FINAL DRAINAGE REPORT

for

KANG STORAGE – 11401 E. HIGHWAY 24
LOT 1, ABIDING WORD LUTHERAN CHURCH SUBDIVISION

Prepared for:

Hammers Construction, Inc.
1411 Woolsey Heights
Colorado Springs, CO 80915

June 22, 2026
Revised November 16, 2026

Prepared by:

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DRAINAGE STATEMENT

Engineer's Statement:

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

_____

John P. Schwab, P.E. #29891

Developer's Statement:

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

By:

_____

Date

Hammers Construction
1411 Woolsey Heights, Colorado Springs, CO 80915

El Paso County's Statement

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

_____

Joshua J. Palmer, P.E. Date
County Engineer / ECM Administrator

Conditions:

I. INTRODUCTION

A. Property Location and Description

Mr. Steve Kang (property owner) is planning to develop the proposed Kang Storage project on the vacant site at 11041 E. Highway 24 in the Falcon area of El Paso County, Colorado. The project site (El Paso County Assessor's Parcel Number 53130-01-013) is a 12.3-acre property located at the southeast corner of US Highway 24 and Falcon Highway. The property is platted as Lot 1, Abiding Word Lutheran Church Subdivision, and the site is zoned CS (Commercial Service). The property is located in the North Half of Section 13, Township 13 South, Range 65 West of the 6th Principal Meridian, El Paso County, Colorado.

The west boundary of the property adjoins US Highway 24 (US24), which is an asphalt-paved arterial CDOT highway. In preparation for upcoming highway improvements, CDOT has acquired a strip of right-of-way along the west boundary of the site. CDOT has also acquired a corridor along the eastern boundary of this site for a proposed public road (Bluestem Road) to be constructed by CDOT for access to properties to the south, minimizing direct access connections to US24. The proposed Bluestem Road will be owned and maintained by El Paso County upon completion and acceptance.

The north boundary of the property adjoins Falcon Highway, which is an asphalt-paved arterial roadway owned and maintained by the City of Colorado Springs. The east boundary of the property adjoins an unplatted 16.1-acre ranch property (Zoned RR5; Rural Residential), and the southwest boundary adjoins another unplatted 5-acre ranch property (Zoned RR5; Rural Residential).

The proposed site improvements consist of crushed asphalt paving of the majority of the developed site for uncovered storage use. Additionally, gated storage yards will be enclosed with fencing along the southwest side of the property. The proposed site improvements will have minimal impacts on the existing Mountain View Electric Association (MVEA) easement along the southwest boundary of the property. Access to the site will be provided by a driveway connection to the proposed private road along the east boundary of the property.

A small area along the east side of the adjoining Bluestem Road corridor (public right-of-way) is located within the Falcon Drainage Basin, and drainage planning for this corridor is detailed in the CDOT drainage report for the "US 24 Garrett to Woodmen" project.

The on-site area is located entirely within the Sand Creek Drainage Basin. Surface drainage from this site sheet flows southwesterly to an existing drainage swale at the south boundary of the property, draining to an existing public double 24-inch culvert crossing US24 beyond the southwest corner of the property.

B. Scope

This report will provide a summary of site drainage issues impacting the proposed commercial site development. The report will analyze upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual, and the report is intended to fulfill the requirements for a "Final Drainage Report" for this property.

C. References

City of Colorado Springs & El Paso County "Drainage Criteria Manual," revised October 31, 2018.

City of Colorado Springs "Drainage Criteria Manual, Volume 1," revised January, 2021.

City of Colorado Springs "Drainage Criteria Manual, Volume 2," revised December, 2020.

El Paso County "Engineering Criteria Manual," revised July 18, 2023.

HDR, "Hydraulic Design Report, US24 Garrett to Woodmen," August 5, 2026.

Mile High Flood District, "Urban Storm Drainage Criteria Manual, Volume 1," revised August, 2018.

Mile High Flood District, "Urban Storm Drainage Criteria Manual, Volume 2," revised September, 2017.

Mile High Flood District, "Urban Storm Drainage Criteria Manual, Volume 3," revised January, 2021.

MVE, Inc., "Abiding Word Lutheran Church Subdivision" Drainage Report, July 10, 2006 (approved by County 10/25/06).

II. EXISTING / PROPOSED DRAINAGE CONDITIONS

A. Existing Drainage Conditions

According to the Custom Soil Resource Report for this site (see details in Appendix A) provided by the Natural Resources Conservation Service (NRCS), on-site soils are comprised of the following:

- "Type 9: Blakeland-Fluvaquentic Haplaquolls" soils. These soils are classified as hydrologic soils group "A" (high infiltration rate).
- "Type 97: Truckton sandy loam" soils (majority of site). These soils are classified as hydrologic soils group "A" (high infiltration rate).

As shown on the enclosed Existing Conditions Drainage Plan (Figure EX1, Appendix E), the property has been delineated as a single on-site drainage basin (Basin A, 12.36-acres), which sheet flows to the southwest corner of the site. Existing peak flows from Bain A are calculated as $Q_5 = 2.9$ cfs and $Q_{100} = 21.4$ cfs.

The adjoining CDOT private road corridor along the east boundary of the site has been delineated as Off-site Basin OA1 (1.6-acres), which contributes off-site drainage flowing into Basin A. Existing peak flows from Bain OA1 are calculated as $Q_5 = 0.4$ cfs and $Q_{100} = 2.8$ cfs.

Drainage from Basin OA1 combines with Basin A at Design Point #1, with existing peak flows calculated as $Q_5 = 3.4$ cfs and $Q_{100} = 24.8$ cfs.

B. CDOT Drainage Plan

The Colorado Department of Transportation (CDOT) has plans for an upcoming "US 24 Garrett to Woodmen" project, which will include improvements to the roadways adjoining this site. In preparation for the project, CDOT acquired right-of-way along the east, west, and north sides of the Kang property. The CDOT plans include improvements to the intersection of US24 and Falcon Highway, along with construction of a new local public road (Bluestem Road) along the east side of this property, extending public road access from Falcon Highway to the south.

Drainage planning for the CDOT project is detailed in the "Hydraulic Design Report, US24 Garrett to Woodmen" by HDR dated August 5, 2026 (see excerpts in Appendix B). The CDOT report identifies this property as being within Basin 197R (20.91-acres), which flows to the existing double 24-inch culvert ("CV-197") crossing US24 southwest of this property. The CDOT drainage report identifies replacement of the existing culvert with a new 36-inch RCP culvert as part of the CDOT project.

The CDOT report identifies several small drainage basins along the proposed Bluestem Road corridor (HDR Basins 77, 81L, 85R, and 85L). CDOT Basin 77 (0.06-acres) consists of a small area along the east side of Bluestem Road, which will flow northwesterly across the new road in the proposed 15" Culvert CV-77. CDOT Basin 85R (0.19-acres) consists of another small basin along the east side of Bluestem Road, which will flow westerly across the new road through the proposed 15" Culvert CV-85. CDOT Basins 81L (0.94-acres) and 85L (0.41-acres) comprise the adjoining segments of Bluestem Road, which has been designed with a straight crown sheet flowing west across the roadway onto the subject property. For the purpose of this report, these CDOT basins have been combined as "Basin OA1" (1.6-acres), which flows westerly onto the subject property (Basin A1).

C. Developed Drainage Plan

Developed flows have been calculated based on the impervious areas associated with the proposed parking and storage area improvements. Developed drainage from Basin A1 will continue to sheet flow southwesterly across the site.

Sub-Basin A1

The majority of the developed site has been delineated as Sub-Basin A1 (10.79-acres), and this area has been planned for compacted crushed asphalt surfacing and use as uncovered outdoor storage areas. Sub-Basin A1 will sheet flow southwesterly to the proposed private stormwater detention pond at the southwest corner of the property. Developed peak flows from Basin A1 are calculated as $Q_5 = 28.8$ cfs and $Q_{100} = 56.6$ cfs.

As noted above, the off-site drainage along the Bluestem Road corridor (Basin OA1; 1.6-acres) will flow westerly into Basin A1. Developed peak flows from Bain OA1 are calculated as $Q_5 = 3.0$ cfs and $Q_{100} = 6.7$ cfs.

Site drainage from off-site Basin OA1 will combine with Basin A1 and flow southwest to Design Point #A1 (Detention Pond A1), with developed peak flows calculated as $Q_5 = 26.9$ cfs and $Q_{100} = 53.5$ cfs.

The 18" HDPE discharge pipe from Detention Pond A1 (along with overflows from the pond spillway) will drain southwesterly to the existing downstream drainage swale at the southwest boundary of the property. A riprap apron will be provided for erosion control at the pipe outlet.

The existing grass-lined drainage swale downstream of the proposed detention pond outlet pipe and spillway (southwest corner of the property) is in stable, well-vegetated condition, and the existing swale serves as a suitable drainage outfall.

Sub-Basin A2

The vegetated area along the south and west edges of the developed site has been delineated as Sub-Basin A2 (1.55-acres), which will sheet flow southwesterly to the adjoining grass-lined drainage swales along the perimeter of the property. Developed peak flows from Sub-Basin A2 are calculated as $Q_5 = 0.4$ cfs and $Q_{100} = 3.0$ cfs.

Sub-Basin A2 is excluded from permanent water quality requirements based on ECM Appendix I.6.3.A.1.A, which allows for 20%, not to exceed 1-acre, of the applicable development site area to not be captured. The disturbed area within Basin A2 is limited to 0.6 acres.

Combined Flows and Developed Drainage Impact

Site drainage from Basins OA1, A1, and A2 will continue to flow southwest to Design Point #1, with developed peak flows calculated as $Q_5 = 27.3$ cfs and $Q_{100} = 56.5$ cfs.

Developed drainage impacts will be mitigated by routing developed flows through the proposed Detention Pond A1, and the resulting detained flows at Design Point #1 are calculated as $Q_5 = 0.7$ cfs and $Q_{100} = 10.1$ cfs. The detained flows discharged downstream of the property will be significantly lower than historic flows.

Hydrologic calculations for the site are detailed in Appendix C, and peak flows are identified on Figure D1 (Appendix F).

III. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in ECM Appendix I.7., the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Extended Detention Basin: Developed flows from the site will be routed through the proposed on-site detention basin (Pond A1), which will be grass-lined to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- There are no major drainageways within this project site. Implementation of the proposed on-site drainage improvements and detention basin will minimize downstream drainage impacts from this site.

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The developed site will drain through an on-site Private Extended Detention Basin (Pond A1) at the southwest corner of the property. The extended detention basin which will capture and slowly release the WQCV over an extended release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- The property owner will implement a Stormwater Management Plan including proper housekeeping practices and spill containment procedures.

- On-site drainage will be routed through the Full-Spectrum Extended Detention Basin (Pond A1) to minimize introduction of contaminants to the downstream drainage system.

IV. FLOODPLAIN IMPACTS

According to the FEMA floodplain map for this area, El Paso County FIRM Panel No. 08041C0561G, dated December 7, 2018, the site is located beyond the limits of any delineated 100-year floodplains.

V. STORMWATER DETENTION AND WATER QUALITY

Proposed drainage improvements will include construction of a new Private Full-Spectrum Extended Detention Basin (Pond A1) to meet current full-spectrum detention design standards. The proposed detention facility has been designed to provide the required stormwater detention and water quality mitigation for the overall site in accordance with current El Paso County drainage criteria. The required on-site detention volume has been calculated based on the developed impervious area of the site. While the current development plan shows proposed crushed asphalt paving over the majority of the site, the detention pond has been conservatively designed assuming potential future asphalt pavement of the full developed storage area.

