

**FINAL DRAINAGE REPORT**

FOR

**Aura at Crossroads**

Date: June 17, 2021

Prepared for:

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**Engineer's Statement**

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the city/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.

\_\_\_\_\_  
Mark A. West, P.E., C.F.M.  
State Of Colorado Registration No. 38561  
On Behalf of Harris Kocher Smith

\_\_\_\_\_  
Date

**Developer's Statement**

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

\_\_\_\_\_  
Trinsic Acquisition Company, LLC

By: \_\_\_\_\_

Title: \_\_\_\_\_

Address: \_\_\_\_\_

**El Paso County**

Filed in accordance with Section 51.1 of the El Paso Land Development Code as amended.

\_\_\_\_\_  
City Engineer

\_\_\_\_\_  
Date

## **Section I – General Location and Description**

### **A. Location**

The proposed Crossroads at Meadowbrook Apartments development (hereinafter referred to as “Site”) is situated in the Southwest ¼ of Section 8, Township 14, Range 65 West of the 6<sup>th</sup> Principle Meridian in the County of El Paso, State of Colorado. The Site is bounded by US Highway 24 to the South, undeveloped and soon to be commercial development to the east, Meadowbrook Parkway to the North, and undeveloped land and dirt roads to the west. The Site is essentially at the intersection of Highway 94 and Highway US 24.

### **B. Description of Property**

The Site is approximately 12.70 acres comprised of paved areas, walks, and a large buildings, as well as undeveloped ground well vegetated by native grasses, weeds, and ferns. The Site generally flows from north to south, being collected in internal parking areas with grades ranging from 1% to 2%. There are no major drainageways located within or around the Site. An existing park/detention pond is located just south of the Site in Tract A of the Crossroads at Meadowbrook Mixed-Use subdivision that will capture and treat Site runoff. The proposed development of the Site includes multiple apartment buildings, a pool and clubhouse with facilities located on-Site, an amenity building, a dog park, walks, parking, and roadways.

The Site is almost entirely comprised of clean to silty sand at 20 to 30-foot depths, with NRCS hydrologic soil group A. The NRCS Custom Soil Resource Report for the Site can be found in Appendix A. According to the Geotechnical Investigation report prepared by CTL Thompson, dated May 18, 2021, the sand encountered was loose to very dense and tested samples contained 5 to 35 percent clay and silt-size particles (passing the No. 2000 sieve). Groundwater was not encountered in all of the borings on-site. There are soils that certify as collapsible-prone for the southern portion of the site and will require sub excavation and remediation up to four feet. A copy of the Geotechnical Investigation can be found in Appendix E.

## **Section II – Drainage Basins and Sub-Basins**

### **A. Major Drainage Basins**

The Site is shown on the Federal Emergency Management Agency’s (FEMA) Flood Insurance Rate Map (FIRM) Community Panel Number 08041C0754G, effective as of December 07, 2018. Site is located in Zone X (areas determined to be outside of the 0.2% annual chance floodplain). Please refer to the FIRMette included in Appendix A for reference.

The Site lies within the Sand Creek FOFO4000 floodplain based on the El Paso County Drainage Basin Map. The Sand Creek East Fork Channel is located to the northwest of the adjacent Meadowbrook Crossing subdivision. There are currently no Master Drainageway Plans (MDP), Flood Hazard Area Delineations (FHAD), or Outfall Systems Plans (OSP) that affect development of the Site, nor are there any channels that impact or are impacted by development of the Site.

## **B. Sub-Drainage Basins**

The historic drainage basins and conditions are described in the Preliminary Drainage Report for Crossroads Mixed Use that is included in Appendix D.

The final drainage basins are described below:

Sub-basin X-1 (0.42 acres) takes up a large area in the northwest portion of the Site. This basin contains primarily landscaped area with half of the rood flow from a residential building. Flow from this basin is collected through downspouts and area drains, with an emergency overflow pathway to the existing Type R 10' inlet in Meadowbrook Parkway at DP 0.

Sub-basin X-2 (0.08 acres) is located at the northern entry of the site. A high point at the point of curb directs flow into Meadowbrook Parkway where it is conveyed to the existing Type R 10' Inlet in Meadowbrook at DP 0.

Sub-basin X-3 (0.08 acres) is located at the northern entry of the Tract C roadway adjacent to the eastern property boundary of the Site. This basin contains mostly paved area with some landscaped area. Flow from this basin is conveyed through the existing Meadowbrook Parkway and collected at the existing Type R 10' Inlet at DP 0.

Sub-basin A-1 (2.07 acres) is located in the northeast portion of the Site. This basin is fairly equal amounts of paved area, roofs, and landscape area. Flow from this basin is collected at a curb inlet designated DP 1, where it is then conveyed through the western storm system into the existing detention pond. This inlet is designed to capture all of the 95% of the minor storm and around 73% of the major storm. Carry-over flow will be collected at DP-7.

Sub-basin A-2 (0.43 acres) is located in the middle of the Site. This basin contains fairly equal amounts of paved area, roofs, and landscape area. Flow from this basin is directed to a curb inlet at DP 3 through curb and gutter or area and landscape drains. This inlet is designed to capture all of the minor storm and about 88% of the major storm to minimize bypass.

Sub-basin A-3 (0.83 acres) is located in the middle south portion of the Site. This basin mostly paved areas and building roofs. Flow from this basin is collected via streets and curb and gutter to a curb inlet at DP 5, and is then conveyed through the western storm system to the detention pond. This inlet is designed to capture all of the minor storm and 95% of the major storm to minimize bypass.

Sub-basin A-4 (0.76 acres) is located in the southern portion of the Site, just south of Basin A-5. This basin contains most paved areas and roofs. Flow from this basin is collected via streets and curb and gutter to a curb inlet at DP 6, and is then conveyed through the western storm system to the detention pond. This inlet is designed to capture all of the minor storm and 88% of the major storm to minimize bypass. The bypass flow will be directed to a curb inlet at DP 7.

Sub-basin A-5 (3.19 acres) is the largest sub-basin located in the eastern area of the Site. This basin contains primarily paved and landscape areas with some roof flows. Flows are conveyed through curb and gutter to a large Type R 15' Inlet at DP 7 at the low point of the Site, just north of the existing detention pond. Flows from Basin A-1, A-3, A-5, A-5, and A-6 are all collected at DP 7 and conveyed to the detention pond through a short storm run. This inlet is designed to capture almost all of the minor storm and 72% of the major storm. Bypassed flow will be conveyed directly into the adjacent detention pond to the south.

Sub-basin B-1 (0.75 acres) is located in the middle of the Site at the pool deck and open space amenity area. This basin contains roofs, paved areas, walks, landscaped areas, and open space. Flow from this basin is collected through area drains and at a Type C area inlet that is sitting in landscape area at DP 8. This inlet has been designed to capture all of the major and minor storm flows from this basin and route it through the eastern on-site storm system.

Sub-basis B-2 (0.28 acres) is located in the middle portion of the Site. This basin contains mostly paved area with building roofs and a few private yards. Runoff from this basin will be collected through area drains or curb and gutter to a curb inlet at DP 9. It is then conveyed through the eastern storm sewer system on Site and eventually to the existing detention pond.

Sub-basin B-3 (1.91 acres) is located along the eastern property boundary of the Site. This basin contains primarily paved area with some landscape and roof flows. The landscape and roof drainage will be collected with area drains and the paved area will be collected through curb and gutter to curb inlet at DP 10. This inlet is designed to capture 94% of the minor storm and 73% of the major storm. Bypassed flow will be directed to the downstream curb inlet.

Sub-basin B-4 (0.78 acres) is located at the southeast corner of the Site. This basin contains mostly paved streets and some roof and landscape areas. Flows are conveyed to a curb large curb inlet at DP 11 at another low point of the Site. Flows from Basin B-2 and B-3 are collected at DP 11 and conveyed to the detention pond through the existing and proposed eastern storm sewer system. This inlet is designed to capture all of the minor storm and 78% of the major storm. Bypassed will be conveyed directly into the adjacent detention pond to the south through overland flow.

Sub-basin OS-1 (0.77 acres) is located adjacent to the eastern property boundary of Lot 11 and contains half of the Tract C limits along with the southeast corner of the Site. This basin contains mostly paved streets with a portion of a building roof and some landscape area. Flow is conveyed to a curb inlet at the south end of the street through curb and gutter or landscape drains. This inlet is designed to capture all of the minor storm and almost all of the major storm.

Sub-basin OS-2 (0.44 acres) is located on the south half of the Tract C roadway and landscaping area. This basin contains primarily paved area with some landscape area. Flow is conveyed to a curb inlet at the south end of the street through curb and gutter. This inlet is designed to capture all of the minor storm and 86% of the major storm. Bypassed flow is conveyed over the crown of the street to other street inlet in Sub-Basin OS-1.

Sub-basin Z-1 (0.37 acres) is located along the southern property boundary of the Site adjacent to the existing detention pond. This basin contains roofs and landscape/open space area that is collected through landscape drains. Any overflow from these area drains is conveyed overland to the adjacent existing detention pond.

Sub-basin Z-2 (0.56 acres) is located along the western property boundary of the Site. This basin contains roofs and landscape/open space area that is collected through landscape drains and/or a grass swale that conveys the flow south to the existing detention pond at DP 15.

The full final drainage plan can be found in Appendix F. A summary of the basin flows can be found in Appendix B.

### **Section III – Drainage Design Criteria**

#### **A. Development Criteria Reference and Constraints**

The basis for design and analysis of the drainage system and drainage impacts for the Site were the studies noted above in Volume 1 of the County of El Paso, Colorado Drainage Criteria Manual (DCM), and the Mile High Flood District (MHFD, formerly known as Urban Drainage and Flood Control district [UDFCD]) Urban Storm Drainage Criteria Manual (USDCM), Volumes 1, 2 and 3 (2001-2019).

#### **B. Hydrologic Criteria**

The total area of the Site to be developed is approximately 13.67 acres. The Rational Method is appropriate and was used to calculate peak rates of stormwater runoff. The design storms analyzed for this Site include the 5-year and 100-year for the minor and major storms, respectively, per the El Paso County DCM. Rainfall intensities were determined using the following Rainfall Intensity Duration (IDF) equations, as applicable, excerpted from Figure 6-5 of the El Paso County DCM Volume 1 Update:

##### **IDF Equations**

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

The runoff coefficients from Table 6-6 of the Volume 1 Update of the El Paso County DCM reference the 2001-2008 UDFCD USDCM, and appear to have been computed using the corresponding equations from that same USDCM. Those equations were used to compute composite runoff coefficients for this study.

Results of hydrologic analyses, in addition to pertinent charts, figures, and tables, are included in Appendix B of this report.

Data for the off-site flows and basins, particularly for and Design Points 0 and 11 and Offsite Basins A, B, and E presented in the Rational Calculations (Appendix B), is information pulled from highlighted excerpts presented in the Area Drainage Summary and the Proposed Conditions Drainage Map of the Preliminary Drainage Report for Crossroads Mixed Use (Appendix D). We are conforming to the text and calculations that are shown in this Preliminary Drainage Report.

#### **C. Hydraulic Criteria**

Hydraulic analyses generally conform to El Paso County DCM methodology. Inlet capture analyses were performed using UD-Inlet v5.01. The storm sewer system was analyzed using StormCAD. Manholes were modeled using HEC-22 Energy (2nd Edition), with “half” benching method; end inlets were modeled using Standard, with 1.25 for the headloss coefficient; in-line inlets were modeled using HEC-22

Crossroads

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May 17, 2021

Energy (2nd Edition), with “flat” benching method. Results of hydraulic analyses are included in Appendix C of this report.

The minimum and maximum velocities in storm sewer pipe generally fall between 4.7 and 14.0 feet per second (fps) respectively during a minor or major storm. The hydraulic grade lines (HGLs) for the minor and major storm were calculated utilizing StormCAD CONNECT, a Bentley product. For the StormCAD model, the 100-year and 5-year event tail water for the proposed pond outfall was set to 6294.63 and 6290.51, respectively. These are the 100-year and WQCV water surface elevations presented in the Drainage Basin Outlet Structure Design of Preliminary Drainage Report for Crossroads Mixed Use (Appendix D). The hydraulic head loss method utilized in the StormCAD software was the HEC-22 energy method. Printouts from StormCAD are included in Appendix C.

#### **D. Waivers from Criteria**

There are no waivers from the criteria set by the El Paso County DCM or the USDCM. The project will abide by all criteria set by El Paso County DCM and Mile High Flood District’s USDCM.

### **Section IV – Drainage Facility Design**

#### **A. General Concept**

No off-site surface flows are expected to affect the Site. Runoff from the Site area is planned to be captured in inlets, and conveyed in pipes to the existing detention and water quality pond just south of the Site. Drainage patterns will remain virtually unchanged from current conditions. A Historic Conditions and Existing Conditions Drainage Map can be found in Appendix D.

The impervious percentage and Rational Method calculations for all basins are found in Appendix B. The inlet sizing and bypass calculations and StormCAD calculations are found in Appendix C. Detention pond storage and release calculations as well as pond infrastructure design can be found in the Preliminary Drainage Report for Crossroads Mixed Use in Appendix D.

#### **B. Specific Details**

The Four Step Process will be implemented as follows:

Step 1: Proposed imperviousness is currently at 65.4% as indicated in Appendix B. Various landscaped areas are planned around the Site. Inlets and area drains are proposed in landscape areas where some stormwater will flow through grass swales and infiltrate. Where practical, openings are encouraged in curbs that are adjacent to landscape areas leading to area drains or inlets. Landscaping has been incorporated around the perimeter of the Site.

Step 2: Runoff from the Site will be collected and routed to the existing detention pond adjacent to the Site. The WQCV Calculations are included in Preliminary Drainage Report for Crossroads Mixed Use in Appendix D.

Step 3: There are no known existing or proposed streams or channels in the vicinity, on or near the Site, to be impacted.

Step 4: To mitigate potential sources of pollution due to construction practices, best management practices (BMPs), per the El Paso County DCM and MHFD manuals, are recommended.

All on-Site storm facilities will be owned and maintained by the owner of the property. Maintenance requirements for all best management practices shall be in accordance with the El Paso County DCM and USDCM.

Proposed inlet types include CDOT Type R and CDOT Type D. Junction structures for the proposed storm sewer lines are to be 5 to 6 foot diameter precast or cast –in-place slab base manholes. Modifications to some standard inlets will be needed to accommodate some pipe connections; details will be added to the construction plans. Inlet capture efficiencies have been determined using UD-Inlet v5.01. Printouts are included in Appendix C.

#### **Section V - Drainage, Bridge, and Pond Fees**

According to the 2021 El Paso County Drainage Basin Fees (Resolution No, 20-424), Sand Creek Drainage Basin (FOFO4000) has a drainage fee of \$20,387 per impervious acre. Based on the total disturbed area of 13.67 acres and a total imperviousness of 65.4 percent, a total drainage fee of \$182,263 is required.

#### **Section VI – Construction Cost Opinion**

All on-site storm facilities will be private. The pipes and appurtenances within Tract C will be owned and maintained by El Paso County. The on-site storm facilities will be owned and maintained by the owner of the property. Maintenance requirements for all BMPs shall be in accordance with the El Paso County DCM and UDFCD/MHFD Criteria.

Opinion of probable costs for the public and remaining private drainage facilities are \$81,178 and \$282,730 respectively. See Appendix F for details.

#### **Section VII – Other Government Agency Requirements**

This Project is not anticipated to be subject to requirements of other agencies (e.g. FEMA, COE, SEO, CWCB).

#### **Section VIII – Conclusions**

Currently, the Site is vacant and undeveloped; flows are undetained and only treated via the existing pervious cover or swales that will lead to the detention pond.

The proposed development includes on-site private and off-site public storm drainage systems to collect and convey runoff from the majority of the Site to the existing off-site regional water quality and detention facility. Site runoff that is not collected onsite will directly flow to the same surrounding storm sewer system that conveys the accumulated flows to existing detention pond. No adverse impacts to the surrounding properties or drainage facilities are anticipated.

The proposed drainage design for the Aura at Crossroads development is in general conformance with pertinent drainage studies. The facilities, if properly constructed and maintained, will effectively control stormwater runoff consistent with the criteria.

Per the County's Drainage Criteria Manual (DCM), a Grading and Erosion Control plan along with a County's Stormwater Management Plan is required, and has been submitted.

## **Section IX – References**

1. Drainage Criteria Manual, Volume 1, Volume 2, and Volume 1 Update, County of El Paso, Colorado, October 31, 2018.
2. Preliminary Drainage Report for Crossroads Mixed Use, El Paso County, Colorado, February 2021, MS Civil Consultants, Inc.
3. National Flood Hazard Layer FIRMette, El Paso County, Colorado, Map No. 08041C0752G, December 7, 2018, Federal Emergency Management Agency.
4. Custom Soil Resource Report, El Paso County Area, Colorado, April 5, 2021, Natural Resources Conservation Service.
5. Geotechnical Investigation, Crossroads Apartments. Colorado Springs, Colorado, CTL Thompson Inc., May, 18, 2021.
6. Urban Storm Drainage Criteria Manual Vol. 1, Mile High Flood District, revised August 2018.
7. Urban Storm Drainage Criteria Manual Vol. 2, Mile High Flood District, revised September 2017.
8. Urban Storm Drainage Criteria Manual Vol. 3, Mile High Flood District, revised October 2019.

**Section X – Appendices**

Appendix A Vicinity Map, FIRMette, NRCS Custom Soil Resource Report

Appendix B Hydrologic Computations

Appendix C Hydraulic Computations

Appendix D Preliminary Drainage Report for Crossroads Mixed Use

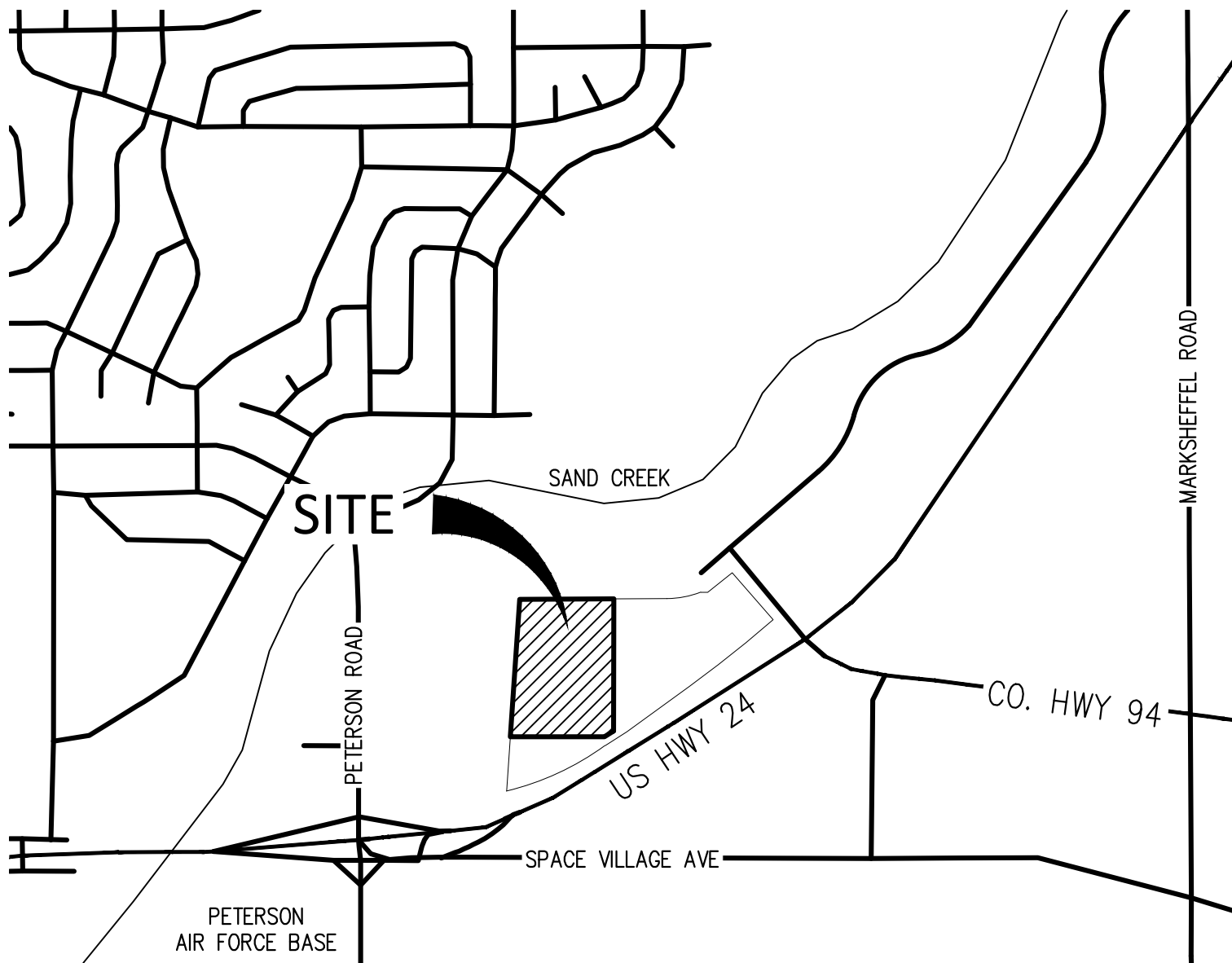
Appendix E Geotechnical Engineering and Geologic Report

Appendix F Drainage Plan

Appendix G Cost Estimate

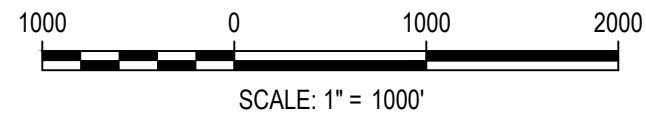
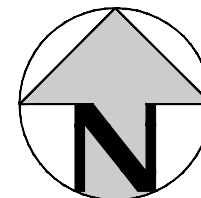
## Appendix A – Vicinity Map, FIRMette, NRCS Custom Soil Resource Report

Plotted: MON 04/05/21 3:02:34P By: Adam Harkness Filepath: k:\200823\engineering\exhibit\vicinity map.dwg Layout: layout1



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## VICINITY MAP





United States  
Department of  
Agriculture

**NRCS**

Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for **El Paso County Area, Colorado**

## Crossroads at Meadowbrook



April 5, 2021

# Preface

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Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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# How Soil Surveys Are Made

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Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

## Custom Soil Resource Report

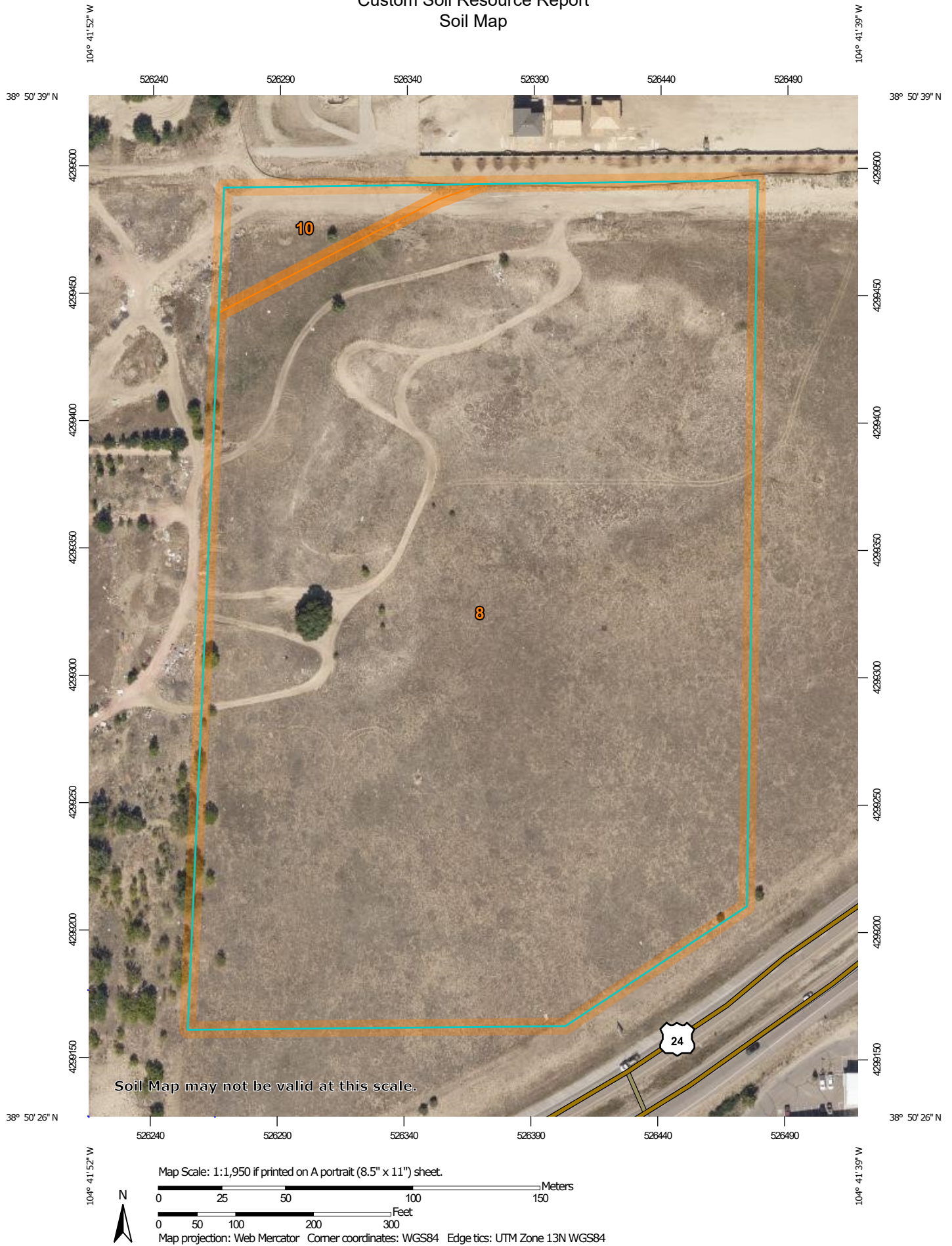
identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

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The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report Soil Map




## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)


### Soils


 Soil Map Unit Polygons


 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features

 Blowout

 Borrow Pit


 Clay Spot

 Closed Depression

 Gravel Pit

 Gravelly Spot

 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry

 Miscellaneous Water

 Perennial Water

 Rock Outcrop

 Saline Spot

 Sandy Spot

 Severely Eroded Spot


 Sinkhole


 Slide or Slip

 Sodic Spot


 Spoil Area

 Stony Spot


 Very Stony Spot

 Wet Spot

 Other

 Special Line Features

### Water Features

 Streams and Canals


### Transportation

 Rails


 Interstate Highways

 US Routes

 Major Roads

 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	16.7	96.6%
10	Blendon sandy loam, 0 to 3 percent slopes	0.6	3.4%
<b>Totals for Area of Interest</b>		<b>17.2</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## El Paso County Area, Colorado

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

#### Map Unit Setting

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

#### Map Unit Composition

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

#### Description of Blakeland

##### Setting

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

##### Typical profile

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

##### Properties and qualities

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

##### Interpretive groups

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* A  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

#### Minor Components

##### Pleasant

*Percent of map unit:* 1 percent

## Custom Soil Resource Report

*Landform:* Depressions

*Hydric soil rating:* Yes

### **Other soils**

*Percent of map unit:* 1 percent

*Hydric soil rating:* No

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

### **Map Unit Setting**

*National map unit symbol:* 3671

*Elevation:* 6,000 to 6,800 feet

*Mean annual precipitation:* 14 to 16 inches

*Mean annual air temperature:* 46 to 48 degrees F

*Frost-free period:* 125 to 145 days

*Farmland classification:* Not prime farmland

### **Map Unit Composition**

*Blendon and similar soils:* 98 percent

*Minor components:* 2 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### **Description of Blendon**

#### **Setting**

*Landform:* Terraces, alluvial fans

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Sandy alluvium derived from arkose

#### **Typical profile**

*A - 0 to 10 inches:* sandy loam

*Bw - 10 to 36 inches:* sandy loam

*C - 36 to 60 inches:* gravelly sandy loam

#### **Properties and qualities**

*Slope:* 0 to 3 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.60 to 2.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 2 percent

*Available water capacity:* Moderate (about 6.2 inches)

#### **Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3e

## Custom Soil Resource Report

*Hydrologic Soil Group: B*

*Ecological site: R049XB210CO - Sandy Foothill*

*Hydric soil rating: No*

### **Minor Components**

#### **Pleasant**

*Percent of map unit: 1 percent*

*Landform: Depressions*

*Hydric soil rating: Yes*

#### **Other soils**

*Percent of map unit: 1 percent*

*Hydric soil rating: No*

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# National Flood Hazard Layer FIRMette



104°42'5"W 38°50'47"N



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

1:6,000

104°41'28"W 38°50'19"N

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

## Legend

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

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



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



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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/6/2021 at 12:22 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

## Appendix B – Hydrologic Computations

IMPERVIOUSNESS AND RUNOFF COEFFICIENTS CALCULATIONS, POST DEVELOPMENT

CALC'D BY: EEM

DATE: 06/23/21

NRCS Hydrologic Soil Group: A/B

PROJECT: Aura at Crossroads

PROJ. NO: 200823

LAND USE TYPES (per Table 6-6 of Volume 1 Update of El Paso County DCM) :

Land Use or Surface Characteristics	Imperviousness	Runoff Coefficients, C											
		2-year		5-year		10-year		25-yr		50-yr		100-yr	
		A/B	C/D	A/B	C/D	A/B	C/D	A/B	C/D	A/B	C/D	A/B	C/D
Paved Streets, Drives, Parking, Walks	100%	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Building Roofs	90%	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns, Landscape Areas	2%	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

Subbasin	Areas	ACRES			Imperviousness	Imperv. Acres	COMPOSITE RUNOFF COEFFICIENTS (Eq. 6-6)					
		Paved Streets, Drives, Parking, Walks	Building Roofs	Lawns, Landscape Areas			C <sub>2</sub> =	C <sub>5</sub> =	C <sub>10</sub> =	C <sub>25</sub> =	C <sub>50</sub> =	C <sub>100</sub> =
X-1	0.42	0.00	0.18	0.24	39.42%	0.16	0.31	0.36	0.41	0.48	0.51	0.55
X-2	0.01	0.01	0.00	0.00	77.91%	0.01	0.69	0.72	0.75	0.78	0.80	0.82
X-3	0.08	0.06	0.00	0.03	70.27%	0.06	0.63	0.65	0.69	0.73	0.75	0.77
A-1	2.07	0.87	0.59	0.61	68.37%	1.42	0.58	0.61	0.65	0.69	0.72	0.74
A-2	0.43	0.13	0.12	0.18	57.23%	0.25	0.48	0.52	0.56	0.61	0.64	0.67
A-3	0.83	0.39	0.31	0.13	80.35%	0.67	0.68	0.70	0.73	0.77	0.79	0.81
A-4	0.76	0.46	0.19	0.11	83.16%	0.63	0.72	0.74	0.76	0.80	0.82	0.83
A-5	3.19	1.53	0.63	1.03	66.40%	2.12	0.57	0.60	0.64	0.69	0.71	0.73
B-1	0.75	0.27	0.09	0.39	48.53%	0.37	0.42	0.46	0.50	0.57	0.60	0.63
B-2	0.28	0.12	0.10	0.06	74.95%	0.21	0.63	0.66	0.69	0.73	0.75	0.77
B-3	1.91	1.17	0.31	0.43	76.49%	1.46	0.67	0.69	0.72	0.76	0.78	0.80
B-4	0.78	0.39	0.15	0.23	68.64%	0.53	0.59	0.62	0.66	0.70	0.73	0.75
OS-1	0.77	0.34	0.17	0.26	64.66%	0.50	0.56	0.59	0.62	0.67	0.70	0.72
OS-2	0.44	0.26	0.00	0.19	58.63%	0.26	0.52	0.55	0.59	0.65	0.68	0.70
Z-1	0.37	0.00	0.14	0.23	35.36%	0.13	0.28	0.33	0.38	0.45	0.49	0.52
Z-2	0.56	0.01	0.17	0.38	29.50%	0.16	0.24	0.28	0.34	0.42	0.46	0.49
Total/Composite	13.67	6.02	3.15	4.50	65.42%	8.94	0.56	0.59	0.63	0.68	0.70	0.72

When multiple sub-basins are delineated, the composite C value calculation is:

$$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + \dots C_iA_i) / A_t$$

(Eq. 6-6)

Where:

- C<sub>c</sub> = composite runoff coefficient for total area
- C<sub>i</sub> = runoff coefficient for subarea corresponding to surface type or land use
- A<sub>i</sub> = area of surface type corresponding to C<sub>i</sub> (units must be the same as those used for total area)
- A<sub>t</sub> = total area of all subareas for which composite runoff coefficient applies
- i = number of surface types in the drainage area

CALCULATED BY: EEM  
 CHECKED BY: MW  
 DATE: 6/23/2021

**Standard Form SF-1 (Modified)**  
**Time of Concentration, Post-Development**

JOB NO: 200823  
 PROJECT: Aura at Crossroads  
 REVISED:

SUB-BASIN DATA			INITIAL/OVERLAND TIME (Ti)			TRAVEL TIME (Ti)					Tc CHECK (URBANIZED BASINS)				FINAL Tc (MIN)	REMARKS
BASIN	AREA (AC)	Cs	LENGTH (FT)	SLOPE %	Ti (MIN)	LENGTH (FT)	SLOPE %	Cv	VELOCITY (FPS)	Ti (MIN)	COMPOS. Tc = Ti + T1 (MIN)	Lt, TOTAL LENGTH	AVG SLOPE	Tc = (L/180) + 10 (MIN)		
X-1	0.42	0.36	243.0	1.26	19.7	16.0	1.00	15	1.50	0.2	19.8	259	1.25	11.4	11.4	to proposed area/landscape drains
X-2	0.01	0.72	28.9	5.29	2.2	285.0	1.30	20	2.28	2.1	5.0	313.9	1.67	11.7	5.0	to existing off-site inlet
X-3	0.08	0.65	87.5	1.41	6.9	613.6	1.10	20	2.10	4.9	11.7	701.1	1.14	13.9	11.7	to existing off-site inlet
A-1	2.07	0.61	362.0	1.13	16.4	318.0	1.18	20	2.17	2.4	18.8	680	1.15	13.8	13.8	to proposed curb inlet
A-2	0.43	0.52	203.0	1.10	14.7	67.4	1.96	20	2.80	0.4	15.1	270.4	1.32	11.5	11.5	to proposed modified curb inlet
A-3	0.83	0.70	200.0	0.03	31.4	318.0	1.12	20	2.11	2.5	33.9	518	0.70	12.9	12.9	to proposed modified curb inlet
A-4	0.76	0.74	52.4	2.18	3.7	282.0	1.10	20	2.10	2.2	6.0	334.4	1.27	11.9	6.0	to proposed modified curb inlet
A-5	3.19	0.60	198.0	1.06	12.6	701.0	1.03	20	2.03	5.8	18.4	899	1.04	15.0	15.0	to proposed curb inlet
B-1	0.75	0.46	180.0	2.11	12.3	5.0	1.00	10	1.00	0.1	12.4	185	2.08	11.0	11.0	to proposed area inlet
B-2	0.28	0.66	182.5	1.28	10.1	76.0	1.70	20	2.61	0.5	10.5	258.5	1.40	11.4	10.5	to proposed curb inlet
B-3	1.91	0.69	210.3	1.54	9.5	451.0	1.00	20	2.00	3.8	13.2	661.3	1.17	13.7	13.2	to proposed curb inlet
B-4	0.78	0.62	125.0	1.48	8.6	40.0	2.60	20	3.22	0.2	8.8	165	1.75	10.9	8.8	to proposed curb inlet
OS-1	0.77	0.59	50.0	2.14	5.2	706.0	1.46	20	2.42	4.9	10.0	756	1.51	14.2	10.0	to proposed curb inlet
OS-2	0.44	0.55	13.0	0.15	6.7	754.0	1.48	20	2.43	5.2	11.9	767	1.45	14.3	11.9	to proposed curb inlet
Z-1	0.37	0.33	90.0	0.24	21.5	277.4	1.06	20	2.06	2.2	23.8	367.4	0.86	12.0	12.0	to proposed area/landscape drains
Z-2	0.56	0.28	126.0	2.25	12.8	67.0	1.22	7	0.77	1.4	14.3	193	1.89	11.1	11.1	to grass swale to detention pond

Estimating Time of Concentration (Tc):

$$t_c = t_i + t_t \quad (\text{RO-2})$$

in which:

$t_c$  = time of concentration (minutes)

$t_i$  = initial or overland flow time (minutes)

$t_t$  = travel time in the ditch, channel, gutter, storm sewer, etc. (minutes)

**2.4.1 Initial Flow Time**

The initial or overland flow time,  $t_i$ , may be calculated using equation RO-3:

$$t_i = \frac{0.395(1.1 - C_s)\sqrt{L}}{S^{0.33}} \quad (\text{RO-3})$$

in which:

$t_i$  = initial or overland flow time (minutes)

$C_s$  = runoff coefficient for 5-year frequency (from [Table RO-5](#))

$L$  = length of overland flow (500 ft maximum for non-urban land uses, 300 ft maximum for urban land uses)

$S$  = average basin slope (ft/ft)

Estimating Overland Travel Time (Ti):

$$V = C_v S_w^{0.5} \quad (\text{RO-4})$$

in which:

$V$  = velocity (ft/sec)

$C_v$  = conveyance coefficient (from [Table RO-2](#))

$S_w$  = watercourse slope (ft/ft)

**Table RO-2—Conveyance Coefficient,  $C_v$**

Type of Land Surface	Conveyance Coefficient, $C_v$
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

The time of concentration,  $t_c$ , is then the sum of the initial flow time,  $t_i$ , and the travel time,  $t_t$ , as per Equation RO-2.

### 1-HR Rainfall

Rainfall Depths for Colorado Springs, DCM Vol 1 Upd., Table 6-2

Return Interval (YR)	1-hour Rainfall	
WQ	0.6	(WQ per MHFD USDCM Vol 3, p 1-9 [29 of 577])
1	unknown	
2	1.19	
5	1.50	
10	1.75	
25	2.00	
50	2.25	
100	2.52	
500	unknown	

FOR COMPARISON INFORMATION ONLY, NOAA Atlas 14 - point on map

Return Interval (YR)	1-hour Rainfall	
WQ	0.6	(WQ per MHFD USDCM Vol 3, p 1-9 [29 of 577])
1	0.863	
2	1.020	
5	1.30	
10	1.57	
25	1.99	
50	2.35	
100	2.74	
500	3.79	

Intensity (per Vol. 1 Update of the El Paso County DCM):

### IDF Equations

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$



### POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION  
NOAA Atlas 14, Volume 8, Version 2

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches) <sup>1</sup>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.238 (0.200-0.285)	0.289 (0.242-0.348)	0.378 (0.315-0.456)	0.457 (0.379-0.554)	0.573 (0.461-0.728)	0.669 (0.523-0.860)	0.771 (0.579-1.02)	0.880 (0.631-1.19)	1.03 (0.708-1.44)	1.15 (0.767-1.62)
10-min	0.349 (0.292-0.419)	0.423 (0.354-0.509)	0.553 (0.461-0.667)	0.669 (0.554-0.811)	0.839 (0.675-1.07)	0.980 (0.786-1.26)	1.13 (0.848-1.49)	1.29 (0.924-1.75)	1.51 (1.04-2.11)	1.69 (1.12-2.38)
15-min	0.425 (0.357-0.511)	0.516 (0.432-0.621)	0.674 (0.563-0.814)	0.815 (0.676-0.989)	1.02 (0.823-1.30)	1.20 (0.934-1.54)	1.38 (1.03-1.81)	1.57 (1.13-2.13)	1.84 (1.26-2.57)	2.06 (1.37-2.90)
30-min	0.647 (0.543-0.778)	0.783 (0.650-0.943)	1.02 (0.852-1.23)	1.23 (1.02-1.50)	1.55 (1.24-1.97)	1.81 (1.41-2.32)	2.08 (1.56-2.74)	2.37 (1.70-3.21)	2.78 (1.91-3.88)	3.11 (2.07-4.38)
60-min	0.863 (0.724-1.04)	1.02 (0.853-1.23)	1.30 (1.09-1.55)	1.57 (1.31-1.91)	1.99 (1.61-2.55)	2.35 (1.84-3.04)	2.74 (2.07-3.54)	3.17 (2.29-4.32)	3.79 (2.61-5.30)	4.30 (2.88-6.04)
2-hr	1.08 (0.912-1.29)	1.25 (1.05-1.50)	1.59 (1.34-1.91)	1.92 (1.60-2.31)	2.44 (2.00-3.12)	2.90 (2.30-3.74)	3.40 (2.59-4.50)	3.97 (2.88-5.39)	4.80 (3.33-6.68)	5.48 (3.67-7.85)
24-hr	1.19	1.36	1.71	2.06	2.64	3.16	3.74	4.41	5.39	6.21

CALCULATED BY: EEM  
DATE: 6/23/2021  
CHECKED BY: MW  
PROJECT MANAGER: JDO

**Standard Form SF-2 (Modified)**  
**Storm Drainage System Design**  
**(Rational Method Procedure) Post Development**

JOB NO: 200823  
PROJECT: Aura at Crossroads  
DESIGN STORM: 5 YR

SUBBASIN(s)	DESIGN POINT (DP)	DIRECT RUNOFF						TOTAL RUNOFF				INLET		PIPE							REMARKS
		AREA (AC)	RUNOFF COEFF	T <sub>c</sub> (min)	C x A (AC)	I (IN/HR)	Q (CFS)	T <sub>c</sub> (MIN)	Σ(C x A) (AC)	I (IN/HR)	Q (CFS)	INLET INTERCEPTION (CFS)	BYPASS (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (IN)	CAPACITY AT 80% (CFS)	LENGTH (FT)	VELOCITY (FPS)	T <sub>t</sub> (min)	
Offsite Basin A		1.68	0.90	8.9	1.51	4.30	6.51														data per PDR for Crossroads Mixed Use (M&S Civil, February 2021)
Offsite Basin B		1.49	0.90	8.8	2.29	4.32	9.89														data per PDR for Crossroads Mixed Use (M&S Civil, February 2021)
X-1		0.42	0.36	11.4	0.15	3.93	0.58														Flows offsite to Meadowbrook Curb Inlet
X-2		0.01	0.72	5.0	0.01	5.17	0.05														Flows offsite to Meadowbrook Curb Inlet
X-3		0.08	0.65	11.7	0.06	3.89	0.21														Flows offsite to Meadowbrook Curb Inlet
Offsite + X-1 + X-2 + X-3	0							11.7	4.02	3.89	15.62			15.62	0.75	30	32.23	246.75	6.6	0.63	
A-1	1	2.07	0.61	13.8	1.26	3.65	4.61					4.40	0.21	4.61	2.00	18	13.48	38.51	7.6	0.08	
DP0+DP1	2							13.9	5.28	3.64	19.22			19.22	1.00	36	60.51	300.00	8.6	0.58	
A-2	3	0.43	0.52	11.5	0.22	3.92	0.88							19.22	0.50	36	42.79	100.80	6.1	0.28	
DP2+DP3	4							14.7	5.50	3.55	19.54			0.88	6.00	15	14.35	36.40	11.7	0.05	
A-3		0.83	0.70	12.9	0.58	3.75	2.19							19.54	0.75	36	52.40	148.55	7.4	0.33	
A-4+DP4	5							15.1	6.09	3.52	21.40										
A-4		0.76	0.74	6.0	0.56	4.91	2.76							21.40	0.75	36	52.40	64.53	7.4	0.15	
A-5+DP5	6							15.2	6.65	3.50	23.28										
A-5		3.19	0.60	15.0	1.92	3.52	6.77							23.28	0.75	36	52.40	132.06	7.4	0.30	
A-6+DP6	7						6.98	15.5	8.57	3.47	29.76	6.80	0.18								
B-1	8	0.75	0.46	11.0	0.35	3.98	1.38							29.76	0.50	48	92.14	131.29	7.3	0.30	
B-2		0.75	0.46	11.0	0.35	3.98	1.38							1.38	0.50	15	4.14	35.33	3.4	0.17	
B-2		0.28	0.66	10.5	0.18	4.05	0.74							0.74	0.50	18	6.74	215.10	3.8	0.94	
B-2+DP7	9							11.2	0.53	3.96	2.09										
B-3		1.91	0.69	13.2	1.32	3.71	4.89														
B-3+DP8	10							13.2	1.85	3.71	6.85	4.60	0.29								
B-4		0.78	0.62	8.8	0.48	4.32	2.08							6.85	1.00	24	20.52	259.87	6.5	0.66	
B-3+DP9	11						2.37	13.9	2.33	3.64	8.46			8.46	1.00	30	37.21	102.47	7.6	0.23	
Offsite Basin E		1.36	0.83	6.9	1.12	4.69	5.27														1/2 of Basin E in Crossroads Mixed Use PDR
OS-1	12							14.2			35.00			35.00	1.25	36	67.65	439.00	9.6	0.76	Flow and Time of Travel is from Crossroads PDR
OS-2		0.77	0.59	10.0	0.45	4.12	1.86							1.86	2.00	18	13.48	16.16	7.6	0.04	
OS-2		0.44	0.55	11.9	0.25	3.87	0.95							0.95	2.00	18	13.48	16.16	7.6	0.04	
OS-1+OS-2+DP11	13							15.0	0.70	3.52	37.46			37.46	1.00	36	60.51	30.49	8.6	0.06	
Z-1	14	0.37	0.33	12.0	0.12	3.85	0.47														Landscape drains and overflow into detention pond
Z-2	15	0.56	0.28	11.1	0.16	3.98	0.63														Swale that flows existing detention pond

