs

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Partially Full Pipe Flow Calculator and Equations

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Fluid Power Equipment

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 =	36	in
Depth of flow, y =	29	in

(must have y ≥ D/2)

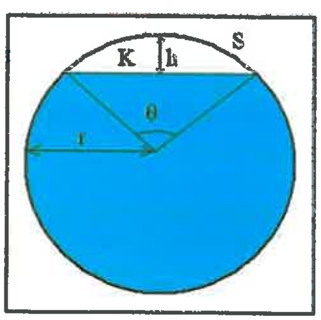
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.0972222
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	3	ft
Pipe Radius, r =	1.5	ft
Circ. Segment Height, h =	0.583	ft
Central Angle, q =	1.83	radians
Cross-Sect. Area, A =	6.10	ft²
Wetted Perimeter, P =	6.7	ft
Hydraulic Radius, R =	0.91	ft
Discharge, Q =	59.98	cfs
Ave. Velocity, V =	9.83	ft/sec
pipe % full [$(A/A_{full})*100\%$] =	86.3%	



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

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

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

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

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

PR 2
Q_{100} = 58.1 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

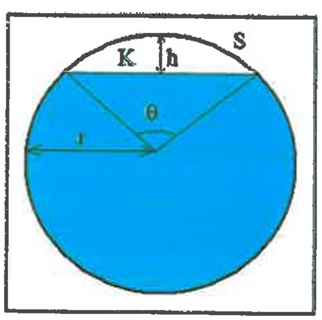
Pipe Diameter, D =	48	in
Depth of flow, y =	28	in
(must have $y \geq D/2$)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.2083333	
Partially Full Manning roughness, n =	0.016	

Calculations

Pipe Diameter, D =	4	ft
Pipe Radius, r =	2	ft
Circ. Segment Height, h =	1.667	ft
Central Angle, q =	2.81	radians
Cross-Sect. Area, A =	7.61	ft^2
Wetted Perimeter, P =	7.0	ft
Hydraulic Radius, R =	1.09	ft
Discharge, Q =	76.67	cfs
Ave. Velocity, V =	10.07	ft/sec
pipe % full [(A/A_{full})*100%] =	60.6%	



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

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

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

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

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 cfs

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

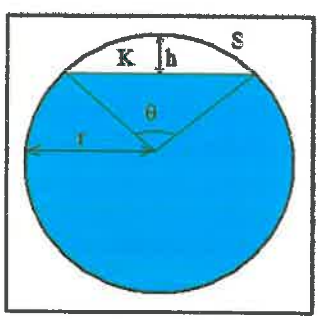
Pipe Diameter, D =	18	in
Depth of flow, y =	8	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.2777777
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, q =	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})*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 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 $0.5 \le y/D \le 1$)

PR 4

Q_{100} = 2.7 cfs

Partially Full Pipe Flow Calculator and Equations

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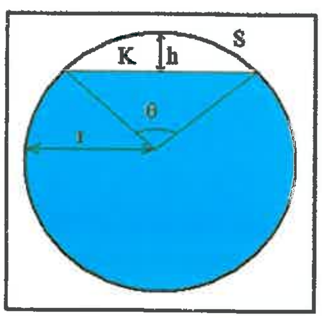
This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

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			**Calculations**		
Pipe Diameter, D =	42	in	Pipe Diameter, D =	3.5	ft
Depth of flow, y =	30	in	Pipe Radius, r =	1.75	ft
(must have $y \geq D/2$)					
			Circ. Segment Height, h =	1.000	ft
Full Pipe Manning roughness, n_{full} =	0.013		Central Angle, q =	2.26	radians
Channel bottom slope, S =	0.01	ft/ft	Cross-Sect. Area, A =	7.35	ft^2
			Wetted Perimeter, P =	7.0	ft
Calculations			Hydraulic Radius, R =	1.04	ft
n/n_{full} =	1.142857		Discharge, Q =	75.85	cfs
Partially Full Manning roughness, n =	0.015		Ave. Velocity, V =	10.32	ft/sec
			pipe % full [(A/A_{full})*100%] =	76.4%	



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

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

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

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

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} = 76.0cfs

Partially Full Pipe Flow Calculator and Equations

Fluid Flow Table of Contents | Hydraulic and Pneumatic Knowledge
Fluid Power Equipment

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 =	30	in
Depth of flow, y =	25	in

(must have y ≥ D/2)

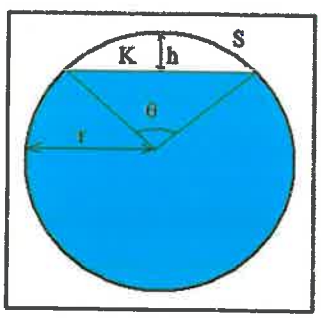
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.083333	
Partially Full Manning roughness, n =	0.014	

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.417	ft
Central Angle, q =	1.68	radians
Cross-Sect. Area, A =	4.37	ft^2
Wetted Perimeter, P =	5.8	ft
Hydraulic Radius, R =	0.76	ft
Discharge, Q =	38.51	cfs
Ave. Velocity, V =	8.81	ft/sec
pipe % full [(A/A_{full})*100%] =	89.0%	



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

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

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

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

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

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 =	30	in
Depth of flow, y =	26	in

(must have y ≥ D/2)

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

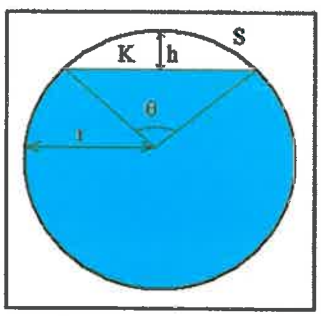
Calculations

n/n_{full} =	1.066666(
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.333	ft
Central Angle, q =	1.50	radians
Cross-Sect. Area, A =	4.52	ft^2
Wetted Perimeter, P =	6.0	ft
Hydraulic Radius, R =	0.76	ft
Discharge, Q =	40.27	cfs
Ave. Velocity, V =	8.91	ft/sec

pipe % full [(A/A_{full})*100%] = 92.1%



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

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

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

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

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 cfs

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 =	18	in
Depth of flow, y =	11	in

(must have y ≥ D/2)

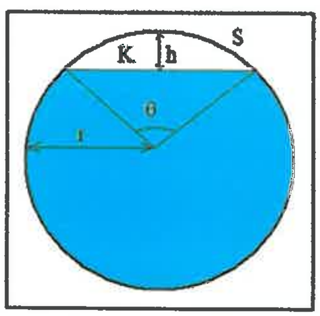
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.194444
Partially Full Manning roughness, n =	0.016

Calculations

Pipe Diameter, D =	1.5	ft
Pipe Radius, r =	0.75	ft
Circ. Segment Height, h =	0.583	ft
Central Angle, q =	2.69	radians
Cross-Sect. Area, A =	1.13	ft^2
Wetted Perimeter, P =	2.7	ft
Hydraulic Radius, R =	0.42	ft
Discharge, Q =	6.09	cfs
Ave. Velocity, V =	5.38	ft/sec
pipe % full [(A/A$_{full}$)*100%] =	64.0%	



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

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

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

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

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

PR8

Q_{100} = 5.4 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

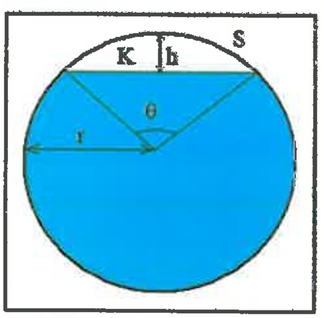
Pipe Diameter, D =	48	in
Depth of flow, y =	37	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.1145833	
Partially Full Manning roughness, n =	0.014	

Calculations

Pipe Diameter, D =	4	ft
Pipe Radius, r =	2	ft
Circ. Segment Height, h =	0.917	ft
Central Angle, q =	2.00	radians
Cross-Sect. Area, A =	10.39	ft^2
Wetted Perimeter, P =	8.6	ft
Hydraulic Radius, R =	1.21	ft
Discharge, Q =	121.53	cfs
Ave. Velocity, V =	11.69	ft/sec
pipe % full [(A/A_{full})*100%] =	82.7%	



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

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

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

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

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

PR 9

$Q_{100} = 117.8$ 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 =	24	in
Depth of flow, y =	15	in

(must have y ≥ D/2)

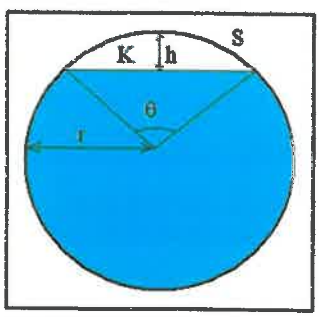
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

Pipe Diameter, D =	2	ft
Pipe Radius, r =	1	ft
Circ. Segment Height, h =	0.750	ft
Central Angle, q =	2.64	radians
Cross-Sect. Area, A =	2.07	ft^2
Wetted Perimeter, P =	3.6	ft
Hydraulic Radius, R =	0.57	ft
Discharge, Q =	13.65	cfs
Ave. Velocity, V =	6.61	ft/sec
pipe % full [(A/A_{full})*100%] =	65.7%	

Calculations

n/n_{full} =	1.1875
Partially Full Manning roughness, n =	0.015



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

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

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

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

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

PR 10 & PR 11

Q_{100} = 34.4 cfs FLOWS SPLIT @ DP 9

FLOWS CAPTURED Q_{100} = 13.65 cfs PERSIDE

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 =	48	in
Depth of flow, y =	42	in

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

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

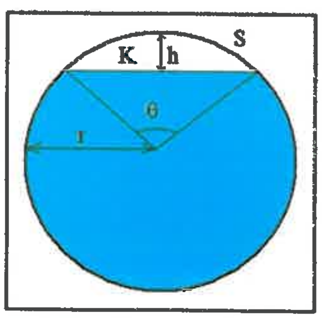
Calculations

n/n_{full} =	1.0625
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	4	ft
Pipe Radius, r =	2	ft
Circ. Segment Height, h =	0.500	ft
Central Angle, q =	1.45	radians
Cross-Sect. Area, A =	11.66	ft^2
Wetted Perimeter, P =	9.7	ft
Hydraulic Radius, R =	1.21	ft
Discharge, Q =	142.43	cfs
Ave. Velocity, V =	12.22	ft/sec

pipe % full [(A/A_{full})*100%] = 92.8%



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

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 $0.5 \leq y/D \leq 1$)

PR 12

Q_{100} = 142.5 cfs

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

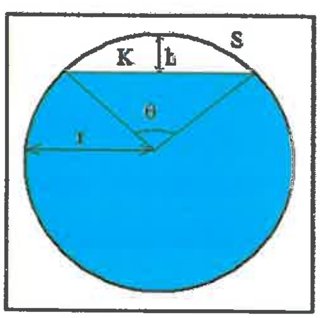
Pipe Diameter, D =	18	in
Depth of flow, y =	17	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.016	ft/ft

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, q =	0.95	radians
Cross-Sect. Area, A =	1.73	ft^2
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 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 $0.5 \le y/D \le 1$)

PR 13
Q_{100} = 14.0 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 =	30	in
Depth of flow, y =	18	in

(must have y ≥ D/2)

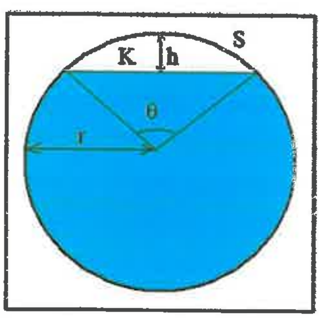
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.016	ft/ft

Calculations

n/n_{full} =	1.2
Partially Full Manning roughness, n =	0.016

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	1.000	ft
Central Angle, q =	2.74	radians
Cross-Sect. Area, A =	3.08	ft^2
Wetted Perimeter, P =	4.4	ft
Hydraulic Radius, R =	0.69	ft
Discharge, Q =	29.13	cfs
Ave. Velocity, V =	9.47	ft/sec
pipe % full [(A/A_{full})*100%] =	62.6%	



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

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

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

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

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

PR 14
Q_{100} = 27.9 cfs

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

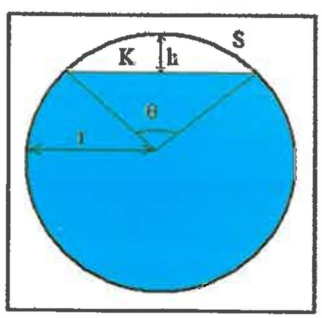
Pipe Diameter, D =	30	in
Depth of flow, y =	21	in
(must have $y \geq D/2$)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.15	
Partially Full Manning roughness, n =	0.015	

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.750	ft
Central Angle, q =	2.32	radians
Cross-Sect. Area, A =	3.67	ft^2
Wetted Perimeter, P =	5.0	ft
Hydraulic Radius, R =	0.74	ft
Discharge, Q =	29.94	cfs
Ave. Velocity, V =	8.16	ft/sec
pipe % full [(A/A_{full})*100%] =	74.8%	



Partially Full Pipe Flow Parameters
(More Than Half Full)

$r = D/2$

$h = 2r - y$

(hydraulic radius)

$R = A/P$

(Manning Equation)

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

$V = Q/A$ 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 $0.5 \leq y/D \leq 1$)

* PR 38

Q_{100} = 27.9 cfs

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 =	24	in
Depth of flow, y =	15	in

(must have y ≥ D/2)

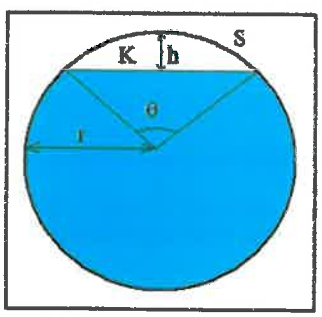
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.1875
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	2	ft
Pipe Radius, r =	1	ft
Circ. Segment Height, h =	0.750	ft
Central Angle, q =	2.64	radians
Cross-Sect. Area, A =	2.07	ft^2
Wetted Perimeter, P =	3.6	ft
Hydraulic Radius, R =	0.57	ft
Discharge, Q =	13.65	cfs
Ave. Velocity, V =	6.61	ft/sec
pipe % full [(A/A_{full})*100%] =	65.7%	



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

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

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

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

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 15

CAPTURED Q_{100} = 13.5 cfs

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Partially Full Pipe Flow Calculator and Equations

Fluid Flow Table of Contents | Hydraulic and Pneumatic Knowledge
Fluid Power Equipment

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 =	30	in
Depth of flow, y =	26	in

(must have y ≥ D/2)

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

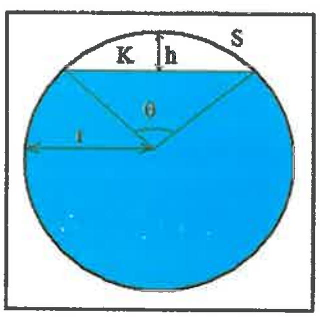
Calculations

n/n_{full} =	1.0666666
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.333	ft
Central Angle, q =	1.50	radians
Cross-Sect. Area, A =	4.52	ft²
Wetted Perimeter, P =	6.0	ft
Hydraulic Radius, R =	0.76	ft
Discharge, Q =	40.27	cfs
Ave. Velocity, V =	8.91	ft/sec

pipe % full [(A/A_{full})*100%] = 92.1%



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

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

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

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

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

#PR 16

Q_{100} = 39.7 cfs

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 =	24	in
Depth of flow, y =	14	in

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

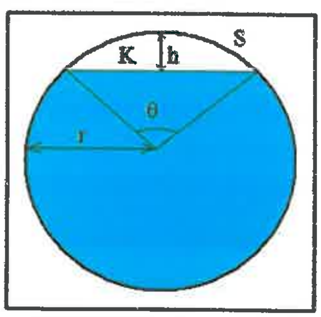
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.208333
Partially Full Manning roughness, n =	0.016

Calculations

Pipe Diameter, D =	2	ft
Pipe Radius, r =	1	ft
Circ. Segment Height, h =	0.833	ft
Central Angle, q =	2.81	radians
Cross-Sect. Area, A =	1.90	ft^2
Wetted Perimeter, P =	3.5	ft
Hydraulic Radius, R =	0.55	ft
Discharge, Q =	12.07	cfs
Ave. Velocity, V =	6.35	ft/sec
pipe % full [(A/A_{full})*100%] =	60.6%	