The proposed Detention Basin has been designed utilizing the Denver Mile High Flood District's "MH-Detention_v4.07" software package. Calculations and details for the proposed Detention Basin are enclosed in Appendix E, and design parameters for the Detention Basin are summarized as follows:

Detention Basin	Tributary Drainage Basins	Tributary Area (ac)	Impervious Percentage	Min. 100-Yr FSD Vol. (af)	Design Volume (af)
A1	OA1-A1	12.4	70.4	1.6	1.8

The proposed on-site Full-Spectrum Detention Pond A1 provides a storage volume of 1.8 acre-feet, which exceeds the minimum required 100-year detention and WQCV volume.

The proposed detention pond will include an outlet structure with a water quality orifice plate to maintain discharges below the allowable release rates. The pond outlet structure has been designed for a 40-hour release of the WQCV, and outlet structure sizing to maintain maximum allowable release rates from the pond. The detention pond will have a grass-lined bottom to encourage infiltration of stormwater prior to discharging into the downstream drainage system.

The majority of developed flow entering Pond A1 will be collected in curb and gutter along the easterly edges of the pond and directed to the proposed private Storm Inlet A1 (20' Type R) at the inside corner of the upstream edge of the pond. Proposed private Storm Drain SD-A1 (30" HDPE) will convey the flow from Inlet A1 into a concrete

forebay designed to capture sediment at the pond entry. Concrete trickle channels will be provided for stability along the bottom of the pond (see hydraulic calculations in Appendix D and E).

The new on-site Detention Basin will be privately owned and maintained by the property owner, and maintenance access will be provided from the existing gravel driveway within the site.

As detailed in the detention basin calculations in Appendix C, detained peak flows from at Design Point #A1 are calculated as $Q_5 = 0.7$ cfs and $Q_{100} = 10.1$ cfs, well below the calculated historic flows.

The estimated cost for the proposed private detention facilities is approximately $24,406 (see estimate in Appendix E).

Areas Excluded from Water Quality Facilities

As discussed in Section II.B. above, Sub-Basin A2 (1.55-acres) is excluded from permanent water quality requirements based on ECM Appendix I, which allows for 20%, not to exceed 1-acre, of the applicable development site area to not be captured. The disturbed area within Basin A2 is limited to 0.6 acres.

VI. DRAINAGE BASIN FEES

The proposed site development will include construction of private stormwater detention and water quality facilities. No public drainage improvements are required.

As noted on Sh. D1, a small area along the east side of the adjoining Bluestem Road corridor is located within the Falcon Drainage Basin. However, the on-site area lies entirely within the Sand Creek Drainage Basin, which is tributary to Fountain Creek.

Drainage and bridge fees are not applicable at this time as this site is a previously platted property (Lot 1, Abiding Word Lutheran Church Subdivision).

VII. SUMMARY

The developed drainage patterns for the proposed Kang Storage site development at 11401 E. Highway 24 will remain consistent with the historic drainage patterns for this site. Developed flows from the site will drain through a Private Full-Spectrum Detention Pond at the southwest corner of the property prior to discharging to the existing downstream drainage system. The existing grass-lined drainage swale downstream of the proposed detention pond outlet pipe and spillway (southwest corner of the property) is in stable, well-vegetated condition, and the existing swale serves as a suitable drainage outfall.

The proposed on-site Detention Pond has been designed to provide both stormwater detention and water quality requirements for the site in accordance with El Paso County Drainage Criteria Manual standards. Construction and proper maintenance of the on-site

drainage facilities and Extended Detention Basin, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A

SOILS INFORMATION

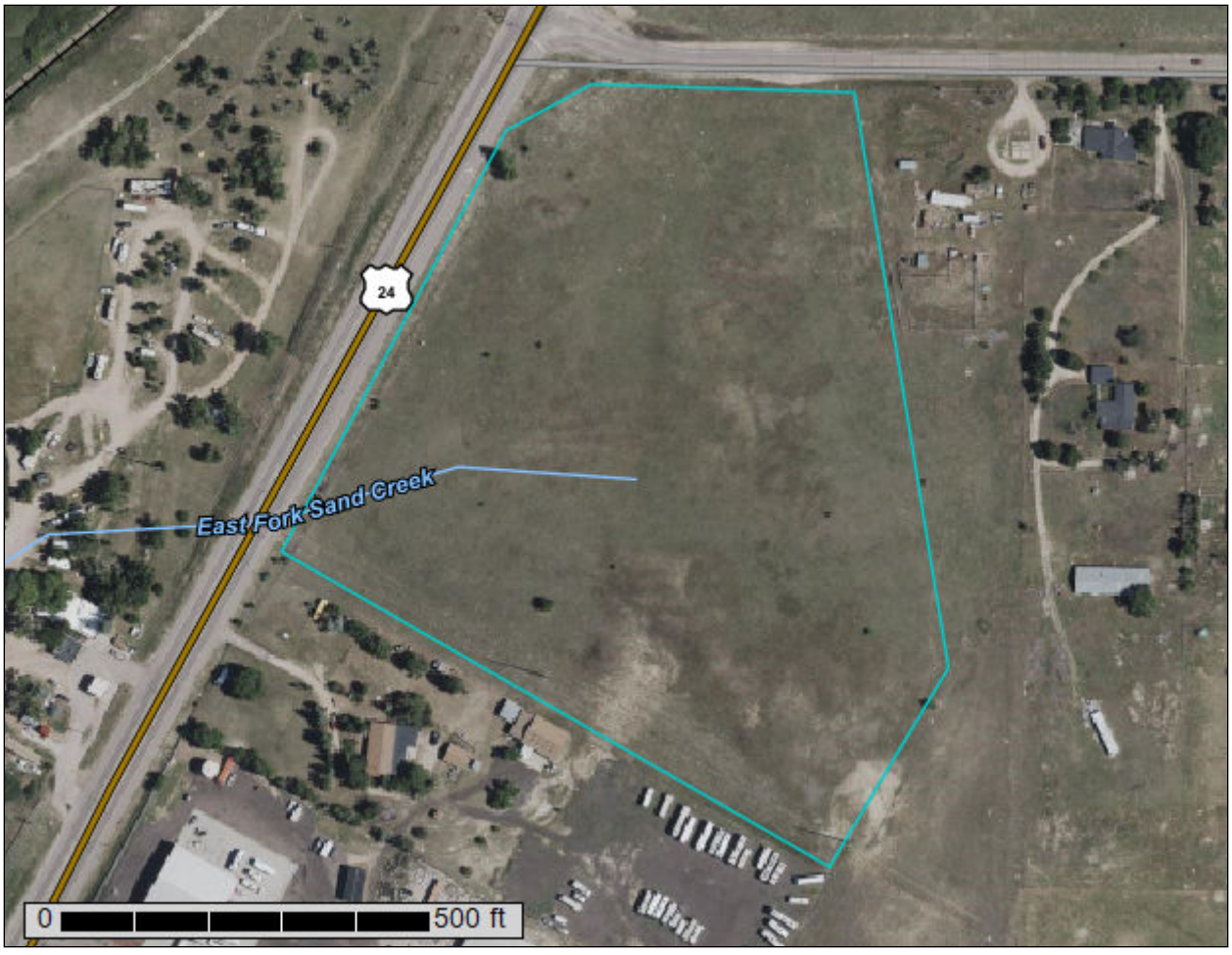
United States Department of Agriculture

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



March 16, 2026

Preface

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).

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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How Soil Surveys Are Made

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.

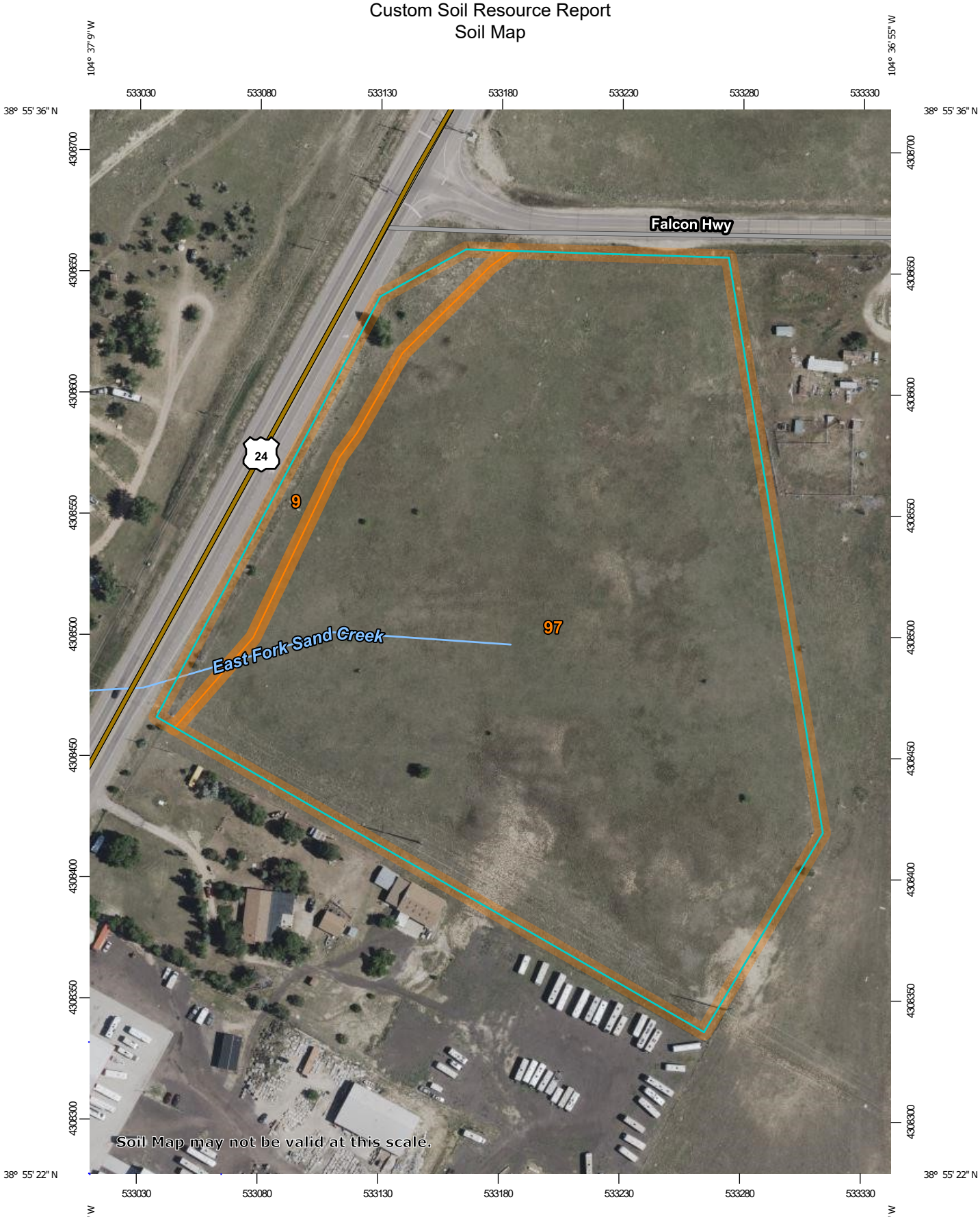
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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

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 Scale: 1:2,140 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 23, Aug 29, 2025

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

Date(s) aerial images were photographed: Jul 23, 2024—Aug 4, 2024

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
9	Blakeland-Fluvaquentic Haplaquolls	1.0	7.2%
97	Truckton sandy loam, 3 to 9 percent slopes	13.2	92.8%
Totals for Area of Interest		**14.2**	**100.0%**