CALCULATED BY: EEM  
DATE: 6/23/2021  
CHECKED BY: MW  
PROJECT MANAGER: JDO

**Standard Form SF-2 (Modified)**  
**Storm Drainage System Design**  
**(Rational Method Procedure) Post Development**

JOB NO: 200823  
PROJECT: Aura at Crossroads  
DESIGN STORM: 100 YR

SUBBASIN(s)	DESIGN POINT (DP)	DIRECT RUNOFF						TOTAL RUNOFF				INLET		PIPE							REMARKS
		AREA (AC)	RUNOFF COEFF	T <sub>c</sub> (min)	C x A (AC)	I (IN/HR)	Q (CFS)	T <sub>c</sub> (MIN)	Σ(C x A) (AC)	I (IN/HR)	Q (CFS)	INLET INTERCEPTION (CFS)	BYPASS (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (IN)	Q <sub>FULL</sub> (CFS)	LENGTH (FT)	VELOCITY (FPS)	T <sub>t</sub> (min)	
Offsite Basin A		1.68	0.96	8.9	2.64	7.23	19.08														data per PDR for Crossroads Mixed Use (M&S Civil, February 2021)
Offsite Basin B		1.49	0.96	8.8	2.64	7.25	19.15														data per PDR for Crossroads Mixed Use (M&S Civil, February 2021)
X-1		0.42	0.55	11.4	0.23	6.59	1.50														Flows offsite to Meadowbrook Curb Inlet
X-2		0.01	0.82	5.0	0.01	8.68	0.10														Flows offsite to Meadowbrook Curb Inlet
X-3		0.08	0.77	11.7	0.07	6.53	0.43														Flows offsite to Meadowbrook Curb Inlet
Offsite + X-1 + X-2 + X-3	0							11.7	5.59	6.53	36.47			36.47	0.75	30	35.52	246.75	7.2	0.57	
A-1	1	2.07	0.74	13.8	1.53	6.12	9.36					6.80	2.56	9.36	2.00	18	14.86	38.51	8.4	0.08	
DP0+DP1	2							13.9	7.11	6.11	43.47			43.47	1.00	36	66.70	300.00	9.4	0.53	
A-2	3	0.43	0.67	11.5	0.29	6.58	1.90					1.70	0.20	43.47	0.50	36	47.16	100.80	6.7	0.25	
DP2+DP3	4							14.6	7.40	5.97	44.21			1.90	6.00	15	15.82	36.40	12.9	0.05	
A-3		0.83	0.81	12.9	0.67	6.30	4.20					4.00	0.20	44.21	0.75	36	57.76	148.55	8.2	0.30	
A-4+DP4	5							14.9	8.07	5.92	47.78										
A-4		0.76	0.83	6.0	0.64	8.24	5.24					4.60	0.64	47.78	0.75	36	57.76	64.53	8.2	0.13	
A-5+DP5	6							15.1	8.71	5.90	51.36			51.36	0.75	36	57.76	132.06	8.2	0.27	
A-5		3.19	0.73	15.0	2.34	5.91	13.85														
A-6+DP6	7						17.45	15.3	11.05	5.85	64.68	11.60	5.85	64.68	0.50	48	101.57	131.29	8.1	0.27	
B-1	8	0.75	0.63	11.0	0.47	6.69	3.17							3.17	0.50	15	4.57	35.33	3.7	0.16	
B-2		0.28	0.77	10.5	0.21	6.80	1.45							1.45	0.50	18	7.43	215.10	4.2	0.85	
B-2+DP7	9							11.2	0.69	6.65	4.57										
B-3		1.91	0.80	13.2	1.53	6.23	9.52					6.90	2.62								
B-3+DP8	10							13.2	2.22	6.23	13.80			13.80	1.00	24	22.62	259.87	7.2	0.60	
B-4		0.78	0.75	8.8	0.58	7.25	4.20														
B-3+DP9	11						6.83	13.8	2.80	6.12	17.10	5.30	1.53	17.10	1.00	30	41.02	102.47	8.4	0.20	
Offsite Basin E		1.36	0.89	6.9	1.21	7.87	9.49														1/2 of Basin E in Crossroads Mixed Use PDR
OS-1	12							14.2			60.50			60.50	1.30	36	76.05	421.62	10.8	0.65	Flow and Time of Travel is from Crossroads PDR
		0.77	0.72	10.0	0.56	6.92	3.84							3.84	2.00	18	14.86	16.16	8.4	0.03	
OS-2		0.44	0.70	11.9	0.31	6.49	2.02					4.00	0.17								
OS-1+OS-2+DP11	13							14.9	0.87	5.94	65.65	1.70	0.32	2.02	2.00	18	14.86	16.16	8.4	0.03	
Z-1	14	0.37	0.52	12.0	0.20	6.46	1.27							65.65	1.00	36	66.70	30.49	9.4	0.05	Landscape drains and overflow into detention pond
Z-2	15	0.56	0.49	11.1	0.28	6.68	1.84														Swale that flows existing detention pond

## Appendix C – Hydraulic Computations

INLET MANAGEMENT

Worksheet Protected

INLET NAME	A2	A4	B1	A6	A7	A8	B2	B4
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	AREA	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	Swale	On Grade	On Grade	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type C	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows								
Minor Q <sub>known</sub> (cfs)	4.6	0.9	1.4	2.2	2.8	6.8	0.7	4.9
Major Q <sub>known</sub> (cfs)	9.4	1.9	3.2	4.2	5.2	13.9	1.5	9.5
Bypass (Carry-Over) Flow from Upstream								
Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	User-Defined	No Bypass Flow Received	No Bypass Flow Received	User-Defined	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q <sub>b</sub> (cfs)	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Major Bypass Flow Received, Q <sub>b</sub> (cfs)	0.0	0.0	0.1	0.0	0.0	3.6	0.0	0.0
Watershed Characteristics								
Subcatchment Area (acres)	2.07	0.43						
Percent Impervious	68.37	57.23						
NRCS Soil Type	A	A						
Watershed Profile								
Overland Slope (ft/ft)	0.011	0.011						
Overland Length (ft)	300	203						
Channel Slope (ft/ft)	0.012	0.020						
Channel Length (ft)	318	67.4						
Minor Storm Rainfall Input								
Design Storm Return Period, T <sub>r</sub> (years)								
One-Hour Precipitation, P <sub>1</sub> (inches)								
Major Storm Rainfall Input								
Design Storm Return Period, T <sub>r</sub> (years)								
One-Hour Precipitation, P <sub>1</sub> (inches)								

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	4.6	0.9	1.4	2.2	2.8	7.0	0.7	4.9
Major Total Design Peak Flow, Q (cfs)	9.4	1.9	3.3	4.2	5.2	17.5	1.5	9.5
Minor Flow Bypassed Downstream, Q <sub>b</sub> (cfs)	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.3
Major Flow Bypassed Downstream, Q <sub>b</sub> (cfs)	2.6	0.2	0.0	0.1	0.4	5.8	0.1	2.6
Minor Storm (Calculated) Analysis of Flow Time								
C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C <sub>s</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Overland Flow Velocity, V <sub>i</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Channel Flow Velocity, V <sub>t</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Overland Flow Time, T <sub>i</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Channel Travel Time, T <sub>t</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculated Time of Concentration, T <sub>c</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Regional T <sub>c</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Recommended T <sub>c</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
T <sub>c</sub> selected by User	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Design Rainfall Intensity, I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculated Local Peak Flow, Q <sub>p</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Major Storm (Calculated) Analysis of Flow Time								
C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C <sub>s</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Overland Flow Velocity, V <sub>i</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Channel Flow Velocity, V <sub>t</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Overland Flow Time, T <sub>i</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Channel Travel Time, T <sub>t</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculated Time of Concentration, T <sub>c</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Regional T <sub>c</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Recommended T <sub>c</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
T <sub>c</sub> selected by User	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Design Rainfall Intensity, I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculated Local Peak Flow, Q <sub>p</sub>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

INLET MANAGEMENT

Worksheet Protected

INLET NAME	B5	C3	C4	Existing Inlet at DP 0
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	In Sump
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q <sub>known</sub> (cfs)	2.1	1.9	1.0	10.5
Major Q <sub>known</sub> (cfs)	4.2	3.8	2.0	20.6

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	User-Defined	User-Defined	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q <sub>b</sub> (cfs)	0.3	0.0	0.0	0.0
Major Bypass Flow Received, Q <sub>b</sub> (cfs)	2.6	0.3	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)				
Percent Impervious				
NRCS Soil Type				

Watershed Profile

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

Minor Storm Rainfall Input

Design Storm Return Period, T <sub>r</sub> (years)				
One-Hour Precipitation, P <sub>1</sub> (inches)				

Major Storm Rainfall Input

Design Storm Return Period, T <sub>r</sub> (years)				
One-Hour Precipitation, P <sub>1</sub> (inches)				

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)

2.4	1.9	1.0	10.5
-----	-----	-----	------

Major Total Design Peak Flow, Q (cfs)

6.8	4.1	2.0	20.6
-----	-----	-----	------

Minor Flow Bypassed Downstream, Q <sub>b</sub> (cfs)	0.0	0.0	0.0	N/A
Major Flow Bypassed Downstream, Q <sub>b</sub> (cfs)	1.5	0.1	0.3	N/A

Minor Storm (Calculated) Analysis of Flow

C	N/A	N/A	N/A	N/A
C <sub>5</sub>	N/A	N/A	N/A	N/A
Overland Flow Velocity, V <sub>i</sub>	N/A	N/A	N/A	N/A
Channel Flow Velocity, V <sub>t</sub>	N/A	N/A	N/A	N/A
Overland Flow Time, T <sub>i</sub>	N/A	N/A	N/A	N/A
Channel Travel Time, T <sub>t</sub>	N/A	N/A	N/A	N/A
Calculated Time of Concentration, T <sub>c</sub>	N/A	N/A	N/A	N/A
Regional T <sub>c</sub>	N/A	N/A	N/A	N/A
Recommended T <sub>c</sub>	N/A	N/A	N/A	N/A
T <sub>c</sub> selected by User	N/A	N/A	N/A	N/A
Design Rainfall Intensity, I	N/A	N/A	N/A	N/A
Calculated Local Peak Flow, Q <sub>p</sub>	N/A	N/A	N/A	N/A

Major Storm (Calculated) Analysis of Flow

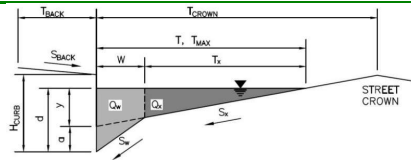
C	N/A	N/A	N/A	N/A
C <sub>5</sub>	N/A	N/A	N/A	N/A
Overland Flow Velocity, V <sub>i</sub>	N/A	N/A	N/A	N/A
Channel Flow Velocity, V <sub>t</sub>	N/A	N/A	N/A	N/A
Overland Flow Time, T <sub>i</sub>	N/A	N/A	N/A	N/A
Channel Travel Time, T <sub>t</sub>	N/A	N/A	N/A	N/A
Calculated Time of Concentration, T <sub>c</sub>	N/A	N/A	N/A	N/A
Regional T <sub>c</sub>	N/A	N/A	N/A	N/A
Recommended T <sub>c</sub>	N/A	N/A	N/A	N/A
T <sub>c</sub> selected by User	N/A	N/A	N/A	N/A
Design Rainfall Intensity, I	N/A	N/A	N/A	N/A
Calculated Local Peak Flow, Q <sub>p</sub>	N/A	N/A	N/A	N/A

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

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

Project: Crossroads

Inlet ID: A2

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK} =$	6.0	ft
$S_{BACK} =$	0.100	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	42.0	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.010	ft/ft
$n_{STREET} =$	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

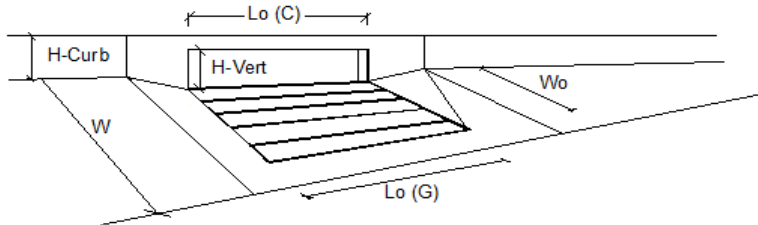
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	42.0	42.0	ft
$d_{MAX} =$	6.0	12.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	13.8	115.4	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE****Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than  $W$ , Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK -  $Q < \text{Allowable Street Capacity}$** 

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_o =$ 

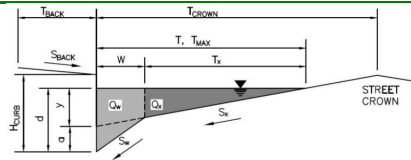
	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL} =$	3.0	3.0	inches
$N_o =$	1	1	
$L_o =$	10.00	10.00	ft
$W_o =$	N/A	N/A	ft
$C_r-G =$	N/A	N/A	
$C-C =$	0.10	0.10	
$Q =$	4.4	6.8	cfs
$Q_o =$	0.2	2.6	cfs
$C\% =$	95	73	%

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

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

Project: Crossroads

Inlet ID: A4

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

T <sub>BACK</sub> =	15.0	ft
S <sub>BACK</sub> =	0.028	ft/ft
n <sub>BACK</sub> =		

H <sub>CURB</sub> =	6.00	inches
T <sub>CROWN</sub> =	24.0	ft
W =	2.00	ft
S <sub>x</sub> =	0.020	ft/ft
S <sub>w</sub> =	0.083	ft/ft
S <sub>o</sub> =	0.010	ft/ft
n <sub>STREET</sub> =	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
T <sub>MAX</sub> =	24.0	24.0	ft
d <sub>MAX</sub> =	6.0	7.2	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

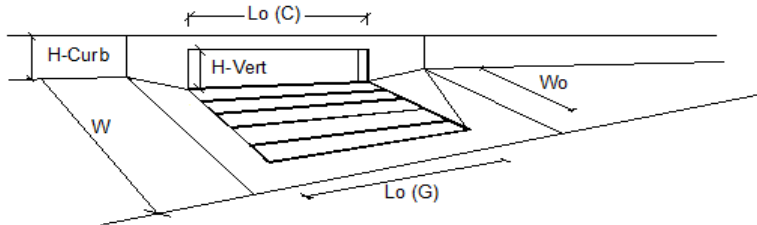
	Minor Storm	Major Storm	
Q <sub>allow</sub> =	13.8	25.1	cfs

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

0.369509995 0.369509995

**INLET ON A CONTINUOUS GRADE**

MHFD-Inlet, Version 5.01 (April 2021)

**Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than W, Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK - Q < Allowable Street Capacity**

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage = Q<sub>i</sub>/Q<sub>o</sub> =

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
a <sub>LOCAL</sub> =	3.0	3.0	inches
No =	1	1	
L <sub>o</sub> =	5.00	5.00	ft
W <sub>o</sub> =	N/A	N/A	ft
C <sub>r-G</sub> =	N/A	N/A	
C-C =	0.10	0.10	

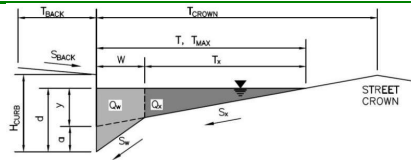
	MINOR	MAJOR	
Q =	0.9	1.7	cfs
Q <sub>b</sub> =	0.0	0.2	cfs
C% =	100	88	%

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

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

Project: Crossroads

Inlet ID: A6

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK}$	=	6.0	ft
$S_{BACK}$	=	0.100	ft/ft
$n_{BACK}$	=	0.016	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	42.0	ft
$W$	=	2.00	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_o$	=	0.010	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	=	16.0	ft
$d_{MAX}$	=	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

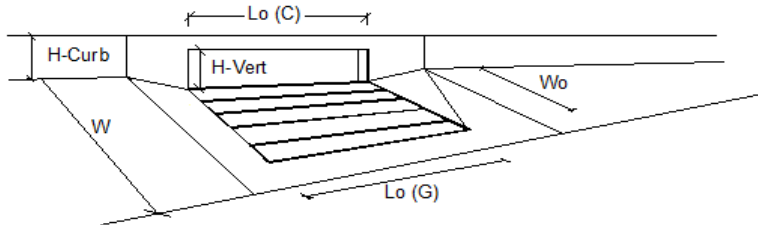
MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	=	9.4	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE**

MHFD-Inlet, Version 5.01 (April 2021)

**Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than W, Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK - Q < Allowable Street Capacity**

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_o$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	=	3.0	inches
No	=	1	
$L_o$	=	10.00	ft
$W_o$	=	N/A	ft
$C_r-G$	=	N/A	
$C-C$	=	0.10	

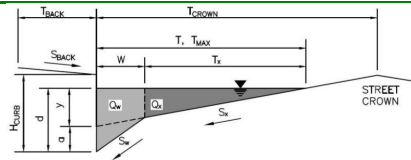
	MINOR	MAJOR	
$Q$	=	2.2	cfs
$Q_b$	=	0.0	cfs
$C\%$	=	100	%

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

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

Project: Crossroads

Inlet ID: A7

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK}$	=	5.0	ft
$S_{BACK}$	=	0.015	ft/ft
$n_{BACK}$	=	0.016	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	60.0	ft
$W$	=	2.00	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_o$	=	0.010	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

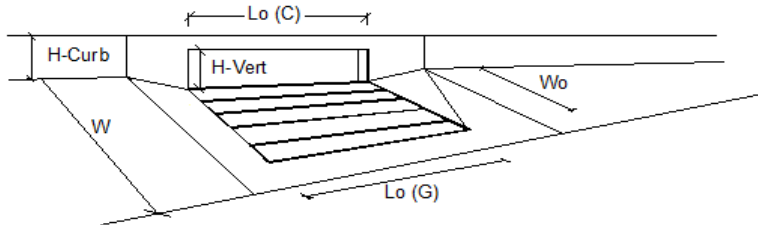
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	20.0	20.0	ft
$d_{MAX}$	6.0	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	13.8	13.8	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE****Design Information (Input)**

Type of Inlet

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than  $W$ , Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK -  $Q < \text{Allowable Street Capacity}$** 

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_o$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	3.0	3.0	inches
$N_o$	1	1	
$L_o$	10.00	10.00	ft
$W_o$	N/A	N/A	ft
$C_r-G$	N/A	N/A	
$C-C$	0.10	0.10	

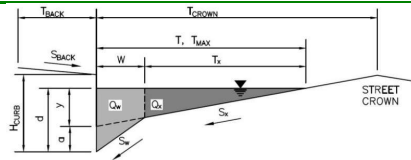
	MINOR	MAJOR	
$Q$	2.8	4.8	cfs
$Q_b$	0.0	0.4	cfs
$C\%$	100	92	%

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

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

Project: Crossroads

Inlet ID: A8

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK}$	=	15.0	ft
$S_{BACK}$	=	0.150	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	30.0	ft
$W$	=	2.00	ft
$S_x$	=	0.010	ft/ft
$S_w$	=	0.083	ft/ft
$S_o$	=	0.020	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	30.0	30.0	ft
$d_{MAX}$	6.0	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

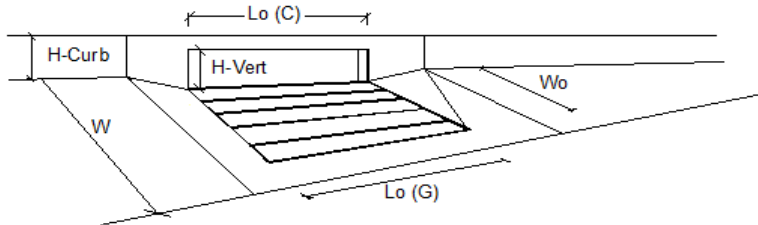
MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	21.5	21.5	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE**

MHFD-Inlet, Version 5.01 (April 2021)

**Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than W, Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK - Q < Allowable Street Capacity**

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_o$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	3.0	3.0	inches
$N_o$	1	1	
$L_o$	15.00	15.00	ft
$W_o$	N/A	N/A	ft
$C_r-G$	N/A	N/A	
$C-C$	0.10	0.10	

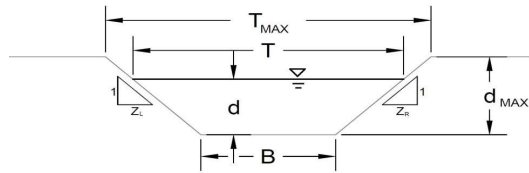
	MINOR	MAJOR	
$Q$	6.8	11.6	cfs
$Q_b$	0.2	5.8	cfs
$C\%$	97	66	%

MHFD-Inlet, Version 5.01 (April 2021)

## AREA INLET IN A SWALE

### Crossroads

B1



This worksheet uses the NRCS vegetative retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

#### Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

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

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

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

Soil Type:	Max. Velocity ( $V_{MAX}$ )	Max Froude No. ( $F_{MAX}$ )
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

A, B, C, D, or E =

A
n = see details below
$S_0$ = 0.0200 ft/ft
B = 0.00 ft
Z1 = 2.00 ft/ft
Z2 = 2.00 ft/ft

Choose One:

- ☐ Non-Cohesive  
☒ Cohesive  
☐ Paved

Maximum Allowable Top Width of Channel for Minor & Major Storm

Maximum Allowable Water Depth in Channel for Minor & Major Storm

	Minor Storm	Major Storm
$T_{MAX}$ =	20.00	20.00
$d_{MAX}$ =	2.00	2.00

#### Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm
$Q_{allow}$ =	4.3	4.3
$d_{allow}$ =	2.00	2.00

#### Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

	Minor Storm	Major Storm
$Q_o$ =	1.4	3.3
$d$ =	1.27	1.82

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

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

#### Inlet Design Information (Input)

Type of Inlet

CDOT Type C

Inlet Type =

CDOT Type C

Angle of Inclined Grate (must be  $\leq 30$  degrees)

Width of Grate

Length of Grate

Open Area Ratio

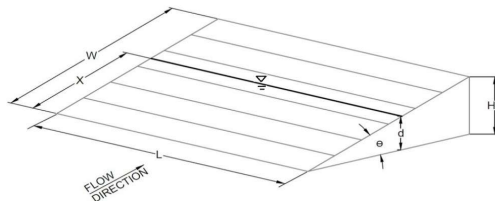
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



$\theta$ =	0.00	degrees
W =	3.00	ft
L =	3.00	ft
$A_{RATIO}$ =	0.70	
$H_B$ =	0.00	ft
$C_f$ =	0.50	
$C_d$ =	0.96	
$C_o$ =	0.64	
$C_w$ =	2.05	

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

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

Capture Percentage =  $Q_a/Q_o$

	MINOR	MAJOR
$d$ =	1.27	1.82
$Q_a$ =	18.2	21.8
$Q_b$ =	0.0	0.0
C% =	100	100

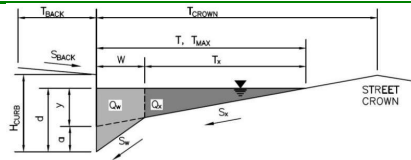
Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.

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

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

Project: Crossroads

Inlet ID: B2

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK}$	=	26.0	ft
$S_{BACK}$	=	0.040	ft/ft
$n_{BACK}$	=	0.016	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	86.0	ft
$W$	=	2.00	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_d$	=	0.020	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	20.0	20.0	ft
$d_{MAX}$	6.0	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

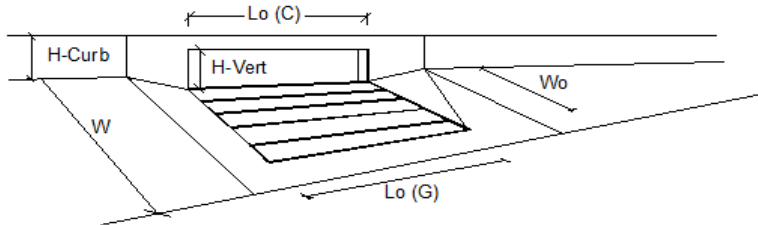
MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	19.5	19.5	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE**

MHFD-Inlet, Version 5.01 (April 2021)

**Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than  $W$ , Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK -  $Q < \text{Allowable Street Capacity}$** 

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_o$ 

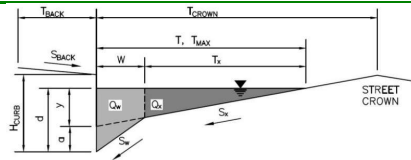
	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	3.0	3.0	inches
$N_o$	1	1	
$L_o$	5.00	5.00	ft
$W_o$	N/A	N/A	ft
$C_r-G$	N/A	N/A	
$C-C$	0.10	0.10	
$Q$	0.7	1.4	cfs
$Q_o$	0.0	0.1	cfs
$C\%$	100	96	%

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

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

Project: Crossroads

Inlet ID: B4

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK}$	=	0.0	ft
$S_{BACK}$	=	0.000	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	26.0	ft
$W$	=	2.00	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_o$	=	0.020	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	11.0	14.0	ft
$d_{MAX}$	6.0	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

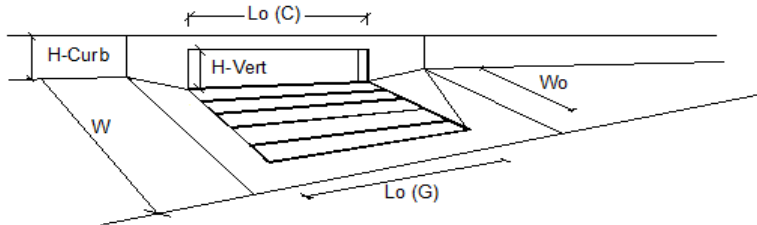
MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	5.5	9.6	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE**

MHFD-Inlet, Version 5.01 (April 2021)

**Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than W, Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK - Q < Allowable Street Capacity**

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_o$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	3.0	3.0	inches
$N_o$	1	1	
$L_o$	10.00	10.00	ft
$W_o$	N/A	N/A	ft
$C_r-G$	N/A	N/A	
$C-C$	0.10	0.10	

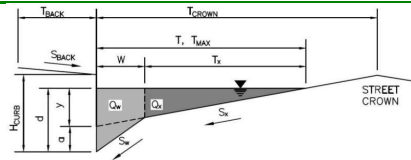
	MINOR	MAJOR	
$Q$	4.6	6.9	cfs
$Q_b$	0.3	2.6	cfs
$C\%$	94	73	%

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

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

Project: Crossroads

Inlet ID: B5

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK} =$	15.0	ft
$S_{BACK} =$	0.060	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	30.0	ft
$W =$	2.00	ft
$S_x =$	0.010	ft/ft
$S_w =$	0.083	ft/ft
$S_o =$	0.020	ft/ft
$n_{STREET} =$	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	30.0	30.0	ft
$d_{MAX} =$	6.0	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

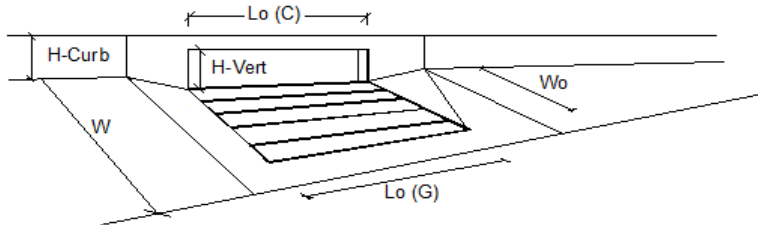
MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	21.5	21.5	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE**

MHFD-Inlet, Version 5.01 (April 2021)

**Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than  $W$ , Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK -  $Q < \text{Allowable Street Capacity}$** 

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_o =$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL} =$	3.0	3.0	inches
$N_o =$	1	1	
$L_o =$	10.00	10.00	ft
$W_o =$	N/A	N/A	ft
$C_r-G =$	N/A	N/A	
$C-C =$	0.10	0.10	

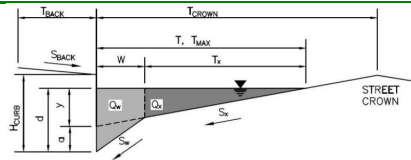
	MINOR	MAJOR	
$Q =$	2.4	5.3	cfs
$Q_b =$	0.0	1.5	cfs
$C\% =$	100	78	%

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

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

Project: Crossroads

Inlet ID: C3

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK}$	=	5.0	ft
$S_{BACK}$	=	0.000	ft/ft
$n_{BACK}$	=	0.020	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	14.0	ft
$W$	=	2.00	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_o$	=	0.010	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

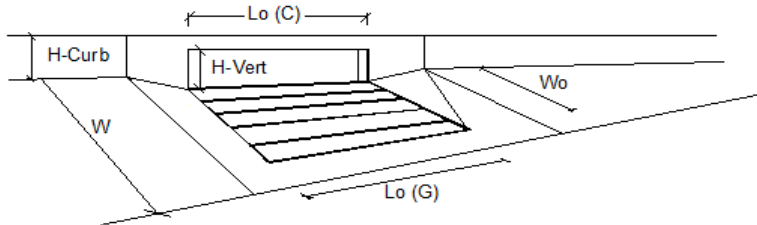
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	14.0	14.0	ft
$d_{MAX}$	5.0	5.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	6.8	6.8	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE****Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than  $W$ , Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK -  $Q < \text{Allowable Street Capacity}$** 

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_o$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	3.0	3.0	inches
$N_o$	1	1	
$L_o$	10.00	10.00	ft
$W_o$	N/A	N/A	ft
$C_r-G$	N/A	N/A	
$C-C$	0.10	0.10	

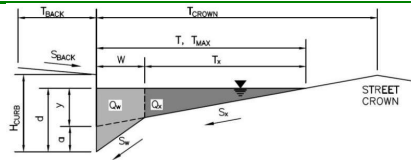
	MINOR	MAJOR	
$Q$	1.9	4.0	cfs
$Q_b$	0.0	0.1	cfs
$C\%$	100	98	%

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

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

Project: Crossroads

Inlet ID: C4

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

$T_{BACK} =$	10.0	ft
$S_{BACK} =$	0.220	ft/ft
$n_{BACK} =$	0.020	

$H_{CURB} =$	6.00	inches
$T_{CROWN} =$	14.0	ft
$W =$	2.00	ft
$S_x =$	0.020	ft/ft
$S_w =$	0.083	ft/ft
$S_d =$	0.010	ft/ft
$n_{STREET} =$	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

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

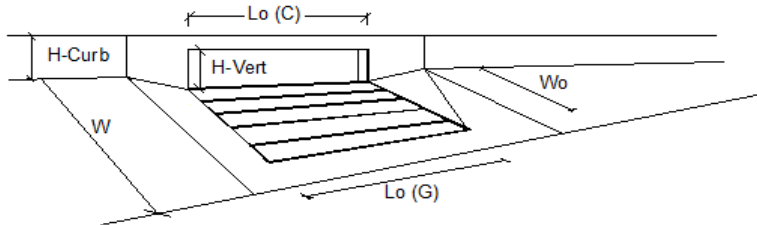
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	14.0	14.0	ft
$d_{MAX} =$	5.0	5.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
$Q_{allow} =$	6.8	6.8	cfs

**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'****INLET ON A CONTINUOUS GRADE****Design Information (Input)**

Type of Inlet

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than  $W$ , Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

**Street Hydraulics: OK -  $Q < \text{Allowable Street Capacity}$** 

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q/Q_0 =$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL} =$	3.0	3.0	inches
$N_0 =$	1	1	
$L_0 =$	5.00	5.00	ft
$W_0 =$	N/A	N/A	ft
$C_r-G =$	N/A	N/A	
$C-C =$	0.10	0.10	

	MINOR	MAJOR	
$Q =$	0.9	1.7	cfs
$Q_b =$	0.0	0.3	cfs
$C\% =$	100	86	%



The figure consists of two separate graphs, each with a highlighted red path.   
 The left graph has nodes labeled A0, A1, A2, A3, A4, A5, A6, A7, A8, EX1, and EX2. The red path starts at A0, goes to A1, then A2, then A3, then A4, then A5, then A6, then A7, then A8, and finally to EX2. There are also edges labeled A-0, A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, and A-9.   
 The right graph has nodes labeled B1, B2, B3, B4, B5, EX1, EX2, EX3, EX4, EX5, EX6, C1, C2, C3, C4, and C5. The red path starts at B1, goes to B2, then B3, then B4, then B5, then EX3, then EX2, then EX1, then C1, then C2, then C3, then C4, and finally to EX6. There are also edges labeled B-1, B-2, B-3, B-4, B-5, B-6, B-7, B-8, B-9, B-10, B-11, B-12, B-13, B-14, B-15, B-16, B-17, B-18, B-19, B-20, B-21, B-22, B-23, B-24, B-25, B-26, B-27, B-28, B-29, B-30, B-31, B-32, B-33, B-34, B-35, B-36, B-37, B-38, B-39, B-40, B-41, B-42, B-43, B-44, B-45, B-46, B-47, B-48, B-49, B-50, B-51, B-52, B-53, B-54, B-55, B-56, B-57, B-58, B-59, B-60, B-61, B-62, B-63, B-64, B-65, B-66, B-67, B-68, B-69, B-70, B-71, B-72, B-73, B-74, B-75, B-76, B-77, B-78, B-79, B-80, B-81, B-82, B-83, B-84, B-85, B-86, B-87, B-88, B-89, B-90, B-91, B-92, B-93, B-94, B-95, B-96, B-97, B-98, B-99, B-100, B-101, B-102, B-103, B-104, B-105, B-106, B-107, B-108, B-109, B-110, B-111, B-112, B-113, B-114, B-115, B-116, B-117, B-118, B-119, B-120, B-121, B-122, B-123, B-124, B-125, B-126, B-127, B-128, B-129, B-130, B-131, B-132, B-133, B-134, B-135, B-136, B-137, B-138, B-139, B-140, B-141, B-142, B-143, B-144, B-145, B-146, B-147, B-148, B-149, B-150, B-151, B-152, B-153, B-154, B-155, B-156, B-157, B-158, B-159, B-160, B-161, B-162, B-163, B-164, B-165, B-166, B-167, B-168, B-169, B-170, B-171, B-172, B-173, B-174, B-175, B-176, B-177, B-178, B-179, B-180, B-181, B-182, B-183, B-184, B-185, B-186, B-187, B-188, B-189, B-190, B-191, B-192, B-193, B-194, B-195, B-196, B-197, B-198, B-199, B-200, B-201, B-202, B-203, B-204, B-205, B-206, B-207, B-208, B-209, B-210, B-211, B-212, B-213, B-214, B-215, B-216, B-217, B-218, B-219, B-220, B-221, B-222, B-223, B-224, B-225, B-226, B-227, B-228, B-229, B-230, B-231, B-232, B-233, B-234, B-235, B-236, B-237, B-238, B-239, B-240, B-241, B-242, B-243, B-244, B-245, B-246, B-247, B-248, B-249, B-250, B-251, B-252, B-253, B-254, B-255, B-256, B-257, B-258, B-259, B-260, B-261, B-262, B-263, B-264, B-265, B-266, B-267, B-268, B-269, B-270, B-271, B-272, B-273, B-274, B-275, B-276, B-277, B-278, B-279, B-280, B-281, B-282, B-283, B-284, B-285, B-286, B-287, B-288, B-289, B-290, B-291, B-292, B-293, B-294, B-295, B-296, B-297, B-298, B-299, B-300, B-301, B-302, B-303, B-304, B-305, B-306, B-307, B-308, B-309, B-310, B-311, B-312, B-313, B-314, B-315, B-316, B-317, B-318, B-319, B-320, B-321, B-322, B-323, B-324, B-325, B-326, B-327, B-328, B-329, B-330, B-331, B-332, B-333, B-334, B-335, B-336, B-337, B-338, B-339, B-340, B-341, B-342, B-343, B-344, B-345, B-346, B-347, B-348, B-349, B-350, B-351, B-352, B-353, B-354, B-355, B-356, B-357, B-358, B-359, B-360, B-361, B-362, B-363, B-364, B-365, B-366, B-367, B-368, B-369, B-370, B-371, B-372, B-373, B-374, B-375, B-376, B-377, B-378, B-379, B-380, B-381, B-382, B-383, B-384, B-385, B-386, B-387, B-388, B-389, B-390, B-391, B-392, B-393, B-394, B-395, B-396, B-397, B-398, B-399, B-400, B-401, B-402, B-403, B-404, B-405, B-406, B-407, B-408, B-409, B-410, B-411, B-412, B-413, B-414, B-415, B-416, B-417, B-418, B-419, B-420, B-421, B-422, B-423, B-424, B-425, B-426, B-427, B-428, B-429, B-430, B-431, B-432, B-433, B-434, B-435, B-436, B-437, B-438, B-439, B-440, B-441, B-442, B-443, B-444, B-445, B-446, B-447, B-448, B-449, B-450, B-451, B-452, B-453, B-454, B-455, B-456, B-457, B-458, B-459, B-460, B-461, B-462, B-463, B-464, B-465, B-466, B-467, B-468, B-469, B-470, B-471, B-472, B-473, B-474, B-475, B-476, B-477, B-478, B-479, B-480, B-481, B-482, B-483, B-484, B-485, B-486, B-487, B-488, B-489, B-490, B-491, B-492, B-493, B-494, B-495, B-496, B-497, B-498, B-499, B-500, B-501, B-502, B-503, B-504, B-505, B-506, B-507, B-508, B-509, B-510, B-511, B-512, B-513, B-514, B-515, B-516, B-517, B-518, B-519, B-520, B-521, B-522, B-523, B-524, B-525, B-526, B-527, B-528, B-529, B-530, B-531, B-532, B-533, B-534, B-535, B-536, B-537, B-538, B-539, B-540, B-541, B-542, B-543, B-544, B-545, B-546, B-547, B-548, B-549, B-550, B-551, B-552, B-553, B-554, B-555, B-556, B-557, B-558, B-559, B-560, B-561, B-562, B-563, B-564, B-565, B-566, B-567, B-568, B-569, B-570, B-571, B-572, B-573, B-574, B-575, B-576, B-577, B-578, B-579, B-580, B-581, B-582, B-583, B-584, B-585, B-586, B-587, B-588, B-589, B-590, B-591, B-592, B-593, B-594, B-595, B-596, B-597, B-598, B-599, B-600, B-601, B-602, B-603, B-604, B-605, B-606, B-607, B-608, B-609, B-610, B-611, B-612, B-613, B-614, B-615, B-616, B-617, B-618, B-619, B-620, B-621, B-622, B-623, B-624, B-625, B-626, B-627, B-628, B-629, B-630, B-631, B-632, B-633, B-634, B-635, B-636, B-637, B-638, B-639, B-640,

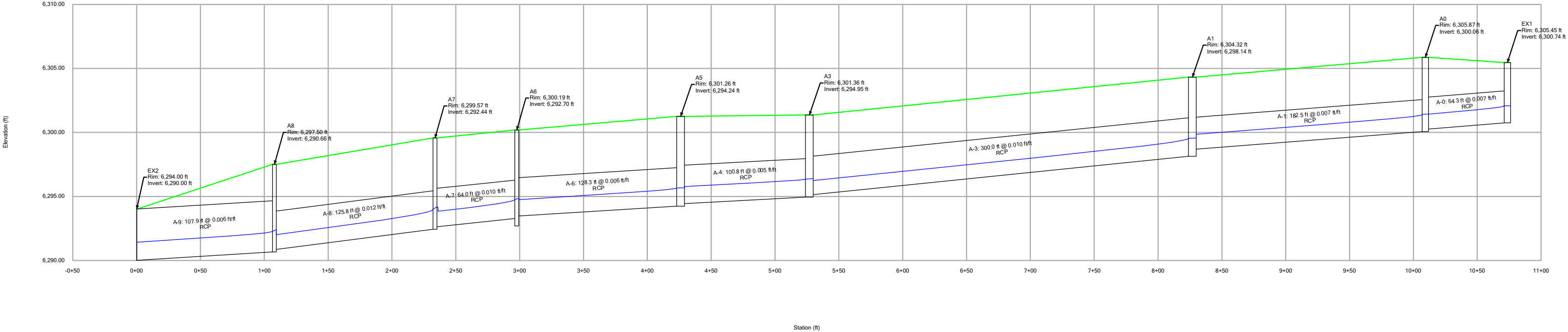
Aura at Crossroads

FlexTable: Conduit Table

Active Scenario: 5 YR

Label	Start Node	Stop Node	Length (Unified) (ft)	Rise (Unified) (ft)	Notes	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	System Known Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)
A-0	EX1	A0	64.3	2.50	30" RCP	6,300.74	6,300.26	0.007	15.62	35.52	7.01	6,302.08	6,301.43	6,305.45	6,305.87
A-1	A0	A1	182.5	2.50	30" RCP	6,300.06	6,298.69	0.007	15.62	35.52	7.01	6,301.40	6,299.85	6,305.87	6,304.32
A-2	A2	A1	38.3	1.50	18" RCP	6,300.18	6,299.41	0.020	4.61	14.85	7.41	6,301.00	6,300.00	6,302.56	6,304.32
A-3	A1	A3	300.0	3.00	36" RCP	6,298.14	6,295.14	0.010	19.22	66.69	8.16	6,299.55	6,296.25	6,304.32	6,301.36
A-4	A3	A5	100.8	3.00	36" RCP	6,294.95	6,294.44	0.005	19.22	47.16	6.33	6,296.35	6,295.78	6,301.36	6,301.26
A-5	A4	A5	36.4	1.25	15" RCP	6,296.72	6,295.99	0.020	0.88	9.13	4.71	6,297.09	6,296.25	6,302.08	6,301.26
A-6	A5	A6	128.3	3.00	36" RCP	6,294.24	6,293.47	0.006	19.54	51.66	6.80	6,295.66	6,294.75	6,301.26	6,300.19
A-7	A6	A7	64.0	3.00	36" RCP	6,293.27	6,292.63	0.010	21.40	66.69	8.40	6,294.76	6,294.19	6,300.19	6,299.57
A-8	A7	A8	125.8	3.00	36" RCP	6,292.44	6,290.86	0.012	23.28	74.56	9.32	6,293.99	6,292.02	6,299.57	6,297.50
A-9	A8	EX2	107.9	4.00	48" RCP	6,290.66	6,290.01	0.006	29.76	111.26	7.50	6,292.28	6,291.43	6,297.50	6,294.00
B-1	B1	B2	34.0	1.25	15" RCP	6,300.08	6,299.91	0.005	1.38	4.57	3.26	6,300.55	6,300.38	6,302.19	6,303.02
B-2	B2	B3	109.4	1.50	18" RCP	6,299.71	6,299.16	0.005	2.09	7.43	3.61	6,300.26	6,299.71	6,303.02	6,305.08
B-3	B3	B4	104.1	1.50	18" RCP	6,298.96	6,298.44	0.005	2.09	7.43	3.61	6,299.51	6,298.99	6,305.08	6,303.54
B-4	B4	B5	261.0	2.00	24" RCP	6,297.94	6,295.98	0.007	6.85	19.59	5.68	6,298.87	6,296.80	6,303.54	6,301.22
B-5	B5	EX3	87.7	2.50	30" RCP	6,295.48	6,292.41	0.035	8.46	76.71	10.28	6,296.45	6,292.97	6,301.22	6,301.39
C-1	EX-6	C1	60.3	3.00	36" RCP	6,301.26	6,300.49	0.013	35.00	75.37	10.46	6,303.19	6,302.01	6,308.24	6,307.03
C-2	C1	C2	378.9	3.00	36" RCP	6,300.29	6,295.74	0.012	35.00	73.06	10.22	6,302.21	6,297.21	6,307.03	6,302.51
C-3	C3	C2	17.2	1.50	18" RCP	6,297.39	6,297.04	0.020	1.86	14.85	5.74	6,297.90	6,297.61	6,302.52	6,302.51
C-4	C4	C2	27.2	1.50	18" RCP	6,297.59	6,297.04	0.020	0.95	14.85	4.71	6,297.95	6,297.61	6,302.62	6,302.51
C-5	C2	EX4	26.5	3.00	36" RCP	6,295.54	6,295.01	0.020	37.46	94.31	12.58	6,297.53	6,296.56	6,302.51	6,304.40
EX-1	EX4	EX3	199.1	4.00		6,294.00	6,290.90	0.016	48.26	179.22	12.10	6,296.08	6,292.33	6,304.40	6,301.39
EX-2	EX3	EX5	99.4	4.00		6,290.60	6,290.00	0.006	56.72	111.62	8.92	6,292.87	6,292.03	6,301.39	6,295.00

Aura at Crossroads  
Profile Report  
Engineering Profile - Storm Sewer A (Crossroads - StormCAD - 2021-06-23.stsw)  
Active Scenario: 5 YR