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

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

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

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

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 39

CAPTURED Q_{100} = 11.5 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

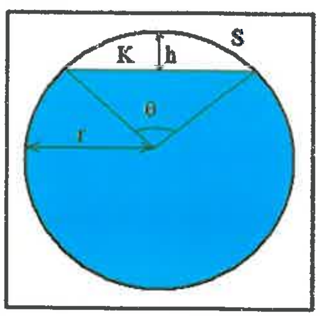
Pipe Diameter, D =	36	in
Depth of flow, y =	26	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.138888
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	3	ft
Pipe Radius, r =	1.5	ft
Circ. Segment Height, h =	0.833	ft
Central Angle, q =	2.22	radians
Cross-Sect. Area, A =	5.47	ft^2
Wetted Perimeter, P =	6.1	ft
Hydraulic Radius, R =	0.90	ft
Discharge, Q =	51.17	cfs
Ave. Velocity, V =	9.36	ft/sec
pipe % full [(A/A_{full})*100%] =	77.3%	



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

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

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

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

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

RR 17

Q_{100} = 50.2 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

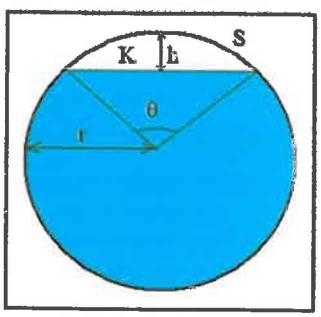
Pipe Diameter, D =	18	in
Depth of flow, y =	17	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.013	ft/ft

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, q =	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   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 $0.5 \le y/D \le 1$)

PR 18

Q_{100} = 12.4 cfs

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 =	30	in
Depth of flow, y =	19	in

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

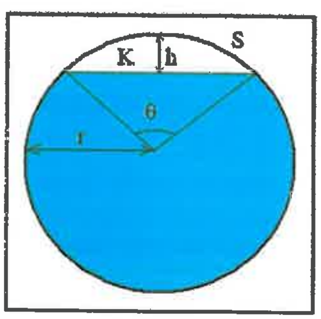
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.1833333
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.917	ft
Central Angle, q =	2.60	radians
Cross-Sect. Area, A =	3.28	ft²
Wetted Perimeter, P =	4.6	ft
Hydraulic Radius, R =	0.71	ft
Discharge, Q =	25.32	cfs
Ave. Velocity, V =	7.72	ft/sec
pipe % full [(A/A_{full})*100%] =	66.8%	



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 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 $0.5 \leq y/D \leq 1$)

PR 19

Q_{100} = 24.8 cfs

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

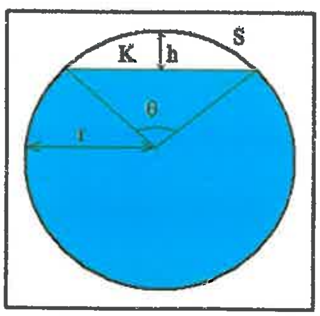
Pipe Diameter, D =	42	in
Depth of flow, y =	30	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.142857:
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	3.5	ft
Pipe Radius, r =	1.75	ft
Circ. Segment Height, h =	1.000	ft
Central Angle, q =	2.26	radians
Cross-Sect. Area, A =	7.35	ft^2
Wetted Perimeter, P =	7.0	ft
Hydraulic Radius, R =	1.04	ft
Discharge, Q =	75.85	cfs
Ave. Velocity, V =	10.32	ft/sec
pipe % full [(A/A_{full})*100%] =	76.4%	



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

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

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

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

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

PR 20

Q_{100} = 74.2 cfs

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Partially Full Pipe Flow Calculator and Equations

Fluid Flow Table of Contents | Hydraulic and Pneumatic Knowledge
Fluid Power Equipment

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

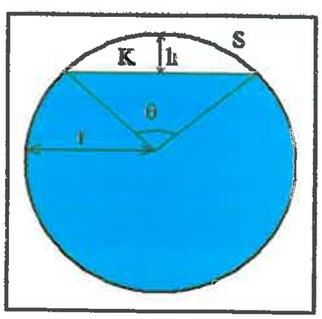
Pipe Diameter, D =	54	in
Depth of flow, y =	53	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.011	ft/ft

Calculations

n/n_{full} =	1.009259	
Partially Full Manning roughness, n =	0.013	

Calculations

Pipe Diameter, D =	4.5	ft
Pipe Radius, r =	2.25	ft
Circ. Segment Height, h =	0.083	ft
Central Angle, q =	0.55	radians
Cross-Sect. Area, A =	15.84	ft²
Wetted Perimeter, P =	12.9	ft
Hydraulic Radius, R =	1.23	ft
Discharge, Q =	216.17	cfs
Ave. Velocity, V =	13.65	ft/sec
pipe % full [(A/A_full)*100%] =	99.6%	



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 $0.5 \le y/D \le 1$)

PR 21

Q_{100} = 213.4 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

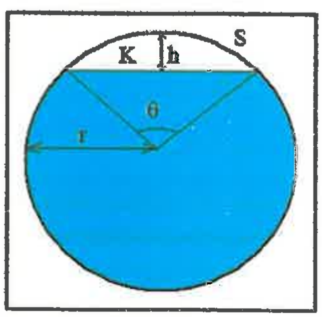
Pipe Diameter, D =	30	in
Depth of flow, y =	20	in
(must have y ≥ D/2)		
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.166666(
Partially Full Manning roughness, n =	0.015

Calculations

Pipe Diameter, D =	2.5	ft
Pipe Radius, r =	1.25	ft
Circ. Segment Height, h =	0.833	ft
Central Angle, q =	2.46	radians
Cross-Sect. Area, A =	3.48	ft^2
Wetted Perimeter, P =	4.8	ft
Hydraulic Radius, R =	0.73	ft
Discharge, Q =	27.63	cfs
Ave. Velocity, V =	7.95	ft/sec
pipe % full [(A/A_{full})*100%] =	70.8%	



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

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 $0.5 \le y/D \le 1$)

PR 22

Q_{100} = 27.7cfs

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 =	36	in
Depth of flow, y =	28	in

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

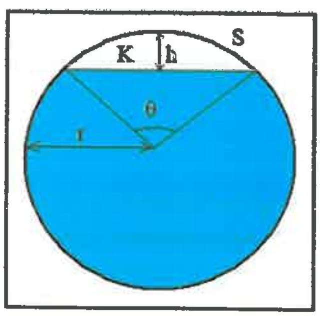
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.111111
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	3	ft
Pipe Radius, r =	1.5	ft
Circ. Segment Height, h =	0.667	ft
Central Angle, q =	1.96	radians
Cross-Sect. Area, A =	5.90	ft^2
Wetted Perimeter, P =	6.5	ft
Hydraulic Radius, R =	0.91	ft
Discharge, Q =	57.16	cfs
Ave. Velocity, V =	9.69	ft/sec
pipe % full $[(A/A_{full})*100\%]$ =	83.5%	



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

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

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

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

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 cfs

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 =	60	in
Depth of flow, y =	55	in

(must have y ≥ D/2)

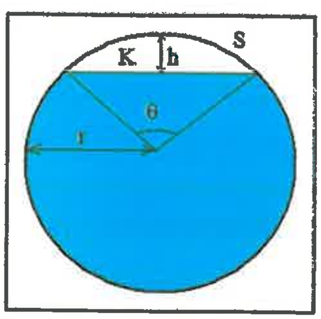
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.0416666
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	5	ft
Pipe Radius, r =	2.5	ft
Circ. Segment Height, h =	0.417	ft
Central Angle, q =	1.17	radians
Cross-Sect. Area, A =	18.85	ft^2
Wetted Perimeter, P =	12.8	ft
Hydraulic Radius, R =	1.48	ft
Discharge, Q =	268.84	cfs
Ave. Velocity, V =	14.26	ft/sec
pipe % full [(A/A_{full})*100%] =	96.0%	



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

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

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

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

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

PR 24

Q_{100} = 268.2 cfs

ENGINEERS EDGE
Solutions By Design

Partially Full Pipe Flow Calculator and Equations

Fluid Flow Table of Contents | Hydraulic and Pneumatic Knowledge
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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 =	48	in
Depth of flow, y =	43	in

(must have y ≥ D/2)

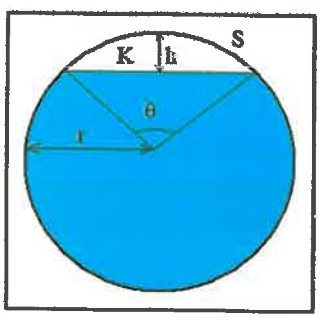
Full Pipe Manning roughness, n_{full} =	0.013	
Channel bottom slope, S =	0.01	ft/ft

Calculations

n/n_{full} =	1.052083
Partially Full Manning roughness, n =	0.014

Calculations

Pipe Diameter, D =	4	ft
Pipe Radius, r =	2	ft
Circ. Segment Height, h =	0.417	ft
Central Angle, q =	1.31	radians
Cross-Sect. Area, A =	11.87	ft^2
Wetted Perimeter, P =	9.9	ft
Hydraulic Radius, R =	1.19	ft
Discharge, Q =	145.62	cfs
Ave. Velocity, V =	12.27	ft/sec
pipe % full [(A/A_{full})*100%] =	94.5%	



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

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

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

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

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

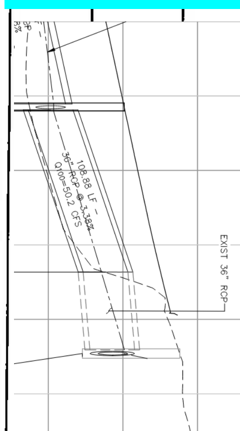
PR 25

Q_{100} = 144.9 cfs

MyReport

STORM SUMMARY

Revise Drainage Model for Storm 2 to match the 36" pipe size in construction plans. See sheet ST04.



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	[illegible]	[illegible]	[illegible]2.00	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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible].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	[illegible]	[illegible]	[illegible]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	[illegible]	[illegible]	[illegible]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

STORM SUMMARY

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

There is no "Storm 6" system shown in street plans.

Project File: Storm Main System.stm | Number of lines: 32 | Date: 6/13/2018

NOTES: ** Critical depth

STORM SUMMARY

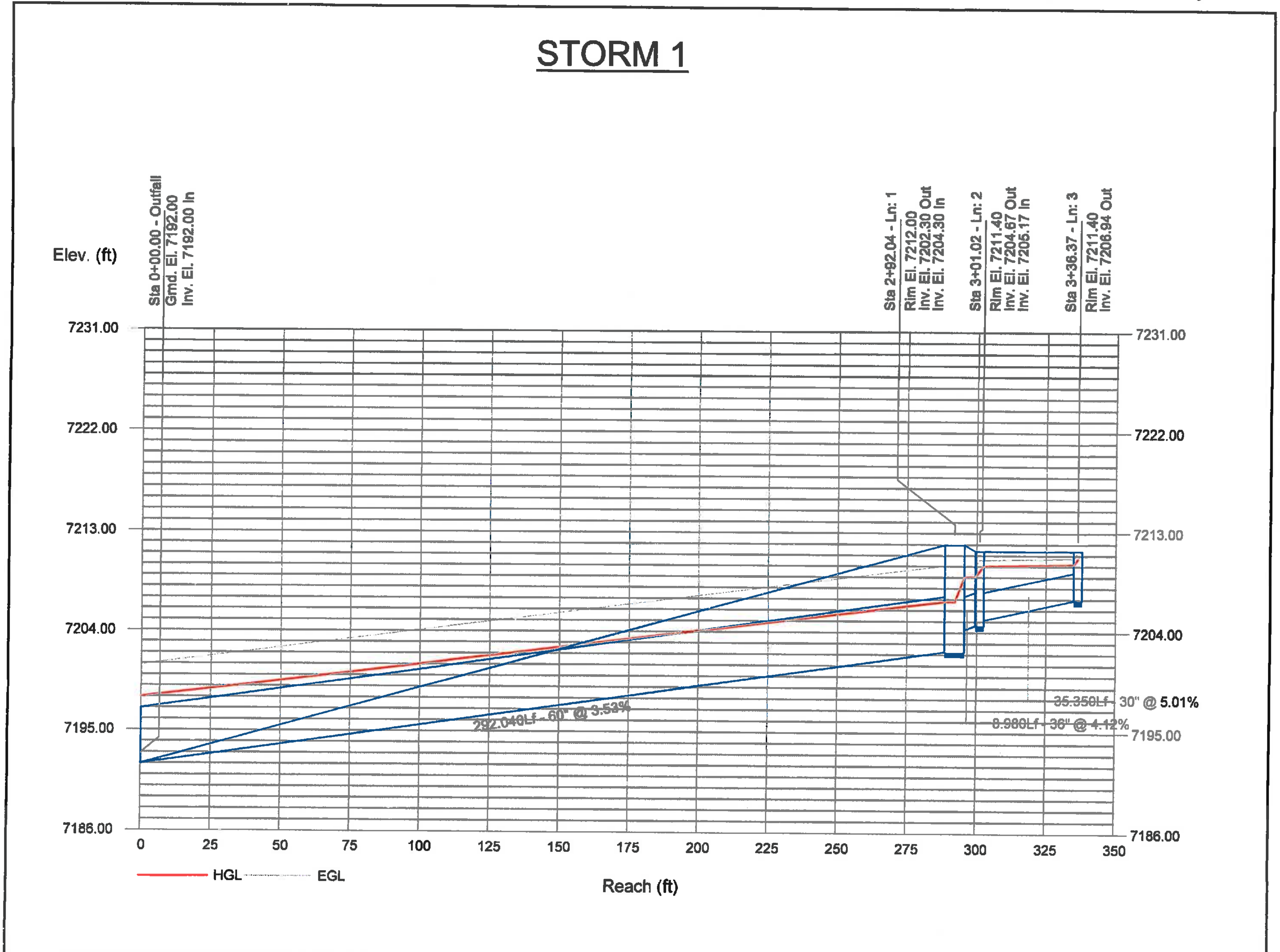
Line No.	Line ID	Line Size (in)	Line Type	Junct Type	J-Loss Coeff	n-val Pipe	Flow Rate (cfs)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Minor Loss (ft)	HGL Jnct (ft)	Vel Ave (ft/s)	Line Length (ft)	Rim-Hw (ft)	
1	Storm 8	18	Cir	Generic	1.25 z	0.013	13.50	7248.00	7249.01	1.70	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 Sewer Profile