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

9—Blakeland-Fluvaquentic Haplaquolls

Map Unit Setting

National map unit symbol: 36b6
Landscape: Uplands
Elevation: 3,500 to 5,800 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 46 to 55 degrees F
Frost-free period: 110 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 60 percent
Fluvaquentic haplaquolls and similar soils: 38 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landscape: Uplands
Landform: Flats, Hills
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose and/or eolian deposits derived from arkose

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 supply, 0 to 60 inches: 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

Description of Fluvaquentic Haplaquolls

Setting

Landform: Swales
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 12 inches: variable
H2 - 12 to 60 inches: stratified very gravelly sand to loam

Properties and qualities

Slope: 1 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: D
Ecological site: R048AY241CO - Mountain Meadow
Hydric soil rating: Yes

Minor Components

Other soils

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

Pleasant

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

97—Truckton sandy loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2x0j2
Landscape: Uplifted piedmonts
Elevation: 5,300 to 6,850 feet
Mean annual precipitation: 14 to 19 inches

Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 85 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Truckton and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truckton

Setting

Landscape: Uplifted piedmonts
Landform: Backslopes of hillslopes, Sideslopes of interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Re-worked alluvium derived from arkose

Typical profile

A - 0 to 4 inches: sandy loam
Bt1 - 4 to 12 inches: sandy loam
Bt2 - 12 to 19 inches: sandy loam
C - 19 to 80 inches: sandy loam

Properties and qualities

Slope: 3 to 9 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): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline (0.1 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.6 inches)

Interpretive groups

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

Minor Components

Blakeland

Percent of map unit: 8 percent
Landscape: Uplifted piedmonts
Landform: Shoulders and backslopes of hillslopes, Sideslopes and crests of interfluves
Landform position (two-dimensional): Shoulder, backslope, summit
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Convex, linear

Across-slope shape: Convex, linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Bresser

Percent of map unit: 7 percent
Landscape: Uplifted piedmonts
Landform: Toeslopes or footslopes of low hills, Baseslopes of interfluves
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

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Hydrologic Soil Group—El Paso County Area, Colorado
(Kang Parcel)



Map Scale: 1:2,140 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 23, Aug 29, 2025

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

Date(s) aerial images were photographed: Jul 23, 2024—Aug 4, 2024

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
9	Blakeland-Fluvaquentic Haplaquolls	A	1.0	7.2%
97	Truckton sandy loam, 3 to 9 percent slopes	A	13.2	92.8%
Totals for Area of Interest			**14.2**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX B

EXCERPTS FROM CDOT DRAINAGE REPORT



Hydraulic Design Report

US 24 Garrett to Woodmen

Prepared for Colorado Department of Transportation, Region 2

August 5, 2026

FINAL DRAINAGE REPORT

CDOT R2 Construction Project Code No. 25094
US 24 Garrett to Woodmen

Prepared for:

COLORADO
Department of Transportation

Prepared by:

5555 Tech Center Drive, Suite 310

Colorado Springs, CO 80919

719-272-8800

August 5, 2026

1 Introduction

1.1 Project Location and Purpose

US 24 from Garrett Road to Woodmen Road project includes widening 3.5 miles of US 24 near Falcon, CO. This project is designed for the Colorado Department of Transportation (CDOT) Region 2 in conjunction with the City of Colorado Springs (COS) and El Paso County (EPC).

The purpose of the project is to widen US 24 from two to four through lanes, from south of Garrett Road to north of Woodmen Road. In existing conditions the area is primarily rural with the drainage system consisting of roadside ditches and cross culverts. The culverts under US 24 will be extended or replaced. A vicinity map is located in Figure 1 below. The project site is located in Township 13 South, Sections 6 and 7, within Range 64 West, and Section 12, 13, 14, and 23 within Range 65 West.

This report provides a narrative of the existing project area and proposed improvements. For additional details and calculations, see the provided appendices.

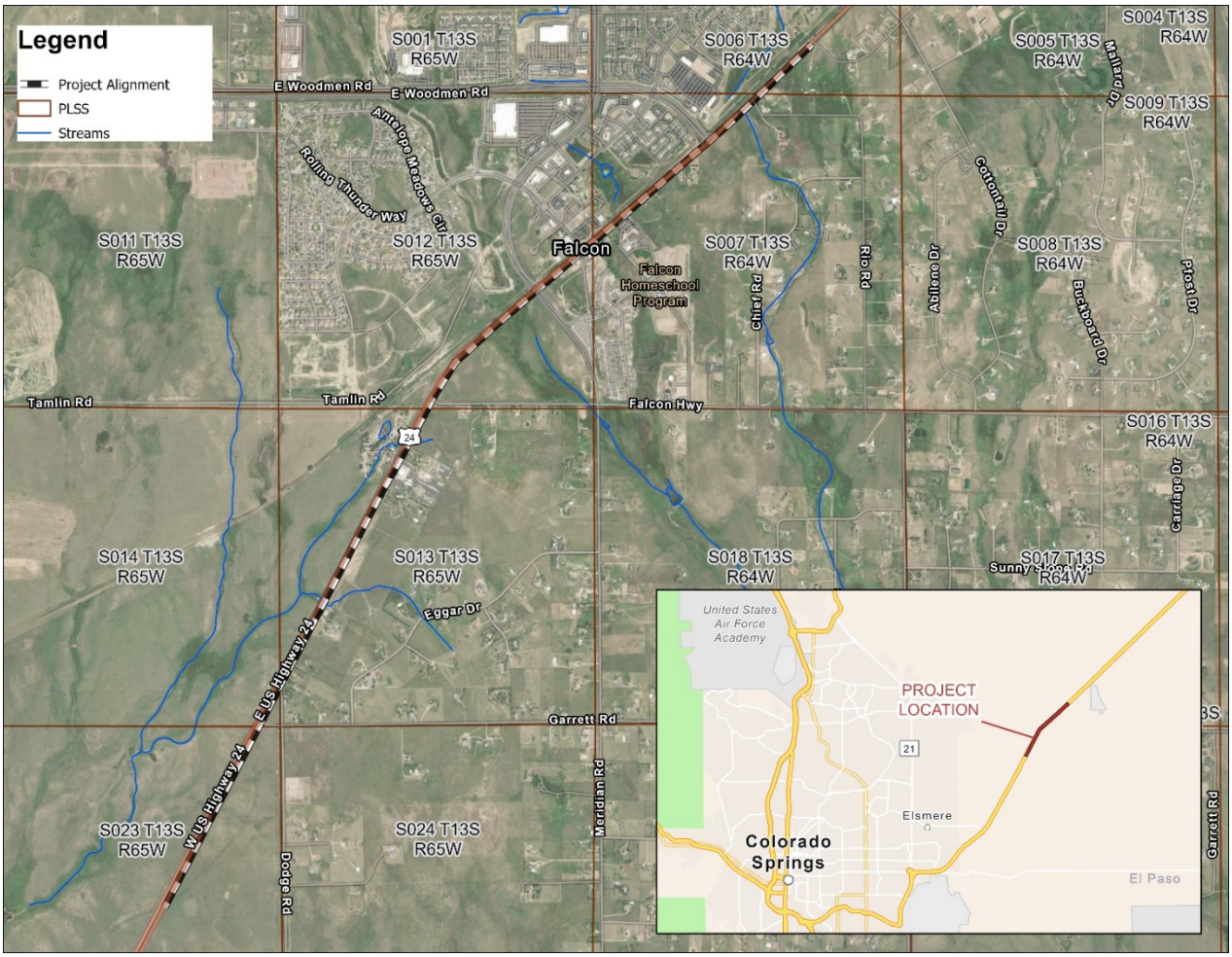


Figure 1– Vicinity Map

1.2 Description of Property

1.2.1 Ground Cover and Topography

South of Falcon Highway, the surrounding topography is predominately sloping to the northwest towards East Fork Sand Creek. This area is mainly rural with large lot residential properties. North of Falcon Highway, the area slopes southeast toward unnamed tributaries to Black Squirrel Creek. This area is developing and urbanizing with smaller residential lots and commercial development.

1.2.2 Soils Description

The majority of the soils within the US 24 project limits are soils in Hydrologic Soil Group A (>95%), with two small areas of Hydrologic Soil Group B near the Meridian Road intersection with US 24. See the soils map and soil report in Appendix C.

1.2.3 Major Drainageways

The project area is located on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panels 08041C0553G, 08041C0561G, and 08041C0545G, effective date December 7, 2018.

South of Falcon Highway, East Fork Sand Creek flows southwest parallel to US 24. East Fork Sand Creek is mapped as a Zone A floodplain, but it will not be impacted by this project.

North of Falcon Highway, three unnamed tributaries to Black Squirrel Creek cross US 24 flowing to the southeast. The El Paso Flood Insurance Study (FIS) lists these Unnamed Tributaries to Black Squirrel Creek (UTBSC) as UTBSC 109, UTBSC 1, and UTBSC 2. These tributaries are also detailed in the Falcon Drainage Basin Planning Study (DBPS) completed by El Paso County in 2015. The southern crossing (UTBSC 2) near Meridian Road is in a Special Flood Hazard Area (SFHA) Zone AE floodplain with Base Flood Elevations (BFEs). UTBSC 1 is shown on FIRM panel 08041C0561G as Zone A upstream of US 24, with the floodplain contained in a structure from US 24 to Swingline Road, and as Zone AE south of Swingline Road. The northern crossing (UTBSC 109) is mapped as Zone A.

The creeks and the project location, as mapped by FEMA are shown on Figure 2 and Appendix G.

4 Existing Structures

4.1 Major Structures

There are five large concrete box culverts that cross US 24 within the project limits. These boxes will be extended or replaced due to impacts to the channel or adjustments to the roadway. See the Design section for the modifications or replacements of these culverts.

4.2 Minor Structures

In existing conditions roadway drainage is predominantly collected in roadside ditches. South of Falcon Highway, the ditches flow to the south to cross culverts. Along the rest of the corridor, the ditches flow toward the major crossing culverts. New culverts will be placed under the intersections, and the driveways.

5 Design Discussion

The intent of the proposed design was to create a drainage system that meets CDOT and El Paso County criteria through new open ditch systems, crossing culverts, and minor storm sewer systems.

5.1 Culverts

There are 5 major box culverts crossing US 24 within the project limits. Most of the box culverts are in good condition and will remain and be extended with the project widening. Two of the large concrete box culverts, CV-249 and CV-278 will be extended with a shorter and wider culvert due to cover restrictions with the extensions and the roadway grades. Culverts CV-124 and CV-168 will be extended with equal box sizes on both sides. Culvert 229 is the only culvert that will be fully replaced due to the adverse existing skew angle and the roadway widening. Table 6 below shows the major culvert crossings.

Table 6: Major Proposed Structures

Culvert ID	US 24 Station	Existing Culvert Size (ft)	Proposed Culvert Size (ft)	10 Year Flow (cfs)	100 Year Flow (cfs)	Design HW/D	Design Outlet Velocity (fps)
CV–124	123+80	6 x 6	6x6 Extension	29.9	143	0.7	14.0
CV–168	167+80	6 x 6	6x6 Extension	23.9	108	0.6	13.9
CV–229	229+10	Triple 12 x 6	Triple 12x6	*	1,230	1.1	10.4
CV–249	249+25	Dual 12 x 6	Dual 14 x 4 Extension	80	560	0.8	6.8
CV–278	277+60	Dual 12 x 6	Dual 14 x 4 Extension	68	640	1.0	8.9

* See Floodplain section, FEMA effective model used for analysis

These culverts are designed to meet the freeboard criteria, and to not adversely impact the floodplains for the three largest culverts. See the floodplain section below for further details.