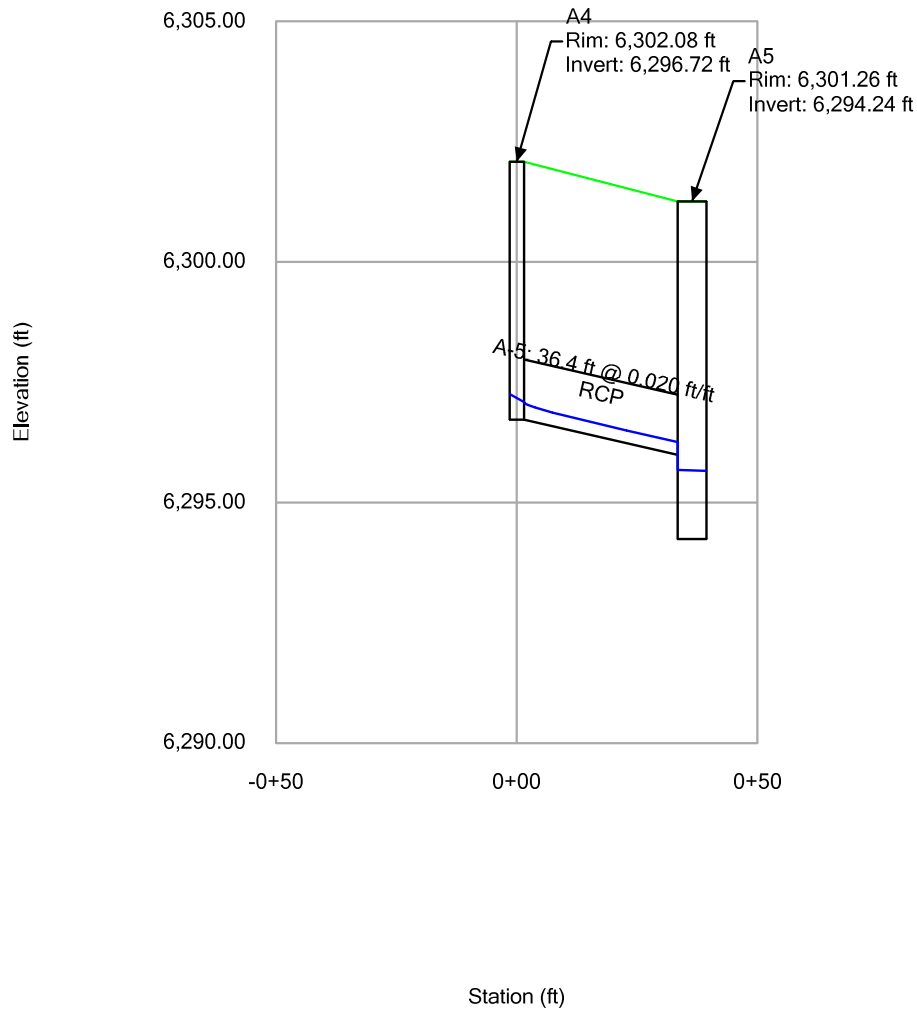


# Aura at Crossroads

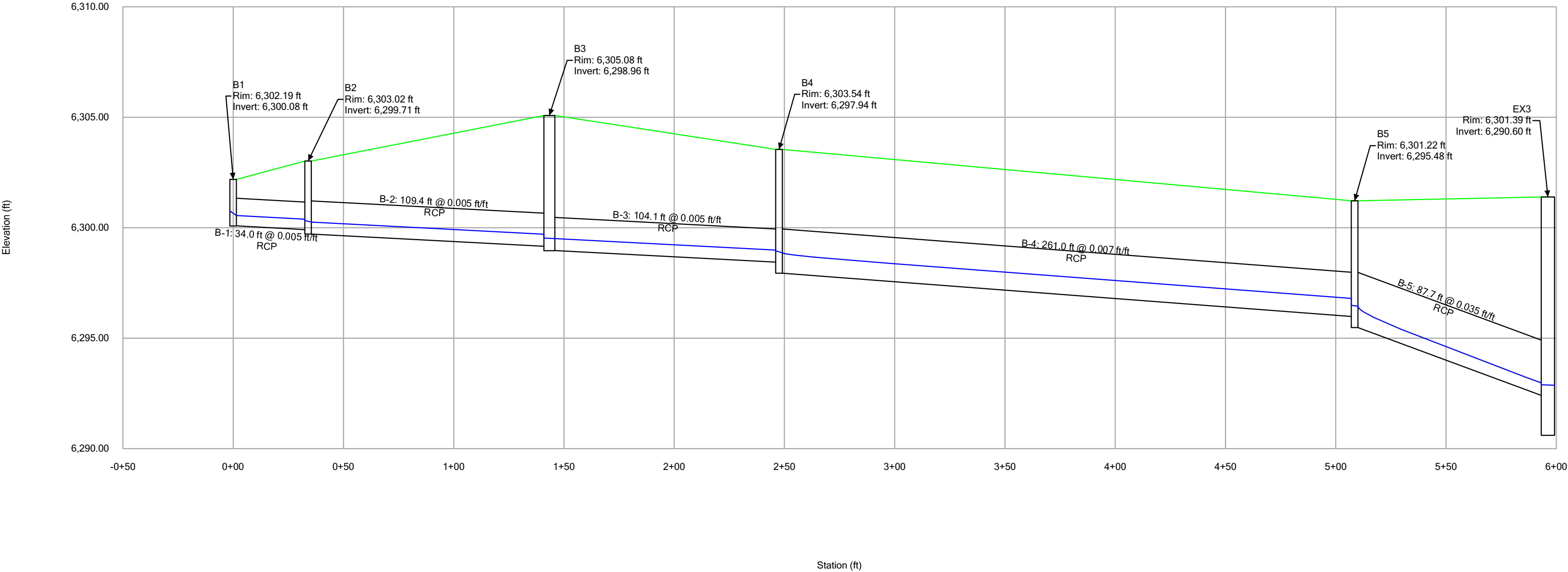
## Profile Report

### Engineering Profile - Storm Sewer AA (Crossroads - StormCAD - 2021-06-23.stsw)

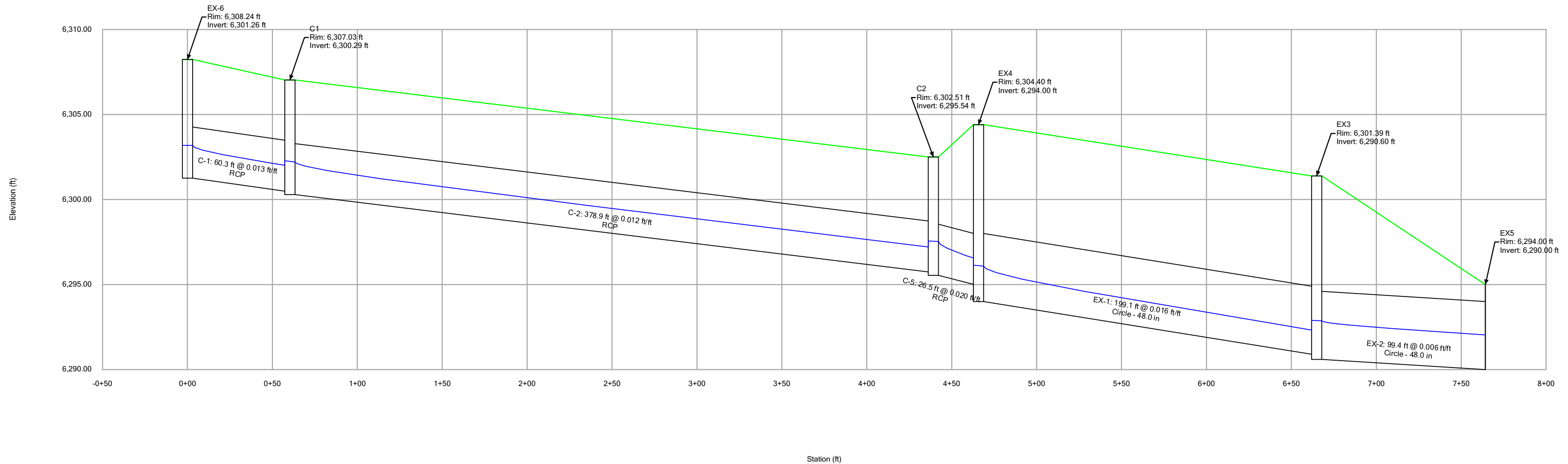
#### Active Scenario: 5 YR



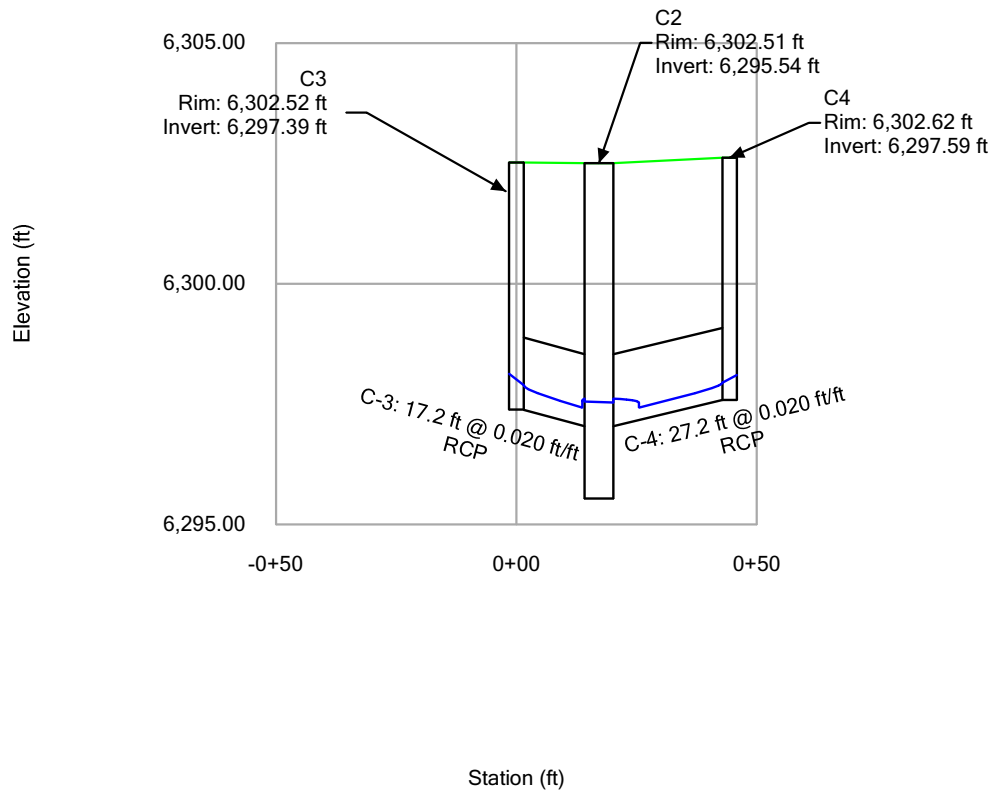
Aura at Crossroads  
Profile Report  
Engineering Profile - Storm Sewer B (Crossroads - StormCAD - 2021-06-23.stsw)  
Active Scenario: 5 YR



Aura at Crossroads  
Profile Report  
Engineering Profile - Storm Sewer C (Crossroads - StormCAD - 2021-06-23.stsw)  
Active Scenario: 5 YR

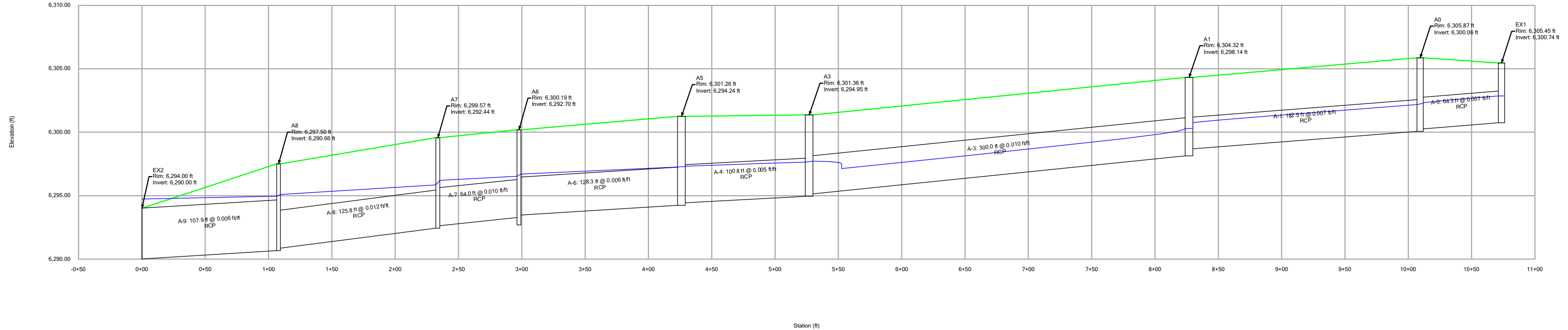


**Aura at Crossroads**  
**Profile Report**  
**Engineering Profile - Storm Sewer CA (Crossroads - StormCAD - 2021-06-23.stsw)**  
**Active Scenario: 5 YR**



Aura at Crossroads															
FlexTable: Conduit Table															
Active Scenario: 100 YR															
Label	Start Node	Stop Node	Length (Unified) (ft)	Rise (Unified) (ft)	Notes	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	System Known Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)
A-0	EX1	A0	64.3	2.50	30" RCP	6,300.74	6,300.26	0.007	36.47	35.52	8.23	6,302.86	6,302.31	6,305.45	6,305.87
A-1	A0	A1	182.5	2.50	30" RCP	6,300.06	6,298.69	0.007	36.47	35.52	8.23	6,302.18	6,300.74	6,305.87	6,304.32
A-2	A2	A1	38.3	1.50	18" RCP	6,300.18	6,299.41	0.020	9.36	14.85	8.88	6,301.36	6,300.32	6,302.56	6,304.32
A-3	A1	A3	300.0	3.00	36" RCP	6,298.14	6,295.14	0.010	43.47	66.69	10.05	6,300.29	6,297.71	6,304.32	6,301.36
A-4	A3	A5	100.8	3.00	36" RCP	6,294.95	6,294.44	0.005	43.47	47.16	7.57	6,297.65	6,297.32	6,301.36	6,301.26
A-5	A4	A5	36.4	1.25	15" RCP	6,296.72	6,295.99	0.020	1.70	9.13	5.69	6,297.24	6,297.30	6,302.08	6,301.26
A-6	A5	A6	128.3	3.00	36" RCP	6,294.24	6,293.47	0.006	44.21	51.66	6.25	6,297.26	6,296.70	6,301.26	6,300.19
A-7	A6	A7	64.0	3.00	36" RCP	6,293.27	6,292.63	0.010	47.78	66.69	6.76	6,296.53	6,296.20	6,300.19	6,299.57
A-8	A7	A8	125.8	3.00	36" RCP	6,292.44	6,290.86	0.012	51.36	74.56	7.27	6,295.85	6,295.10	6,299.57	6,297.50
A-9	A8	EX2	107.9	4.00	48" RCP	6,290.66	6,290.01	0.006	64.68	111.26	5.15	6,294.96	6,294.74	6,297.50	6,294.00
B-1	B1	B2	34.0	1.25	15" RCP	6,300.08	6,299.91	0.005	3.17	4.57	4.02	6,300.85	6,300.69	6,302.19	6,303.02
B-2	B2	B3	109.4	1.50	18" RCP	6,299.71	6,299.16	0.005	4.57	7.43	4.42	6,300.56	6,299.98	6,303.02	6,305.08
B-3	B3	B4	104.1	1.50	18" RCP	6,298.96	6,298.44	0.005	4.57	7.43	4.42	6,299.81	6,299.45	6,305.08	6,303.54
B-4	B4	B5	261.0	2.00	24" RCP	6,297.94	6,295.98	0.007	13.80	19.59	6.75	6,299.28	6,297.22	6,303.54	6,301.22
B-5	B5	EX3	87.7	2.50	30" RCP	6,295.48	6,292.41	0.035	17.10	76.71	12.58	6,296.88	6,295.41	6,301.22	6,301.39
C-1	EX-6	C1	60.3	3.00	36" RCP	6,301.26	6,300.49	0.013	60.50	75.37	11.85	6,303.77	6,302.63	6,308.24	6,307.03
C-2	C1	C2	378.9	3.00	36" RCP	6,300.29	6,295.74	0.012	60.50	73.06	11.55	6,302.80	6,297.83	6,307.03	6,302.51
C-3	C3	C2	17.2	1.50	18" RCP	6,297.39	6,297.04	0.020	4.17	14.85	7.21	6,298.17	6,298.31	6,302.52	6,302.51
C-4	C4	C2	27.2	1.50	18" RCP	6,297.59	6,297.04	0.020	2.02	14.85	5.88	6,298.24	6,298.31	6,302.62	6,302.51
C-5	C2	EX4	26.5	3.00	36" RCP	6,295.54	6,295.01	0.020	65.65	94.31	14.42	6,298.14	6,297.18	6,302.51	6,304.40
EX-1	EX4	EX3	199.1	4.00		6,294.00	6,290.90	0.016	85.25	179.22	14.08	6,296.80	6,295.31	6,304.40	6,301.39
EX-2	EX3	EX5	99.4	4.00		6,290.60	6,290.00	0.006	102.35	111.62	8.14	6,295.24	6,294.74	6,301.39	6,295.00

Aura at Crossroads  
Profile Report  
Engineering Profile - Storm Sewer A (Crossroads - StormCAD - 2021-06-23.stsw)  
Active Scenario: 100 YR

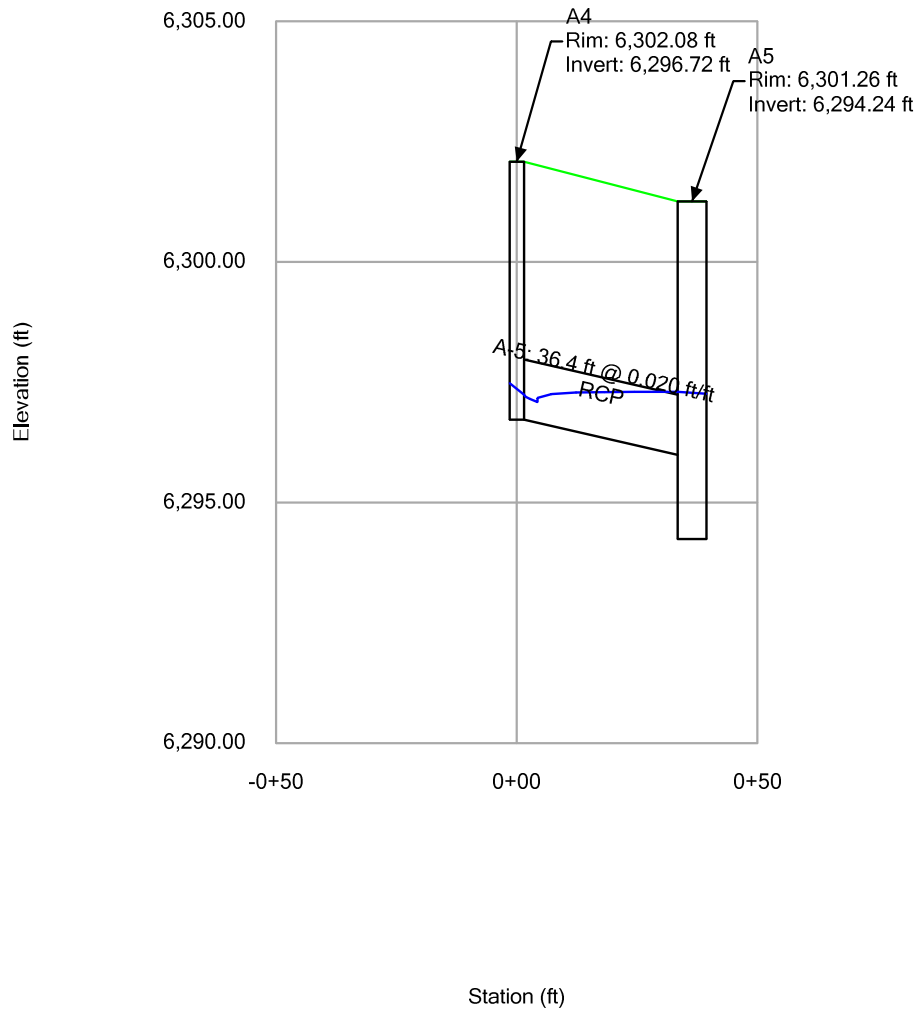


# Aura at Crossroads

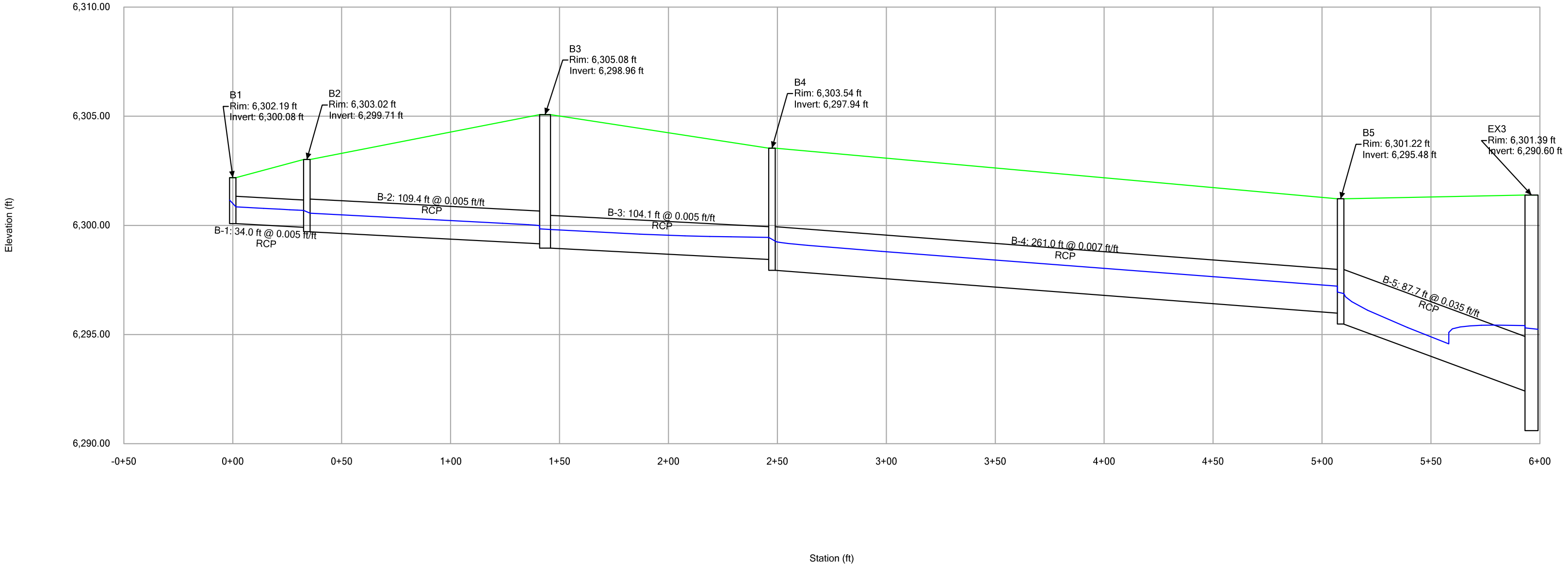
## Profile Report

### Engineering Profile - Storm Sewer AA (Crossroads - StormCAD - 2021-06-23.stsw)

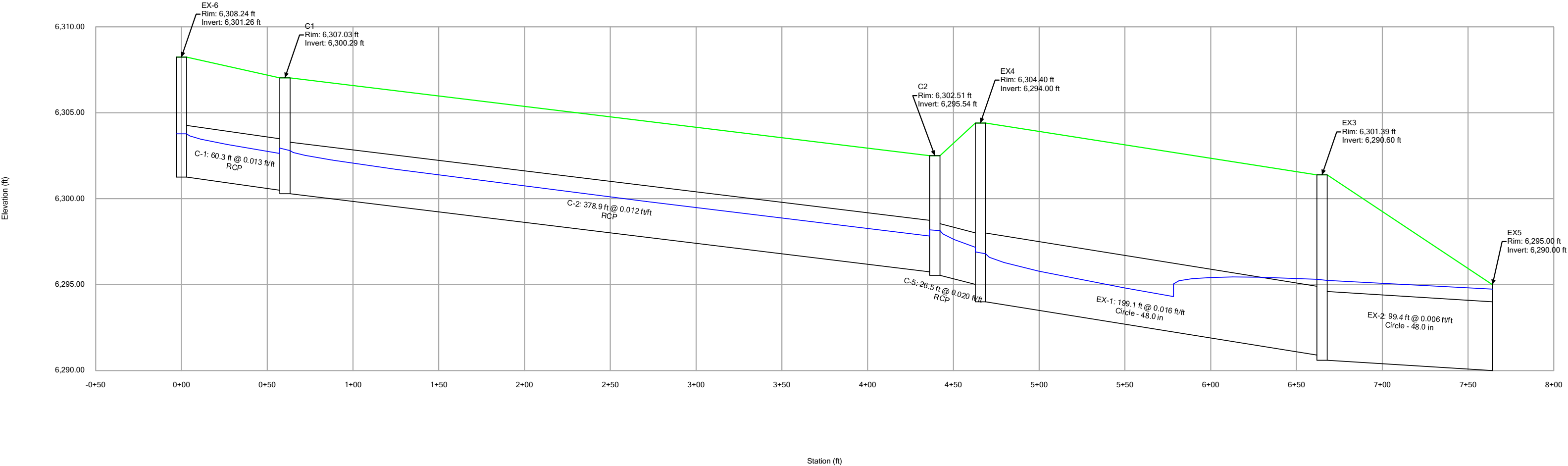
#### Active Scenario: 100 YR



**Aura at Crossroads**  
**Profile Report**  
**Engineering Profile - Storm Sewer B (Crossroads - StormCAD - 2021-06-23.stsw)**  
**Active Scenario: 100 YR**



Aura at Crossroads  
Profile Report  
Engineering Profile - Storm Sewer C (Crossroads - StormCAD - 2021-06-23.stsw)  
Active Scenario: 100 YR

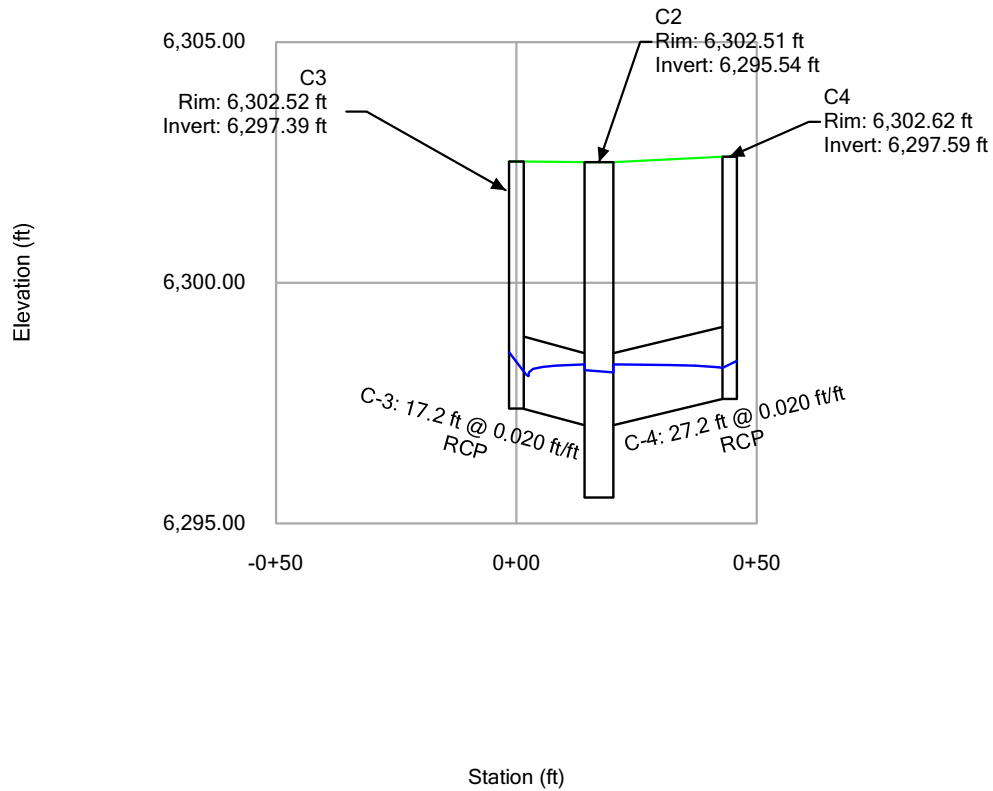


# Aura at Crossroads

## Profile Report

### Engineering Profile - Storm Sewer CA (Crossroads - StormCAD - 2021-06-23.stsw)

#### Active Scenario: 100 YR



## Appendix D – Preliminary Drainage Report for Crossroads Mixed Use

# **PRELIMINARY DRAINAGE REPORT**

## **FOR**

### **CROSSROADS MIXED USE**

### **EL PASO COUNTY, COLORADO**

FEBRUARY 2021

Prepared for:  
Crossroads Metropolitan District No. 2  
Mr. Danny Mientka  
90 South Cascade Avenue, Suite 1500  
Colorado Springs, Colorado Springs 80903

Prepared by:



**CIVIL CONSULTANTS, INC.**

212 N. Wahsatch Avenue, Suite 305  
Colorado Springs, CO 80903  
(719) 955-5485

Project #18-003A  
PCD Filing No.: SP-20-011

**PRELIMINARY  
DRAINAGE REPORT  
FOR  
CROSSROADS MIXED USE**

**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: \_\_\_\_\_  
Danny Mientka –Owner

DATE: \_\_\_\_\_

ADDRESS: The Equity Group, LLC  
90 South Cascade Avenue, Suite 1500  
Colorado Springs, CO 80903

EL PASO COUNTY'S STATEMENT

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

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

CONDITIONS:

**PRELIMINARY DRAINAGE REPORT  
FOR  
CROSSROADS MIXED USE**

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# **PRELIMINARY DRAINAGE REPORT FOR CROSSROADS MIXED USE**

## **Purpose**

This preliminary drainage report for Crossroads Mixed Use is in support of a Preliminary Plan and Rezone of the subject site. This report functions to identify the existing and proposed runoff patterns and recommend proposed drainage improvements which are intended to safely convey runoff through the proposed development, while minimizing impacts to downstream facilities and adjacent properties.

A Final Drainage Report for this site and Construction Drawings will be submitted concurrently with the Final Plat. Individual drainage letters and/or reports shall be required with the development of each lot not otherwise clearly analyzed by the aforementioned by this Final Drainage Report for Crossroads Mixed Use.

## **Project Location and Description**

The subject site is located at 0 Meadowbrook Parkway in the southwestern quarter of Section 8, Township 14 South, Range 65 West of the 6<sup>th</sup> P.M. in El Paso County, Colorado. The 29.04 Acre site is currently undeveloped. The site is bound to the west by undeveloped Softball West Subdivision Filing No.2, to the north by Meadowbrook Crossing Subdivision and south by Highway 24 and to the east by Newt Drive.

The proposed site is will be developed into ten (10) commercial lots, one (1) multifamily residential and three tracts. The development will extend Meadowbrook Parkway to the west and will include a single lane roundabout to be constructed at the intersection of the Meadowbrook Parkway and Newt Drive. The property is within the commercial aviation district overlay. A concurrent rezone application has been submitted to rezone 12.695 acres from CR to the RM-30 Zone.

The majority of the existing site is covered with native grasses with fair to good cover, the exception being portions of the future Meadowbrook Parkway corridor where exposed soils are present. Known earthwork operations to “borrow material” have occurred over a small segment of the eastern portion of the site in early and mid 2019, but have since stabilized. A few dirt paths/trails are present along the far west end of the site, likely from recreational vehicles. Generally the site slopes from east to west at slightly greater than 1% with some localized depressions and general terrain undulations near the west boundary that have slopes ranging from 1- 20%. Some of these may be the results of previous earthwork activities. The site lies within the Sand Creek Drainage Basin. No existing drainage facilities or improvements exist onsite. No known irrigation or wells are present.

## **Soils**

Soils in the project area have been determined to be Blakeland Loamy Sand (8) and Blendon Sandy Loam (10) which are characterized to be part of Hydrologic Soil Types "A" & "B" as determined from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) "Web Soils Survey". A soils map illustrating the site location and soil types is provided in the appendix of this report.

## **Floodplain Statement**

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Nos. 08041C0754 G & 08041C0752 G, effective date December 7<sup>th</sup>, 2018; none of the site lies within a designated floodplain. A copy of these annotated maps can be found in the appendix. The Sand Creek East Fork Channel is located to the northwest of the adjacent Meadowbrook Crossing subdivision.

## **Previous Studies**

The area which encompasses Crossroads Mixed Use has been previously studied. Below is a short outline of the assumptions regarding the lands of the subject site and those based upon the previously assembled and approved drainage reports and how the assumptions within them impact the subject site.

Sand Creek Drainage Basin Planning Study, Preliminary Design Report", prepared by Kiowa Engineering Corporation, dated January 1993, revised March 1996.

- Establishes that the subject site falls within the East Fork Sand Creek Drainage Basin a portion of the larger Sand Creek Watershed
- Establishes that there are no requirements for major infrastructure improvements and subsequently no drainage improvement related reimbursements with the development of this parcel
- Drainage fees shall be required to plat

"Claremont Business Park Filing No.2 prepared by Matrix Design Group, revised November 2006

- Establishes the drainage patterns of offsite Basins 0S4 and E2 which are to be conveyed within the Meadowbrook Rights of Way
- Established up-gradient offsite drainage to be directed under Meadowbrook north to offsite East Fork Sand Creek Channel, and away from the subject site

"Final Drainage Report, Lot 1 24/94 Business Park Filing No.1 prepared by Core Engineering Group, dated July 14, 2016

- The development of the 24/94 Business Park FDR shows future curb inlets along the future

Meadowbrook Parkway extension on the south and west corners of the intersection to capture runoff from up-gradient watersheds in addition to a proposed inlet which was to be located above the intersection at the northwest corner of the subject site.

- Establishes that flows from the parcel upstream of the convenience store (29/94 FDR Basin OS4) EX-B now to be collected by the extension of a 36" RCP along the south side of Meadowbrook Parkway. Runoff within the right of way/roadway separated out as Basin EXA2.
- Continues assumption that flows from Newt Drive be conveyed north to East Fork Sand Creek.
- Evaluated predevelopment drainage patterns for subject site. Including direct discharge flow rates to the CDOT rights of way of 1.9 and 14.5 cfs for the 5 and 100 year events respectively. (Basin EX-E).

"Preliminary and Final Drainage Report Meadowbrook Crossing Filing No. 1 and Filing 2, El Paso County, Colorado prepared by Kiowa Engineering Corporation, dated July 25, 2017

- Proposed the installation of a future 10' Type R inlet at the southeast corner of Newt Drive and Meadowbrook Parkway with the extension of Meadowbrook Parkway to the west (along the northern boundary of the subject site). The inlet was to function to collect offsite runoff from a portion of the south half of Meadowbrook Parkway and Newt Drive north of Hwy 24. Intercepted runoff would be conveyed via a proposed 24" storm sewer to the existing storm sewer system within the Meadowbrook Crossings development.
- Proposed the installation of a 10' Type R inlet at the west end of future Meadowbrook Parkway. The inlet was to collect runoff from the north half of the future roadway. An 18" storm drain was proposed to convey collected runoff to the existing water quality pond located within the Meadowbrook Crossings Development. The report indicates a separate forebay or the modification of an existing forebay would be required.
- Shifted the location of the existing 10'ft Type R curb inlet to be installed upstream of the intersection of Newt Drive (as shown with the 24/94 Business Park FDR), flows in excess of the inlet capacity are to continue within the future Meadowbrook.

"Final Drainage Report for Meadowbrook Dirt Borrow Site, El Paso County Colorado, prepared by M&S Civil Consultants, November 2018.

- Evaluated onsite drainage patterns
- Excluded offsite runoff impacts from areas to the east of site.
- Allowed site to be utilized as a "borrow site" for offsite earthwork activities.

## **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 and City of Colorado Springs Storm Drainage Design Criteria manual. The relevant data sheets are included in the appendix of this report. Hydraulic grade line calculations shall be provided with the Final Drainage report.

## **Drainage Criteria**

This drainage analysis has been prepared in accordance with current El Paso County Drainage Criteria Manual and where applicable the City of Colorado Springs and Mile High Flood District Criteria Manuals. 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. See Appendix for supporting calculations.

## **Historic (Pre-Grading) Drainage Characteristics**

The historic drainage patterns discussed within this report reflect the site conditions prior to the approval of the 2018 Meadowbrook Dirt Borrow Site Grading and Erosion Control Plan. This 'historic condition' generally coincides with the existing condition analysis and mapping that accompanied that project's hydrologic analysis.

The following excerpt is from the existing Drainage Characteristics section of the Final Drainage Report for Meadowbrook Dirt Borrow Site, El Paso County, Colorado, by M&S Civil Consultants and adequately describes the general site characteristics prior to grading.

"Site vegetation is sparse, consisting primarily of native grasses and weeds. The parcel possesses a ridgeline that bisects the parcel, directing runoff to the south and west boundaries, with slopes varying from 1% to 20%. A few small depressions are located on site, near the west boundary. For the purposes of hydrologic analysis, the small depressions are not considered to detain runoff."

Given the increase in breadth and scope of this study, significant consideration of the impacts of offsite drainage from the adjacent developments will be evaluated. This includes drainage from a small portion of Hwy 24 which combines with flows within existing from portions of Newt Drive. Runoff from this offsite area combines with by-pass flows from two inlets located within existing Meadowbrook Drive, prior to entering the site at its northeast corner. Runoff from these locations ultimately combines with onsite flows within the proposed Meadowbrook Parkway corridor, before discharging to downstream properties.

The detailed description of the historic (pre-grading) condition is as follows. Please refer to the historic conditions drainage map which is provided within the appendix of this report.

## Historic Conditions - Detailed Drainage Discussion

### Design Point 1

**Basin E2 (Claremont Business Park Filing No.2)** consists of a reported 3.86 developed acres of Development located along the southeastern half of existing Meadowbrook Parkway some 1200' northeast of the subject site. Runoff produced by the offsite development (CBPF2 Lot 46) is conveyed to Meadowbrook Parkway at flow rates of  $Q_5=15.1$ ,  $Q_{100}=28.6$  cfs in the 5 and 100-year storm events respectively. The collected flows combines with runoff from **Basin EX-A2 (Lot 1 24/94 Business Park Filing No.1)** ( $Q_5=2.5$ ,  $Q_{100}=4.5$  cfs) which consist of 0.59 acres of the southeastern half of Meadowbrook Parkway located immediately east of existing Newt Drive. The collected flows from the two basins culminate at **Design Point 1** at peak rates of  $Q_5=14.2$  and  $Q_{100}=26.5$  cfs. An existing 10' CDOT Type R at-grade inlet (**Inlet 1**) intercepts flows of  $Q_5=8.4$  and  $Q_{100}=11.1$  cfs, with subsequent by-pass flows of 5.8 and 15.4 cfs in the 5 and 100 year events. Surface flows continue west within the south half of existing Meadowbrook Parkway.

### Design Point 2

**Basin OS-A (Meadowbrook Crossing Filing 1 and 2)** consists of 1.29 acres of the northern half of existing Meadowbrook Parkway located immediately east of Newt Drive. Runoff produced within this basin totals  $Q_5=3.1$  and  $Q_{100}=6.0$  cfs. An existing 10' CDOT Type R at grade inlet (**Inlet 2**) collects runoff of  $Q_5=3.1$  and  $Q_{100}=5.3$  cfs, with subsequent by-pass flows in only the 100 year event of 0.7 cfs. Runoff leaving the design point continuing west within the north half of existing Meadowbrook Parkway.

### Design Point 3

**Basin OS-1** consists of approximately 1.28 developed acres of existing Newt Drive located along the eastern boundary of the site. Runoff produced within the basin ( $Q_5=5.8$  cfs,  $Q_{100}=10.5$  cfs) combine with flow-by from **DP1** in the intersection at peak flow rates of 9.8 cfs, and 22.5 cfs in the 5 and 100-year storm events.

Surface runoff and by-pass flows from both **DP2** and **DP3** entering **Basin A**, and the undeveloped rights of way of future Meadowbrook Parkway, at the northeast corner of the site.

### Design Point 4

**Basin A** consists of 12.88 undeveloped acres located along the northern boundary that drain from east to west across the subject site. Runoff produced by this basin ( $Q_5=1.9$  cfs,  $Q_{100}=14.2$  cfs) combine with flows from **DP2** and **DP3**. The cumulative runoff at **DP4** of  $Q_5=7.4$  cfs,  $Q_{100}=27.7$  cfs discharges onto the adjacent property (Lot 1, Softball West Subdivision 2) along the western boundary of the site, approximately 250' to south of the northern property line.

### **Design Point 5**

**Basin B** consists of 13.63 undeveloped acres located along the western side of the subject site. Runoff produced by the basin generally flows from northeast to southwest discharging onto the adjacent property (Lot 2, Softball West Subdivision 2) approximately 200' north of the southern property line. Runoff reaching the boundary at **DP5**, is estimated at 8.3 cfs and 18.2 cfs in the 5 year and 100 year events respectively.

### **Design Point 6**

**Basin C** currently consists of 5.89 undeveloped acres located along the southern boundary of the site. Runoff produced within the basin travels east to west as sheet flow before eventually discharging into the existing barrow ditch which travels along the US HWY 24 CDOT right of way. Peak runoff rates reaching the subdivision boundary at this location are calculated at 1.2 cfs and 8.5 cfs in the 5 year and 100 year events respectively.

### **Design Point 7**

**Basin OS-2** consists of 4.98 acres of a portion of the northern half of the US HWY 24 roadway and adjoining native grass lined barrow ditch. Runoff produced within the basin combines with runoff from the subject site (**DP6**) at cumulative peak runoff rates of 10.4. and 31.9 cfs in the 5 and 100 year storm events at **DP7**. A modeled hydraulic cross section of the ditch section at **DP7** calculates flow depths of 0.76 feet traveling at a velocity of approximately 3.54 feet per second. Input parameters for this analysis can be found in the Hydraulics section of the Appendix below.

Runoff from **Design Points 4 and 5** ultimately combine with the flows from **DP7** within the barrow ditch of US Hwy 24 several hundred feet downstream of the subject site. An existing 36" RCP culvert located at the interchange of HWY 24 and Peterson Road aids in conveying a portion of the runoff from the subject site and adjacent offsite areas under the roadway. Flows in excess of the culverts carrying capacity, overtop the roadway before rejoining within a subsequent drainage swale that parallels the west bound HWY 24 on-ramp. Ultimately flows discharge into the East Fork of the Sand Creek via an existing riprap rundown. Site visits conducted by M&S Civil at the time of the writing of this report, found no significant signs of erosion or deposition along the aforementioned corridor.

A Drainageway Exhibit in the appendix of this report provides and aerial illustration the aforementioned conveyance route to the channel, which will also serve to function as the emergency overflow path for the proposed site development.

### **Existing Drainage Characteristics**

The subject site has been utilized as a "borrow site" to provide surplus earthwork to offsite developments in the area. This recent grading effort occurred during the spring and summer of 2019. At the request of El Paso County, an existing condition drainage analysis has been provided to show the changes to the topography and drainage pattern as a result of this effort. As the only changes between the two conditions are onsite, the offsite drainage patterns calculations and assumptions determined with the historical analysis will remain the same. It should be noted that

the subject site was not disturbed to the full extent of the approved plan, with limited excavation primarily occurring within the eastern side of the subject site.

In the existing condition, vegetation remains sparse, consisting primarily of native grasses and weeds with good to fair cover. Areas disturbed by grading activities were reseeded and have since stabilized. In regarding to historic versus existing drainage basin delineation, the bisecting parcel ridgeline has been relocated further to the south, which results in redirecting more of the runoff to the southwestern part of the site and less to the CDOT rights of way. The few small depressions remain on site, near the west boundary. For the purposes of hydrologic analysis, these small depressions will continue to not be evaluated for their ability to detain runoff. Ultimately, all runoff from the parcel is conveyed to the west toward to existing drainage facilities located under Peterson Road and ultimately the East Fork of Sand Creek as in the historic condition.

This section only discusses the changes in basin geometry and drainage pattern and provides a direct comparison the historic versus existing conditions utilizing the same outfall (design) points, which have remained undisturbed.

#### **Design Point 4**

**Basin A** currently consists of 11.02 acres which continues to drain from east to west eventually discharging along the western boundary of the site, approximately 250' south of the northern property line. Peak runoff, post grading, is lower at an estimated 7.1 cfs and 25.5 cfs (**Design Point 2**) as compared to the historic condition flow rates of 7.4 cfs and 27.7 cfs in the 5-year and 100-year events respectively

#### **Design Point 5**

**Basin C** currently consists of 7.84 acres that drain from northeast to southwest eventually discharging along the western boundary of the site, approximately 200' north of the southern property line. Peak runoff rates at this location, are also than lower than the historic conditions with post grading flows of 5.0 cfs and 14.5 cfs at **Design Point 3** as compared to 8.3 cfs and 18.2 cfs in the 5-year and 100-year events respectively. Despite the basin currently being larger in area than in the historic condition, a decrease occurs in the peak flow rates as a result of a longer flow path to the given design point.

#### **Design Point 6**

**Basin A** consists of 3.99 undeveloped acres that drains from east to west into the US HWY 24 Right of Way at the southern boundary of the site. Peak runoff at this location is lower than the historic condition at an estimated 0.9 cfs and 6.3 cfs (**DP 6**), as compared to 1.2 cfs and 8.5 cf in the 5-year and 100-year events respectively.

#### **Design Point 7**

**Basin OS-2** consists of 4.98 acres of the northern half of the US HWY 24 roadway and adjoining native grass lined barrow ditch. Runoff produced within the basin combines with runoff from the subject site (**DP6**) at a lower cumulative peak runoff rates of 9.9 and 28.0 cfs in the 5 and 100-year storm events at **DP7**.

## **Four Step Process**

**Step 1      Employ Runoff Reduction Practices** – Approx. 2.54 acres of the proposed development is being set aside for a Full Spectrum Detention (FSD) Pond. Whenever possible, runoff produced within developable area containing impervious surfaces will be routed through landscaped areas or earthen swales (grass-lined where slope exceeds 2%) to minimize direct connection of impervious surfaces. In the interim, runoff will be reduced through the use of (4) temporary sediments ponds until the ground has been stabilized with vegetation or permanently developed.

**Step 2      Provide Water Quality Capture Volume** – A Full Spectrum Detention Pond is proposed to reduce peak discharge rates and provide water quality treatment. In the interim stage, four (4) temporary Sedimentation Ponds are provided to collect sediment for the disturbed area this will function to maintain existing water quality levels during construction, and prior to permanent development.

**Step 3      Stabilize Drainageways** – The site will use a Full Spectrum Detention (FSD) Pond to control developed runoff that is discharging into an existing CDOT ROW roadside ditch and ultimately into Sand Creek. The FSD outlet structure will be designed to drain the water quality event storm in 40 hours, while reducing the 100 year peak discharge to approximately 90% of the predevelopment conditions. As the flow is discharged offsite, it continues southwest in CDOT's manmade roadside ditch until it reaches Peterson Road. From here, it is conveyed to the other side of the road, into a similar earthen channel, via a 36" CMP culvert. The drainage continues southwest in the right of way, until it reaches the East Fork Sand Creek Channel. Rip Rap barriers are lined throughout this portion of the pathway approximately every 90-100 feet to the channel. The Drainageway Exhibit provided in the Drainage Maps section of the Appendix provides a better visual representation of this information.

The development of this site is not anticipated to have negative effects on downstream drainage ways since flows released will be below historic rates. In the interim, the site proposes four temporary sedimentation ponds, before discharging at the southwest property corner of the site and onto an adjacent undeveloped property via riprap-lined spillways. This ensures that in this stage of the development negative effects on the downstream drainage ways will be avoided.

**Step 4      Consider Need for Industrial and Commercial BMP's** – The proposed development will implement a Stormwater Management Plan including property housekeeping practices and spill containment procedures.

## **Proposed Drainage Characteristics**

The proposed site is will be developed into ten (10) commercial lots, one (1) multifamily residential and three tracts. The proposed development will extend Meadowbrook Parkway to the west and will include a single lane roundabout to be constructed at the intersection of the Meadowbrook Parkway and Newt Drive to aid in traffic control. A proposed private looped roadway, Crossroad Heights, will extend into the site to provide access and a utility corridor to both the commercial and

residential developments. At this time, it is anticipated that the development and design of Lot 11 (by others) is planned to occur concurrently with the construction of the proposed utilities and infrastructure provided by this plan. Coordination is ongoing, as such; the routing of storm sewer main line thru the site and the planned outfall locations will be formalized with the Final Drainage Report. A separate drainage letter or report will be required for that portion of the development.

The following summary generalizes the proposed drainage patterns and drainage improvements required to safely route developed runoff to downstream facilities.

A storm sewer pipe and inlet will be constructed at the southwest corner of the newly constructed roundabout to aid in collecting runoff reaching the site from offsite watersheds. These facilities will connect to the existing system located inside the existing Meadowbrook Subdivision. Bypassed flows and developed flows within the newly constructed Meadowbrook Parkway will be collected by a pair of sump inlets located at the west end of the roadway. The drainage facilities located with the rights of way will be public all remaining onsite storm sewer and drainage improvements shall be private. A private looped roadway will provide access and utility corridors for development. Private storm sewer mains, stubs, and inlets will be extended along these corridors to serve the development. The extension of these facilities beyond what is shown by this plan is likely with future development. Runoff collected by the infrastructure will be conveyed to a single full spectrum detention pond located in the southwest corner of the subdivision. The proposed outfall from the pond is planned to discharge to the existing barrow ditch located with the north half of the existing CDOT Right of Way. A drainage easement will be required from CDOT for the outfall and slope protection facilities that fall within the corridor. It should be noted that the storm outfall will be shaped into the existing hillside and any soil riprap protection will be buried. Runoff leaving the site and entering the CDOT corridor will discharge at less than historic rates. The previous discharge points along the west boundary of the subject site which also previously contributed to the barrow ditch will be virtually eliminated, further reducing the peak flow rates to downstream facilities.

## **Proposed Detailed Drainage Discussion**

### **Design Point 1**

**Basin E2 (Claremont Business Park Filing No.2)** consists of a reported 3.86 developed acres of Development located along the southeastern half of existing Meadowbrook Parkway some 1200' northeast of the subject site. Runoff produced by the offsite development (CBPF2 Lot 46) is conveyed to Meadowbrook Parkway at flow rates of  $Q_5=15.1$ ,  $Q_{100}=28.6$  cfs in the 5 and 100-year storm events respectively. The collected flows combines with runoff from **Basin EX-A2 (Lot 1 24/94 Business Park Filing No.1)** ( $Q_5=2.5$ ,  $Q_{100}=4.5$  cfs) which consist of 0.59 acres of the southeastern half of Meadowbrook Parkway located immediately east of existing Newt Drive. The collected flows from the two basins culminate at **Design Point 1** at peak rates of  $Q_5=14.2$  and  $Q_{100}=26.5$ . An existing 10' CDOT Type R at-grade inlet (**Inlet 1**) intercepts flows of  $Q_5=8.4$  and  $Q_{100}=11.1$ , with subsequent by-pass flows of 5.8 and 15.4 cfs in the 5 and 100 year events. Surface flows continue west within the south half of existing Meadowbrook Parkway.

### **Design Point 2**

**Basin OS-A (Meadowbrook Crossing Filing 1 and 2)** consists of 1.29 acres of the northern half of existing Meadowbrook Parkway located immediately east of Newt Drive. Runoff produced within this basin totals  $Q_5=3.1$  and  $Q_{100}=6.0$  cfs. An existing 10' CDOT Type R at grade inlet (**Inlet 2**) collects runoff of  $Q_5=3.1$  and  $Q_{100}=5.3$  cfs, with subsequent by-pass flows in only the 100 year event of 0.7 cfs. Runoff leaving the design point continuing west within the north half of existing Meadowbrook Parkway.