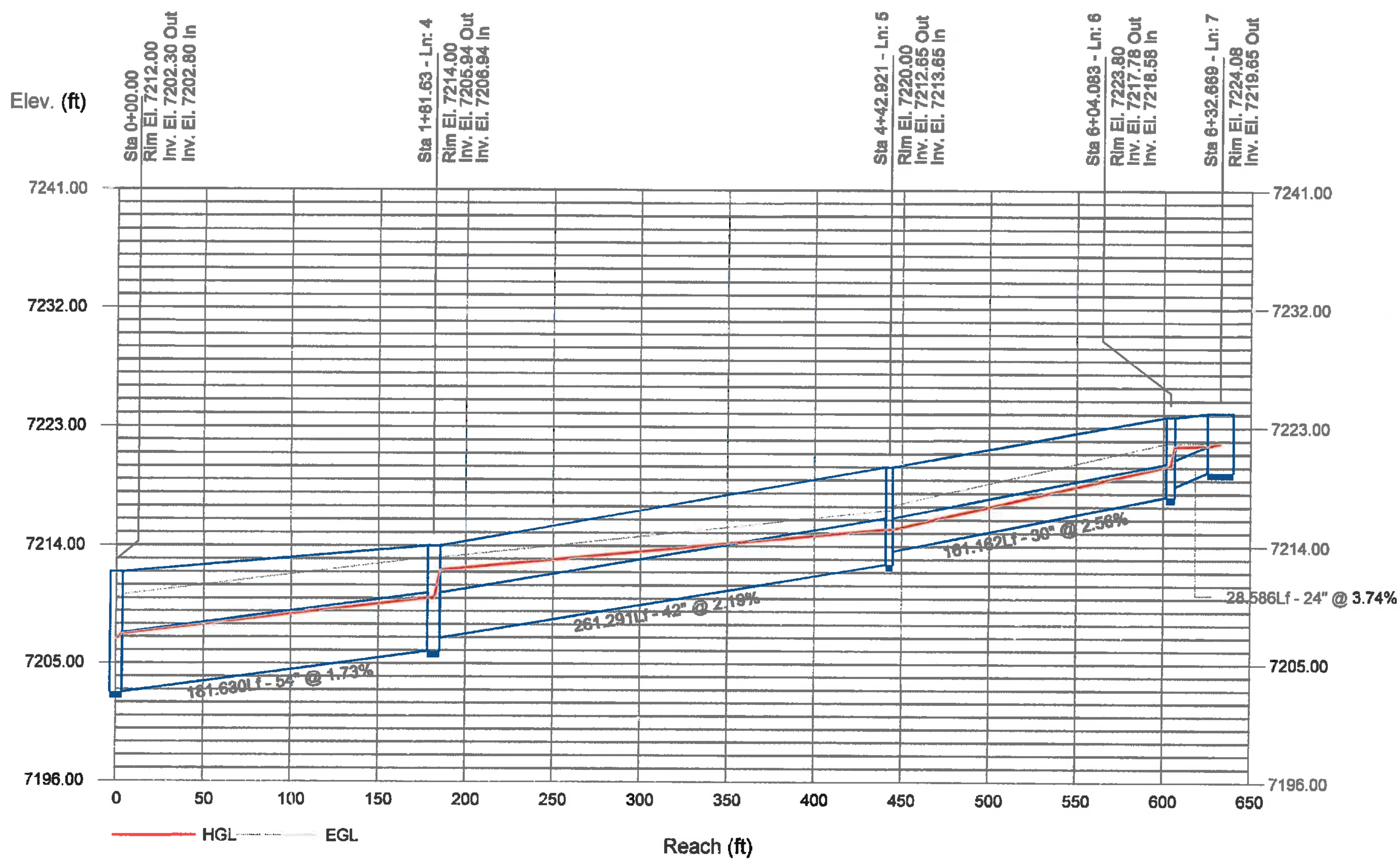
Proj. file: Storm Main System.stm



Storm Sewer Profile

Proj. file: Storm Main System.stm

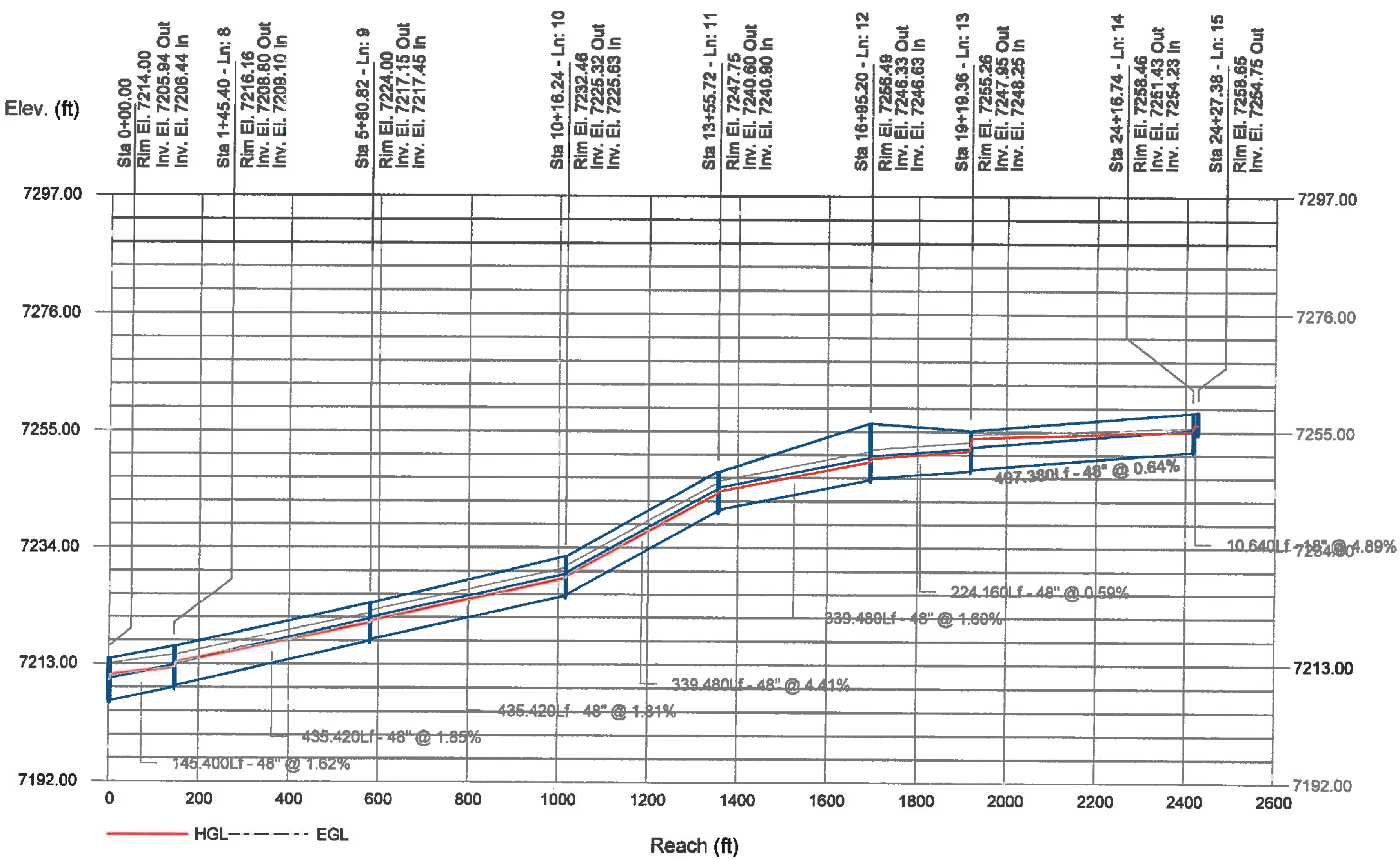
STORM 2



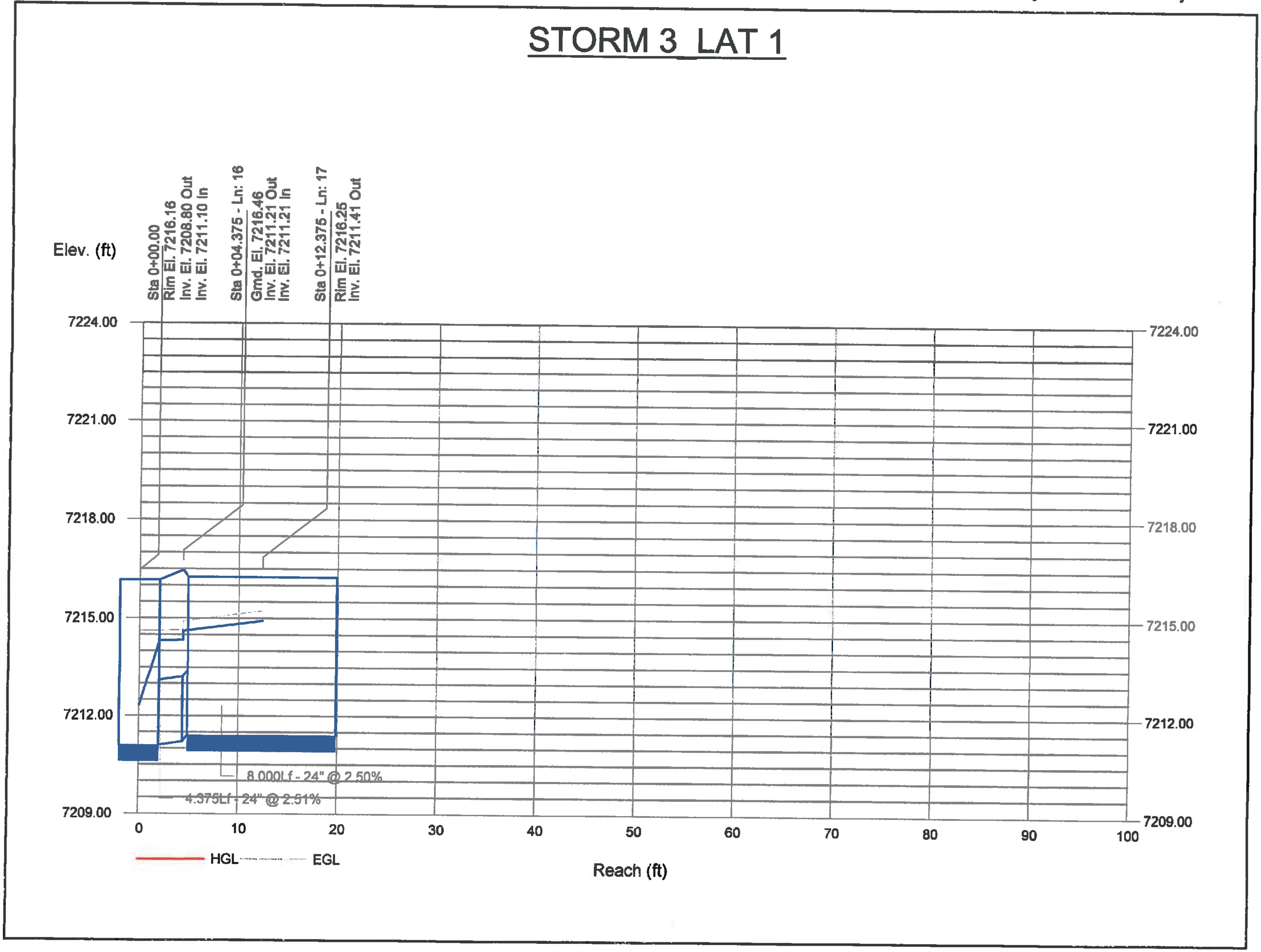
Storm Sewer Profile

Proj. file: Storm Main System.stm

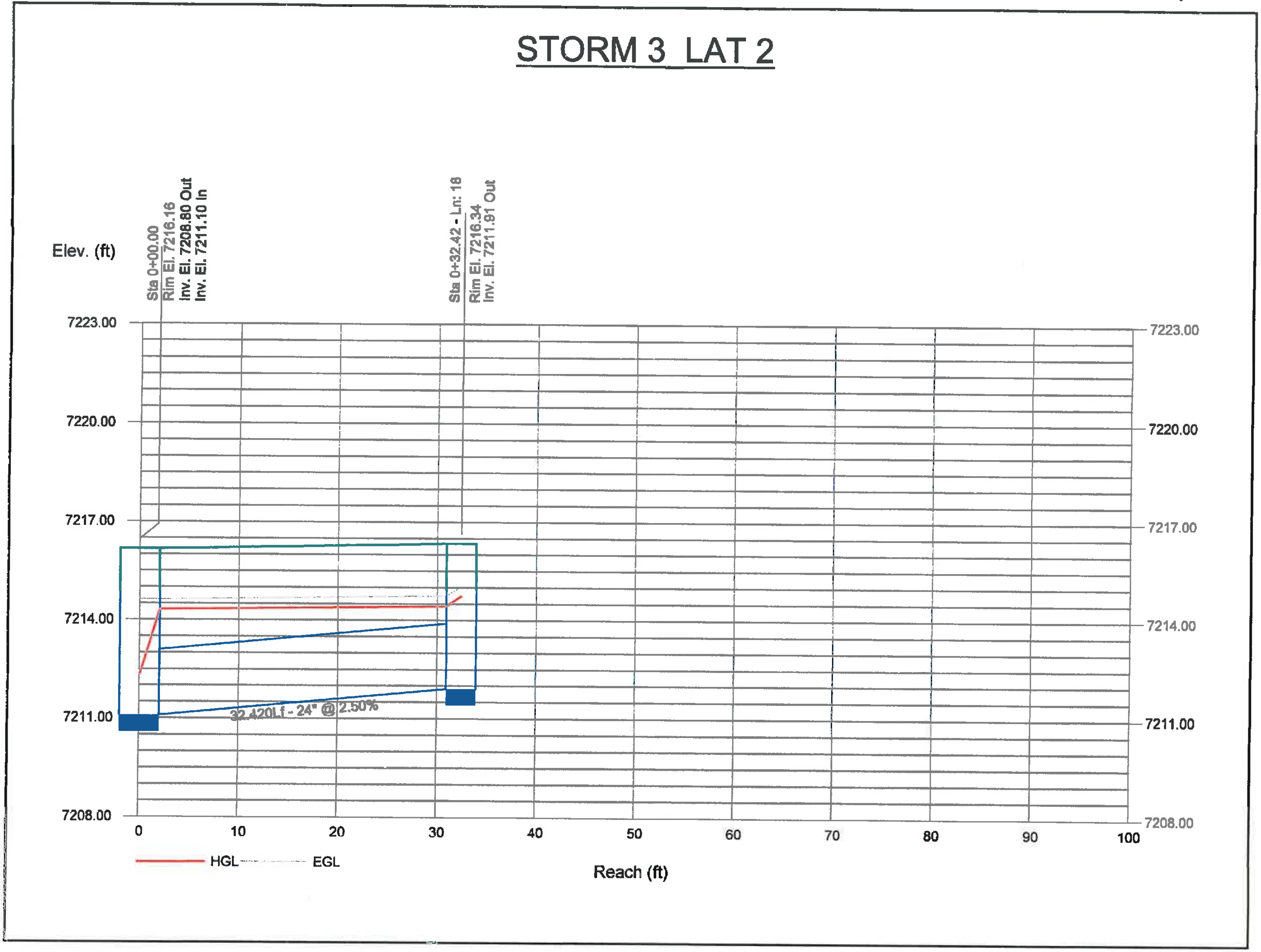
STORM 3



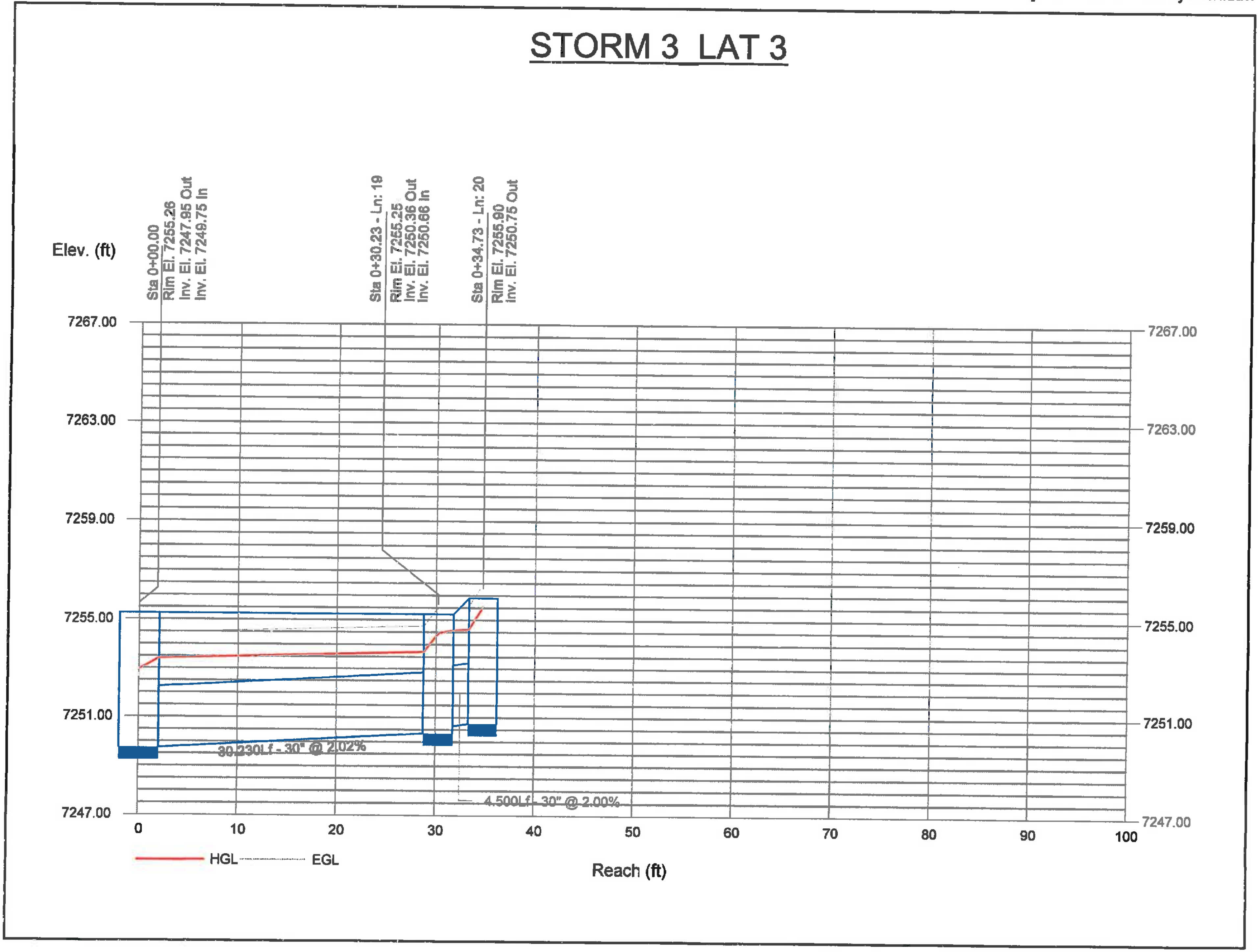
Storm Sewer Profile



Storm Sewer Profile

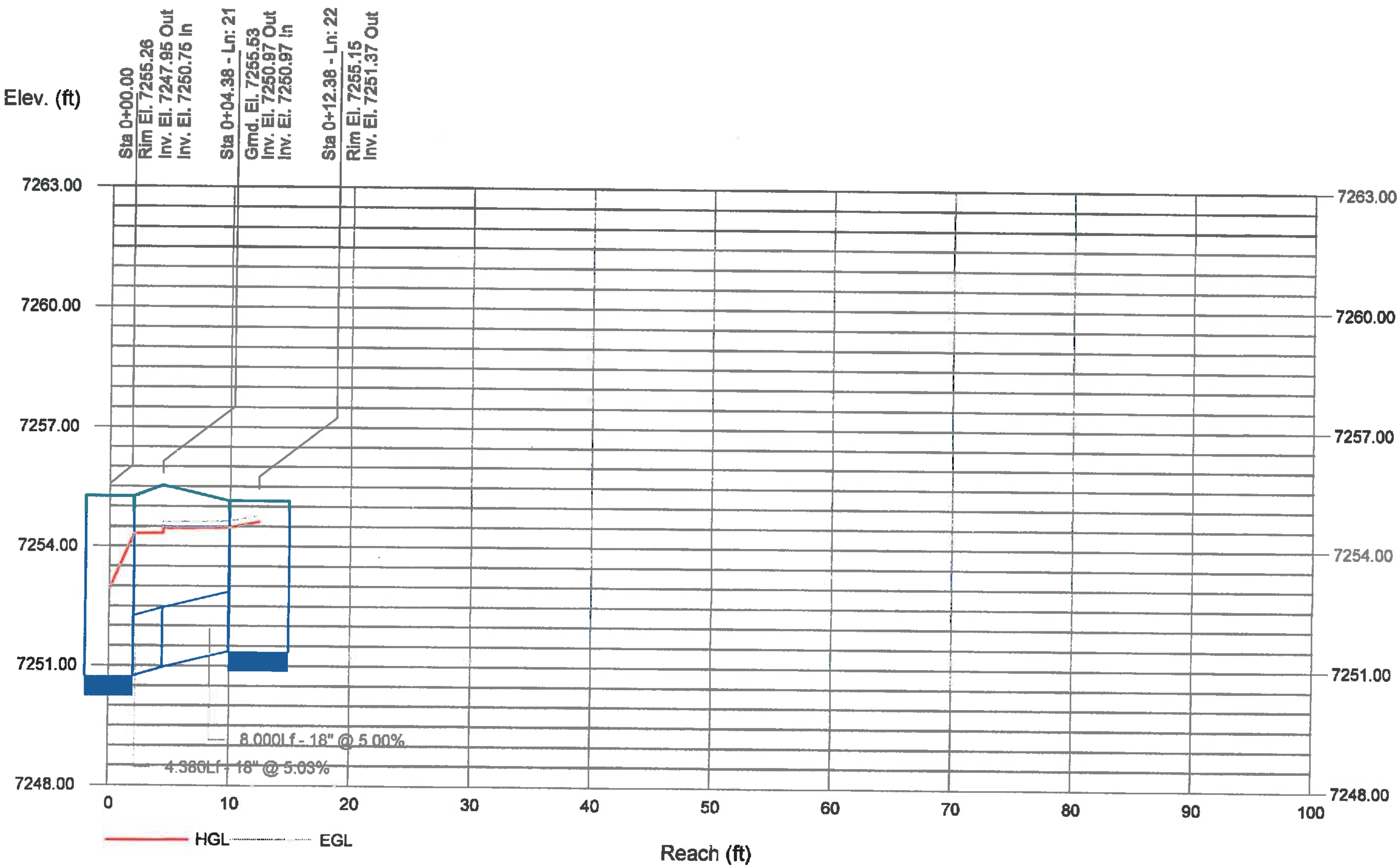


Storm Sewer Profile



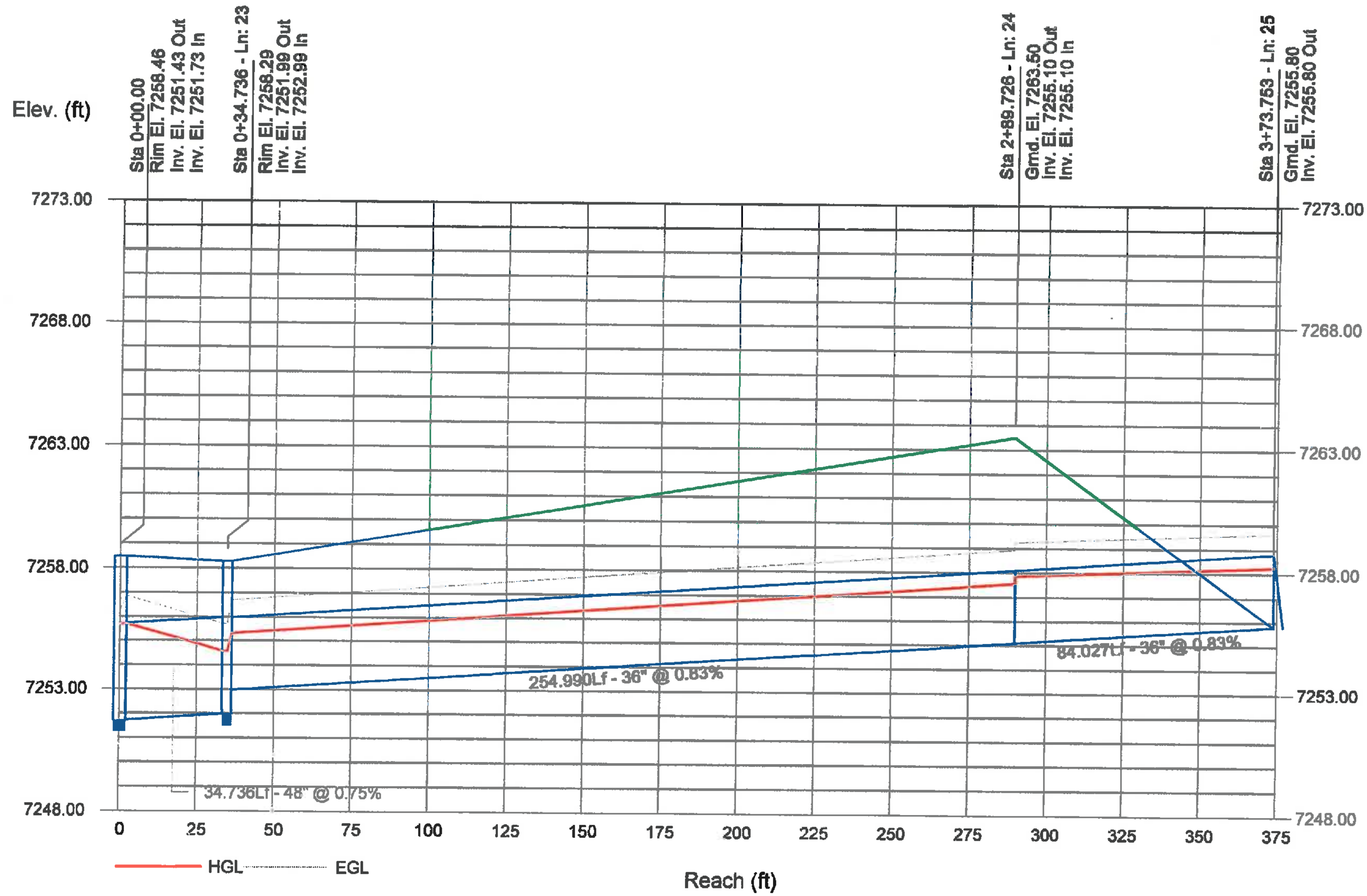
Storm Sewer Profile

STORM 3 LAT 4

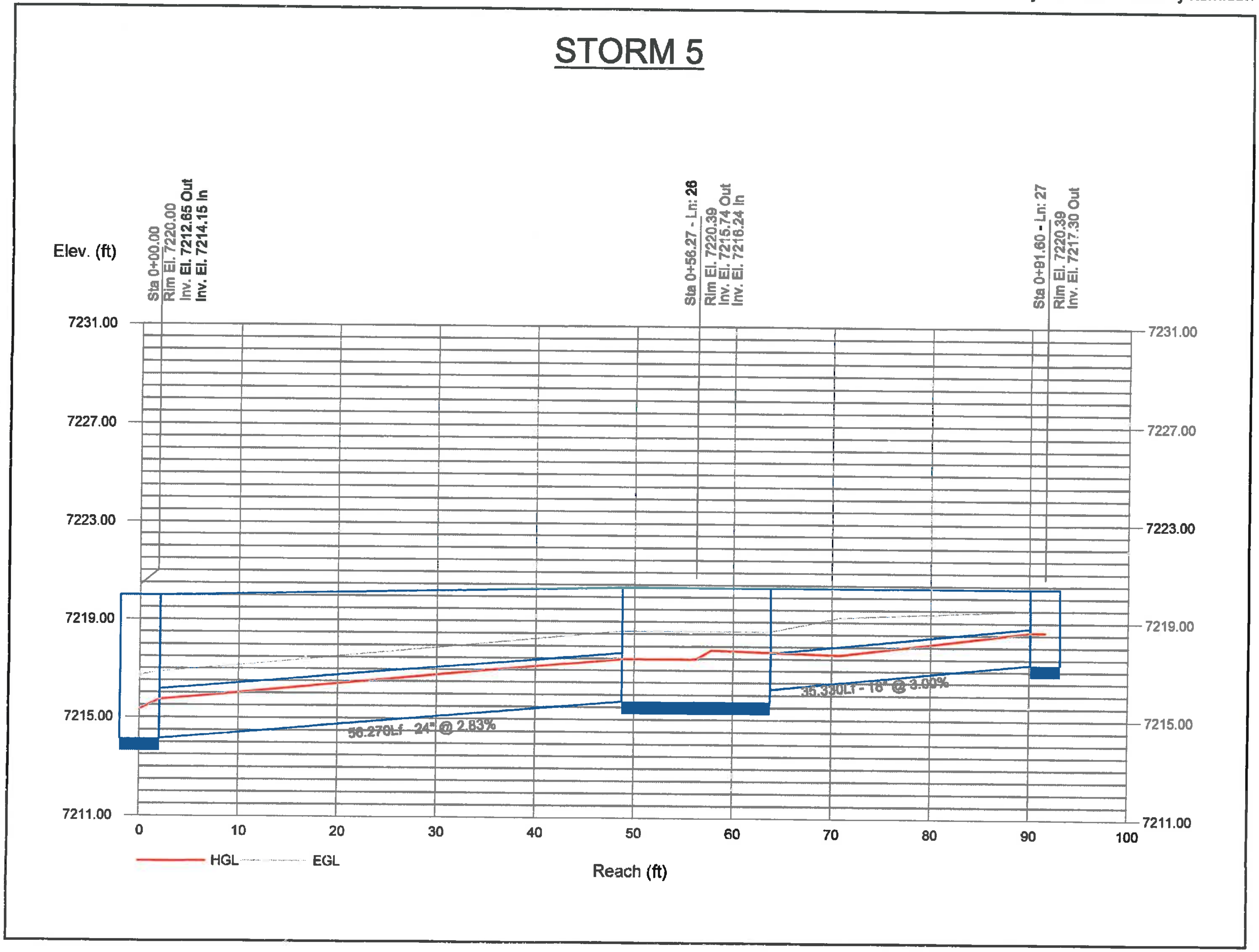


Storm Sewer Profile

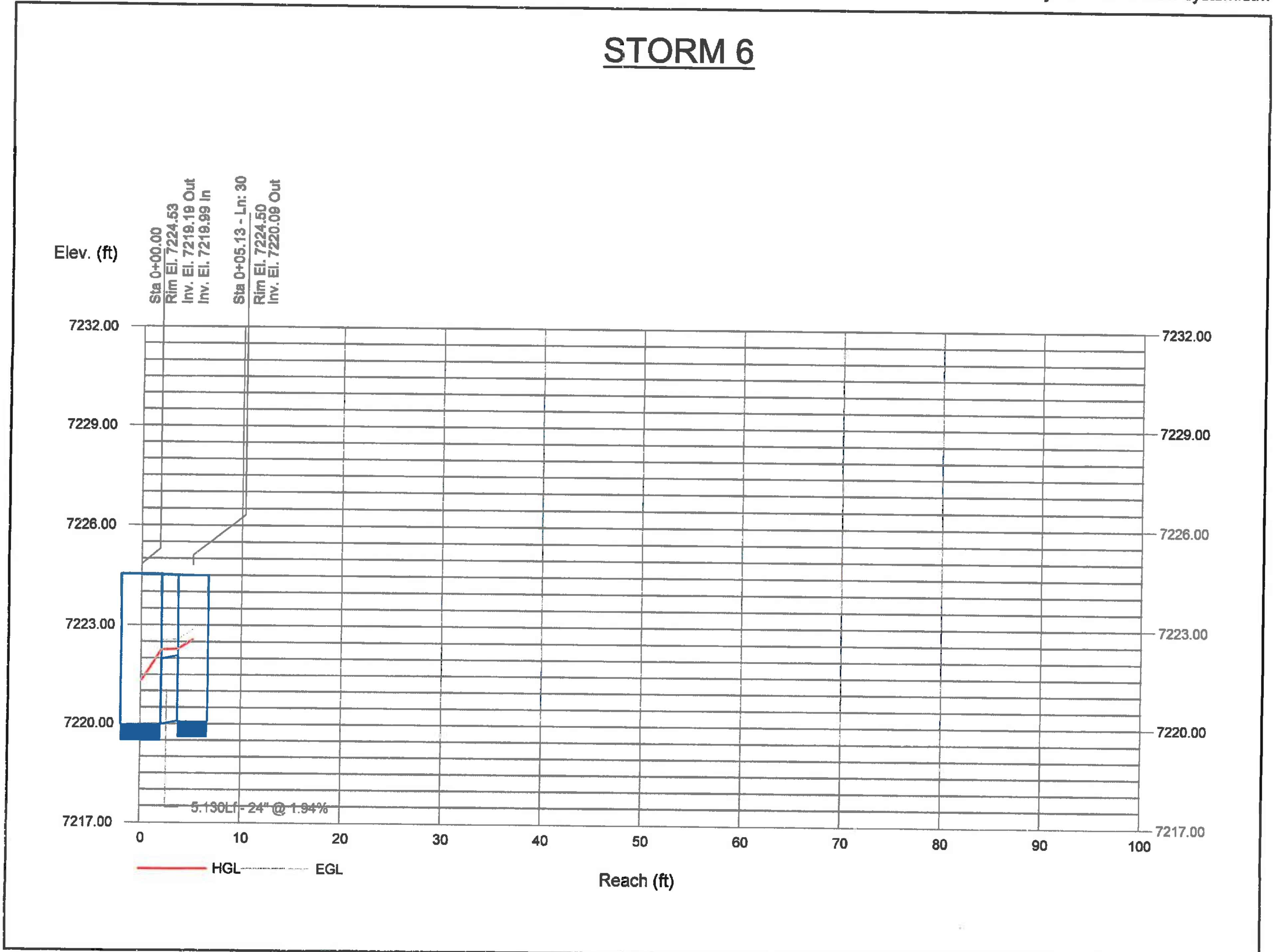
STORM 4



Storm Sewer Profile

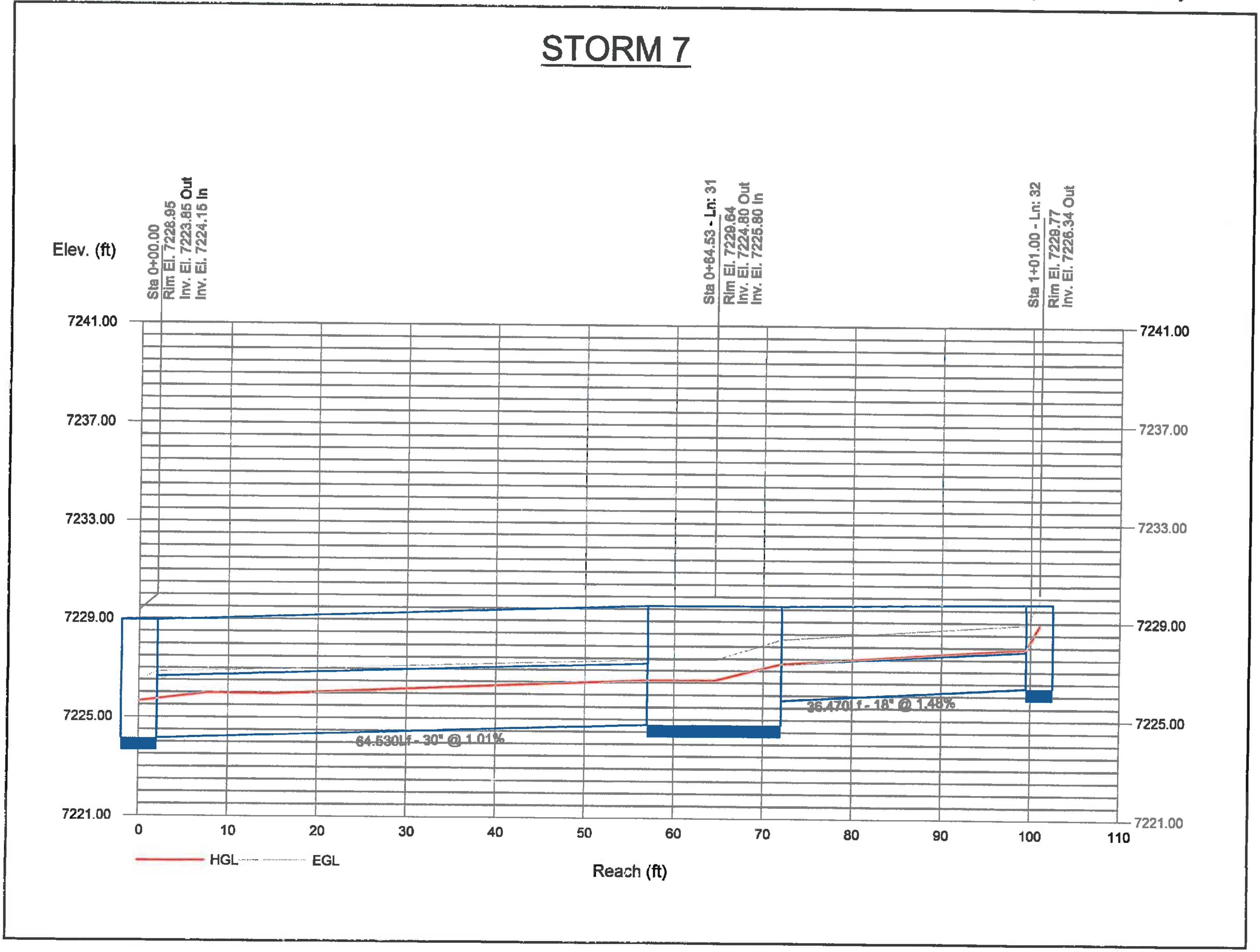


Storm Sewer Profile

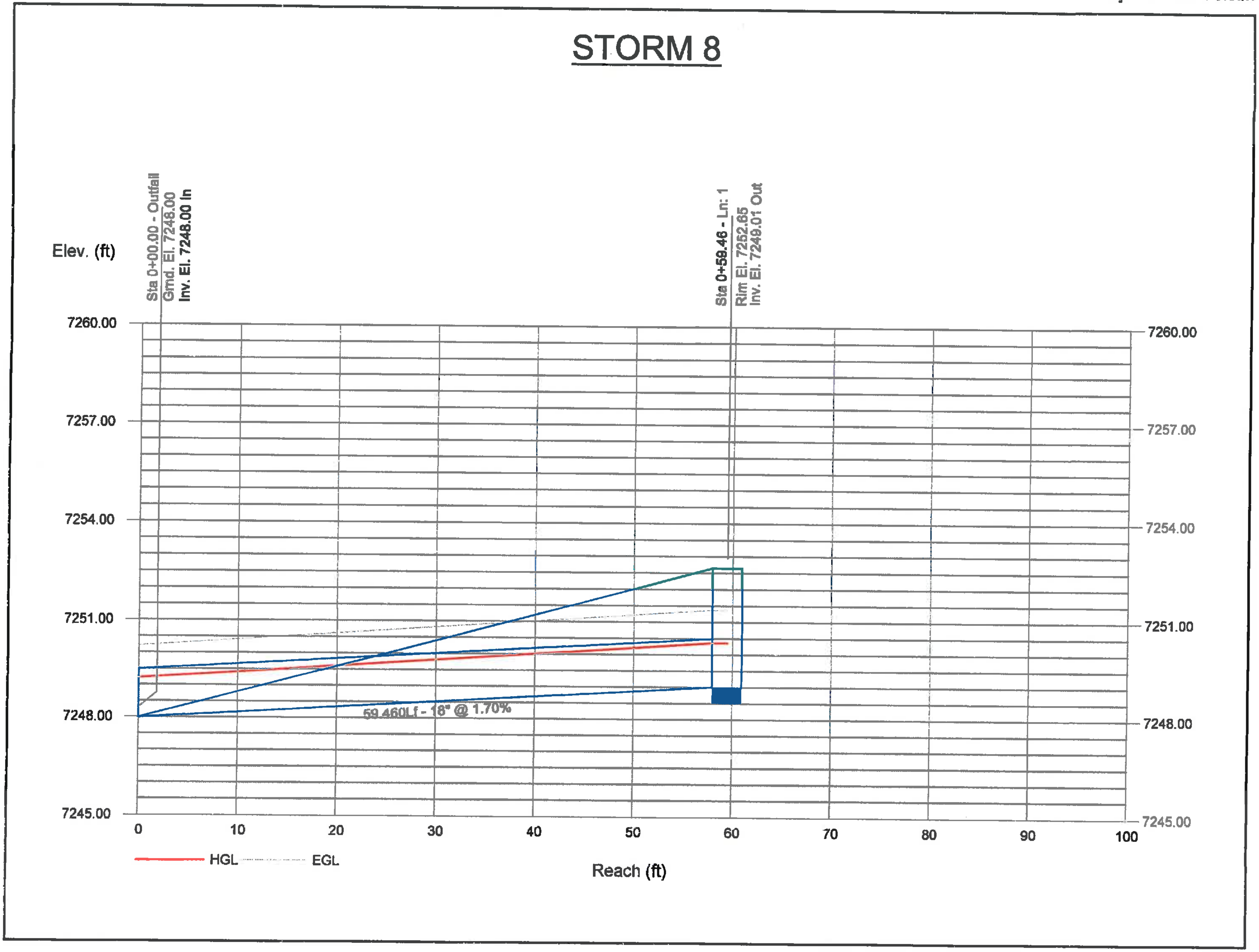


Storm Sewer Profile

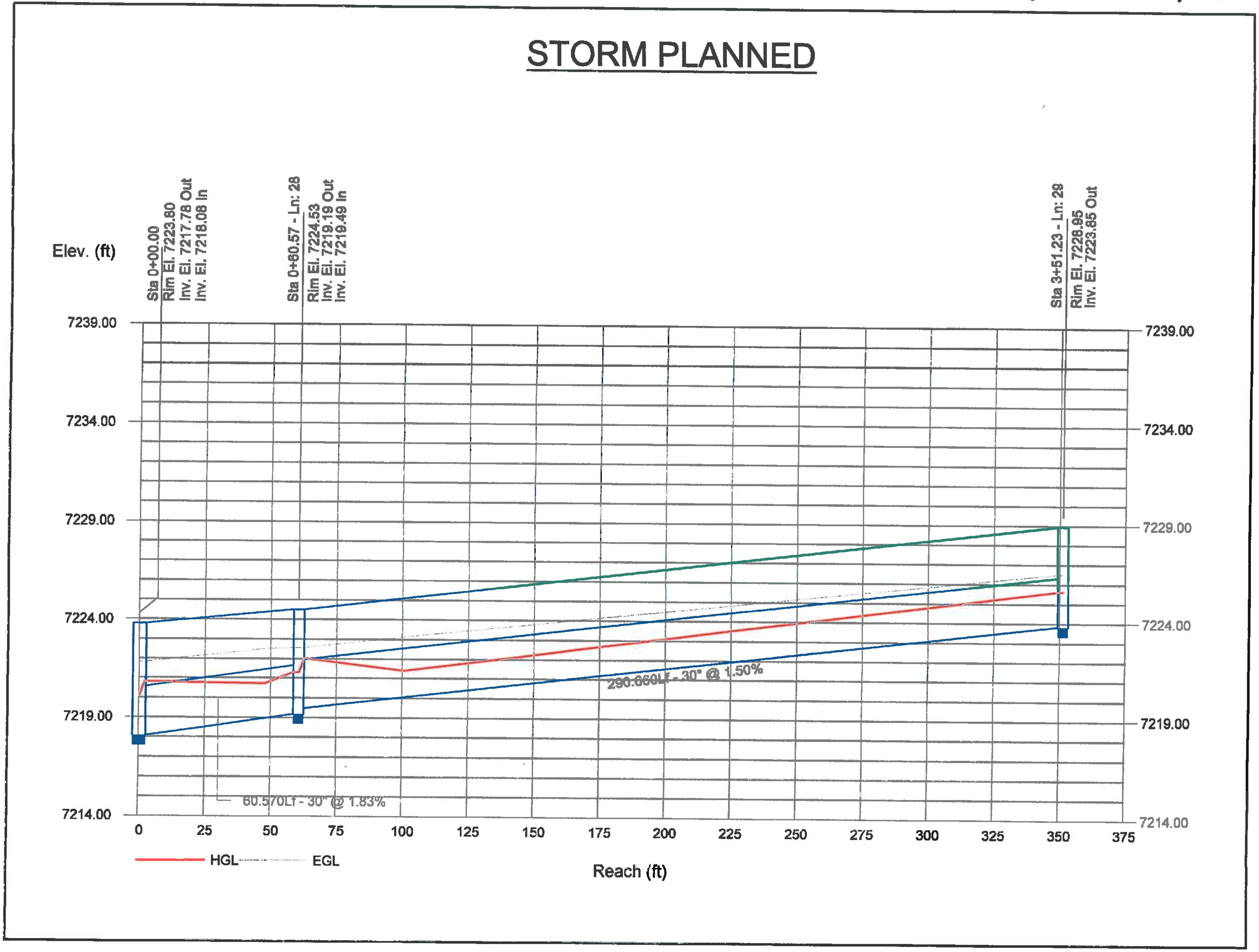