There is one large, mainly open area that drains toward culvert CV-124, an existing 6-foot by 6-foot concrete box culvert that will be extended with this project. This culvert is sized adequately for both minor and major storm events, capturing 29.94 cfs and 143.44 cfs respectively. However, there is an existing 36-inch culvert, CV-129, approximately 500 feet upstream of CV-124, which is fully replaced with this project. Based on existing and finished grade conditions, CV-129 acts as an overflow culvert for CV-124,

since the upstream side of the culvert is not depressed, it is anticipated most of the ditch flow will bypass it. Therefore, culvert CV-129 was modeled only at half of its full capacity.

Additionally, there are several minor culverts crossing within the project limits. Table 7 below shows the sizes of these proposed culverts. For full culvert calculations, see Appendix J.

Table 7: Minor Proposed Culvert Crossings

Crossing	Size	Shape	Q 10-yr (cfs)	10 Year HW/D (ft)	10 Year Outlet Velocity (ft/s)	Q 100-yr (cfs)	100 Year HW/D (ft)	100 Year Outlet Velocity (ft/s)
CV-35	12”	Round	0.18	0.23	3.58	0.49	0.39	4.81
CV-36	12”	Round	0.05	0.12	0.82	0.16	0.22	2.73
CV-60	30”x19”	Elliptical	3.26	0.44	6.10	26.1	2.04	10.0
CV-63	15”	Round	1.33	0.50	1.85	2.62	0.76	2.72
CV-65	15”	Round	1.01	0.43	3.63	2.02	0.65	4.37
CV-70	15”	Round	0.19	0.18	1.29	0.40	0.27	2.91
CV-74	15”	Round	0.32	0.24	2.90	0.64	0.34	3.55
CV-75L	15"	Round	0.52	0.30	3.82	1.01	0.43	4.52
CV-75R	15"	Round	0.36	0.25	3.50	1.25	0.48	4.85
CV-77	15"	Round	0.37	0.25	3.89	1.31	0.49	5.64
CV-85	15"	Round	0.01	0.05	0.26	0.19	0.18	2.03
CV-113	3-30"	Round	8.78	0.30	2.18	47.6	0.80	7.45
CV-124	6'x6'	Box	29.9	0.03	3.23	143	0.66	14.0
CV-129	36"	Round	14.4	0.56	11.0	35.5	1.0	13.7
CV-146	30"x19"	Elliptical	6.09	0.64	5.76	13.4	1.10	7.25
CV-160	24"	Round	4.66	0.53	6.74	13.2	1.02	8.96
CV-168	6’x6'	Box	23.9	0.22	8.29	108	0.60	13.9
CV-197	36"	Round	21.7	0.73	10.6	54.4	1.44	13.2
CV-206	30"x19"	Elliptical	3.18	0.44	4.28	7.08	0.71	5.73
CV-221	42”	Elliptical	4.90	0.25	8.10	10.0	0.37	9.94
CV-242	45"x29"	Elliptical	22.8	0.77	6.56	42.9	1.23	7.81
CV-257	15"	Round	3.61	0.94	5.13	7.21	1.75	6.43
CV-263	15"	Round	1.72	0.58	5.84	3.31	0.88	6.79
CV-265	15"	Round	1.02	0.44	3.19	1.97	0.65	3.82
CV-279	24”	Round	6.56	0.71	4.73	17.5	1.30	6.89
CV-283	24"	Round	2.06	0.34	6.16	5.23	0.56	8.07
CV-289	18"	Round	2.77	0.60	6.07	8.18	1.23	8.09

*All culverts with outlet velocities of less than 3 ft/s convey minor flows and are located along Dodge Rd and Bluestem Rd. A Variance Memo was submitted to EPC to document these velocities.

5.2 Outlet Protection

Several design manuals and software were used as guidance to design the outlet protection for all culverts. The MHFD design formulas from Chapter 9, Section 3.2, from their Volume 2 design manual were applied to design all minor culvert outlet protection and determine the rock diameter. The HY-8 outlet protection recommended apron length was used for all the major concrete box culverts, CV-229, CV-249, and CV-278.

There is one proposed riprap plunge pool for culvert, CV-197. In existing conditions, a corrugated steel, double cell culvert crosses US 24 and outfalls near the campground located on the northwest side of US 24, near Falcon Hwy. The existing culvert does not have any downstream outlet protection nor an energy dissipator, as a result it outlets uncontrolled flows and velocities to the campground. The campground is in the East Fork Sand Creek flowpath and this area could regularly be exposed to high water levels during a major storm event. The existing outlet velocity is unknown due to the unconfirmed existing culvert pipe

Ditch ID	Channel Slope (ft/ft)	10-YR Discharge (cfs)	100-YR Discharge (cfs)	10-YR Normal Depth (in)	100-YR Normal Depth (in)	10-YR Velocity (fps)	100-YR Velocity (fps)	Design Ditch Depth (ft)	Lining
D-202M	0.006	1.75	3.15	5.7	7.1	1.28	1.49	1.1	Seeding
D-208L	0.007	0.31	1.30	3.9	6.6	0.99	1.42	1.3	Seeding
D-217M	0.011	2.85	5.11	6.2	7.7	1.81	2.09	1.4	Seeding
D-219M	0.005	0.82	1.64	4.5	5.8	0.97	1.16	0.4	Seeding
D-219R	0.010	3.69	7.02	5.9	8.1	2.02	2.40	2.4	Seeding
D-221M	0.005	0.42	0.82	3.5	4.5	0.82	0.97	0.4	Seeding
D-221L	0.006	0.81	2.43	3.10	5.4	1.09	1.50	1.8	Seeding
D-236L	0.004	8.66	18.1	11.4	15.9	1.88	2.27	1.5	Seeding
D-238L	0.010	69.0	129	5.4	7.8	6.39	8.03	2.7	Seeding
D-244L	0.018	22.8	42.9	7.3	9.7	3.03	3.69	2.3	Seeding
D-254R	0.005	4.15	8.63	7.3	10.3	1.59	1.93	2.4	Seeding
D-259R	0.041	3.61	7.21	4.1	5.8	3.34	4.05	2.0	SRB I/Seeding
D-260L	0.019	4.71	9.76	5.7	8.1	2.71	3.29	1.6	SRB I/Seeding
D-264R	0.005	1.72	3.31	4.6	6.3	1.72	1.45	3.2	Seeding
D-266R	0.007	1.02	1.97	3.2	4.5	1.18	1.42	1.2	Seeding
D-268L	0.003	10.4	20.5	13.0	17.5	1.66	1.97	2.5	Seeding
D-274L	0.005	14.5	29.8	2.9	4.5	1.16	1.54	3.0	Seeding
D-278RB	0.003	6.90	18.3	10.6	16.4	1.53	1.96	4.3	Seeding
D-284L	0.004	2.06	5.23	5.5	8.7	1.23	1.58	2.5	Seeding
D-285R	0.003	6.56	17.5	10.1	15.8	1.57	2.01	3.0	Seeding
D-289L	0.006	2.77	8.18	5.8	9.8	1.55	2.07	2.0	Seeding

5.6 Water Quality Design

The US 24 corridor segment within this project is located on the CDOT's MS4 permit boundary (COS000005), the project also disturbs more than 1 acre and increases the existing impervious area by 20% or more. However, the project does not discharge any pollutants of concern to a 303(d) listed stream, or discharges to the Cherry Creek Reservoir drainage basin, and or is not part of an environmental assessment. Therefore, permanent water quality is not required for this project to meet CDOT's water quality requirements.

There are two local roads within the project boundary that fall under the El Paso County (EPC) jurisdiction and located on the EPC MS4 permit boundary (COR90000) and will require permanent water quality treatment only. Dodge Road is an existing local road with proposed improvements and Bluestem Road is a new local road introduced by this project. The total existing disturbed area at Dodge Road is 0.34 acres and the new proposed disturbed area for both roads, excluding the existing impervious area is 3.11 acres. Dodge Road qualifies for a water quality exclusion, according to EPC Engineering Criteria Manual (ECM), since the site does not add more than 8.25 feet or less of paved width and any location of the existing roadway, ECM water quality exclusion I.7B.2.

During the 60 percent design stage of the project a meeting with the HDR design team and EPC hydraulics engineers was held to go over permanent water quality requirements. The team agreed that due to right of way constraints, the location of the project (non-urbanized area), and to reduce maintenance cost, it was preferred to not provide water quality detention and to instead add roadside ditches along both sides of the roads and apply the runoff reduction method. The runoff reduction method was preferred by EPC to meet the water quality requirements.

The project will consider and meet step one of the "Four Step Process" as shown in the EPC Drainage Criteria Manual (DCM) for Dodge Road and Bluestem Road.

- Step 1: Reduce runoff by disconnecting impervious area, eliminating "unnecessary" impervious area, and encouraging infiltration into soils that are suitable. The runoff reduction must be greater than 60% of the water quality capture volume.
    - Runoff reduction is met due to the roadways draining into the grassed lined ditches. As a result, additional water quality control measures will not be required for this project. For Dodge Road, 98% of the required Water Quality Capture Volume (WQCV) is being reduced. For Bluestem Road 96% of the required WQCV is being reduced. The calculations are provided in the appendices.

5.7 Floodplains

Three hydraulic models were created using HEC-RAS version 6.6 to analyze the impact of the project on FEMA regulatory floodplains in the vicinity. Each of the three SFHA crossings and their associated culverts are described below.

- Culvert 229 - Unnamed Tributary to Black Squirrel Creek No. 2 - Located southwest of the intersection of Meridian Road and US 24. The existing structure consists of triple 12' x 6' concrete box culverts with a 1-foot-tall weir at the outlet of each cell. Upstream of the culvert there is an old railroad / pedestrian bridge and regional detention pond. The area is mapped as SFHA Zone AE with known Base Flood Elevations (BFE) and no floodway.

- Culvert 249 – Unnamed Tributary to Black Squirrel Creek No.1 - Located northeast of the intersection of Old Meridian Road and US 24. The existing structure consists of dual 12' x 6' concrete box culverts with a 1-foot-tall weir at the outlet to each cell. Upstream of the culvert there is an old railroad / pedestrian bridge. The area is mapped as SFHA Zone A.

- Culvert 278 – Unnamed Tributary 109 - Located southwest of the intersection of Rio Lane and US 24. The existing structure consists of dual 12' x 6' concrete box culverts with a 1-foot-tall weir at the outlet to each cell. The area is currently not mapped as a SFHA, however, upstream there is a SHFA Zone A and downstream of the crossing there is a Conditional Letter of Map Revision (CLOMR) completed on May 13, 2024, by Drexel, Barrell & Co.

This finalized floodplain analysis has determined that the proposed conceptual design will have no negative floodplain impacts at any of the three culvert crossings. The details of these determinations are included in the Floodplain Development Memo, June 4, 2026, see appendix H .