### **Design Point 3**

**Basin OS-1** consists of approximately 1.40 acres of existing Newt Drive that will be retrofitted with new raised median as part of an intersection conversion to a roundabout. Runoff produced within the basin ( $Q_5=6.5$ ,  $Q_{100}=11.6$  cfs) will combine with flow-by from **DP1** at a proposed public 10'-a-grade inlet located at DP3. A proposed public 24 storm sewer (**PR1**) will convey water across the intersection to the existing 42" storm sewer with Meadowbrook Crossings in accordance with that subdivisions drainage report. A new larger manhole may be required to make the connection to the existing line. It is important to note that this connection remains feasible as the roundabout is not anticipated to significantly increase the overall imperviousness of the area above that of the existing condition. Runoff in excess of the inlet capacity ( $Q_5=3.5$  and  $Q_{100}=13.5$  cfs) will continue westward via the curb and gutter of Proposed Meadowbrook Parkway.

### **Design Point 4**

**Basin A** consists of 1.68 acres of the north half of proposed Meadowbrook. Runoff within this basin ( $Q_5=6.5$ ,  $Q_{100}=11.6$  cfs) combines with minor flow by from **DP2**. A proposed 10' sump inlet located at west end of the roadway will prevent developed flows from leaving the roadway corridor. The inlet will convey intercept runoff of 6.5 and 19.1 (split 100 yr flows with DP5) underneath the roadway via a public 24" RCP (**PR2**).

### **Design Point 5**

**Basin B** consists of 1.49 acres of the south half of proposed Meadowbrook Parkway. Runoff produced within this basin ( $Q_5=5.8$ ,  $Q_{100}=10.4$  cfs) combines with flow-by leaving **DP3**. A proposed public 10' sump inlet located at west end of the roadway will prevent developed flows from leaving exiting the roadway corridor. The intercepted runoff of 9.9 cfs and 19.1 cfs in the 5 and 100 year events respectively will combine with **PR2** flows in a 36" Private storm sewer system (**PR3**). Combined flows within the proposed system are calculated to peak at 16.4 and 38.2 cfs.

### **Design Point 6**

**Basin C** consists of 4.61 acres of commercial lots (1-5 and portions of lot 6) located along the east side of the site. A private 36" storm drain (**PR4-PR6**) is provided to collect flows of  $Q_5=5.8$  and  $Q_{100}=10.4$  cfs at **DP6** in the 5 and 100 years respectively. Intercepted flows are conveyed west underground within a public access and utility easement.

### **Design Point 7**

**Basin D** consists of 2.22 acres of commercial lots located between Meadowbrook Parkway and the looped roadway. **Basin D** which includes portions of lot 9 and 10 will require a private 24" storm drain (**PR7**) to collect flows of  $Q_5=9.3$  and  $Q_{100}=17.0$  cfs in the 5 and 100 year storm event.

### **Design Points 8 and 9**

**Basin E** consists of 2.71 acres of commercial lots and roadway located in the central portion of the site. Two private 10' CDOT Type R at-grade inlets (**Inlets 7 and 8**) located on the north and south will each collect flows approximately 4.8 and 6.9 cfs in the minor and major storm events. Runoff collected from the inlets will be conveyed to the south side of the planned roadway via private 24" (**PR8**) and 30" (**PR9**) storm drains. A proposed 36" storm sewer (**PR10**) will convey flows to the west underground a peak flow rates of 35.0 and 60.5 cfs in the 5 and 100 year events. A drainage easement storm sewer easement may need to be provided along this portion of the alignment depending upon the building setback requirements.

### **Design Point 10 and 11**

**Basin G** consists of 0.94 acres of commercial lots and roadway located in the central portion of the site. Two private 10' CDOT Type R sump inlets (**Inlets 7 and 8**) located on the east and west side of the street function to collect the runoff from basin G as well as any by pass flows from Design DP8 and 9. Pipe Run 14 a 42" private storm sewer will direct runoff south underground at peak flow rates of 39.9 cfs and 78.1 cfs in the minor and major storm event.

### **Design Point 12**

**Basin F** consists of 2.57 acres of commercial lots (lot 8 and portions of lot 7) located along the southern boundary of the site. A private 24" storm drain (**PR15**) is provided to collect flows of  $Q_5=10.8$  and  $Q_{100}=19.6$  cfs at **DP12** in the 5 and 100 years respectively. Intercepted flows are conveyed west underground to the main line. **Pipe Runs 16 and 17** (private 42" storm sewer) direct the collected runoff to the concrete forebay located within the east end of a proposed full spectrum detention pond at peak flow rates of  $Q_5=49.7$  and  $Q_{100}=96.0$  cfs

### **Design Point 12**

**Basin F** consists of 2.57 acres of commercial lots (lot 8 and portions of lot 7) located along the southern boundary of the site. A private 24" storm drain (**PR15**) is provided to collect flows of  $Q_5=10.8$  and  $Q_{100}=19.6$  cfs at **DP12** in the 5 and 100 years respectively. Intercepted flows are conveyed west underground to the main line. **Pipe Runs 16 and 17** (private 42" storm sewer) direct the collected runoff to the concrete forebay located within the east end of a proposed full spectrum detention pond at peak flow rates of  $Q_5=49.7$  and  $Q_{100}=96.0$  cfs

### **Design Points 13**

**Basin H** consists of 11.07 acres of proposed apartment site (Lot 11). Runoff produced within this basin ( $Q_5=26.2$ ,  $Q_{100}=53.8$  cfs) flows from northeast to southwest until it reaches the proposed public 42" RCP storm sewer at the design point. The cumulative flows at **Design Point 13** are  $Q_5=26.2$  and  $Q_{100}=53.8$  cfs and will be routed to the full spectrum detention pond at **Design Point 15** via **Pipe Run 18** ( $Q_5=42.1$ ,  $Q_{100}=91.1$ ).

### **Design Points 14**

**Basin I** consists of 1.60 acres of proposed apartment site (Lot 11). Runoff produced within this basin ( $Q_5=3.8$ ,  $Q_{100}=7.8$  cfs) flows from north to south and collects in the proposed, grass-lined swale. The cumulative flows at **Design Point 14** are  $Q_5=3.8$  and  $Q_{100}=7.8$  cfs and will be routed to the full spectrum detention pond at **Design Point 15**.

### **Design Points 15**

**Basin J** consists of 3.21 acres of the proposed full spectrum detention pond. Runoff produced within this basin ( $Q_5=2.3$ ,  $Q_{100}=10.0$  cfs) flows from northeast to southwest, combining with flows from **Design Point 14**, **Pipe Run 17**, and **Pipe Run 18**. This combination of runoff collects in the proposed outlet structure of the pond. The cumulative flows at **Design Point 14** are  $Q_5=95.3$  and  $Q_{100}=199.8$  cfs, and will be routed to the existing 5' bottom earthen swale in CDOT's Right of Way at **Design Point 16** via **Pipe Run 19** ( $Q_5=1.9$ ,  $Q_{100}=8.2$ ).

### **Design Points 16**

**Basin OS-2** consists of 4.98 acres. Approximately half of this basin is comprised of the paved surface of U.S. Highway 24, while the other half is comprised of the 5 foot bottom earthen swale in CDOT's Right of Way. Runoff produced within this basin ( $Q_5=8.7$ ,  $Q_{100}=19.6$  cfs) flows from northeast to southwest, combining with flows from **Design Point 15**. This combination of runoff collects in the existing swale in the right of way. The cumulative flows at **Design Point 16** are  $Q_5=9.9$  and  $Q_{100}=27.7$  cfs, which are lower than the historic rates. Flows from this design point continue to downstream infrastructure. A rip rap pad is located at the terminus of the storm sewer.

In accordance with the assumptions outlined within the Meadowbrook Subdivision Final Drainage Report an offsite public storm sewer pipe and inlet will be constructed at the southwest corner of the newly constructed roundabout to aid in collecting runoff from the a portion of the offsite watersheds located to the east of the site. A new manhole may be required to connect the outfall to the existing pipe located inside the existing Meadowbrook Subdivision. As the area is already paved increases to the imperviousness of this area are not anticipated and thus should not initiate the need for

## **Water Quality Provisions and Maintenance**

The proposed full spectrum detention (FSD) pond functions to provide detention and water quality for the proposed development. This full spectrum detention pond will function to treat approximately 32.10 acres of tributary area by providing 0.857 acre-feet of storage for the water quality event, 3306 acre feet of storage at the EURV storm event, and 4.729 acre-feet of storage in the 100-year event. The 25' wide emergency spillway is designed with a foot of freeboard in the 100-year event. This spillway safely conveys flows to CDOT's Right of Way in the event of outlet clogging or failure, and will be armored with permanent erosion control fabric. The results show that the FSD pond remains functional in the 100-year event and the outlet structure is able to

discharge flows to the to an existing swale and ultimately to Sand Creek. The sizing for the full spectrum detention facility has been determined using the guidelines set forth in the Urban Drainage and Flood Control District Criteria Manual. Refer to the UDFCD MHFD-Detention, Version 4.03, Excel Workbook located within the appendix of this report for calculations.

The proposed FSD pond will be privately owned and maintained by the property owner or the metropolitan district. Access to the pond shall be granted to the owner/district and El Paso County for access and maintenance of the private facility. A private maintenance agreement document shall accompany this report submittal.

### **Erosion Control**

It is the policy of the El Paso County that M&S Civil Consultants submit a grading and erosion control plan with the drainage report since pre-development grading is being requested. The plan includes proposed silt fence, vehicle traffic control and (4) temporary sediment basins as proposed as erosion control measures. The plan also includes provisions for stockpiling and staging. A stormwater management plan is provided to accompany the plans.

## 2021 Drainage & Bridge Fees:

<b>Drainage Fees:</b>	29.04	x	77.4%	\$	13,775.00	=	\$ 309,513.51
<b>Bridge Fees:</b>	29.04	x	77.4%	\$	819.00	=	<u>\$ 18,402.29</u>
<b>Total</b>							<b>\$ 327,915.80</b>

Drainage fees shall be paid at the time of platting.

### Construction Cost Estimate (Non-Reimbursable)

Item	Amount	Unit	Unit Cost	Total Cost
10' CDOT Type R Inlet	5	EA	\$ 9,890.00	\$ 49,450.00
15' CDOT Type R Inlet	2	EA	\$ 13,002.00	\$ 26,004.00
Type II MH	8	EA	\$ 6,000.00	\$ 48,000.00
18" RCP	181	LF	\$ 69.00	\$ 12,489.00
24" RCP	184	LF	\$ 107.00	\$ 19,688.00
30" RCP	33	LF	\$ 170.00	\$ 5,610.00
42" RCP	746	LF	\$ 306.00	\$ 228,276.00
<b>Total Cost:</b>				<b>\$ 389,517.00</b>

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

### Summary:

The construction of this site is for the purposes of creating commercial lots and an apartment site. Currently, no impervious surfaces are being constructed. The site will be graded and all disturbed areas will be seeded and mulched. Post construction runoff will be discharged to downstream property at rates that are below historic discharge rates. In the historic condition, the total flows leaving the site that reach the East Fork Sand Creek Channel are 19.0 cfs and 68.1 cfs in the 5 year and 100 year storm events, respectively. Through the strategic design and placement of storm sewer infrastructure components, this overall rate is reduced to approximately 50% of historic rates at 9.9 and 27.7 cfs in the proposed condition. Erosion control measures will be implemented to prevent sediment migration. The construction of Crossroads Mixed Use shall not adversely affect adjacent or downstream property. Subsequent drainage reports will be required if and when the site is developed behind the uses defined within this report.

**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, Revised date December 7<sup>th</sup>, 2018.
- 5.) "Final Drainage Report for Claremont Business Park Filing No. 2", dated November 2006, by Matrix Design Group, Inc.
- 6.) "Preliminary and Final Drainage Report Meadowbrook Crossing Filing 1 and Filing 2", dated July 25, 2017, by Kiowa Engineering Corporation.
- 7.) "Final Drainage Report Lot 1 24/94 Business Park Filing No. 1 on Platte Avenue and Meadowbrook Parkway", dated April 28, 2016 and revised July 14, 2016, by Core Engineering Group, LLC.
- 8.) "Final Drainage Report for Meadowbrook Dirt Borrow Site ", dated November 2018, by M&S Civil Consultants, Inc.
- 9.) "Sand Creek Drainage Basin Planning Study", revised March 1996, by Kiowa Engineering Corporation.

## **APPENDIX**

## **FIRM PANELS**

**NOTES TO USERS**

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

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

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

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

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

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

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

NGS Information Services  
NOAA, NIMS12  
National Geodetic Survey  
SSMC-3, #9202  
1315 East-West Highway  
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at <http://www.ngs.noaa.gov/>.

**Base Map** information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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

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

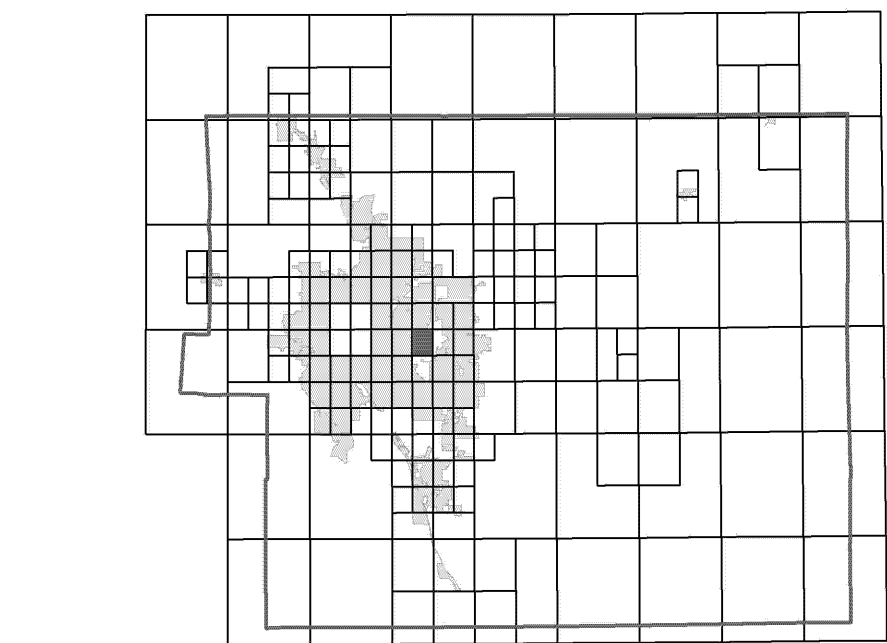
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which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

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

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

Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

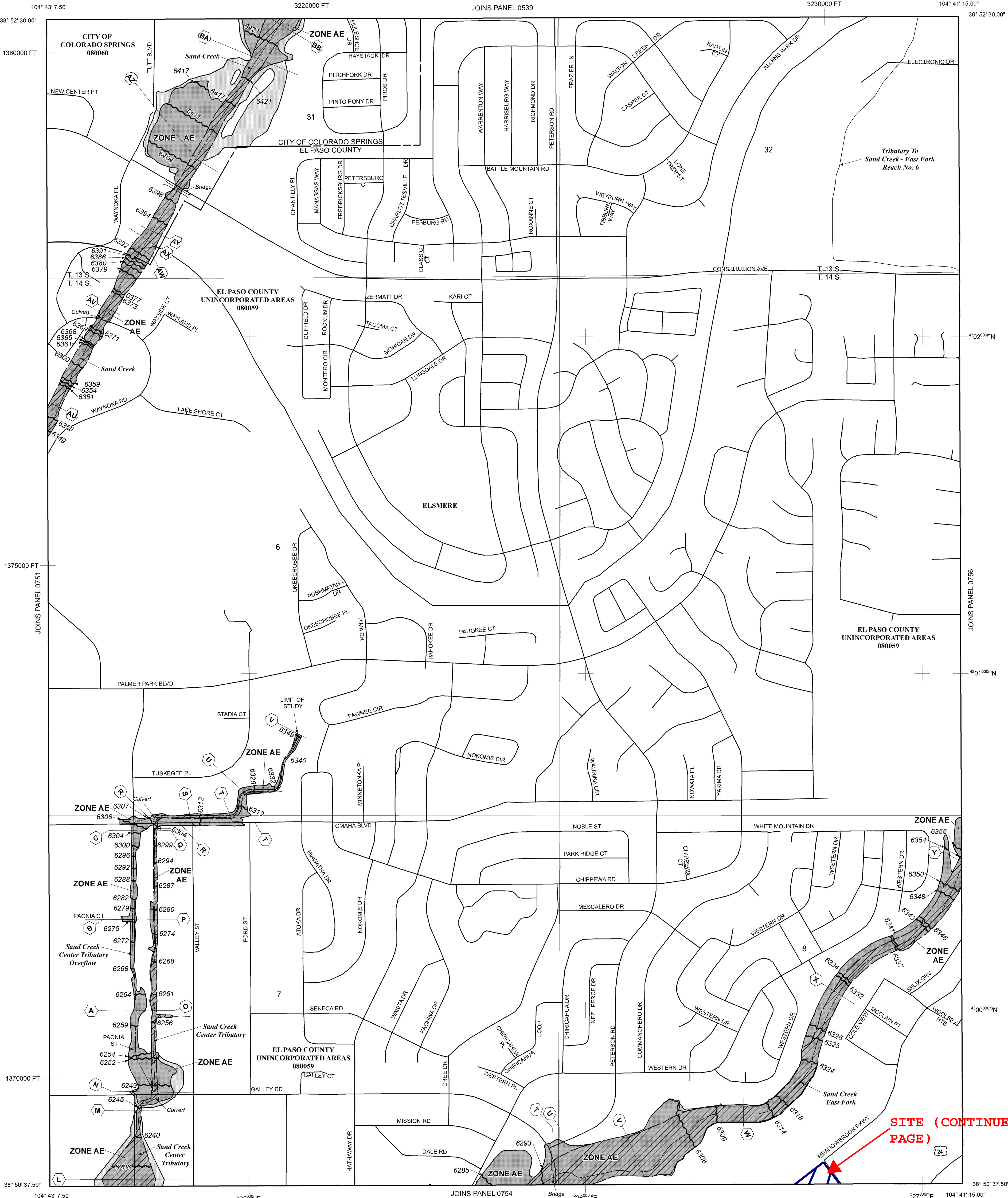
**Panel Location Map**



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



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



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

## LEGEND

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

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

**ZONE A** No Base Flood Elevations determined.  
**ZONE AE** Base Flood Elevations determined.  
**ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

**ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

**ZONE AR** Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently identified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

**ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

**ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

**ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

**FLOODWAY AREAS IN ZONE AE**

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

**OTHER FLOOD AREAS**

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

**OTHER AREAS**

**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.

**ZONE D** Areas in which flood hazards are undetermined, but possible.

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**

**OTHERWISE PROTECTED AREAS (OPAs)**

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

**Legend Symbols:**  
Floodplain boundary  
Floodway boundary  
Zone D Boundary  
CBRS and OPA boundary  
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.  
Base Flood Elevation line and value; elevation in feet\* (EL 987)  
Base Flood Elevation value where uniform within zone; elevation in feet\*  
Cross section line  
Transect line  
Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)  
1000-meter Universal Transverse Mercator grid ticks, zone 13  
5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection  
Bench mark (see explanation in Notes to Users section of this FIRM panel)  
River Mile  
MAP REPOSITORIES  
Refer to Map Repositories list on Map Index  
EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP  
MARCH 17, 1997  
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL  
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

\* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

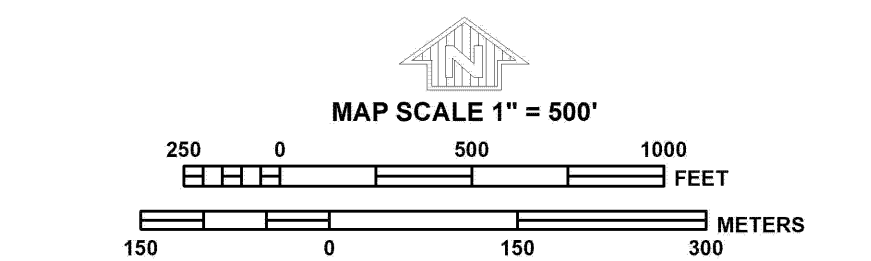
**Legend Symbols:**  
Floodplain boundary  
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Base Flood Elevation line and value; elevation in feet\* (EL 987)  
Base Flood Elevation value where uniform within zone; elevation in feet\*  
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River Mile  
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For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

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



**PANEL 0752G**

## FIRM

**FLOOD INSURANCE RATE MAP**  
**EL PASO COUNTY, COLORADO AND INCORPORATED AREAS**

**PANEL 752 OF 1300**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

**CONTAINS:**

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	08060	0752	G
EL PASO COUNTY	08059	0752	G

Notice: This map was released on 05/15/2020 to make a correction. This version replaces any previous versions. See the Notice to User Letter that accompanied this correction for details.

Notice to User: The Map Number shown below should be used when placing map orders. The Community Number shown above should be used on insurance applications for the subject community.



**MAP NUMBER**  
**08041C0752G**

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

Federal Emergency Management Agency

**NOTES TO USERS**

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NGS Information Services  
NOAA, NIMS12  
National Geodetic Survey  
SSMC-3, #9202  
1315 East-West Highway  
Silver Spring, MD 20910-3282

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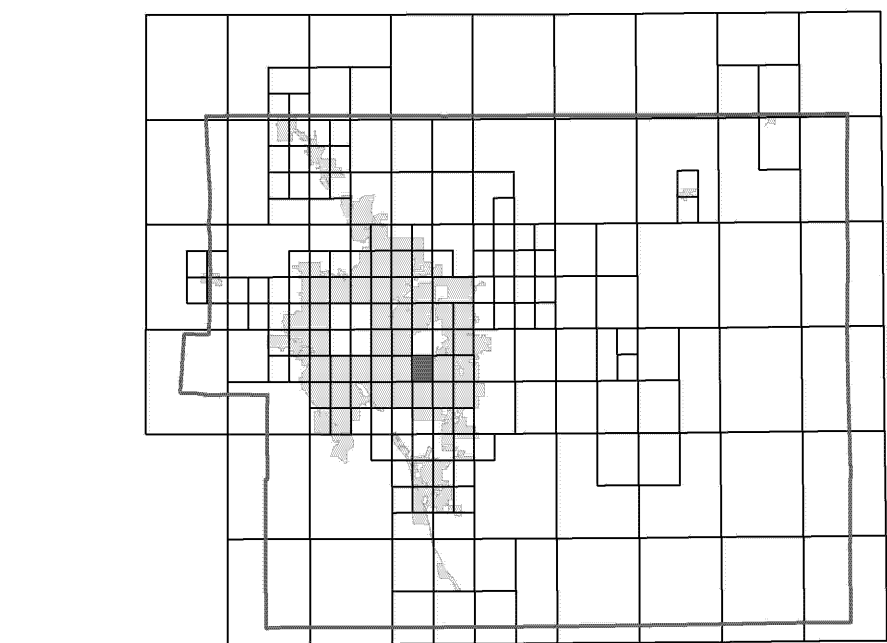
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El Paso County Vertical Datum Offset Table	
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

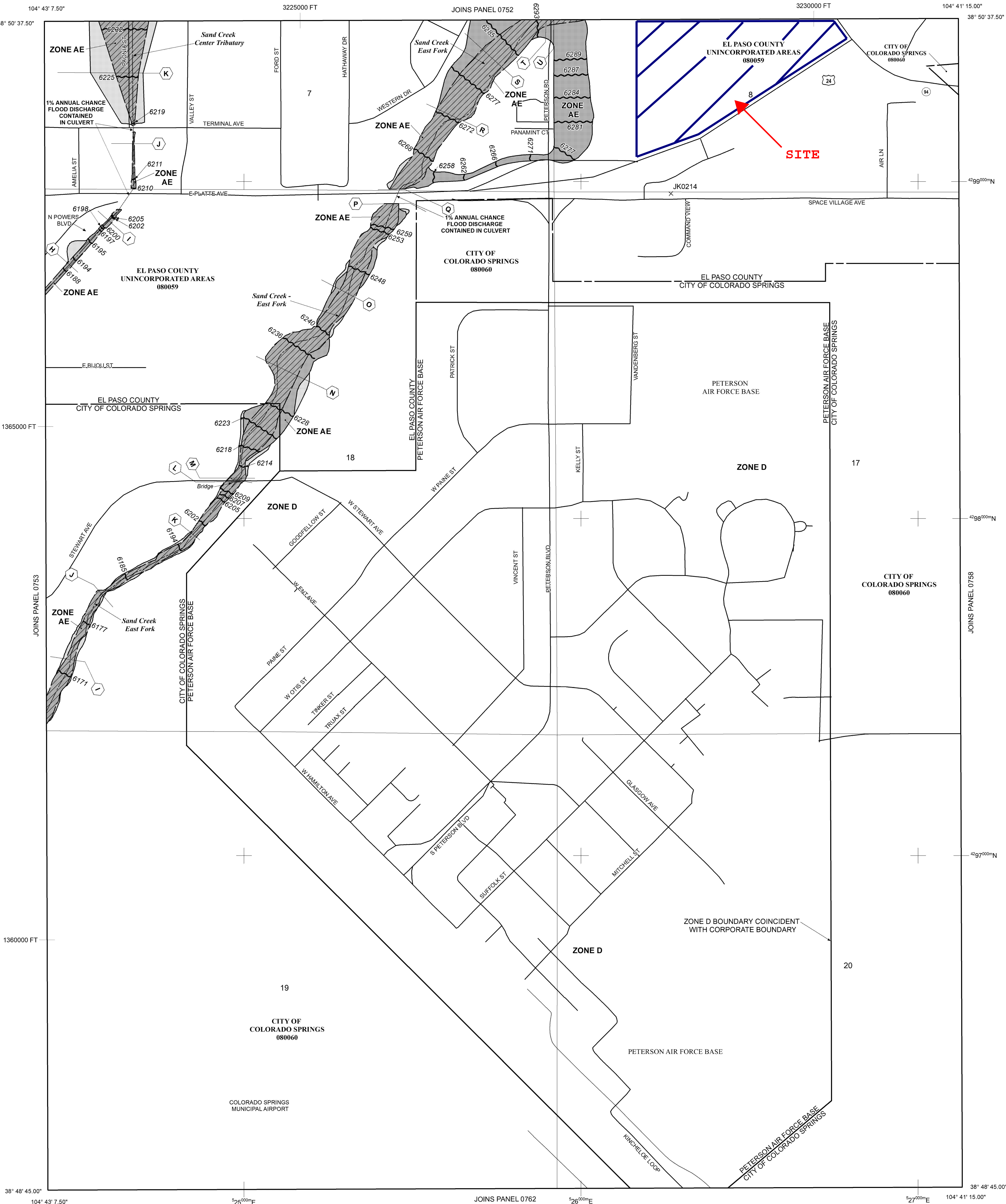
Panel Location Map



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



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



## **HYDROLOGIC CALCULATIONS**

***Crossroads Mixed Use***  
***PRELIMINARY DRAINAGE REPORT***  
***(Historic Area Runoff Coefficient Summary)***

			<b><i>STREETS / DEVELOPED</i></b>			<b><i>OVERLAND / DEVELOPED</i></b>			<b><i>WEIGHTED</i></b>	
<b>BASIN</b>	<b>TOTAL AREA (SF)</b>	<b>TOTAL AREA (Acres)</b>	<b>AREA (Acres)</b>	<b>C<sub>5</sub></b>	<b>C<sub>100</sub></b>	<b>AREA (Acres)</b>	<b>C<sub>5</sub></b>	<b>C<sub>100</sub></b>	<b>C<sub>5</sub></b>	<b>C<sub>100</sub></b>
<b><i>C</i></b>	256383.3	5.89	0.00	0.90	0.96	5.89	0.08	0.35	<b><i>0.08</i></b>	<b><i>0.35</i></b>
<b><i>A</i></b>	561176.6	12.88	0.00	0.90	0.96	12.88	0.08	0.35	<b><i>0.08</i></b>	<b><i>0.35</i></b>
<b><i>B</i></b>	593693.4	13.63	0.00	0.90	0.96	13.63	0.08	0.35	<b><i>0.08</i></b>	<b><i>0.35</i></b>
<b><i>OS-1</i></b>	55560.16	1.28	1.28	0.90	0.96	0.00	0.08	0.35	<b><i>0.90</i></b>	<b><i>0.96</i></b>
<b><i>OS-2</i></b>	216993.7	4.98	2.49	0.90	0.96	2.49	0.08	0.35	<b><i>0.49</i></b>	<b><i>0.66</i></b>
<b><i>EX-A2***</i></b>		0.59	0.59	0.90	0.96	0.00	0.08	0.35	<b><i>0.90</i></b>	<b><i>0.96</i></b>
<b><i>OS-A**</i></b>		1.29	1.29	0.62	0.72	0.00	0.08	0.35	<b><i>0.62</i></b>	<b><i>0.72</i></b>
<b><i>E2*</i></b>		3.86	3.86	0.80	0.90	0.00	0.08	0.35	<b><i>0.80</i></b>	<b><i>0.90</i></b>

\*FROM FDR FOR CLAREMONT BUSINESS PARK FILING NO. 2

\*\*FROM FDR FOR MEADOWBROOK CROSSING FILING 1 AND FILING 2

\*\*\*FROM FDR FOR LOT 1 24/94 BUSINESS PARK FILING NO. 1 ON PLATTE AVENUE AND MEADOWBROOK PARKWAY

**Crossroads Mixed Use**  
**PRELIMINARY DRAINAGE REPORT**  
**(Historic Area Drainage Summary)**

From Area Runoff Coefficient Summary				OVERLAND				STREET / CHANNEL FLOW				Time of Travel ( $T_t$ )		INTENSITY ^		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C <sub>5</sub>	C <sub>100</sub>	C <sub>5</sub>	Length	Height	T <sub>C</sub>	Length	Slope	Velocity	T <sub>t</sub>	TOTAL	CHECK	I <sub>5</sub>	I <sub>100</sub>	Q <sub>5</sub>	Q <sub>100</sub>
		From DCM Table 5-1			(ft)	(ft)	(min)	(ft)	(%)	(fps)	(min)	(min)	(min)	(in/hr)	(in/hr)	(c.f.s.)	(c.f.s.)
<b>C</b>	5.89	0.08	0.35	0.08	300	9	22.2	500	2.0%	1.0	8.4	30.6	14.4	2.5	4.1	1.2	8.5
<b>A</b>	12.88	0.08	0.35	0.08	300	13	19.7	1350	1.6%	0.9	25.2	44.8	19.2	1.9	3.2	1.9	14.2
<b>B</b>	13.63	0.08	0.35	0.08	300	11	20.8	750	1.7%	0.9	13.7	34.5	15.8	2.3	3.8	2.5	18.2
<b>OS-1</b>	1.28	0.90	0.96	0.90	100	3	2.5	490	2.2%	3.0	2.8	5.3	13.3	5.1	8.5	5.8	10.5
<b>OS-2</b>	4.98	0.49	0.66	0.49	85	8	4.8	1165	1.8%	2.0	9.6	14.5	16.9	3.6	6.0	8.7	19.6
<b>EX-A2***</b>	0.59	0.90	0.96	0.90	10	0.2	0.9	916	1.9%	2.7	5.6	6.5	15.1	4.8	8.0	2.5	4.5
<b>OS-A**</b>	1.29	0.62	0.72	0.62	40	0.8	4.4	1310	1.9%	2.8	7.9	12.3	17.5	3.8	6.4	3.1	6.0
<b>E2*</b>	3.86	0.80	0.90	0.80	50	1	3.0	400	1.3%	2.3	2.9	6.0	12.5	4.9	8.2	15.1	28.6

^ Intensity equations assume a minimum travel time of 5 minutes.

\*VALUES DERIVED USING DATA FROM FDR FOR CLAREMONT BUSINESS PARK FILING NO. 2

\*\*VALUES DERIVED USING DATA FROM FDR FOR MEADOWBROOK CROSSING FILING 1 AND FILING 2 PAGE 31

\*\*\*VALUES DERIVED USING DATA FROM FDR FOR LOT 1 24/94 BUSINESS PARK FILING NO. 1 ON PLATTE AVENUE AND MEADOWBROOK PARKWAY

Calculated by: CVW

Date: 2/23/2021

Checked by: DLM

# Crossroads Mixed Use

## PRELIMINARY DRAINAGE REPORT

### (Historic Basin Routing Summary)

From Area Runoff Coefficient Summary				OVERLAND				PIPE / CHANNEL FLOW				Time of Travel (T <sub>t</sub> )		INTENSITY *		TOTAL FLOWS		COMMENTS
DESIGN POINT	CONTRIBUTING BASINS	CA <sub>5</sub>	CA <sub>100</sub>	C <sub>s</sub>	Length (ft)	Height (ft)	T <sub>C</sub> (min)	Length (ft)	Slope (%)	Velocity (fps)	T <sub>t</sub> (min)	TOTAL (min)	I <sub>5</sub> (in/hr)	I <sub>100</sub> (in/hr)	Q <sub>5</sub> (c.f.s.)	Q <sub>100</sub> (c.f.s.)		
1	E2 EX-A2	3.09	3.47				6.0	916	1.9%	2.7	5.6	11.6	3.9	6.6	14.2	26.5	EXISTING 10' CDOT TYPE R AT GRADE INLET	
		0.53	0.57															
		3.62	4.04	Tc for E2 Used														
2	OS-A	0.80	0.93									12.3	3.8	6.4	3.1	6.0	EXISTING 10' CDOT TYPE R AT GRADE INLET	
				See Area Drainage Sheet for Input														
3	OS-1 FB-DP1	1.15	1.22				11.6	150	1.0%	2.0	1.3	12.8	3.8	6.3	9.8	22.5	END OF PAVEMENT	
		1.47	2.35															
		2.62	3.57	Tc for DP1 Used														
4	A FB-INDP5 DP3	1.03	4.51				12.8	1470	1.6%	0.9	28.0	40.8	2.0	3.4	7.4	27.7	ADJACENT PARCEL (LOT 1)	
		0.00	0.10															
		2.62	3.57															
		3.65	8.19	Tc for DP3 Used														
5	B	1.09	4.77									34.5	2.3	3.8	8.3	18.2	ADJACENT PARCEL (LOT 2)	
				See Area Drainage Sheet for Input														
6	C	0.47	2.06									30.6	2.5	4.1	1.2	8.5	DISCHARGE TO CDOT ROW	
				See Area Drainage Sheet for Input														
7	OS2 DP6	2.44	3.26									14.5	3.6	6.0	10.4	31.9	BARROW DITCH SW CORNER OF SITE/CDOT ROW	
		0.47	2.06															
		2.91	5.32	Tc for OS2 Used														

Calculated by: CVW  
Date: 2/23/2021  
Checked by: DLM

***Crossroads Mixed Use***  
***PRELIMINARY DRAINAGE REPORT***  
***(Existing Area Runoff Coefficient Summary)***

			<b><i>STREETS / DEVELOPED</i></b>			<b><i>OVERLAND / DEVELOPED</i></b>			<b><i>WEIGHTED</i></b>	
<b>BASIN</b>	<b>TOTAL AREA (SF)</b>	<b>TOTAL AREA (Acres)</b>	<b>AREA (Acres)</b>	<b>C<sub>5</sub></b>	<b>C<sub>100</sub></b>	<b>AREA (Acres)</b>	<b>C<sub>5</sub></b>	<b>C<sub>100</sub></b>	<b>C<sub>5</sub></b>	<b>C<sub>100</sub></b>
<b><i>C</i></b>	173960	3.99	0.00	0.90	0.96	5.89	0.08	0.35	<b><i>0.08</i></b>	<b><i>0.35</i></b>
<b><i>A</i></b>	480166.8	11.02	0.00	0.90	0.96	11.02	0.08	0.35	<b><i>0.08</i></b>	<b><i>0.35</i></b>
<b><i>B</i></b>	754121.6	17.31	0.00	0.90	0.96	17.31	0.08	0.35	<b><i>0.08</i></b>	<b><i>0.35</i></b>
<b><i>OS-1</i></b>	55560.16	1.28	1.28	0.90	0.96	0.00	0.08	0.35	<b><i>0.90</i></b>	<b><i>0.96</i></b>
<b><i>OS-2</i></b>	216993.7	4.98	2.49	0.90	0.96	2.49	0.08	0.35	<b><i>0.49</i></b>	<b><i>0.66</i></b>
<b><i>EX-A2***</i></b>		0.59	0.59	0.90	0.96	0.00	0.08	0.35	<b><i>0.90</i></b>	<b><i>0.96</i></b>
<b><i>OS-A**</i></b>		1.29	1.29	0.62	0.72	0.00	0.08	0.35	<b><i>0.62</i></b>	<b><i>0.72</i></b>
<b><i>E2*</i></b>		3.86	3.86	0.80	0.90	0.00	0.08	0.35	<b><i>0.80</i></b>	<b><i>0.90</i></b>

\*FROM FDR FOR CLAREMONT BUSINESS PARK FILING NO. 2

\*\*FROM TO FDR MEADOWBROOK CROSSING FILING 1 AND FILING 2

\*\*\*FROM FDR LOT 1 24/94 BUSINESS PARK FILING NO. 1 ON PLATTE AVENUE AND MEADOWBROOK PARKWAY

**Crossroads Mixed Use**  
**PRELIMINARY DRAINAGE REPORT**  
**(Existing Area Drainage Summary)**

From Area Runoff Coefficient Summary				OVERLAND				STREET / CHANNEL FLOW				Time of Travel ( $T_t$ )		INTENSITY ^		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C <sub>5</sub>	C <sub>100</sub>	C <sub>5</sub>	Length	Height	T <sub>C</sub>	Length	Slope	Velocity	T <sub>t</sub>	TOTAL	CHECK	I <sub>5</sub>	I <sub>100</sub>	Q <sub>5</sub>	Q <sub>100</sub>
		From DCM Table 5-1			(ft)	(ft)	(min)	(ft)	(%)	(fps)	(min)	(min)	(min)	(in/hr)	(in/hr)	(c.f.s.)	(c.f.s.)
<b>C</b>	3.99	0.08	0.35	0.08	120	2.8	15.3	555	1.5%	0.9	10.6	25.9	13.8	2.7	4.5	0.9	6.3
<b>A</b>	11.02	0.08	0.35	0.08	165	8	13.8	1730	1.3%	0.8	36.3	50.1	20.5	1.7	2.9	1.5	11.1
<b>B</b>	17.31	0.08	0.35	0.08	300	3	30.9	1390	1.2%	0.8	29.7	60.6	19.4	1.4	2.4	2.0	14.5
<b>OS-1</b>	1.28	0.90	0.96	0.90	100	3	2.5	490	2.2%	3.0	2.8	5.3	13.3	5.1	8.5	5.8	10.5
<b>OS-2</b>	4.98	0.49	0.66	0.49	85	8	4.8	1165	1.8%	2.0	9.6	14.5	16.9	3.6	6.0	8.7	19.6
<b>EX-A2***</b>	0.59	0.90	0.96	0.90	10	0.2	0.9	916	1.9%	2.7	5.6	6.5	15.1	4.8	8.0	2.5	4.5
<b>OS-A**</b>	1.29	0.62	0.72	0.62	40	0.8	4.4	1310	1.9%	2.8	7.9	12.3	17.5	3.8	6.4	3.1	6.0
<b>E2*</b>	3.86	0.80	0.90	0.80	50	1	3.0	400	1.3%	2.3	2.9	6.0	12.5	4.9	8.2	15.1	28.6

^ Intensity equations assume a minimum travel time of 5 minutes.

\*VALUES DERIVED USING DATA FROM FDR FOR CLAREMONT BUSINESS PARK FILING NO. 2

\*\*VALUES DERIVED USING DATA FROM FDR FOR MEADOWBROOK CROSSING FILING 1 AND FILING 2 PAGE 31

\*\*\*VALUES DERIVED USING DATA FROM FDR FOR LOT 1 24/94 BUSINESS PARK FILING NO. 1 ON PLATTE AVENUE AND MEADOWBROOK PARKWAY

Calculated by: CVW

Date: 2/23/2021

Checked by: DLM

**Crossroads Mixed Use**  
**PRELIMINARY DRAINAGE REPORT**  
**(Existing Basin Routing Summary)**

From Area Runoff Coefficient Summary				OVERLAND				PIPE / CHANNEL FLOW				Time of Travel (T <sub>t</sub> )		INTENSITY *		TOTAL FLOWS		COMMENTS
DESIGN POINT	CONTRIBUTING BASINS	CA <sub>5</sub>	CA <sub>100</sub>	C <sub>s</sub>	Length (ft)	Height (ft)	T <sub>C</sub> (min)	Length (ft)	Slope (%)	Velocity (fps)	T <sub>t</sub> (min)	TOTAL (min)	I <sub>5</sub> (in/hr)	I <sub>100</sub> (in/hr)	Q <sub>5</sub> (c.f.s.)	Q <sub>100</sub> (c.f.s.)		
1	E2 EX-A2	3.09	3.47				6.0	916	1.9%	2.7	5.6	11.6	3.9	6.6	14.2	26.5	EXISTING 10' CDOT TYPE R AT GRADE INLET	
		0.53	0.57															
		3.62	4.04	Tc for E2 Used														
2	OS-A	0.80	0.93									12.3	3.8	6.4	3.1	6.0	EXISTING 10' CDOT TYPE R AT GRADE INLET	
				See Area Drainage Sheet for Input														
3	OS-1 FB-DP1	1.15	1.22				11.6	150	1.0%	2.0	1.3	12.8	3.8	6.3	9.8	22.5	END OF PAVEMENT	
		1.47	2.35															
		2.62	3.57	Tc for DP1 Used														
4	A FB-DP2 DP3	0.88	3.86				12.8	1470	1.6%	0.9	28.0	40.8	2.0	3.4	7.1	25.5	ADJACENT PARCEL (LOT 1)	
		0.00	0.10															
		2.62	3.57															
		3.50	7.54	Tc for DP3 Used														
5	B	1.38	6.06									60.6	1.4	2.4	5.0	14.5	ADJACENT PARCEL (LOT 2)	
				See Area Drainage Sheet for Input														
6	C	0.32	1.40									25.9	2.7	4.5	0.9	6.3	DISCHARGE TO CDOT ROW	
				See Area Drainage Sheet for Input														
7	OS2 DP6	2.44	3.26									14.5	3.6	6.0	9.9	28.0	BARROW DITCH SW CORNER OF SITE/CDOT ROW	
		0.32	1.40															
		2.76	4.66	Tc for OS2 Used														

Calculated by: CVW  
Date: #####  
Checked by: DLM

**CROSSROADS MIXED USE**  
**PRELIMINARY DRAINAGE CALCULATIONS**  
*(Area Runoff Coefficient Summary)*

			<i>STREETS / COMMERC.</i>			<i>MULTI-FAMILY/PARKLAND</i>			<i>OVERLAND / UNDEVELOPED</i>			<i>WEIGHTED</i>	
BASIN	TOTAL AREA (Sq Ft)	TOTAL AREA (Acres)	AREA (Acres)	C <sub>5</sub>	C <sub>100</sub>	AREA (Acres)	C <sub>5</sub>	C <sub>100</sub>	AREA (Acres)	C <sub>5</sub>	C <sub>100</sub>	C <sub>5</sub>	C <sub>100</sub>
<b>PROPOSED BASINS</b>													
<i>OS-A**</i>		1.29	1.29	0.62	0.72	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.62</i>	<i>0.72</i>
<i>E2*</i>		3.86	3.86	0.80	0.90	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.80</i>	<i>0.90</i>
<i>EX-A2***</i>		0.59	0.59	0.90	0.96	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.90</i>	<i>0.96</i>
<i>OS-1</i>	<i>60793.3017</i>	1.40	1.40	0.90	0.96	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.90</i>	<i>0.96</i>
<i>OS-2</i>	<i>216993.7096</i>	4.98	2.49	0.90	0.96	0.00	0.49	0.62	2.49	0.08	0.35	<i>0.49</i>	<i>0.66</i>
<i>A</i>	<i>72967.0787</i>	1.68	1.68	0.90	0.96	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.90</i>	<i>0.96</i>
<i>B</i>	<i>65021.9778</i>	1.49	1.49	0.90	0.96	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.90</i>	<i>0.96</i>
<i>C</i>	<i>200631.5748</i>	4.61	4.46	0.81	0.88	0.00	0.49	0.62	0.15	0.08	0.35	<i>0.79</i>	<i>0.86</i>
<i>D</i>	<i>96773.7602</i>	2.22	2.22	0.81	0.88	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.81</i>	<i>0.88</i>
<i>E</i>	<i>118133.5827</i>	2.71	0.48	0.90	0.96	2.23	0.81	0.88	0.00	0.08	0.35	<i>0.83</i>	<i>0.89</i>
<i>F</i>	<i>112036.6061</i>	2.57	2.57	0.81	0.88	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.81</i>	<i>0.88</i>
<i>G</i>	<i>40937.4999</i>	0.94	0.94	0.90	0.96	0.00	0.49	0.62	0.00	0.08	0.35	<i>0.90</i>	<i>0.96</i>
<i>H</i>	<i>482081.5171</i>	11.07	0.00	0.90	0.96	11.07	0.54	0.66	0.00	0.08	0.35	<i>0.54</i>	<i>0.66</i>
<i>I</i>	<i>69600.2016</i>	1.60	0.00	0.90	0.96	1.60	0.54	0.66	0.00	0.08	0.35	<i>0.54</i>	<i>0.66</i>
<i>J</i>	<i>139924.2472</i>	3.21	0.00	0.90	0.96	3.21	0.16	0.41	0.00	0.08	0.35	<i>0.16</i>	<i>0.41</i>

# CROSSROADS MIXED USE

## PRELIMINARY DRAINAGE REPORT

### (Area Drainage Summary)

From Area Runoff Coefficient Summary				OVERLAND				STREET / CHANNEL FLOW				Time of Travel (T <sub>t</sub> )		INTENSITY #		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C <sub>5</sub>	C <sub>100</sub>	C <sub>5</sub>	Length (ft)	Height (ft)	T <sub>C</sub> (min)	Length (ft)	Slope (%)	Velocity (fps)	T <sub>t</sub> (min)	TOTAL (min)	CHECK (min)	I <sub>5</sub> (in/hr)	I <sub>100</sub> (in/hr)	Q <sub>5</sub> (c.f.s.)	Q <sub>100</sub> (c.f.s.)
<i>Proposed Area Drainage Summary</i>																	
<i>OS-A**</i>	1.29	0.62	0.72	0.62	40	0.8	4.4	1310	1.9%	2.8	7.9	12.3	17.5	3.8	6.4	3.1	6.0
<i>E2*</i>	3.86	0.80	0.90	0.80	50	1	3.0	400	1.3%	2.3	2.9	6.0	12.5	4.9	8.2	15.1	28.6
<i>EX-A2***</i>	0.59	0.90	0.96	0.90	10	0.2	0.9	916	1.9%	2.7	5.6	6.5	15.1	4.8	8.0	2.5	4.5
<i>OS-1</i>	1.40	0.90	0.96	0.90	100	3	2.5	490	2.2%	3.0	2.7	5.2	13.3	5.1	8.6	6.4	11.5
<i>OS-2</i>	4.98	0.49	0.66	0.49	85	8	4.8	1165	1.8%	2.0	9.6	14.5	16.9	3.6	6.0	8.7	19.6
<i>A</i>	1.68	0.90	0.96	0.90	30	0.6	1.6	1325	0.7%	1.7	7.3	8.9	17.5	4.3	7.2	6.5	11.6
<i>B</i>	1.49	0.90	0.96	0.90	25	0.5	1.4	1335	0.7%	1.7	7.3	8.8	17.6	4.3	7.3	5.8	10.4
<i>C</i>	4.61	0.79	0.86	0.79	50	1	3.2	260	1.5%	2.4	1.4	5.0	11.7	5.2	8.7	18.7	34.5
<i>D</i>	2.22	0.81	0.88	0.81	50	1	2.9	200	1.5%	2.4	1.1	5.0	11.4	5.2	8.7	9.3	17.0
<i>E</i>	2.71	0.83	0.89	0.83	60	1.2	3.0	700	1.0%	2.0	3.8	6.9	14.2	4.7	7.9	10.5	19.1
<i>F</i>	2.57	0.81	0.88	0.81	50	0.8	3.2	300	1.3%	2.3	1.6	5.0	11.9	5.2	8.7	10.8	19.6
<i>G</i>	0.94	0.90	0.96	0.90	50	1	2.0	500	1.0%	2.0	2.7	5.0	13.1	5.2	8.7	4.4	7.8
<i>H</i>	11.07	0.54	0.66	0.54	50	1	5.7	500	1.5%	2.4	2.7	8.4	13.1	4.4	7.4	26.2	53.8
<i>I</i>	1.60	0.54	0.66	0.54	50	1	5.7	500	1.5%	2.4	2.7	8.4	13.1	4.4	7.4	3.8	7.8
<i>J</i>	3.21	0.16	0.41	0.16	50	2	7.6	0	0.0%	0.0	0.0	7.6	10.3	4.5	7.6	2.3	10.0

# Intensity equations assume a minimum travel time of 5 minutes.

Calculated by: DLM

Date: 2/21/2021

Checked by: VAS

\*VALUES DERIVED USING DATA FROM FDR FOR CLAREMONT BUSINESS PARK FILING NO. 2

\*\*VALUES DERIVED USING DATA FROM FDR MEADOWBROOK CROSSING FILING 1 AND FILING 2 PAGE 31

\*\*\*VALUES DERIVED USING DATA FROM FDR LOT 1 24/94 BUSINESS PARK FILING NO. 1 ON PLATTE AVENUE AND MEADOWBROOK PARKWAY

[illegible]

Calculated by: DLM  
Date: 2/24/2021  
Checked by: VAS

**CROSSROADS MIXED USE**  
**PRELIMINARY DRAINAGE CALCULATIONS**  
**(Storm Sewer Routing Summary)**

PIPE RUN	Contributing Pipes/Design Points	Equivalent CA <sub>5</sub>	Equivalent CA <sub>100</sub>	Maximum T <sub>c</sub>	Intensity*		Flow		PIPE SIZE
					I <sub>5</sub>	I <sub>100</sub>	Q <sub>5</sub>	Q <sub>100</sub>	
1	INLET 3	1.78	1.55	12.8	3.8	6.3	6.7	9.8	18" SD
2	INLET 4	1.51	2.64	8.9	4.3	7.2	6.5	19.1	24" SD
3	PR2, INLET 5	3.79	5.28	8.9	4.3	7.2	16.4	38.2	36" SD
4	DP6	3.62	3.98	5.0	5.2	8.7	18.7	34.5	36" SD
5	PR4	3.62	3.98	5.0	5.2	8.7	18.7	34.5	36" SD
6	PR5	3.62	3.98	5.0	5.2	8.7	18.7	34.5	36" SD
7	DP7	1.80	1.96	5.0	5.2	8.7	9.3	17.0	24" SD
8	PR7, INLET 6	2.82	2.83	6.9	4.7	7.9	13.2	22.3	24" SD
9	PR8, INLET 7	3.85	3.71	6.9	4.7	7.9	18.0	29.2	30" SD
10	PR6, PR9	7.47	7.68	6.9	4.7	7.9	35.0	60.5	36" SD
11	PR10	7.47	7.68	6.9	4.7	7.9	35.0	60.5	36" SD
12	INLET 8	0.42	1.12	6.9	4.7	7.9	2.0	8.8	18" SD
13	INLET 9	0.61	1.12	6.9	4.7	7.9	2.9	8.8	18" SD
14	PR11, PR12, PR13	8.51	9.93	6.9	4.7	7.9	39.9	78.1	42" SD
15	DP12	2.08	2.26	5.0	5.2	8.7	10.8	19.6	24" SD
16	PR14, PR15	10.59	12.19	6.9	4.7	7.9	49.7	96.0	42" SD
17	PR16	10.59	12.19	6.9	4.7	7.9	49.7	96.0	42" SD
18	PR3, DP13	9.77	12.58	8.9	4.3	7.2	42.1	91.1	42" SD
19	POND OUTFALL	PER	MHFD	WKSHT			1.2	8.2	18" SD

\* Intensity equations assume a minimum travel time of 5 minutes.