Proj. file: Storm Main System.stm



Storm Sewer Profile



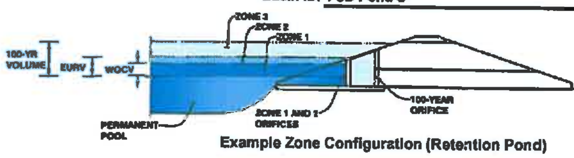
Storm Sewer Profile



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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.72	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.70	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	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)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.72	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	12.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	5.72	N/A	feet
Over Flow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	2.67	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	33.60	N/A	ft^2
Overflow Grate Open Area w/ Debris =	16.80	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	48.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	48.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	12.57	N/A	ft^2
Outlet Orifice Centroid =	2.00	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	8.15	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	83.00	feet
Spillway End Slopes =	6.67	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	1.05	feet
Stage at Top of Freeboard =	10.20	feet
Basin Area at Top of Freeboard =	2.43	acres

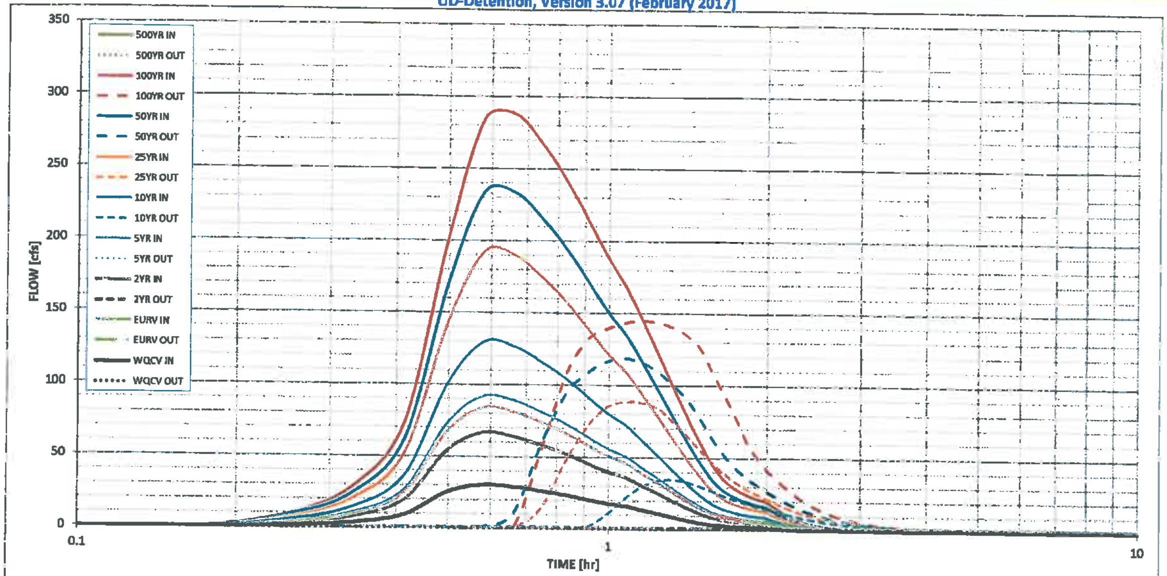
Routed Hydrograph Results

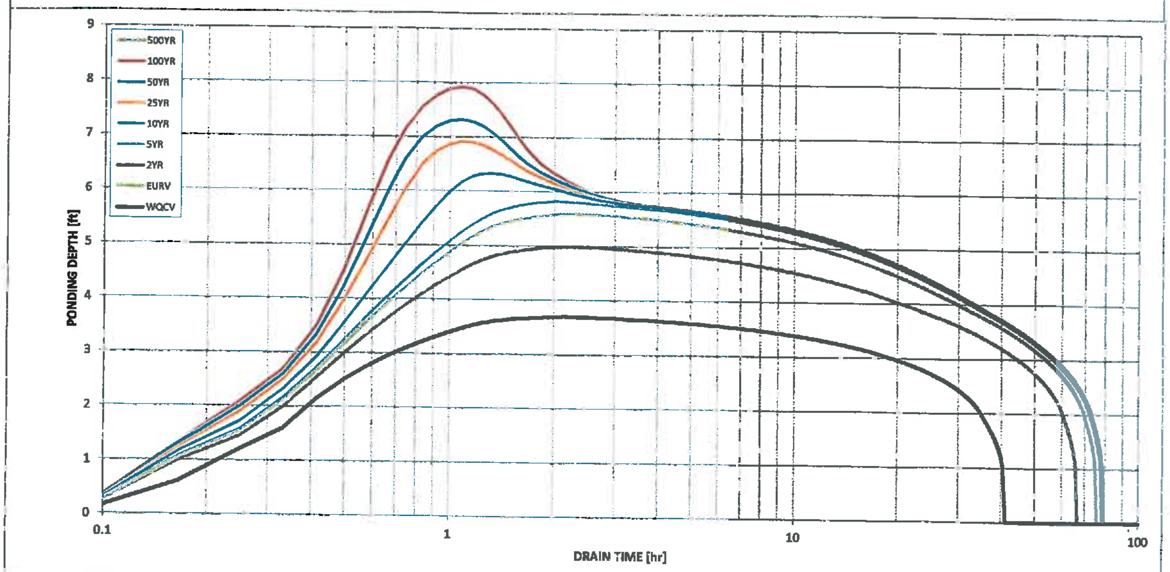
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	0.00
Calculated Runoff Volume (acre-ft) =	1.851	5.188	4.092	5.690	8.084	12.153	14.895	18.488	0.000
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	1.851	5.185	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	83.9	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