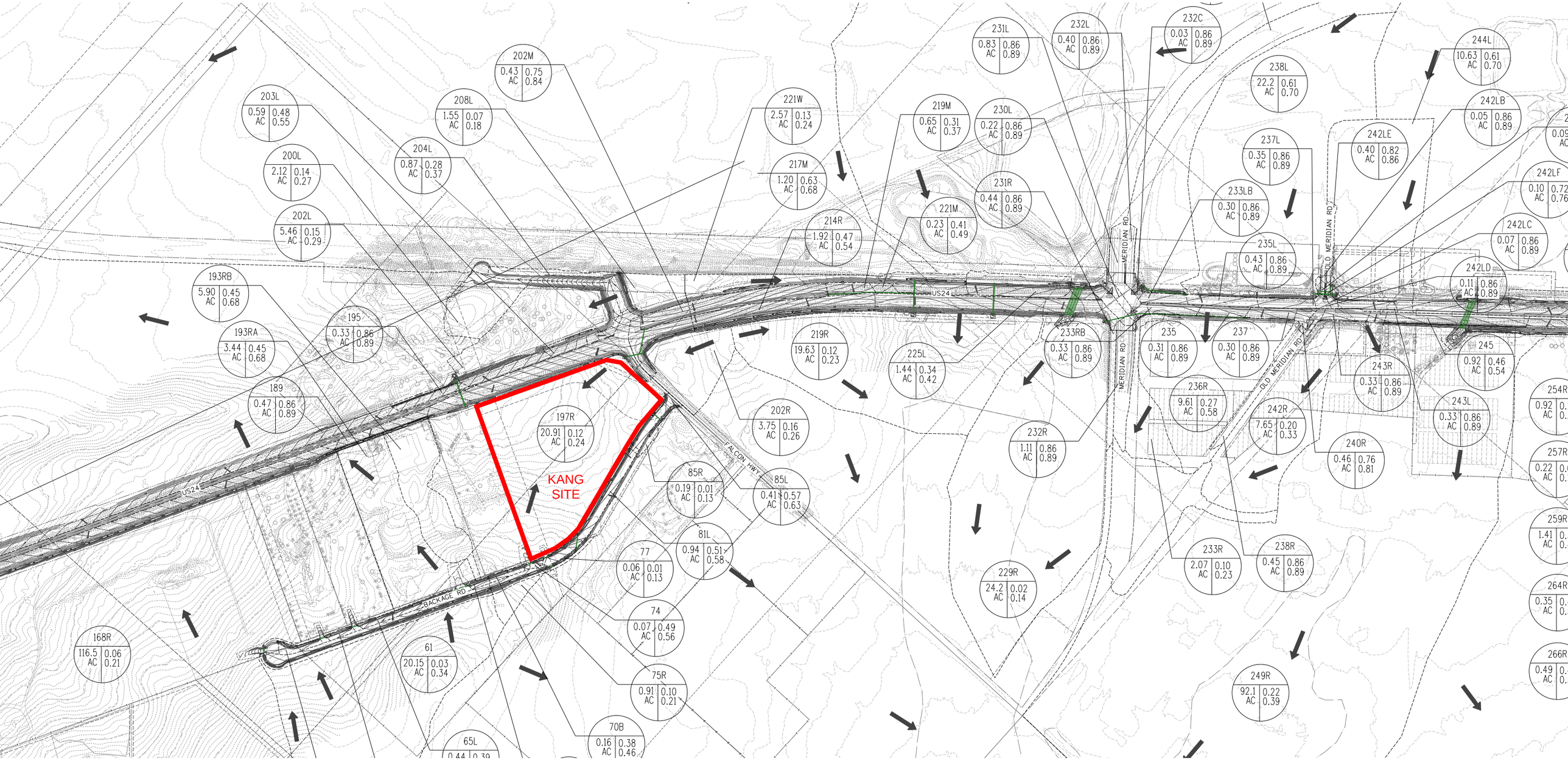
5.7.1 Floodplain Criteria

According to the Pikes Peak Regional Building Department (PPRB) 2023 Building Code, Section RBC313.14, "a floodplain development permit shall be obtained before construction, or development begins within any area of special flood hazard area." The floodplain impact of each structure crossing was analyzed and is discussed in detail below.

5.7.2 Hydrology

A hydrologic analysis was not necessary for the three culvert crossings because for both Culverts 249 and 278, an HEC-HMS hydrology study was already completed by El Paso County titled "Falcon Basin, Drainage Basin Planning Study, Selected Plan Report Final" (Falcon DBPS, 2015) that have peak flow

"Proposed Drainage Basins" Map



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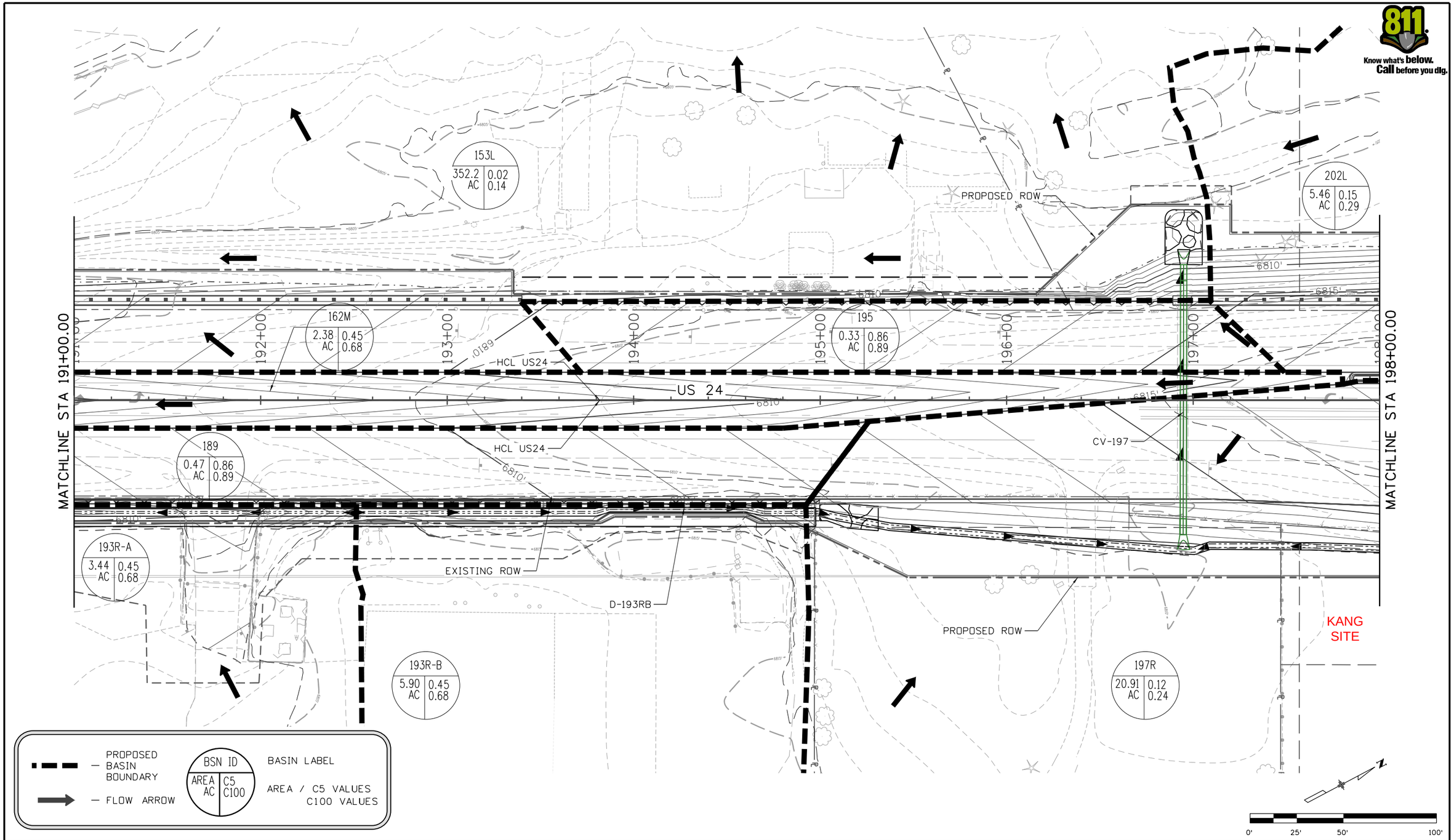

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DENVER, COLORADO 80202
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FAX: 303-860-7139

Sheet Revisions

Date:	Comments	Init.

Colorado Department of Transportation
1480 Quail Lake Loop
Colorado Springs, CO 80906
Phone: 719-562-5568
Region 2 AS

As Constructed
No Revisions:
Revised:
Void:

US 24 GARRETT TO WOODMEN
PROPOSED DRAINAGE BASINS
STA 191+00 TO 198+00

Designer: ESTATEN
Detailer: MBARRAZA
Sheet Subset: BASINS
Structure Numbers:
Subset Sheets: 14 of 41

Project No./Code
NHPP 0243-094
25094
Sheet Number

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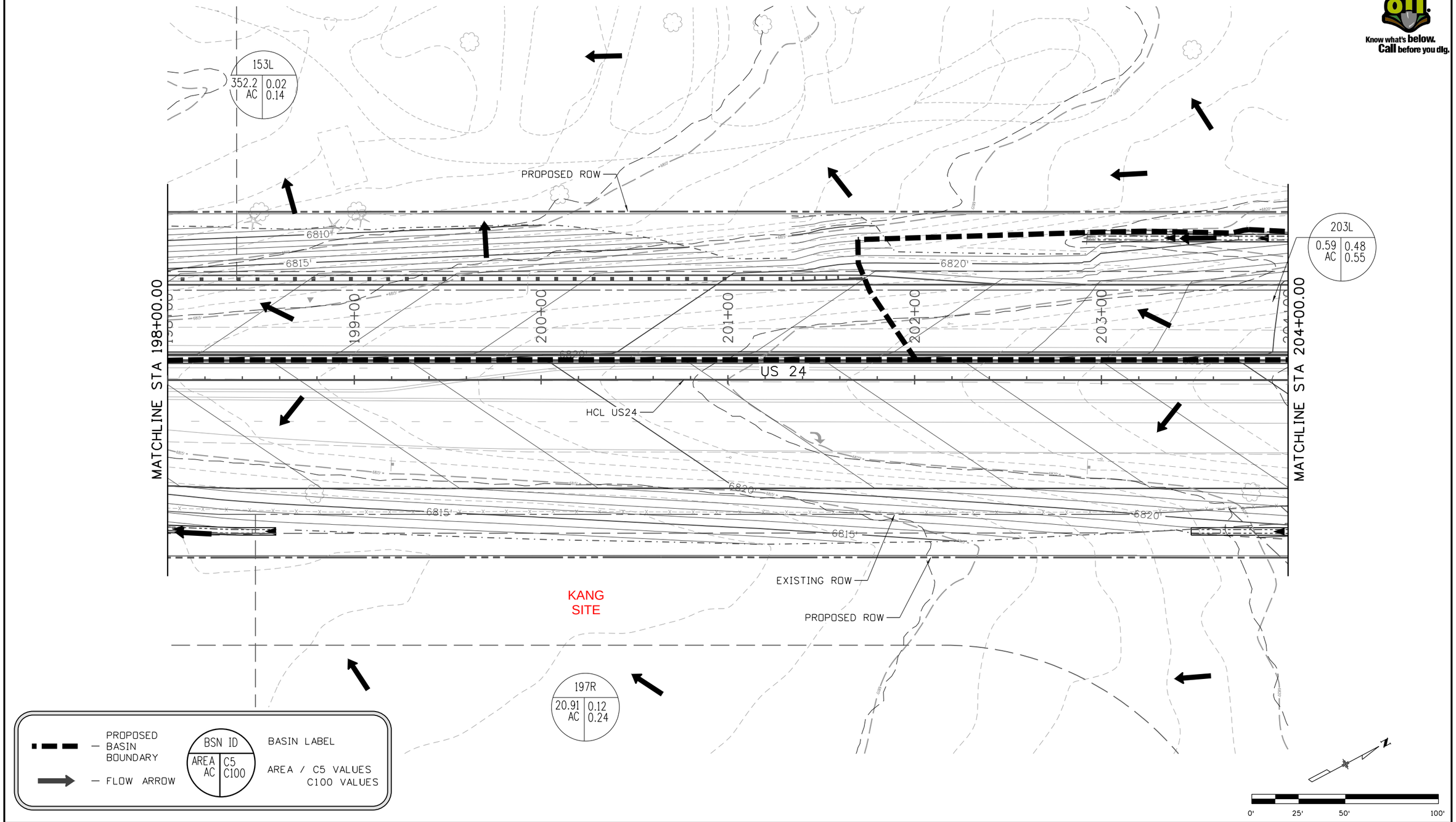

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US 24 GARRETT TO WOODMEN PROPOSED DRAINAGE BASINS STA 198+00 TO 204+00

Designer: ESTATEN
Detailer: MBARRAZA
Sheet Subset: BASINS
Structure Numbers:
Subset Sheets: 15 of 41

Project No./Code
NHPP 0243-094
25094
Sheet Number

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Know what's below. Call before you dig.