DP - Design Point

EX - Existing Design Point

FB- Flow By from Design Point

INT- Intercepted Flow from Design Point

Calculated by: DLM

Date: 2/24/2021

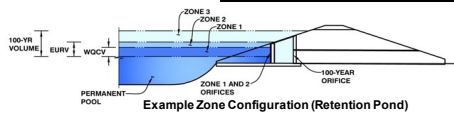
Checked by: VAS

<i>Weighted Percent Imperviousness of WQ Pond 1</i>				
<i>Contributing Basins</i>	<i>Area (Acres)</i>	<i>C<sub>s</sub></i>	<i>Impervious % (I)</i>	<i>(Acres)*(I)</i>
<i>A</i>	1.68	0.90	100	167.51
<i>B</i>	1.49	0.90	100	149.27
<i>C</i>	4.61	0.79	93	428.35
<i>D</i>	2.22	0.81	95	211.05
<i>E</i>	2.71	0.83	96	260.35
<i>F</i>	2.57	0.81	95	244.34
<i>G</i>	0.94	0.90	100	93.98
<i>H</i>	11.07	0.54	75	830.03
<i>I</i>	1.60	0.54	75	119.84
<i>J</i>	3.21	0.16	7	22.49
<i>Totals</i>	<i>32.10</i>			<i>2527.20</i>
<i>Imperviousness of WQ Pond 1</i>	<i>78.7</i>	<i>%</i>		

## **HYDRAULIC CALCULATIONS**

*MHFD-Detention, Version 4.03 (May 2020)*

**Basin ID:**



### Example Zone Configuration (Retention Pond)

## 6287.6

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

### Optional User Overrides

	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

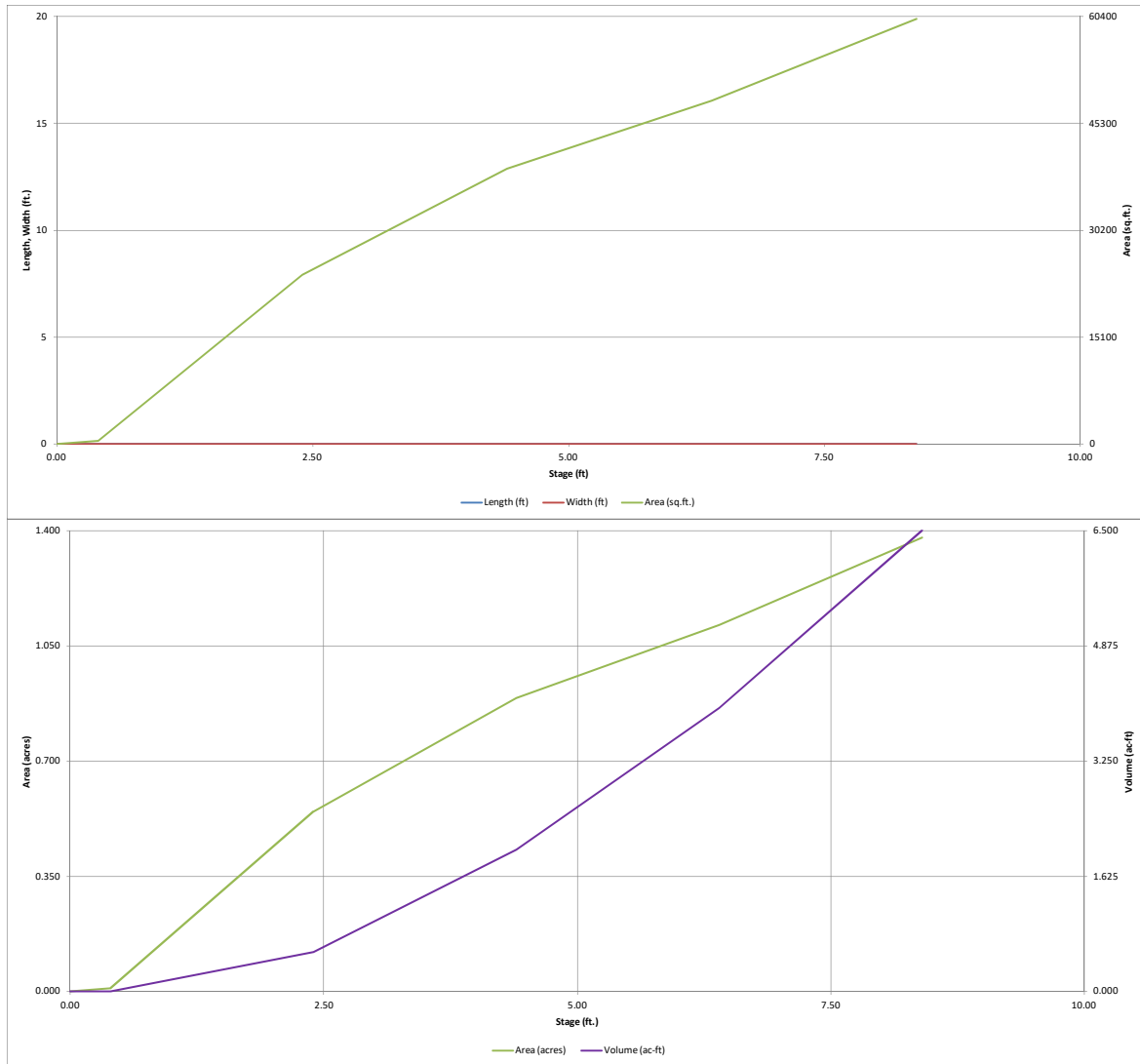
Zone 1 Volume (WQCV) =	0.857	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.449	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.424	acre-feet
Total Detention Basin Volume =	4.729	acre-feet
Initial Surge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surge Depth (ISD) =	user	ft
Total Available Detention Depth (H <sub>total</sub> ) =	user	ft
Depth of Trickle Channel (H <sub>TC</sub> ) =	user	ft
Slope of Trickle Channel (S <sub>TC</sub> ) =	user	ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	user	H:V
Basin Length-to-Width Ratio (R <sub>LW</sub> ) =	user	

Initial Surcharge Area ( $A_{SV}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{SV}$ )	=	user	ft
Surcharge Volume Width ( $W_{SV}$ )	=	user	ft
Depth of Basin Floor ( $H_{LFLOOR}$ )	=	user	ft
Length of Basin Floor ( $L_{LFLOOR}$ )	=	user	ft
Width of Basin Floor ( $W_{LFLOOR}$ )	=	user	ft
Area of Basin Floor ( $A_{LFLOOR}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{LFLOOR}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	user	ft
Length of Main Basin ( $L_{MAIN}$ )	=	user	ft
Width of Main Basin ( $W_{MAIN}$ )	=	user	ft
Area of Main Basin ( $A_{MAIN}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	user	acre-feet

[illegible]

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

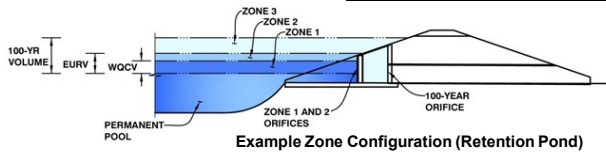


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project:

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.91	0.857	Orifice Plate
Zone 2 (EURV)	5.76	2.449	Orifice Plate
Zone 3 (100-year)	7.03	1.424	Weir&Pipe (Restrict)
Total (all zones)		4.729	

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

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

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

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

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

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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	1.92	3.84					
Orifice Area (sq. inches)	4.66	4.66	12.20					

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

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =  ft<sup>2</sup>  
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

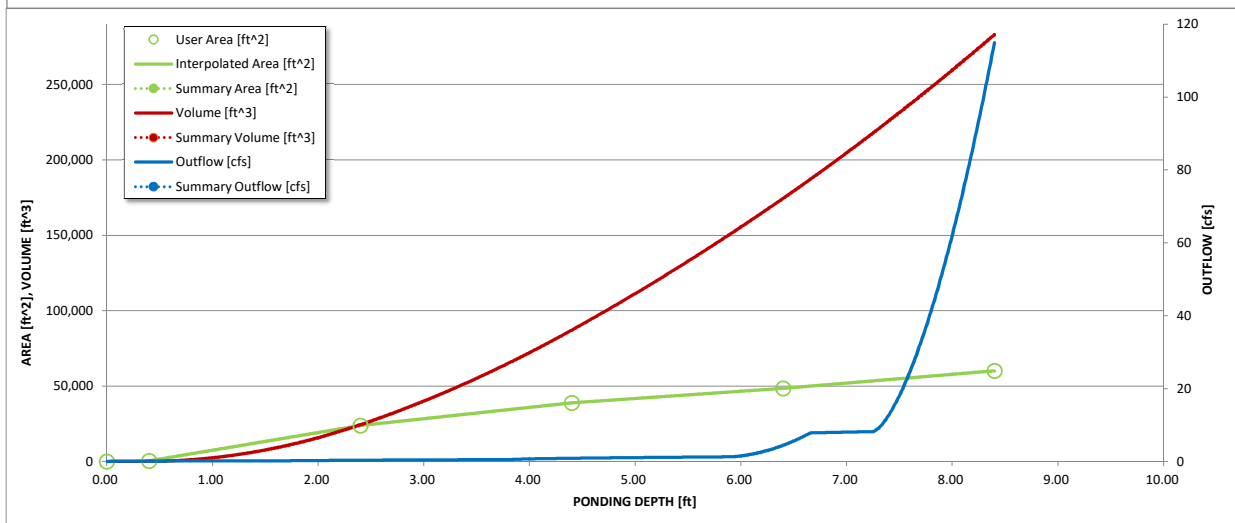
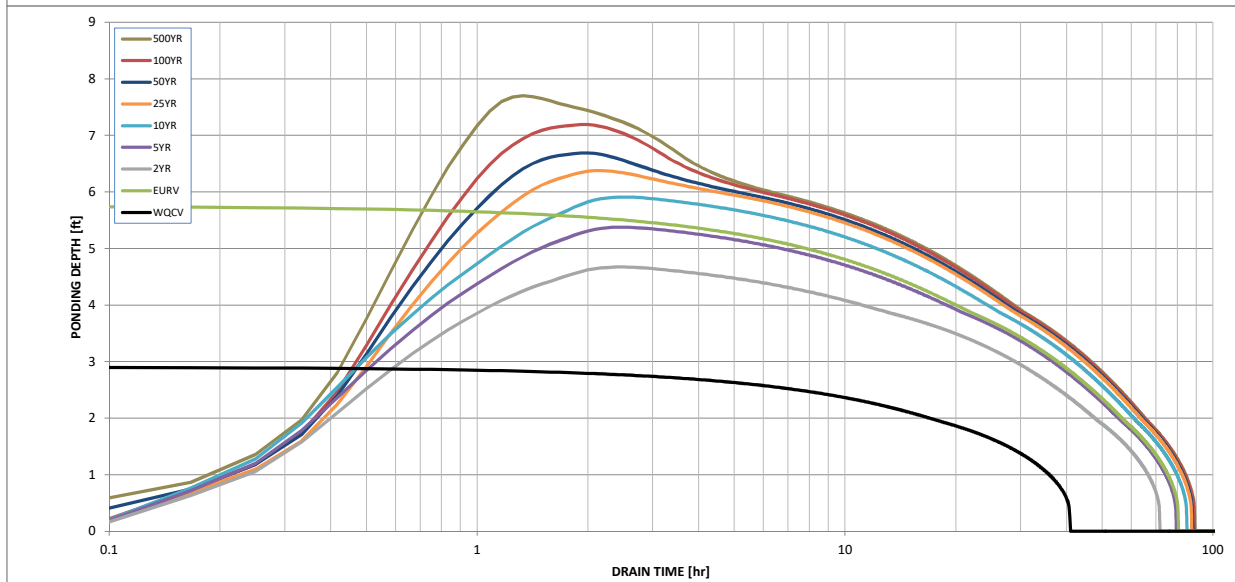
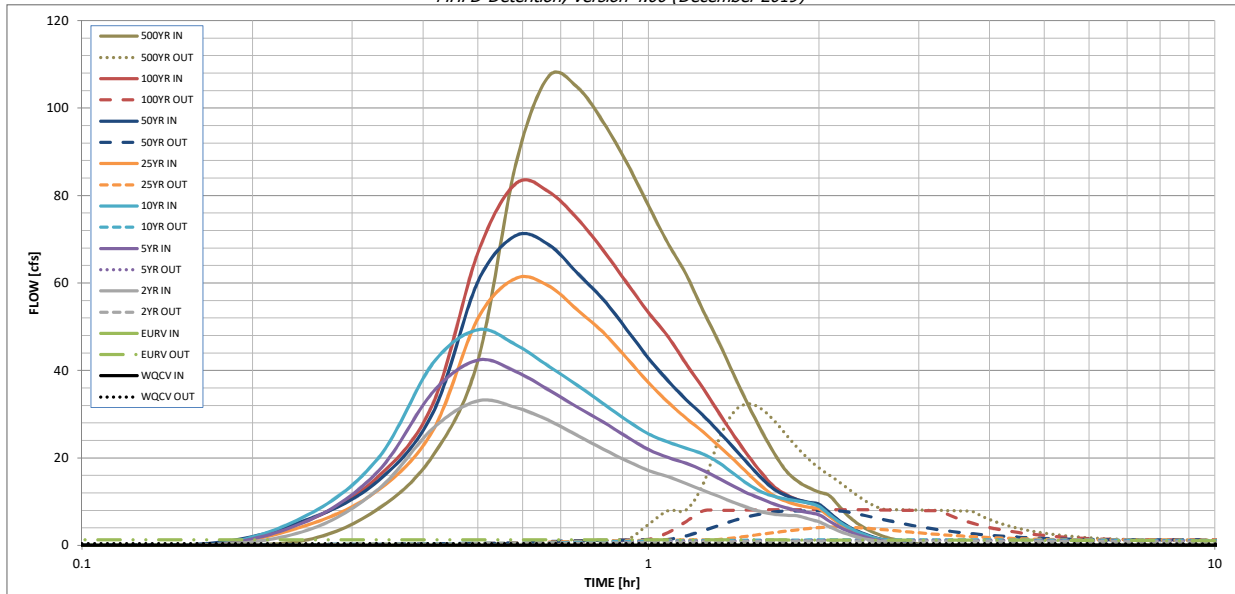
## Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.857	3.306	2.394	3.107	3.679	4.353	5.011	5.779	7.477
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.394	3.107	3.679	4.353	5.011	5.779	7.477
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.3	0.4	4.0	8.1	13.5	24.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.13	0.25	0.42	0.77
Peak Inflow Q (cfs) =	N/A	N/A	33.0	42.4	49.3	61.1	70.9	82.7	107.3
Peak Outflow Q (cfs) =	0.4	1.2	1.0	1.2	1.3	4.2	7.9	8.2	32.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.7	2.9	1.0	1.0	0.6	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.3	0.7	0.8	0.8
Max Velocity through Gate 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	72	66	72	76	77	77	76	73
Time to Drain 99% of Inflow Volume (hours) =	40	77	69	77	81	84	84	84	83
Maximum Ponding Depth (ft) =	2.91	5.76	4.67	5.38	5.91	6.38	6.69	7.19	7.70
Area at Maximum Ponding Depth (acres) =	0.64	1.04	0.92	1.00	1.06	1.11	1.15	1.22	1.29
Maximum Volume Stored (acre-ft) =	0.861	3.315	2.244	2.917	3.462	3.971	4.322	4.914	5.552

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-DETENTION, Version 4.00 (December 2019)



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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

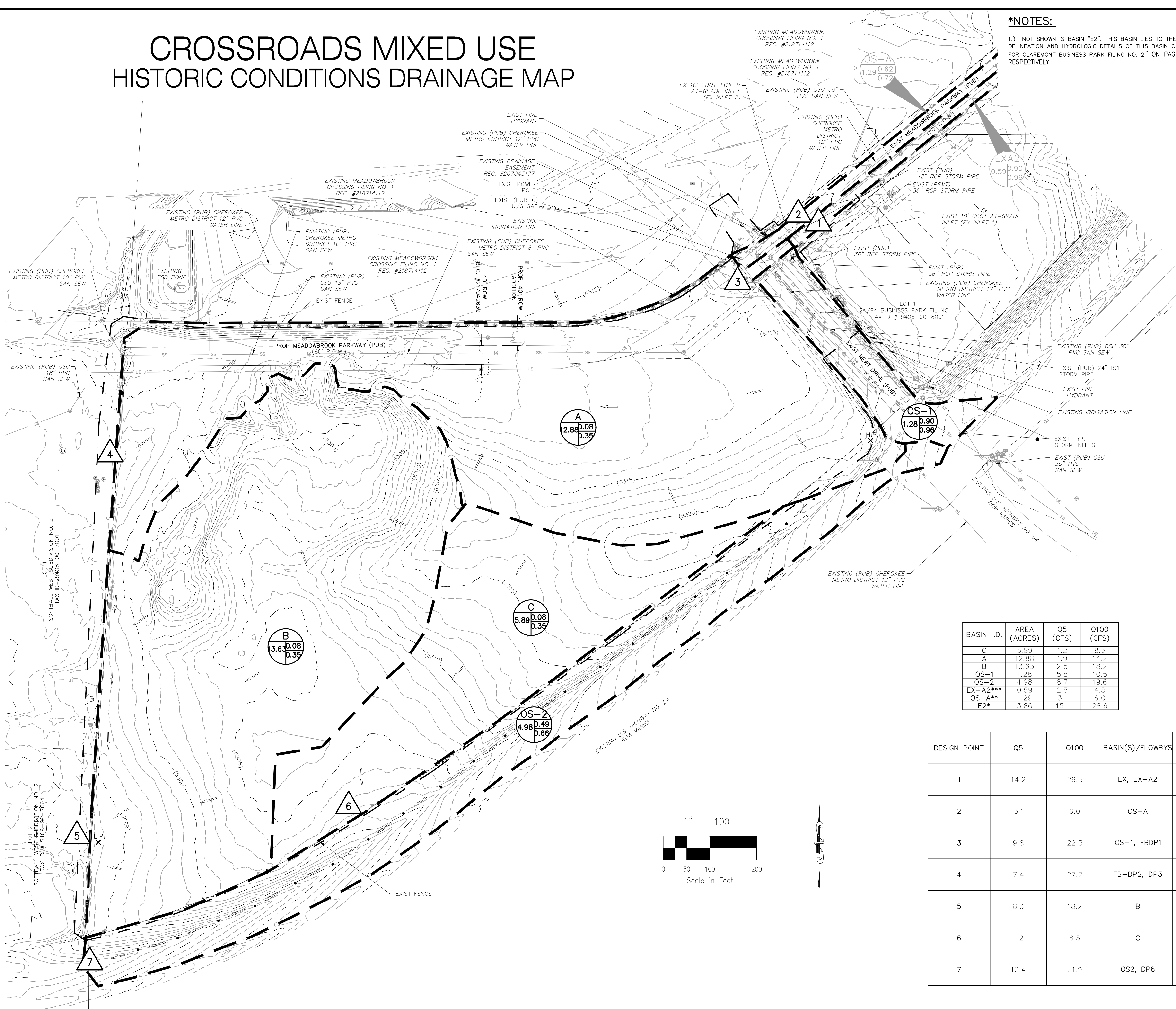
## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.04	1.24
	0:15:00	0.00	0.00	3.44	5.59	6.92	4.65	5.86	5.67	8.32
	0:20:00	0.00	0.00	12.78	16.91	19.91	12.60	14.73	15.68	20.52
	0:25:00	0.00	0.00	26.73	35.08	41.65	26.31	30.33	32.40	42.15
	0:30:00	0.00	0.00	33.01	42.36	49.32	51.87	60.30	66.84	87.16
	0:35:00	0.00	0.00	31.50	39.75	45.90	61.06	70.86	82.69	107.26
	0:40:00	0.00	0.00	28.56	35.55	40.98	59.34	68.80	80.85	104.71
	0:45:00	0.00	0.00	25.08	31.57	36.59	53.77	62.23	74.62	96.69
	0:50:00	0.00	0.00	21.95	28.17	32.36	48.63	56.17	67.37	87.45
	0:55:00	0.00	0.00	19.27	24.80	28.59	42.77	49.30	59.91	77.73
	1:00:00	0.00	0.00	17.09	21.92	25.50	37.24	42.84	53.26	69.04
	1:05:00	0.00	0.00	15.69	20.09	23.63	32.75	37.62	47.72	61.90
	1:10:00	0.00	0.00	14.09	18.74	22.22	29.04	33.31	41.43	53.62
	1:15:00	0.00	0.00	12.53	17.12	20.86	25.93	29.66	35.88	46.28
	1:20:00	0.00	0.00	11.15	15.26	18.89	22.66	25.87	30.24	38.88
	1:25:00	0.00	0.00	9.80	13.45	16.32	19.52	22.23	25.05	32.12
	1:30:00	0.00	0.00	8.57	11.86	14.01	16.40	18.64	20.55	26.27
	1:35:00	0.00	0.00	7.62	10.63	12.22	13.58	15.38	16.61	21.13
	1:40:00	0.00	0.00	7.10	9.45	11.20	11.35	12.81	13.45	17.04
	1:45:00	0.00	0.00	6.86	8.58	10.58	10.07	11.35	11.63	14.70
	1:50:00	0.00	0.00	6.71	7.96	10.14	9.25	10.42	10.49	13.20
	1:55:00	0.00	0.00	6.04	7.49	9.66	8.72	9.82	9.70	12.18
	2:00:00	0.00	0.00	5.37	6.98	8.92	8.33	9.38	9.14	11.44
	2:05:00	0.00	0.00	4.28	5.60	7.14	6.72	7.56	7.26	9.07
	2:10:00	0.00	0.00	3.28	4.28	5.46	5.11	5.75	5.44	6.78
	2:15:00	0.00	0.00	2.52	3.28	4.17	3.89	4.37	4.10	5.10
	2:20:00	0.00	0.00	1.92	2.49	3.15	2.95	3.31	3.11	3.87
	2:25:00	0.00	0.00	1.45	1.87	2.35	2.22	2.49	2.34	2.91
	2:30:00	0.00	0.00	1.08	1.37	1.74	1.64	1.84	1.75	2.17
	2:35:00	0.00	0.00	0.79	0.99	1.28	1.20	1.34	1.29	1.60
	2:40:00	0.00	0.00	0.57	0.72	0.95	0.90	1.01	0.96	1.20
	2:45:00	0.00	0.00	0.39	0.50	0.67	0.64	0.72	0.69	0.85
	2:50:00	0.00	0.00	0.24	0.33	0.43	0.43	0.48	0.46	0.57
	2:55:00	0.00	0.00	0.13	0.20	0.25	0.26	0.29	0.28	0.34
	3:00:00	0.00	0.00	0.06	0.10	0.12	0.13	0.14	0.14	0.17
	3:05:00	0.00	0.00	0.02	0.03	0.04	0.04	0.05	0.05	0.06
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

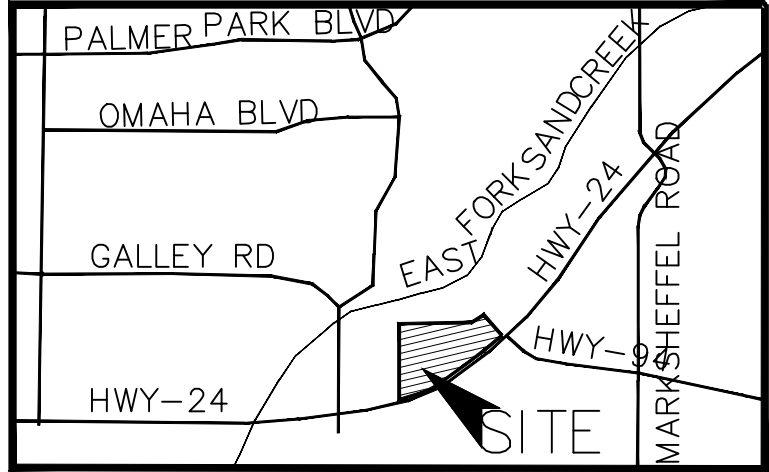
## **DRAINAGE MAPS**

# CROSSROADS MIXED USE HISTORIC CONDITIONS DRAINAGE MAP



## \*NOTES:

1.) NOT SHOWN IS BASIN "E2". THIS BASIN LIES TO THE EAST OF BASIN "EX-A2". DELINEATION AND HYDROLOGIC DETAILS OF THIS BASIN CAN BE FOUND IN THE "FDR FOR CLAREMONT BUSINESS PARK FILING NO. 2" ON PAGES 39 AND 41, RESPECTIVELY.



VICINITY MAP  
N.T.S.

## LEGEND

- BASIN DESIGNATION
- ACRES
- 1
- 25
- 1.25
- 0.35
- C5
- C100
- 1
- SURFACE DESIGN POINT
- BASIN BOUNDARY
- EXIST MAJ CONT
- EXIST MIN CONT
- EXISTING FLOW DIRECTION ARROW
- H.P.
- X
- L.P.
- X
- PROPOSED SWALE
- EXISTING SWALE
- CONSTRUCTION/DISTURBANCE LIMITS
- SITE BOUNDARY
- R.O.W./EASEMENT
- LOT LINE
- ST
- EX. STORM SEWER LINE
- UE
- EX. UNDERGROUND ELECTRIC LINE
- SS
- EX. SANITARY SEWER LINE
- WL
- EX. WATER LINE
- ST
- EX. STORM SEWER LINE
- 9
- LOT NUMBER
- ICV
- EX. IRRIGATION VALVE
- ST
- EX. STORM INLET
- G
- EX. GAS TEST NODE
- T
- EX. TELEPHONE PEDESTAL
- EV
- EX. ELECTRIC VAULT
- SS
- EX. SANITARY MANHOLE
- W
- EX. WATER VALVE

BASIN I.D.	AREA (ACRES)	Q5 (CFS)	Q100 (CFS)
C	5.89	1.2	8.5
A	12.88	1.9	14.2
B	13.63	2.5	18.2
OS-1	1.28	5.8	10.5
OS-2	4.98	8.7	19.6
EX-A2**	0.59	2.5	4.5
OS-A**	1.29	3.1	6.0
E2*	3.86	15.1	28.6

DESIGN POINT	Q5	Q100	BASIN(S)/FLOWBYS	OUTFALL
1	14.2	26.5	EX, EX-A2	EXIST 10' CDOT TYPE R AT GRADE INLET
2	3.1	6.0	OS-A	EXIST 10' CDOT TYPE R AT GRADE INLET
3	9.8	22.5	OS-1, FBPD1	END OF PAVEMENT
4	7.4	27.7	FB-DP2, DP3	DISCHARGE TO ADJACENT PARCEL (LOT 1)
5	8.3	18.2	B	DISCHARGE TO ADJACENT PARCEL (LOT2)
6	1.2	8.5	C	DISCHARGE TO CDOT ROW
7	10.4	31.9	OS2, DP6	CDOT BARROW DITCH

HISTORIC DRAINAGE MAP  
CROSSROADS MIXED USE  
JOB NO. 18-003  
DATE PREPARED: FEBRUARY 23, 2021  
DATE REVISED:

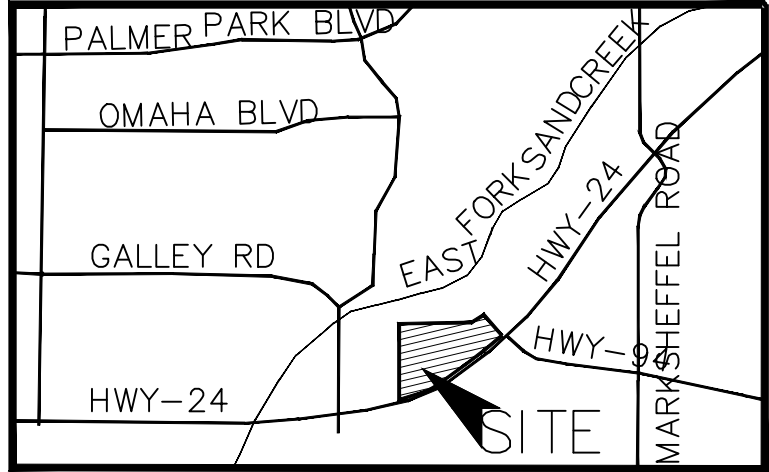


212 N. WAHSATCH AVE., STE 305  
COLORADO SPRINGS, CO 80903  
PHONE: 719.955.5485

# CROSSROADS MIXED USE EXISTING CONDITIONS DRAINAGE MAP

## \*NOTES:

1.) NOT SHOWN IS BASIN "E2". THIS BASIN LIES TO THE EAST OF BASIN "EX-A2". DELINEATION AND HYDROLOGIC DETAILS OF THIS BASIN CAN BE FOUND IN THE "FDR FOR CLAREMONT BUSINESS PARK FILING NO. 2" ON PAGES 39 AND 41, RESPECTIVELY.



## VICINITY MAP N.T.S.

## LEGEND

- BASIN DESIGNATION
- ACRES
- 1
- SURFACE DESIGN POINT
- BASIN BOUNDARY
- EXIST MAJ CONT
- EXIST MIN CONT
- EXISTING FLOW DIRECTION ARROW
- H.P.
- X
- L.P.
- X
- PROPOSED SWALE
- EXISTING SWALE
- CONSTRUCTION/DISTURBANCE LIMITS
- SITE BOUNDARY
- R.O.W./EASEMENT
- LOT LINE
- ST
- EX. STORM SEWER LINE
- UE
- EX. UNDERGROUND ELECTRIC LINE
- SS
- EX. SANITARY SEWER LINE
- WL
- EX. WATER LINE
- ST
- EX. STORM SEWER LINE
- 9
- LOT NUMBER
- ICV
- EX. IRRIGATION VALVE
- ST
- EX. STORM INLET
- Q
- EX. GAS TEST NODE
- T
- EX. TELEPHONE PEDESTAL
- EV
- EX. ELECTRIC VAULT
- SS
- EX. SANITARY MANHOLE
- W
- EX. WATER VALVE

BASIN I.D.	AREA (ACRES)	Q5 (CFS)	Q100 (CFS)
C	3.99	0.9	6.3
A	11.02	1.5	11.1
B	17.31	2.0	14.5
OS-1	1.28	5.8	10.5
OS-2	4.98	8.7	19.6
EX-A2**	0.59	2.5	4.5
OS-A**	1.29	3.1	6.0
E2*	3.86	15.1	28.6

DESIGN POINT	Q5	Q100	BASIN(S)/FLOWBYS	OUTFALL
1	14.2	26.5	E2, EX-A2	EXIST 10' CDOT TYPE R AT GRADE INLET
2	3.1	6.0	OS-A	EXIST 10' CDOT TYPE R AT GRADE INLET
3	9.8	22.5	OS-1, FB-DP1	END OF PAVEMENT
4	7.1	25.5	A, FB-DP2, DP3	DISCHARGE TO ADJACENT PARCEL (LOT 1)
5	5.0	14.5	B	DISCHARGE TO ADJACENT PARCEL (LOT 2)
6	0.9	6.3	C	DISCHARGE TO CDOT ROW
7	9.9	28.0	OS2, DP6	CDOT BARROW DITCH

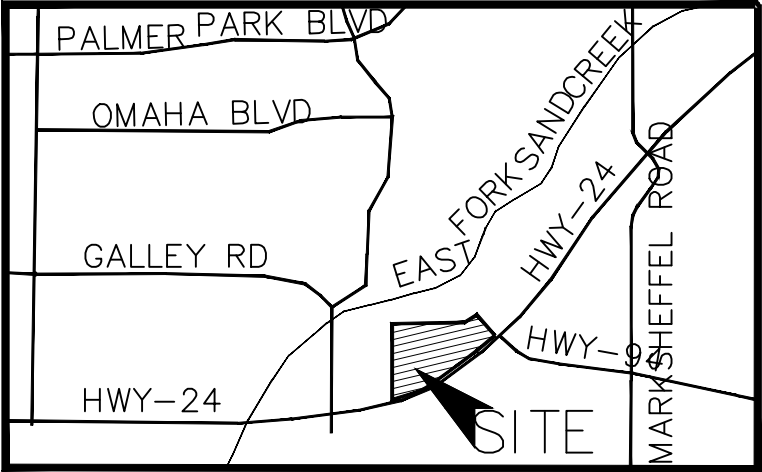
EXISTING DRAINAGE MAP  
CROSSROADS MIXED USE  
JOB NO. 18-003  
DATE PREPARED: FEBRUARY 23, 2021  
DATE REVISED:



212 N. WAHSATCH AVE., STE 305  
COLORADO SPRINGS, CO 80903  
PHONE: 719.955.5485

# CROSSROADS MIXED USE PROPOSED CONDITIONS DRAINAGE MAP

EXISTING MEADOWBROOK  
CROSSING FILING NO. 1  
REC. #218714112



VICINITY MAP  
N.T.S.

## LEGEND

- BASIN DESIGNATION
- ACRES
- 1
- SURFACE DESIGN POINT
- BASIN BOUNDARY
- PROF MAJ CONT
- PROF MIN CONT
- EXIST MAJ CONT
- EXIST MIN CONT
- PROPOSED STORM SEWER PIPE
- H.P.
- L.P.
- PROPOSED SWALE
- EXISTING SWALE
- SITE BOUNDARY
- R.O.W./EASEMENT
- LOT LINE
- ST
- EX. UNDERGROUND ELECTRIC LINE
- SS
- EX. SANITARY SEWER LINE
- WL
- EX. WATER LINE
- ST
- EX. STORM SEWER LINE
- 9
- EX. IRRIGATION VALVE
- ST
- EX. STORM INLET
- GS
- EX. GAS TEST NODE
- TEL
- EX. TELEPHONE PEDESTAL
- EV
- EX. ELECTRIC VAULT
- SM
- EX. SANITARY MANHOLE
- WV
- EX. WATER VALVE
- PROPOSED RIPRAP
- EMERGENCY OVERFLOW DIRECTION

1" = 100'

0 50 100 200

Scale in Feet

BASIN SUMMARY				
BASIN	AREA (ACRES)	Q <sub>s</sub>	Q <sub>100</sub>	
OS-A	1.29	3.0	5.9	
E2*	3.86	11.8	23.2	
EXA2	0.59	2.8	5.1	
OS-1	1.40	6.4	11.5	
A	1.68	6.5	11.7	
B	1.49	5.9	10.5	
C	4.61	18.7	34.5	
D	2.22	9.3	17.0	
E	2.71	10.5	19.1	
F	2.57	10.8	19.6	
G	0.94	4.4	7.8	
H	11.07	26.2	53.8	
I	1.60	3.8	7.8	
J	3.21	2.3	10.0	
OS-2	4.98	8.7	19.6	

DESIGN POINT SUMMARY				
DESIGN POINT	Q <sub>s</sub>	Q <sub>100</sub>	BASIN	STRUCTURE
1	14.2	26.5	E2, EX-A2	EX 10' AT-GRADE INLET
2	3.1	6.0	OS-A	EX 10' AT-GRADE INLET
3	10.2	23.3	OS-1, FB-DP1	PROP. 10' AT-GRADE INLET
4	6.5	19.1	A, FB-DP2	PROP. 15' SUMP INLET
5	9.9	19.1	B, FB-DP3	PROP. 15' SUMP INLET
6	18.7	34.5	C	PROP. 36" SD
7	9.3	17.0	D	PROP. 24" SD
8	5.2	9.5	1/2 E	PROP. 10' AT-GRADE INLET
9	5.2	9.5	1/2 E	PROP. 10' AT-GRADE INLET
10	2.0	8.8	1/2 G	PROP. 10' SUMP INLET
11	2.9	8.8	1/2 G FB-DP8/9	PROP. 10' SUMP INLET
12	10.8	19.6	F	PROP. 24" SD
13	26.2	53.8	H	PROP. 42" SD
14	3.8	7.8	I	PROP. GRASSLINED SWALE
15	95.3	199.8	J, DP14, PR17, PR18	FULL SPECTRUM DET POND
16	9.9	27.7	POND OUTFALL, OS2	EXISTING ROADSIDE DITCH

STORM SEWER SUMMARY				
PIPE RUN	Q <sub>s</sub>	Q <sub>100</sub>	PIPE SIZE	CONTRIBUTING PIPES/DESIGN POINTS
1	6.7	9.8	18" SD	INLET 1
2	6.5	19.1	24" SD	INLET 2
3	16.8	38.2	30" SD	PR2, INLET 3
4	18.7	34.5	30" SD	DP6
5	18.7	34.5	30" SD	PR4
6	18.7	34.5	30" SD	PR5
7	9.3	17.0	24" SD	DP7
8	13.2	22.3	24" SD	PR7, INLET 4
9	18.0	29.2	30" SD	PR8, INLET 5
10	35.0	60.5	36" SD	PR6, PR9
11	35.0	60.5	36" SD	PR10
12	2.0	8.8	18" SD	INLET 6
13	2.9	8.8	18" SD	INLET 7
14	39.9	78.1	36" SD	PR11, PR12, PR13
15	10.8	19.6	24" SD	DP12
16	49.7	96.0	42" SD	PR14, PR15
17	49.7	96.0	42" SD	PR16
18	42.1	91.1	42" SD	PR3, DP13
19	1.2	8.2	18" SD	POND OUTFALL

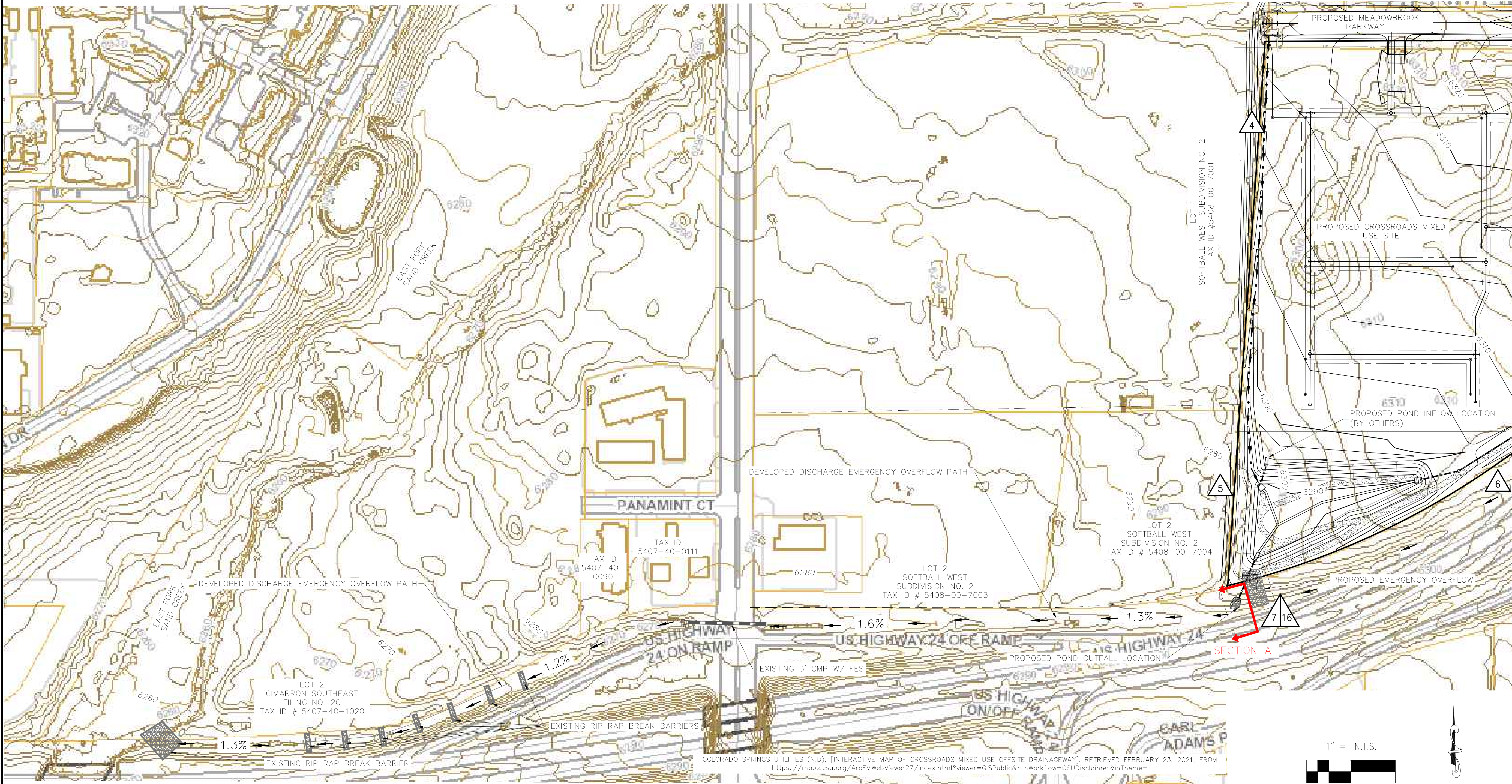
\*REFER TO FDR FOR CLAREMONT BUSINESS PARK FILING NO. 2 FOR CONTRIBUTING BASIN GEOMETRY



102 E PIKES PEAK AVE, SUITE 500  
COLORADO SPRINGS, CO 80903  
PHONE: 719.955.5485

# CROSSROADS MIXED USE

DRAINAGEWAY EXHIBIT  
FEBRUARY 2021



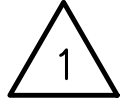
COLORADO SPRINGS UTILITIES (N.D.). [INTERACTIVE MAP OF CROSSROADS MIXED USE OFFSITE DRAINAGEWAY]. RETRIEVED FEBRUARY 23, 2021, FROM <https://maps.csu.org/ArcFWWebViewer27/index.html?viewer=GISPublic&runWorkflow=CSUDisclaimer&inTheme=>

1" = N.T.S.  
0 N.T.S.  
Scale in Feet

PCD FILING NO: SP-20-011



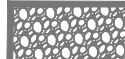
212 N. WAHSATCH AVE., STE 305  
COLORADO SPRINGS, CO 80903  
PHONE: 719.955.5485



SURFACE DESIGN POINT



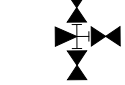
SITE BOUNDARY



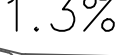
EXISTING RIP RAP BARRIERS

6280

6290



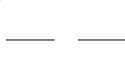
PROPOSED WATER FITTING



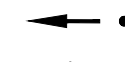
1.3%



EXISTING DITCH SLOPE



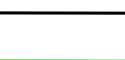
EXISTING STORM SEWER AND FES



PROPOSED STORM SEWER



R.O.W./EASEMENT



PROPOSED SWALE



PROPOSED SANITARY SEWER MANHOLE



PROPOSED SEWER LINE



PROPOSED WATER LINE



PROPOSED EMERGENCY OVERFLOW DIRECTION

## HISTORIC DESIGN POINT SUMMARY

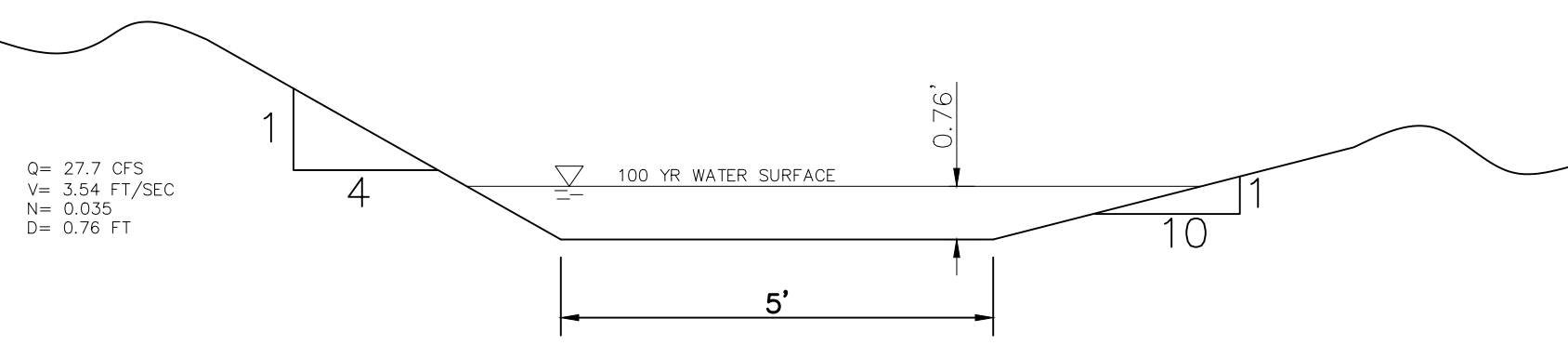
DESIGN POINT	Q5 (CFS)	Q100 (CFS)
4	7.4	27.7
5	8.3	18.2
6	1.2	8.5
7	10.4	31.9

## PROPOSED DESIGN POINT SUMMARY

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
4	0.0	0.0
5	0.0	0.0
6	0.0	0.0
16	9.9	27.7

## NOTES:

1.) REFER TO DRAINAGE MAPS IN PRELIMINARY DRAINAGE REPORT FOR CROSSROADS MIXED USE FOR DETAILED ON SITE FLOWS AS WELL AS HYDROLOGIC AND HYDRAULIC ANALYSES CORRESPONDING TO CHANGES FROM HISTORIC AND EXISTING CONDITIONS



SECTION A

## Appendix E – Geotechnical Engineering and Geologic Report

**GEOTECHNICAL INVESTIGATION  
CROSSROADS APARTMENTS  
MEADOWBROOK PARKWAY AND US HIGHWAY 24  
COLORADO SPRINGS, COLORADO**

Prepared for:

TRINSIC RESIDENTIAL GROUP  
1801 Wewatta Street, Floor 11  
Denver, Colorado 80202

Attention: Allison Jones

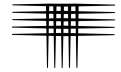
CTL|T Project No. CS19308-125

May 18, 2021



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## SCOPE

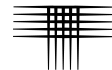
This report presents the results of our Geotechnical Investigation for the Crossroads Apartments to be located west of the intersection of Highway 24 and Highway 94 in Colorado Springs, Colorado. The investigated parcel is planned for development of multi-family, apartment buildings. The purpose of our investigation was to evaluate the subsurface conditions at the site and provide geotechnical recommendations and criteria for design and construction of foundations, floor systems, and pavement section alternatives, as well as surface drainage precautions. The scope of our services is described in our proposal (CS-20-0127) dated February 10, 2010.