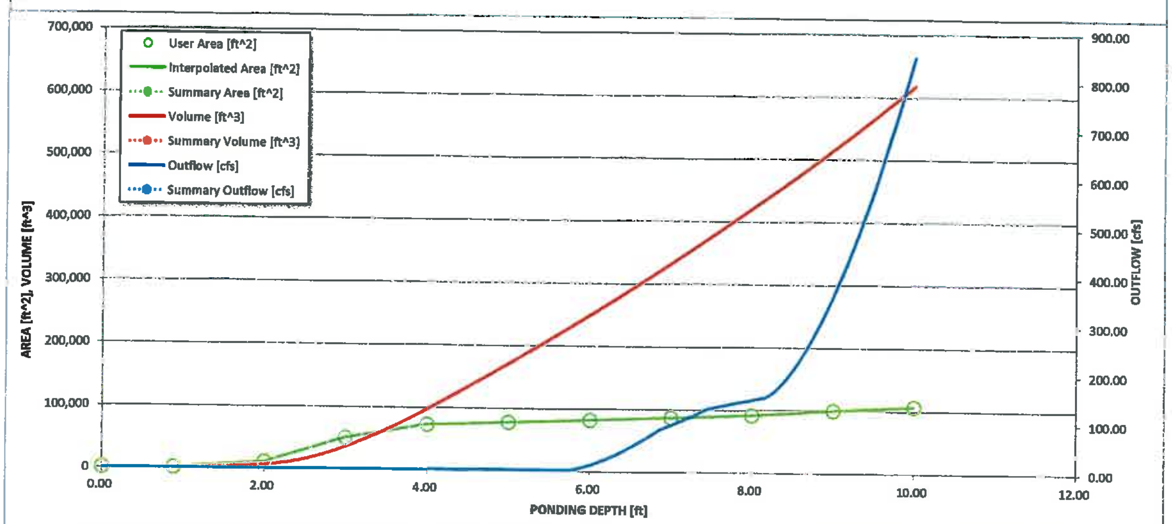
Update the outlet design. These must be equal to or less than historic for full spectrum design

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			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Paint Brush Hills Filing 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	ft/ft
Watershed Imperviousness =	40.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired 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.) =	12.153	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
500-yr Runoff Volume (P1 = 0 in.) =	0.000	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 =	8.624	acre-feet
Approximate 100-yr Detention Volume =	9.881	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

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) =	4.693	acre-feet
Total Detention Basin Volume =	9.881	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Depth Increment = ft

	Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
7190.09	Top of Micropool	--	0.00	--	--	--	200	0.005		
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	--	--	--	76,365	1.753	170,168	3.907
7196.00		--	6.00	--	--	--	81,024	1.860	248,863	5.713
7197.00		--	7.00	--	--	--	85,770	1.969	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
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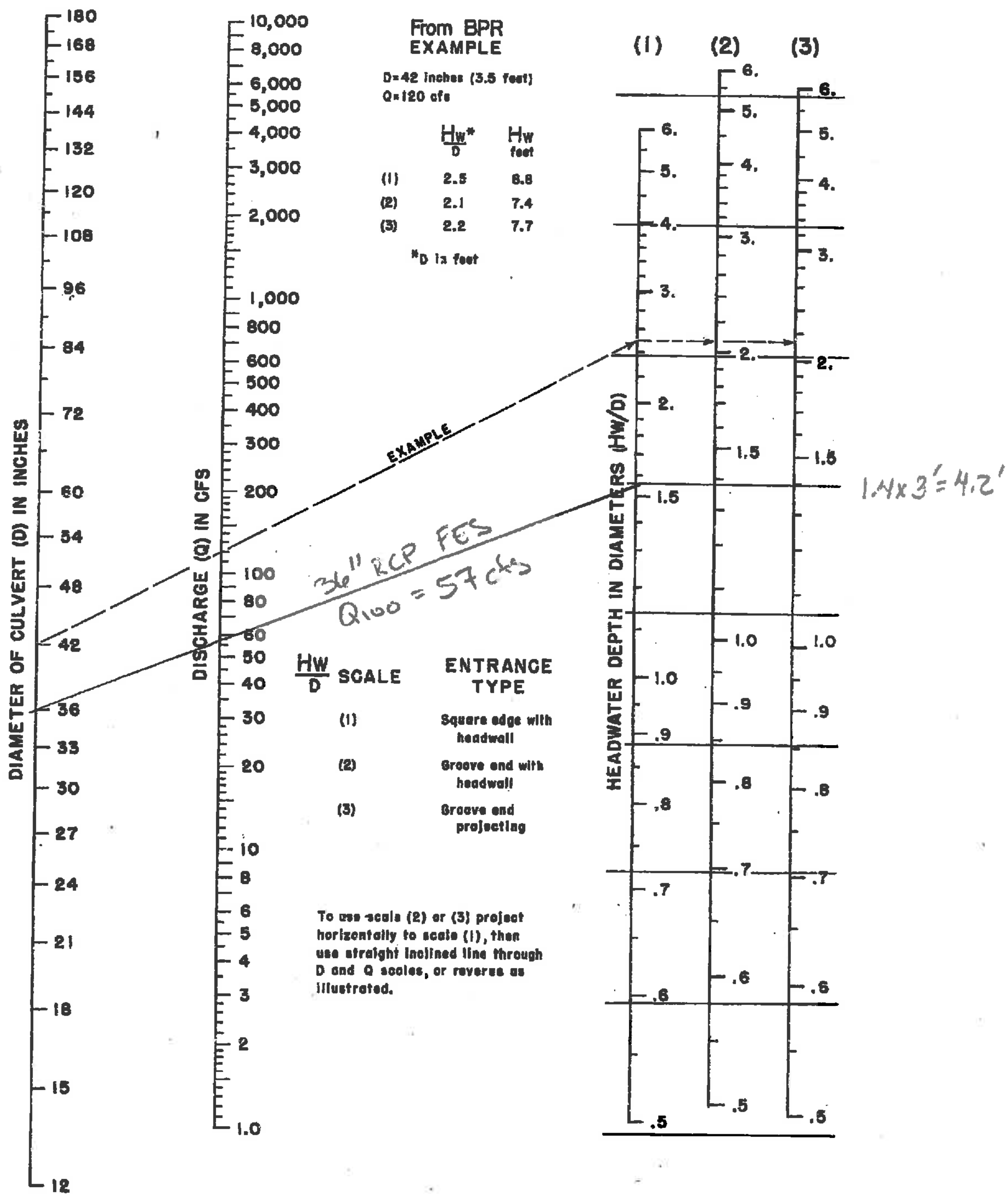
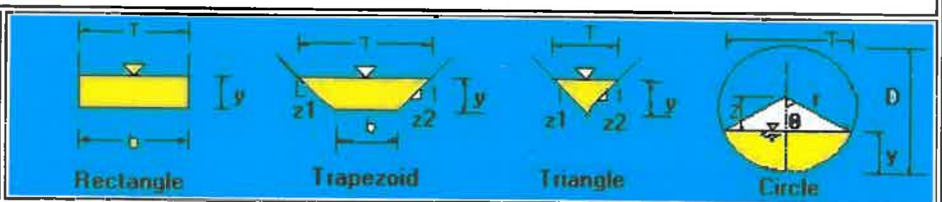


Figure CU-9—Inlet Control Nomograph—Example

DP 3 Q_{100} = 57cfs

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 ft^3/s	Input n value 0.013 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3 ft	Flow area 1 ft^2	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

LOW FLOW TRICKLE CHANNEL

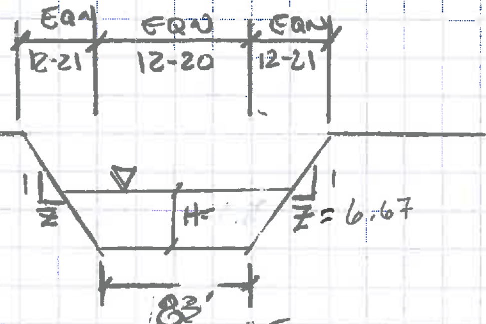
MS CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, STE 110
COLORADO SPRINGS, CO 80903
(719) 955-5485

PROJECT: 10-014 PAINT BRUSH HILLS FILING 14

DATE: 5-31-2018

SIZE SPILLWAY POND C

FROM UDFCD 12-23 STORAGE



Q_{100} = 287.7 cfs C= 3.0

EQN 12-20 $Q = CLH^{1.5}$ $Q = 3.0\,(83')\,(1.0)^{1.5}$ = 249 cfs

EQN 12-21 $Q = CZH^{2.5}$ $Q = 3.0\,(6.7)(1.0)^{2.5}$ = 20.1 cfs

Q_{TOTAL} = 249 cfs + 2 (20.1 cfs) = 289.2 cfs ≥ 287.7 cfs OK

POND C SURCHARGE VOL.

ACRES = 123.51 ACRES WATERSHED IMPERVIOUS = 40%

TRIBUTARY IMPERVIOUS AREA = 123.51 × 40% = 49.40 ACRES

FROM FIG 1 MICROPOOL AREA = 200 SQ FT ≅ 200 SQ FT ACTUAL

MINIMUM FOREBAY VOLUME

3% OF WQCV 3% × 1.724 AC-FT = 0.052 AC-FT × 43560 $\frac{cu\,ft}{AC\text{-}FT}$ = 2252.92 CU-FT

2253 CU-FT

2253 cu-ft ÷ 1.5 ft = 1502 SQ FT ≤ 1522 SQ FT OK

FOREBAY RELEASE & CONFIGURATION

PEAK 100-YR DISCHARGE Q_{100} = 142.6 cfs × 2% RELEASE = 2.85 cfs

WEIR EQN $Q = CLH^{3/2}$ C = 3.0 FOREBAY 1.5 ft DEEP

$Q = 3.0\,(0.52')\,(1.5)^{3/2}$ = 2.87 cfs ≥ 2.85 cfs OK

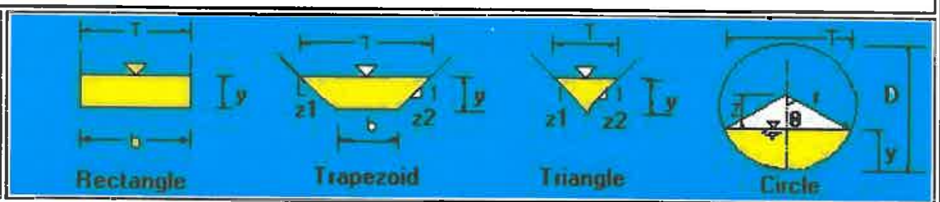
TRICKLE CHANNEL CAPACITY

SEE OPEN CHANNEL FLOW CALCULATOR SHEET

LOW FLOW CHANNEL 6" H × 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 ft^3/s	Input n value 0.06 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 86.83 ft	Flow area 39.46 ft^2	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

POND C SPILLWAY RUNDOWN

North American Green
14649 Highway 41 North
Evansville, IN 47725
800-772-2040
FAX: 812-867-0247
www.nagreen.com

NORTH AMERICAN GREEN®

A tensar Company

Material and Performance Specification Sheet

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/yd² (0.19 kg/m²) / 0.15 lbs/yd² (0.08 kg/m²)
Nettings	Top and Bottom, UV stabilized Polypropylene	5 lb/1000 ft² (2.44 kg/100 m²)
	Middle, corrugated UV stabilized Polypropylene	24 lb/1000 ft² (11.7 kg/100 m²)
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 yd² (33.4 m²)

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/in³	---
Mass/Unit Area	ASTM 6566	17.88 oz/yd² (606 g/m²)	---
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/ft²**
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)

Performance Design Values:

Maximum Permissible Shear Stress	Short Duration	Long Duration
Phase 1 Unvegetated	3.0 lbs/ft² (144 Pa)	2.5 lbs/ft² (120 Pa)
Phase 2 Partially Veg.	8.0 lbs/ft² (383 Pa)	8.0 lbs/ft² (383 Pa)
Phase 3 Fully Veg.	10.0 lbs/ft² (480 Pa)	8.0 lbs/ft² (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: QDOR

Updated 3/09

CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, STE 110
COLORADO SPRINGS, CO 80903
(719) 955-5485

PROJECT: PAINT BRUSH HILLS FILING No. 14

DATE: 6-12-18

LOW TAILWATER RIPRAP BASIN PIPE RUN 1

Q_{100} = 13.7 cfs 24" RCP

PER FIGURE 9-37 LOW TAILWATER RIPRAP BASIN (UDFCD)
FOR 24" PIPE RIP RAP BASIN 15'L x 10'W

PER FIGURE 9-38 RIP RAP EROSION 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 RIPRAP D_{50} = 9"

$2D_{50} = 2(9") =$ 18" THICK

Include the reference figure in the drainage report.