153L | 352.2 AC | 0.02 / 0.14

208L | 1.55 AC | 0.07 / 0.18

221W | 2.57 AC | 0.13 / 0.24

203L | 0.59 AC | 0.48 / 0.55

202M | 0.43 AC | 0.75 / 0.84

217M | 1.20 AC | 0.63 / 0.68

214R | 1.92 AC | 0.47 / 0.54

197R | 20.91 AC | 0.12 / 0.24

202R | 3.75 AC | 0.16 / 0.26

DUBLIN BLVD

HCL DUBLIN BLVD

493+00

PROPOSED ROW

EXISTING ROW

6830'

6825'

205+00

206+00

207+00

208+00

209+00

500+00

HCL US24

US 24

IN-207

HCL FALCON HWY

MATCHLINE STA 204+00.00

MATCHLINE STA 210+00.00

501+00

6825' HDW

FALCON HWY

CV-206

502+00

KANG SITE

PROPOSED BASIN BOUNDARY

FLOW ARROW

BSN ID | AREA AC | C5 C100

BASIN LABEL

AREA / C5 VALUES
C100 VALUES

0' 25' 50' 100'

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US 24 GARRETT TO WOODMEN PROPOSED DRAINAGE BASINS STA 204+00 TO 210+00

Designer: ESTATEN
Detailer: MBARRAZA
Sheet Subset: BASINS
Structure Numbers:
Subset Sheets: 16 of 41

Project No./Code: NHPP 0243-094

25094

Sheet Number

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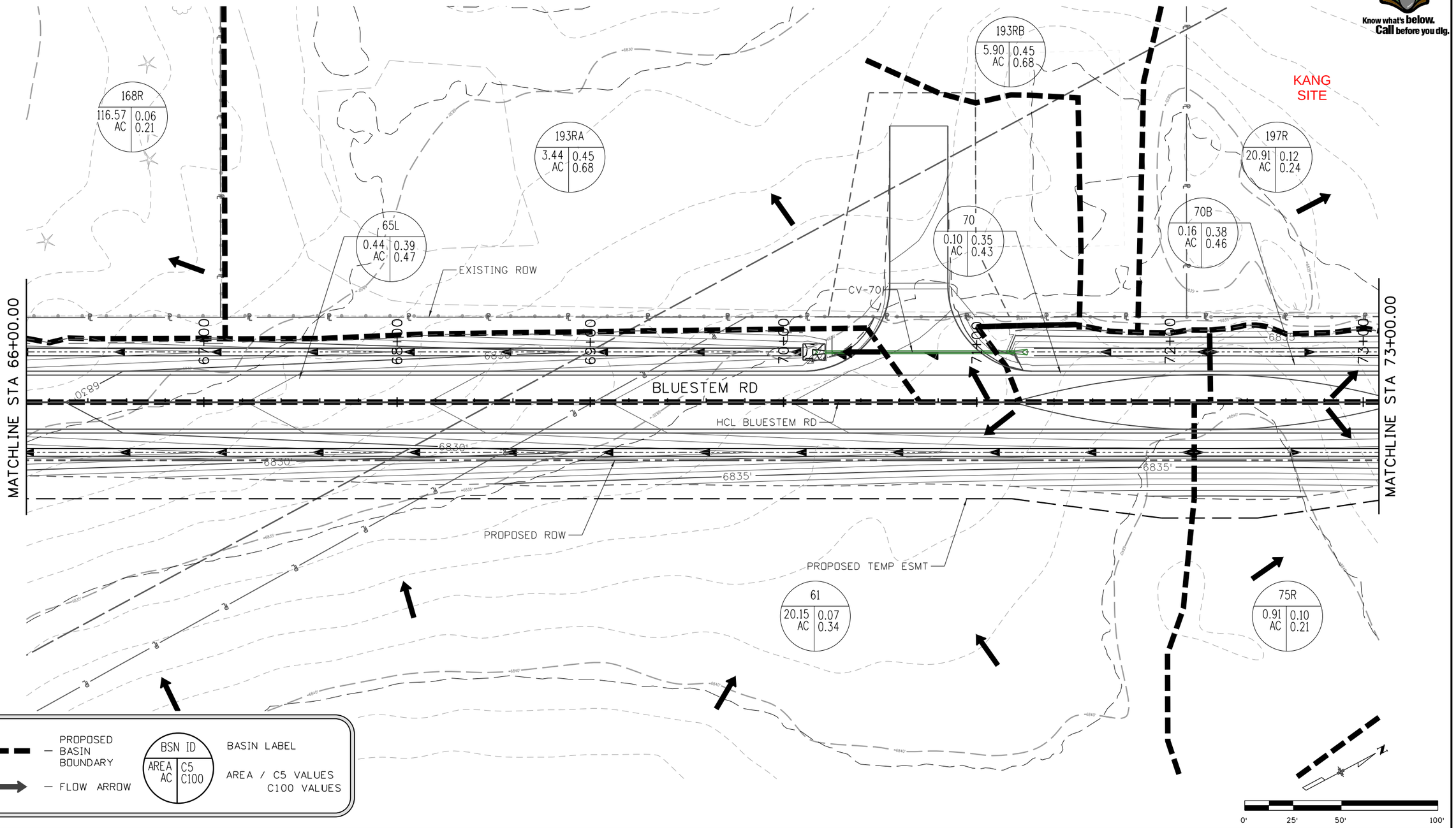

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US 24 GARRETT TO WOODMEN
PROPOSED DRAINAGE BASINS
BLUESTEM RD

Designer: LSTATEN
Detailer: MBARRAZA
Sheet Subset: BASINS
Structure Numbers:
Subset Sheets: 35 of 41

Project No./Code
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Sheet Number

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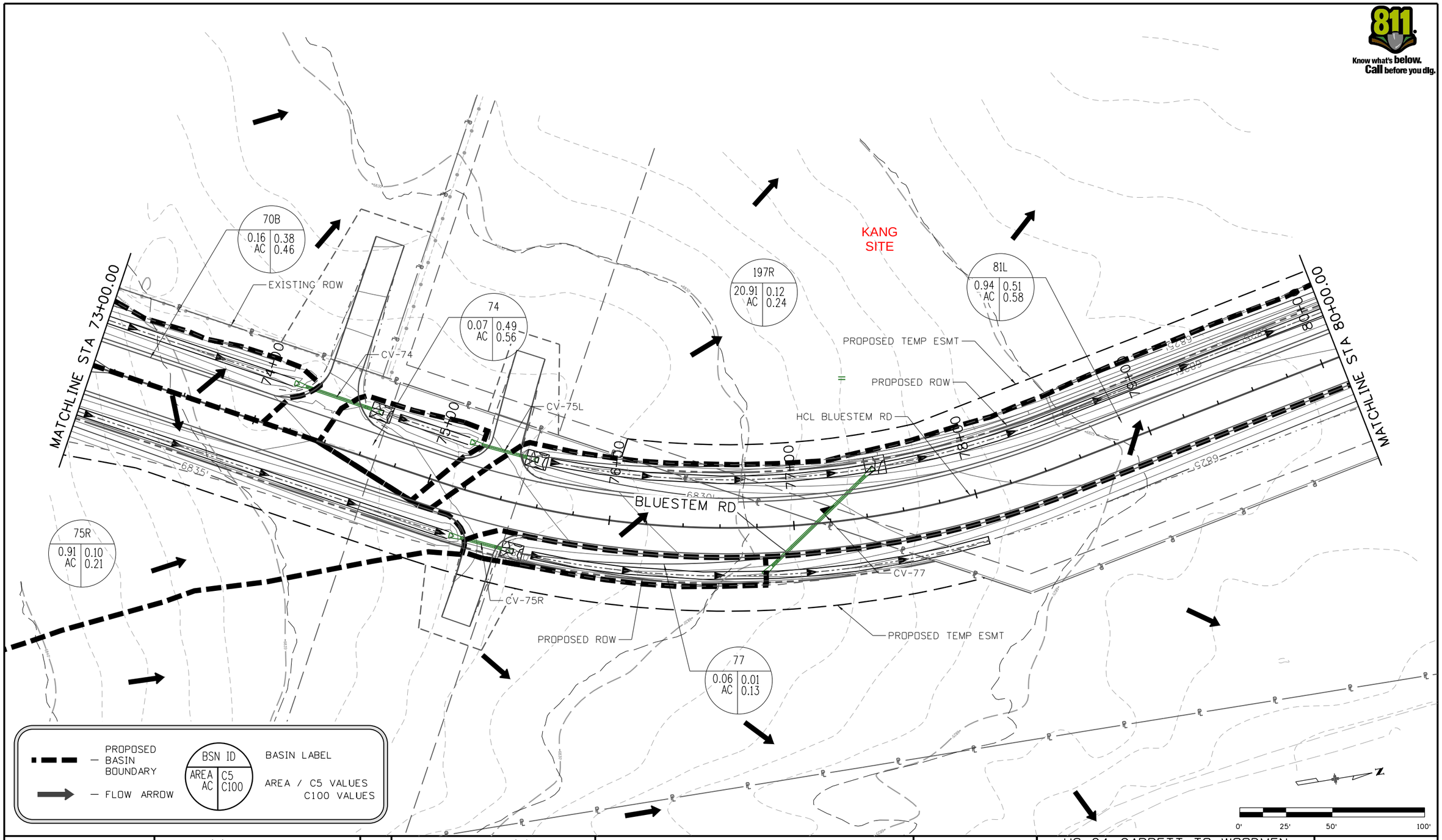

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US 24 GARRETT TO WOODMEN
PROPOSED DRAINAGE BASINS
BLUESTEM RD

Designer: ESTATEN
Detailer: MBARRAZA
Sheet Subset: BASINS
Structure Numbers:
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811 Know what's below. Call before you dig.