The report was prepared based on conditions interpreted from field reconnaissance of the site, review of previous information, conditions found in our exploratory borings, results of laboratory tests, engineering analysis, and our experience. Observations made during grading or construction may indicate conditions that require revision or re-evaluation of some of the criteria presented in this report. The criteria presented are for the development as described. Revision in the scope of the project could influence our recommendations. If changes occur, we should review the development plans and the effect of the changes on our preliminary design criteria. Evaluation of the property for the possible presence of potentially hazardous materials (Environmental Site Assessment) was beyond the scope of this investigation.

The following section summarizes the report. A more complete description of the conditions found at the site, our interpretations, and our recommendations are included in the report.

## SUMMARY

1. The near-surface soils encountered in the twenty-two (22) borings drilled during this investigation consisted of 20 to 30 feet of sand and silty sand soils.
2. At the time of drilling, groundwater was not encountered. Groundwater levels will vary with seasonal precipitation and landscaping irrigation.

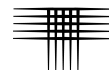


3. We understand both post-tensioned slabs-on-grade (PTS) and spread footing foundations are being considered. Foundation design and construction criteria are presented in the report.
4. If spread footings are used for the apartment buildings, the potential for differential movement between the spread footings and slabs-on-grade would need to be accommodated during design. Post-tensioned slab foundations are structurally integrated and should exhibit more reliable, long-term performance than conventional slabs-on-grade and isolated shallow foundations.
5. Full-depth asphalt concrete and composite asphalt and aggregate base course pavement section alternatives are presented in the report for the planned parking lots and access driveways.
6. Surface drainage should be designed, constructed, and maintained to provide rapid removal of runoff away from the proposed buildings. Conservative irrigation practices should be followed to avoid excessive wetting.
7. The design and construction criteria for foundations and slabs-on-grade included in this report were compiled with the expectation that all recommendations will be incorporated into the project and that the property manager will maintain the structures, use prudent irrigation practices, and maintain surface drainage. It is critical that all recommendations in this report are followed.

## **SITE CONDITIONS**

The investigated parcel of land is situated west of the intersection of Highway 24 and Highway 94 in Colorado Springs, Colorado. The overall ground surface gently slopes downward to the south. Vegetation on the site consists of a slight to moderate stand of mostly grasses and weeds and scattered trees. The parcel is crisscrossed by several narrow, dirt paths. The surficial soils on the site were very loose in areas, generally on the southern side of the lot, and may cause issues with vehicles traversing the site. We had difficulties accessing these areas with the drill rig.

To the south of the site is Highway 24, to the north is a residential development. An abandoned sports complex that once had baseball diamonds is to the west. The parcel directly to the east is vacant.



## **PROPOSED DEVELOPMENT**

We understand the proposed development will include an apartment complex consisting of eight apartment buildings, a clubhouse, and a pool. The apartments are anticipated to be two to three-story, wood-frame structures. Foundation loads are expected to be light to moderate. No habitable, below-grade construction is expected. The complex will include paved access roads and automobile parking stalls.

## **PREVIOUS INVESTIGATION**

We previously reviewed the Soils and Geology Study performed by RMG Engineers, CTL|T Project No. CS19308-115, report dated November 13, 2020. This report was reviewed as part of this investigation.

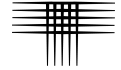
## **SUBSURFACE INVESTIGATION**

Subsurface conditions at the site were investigated by drilling twenty-two borings at the locations shown in Fig. 1. Graphical logs of the conditions found in our exploratory borings, the results of field penetration resistance tests, and some laboratory data are presented in Appendix A. Swell-consolidation and gradation test results are presented in Appendix B. Laboratory test data are summarized in Table B-1. Summary logs from our previous investigation are shown in Appendix D.

Soil samples obtained during this study were returned to our laboratory and visually classified. Laboratory testing was then assigned to representative samples. Testing included moisture content and dry density, gradation analysis, Atterberg limits, and water-soluble sulfate content tests.

## **SUBSURFACE CONDITIONS**

The soils encountered in the twenty-two borings drilled during this investigation consisted of 20 to 30-feet of sand and silty sand soils. Sandstone bedrock was encountered in one boring at a depth of 29-feet. Some of the pertinent engineering characteris-



tics of the soils and bedrock encountered and groundwater conditions are discussed in the following paragraphs.

### **Sand Soils**

The soils encountered consisted of clean to silty sand. The sand encountered in the borings extended to the maximum depth explored of 30-feet below the existing ground surface. The sand was loose to very dense based on the results of field penetration resistance tests. Samples of the sand tested in our laboratory contained 5 to 35 percent clay and silt-sized particles (passing the No. 200 sieve). Our experience indicates the clean to silty sands are non-expansive when wetted.

Sand fill was logged in one boring (TH-2) to a depth of 7-feet below the existing ground surface. The material was identified as fill based on the color variation of the sample, however the lab testing indicates that the material properties are consistent with the native sand soil.

### **Bedrock**

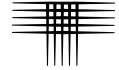
Sandstone bedrock was encountered in one boring (TH-10) at a depth of 29 feet. The sandstone was very hard based on the results of field penetration resistance tests. Our experience indicates the bedrock is non-expansive when wetted.

### **Groundwater**

At the time of drilling, groundwater was not encountered. Due to the nature of the onsite materials, we were not able to check water levels several days after the completion of drilling operations as the boring holes had collapsed. Groundwater levels will vary with seasonal precipitation and landscaping irrigation.

### **Seismicity**

This area, like most of central Colorado, is subject to a degree of seismic activity. Geologic evidence has been interpreted to indicate that movement along some Front



Range faults has occurred during the last two million years (Quaternary). This includes the Rampart Range Fault, which is located several miles west of the site. We believe the soils on the property classify as Site Class D (stiff soil profile) according to the 2015 International Building Code (2015 IBC).

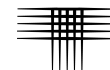
## **SITE DEVELOPMENT**

We do not expect significant issues due to geotechnical considerations to impact the development of the site. The most significant geotechnical constraint identified is the presence of collapse-prone soils. The following sections provide considerations and recommendations as they relate to site development

Grading plans prepared by Civil Consultants, Inc. dated February 16, 2021 were provided. The plans suggest cuts up to about 6-feet and fills up to about 8-feet will be necessary to achieve the desired building pad elevations. We believe site grading can be accomplished using conventional, heavy-duty earthmoving equipment. We recommend grading plans consider long-term cut and fill slopes no steeper than 3:1 (horizontal to vertical). This ratio considers that no seepage of groundwater occurs. If groundwater seepage does occur, a drain system and flatter slopes may be appropriate.

### **Collapse-Prone Soils**

Collapse-prone soils are present at this site. Collapse-prone soils may be susceptible to hydro-collapse, a phenomenon where soils undergo a decrease in volume upon an increase in moisture content, with or without an increase in external loads. The presence of collapse-prone soils implies risk that slabs-on-grade and foundations will settle and be damaged. The risks associated with collapse-prone soils can be mitigated by careful design, construction, and maintenance procedures. We believe the recommendations in this report will help to control risk of foundation and/or slab damage; they will not eliminate that risk. The owner should understand that slabs-on-grade and, in some instances, foundations may be affected by these soils. Maintenance will be required to control risk. We believe the collapse-prone soils at this site present a moder-



ate to low risk without mitigation, with the risk being lower on the northern side of the property and increasing to the south.

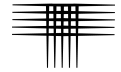
In general, the soils identified as collapse-prone are on the southern half of the site. The RMG report discussed in the Previous Investigation section, indicated that the northern half of this parcel has a circular, bulbous feature that they mapped as an area that has been “disturbed from past activity on the site and/or from historical overflow of sediment and water from EFSC from the north.” Our testing indicates the soils in this area more consolidated.

### **Sub-Excavation**

Sub-excavation will reduce the risk of excessive differential movement and create a more uniform bearing layer for support of the proposed structures. The northern buildings and the swimming pool should be constructed on at least a 2-foot-thick layer of new or sub-excavation backfill and the southern buildings should be constructed on at least a 4-foot-thick layer of new or sub-excavation backfill. The thickness of fill should be measured from the lowest member of the foundation system, or the swimming pool subgrade. The recommended depth of sub-excavation for each building is shown in Fig. 2.

The sub-excavation zone should extend laterally at least 5 feet beyond the outer edges of the structures and should have a uniform bottom elevation throughout the structure footprint. After the existing material is removed, the on-site existing fill materials, or imported granular fill can be used as excavation backfill. The sub-excavation zone should be backfilled to the bottom of foundation elevations with densely compacted fill that has been properly moisture conditioned and compacted as described in the Fill Placement section.

Our representative should observe the completed excavation prior to any backfill placement to verify the conditions exposed in the excavation are as expected. The placement and compaction of fill below foundations and foundation subgrade preparation should be observed and tested by a representative of our firm during construction.



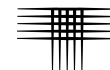
## **Excavation**

We believe the soils encountered in our exploratory borings can be excavated with conventional, heavy-duty excavation equipment. We recommend the contractor become familiar with applicable local, state, and federal safety regulations, including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards, to determine appropriate excavation slopes. We anticipate the grading fill (existing and new) and the near-surface, natural soils will classify as Type C materials. Temporary excavations in Type C soils require a maximum slope inclination of 1.5:1 (horizontal to vertical), unless the excavation is shored or braced. If groundwater seepage occurs, flatter slopes will likely be required. The contractor's "competent person" should review excavation conditions and refer to OSHA standards when worker exposure is anticipated. Stockpiles and equipment should not be placed within a horizontal distance equal to one-half the excavation depth, from the edge of the excavation. Excavations deeper than 20 feet should be designed by a registered professional engineer.

## **Fill Placement**

The properties of the fill will affect the performance of foundations, slabs-on-grade, and pavements. The on-site soils, when free of debris, can be used as site grading fill. We anticipate most of the grading fill will consist of silty sand soils that are generated from cuts into the near surface. If import materials will be used, the import should preferably consist of granular soils, similar to the on-site soils. Import fill materials should exhibit liquid limits of less than 30 and plasticity indices of less than 10. A sample of the import fill should be submitted to our office for testing before transporting to the site.

Vegetation, topsoil, and organic materials should be removed from the ground surface where fill will be placed at the site. Soft or loose soils, if encountered, should be stabilized or removed to stable material prior to placement of grading fill. Organic soils should be wasted in landscaped areas. The ground surface in areas to receive fill



should be scarified, moisture conditioned to near optimum moisture contents, and compacted to a high density to provide a firm base.

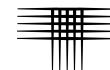
We recommend the fill be placed at relatively uniform moisture contents within 2 percent of optimum moisture content and compacted in thin lifts to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557) for granular materials. Placement and compaction of the grading fill should be observed and tested by our representative during construction.

Water and sewer lines are often constructed beneath slabs and pavements. Compaction of utility trench backfill can have a significant effect on the life and serviceability of floor slabs, pavements, and exterior flatwork. We recommend utility trench backfill be placed in compliance with City of Colorado Springs specifications. Personnel from our firm should periodically observe utility trench backfill placement and test the density of the backfill materials during construction.

## **FOUNDATIONS**

Based on the conditions encountered in our exploratory borings and the planned site grading cuts and fills, we anticipate the near-surface soils found at or near shallow foundation levels for the proposed apartment buildings and clubhouse will consist predominantly of clean to silty sand and new, sand grading fill. These granular materials are non-expansive when wetted.

Based on the results of our borings, laboratory testing, and understanding of the planned construction, we believe the proposed apartment buildings can be constructed with shallow foundations consisting of post-tensioned, slab-on-grade (PTS) foundations or spread footing foundations. If spread footings are used for the apartment buildings, the potential for differential movement for this type of building, between the spread footings and slabs-on-grade would need to be accommodated during design. Post-tensioned slab foundations are structurally integrated and should exhibit more reliable, long-term performance than conventional slabs-on-grade and isolated shallow founda-

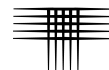


tions. Criteria for post-tensioned, slabs-on-grade are presented in the Post-Tensioned, Slabs-on-Grade section. Criteria for spread footings are presented in the Spread Footings section. We are available to discuss foundation alternatives, as desired.

### **Post-Tensioned, Slabs-On-Grade (PTS)**

We understand post-tensioned, slab-on-ground (PTS) foundations are being considered for the proposed apartment buildings and the clubhouse. In our opinion, the on-site soils are suitable for construction of the planned PTS foundations. Conditions encountered in our borings suggest that the complex can be considered a “Non-Active Site” as defined in Section 3.2.3 of the “Design of Post-Tensioned Slabs-on-Ground” manual developed by the Post-Tensioning Institute (PTI, 3rd Edition, 2004). The design of a PTS foundation for a non-active site requires that the foundation need only be checked for bearing and lightly reinforced against shrinkage and temperature cracking.

1. PTS foundations should be constructed on newly placed fill, and/or reprocessed fill, as described previously.
2. The PTS foundations should be designed for a maximum allowable soil pressure of 2,000 psf.
3. Perimeter stiffening beams may be poured “neat” into trenches excavated in the building pads. The on-site sands may cave or slough during trench excavation for the stiffening beams. Disturbed soils should be removed from trench bottoms prior to placement of concrete. Formwork or other methods may be required for proper beam installation.
4. For slab tensioning design, a coefficient of friction value of 0.75 or 1.0 can be used for slab construction on polyethylene sheeting or a sand layer, respectively. A coefficient of friction of 2 should be used for slabs on fill or native soil.
5. Exterior stiffening beams must be protected from frost action. Normally, 30 inches of frost cover is provided in this area.
6. A representative of our firm should observe the completed excavations. We should also observe the placement of the reinforcing tendons and reinforcement prior to placing the slabs and beams, as well as observe the tensioning of the tendons.



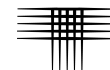
## **Spread Footing Foundations**

1. We recommend the spread footing foundations be constructed on newly placed fill, and/or reprocessed fill, as described previously.
2. Spread footings can be designed for a maximum allowable soil pressure of 2,000 psf.
3. Spread footings beneath continuous foundation walls should be at least 16 inches wide. Footings beneath isolated column pads should be at least 24 inches square. Larger footing sizes could be required to accommodate the anticipated foundation loads.
4. We recommend designs consider total settlement of 1-inch and differential settlement of 1/2-inch.
5. Continuous foundation stem walls should be reinforced, top and bottom, to span local anomalies in the subsoils. We recommend the reinforcement required to simply span an unsupported distance of at least 10 feet.
6. Exterior spread footings within the garages must be protected from frost action. Typically, at least 30 inches of soil cover is provided in this area.
7. A representative of our firm should observe the completed foundation excavations to confirm the exposed conditions are similar to those encountered in our exploratory borings. The placement and compaction of below-foundation fill and foundation subgrade preparation should be observed and tested by a representative of our firm during construction.

## **FLOOR SYSTEMS AND SLABS-ON-GRADE**

As previously discussed, soils below the foundations will consist of a layer of granular fill over the existing granular soils. Considering a 15-foot depth of wetting, our calculations indicate potential ground settlement within the building footprint of less than 1 inch to about 2 inches. Granular material settles more quickly than clay and clayey materials, and some of the internal settlement may occur during construction.

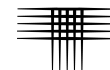
For the PTS system, the foundation is structurally integrated with the floor slab and should exhibit more reliable long-term performance, as compared to conventional slab-on-grade floors. Under-slab utilities such as water and sewer lines should be pressure tested prior to installing slabs. Utilities that penetrate slabs should be provided with sleeves and flexible connections that allow for independent movement of the slab and that reduce the likelihood of damaging buried pipes. We recommend these details allow at least 2 inches of differential movement between the slabs and pipes.



For the post-tensioned slabs-on-grade system, the foundation is structurally integrated with the floor slab and should exhibit more reliable long-term performance, as compared to conventional slab-on-grade floors. Where slab-on-grade construction is used, we recommend the following precautions.

Fill placed below the slabs should be constructed per the Fill Placement section of this report. Building foundations underlain by granular soils will settle relative to more lightly loaded slab-on-grade floors. The settlement can cause cosmetic cracking of drywall. We recommend slab-on-grade floors be separated from exterior walls and interior bearing members with joints that allow for independent vertical movements of the slab relative to the foundation. Provision of a 1-1/2 inch thick slip joint in slab-bearing partitions can reduce the risk of cracking of drywall resulting from movement of structural elements. If the “float” is provided at the tops of partitions, the connection between interior, slab-supported partitions and exterior, foundation-supported walls should be detailed to allow differential movement. These architectural connections are critical to help reduce cosmetic damage when foundations and floor slabs move relative to each other. We have seen instances where these architectural connections were not designed and constructed properly and resulted in moderate cosmetic damage, even though the movement experienced was well within the anticipated range. The architect should pay special attention to these issues and detail the connections accordingly.

From a geotechnical viewpoint, we believe the floor slabs can be placed directly on the subgrade soils. The 2015 International Building Code (IBC) requires a vapor retarder be placed between base course or subgrade soils and the concrete slab-on-grade floor, unless the designer of the floor (structural engineer) waives this requirement. The merits of installation of a vapor retarder below a floor slab depend on the sensitivity of floor coverings and building use to moisture. A properly installed vapor retarder (10 mil minimum) is more beneficial below concrete slab-on-grade floors where floor coverings, painted floor surfaces or products stored on the floor will be sensitive to moisture. The vapor retarder is most effective when concrete is placed directly on top of it, rather than placing a sand or gravel leveling course between the vapor retarder and the floor slab. The placement of concrete on the vapor retarder may increase the risk of



shrinkage cracking and curling. Use of concrete with reduced shrinkage characteristics including minimized water content, maximized coarse aggregate content, and reasonably low slump will reduce the risk of shrinkage cracking and curling. Considerations and recommendations for the installation of vapor retarders below concrete slabs are outlined in Section 3.2.3 of the 2006 report of the American Concrete Institute (ACI) Committee 302, “Guide for Concrete Floor and Slab Construction (ACI 302.R-96)”.

Underslab plumbing should be avoided as much as possible. If underslab plumbing is necessary, service lines should be pressure tested for leaks during construction. Any utility lines that penetrate the slabs should be isolated from the slabs with joints to allow for free vertical movement. Slab-supported mechanical systems should have flexible connections to allow for vertical movement without rupturing supply lines.

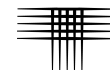
Frequent control joints should be provided in the slabs to reduce the effects of curling and help reduce shrinkage cracking. Our experience indicates joint spacing of not greater than 30 times the slab thickness is effective in this area.

### **Exterior Flatwork**

Exterior flatwork is normally constructed as a slab-on-grade. Performance of conventional slabs-on-grade is erratic. Various properties of the soils and environmental conditions influence magnitude of settlement and other performance characteristics. Increases in the moisture content in the underlying soils can result in settlement and possible cracking of slabs-on-grade. Backfill below slabs should be moisture conditioned and compacted to reduce settlement, as discussed in the Fill Placement section. Driveways and exterior slabs founded on backfill may settle and crack if the backfill is not properly moisture treated and compacted.

## **SWIMMING POOL AND POOL DECK**

We understand a swimming pool is planned in association with the proposed clubhouse. No plans were available at the time of this investigation. We anticipate the pool structure may consist of spray-applied gunite against natural soil, or possibly a

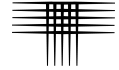


steel or a fiberglass shell. Because of the granular nature of the on-site soils, vertical excavation of the pool walls required for gunite pool construction may not be possible. A fiberglass or steel shell placed in an enlarged excavation may then be the more feasible option. If gunite methods are used, the cement slurry should be properly reinforced.

We recommend the pool be underlain by a drain system that collects water leakage and provides for discharge of the water to a sump or gravity outfall. The drain system should consist of free-draining gravel covering the bottom of the pool excavation. The excavation should slope to a 3 to 4-inch diameter, perforated or slotted pipe placed within the gravel layer. The drain should lead to a positive gravity outlet, such as a sub-drain located beneath the sewer, or to a sump where water can be removed by pumping. A conceptual pool drain system is presented in Fig. 3. Overall surface drainage patterns should be planned to provide for the rapid removal of storm runoff and water that splashes over the edges of the pool.

The swimming pool structure may settle more than the flatwork surrounding the pool. To avoid damage to the pool structure, a slip joint should be used around the perimeter of the pool structure and adjacent to any other structural elements. Utility lines that penetrate the pool structure should be separated and isolated with joints to allow for free vertical movement. All ducts with connections between the pool structure and surrounding soil should be flexible or “crushable,” to allow some relative movement.

Pool decking should be constructed directly on the newly moisture conditioned and densely compacted sub-excavation backfill and be isolated from the swimming pool. Movement of the deck should not be transmitted to the swimming pool. The deck slab should be reinforced to function as an independent unit. Frequent control joints should be provided to reduce problems associated with potential soil movements. Panels that are approximately square generally perform better than rectangular areas.



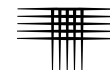
## PAVEMENTS

Our exploratory borings and understanding of the proposed construction suggest the subgrade soils within the planned access driveways and parking lots will consist of silty sand and new grading fill. The anticipated subgrade soil sample tested in our laboratory classified as A-1-b to A-2-4 material, according to the American Association of State Highway Transportation Officials (AASHTO) classification system. These group classifications generally exhibit good pavement support characteristics. Based on our laboratory classification testing (Atterberg Limits and sieve analysis) and experience with similar soils in the area a Hveem Stabilometer (“R”) value of 50 was assigned to the subgrade materials for design purposes.

We anticipate the access driveways could be subjected to occasional heavy vehicle loads such as trash trucks and moving vans. We considered daily traffic numbers (DTN) of 2 for the parking stalls and 10 for the access driveways, which correspond to 18-kip Equivalent Single-Axle Loads (ESAL) of 14,600 and 73,000, respectively, for a 20-year pavement design life. We believe the parking stalls can be paved with 4 inches of asphalt concrete or 3 inches of asphalt concrete over 4 inches of aggregate base course. The access driveways and other portions of the proposed paved areas subjected to occasional truck traffic should be paved with 6 inches of asphalt concrete or 4 inches of asphalt underlain by 6 inches of aggregate base course.

We recommend a concrete pad be provided at the trash dumpster sites. The pads should be at least 6 inches thick and long enough to support the entire length of the trash truck and dumpster. The concrete pad should extend at least 5 feet outside of the anticipated truck dimensions. Joints between concrete and asphalt pavements should be sealed with a flexible compound.

Our design considers pavement construction will be completed in accordance with the City of Colorado Springs “Standard Specifications” and the Pikes Peak Region Asphalt Paving Specifications. The specifications contain requirements for the pavement materials (asphalt, base course, and concrete) as well as the construction practic-



es used (compaction, materials sampling, and proof-rolling). Of particular importance are those recommendations directed toward subgrade and base course compaction and proof-rolling. During proof-rolling, particular attention should be directed toward the areas of confined backfill compaction. Soft or loose subgrade or areas that pump excessively should be stabilized prior to pavement construction. A representative of our office should be present at the site during placement of fill and construction of pavements to perform density testing.

## **CONCRETE**

Concrete in contact with soils can be subject to sulfate attack. We measured the water-soluble sulfate concentration in three samples from the site at less than 0.1 percent. Sulfate concentrations of less than 0.1 percent indicate Class 0 exposure to sulfate attack for concrete in contact with the subsoils, according to ACI 201.2R-01, as published in the 2008 American Concrete Institute (ACI) Manual of Concrete Practice. For this level of sulfate concentration, the ACI indicates Type I cement can be used for concrete in contact with the subsoils. Superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious material ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high-water tables. Concrete subjected to freeze-thaw cycles should be air entrained.

## **LIMITATIONS**

The recommendations and conclusions presented in this report were prepared based on conditions disclosed by our exploratory borings, geologic reconnaissance, engineering analyses, and our experience. Variations in the subsurface conditions not indicated by the borings are possible and should be expected.

We believe this report was prepared with that level of skill and care ordinarily used by geologists and geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.



Should you have any questions regarding the contents of this report or the project from a geotechnical engineering point-of-view, please call.

CTL | THOMPSON, INC.

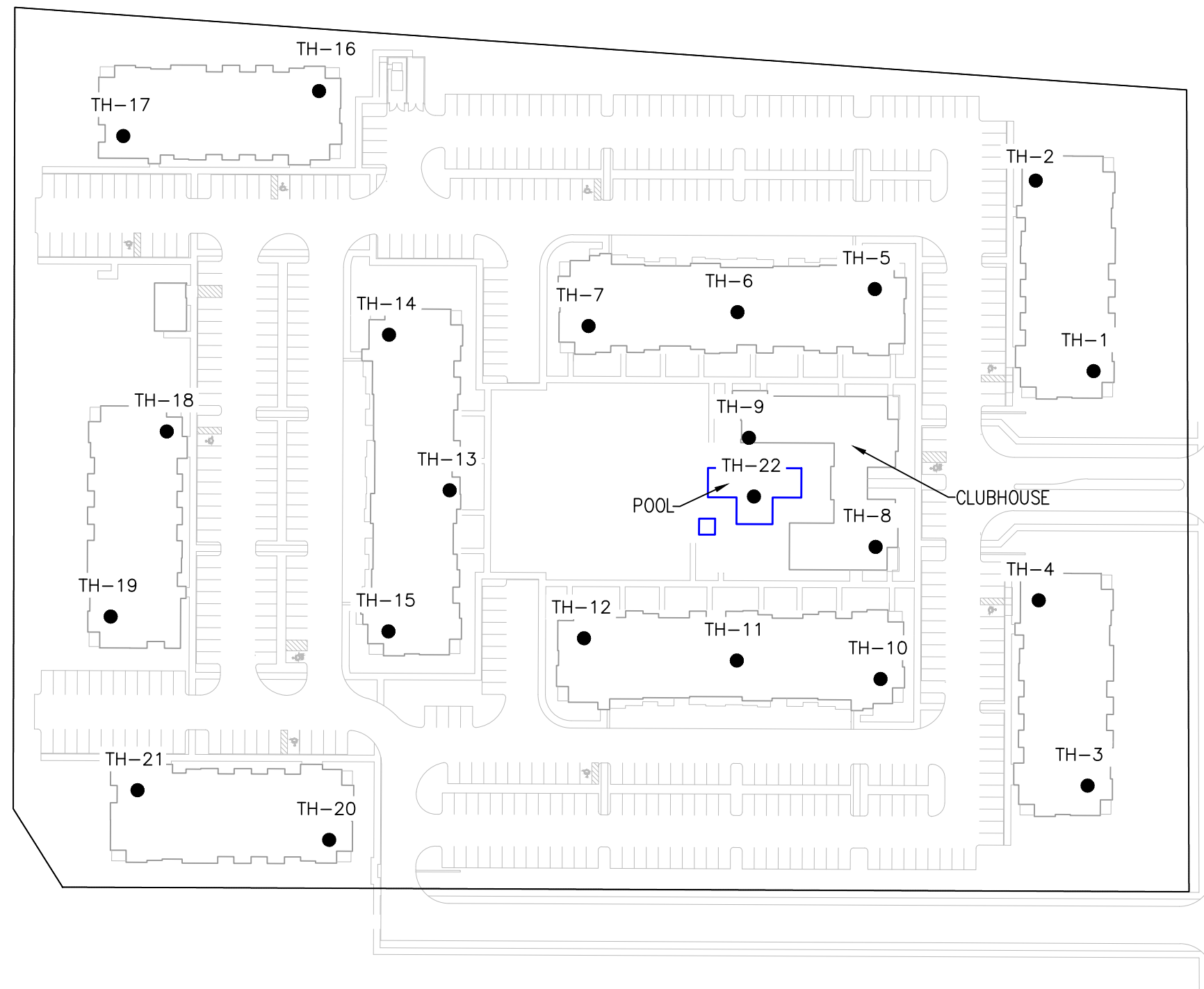
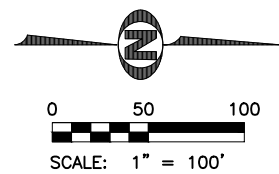


Gwendolyn E. Eberhart, P.E.  
Project Engineer

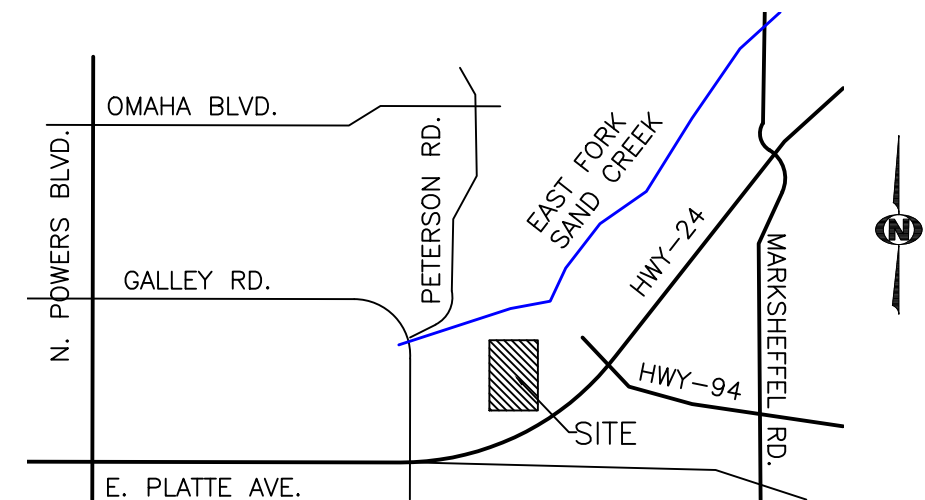
Reviewed by:

Jeffery M. Jones, P.E.  
Associate Engineer

GE:JMJ:ge  
(3 copies sent)  
Via email: [ajones.@trinsicres.com](mailto:ajones.@trinsicres.com)



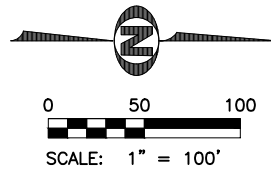
PROPOSED MEADOWBROOK PARKWAY



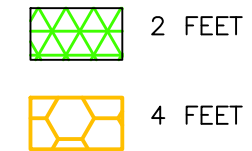
VICINITY MAP  
NOT TO SCALE

LEGEND:

- TH-1      APPROXIMATE LOCATION OF EXPLORATORY BORING



RECOMMENDED SUB-EXCAVATION DEPTHS:

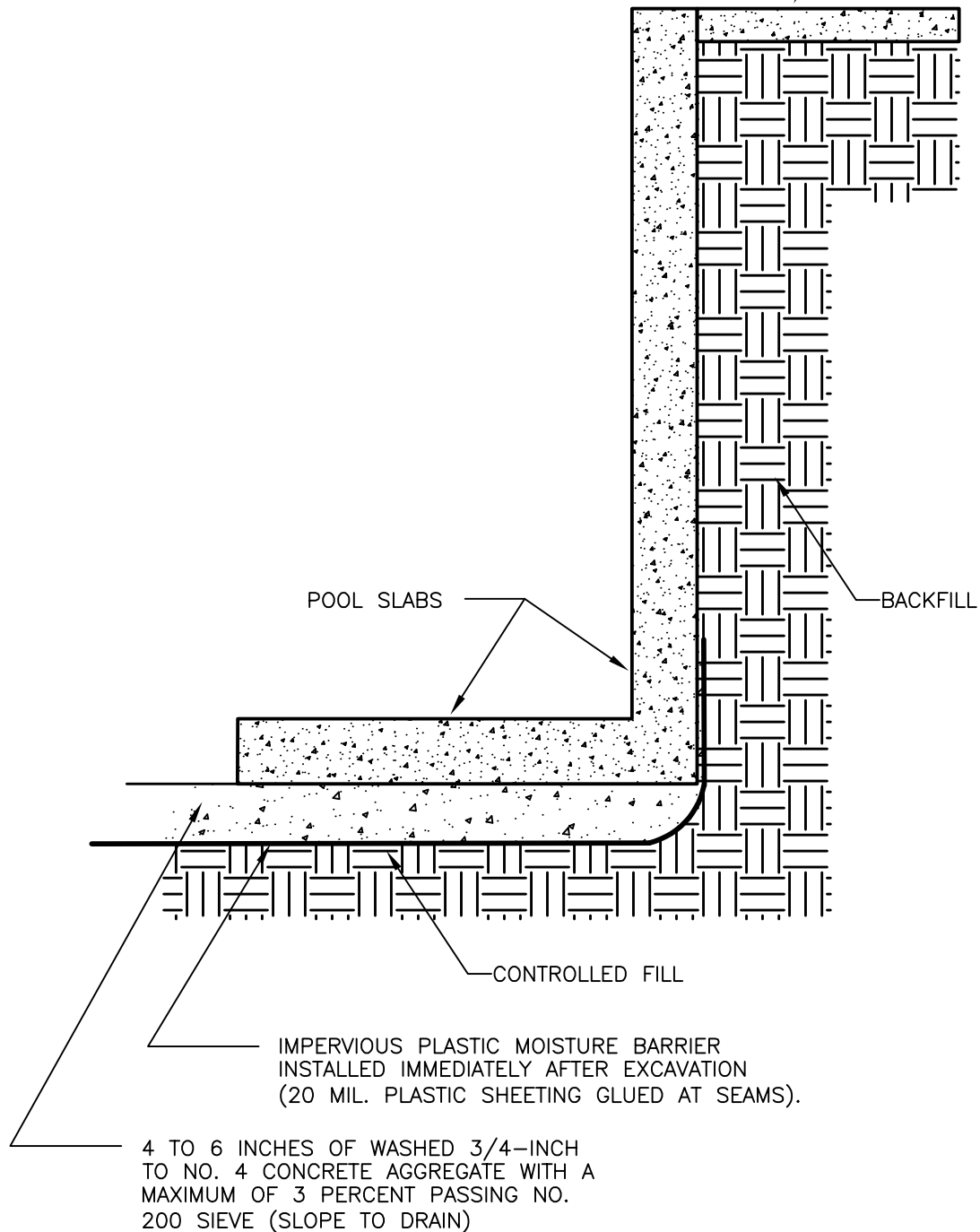


LEGEND:

TH-1    ●    APPROXIMATE LOCATION OF  
EXPLORATORY BORING

NOT TO SCALE

POOL DECK

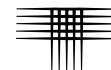


NOTE:

DRAIN PIPE SHOULD CONSIST OF A 3 OR  
4-INCH DRAIN PIPE WITH A MINIMUM SLOPE  
OF 1/8 INCH DROP PER FOOT, TO A POSITIVE  
GRAVITY OUTLET OR TO A SUMP WHERE WATER  
CAN BE REMOVED BY PUMPING.

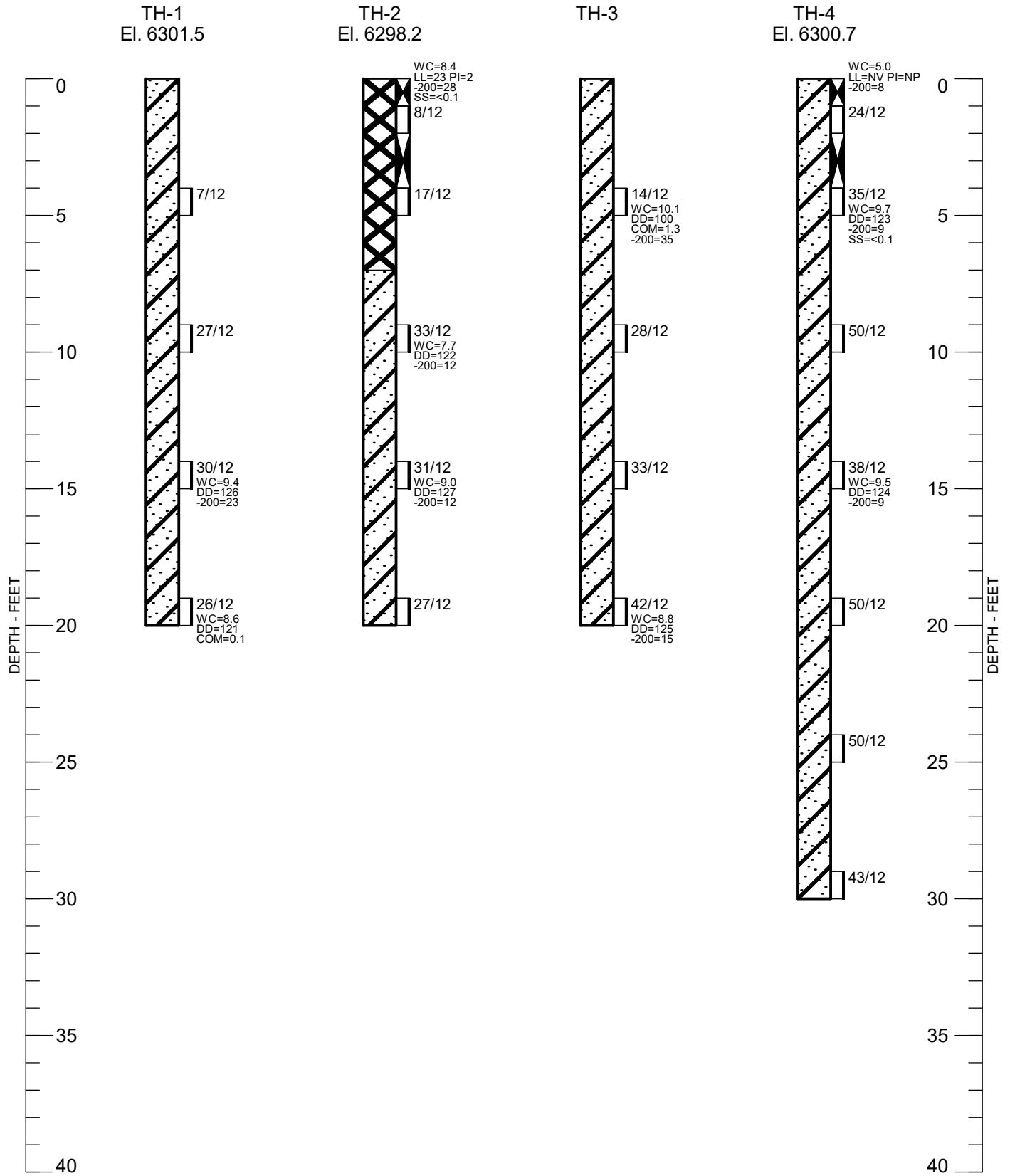
## Recommended Pool Drain Detail

Fig. 3

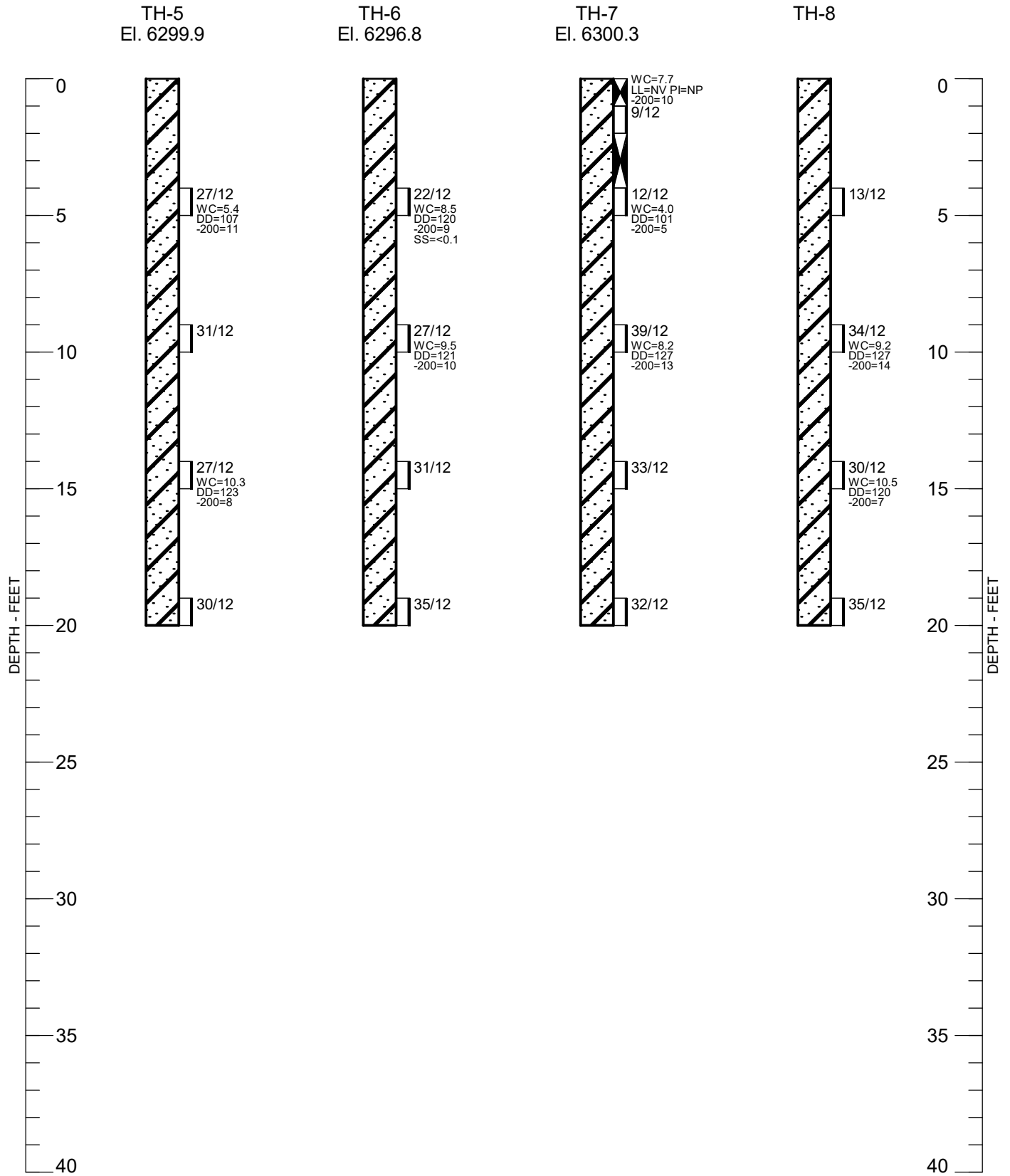


## **APPENDIX A**

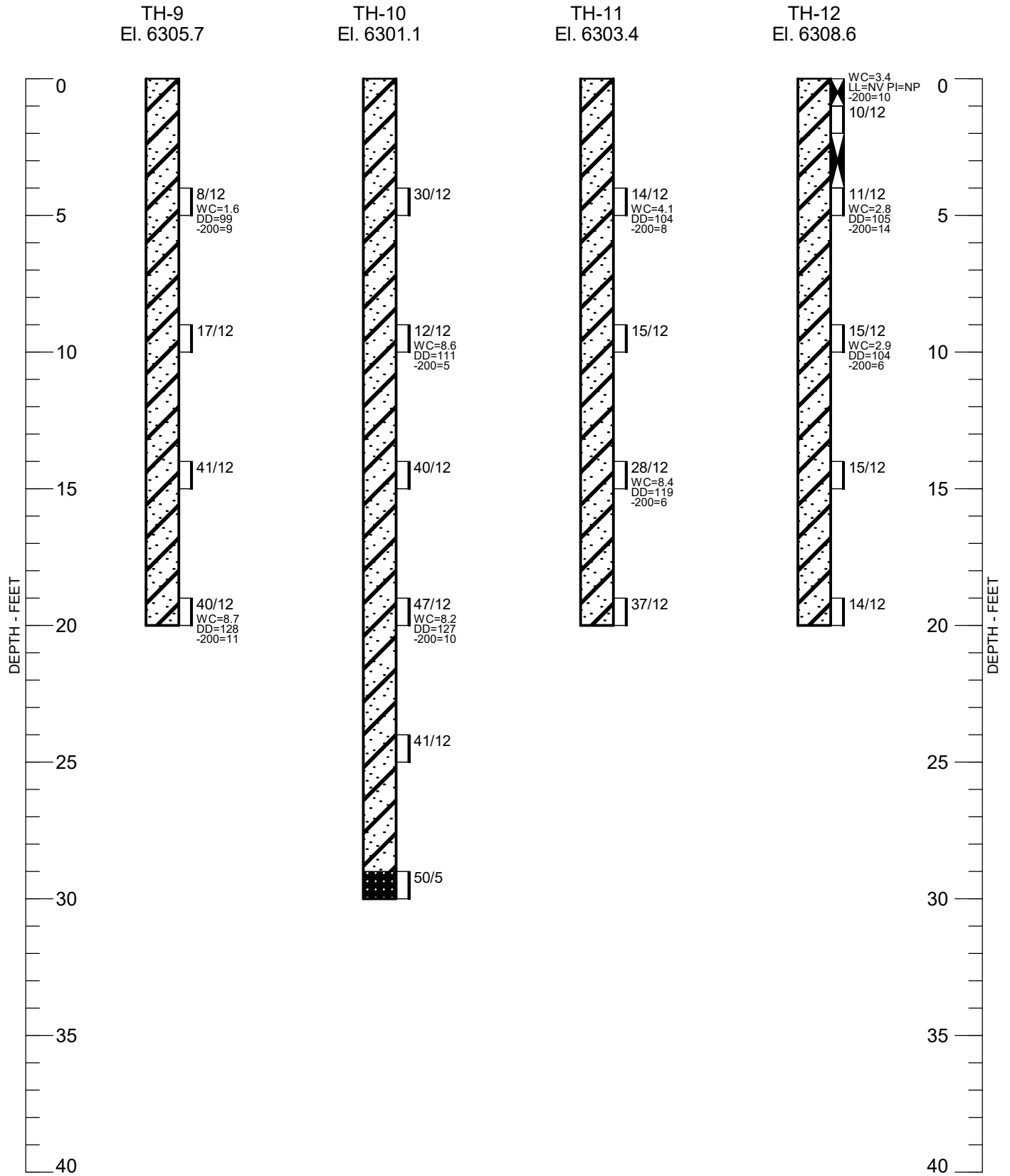
### **SUMMARY LOGS OF EXPLORATORY BORINGS**