LOW TAILWATER RIPRAP BASIN PIPE RUN #25

Q_{100} = 144.9 cfs 48" RCP

PER FIG 9-37 LOW TAILWATER RIPRAP BASIN (UDFCD)
FOR 48" PIPE RIPRAP BASIN 24'L x 19'W

PER FIGURE 9-38 RIPRAP EROSION 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"

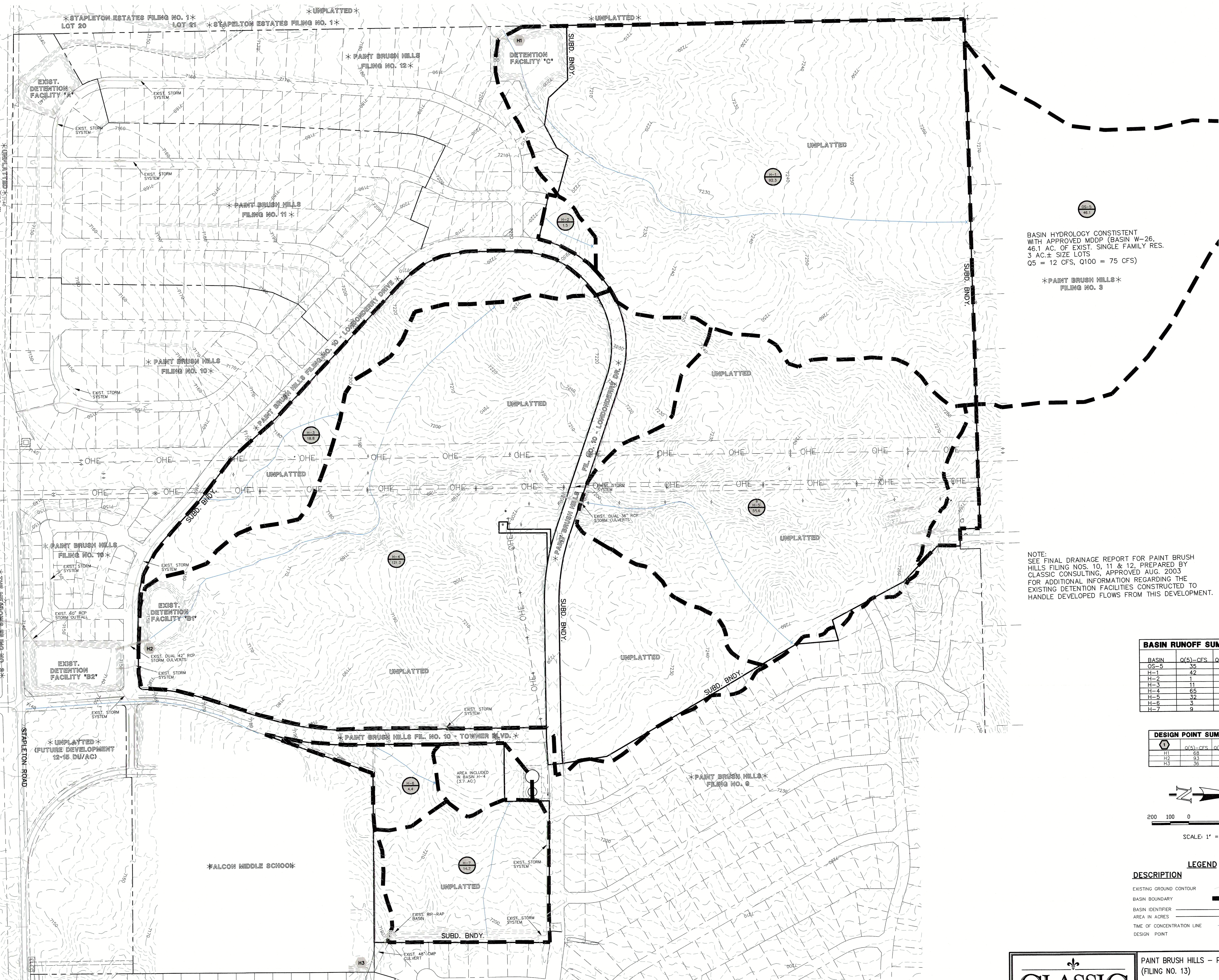
$2D_{50} = 2(18") =$ 36" THICK

PER "PAINT BRUSH HILLS FILING 12" CONSTRUCTION PLANS

EXISTING RIPRAP FOR OUT FALL 20'x20' x 3'THICK (D_{50}= 18")

EXISTING RIPRAP PAD IS IN CONFORMANCE

PROPOSED AND EXISTING DRAINAGE MAP
& REFERENCE MAPS



NOTE:
SEE FINAL DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NOS. 10, 11 & 12, PREPARED BY CLASSIC CONSULTING, APPROVED AUG. 2003 FOR ADDITIONAL INFORMATION REGARDING THE EXISTING DETENTION FACILITIES CONSTRUCTED TO 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	1	3
H-3	11	27
H-4	65	158
H-5	32	80
H-6	3	8
H-7	9	23

DESIGN POINT SUMMARY

1	Q(5)-CFS	Q(100)-CFS
H1	68	169
H2	93	227
H3	36	73

N

200 100 0 200 400

SCALE: 1" = 200'

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
BASIN BOUNDARY	
BASIN IDENTIFIER / AREA IN ACRES	BB 10.0
TIME OF CONCENTRATION LINE	
DESIGN POINT	1

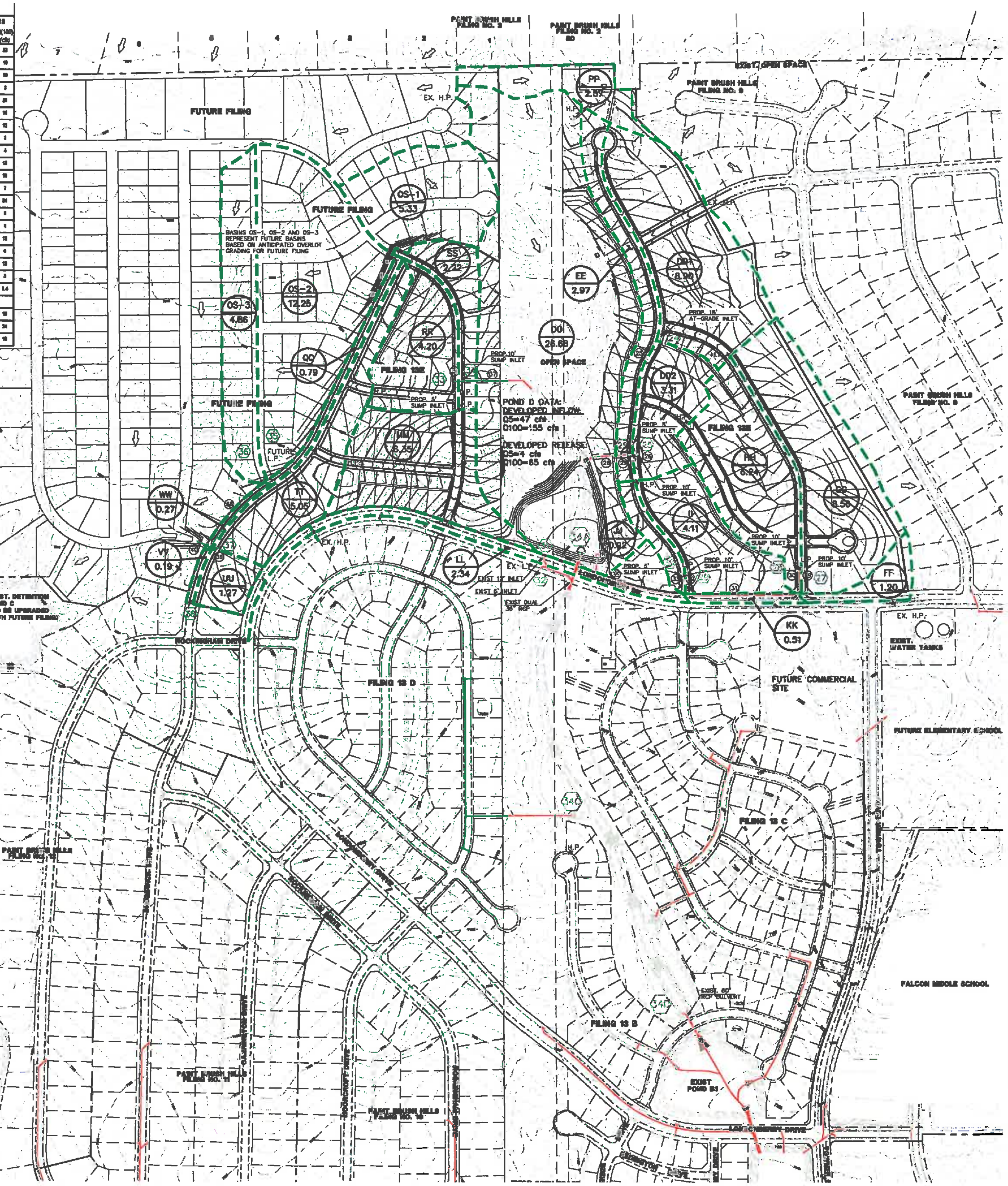
CLASSIC CONSULTING ENGINEERS & SURVEYORS
6385 Corporate Drive, Suite 101 Colorado Springs, Colorado 80919
(719)785-0790
(719)785-0799 (Fax)

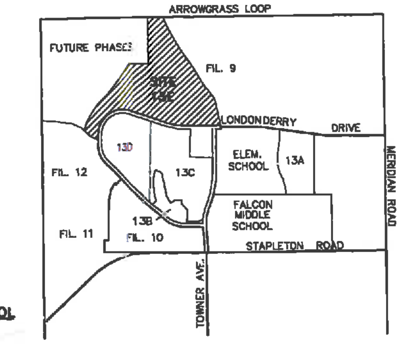
PAINT BRUSH HILLS – PHASE 2
(FILING NO. 13)
FINAL DRAINAGE REPORT
HISTORIC CONDITIONS DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE 8/20/12
DRAWN BY	MAW	(H) 1"= 200'	SHEET 1 OF 2
CHECKED BY		(V) 1"= N/A	JOB NO. 2053.21

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED CA(2)	CA(5)	CA(100)	OVERLAND C(5)	Length (ft)	Height (ft)	Tc (min)	STREET / CHANNEL FLOW Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc TOTAL (min)	INTENSITY I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	TOTAL FLOWS Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
DD1	1.34	1.96	4.09	0.22	160	4	16.4	480	3.0%	6.1	1.3	18.2	2.58	3.23	5.43	3	6	22
DD2	0.78	0.99	1.86	0.30	130	2.6	13.1	480	3.0%	6.1	1.2	14.3	2.87	3.59	6.02	2	4	10
EE	0.68	0.89	1.40	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	0.28	0.55	0.22	200	6	18.8	300	1.3%	4.0	1.3	20.1	2.47	3.08	5.18	0.4	0.9	3
GG	1.28	1.88	3.94	0.22	160	6	14.3	600	3.0%	6.1	2.5	16.8	2.68	3.35	5.62	3	6	20
HH	1.44	1.67	3.12	0.30	120	2.4	12.8	780	1.5%	4.3	2.8	15.6	2.77	3.47	5.83	4	6	18
II	0.99	1.23	2.05	0.30	150	3	14.1	280	1.5%	4.3	1.4	15.4	2.78	3.48	5.84	3	4	12
JJ	0.21	0.28	0.48	0.30	50	1	8.1	360	1.5%	4.3	1.4	9.5	3.36	4.21	7.07	0.7	1.2	3
KK	0.45	0.48	0.49	0.08	20	1	4.8	400	1.5%	4.3	1.6	6.4	3.83	4.80	8.06	2	2	4
LL	2.80	2.11	2.25	0.08	150	4	16.3	380	1.3%	4.0	1.6	17.8	2.61	3.27	5.49	5	7	12
MM	1.46	1.81	3.18	0.30	130	2.6	13.1	520	4.0%	7.0	1.2	14.3	2.87	3.59	6.02	4	7	19
NN	0.81	0.92	0.98	0.08	20	1	4.8	600	1.3%	4.0	2.7	7.8	3.63	4.55	7.64	3	4	7
OO	1.86	4.48	11.60	0.18	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	0.18	300	10	19.8					19.8	2.48	3.11	5.22	1	2	6
QQ	0.55	0.58	0.96	0.30	300	10	21.4	2200	2.0%	4.9	7.4	28.8	2.03	2.64	4.28	1	1	3
RR	0.97	1.28	2.10	0.30	[illegible]	3	14.1	250	2.0%	4.9	0.8	14.9	2.82	3.53	5.93	3	4	12
SS	0.51	0.67	1.11	0.30	150	3	14.1	400	2.0%	4.9	1.3	15.4	2.78	3.48	5.84	1	2	6
TT	0.76	1.11	2.32	0.22	150	3	15.8	480	2.0%	4.9	1.6	17.0	2.66	3.33	5.60	2	4	13
UU	0.19	0.28	0.58	0.22	150	3	15.5	160	2.0%	4.9	0.5	16.0	2.74	3.43	5.76	1	1	3
VV	0.14	0.14	0.18	0.22	20	0.5	8.3					5.0	4.06	5.10	8.55	0.6	0.7	1.4
OS-1	1.23	1.60	3.47	0.30	150	3	14.1	400	3.0%	6.5	1.1	15.2	2.80	3.50	5.87	3	6	19
OS-2	2.82	[illegible]	6.13	0.30	150	3	14.1	1100	2.0%	6.1	3.0	17.1	2.66	3.32	5.58	7	12	34
OS-3	1.12	1.46	2.43	0.30	50	1	8.1	1100	3.0%	6.1	3.0	11.1	3.17	3.97	[illegible]	4	6	16





VICINITY MAP
N.T.S.

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	5910
PROPOSED FINISHED CONTOUR	5910
BASIN BOUNDARY	
DESIGN POINT	3
BASIN IDENTIFIER / AREA IN ACRES	BB 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 I(5)	I(100)	Flow Q(5)	Q(100)	Inlet Size
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	1.40	11.7	3.89	6.54	3	10	5' Type R Sump
27	GG, FF	2.15	4.49	20.1	3.08	5.18	7	23	10' Type R Sump
28	HH	1.67	3.12	15.6	3.47	5.83	6	18	10' Type R Sump
29	II, KK	1.[illegible]	2.54	15.4	3.48	6.04	5	16	10' Type R Sump
30	JJ	0.28	0.48	9.5	4.21	7.07	1	3	5' Type R Sump
31	LL, MM	4.01	5.42	17.2	3.27	5.49	13	30	Ex. 12' Type R
32	NN	0.92	0.98	7.8	4.55	7.64	4	7	Ex. 5' Type R
33	RR	1.28	2.10	14.9	3.53	5.93	4	12	5' Type R Sump
34	SS, OS-1	2.27	3.78	16.2	3.40	5.71	8	22	10' Type R Sump
34A	Total Inflow to Pond D	17.84	35.33	27.2	2.63	4.41	47	155	
35	QQ, OS-2	4.28	6.79	17.1	3.32	5.58	14	38	15' Type R Sump
36	OS-3	1.46	2.43	11.1	3.97	6.66	6	16	10' Type R Sump
37	TT	1.11	2.32	17.0	3.33	5.60	4	13	15' Type R At-Grade
38	UU, VV and DP-37 Flow-by	0.42	0.88	17.2	3.32	5.57	1	5	

FINAL DRAINAGE REPORT ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	I(100)	Flow Q(5)	Q(100)	Pipe Size*	Velocity (ft/sec)
25	DP24 Pickup	1.96	2.74	18.2	3.23	5.43	6	15	24" RCP	
26	DP25	0.99	3.01	18.7	3.19	5.36	3	16	24" RCP	
27	PR26, PR28	2.95	5.76	18.8	3.18	5.33	9	31	30" RCP	
28	DP26, PR27	3.84	7.23	19.2	3.15	5.29	12	38	36" RCP	
29	DP27	2.15	4.49	20.1	3.08	5.18	7	23	30" RCP	
30	DP28	1.67	3.12	15.5	3.47	5.83	6	18	24" RCP	
31	PR29, PR30	4.02	7.61	20.8	3.05	5.11	12	39	36" RCP	
32	DP29	1.69	2.54	15.4	3.48	6.04	6	15	24" RCP	
33	DP30	0.28	0.48	9.5	4.21	7.07	1	3	18" RCP	
34	PR 32, PR33	1.97	3.00	12.8	3.43	6.31	7	17	24" RCP	
35	PR31, PR34	3.99	10.61	21.3	3.00	5.03	18	53	36" RCP	
36	DP 33	1.28	2.10	14.9	3.53	5.93	4	12	24" RCP	
37	DP34, PR36	3.53	5.[illegible]	16.5	3.38	5.67	12	33	30" RCP	
38	Future DP-35 and DP-36	5.71	9.22	17.3	3.31	5.56	19	51	36" RCP	
39	DP-37 Pick-up	1.11	2.07	17.8	3.30	5.64	4	12	24" RCP	
40	PR-38, PR-39	6.82	11.28	17.8	3.28	5.46	22	62	36" RCP	

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 08041C 0535F AND 08041C 0575, WITH EFFECTIVE DATES OF MARCH 17, 1997 (SEE APPENDIX).

NOTES:
THIS MAP IS FOR DRAINAGE PURPOSES ONLY. SEE GRADING PLAN FOR APPROPRIATE GRADING INFORMATION.