KANG SITE

81L
0.94 AC | 0.51 | 0.58

85L
0.41 AC | 0.57 | 0.63

197R
20.91 AC | 0.12 | 0.24

85R
0.19 AC | 0.01 | 0.13

202R
3.75 AC | 0.16 | 0.26

PROPOSED TEMP ESMT

PROPOSED ROW

EXISTING ROW

MATCHLINE STA 80+00.00

BLUESTEM RD

HCL BLUESTEM RD

HCL FALCON HWY

FALCON HWY

CV-85

6825'

80+00

81+00

82+00

83+00

84+00

85+00

86+00

503+00

504+00

505+00

506+00

N

0' 25' 50' 100'

PROPOSED BASIN BOUNDARY

FLOW ARROW

BSN ID
AREA AC | C5 C100

BASIN LABEL

AREA / C5 VALUES
C100 VALUES

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US 24 GARRETT TO WOODMEN
PROPOSED DRAINAGE BASINS
BLUESTEM RD

Designer: ESTATEN
Detailer: MBARRAZA
Sheet Subset: BASINS
Structure Numbers:
Subset Sheets: 37 of 41

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NHPP 0243-094
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Sheet Number

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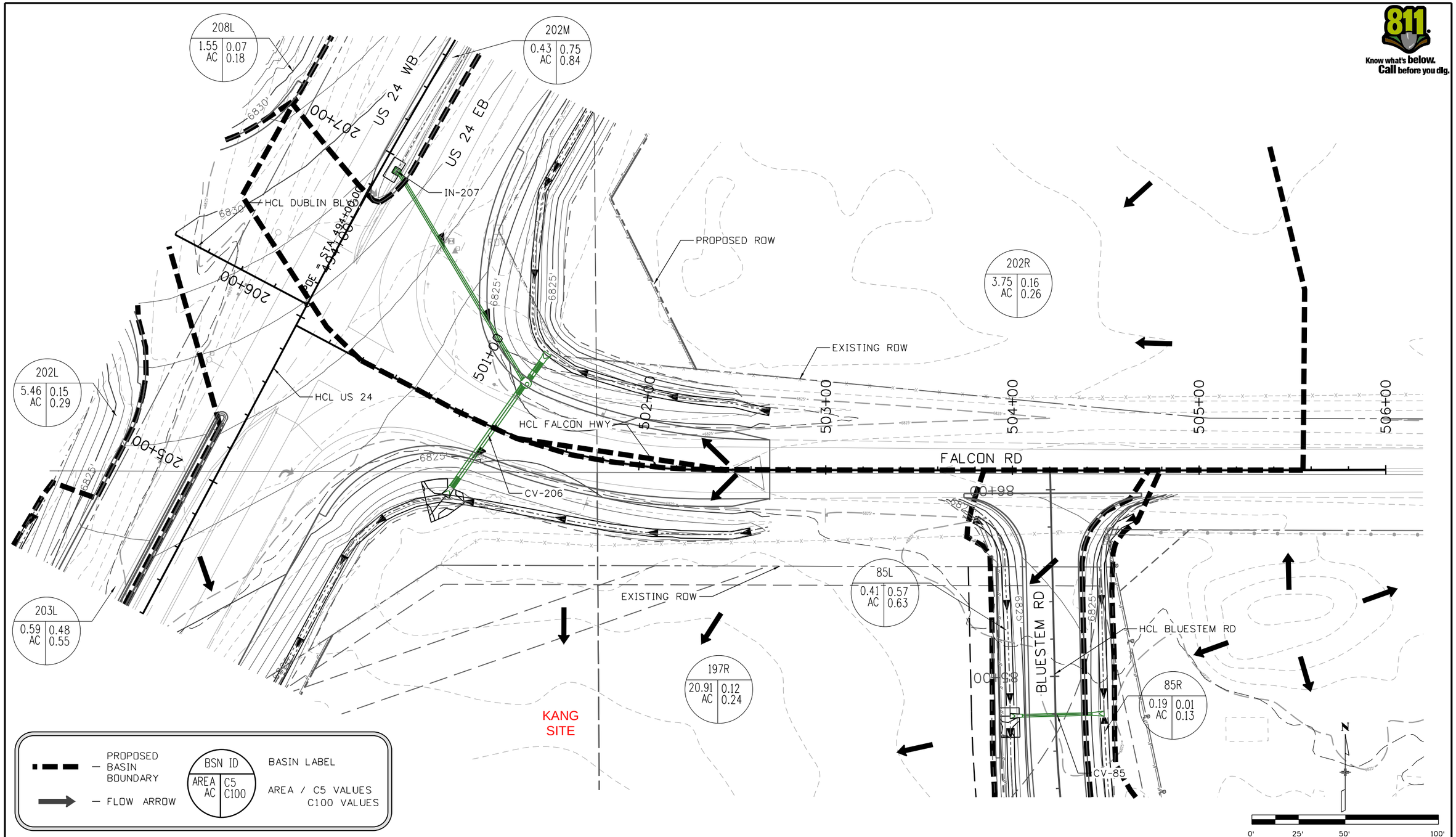

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PROPOSED DRAINAGE BASINS
FALCON RD

Designer: ESTATEN
Detailer: MBARRAZA
Sheet Subset: BASINS
Structure Numbers
Subset Sheets: 41 of 41

Project No./Code
NHPP 0243-094
25094
Sheet Number

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Runoff Coefficients

Corridor: CDOT R2 US-24 Garrett to Woodmen
System Name: Proposed

Computed: MGB Date: 2/16/2026
Checked: AJF Date: 3/11/2026

| Sub-Basin Data | Composite C | | | | | Sub Area - Pavement (100%) | | | | | Business Suburban Areas HSG A (75%) | | | | | Industrial: School HSG A (55%) | | | | | Undeveloped Areas: Greenbelts, agricultural HSG A (2%) | | | | | Undeveloped Areas: Greenbelts, agricultural HSG B (2%) | | | | | Residential-0.25-0.75 ac HSG A (30%) | | | | | Residential-0.75-2.5 ac HSG A (20%) | | | | | Residential-2.5 ac or larger HSG A (12%) | | | | | Residential-0.25-0.75 ac HSG B (30%) | | | | | Residential-0.75-2.5 ac HSG B (20%) | | | | | Residential-2.5 ac or larger HSG B (12%) | | | | |
|---|---|---