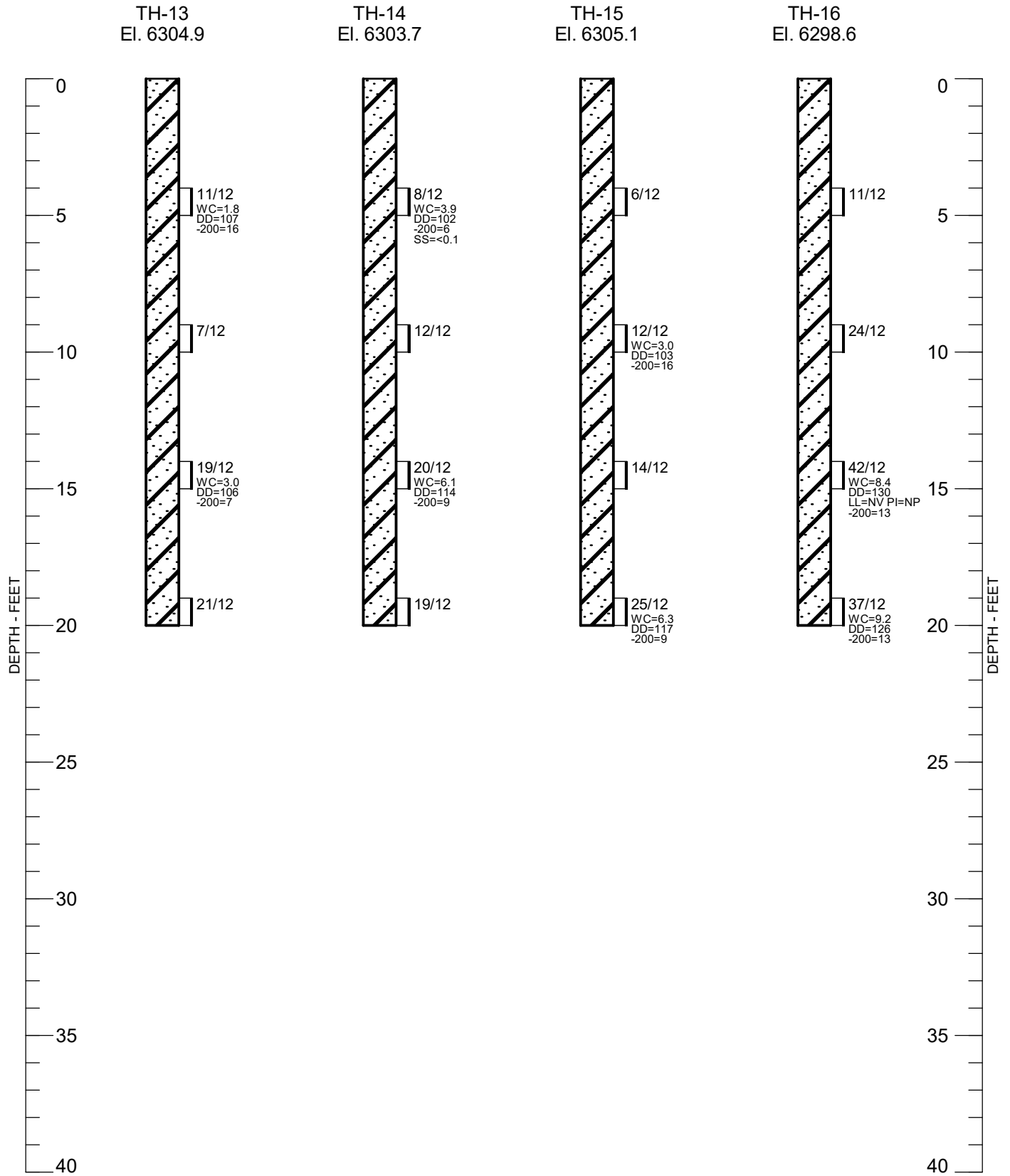
### SUMMARY LOGS OF EXPLORATORY BORINGS



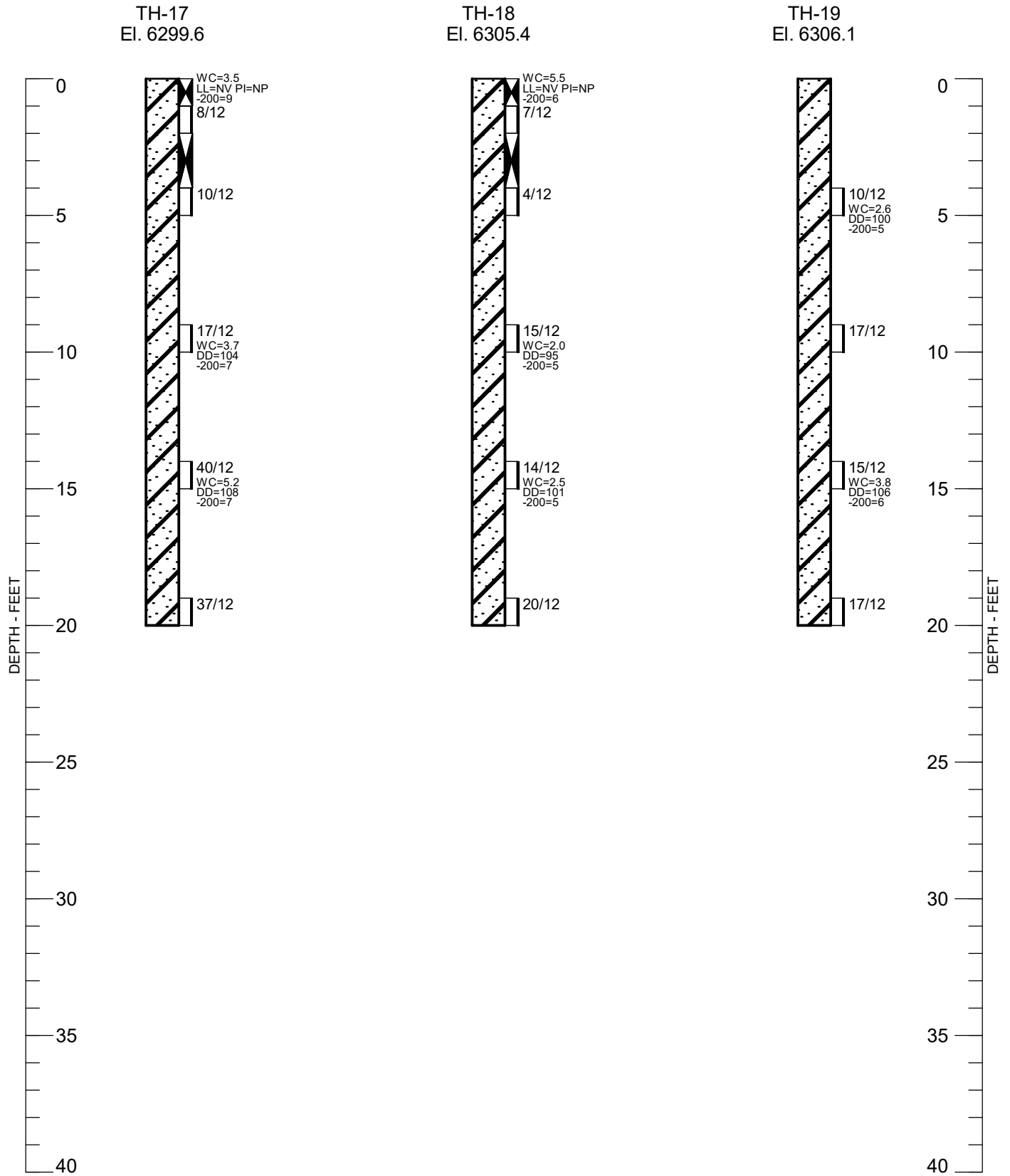
### SUMMARY LOGS OF EXPLORATORY BORINGS



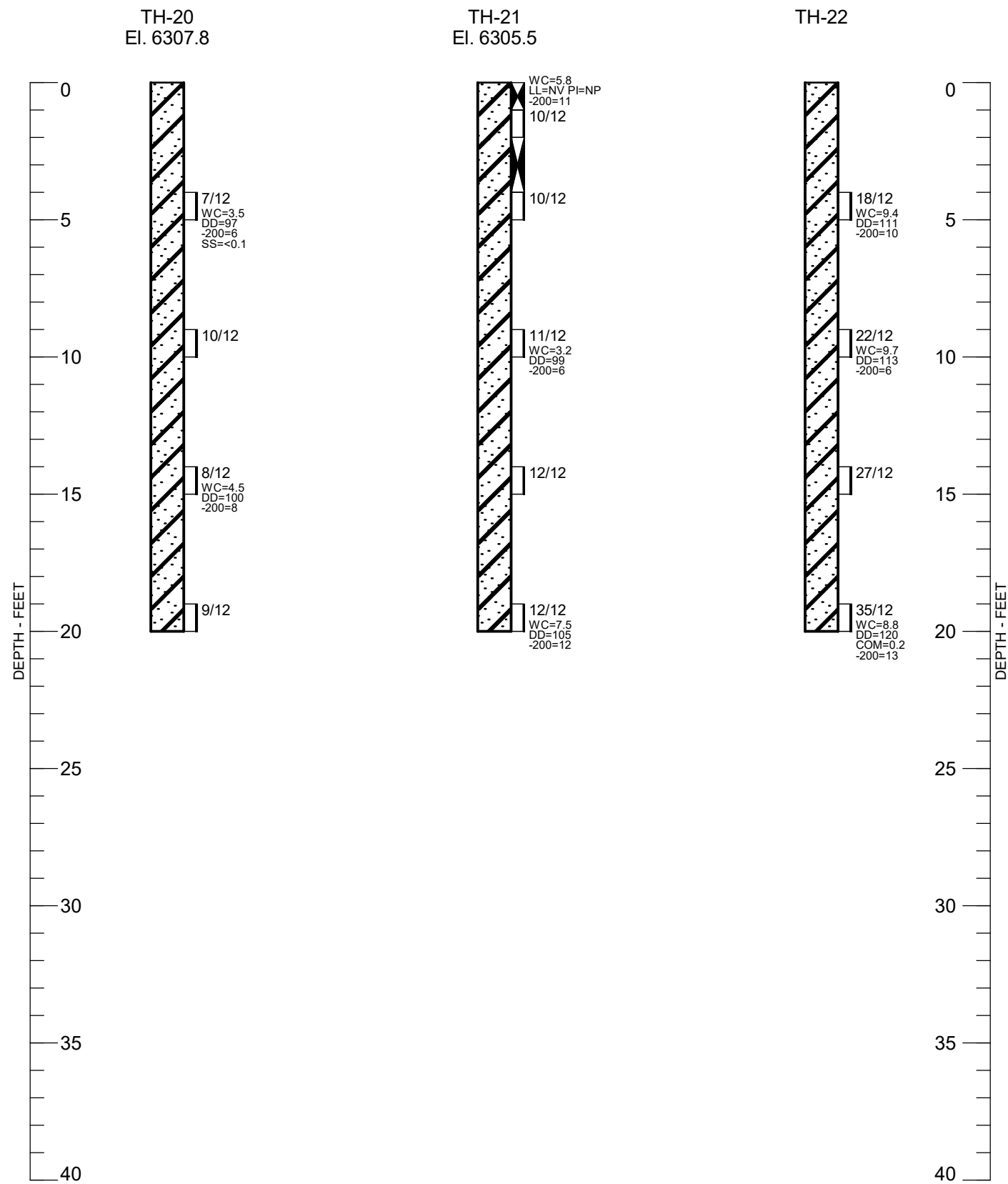
### SUMMARY LOGS OF EXPLORATORY BORINGS



SUMMARY LOGS OF EXPLORATORY BORINGS



### SUMMARY LOGS OF EXPLORATORY BORINGS



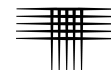
**LEGEND:**

- FILL, SAND, SILTY, LOOSE TO MEDIUM DENSE, SLIGHTLY MOIST, DARK BROWN.
- SAND, CLEAN TO SILTY, LOOSE TO DENSE, DRY TO SLIGHTLY MOIST, LIGHT TO MEDIUM BROWN (SP-SM, SM).
- BEDROCK, SANDSTONE, SLIGHTLY CLAYEY, VERY HARD, MOIST, MEDIUM BROWN, RUST.
- DRIVE SAMPLE. THE SYMBOL 7/12 INDICATES 7 BLOWS OF AN AUTOMATIC 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.
- BULK SAMPLE COLLECTED FROM AUGER CUTTINGS.

**NOTES:**

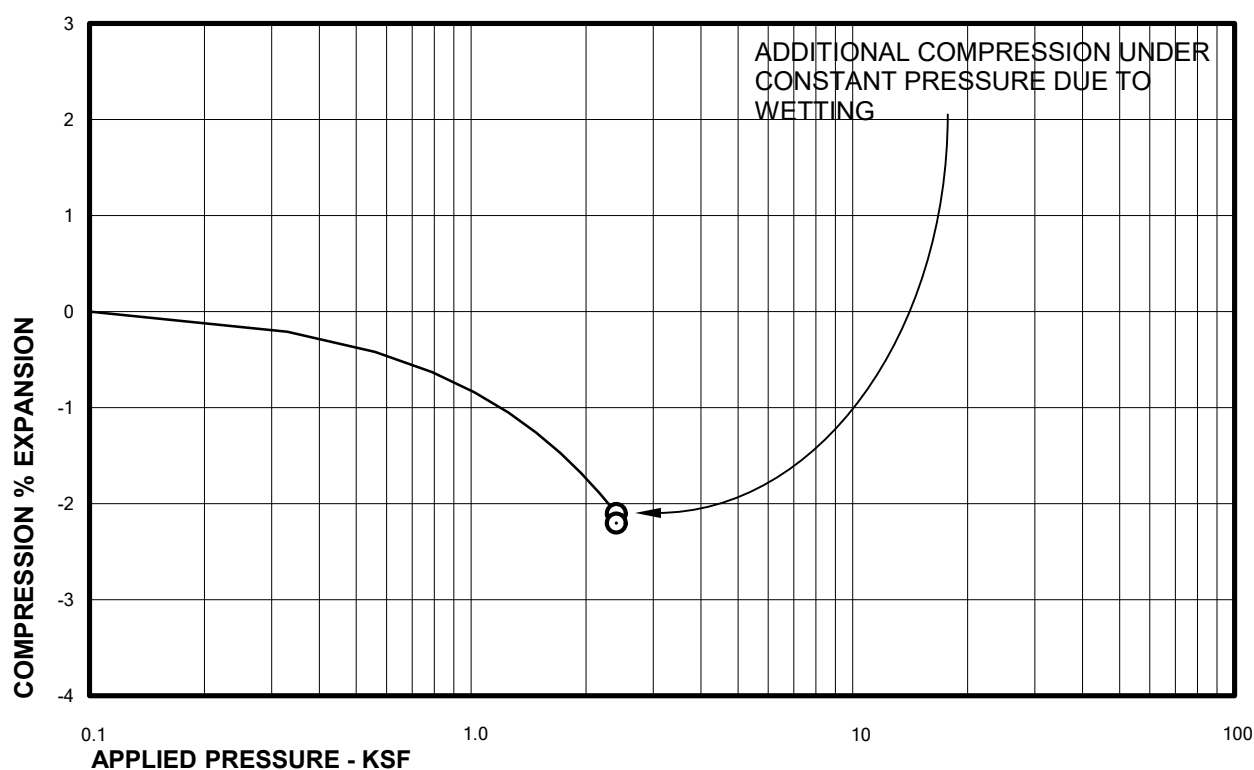
- THE BORINGS WERE DRILLED ON MARCH 11, 12, 19, 25 AND 29, 2021 USING 4-INCH DIAMETER, CONTINUOUS-FLIGHT SOLID-STEM AUGER AND TRUCK-MOUNTED CME-45 DRILL RIG.
- GROUNDWATER WAS NOT ENCOUNTERED DURING THIS INVESTIGATION.
- WC - INDICATES MOISTURE CONTENT (%).  
DD - INDICATES DRY DENSITY (PCF).  
SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE (%).  
COM - INDICATES COMPRESSION WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE (%).  
LL - INDICATES LIQUID LIMIT.  
PI - INDICATES PLASTICITY INDEX.  
-200 - INDICATES PASSING NO. 200 SIEVE (%).  
SS - INDICATES WATER-SOLUBLE SULFATE CONTENT (%).
- THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS CONTAINED IN THIS REPORT.

**SUMMARY LOGS OF EXPLORATORY BORINGS**



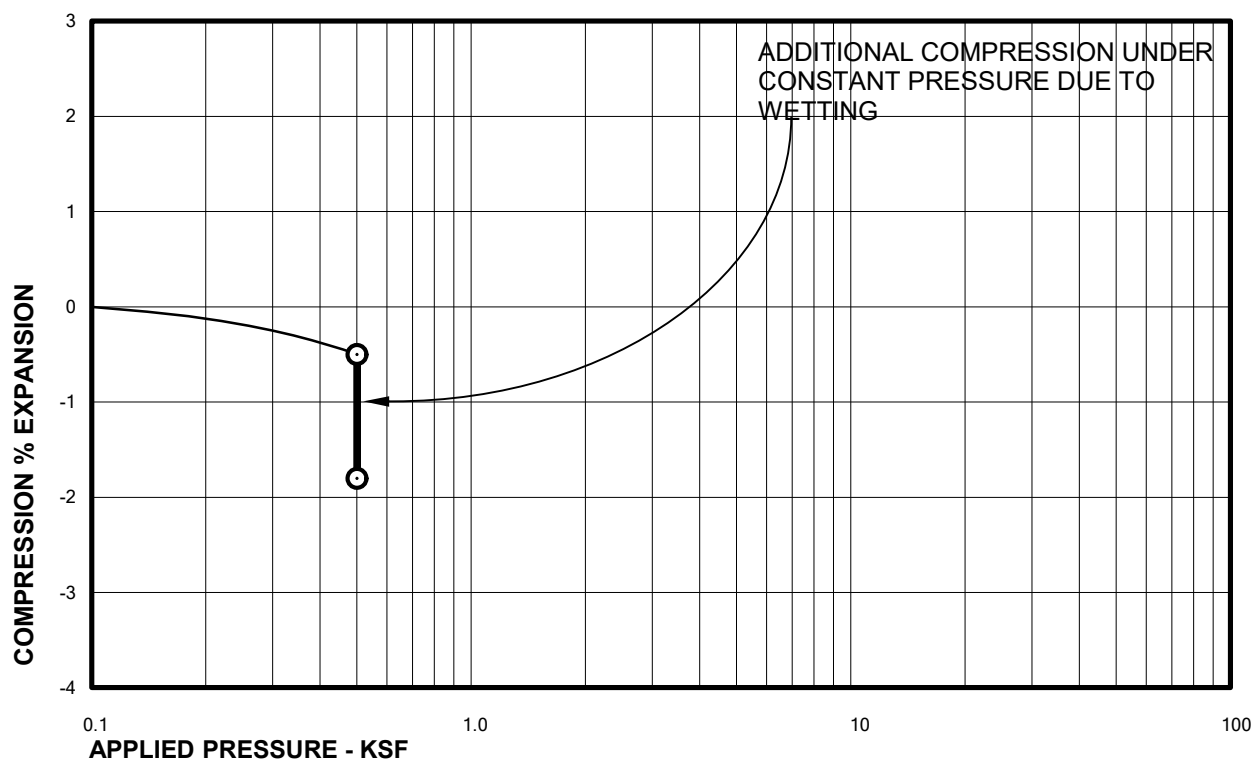
## **APPENDIX B**

### **LABORATORY TEST RESULTS TABLE B-1: SUMMARY OF LABORATORY TESTING**



Sample of SAND, SILTY (SM)  
From TH-1 AT 19 FEET

DRY UNIT WEIGHT= 121 PCF  
MOISTURE CONTENT= 8.6 %

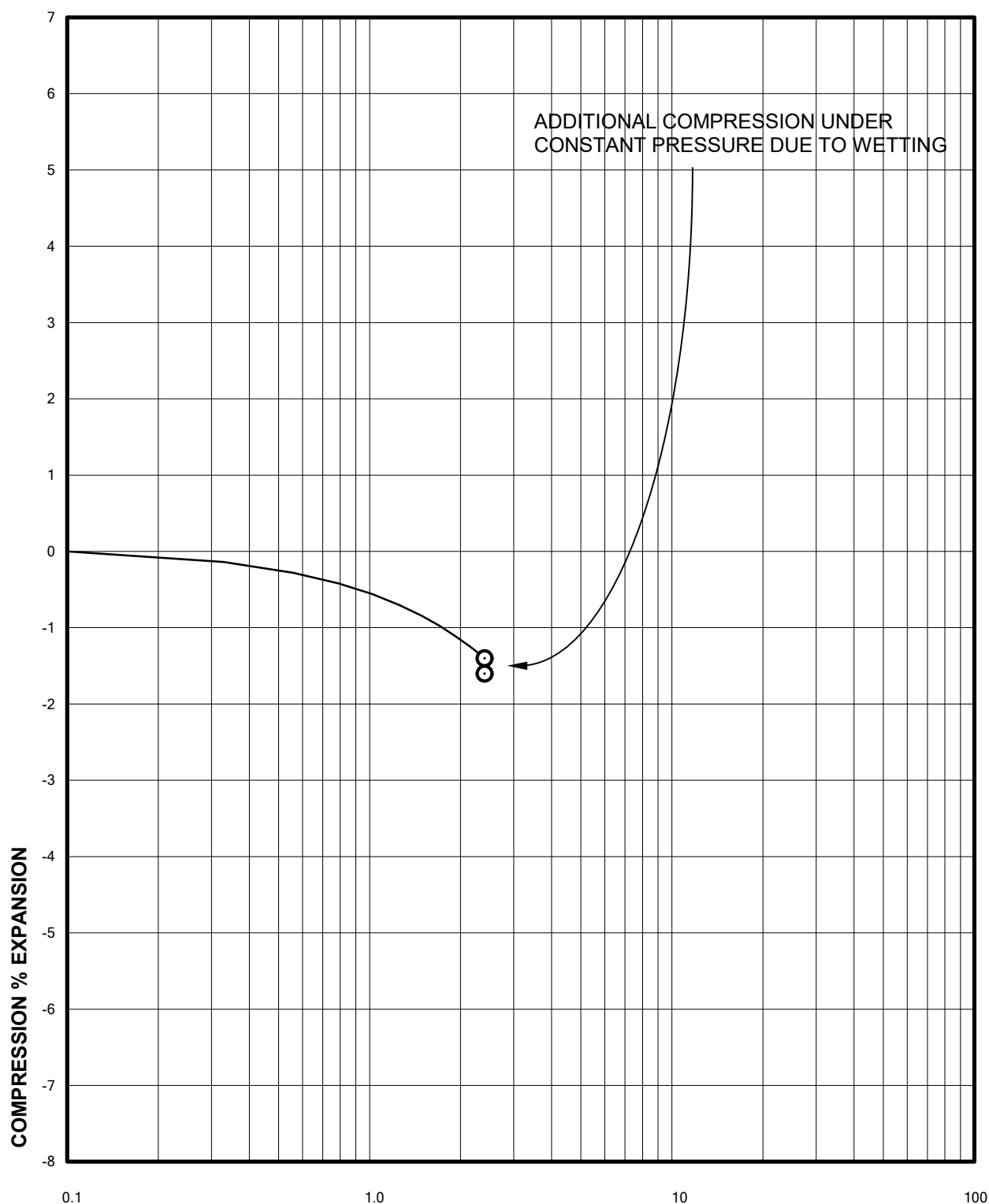
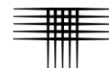


Sample of SAND, SILTY (SM)  
From TH-3 AT 4 FEET

DRY UNIT WEIGHT= 100 PCF  
MOISTURE CONTENT= 10.1 %

## Swell Consolidation Test Results

FIG. B-1

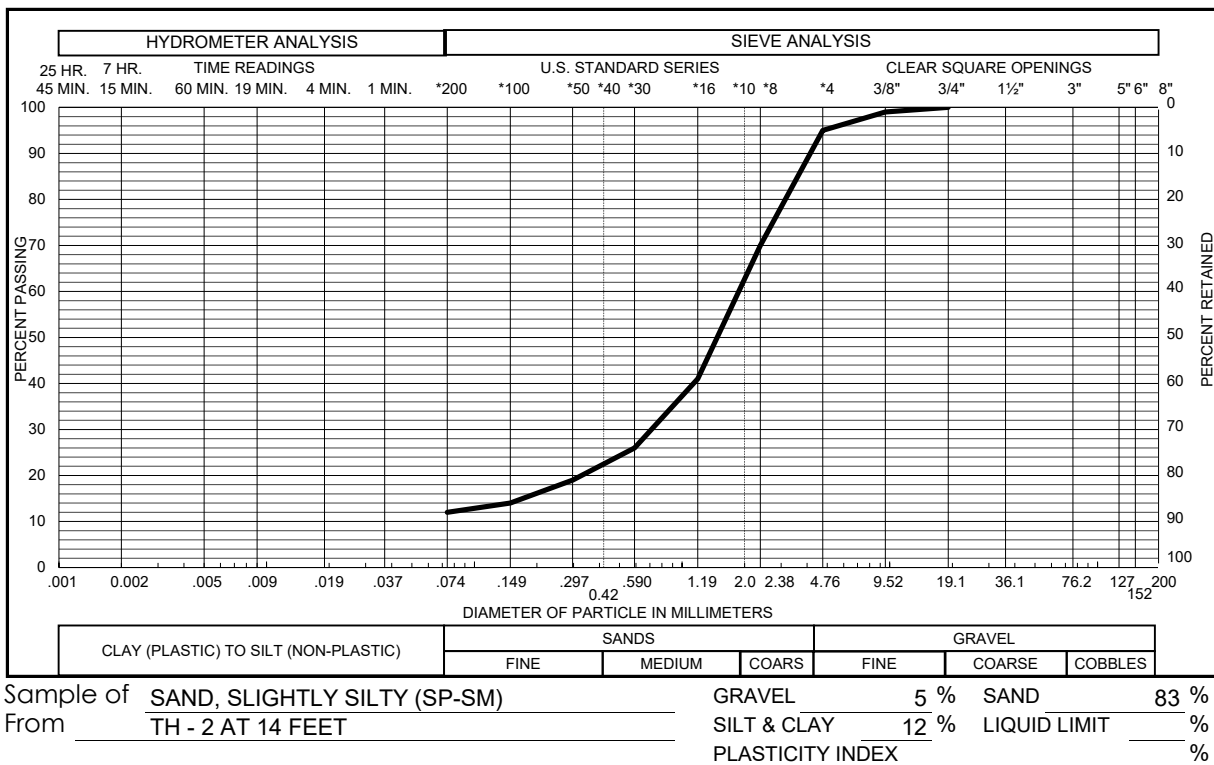
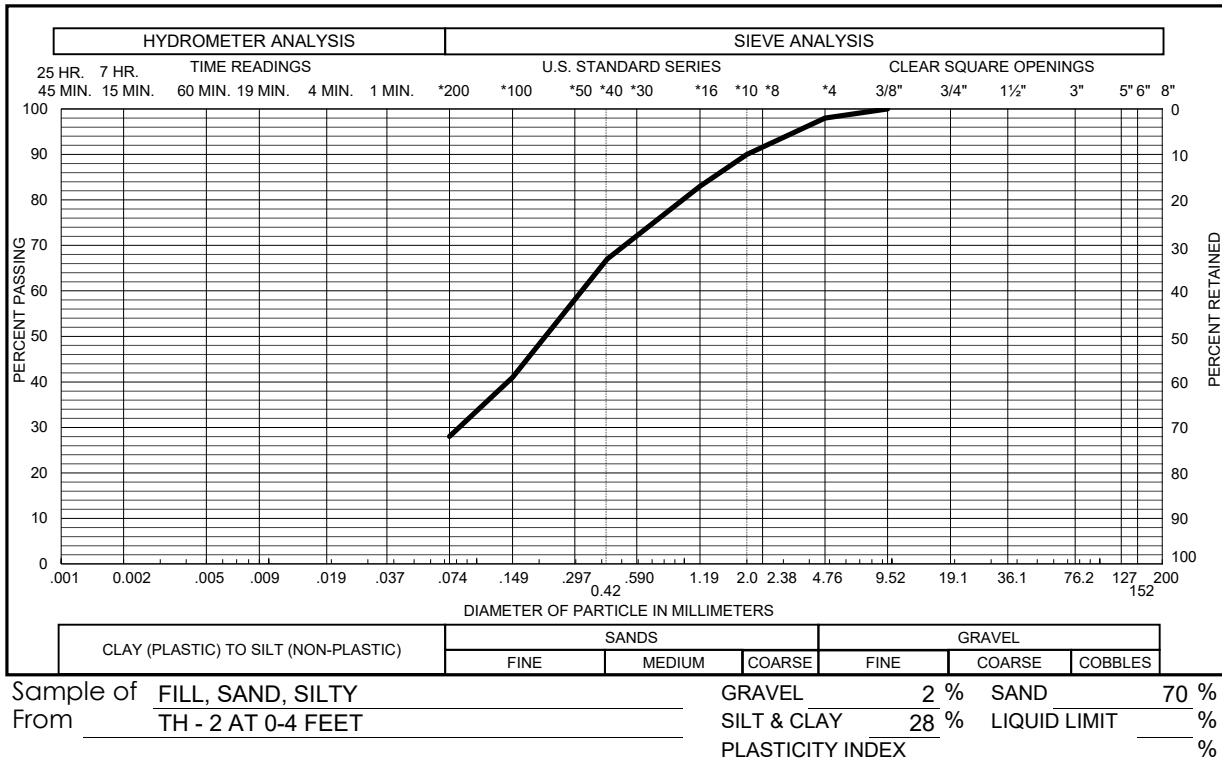
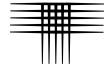


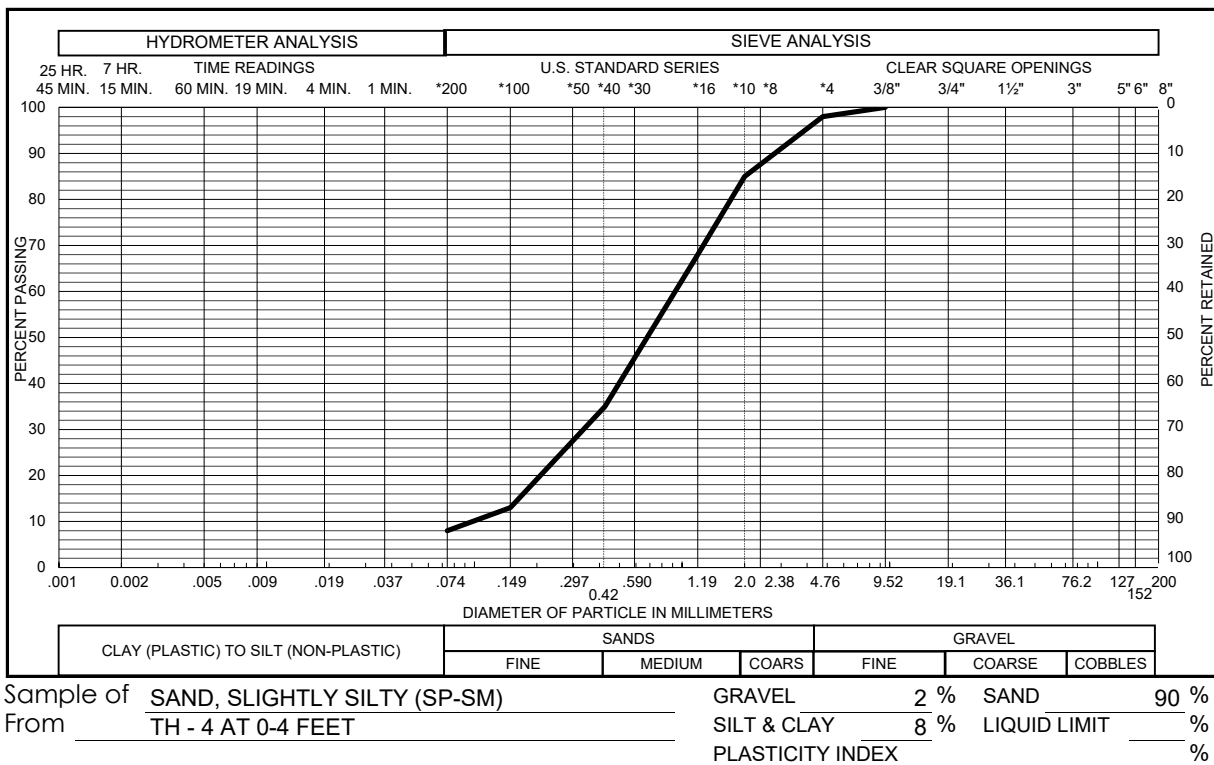
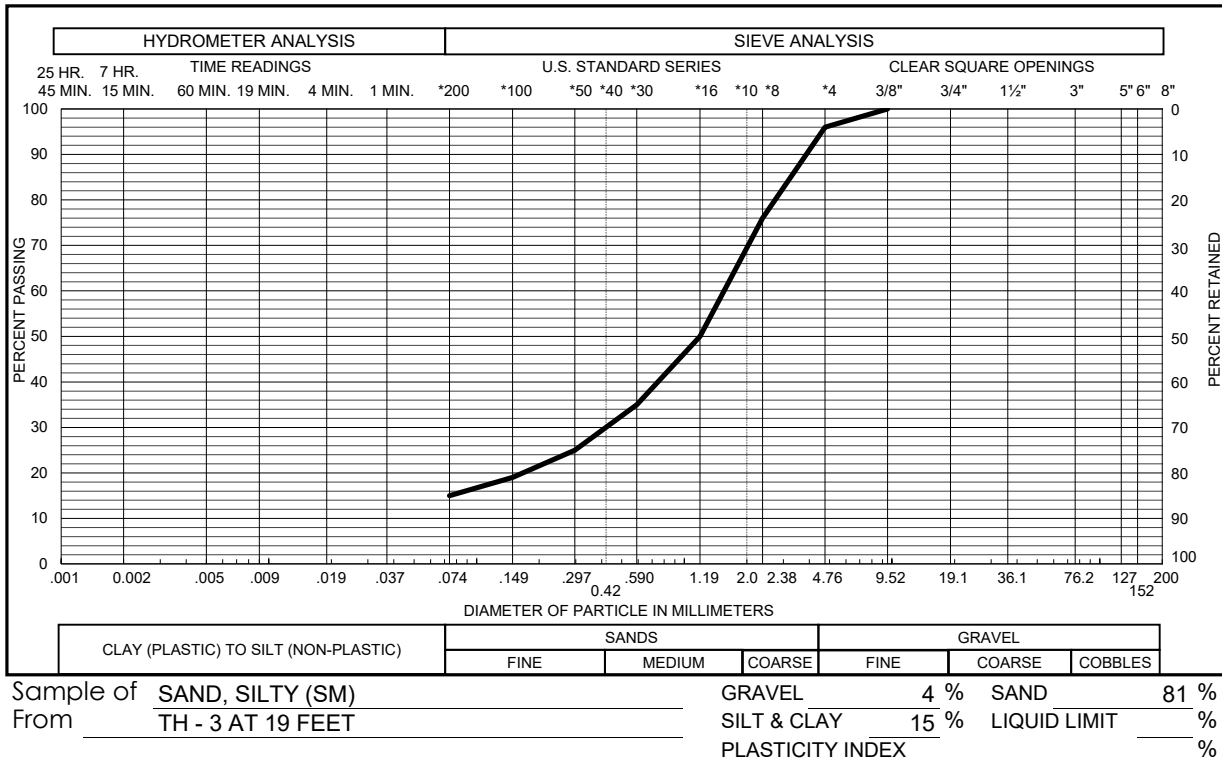
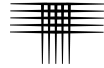
**APPLIED PRESSURE - KSF**  
Sample of SAND, SILTY (SM)  
From TH-22 AT 19 FEET

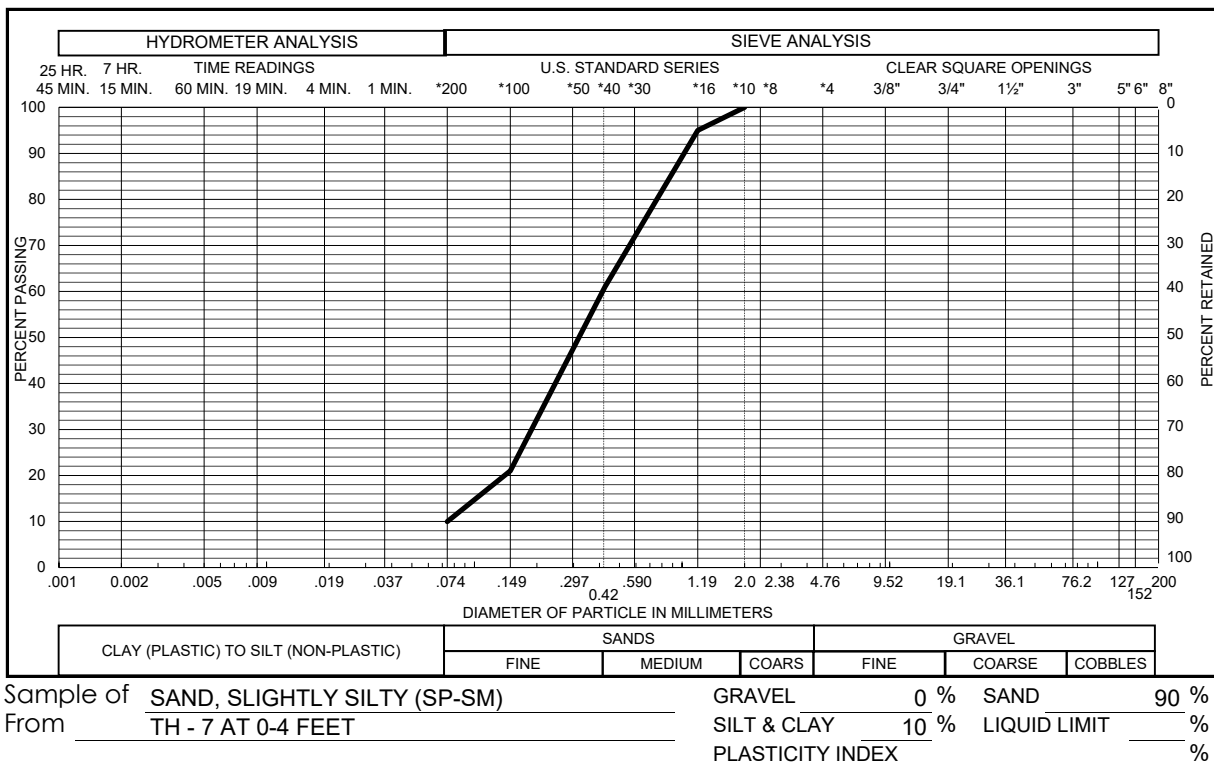
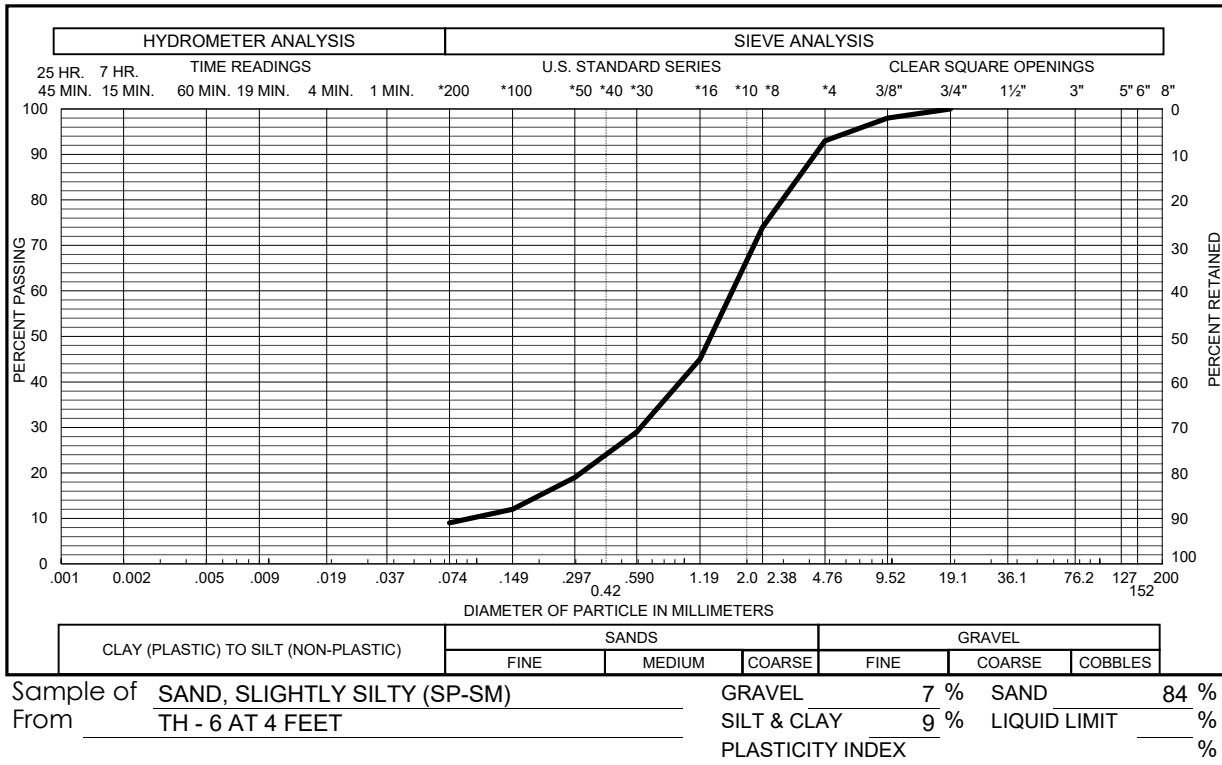
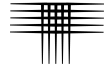
DRY UNIT WEIGHT= 120 PCF  
MOISTURE CONTENT= 8.8 %

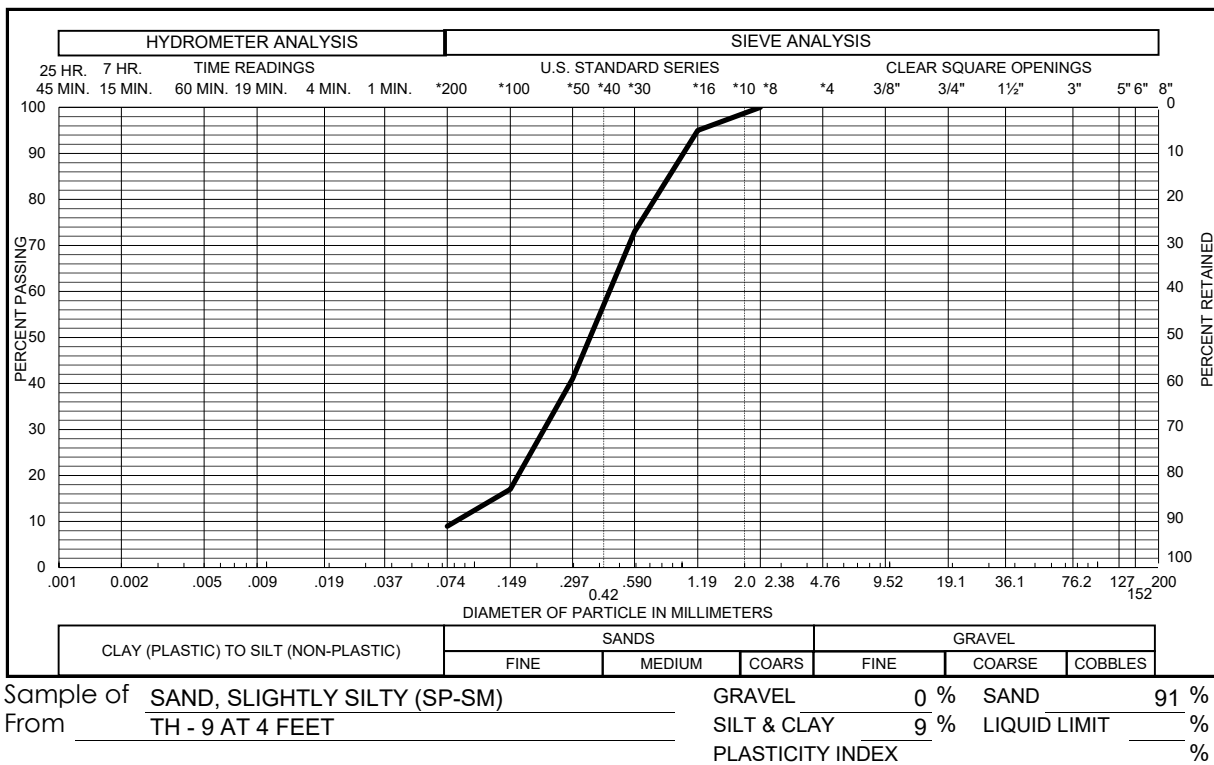
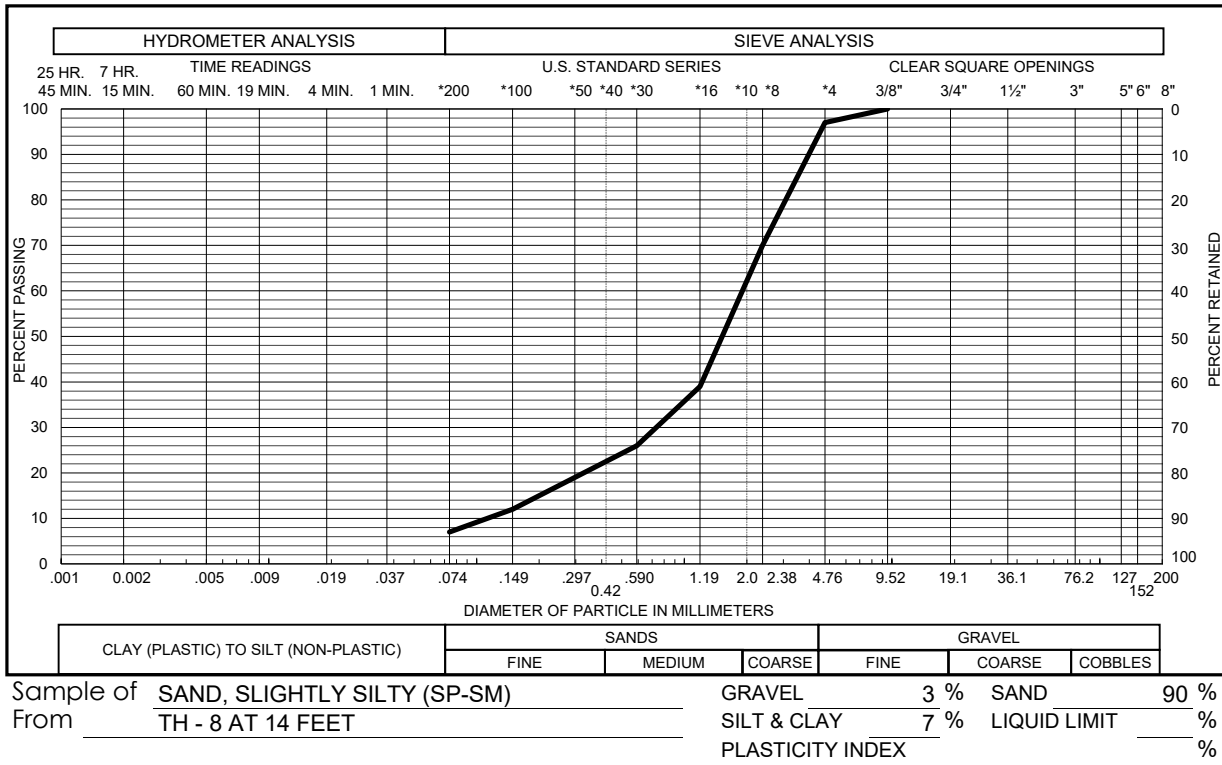
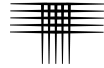
## Swell Consolidation Test Results