N
200 100 0 200 400
SCALE: 1" = 200'

POND D DESIGN DATA:
TRIBUTARY ACREAGE = 76.53 AC. @ 27% IMP
WQCV REQ. = 0.88 AC-FT
EURV REQ. = 2.10 AC-FT
RELEASE:
Q5 = 4.5 cfs @ WSE = 7203.88 (2.70 AC-FT)
Q100 = 85.3 cfs @ WSE = 7205.49 (5.86 AC-FT)
EMERGENCY SPILLWAY ELEV. = 7205.75
EMERGENCY OVERFLOW ELEV. = 7206.72

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

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

PAINT BRUSH HILLS FILING NO. 14

COUNTY OF EL PASO, STATE OF COLORADO

PROPOSED DRAINAGE MAP

JUNE 2018

BASIN SUMMARY			
BASIN	AREA (ACRES)	Q_5	Q_{100}
*RR	4.20	4.0	12.0
**SS	3.01	3.5	9.7
**OS1	4.44	4.9	13.7
*OO	28.06	12.0	51.0
*LL	2.34	7.0	19.0
*MM	6.35	4.0	7.0
*TT	5.05	4.0	13.0
*UU	1.27	1.0	3.0
***OS-5	46.10	14.0	32.0
OS5A	3.66	1.5	8.4
OS5B	13.44	4.6	25.8
OS5C	29.00	25.5	57.0
A	0.52	0.4	1.4
B	9.16	6.2	22.9
C	11.80	9.2	28.6
D	5.20	3.8	14.0
E	0.49	2.3	4.1
F	1.60	1.9	5.4
G	12.20	14.0	34.8
H	10.78	11.9	29.7
I	12.70	14.5	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

DESIGN POINT SUMMARY				
DESIGN POINT	Q_5	Q_{100}	CONTRIBUTING BASIN (S)	STRUCTURE
1	4.9	13.7	**OS1	PROP 10' TYPE R SUMP INLET
*33	4.4	12.4	*RR	*10' TYPE R SUMP INLET
**34	3.5	9.7	**SS	*10' TYPE R SUMP INLET
**34A	46.8	155.2	DD1, DD2, EE, FF, GG, HH, II, JJ, KK, OO, OS1, RR, SS	*EX POND D
3	25.7	58.1	A, OS5C	PROP 36" RCP FES
4	5.6	19.1	J	PROP 15" TYPE R SUMP INLET
5	1.1	2.7	K	PROP 5' TYPE R SUMP INLET
6	7.8	37.7	OS5B, D	PROP 2.9'x8.0' CDOT MOD TYPE D INLET
7	2.3	4.1	E	PROP 5' TYPE R SUMP INLET
8	1.9	5.4	F	PROP 5' TYPE R SUMP INLET
9	13.8	34.4	G	PROP DUAL 15' TYPE R AT-GRADE INLET
10	14.5	36.2	I	PROP DUAL 15' TYPE R AT-GRADE INLET
11	3.7	17.0	L, FLOWBY DP10	PROP 15' TYPE R AT-GRADE INLET
*37	3.7	13.0	*TT	PROP DUAL 15' TYPE R AT-GRADE INLET
12	11.9	29.7	H	PROP DUAL 15' TYPE R AT-GRADE INELT
13	2.1	21.3	M,FLOWBY DP9, FLOWYBY DP12, FLOWBY DP11	SEE DP15 FOR CUMULATIVE FLOW
14	10.3	34.8	C, OS5A	SEE DP15 FOR CUMULATIVE FLOW
15	12.3	55.4	DP13, DP14	PROP DUAL 20' TYPE R SUMP INLET
16	102.2	287.8	N, PR24	EX POND C

STORM SEWER SUMMARY			
PIPE RUN	Q_5	Q_{100}	PIPE SIZE
*36	4.4	12.4	*18" RCP
*37	7.6	21.4	*24" RCP
1	4.9	13.7	18" RCP
2	25.7	58.1	36" RCP
3	30.4	74.0	48" RCP
4	1.1	2.7	18" RCP
5	31.2	76.0	48" RCP
6	7.8	37.7	30" RCP
7	9.2	40.2	30" RCP
8	1.9	5.4	18" RCP
9	41.2	117.8	48" RCP
10	7.0	13.7	24" RCP
11	7.0	13.7	24" RCP
12	53.9	142.5	48" RCP
13	7.3	14.0	18" RCP
14	14.6	27.9	30" RCP
#38	14.6	27.9	30" RCP
15	3.7	13.5	24" RCP
#16	17.4	39.7	**30" RCP
*39	3.7	11.5	24" RCP
17	20.8	50.2	**30" RCP
18	6.0	12.4	18" RCP
19	11.9	24.8	30" RCP
20	32.4	74.2	42" RCP
21	84.8	213.4	54" RCP
22	6.1	27.7	30" RCP
23	12.3	55.4	36" RCP
24	97.0	268.2	60" RCP
#25	3.6	144.9	EX 48" RCP

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

1" = 100'

0 50 100 200

Scale in Feet

LEGEND

- BASIN DESIGNATION (Z = basin, 25 = ACRES, .25 = C5, .35 = C100)
- PIPE RUN REFERENCE LABEL
- SURFACE DESIGN POINT
- BASIN BOUNDARY
- CCES BASIN BOUNDARY
- (6920) EXISTING CONTOUR
- 6920 PROP CONTOUR
- PROP FENCE
- EX STORM SEWER PIPE
- STORM SEWER PIPE
- FLARED END SECTION
- CROSSPAN
- INLET/OUTLET STRUCTURE
- EXISTING FLOW DIRECTION ARROW
- EMERGENCY OVERFLOW DIRECTION
- PROPOSED FLOW DIRECTION
- H.P. HIGH POINT
- L.P. LOW POINT
- RIPRAP
- EROSION CONTROL BLANKET

*VALUES TAKEN FROM "PRELIMINARY DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NO.13E" PREPARED BY CLASSIC ENGINEERS AND SURVEYORS, DATED FEB. 2018 SEE PAINT BRUSH HILLS FILING NO.13E DRAINAGE MAP BASINS DD1, DD2, EE, FF, GG, HH, II, JJ AND KK FOR AREA DRAINAGE SUMMARY, BASIN ROUTING SUMMARY AND STORM SEWER ROUTING SUMMARY.

**REVISED FROM"PRELIMINARY DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NO.13E" PREPARED BY CLASSIC ENGINEERS AND SURVEYORS, DATED FEB. 2018

***"FINAL DRAINAGE REPORT FOR PAINT BRUSH HILLS PHASE 2 (FILING NO.13)" PREPARED BY CLASSIC ENGINEERS AND SURVEYORS, REVISED JUNE 2008

#REVISED FLOWS AND/OR PIPE SIZE FROM"PRELIMINARY DRAINAGE REPORT FOR PAINT BRUSH HILLS FILING NO.13E" PREPARED BY CLASSIC ENGINEERS AND SURVEYORS, DATED FEB. 2018

Revise reference to "Final Drainage Report for Paint Brush Hills Filing 13E" dated Sep 2018.
See PCD File No SF189 for the approved report. Update any reference values that may have changed from the preliminary to the the final drainage report

FOR LOCATING & MARKING GAS, ELECTRIC, WATER & TELEPHONE LINES

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CALL 1-800-922-1987

M&S CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, SUITE 110
COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

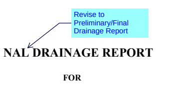
PAINT BRUSH HILLS FILING NO. 14

PROPOSED DRAINAGE MAP

PROJECT NO. 10-014	SCALE: HORIZONTAL: 1"=100' VERTICAL: N/A	DATE: 6/15/2018	
DESIGNED BY: GT DRAWN BY: CMN CHECKED BY: VAS		SHEET 1OF 1	FDM

Drainage Report_v1_redlines.pdf Markup Summary

Callout (23)



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Layer:
Space:

Revise to Preliminary/Final Drainage Report

Subject: Callout
Page Label: 1
Author: dsdlaforce
Date: 11/3/2020 11:50:33 AM
Status:
Color:
Layer:
Space:

SP206 & SF2024

Subject: Callout
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Author: dsdlaforce
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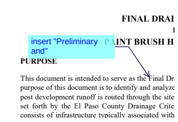
update to preliminary/final drainage report



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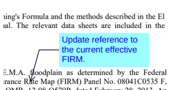

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Author: dsdlaforce
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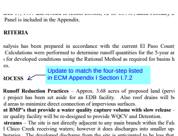
Color:
Layer:
Space:

Update reference to the current effective FIRM.

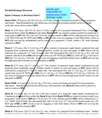


Subject: Callout
Page Label: 5
Author: dsdlaforce
Date: 11/3/2020 12:04:27 PM
Status:
Color:
Layer:
Space:

Update to match the four-step listed in ECM Appendix I Section I.7.2

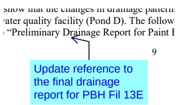
Subject: Callout
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/3/2020 2:08:24 PM
Status:
Color:
Layer:
Space:

Fix



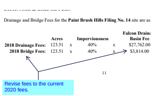
Subject: Callout
Page Label: 7
Author: dsdlaforce
Date: 11/3/2020 2:37:57 PM
Status:
Color:
Layer:
Space:

identify who' responsible for maintenance of the drainage swale.



Subject: Callout
Page Label: 9
Author: dsdlaforce
Date: 11/4/2020 11:31:12 AM
Status:
Color:
Layer:
Space:

Update reference to the final drainage report for PBH Fil 13E



Subject: Callout
Page Label: 11
Author: dsdlaforce
Date: 11/4/2020 11:41:35 AM
Status:
Color:
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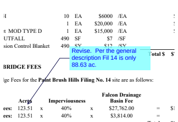
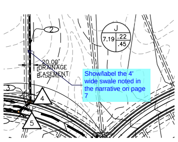
Space:

Revise fees to the current 2020 fees.



Subject: Callout
Page Label: 11
Author: dsdlaforce
Date: 11/4/2020 11:55:07 AM
Status:
Color:
Layer:
Space:

Revise. Per the general description Fil 14 is only 88.63 ac.



Subject: Callout
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/4/2020 11:58:04 AM
Status:
Color:
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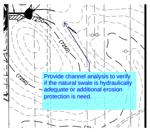
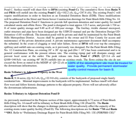
Space:

Show/label the 4' wide swale noted in the narrative on page 7



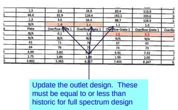
Subject: Callout
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/4/2020 11:59:18 AM
Status:
Color:
Layer:
Space:

Provide channel analysis to verify if the natural swale is hydraulically adequate or additional erosion protection is need.



Subject: Callout
Page Label: 9
Author: dsdlaforce
Date: 11/4/2020 3:48:31 PM
Status:
Color:
Layer:
Space:

100% of the development site must be treated for water quality. Provide permanent stormwater quality control measure for basin B.



Subject: Callout
Page Label: 122
Author: dsdlaforce
Date: 11/4/2020 3:55:04 PM
Status:
Color:
Layer:
Space:

Update the outlet design. These must be equal to or less than historic for full spectrum design

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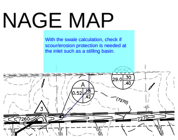
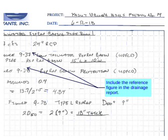


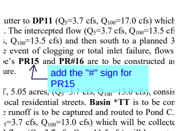
Subject: Callout
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/4/2020 3:57:10 PM
Status:
Color:
Layer:
Space:

With the swale calculation, check if scour/erosion protection is needed at the inlet such as a stilling basin.



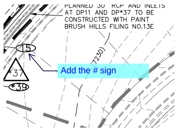
Subject: Callout
Page Label: 130
Author: dsdlaforce
Date: 11/4/2020 4:08:35 PM
Status:
Color:
Layer:
Space:

Include the reference figure in the drainage report.



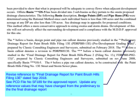
Subject: Callout
Page Label: 8
Author: dsdlaforce
Date: 11/4/2020 7:38:03 AM
Status:
Color:
Layer:
Space:

add the "#" sign for PR15



Subject: Callout
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/4/2020 7:39:31 AM
Status:
Color:
Layer:
Space:

Add the # sign



Subject: Callout
Page Label: 6
Author: dsdlaforce
Date: 11/4/2020 7:45:39 AM
Status:
Color:
Layer:
Space:

Revise reference to "Final Drainage Report for Paint Brush Hills Filing 13E" dated Sep 2018. See PCD File No SF189 for the approved report. Update any reference values that may have changed from the preliminary to the the final drainage report

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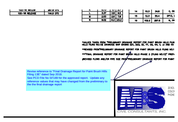

Subject: Callout
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/4/2020 7:46:09 AM
Status:
Color:
Layer:
Space:

Revise reference to "Final Drainage Report for Paint Brush Hills Filing 13E" dated Sep 2018. See PCD File No SF189 for the approved report. Update any reference values that may have changed from the preliminary to the the final drainage report

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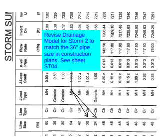
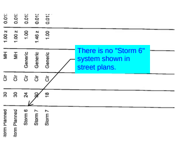


Subject: Callout
Page Label: 106
Author: dsdlaforce
Date: 11/6/2020 9:43:31 AM
Status:
Color:
Layer:
Space:

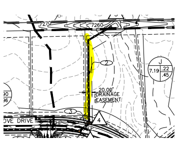
Revise Drainage Model for Storm 2 to match the 36" pipe size in construction plans. See sheet ST04.



Subject: Callout
Page Label: 107
Author: dsdlaforce
Date: 11/6/2020 9:44:02 AM
Status:
Color:
Layer:
Space:

There is no "Storm 6" system shown in street plans.

Highlight (5)



Subject: Highlight
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/3/2020 2:24:46 PM
Status:
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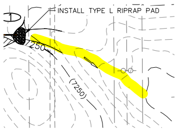
Space:



Subject: Highlight
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/4/2020 11:34:12 AM
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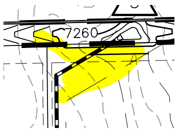
Space:



Subject: Highlight
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/5/2020 9:22:48 AM
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Color:
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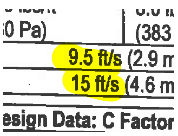
Space:



Subject: Highlight
Page Label: 129
Author: dsdlaforce
Date: 11/6/2020 9:50:14 AM
Status:
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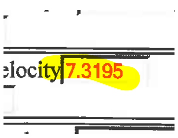

Subject: Highlight
Page Label: 128
Author: dsdlaforce
Date: 11/6/2020 9:50:38 AM
Status:
Color:
Layer:
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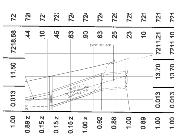
Image (1)

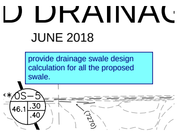


Subject: Image
Page Label: 106
Author: dsdlaforce
Date: 11/6/2020 9:43:31 AM
Status:
Color:
Layer:
Space:

Text Box (4)

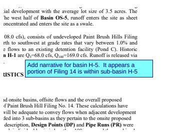
Subject: Text Box
Page Label: 21
Author: dsdlaforce
Date: 11/3/2020 12:01:56 PM
Status:
Color:
Layer:
Space:

Replace the firmette with the current effective FIRM



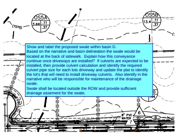
Subject: Text Box
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/4/2020 3:57:31 PM
Status:
Color:
Layer:
Space:

provide drainage swale design calculation for all the proposed swale.



Subject: Text Box
Page Label: 6
Author: dsdlaforce
Date: 11/5/2020 8:07:49 AM
Status:
Color:
Layer:
Space:

Add narrative for basin H-5. It appears a portion of Filing 14 is within sub-basin H-5



Subject: Text Box
Page Label: [1] PDM
Author: dsdlaforce
Date: 11/6/2020 11:30:29 AM
Status:
Color:
Layer:
Space:

Show and label the proposed swale within basin D. Based on the narrative and basin delineation the swale would be located at the back of sidewalk. Explain how this conveyance continue once driveways are installed? If culverts are expected to be installed, then provide culvert calculation and identify the required culvert pipe size for each lots driveway and update the plat to identify the lot's that will need to install driveway culverts. Also identify in the narrative who will be responsible for maintenance of the drainage swale.
Swale shall be located outside the ROW and provide sufficient drainage easement for the swale.