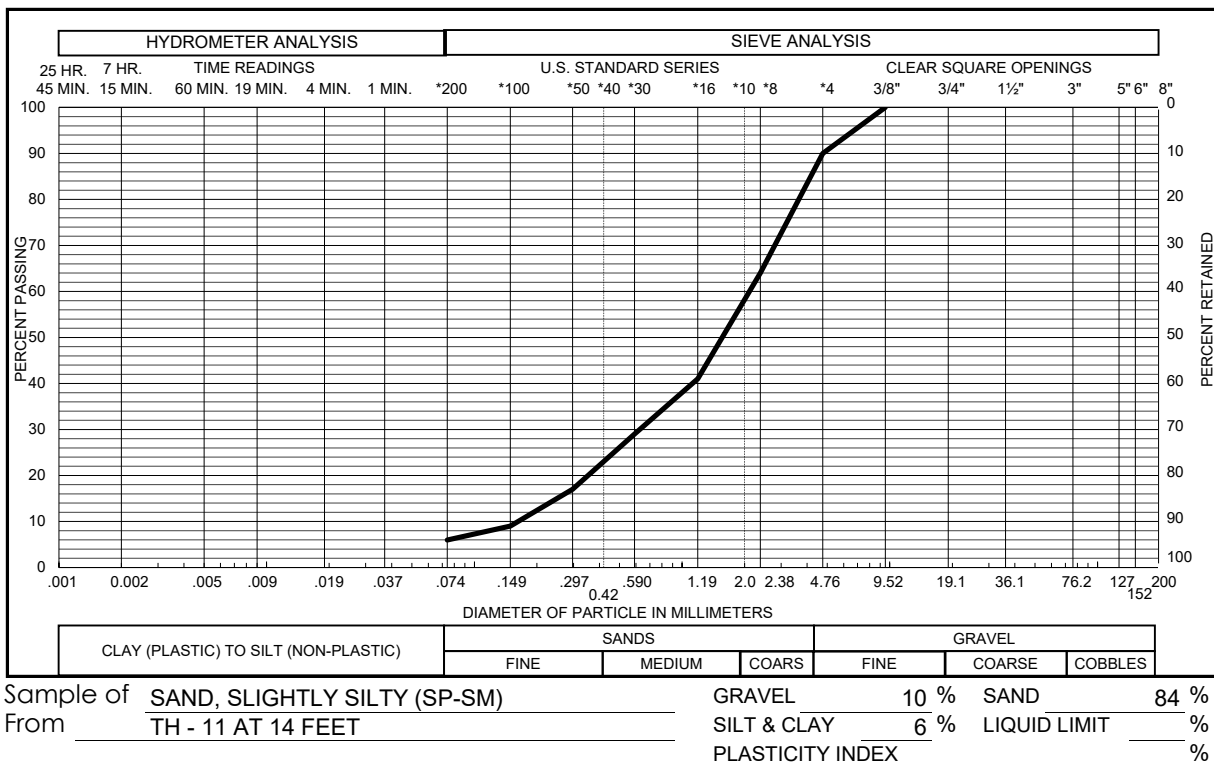
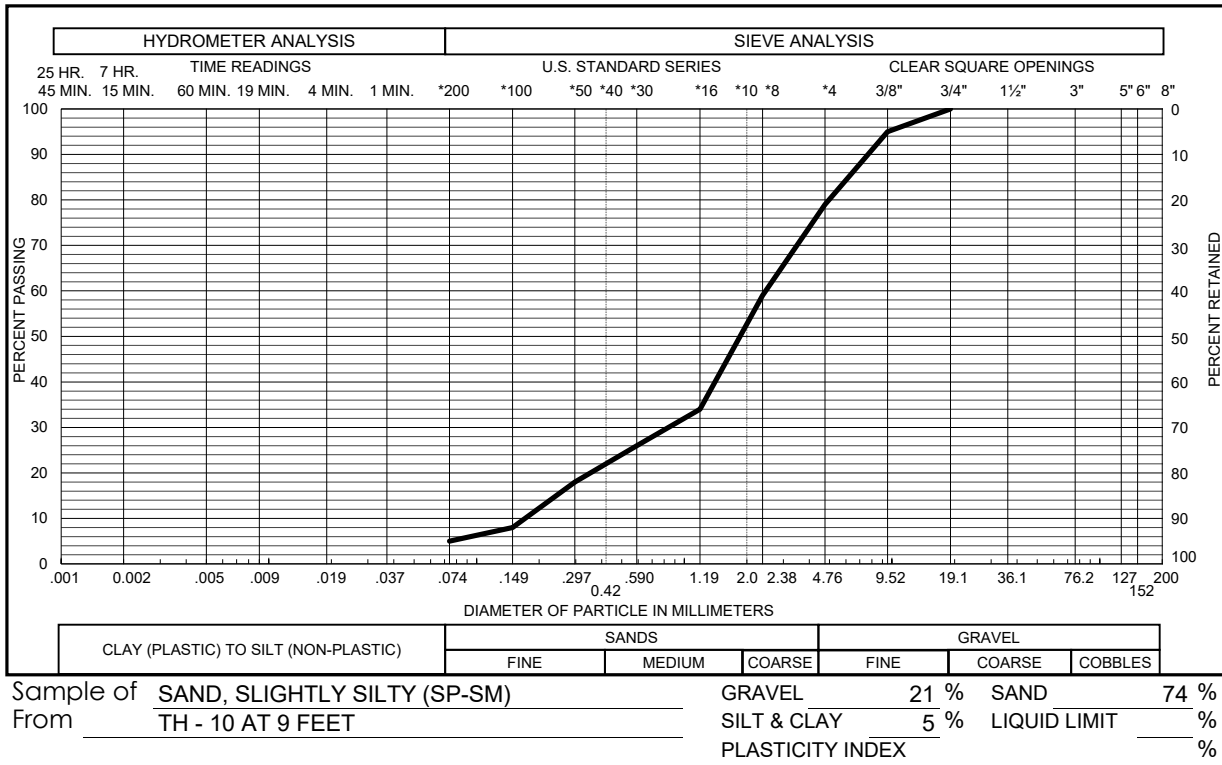
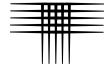
FIG. B-2

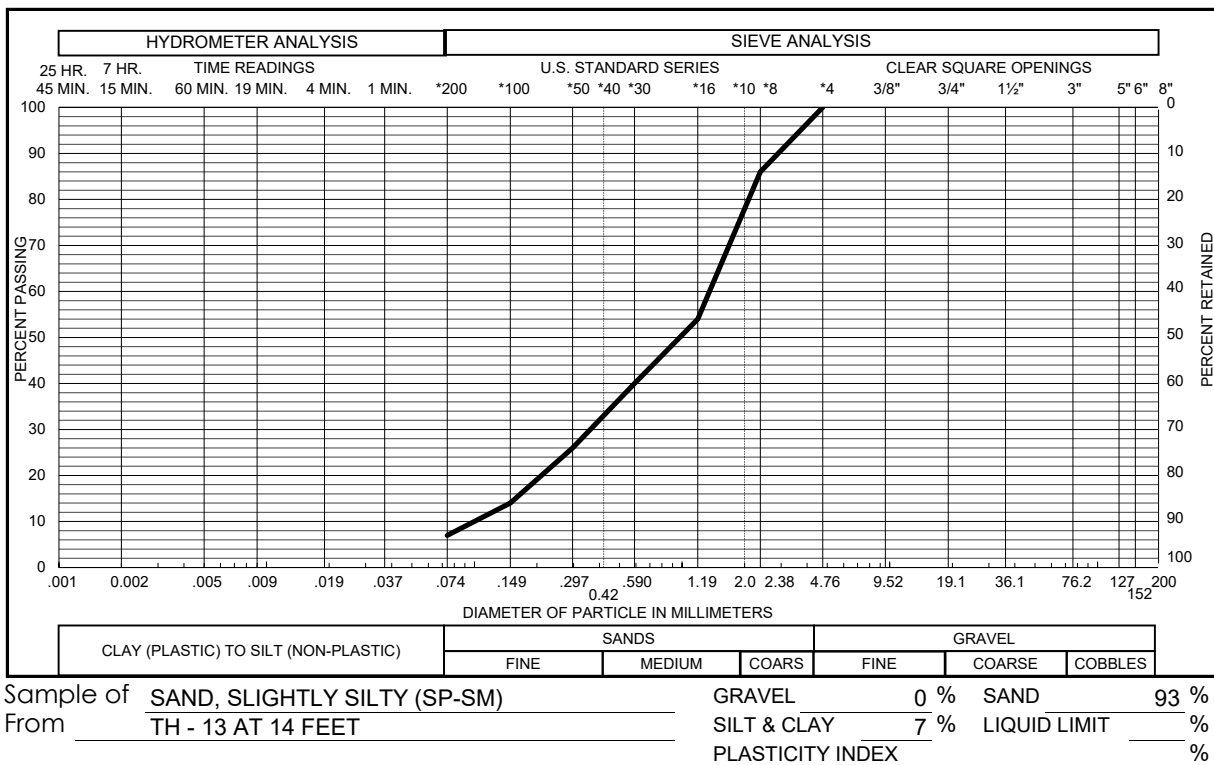
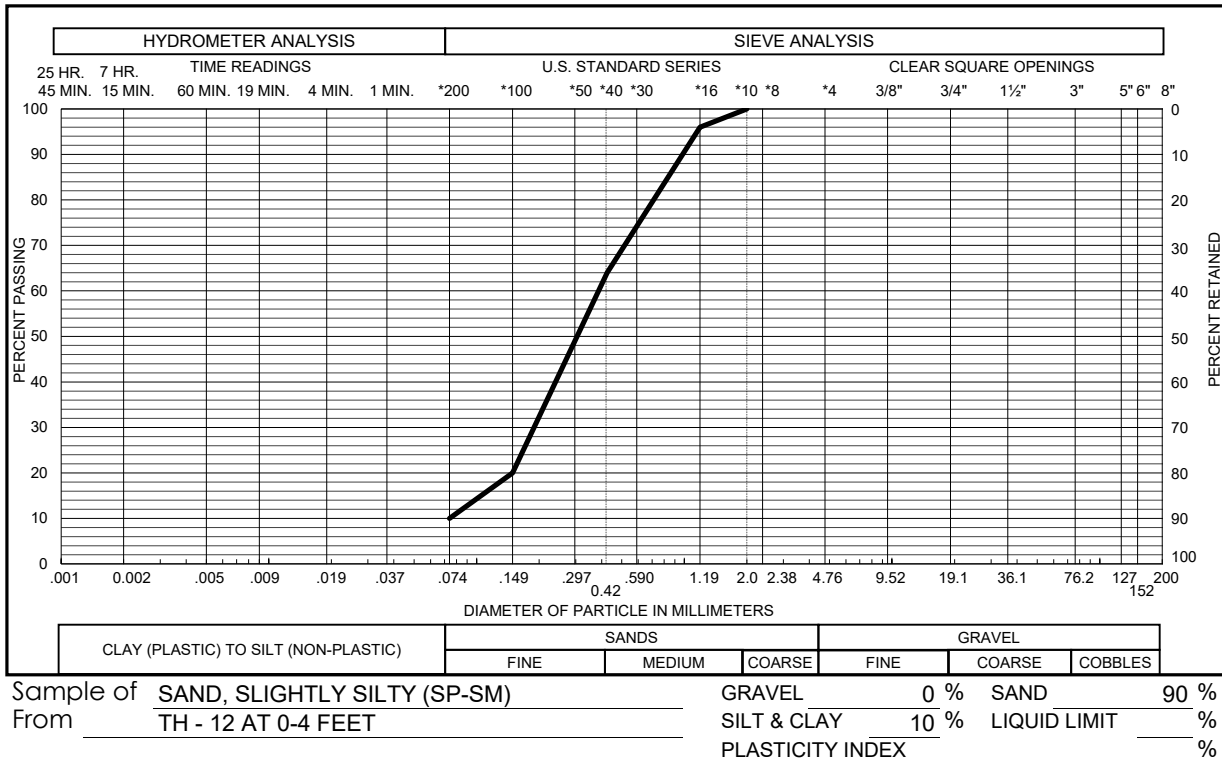
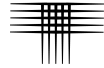


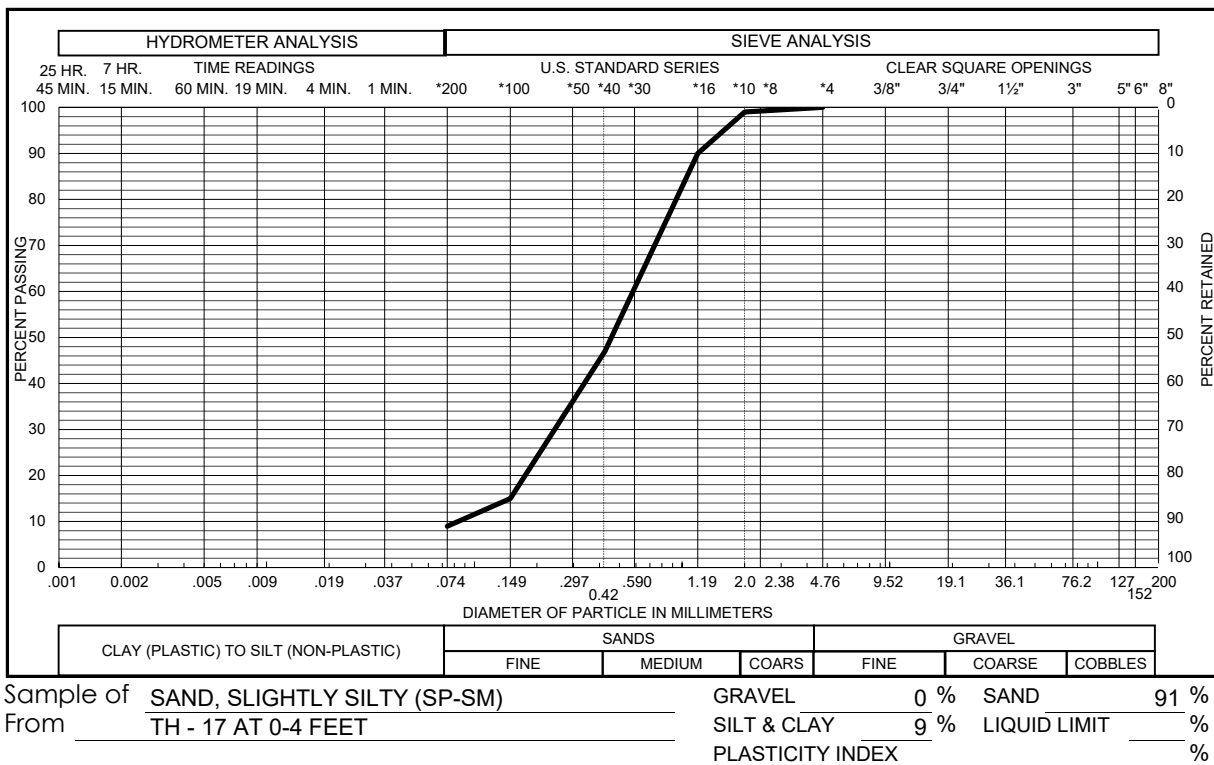
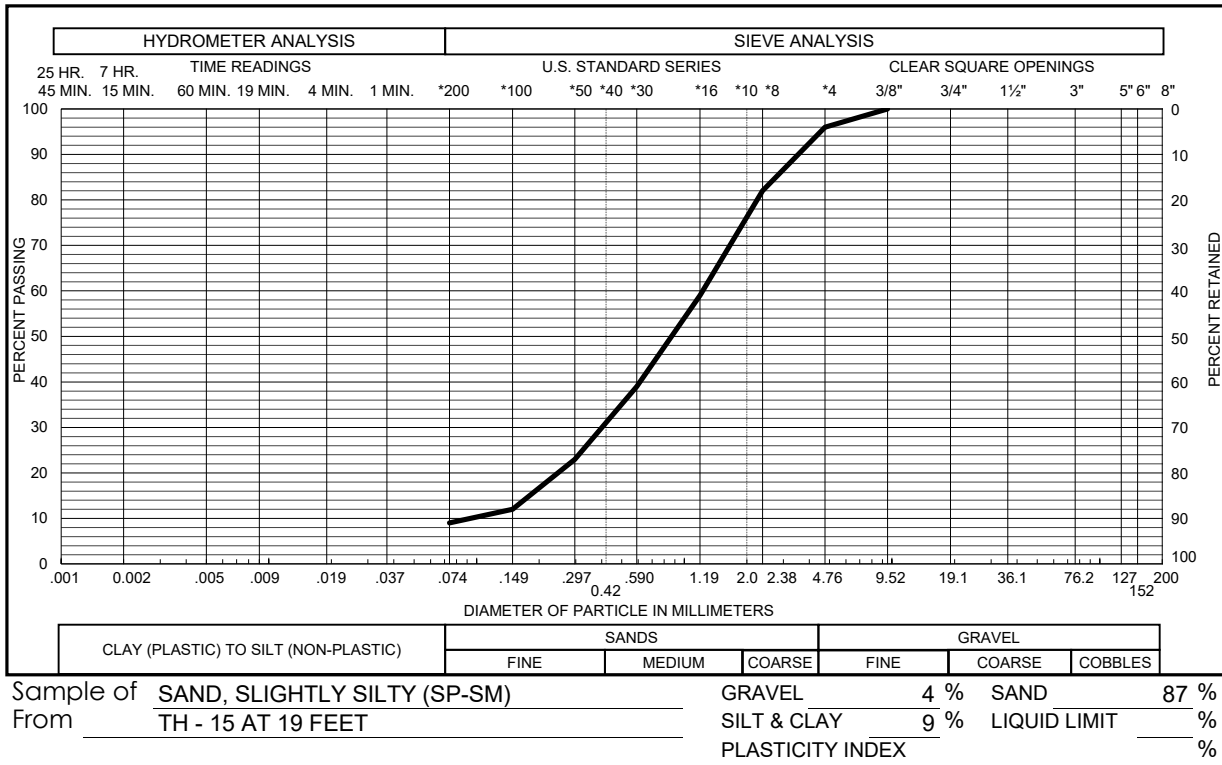
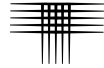


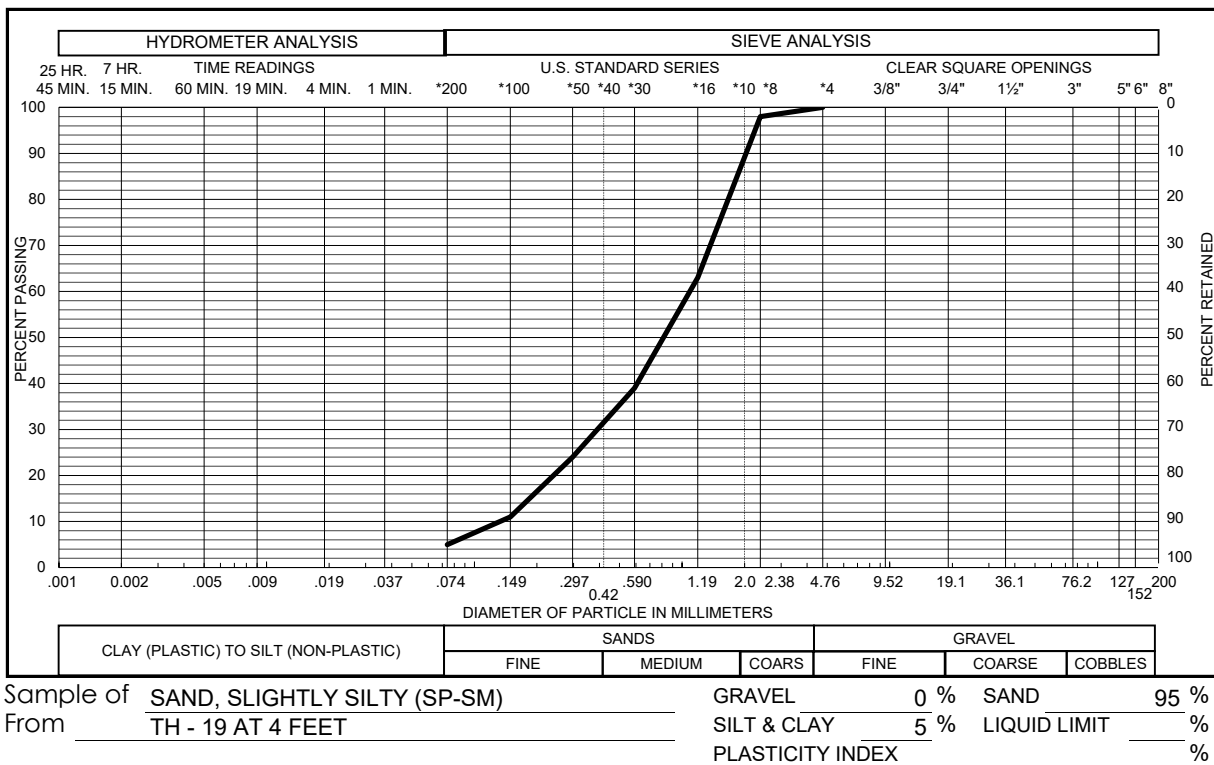
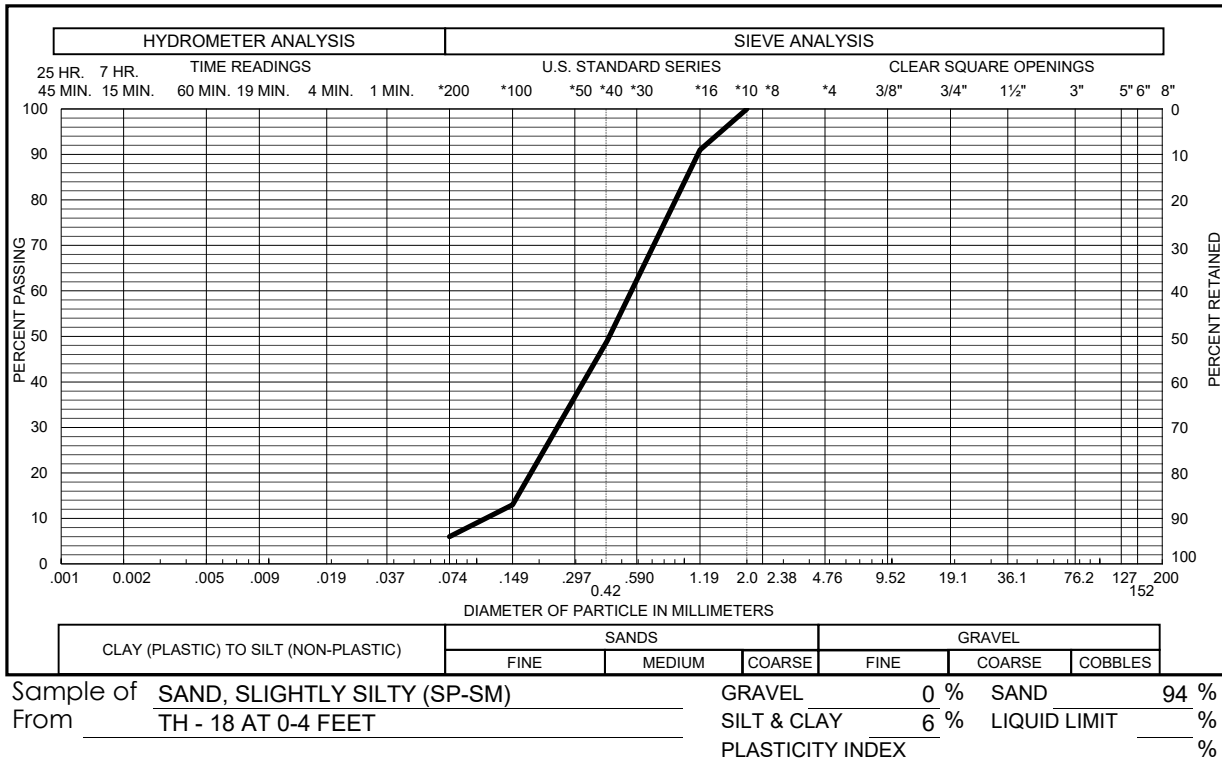
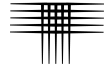












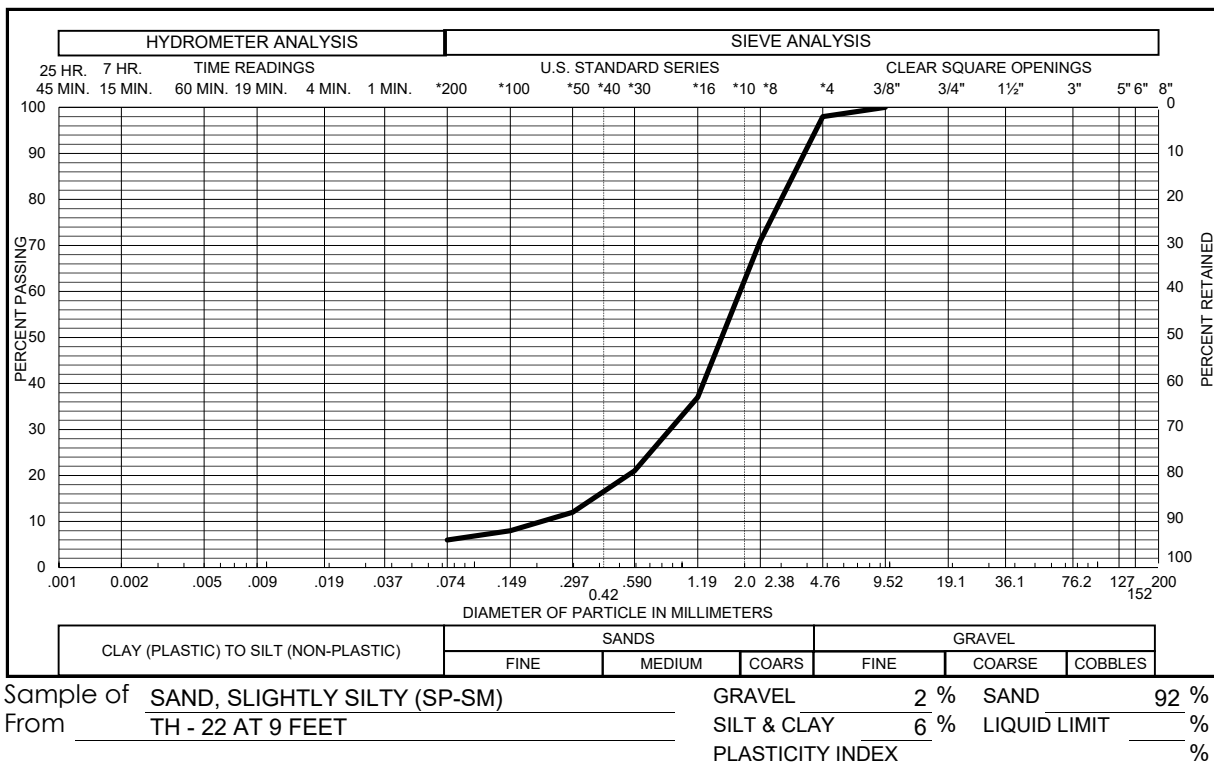
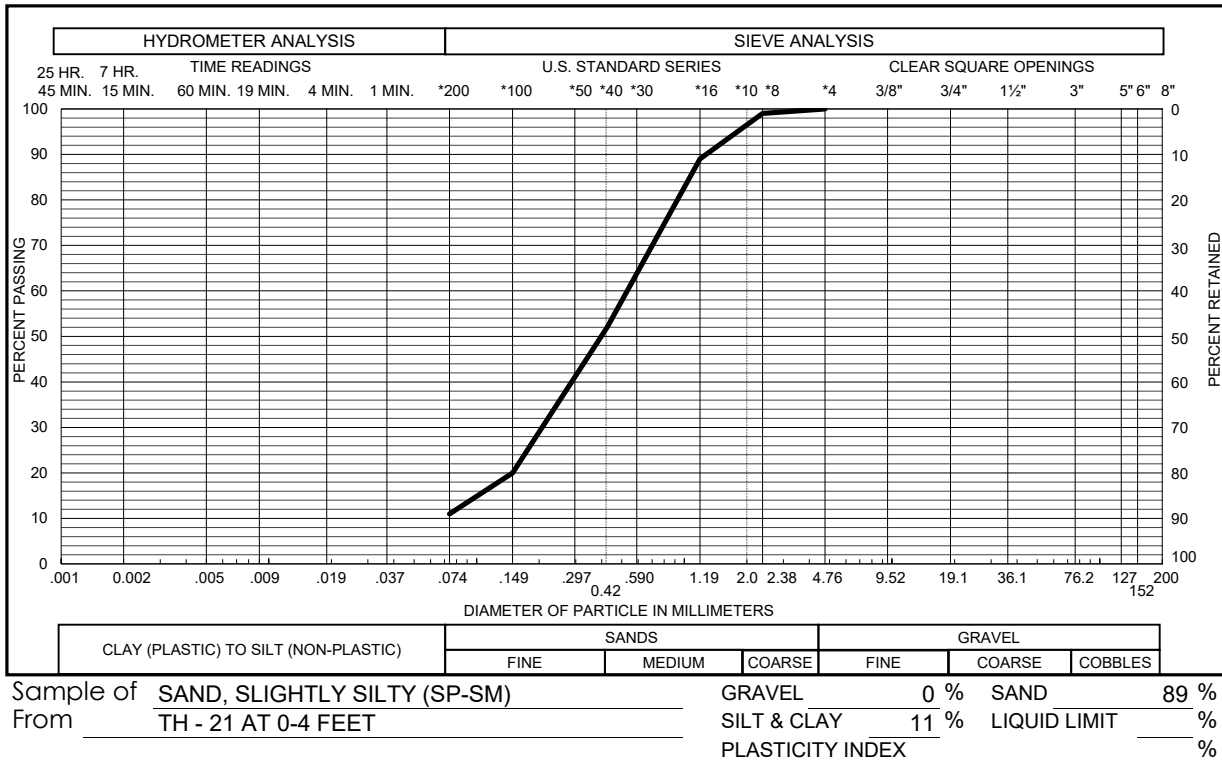
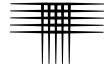


TABLE 1

**SUMMARY OF LABORATORY TESTING  
CTLJT PROJECT NO. CS19308-125**

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS		SWELL TEST RESULTS*			PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)			
TH-1	14	9.4	126						23		SAND, SILTY (SM)
TH-1	19	8.6	121			-0.1	2400				SAND, SILTY (SM)
TH-2	0-4	8.4		23	2				28	<0.1	FILL, SAND, SILTY
TH-2	9	7.7	122						12		SAND, SLIGHTLY SILTY (SP-SM)
TH-2	14	9.0	127						12		SAND, SLIGHTLY SILTY (SP-SM)
TH-3	4	10.1	100			-1.3	500		35		SAND, SILTY (SM)
TH-3	19	8.8	125						15		SAND, SILTY (SM)
TH-4	0-4	5.0		NV	NP				8		SAND, SLIGHTLY SILTY (SP-SM)
TH-4	4	9.7	123						9	<0.1	SAND, SLIGHTLY SILTY (SP-SM)
TH-4	14	9.5	124						9		SAND, SLIGHTLY SILTY (SP-SM)
TH-5	4	5.4	107						11		SAND, SLIGHTLY SILTY (SP-SM)
TH-5	14	10.3	123						8		SAND, SLIGHTLY SILTY (SP-SM)
TH-6	4	8.5	120						9	<0.1	SAND, SLIGHTLY SILTY (SP-SM)
TH-6	9	9.5	121						10		SAND, SLIGHTLY SILTY (SP-SM)
TH-7	0-4	7.7		NV	NP				10		SAND, SLIGHTLY SILTY (SP-SM)
TH-7	4	4.0	101						5		SAND, SLIGHTLY SILTY (SP-SM)
TH-7	9	8.2	127						13		SAND, SILTY (SM)
TH-8	9	9.2	127						14		SAND, SILTY (SM)
TH-8	14	10.5	120						7		SAND, SLIGHTLY SILTY (SP-SM)
TH-9	4	1.6	99						9		SAND, SLIGHTLY SILTY (SP-SM)
TH-9	19	8.7	128						11		SAND, SLIGHTLY SILTY (SP-SM)
TH-10	9	8.6	111						5		SAND, SLIGHTLY SILTY (SP-SM)
TH-10	19	8.2	127						10		SAND, SLIGHTLY SILTY (SP-SM)
TH-11	4	4.1	104						8		SAND, SLIGHTLY SILTY (SP-SM)
TH-11	14	8.4	119						6		SAND, SLIGHTLY SILTY (SP-SM)
TH-12	0-4	3.4		NV	NP				10		SAND, SLIGHTLY SILTY (SP-SM)
TH-12	4	2.8	105						14		SAND, SILTY (SM)
TH-12	9	2.9	104						6		SAND, SLIGHTLY SILTY (SP-SM)
TH-13	4	1.8	107						16		SAND, SILTY (SM)
TH-13	14	3.0	106						7		SAND, SLIGHTLY SILTY (SP-SM)
TH-14	4	3.9	102						6	<0.1	SAND, SLIGHTLY SILTY (SP-SM)
TH-14	14	6.1	114						9		SAND, SLIGHTLY SILTY (SP-SM)
TH-15	9	3.0	103						16		SAND, SILTY (SM)

\* SWELL MEASURED UNDER ESTIMATED IN-SITU OVERBURDEN PRESSURE.  
NEGATIVE VALUE INDICATES COMPRESSION.

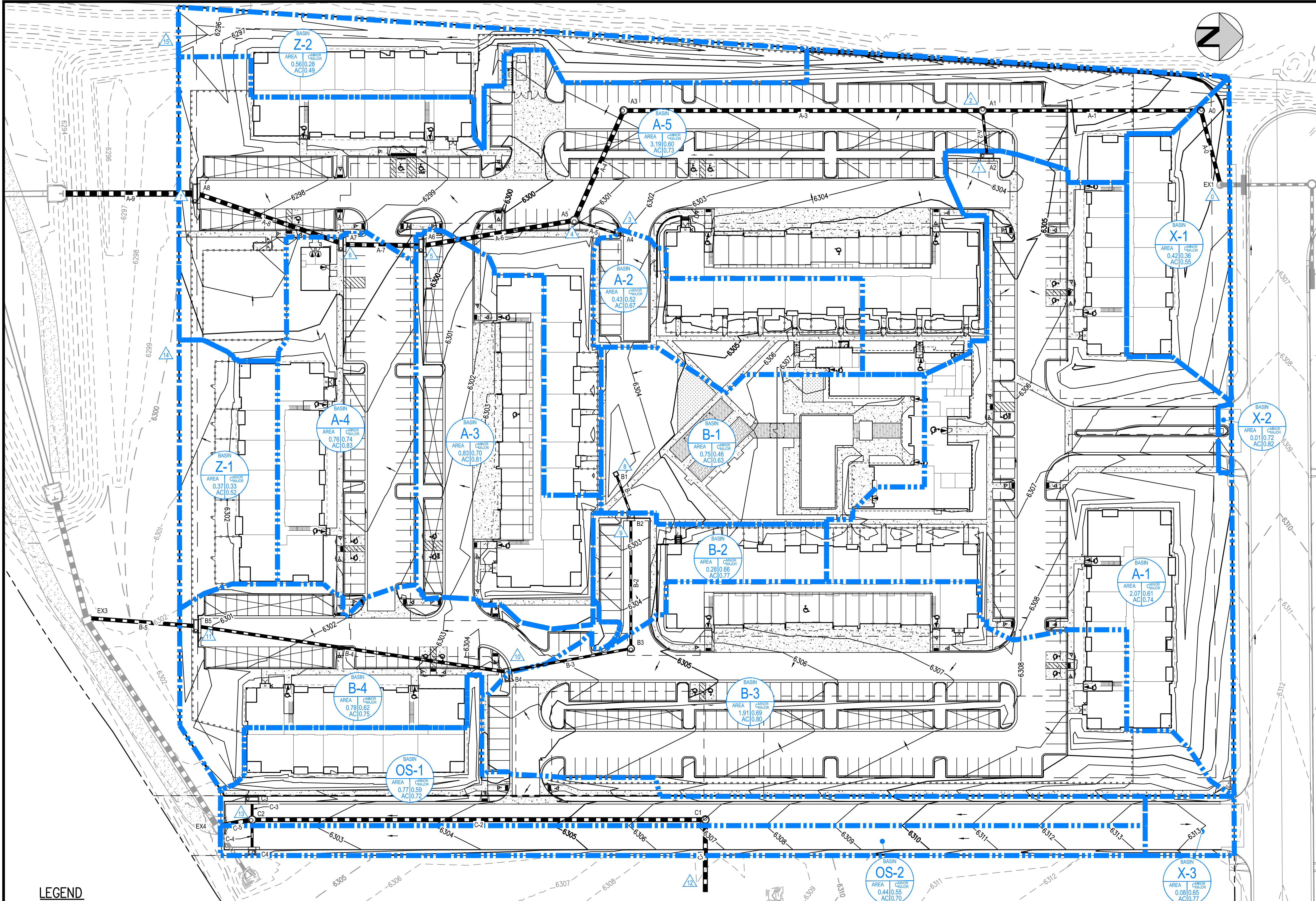
**TABLE 1****SUMMARY OF LABORATORY TESTING  
CTL|T PROJECT NO. CS19308-125**

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS		SWELL TEST RESULTS*			PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)			
TH-15	19	6.3	117						9		SAND, SLIGHTLY SILTY (SP-SM)
TH-16	14	8.4	130	NV	NP				13		SAND, SILTY (SM)
TH-16	19	9.2	126						13		SAND, SILTY (SM)

\* SWELL MEASURED UNDER ESTIMATED IN-SITU OVERBURDEN PRESSURE.  
NEGATIVE VALUE INDICATES COMPRESSION.

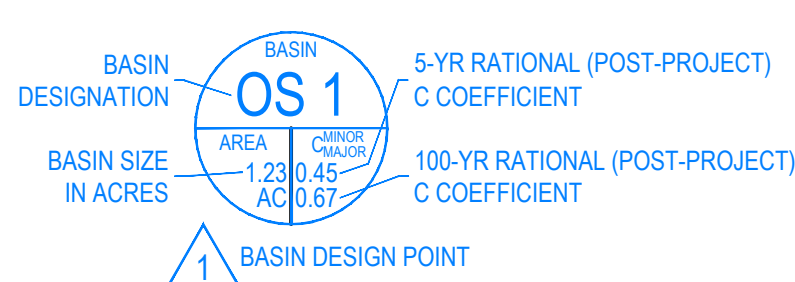
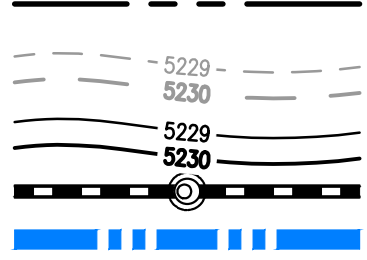
## Appendix F – Drainage Plan

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH.



### LEGEND

- PROPERTY LINE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- PROPOSED STORM SEWER
- PROPOSED DRAINAGE BASIN
- SURFACE FLOW DIRECTION



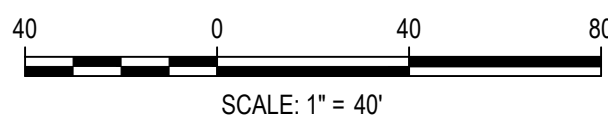
STRUCTURE TABLE	
STRUCTURE ID	DESCRIPTION
A0	5"Ø MANHOLE
A1	6"Ø MANHOLE
A2	INLET TYPE R 10'
A3	6"Ø MANHOLE
A4	INLET TYPE R 5'
A5	6"Ø MANHOLE
A6	INLET TYPE R 10'
A7	INLET TYPE R 10'
A8	INLET TYPE R 15'
B1	INLET TYPE C
B2	INLET TYPE R 5'

STRUCTURE TABLE	
STRUCTURE ID	DESCRIPTION
B3	5"Ø MANHOLE
B4	INLET TYPE R 10'
B5	INLET TYPE R 10'
C1	6"Ø MANHOLE
C2	6"Ø MANHOLE
C3	INLET TYPE R 10'
C4	INLET TYPE R 5'
EX1	5"Ø MANHOLE
EX3	EX 6"Ø MANHOLE
EX4	EX 6"Ø MANHOLE

PIPE TABLE						
NAME	UPSTREAM STRUCTURE	DOWNSTREAM STRUCTURE	SIZE	LENGTH	SLOPE	MATERIAL
A-0	EX1	A0	30"	64.26'	0.75%	RCP
A-1	A0	A1	30"	182.49'	0.75%	RCP
A-2	A2	A1	18"	38.27'	2.00%	RCP
A-3	A1	A3	36"	299.96'	1.00%	RCP
A-4	A3	A5	36"	100.82'	0.50%	RCP
A-5	A4	A5	15"	36.40'	2.00%	RCP
A-6	A5	A6	36"	128.32'	0.60%	RCP
A-7	A6	A7	36"	64.03'	1.00%	RCP
A-8	A7	A8	36"	125.80'	1.25%	RCP
A-9	A8	A8	48"	107.89'	0.60%	RCP
B-1	B1		15"	35.69'	0.50%	RCP
B-2	B2	B3	18"	109.40'	0.50%	RCP
B-3	B3	B4	18"	104.30'	0.50%	RCP
B-4	B4	B5	24"	260.85'	0.75%	RCP
B-5	B5	EX3	30"	87.62'	3.50%	RCP
C-1		C1	36"	60.28'	1.28%	RCP
C-2	C1	C2	36"	378.89'	1.20%	RCP
C-3	C3	C2	18"	17.17'	2.00%	RCP
C-4	C4	C2	18"	27.17'	2.00%	RCP
C-5	C2	EX4	36"	26.52'	2.00%	RCP

DESIGN POINT SUMMARY			
DESIGN POINT	Q5 (CFS)	Q100 (CFS)	
0	15.62	36.47	
1	4.61	9.36	
2	19.22	43.47	
3	0.88	1.90	
4	19.54	44.21	
5	21.40	47.78	
6	23.28	51.36	
7	29.76	64.68	
8	1.38	3.17	
9	2.09	4.57	
10	6.85	13.80	
11	8.46	17.10	
12	35.00	60.50	
13	37.46	65.65	
14	0.47	1.27	
15	0.63	1.84	

DIRECT RUNOFF SUMMARY			
SUBBASIN	AREA (AC)	Q5 (CFS)	Q100 (CFS)
X-1	0.42	0.58	1.50
X-2	0.01	0.05	0.10
X-3	0.08	0.21	0.43
A-1	2.07	4.61	9.36
A-2	0.43	0.88	1.90
A-3	0.83	2.19	4.20
A-4	0.76	2.76	5.24
A-5	3.19	6.77	13.85
B-1	0.75	1.38	3.17
B-2	0.28	0.74	1.45
B-3	1.91	4.89	9.52
B-4	0.78	2.08	4.20
OS-1	0.77	1.86	3.84
OS-2	0.44	0.95	2.02
Z-1	0.37	0.47	1.27
Z-2	0.56	0.63	1.84



ISSUE DATE: 08-06-2021	
DATE	REVISION COMMENTS



TRINIS ACQUISITION COMPANY, LLC

AURA AT CROSSROADS  
DRAINAGE PLAN

PROJECT #: 200823  
SHEET NUMBER

1

1 OF 1

FILEPATH: K:\200823\ENGINEERING\DRAINAGE\PLANNING LAYOUT\1 (2)  
5/15/2021  
PLOTTED: MON 08/06/21 9:57:16A BY: ETIAN MARKS

## Appendix G – Cost Estimate



**Aura at Crossroads  
Opinion of Probable Cost  
August 6, 2021**

**Storm Sewer Improvements**

Tract C (Metro District) Storm Sewer Improvements					
Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Connect to Existing 6'Ø Manhole	EA	1	\$ 500.00	\$ 500.00
2	18" Ø RCP (CIP)	LF	44	\$ 67.00	\$ 2,948.00
3	36" Ø RCP (CIP)	LF	405	\$ 124.00	\$ 50,220.00
4	36"Ø Plug	EA	1	\$ 200.00	\$ 200.00
5	6'Ø Manhole	EA	2	\$ 5,400.00	\$ 10,800.00
6	CDOT Type R 5' Inlet	EA	1	\$ 5,736.00	\$ 5,736.00
7	CDOT Type R 10' Inlet	EA	1	\$ 7,894.00	\$ 7,894.00
Tract C Storm Sewer Improvements Subtotal					\$ 78,298.00

Private Storm Sewer Improvements (Non-Reimbursable)					
Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Connect to Existing 30" Stub	EA	1	\$ 200.00	\$ 200.00
2	Connect to Existing 48" Stub	EA	1	\$ 300.00	\$ 300.00
3	Connect to Existing 6'Ø Manhole	EA	1	\$ 500.00	\$ 500.00
4	15" RCP (CIP)	LF	72	\$ 65.00	\$ 4,680.00
5	18" RCP (CIP)	LF	252	\$ 67.00	\$ 16,884.00
6	24" RCP (CIP)	LF	261	\$ 81.00	\$ 21,141.00
7	30" RCP (CIP)	LF	508	\$ 100.00	\$ 50,760.00
8	36" RCP (CIP)	LF	719	\$ 124.00	\$ 89,143.60
9	48" RCP (CIP)	LF	108	\$ 202.00	\$ 21,816.00
10	5'Ø Manhole	EA	2	\$ 4,500.00	\$ 9,000.00
11	6'Ø Manhole	EA	3	\$ 5,400.00	\$ 16,200.00
12	CDOT Type R 5' Inlet	EA	1	\$ 5,736.00	\$ 5,736.00
13	CDOT Type R 10' Inlet	EA	5	\$ 7,894.00	\$ 39,470.00
14	CDOT Type R 15' Inlet	EA	1	\$ 10,265.00	\$ 10,265.00
15	CDOT Type C Inlet	EA	1	\$ 5,000.00	\$ 6,000.00
Private Storm Sewer Improvements Subtotal					\$ 292,095.60

<b>Storm Sewer Improvements Grand Total</b>					<b>\$ 370,393.60</b>
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