Standard Form SF-1 . Time of Concentration

Corridor: CDOT R2 US-24 Garrett to Woodmen
System Name: Proposed

Computed: MGB Date: 2/16/2026
Checked: AJF Date: 3/11/2026

SUB-BASIN DATA			INITIAL/OVERLAND FLOW (t_i)					TRAVEL TIME (t_t)									Total	Tc CHECK - Regional Tc (Urbanized basins)				FINAL Tc (min)
												Type of Land Surface										
Basin ID	C5	Area (ac)	Length (ft)	Start Elevation (ft)	End Elevation (ft)	Slope (ft/ft)	t_i (min)	Length (ft)	Start Elevation (ft)	End Elevation (ft)	S_w (ft/ft)	Cover	Description	Convey Coef (C_v)	Velocity (ft/s)	Travel Time (min)	$t_c = t_i + t_t$ (min)	Urban (Yes /No)	Total Length (ft)	$T_{c\,max}$ (min)	$Tc_{max} > t_c$	
113R	0.03	81.1	296.5	6770.0	6765.0	0.02	27.8	1214.2	6765.0	6715.0	0.04	3	Short pasture and lawns	7	1.4	14.2	42.1	No	1511	DNU	Check	42.05
114M	0.40	2.1	109.3	6761.0	6758.0	0.03	9.5	2897.9	6758.0	6715.9	0.01	5	Grassed waterway	15	1.8	26.7	36.2	Yes	3007	26.71	Regional Tc	26.71
124R	0.05	10.9	295.1	6765.0	6760.0	0.02	27.4	781.7	6760.0	6716.8	0.06	3	Short pasture and lawns	7	1.6	7.9	35.3	No	1077	DNU	Check	35.27
129R	0.03	149.7	299.7	6846.0	6833.0	0.04	20.5	4265.2	6833.0	6724.8	0.03	3	Short pasture and lawns	7	1.1	63.8	84.2	No	4565	DNU	Check	84.23
146R	0.46	0.5	30.4	6767.1	6763.7	0.11	2.9	512.0	6763.7	6756.0	0.02	5	Grassed waterway	15	1.8	4.6	7.5	Yes	542	13.01	Check	7.49
35	0.25	0.1	16.0	6767.5	6767.4	0.01	7.1	67.0	6767.4	6766.6	0.01	5	Grassed waterway	15	1.6	0.7	7.8	Yes	83	10.46	Check	7.82
36	0.13	0.1	29.5	6768.3	6767.8	0.02	8.0	94.4	6767.8	6767.2	0.01	5	Grassed waterway	15	1.2	1.3	9.3	Yes	124	10.69	Check	9.27
38	0.10	0.3	131.0	6773.0	6771.7	0.01	20.6	61.6	6771.7	6768.4	0.05	5	Grassed waterway	15	3.5	0.3	20.9	Yes	193	11.07	Regional Tc	11.07
146RB	0.53	0.7	61.2	6767.4	6763.0	0.07	4.2	346.3	6763.0	6758.0	0.01	6	Paved areas and shallow paved swales	20	2.4	2.4	6.6	Yes	408	12.26	Check	6.59
146M	0.84	0.04	19.5	6765.7	6765.5	0.01	2.0	118.7	6765.5	6763.0	0.02	6	Paved areas and shallow paved swales	20	2.9	0.7	2.7	Yes	138	10.77	Check	5.00
147R	0.16	2.3	299.4	6766.0	6763.4	0.01	30.8	284.0	6763.4	6754.7	0.03	3	Short pasture and lawns	7	1.2	3.9	34.7	No	583	DNU	Check	34.68
152M	0.39	0.5	15.5	6775.6	6773.1	0.16	2.0	1005.1	6773.1	6758.5	0.01	5	Grassed waterway	15	1.8	9.3	11.3	Yes	1021	15.67	Check	11.29
153L	0.02	352.2	FOR INFO ONLY			#######	#VALUE!	FOR INFO ONLY			#######	3	Short pasture and lawns	7	#VALUE!	#VALUE!	#VALUE!	No	#VALUE!	DNU	#VALUE!	#VALUE!
156R	0.21	5.7	299.0	6805.4	6797.6	0.03	20.2	1549.0	6797.6	6764.5	0.02	5	Grassed waterway	15	2.2	11.8	32.0	No	1848	DNU	Check	32.01
160R	0.09	9.1	294.8	6816.0	6807.4	0.03	21.9	1420.0	6807.4	6772.3	0.02	3	Short pasture and lawns	7	1.1	21.5	43.4	No	1715	DNU	Check	43.4
162M	0.39	2.4	4.8	6816.8	6816.2	0.13	1.2	3569.2	6816.2	6773.5	0.01	5	Grassed waterway	15	1.6	36.3	37.5	Yes	3574	29.86	Regional Tc	29.9
162R	0.06	73.9	286.4	6900.0	6895.0	0.02	26.3	5107.9	6895.0	6758.1	0.03	3	Short pasture and lawns	7	1.1	74.3	100.5	No	5394	DNU	Check	100.5
162RB	0.06	28.8	300.0	6811.6	6805.3	0.02	25.4	1808.2	6805.3	6758.1	0.03	3	Short pasture and lawns	7	1.1	26.6	52.0	No	2108	DNU	Check	52.0
168R	0.05	116.6	291.8	6900.0	6896.0	0.01	29.0	3275.9	6896.0	6773.3	0.04	3	Short pasture and lawns	7	1.4	40.3	69.3	No	3568	DNU	Check	69.3
61	0.03	20.2	263.6	6840.5	6831.8	0.03	21.1	1128.9	6831.8	6822.9	0.01	6	Paved areas and shallow paved swales	20	1.8	10.6	31.7	No	1393	DNU	Check	31.7
62L	0.48	0.2	128.0	6826.2	6825.7	0.00	17.2	87.8	6825.7	6822.9	0.03	6	Paved areas and shallow paved swales	20	3.6	0.4	17.6	No	216	DNU	Check	17.6
63L	0.49	0.1	26.9	6826.8	6826.2	0.02	4.4	102.2	6826.2	6826.0	0.00	6	Paved areas and shallow paved swales	20	0.9	1.9	6.3	No	129	DNU	Check	6.3
65L	0.38	0.4	32.4	6836.3	6835.4	0.03	5.2	539.8	6835.4	6826.4	0.02	6	Paved areas and shallow paved swales	20	2.6	3.5	8.7	No	572	DNU	Check	8.7
189	0.84	0.5	50.8	6813.0	6811.8	0.02	2.5	502.0	6811.8	6807.2	0.01	6	Paved areas and shallow paved swales	20	1.9	4.4	6.9	Yes	553	13.07	Check	6.9
193R-A	0.39	3.4	291.2	6834.4	6823.8	0.04	14.3	678.4	6823.8	6811.5	0.02	6	Paved areas and shallow paved swales	20	2.7	4.2	18.5	No	970	DNU	Check	18.5
193R-B	0.39	5.9	297.1	6837.3	6827.6	0.03	15.0	858.4	6827.6	6802.0	0.03	6	Paved areas and shallow paved swales	20	3.5	4.1	19.1	No	1156	DNU	Check	19.1
195	0.84	0.3	29.9	6814.8	6812.0	0.09	1.2	354.3	6812.0	6808.9	0.01	6	Paved areas and shallow paved swales	20	1.9	3.2	4.4	Yes	384	12.13	Check	5.0
197R	0.11	20.9	41.1	6827.5	6824.8	0.07	6.1	1261.0	6824.8	6809.2	0.01	3	Short pasture and lawns	7	0.8	27.0	33.1	No	1302	DNU	Check	33.1
70	0.34	0.1	25.7	6835.3	6832.5	0.11	3.2	110.6	6832.5	6832.2	0.00	6	Paved areas and shallow paved swales	20	1.0	1.8	4.9	Yes	136	10.76	Check	5.0
70B	0.37	0.2	25.7	6839.8	6839.1	0.03	4.8	194.0	6839.1	6833.5	0.03	5	Grassed waterway	15	2.5	1.3	6.1	Yes	220	11.22	Check	6.1
75R	0.10	0.9	163.9	6841.2	6832.1	0.06	13.1	187.1	6832.1	6830.7	0.01	6	Paved areas and shallow paved swales	20	1.7	1.8	14.9	Yes	351	11.95	Regional Tc	12.0
74	0.48	0.1	29.4	6834.1	6833.1	0.03	4.0	63.0	6833.1	6832.7	0.01	6	Paved areas and shallow paved swales	20	1.6	0.7	4.7	Yes	92	10.51	Check	5.0
77	0.01	0.1	33.6	6833.2	6829.9	0.10	5.4	127.4	6829.9	6827.8	0.02	6	Paved areas and shallow paved swales	20	2.6	0.8	6.2	Yes	161	10.89	Check	6.2
81L	0.50	0.9	59.8	6833.1	6829.2	0.07	4.5	691.9	6829.2	6822.5	0.01	6	Paved areas and shallow paved swales	20	2.0	5.9	10.3	Yes	752	14.18	Check	10.3
85R	0.01	0.2	5.0	6824.1	6823.9	0.04	2.8	317.0	6823.9	6823.3	0.00	6	Paved areas and shallow paved swales	20	0.9	6.1	8.9	Yes	322	11.79	Check	8.9
85L	0.55	0.4	70.7	6826.0	6825.0	0.01	7.4	224.0	6825.0	6822.7	0.01	5	Grassed waterway	15	1.5	2.5	9.8	Yes	295	11.64	Check	9.8
200L	0.14	2.1	188.3	6816.3	6809.0	0.04	15.2	331.0	6809.0	6804.9	0.01	3	Short pasture and lawns	7	0.8	7.1	22.3	No	519	DNU	Check	22.3
202L	0.15	5.5	69.0	6830.9	6820.6	0.15	5.8	870.5	6820.6	6803.9	0.02	3	Short pasture and lawns	7	1.0	15.0	20.8	No	940	DNU	Check	20.8
202M	0.72	0.4	66.2	6832.8	6828.3	0.07	2.9	236.0	6828.3	6827.2	0.00	5	Grassed waterway	15	1.0	3.8	6.8	Yes	302	11.68	Check	6.8
202R	0.15	3.8	299.7	6832.2	6826.3	0.02	23.6	292.4	6826.3	6822.8	0.01	3	Short pasture and lawns	7	0.8	6.4	30.0	No	592	DNU	Check	30.0
203L	0.47	0.6	76.2	6828.4	6826.6	0.02	7.4	344.1	6826.6	6816.5	0.03	5	Grassed waterway	15	2.6	2.2	9.7	Yes	420	DNU	Check	9.7
204L	0.27	0.9	90.8	6830.2	6823.2	0.08	7.3	556.6	6823.2	6810.9	0.02	3	Short pasture and lawns	7	1.0	8.9	16.2	No	647	DNU	Check	16.2
208L	0.07	1.5	190.2	6832.8	6825.5	0.04	16.4	313.7	6825.5	6822.7	0.01	3	Short pasture and lawns	7	0.7	7.9	24.3	No	504	DNU	Check	24.3
214R	0.46	1.9	66.1	6929.5	6823.0	1.61	1.8	931.3	6823.0	6816.3	0.01	6	Paved areas and shallow paved swales	20	1.7	9.1	10.9	Yes	997	DNU	Check	10.9
217M	0.61	1.2	67.1	6832.8	6828.4	0.06	3.9	703.7	6828.4	6822.5	0.01	5	Grassed waterway	15	1.4	8.5	12.4	Yes	771	DNU	Check	12.4
219M	0.30	0.7	60.8	6827.1	6822.5	0.08	5.8	238.9	6822.5	6821.8	0.00	5	Grassed waterway	15	0.8	4.9	10.7	Yes	300	11.67	Check	10.7
219R	0.11	19.6	134.2	6832.6	6823.0	0.07	10.7	1676.3	6823.0	6802.5	0.01	3	Short pasture and lawns	7	0.8	36.1	46.8	No	1811	DNU	Check	46.8
221M	0.40	0.2	60.4	6823.6	6821.6	0.03	6.6	184.9	6821.6	6820.5	0.01	5	Grassed waterway	15	1.2	2.7	9.2	Yes	245	11.36	Check	9.2
221W	0.13	2.6	95.0	6831.0	6828.6	0.03	12.6	865.4	6828.6	6815.5	0.02	3	Short pasture and lawns	7	0.9	16.7	29.3	No	960	DNU	Check	29.3
225L	0.33	1.4	89.9	6826.6	6819.9	0.07	6.8	497.3	6819.9	6816.7	0.01	5	Grassed waterway	15	1.2	6.9	13.7	Yes	587	13.26	Regional Tc	13.3
226L	0.08	2317.1	FOR INFO ONLY			#######	#VALUE!	FOR INFO ONLY			#######	5	Grassed waterway	15	#VALUE!	#VALUE!	#VALUE!	No	#VALUE!	DNU	#VALUE!	#VALUE!
229R	0.02	24.2	273.9	6825.8	6815.0	0.04	20.5	1789.3	6815.0	6787.5	0.02	3	Short pasture and lawns	7	0.9	34.4	54.8	No	2063	DNU	Check	54.8
230L	0.84	0.2	15.5	6828.6	6828.3	0.02	1.5	240.3	6828.3	6826.0	0.01	6	Paved areas and shallow paved swales	20	2.0	2.0	3.5	Yes	256	11.42	Check	5.0
231L	0.84	0.8	88.8	6830.0	6827.8	0.02	3.3	216.9	6827.8	6824.8	0.01	6	Paved areas and shallow paved swales	20	2.4	1.5	4.8	Yes	306	11.70	Check	5.0
231R	0.84	0.4	33.3	6828.0	6827.9	0.00	3.9	614.2	6827.9	6814.0	0.02	6	Paved areas and shallow paved swales	20	3.0	3.4	7.3	Yes	648	13.60	Check	7.3
232R	0.84	1.1	132.0	6828.0	6825.7	0.02	4.5	506.7	6825.7	6814.0	0.02	6	Paved areas and shallow paved swales	20	3.0	2.8	7.3	Yes	639	13.55	Check	7.3
232L	0.84	0.4	62.3	6830.0	6828.3	0.03	2.7	201.5	6828.3	6825.1	0.02	6	Paved areas and shallow paved swales	20	2.5	1.3	4.0	Yes	264	11.47	Check	5.0
232C	0.84	0.03	39.6	6827.6	6827.4	0.01	3.7	15.6	6827.4	6827.4	0.00	6	Paved areas and shallow paved swales	20	1.1	0.2	3.9	Yes	55	10.31	Check	5.0
233R	0.10	2.1	184.2	6828.8	6827.0	0.01	24.7	712.7	6827.0	6810.0	0.02	5	Grassed waterway	15	2.3	5.1	29.8	Yes	897	14.98	Regional Tc	15.0
233R-B	0.84	0.3	58.3	6830.0	6828.6	0.02	2.7	313.9	6828.6	6827.7	0.00	6	Paved areas and shallow paved swales	20	1.1	4.9	7.6	Yes	372	12.07	Check	7.6
233L-B	0.84	0.3	52.9	6829.3	6828.5	0.02	3.0	155.7	6828.5	6827.2	0.01	6	Paved areas and shallow paved swales	20	1.8	1.4	4.4	Yes	209	11.16	Check	5.0
235	0.84	0.3	61.9	6831.4	6829.9	0.02	2.7	243.3	6829.9	6828.6	0.01	6	Paved areas and shallow paved swales	20	1.5	2.8	5.5	Yes	305	11.70	Check	5.5
235L	0.84	0.4	52.8	6830.9	6829.6	0.02	2.5	289.7	6829.6	6828.0	0.01	6	Paved areas and shallow paved swales	20	1.5	3.2	5.8	Yes	343	11.90	Check	5.8

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Corridor: CDOT R2 US-24 Garrett to Woodmen | Computed: MGB | Date: 2/16/2026

System Name: Proposed | Checked: AJF | Date: 3/11/2026

Design Storm: 5-yr

BASIN ID	DESIGN POINT	DIRECT RUNOFF						REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	
(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)	
113R	CV-113	81.1	0.04	42.05	2.88	1.65	4.75	
114M	IN-114	2.1	0.46	26.71	0.97	2.15	2.08	
124R	CV-124	10.9	0.05	35.27	0.53	1.82	0.97	
129R	CV-129	149.7	0.04	84.23	5.36	1.22	6.54	
146R	EX-CV-403	0.5	0.47	7.49	0.25	4.09	1.03	
35	CV-35	0.1	0.26	7.82	0.03	4.09	0.11	
36	CV-36	0.1	0.14	9.27	0.01	3.60	0.04	
38	-	0.3	0.11	11.07	0.03	3.23	0.09	
146RB	CV-146	0.7	0.54	6.59	0.38	4.33	1.65	
146M	IN-146	0.04	0.86	5.00	0.03	4.58	0.16	
147R	EX-CV-403	2.3	0.16	34.68	0.37	1.84	0.69	
152M	IN-152	0.5	0.45	11.29	0.23	3.23	0.75	
153L	-	352.2	0.02	#VALUE!	7.17	#VALUE!	#VALUE!	For basin area info only
156R	FES-151R	5.7	0.21	32.01	1.23	1.89	2.32	
160R	CV-160	9.1	0.10	43.37	0.87	1.63	1.43	
162M	IN-162	2.4	0.45	29.86	1.07	1.99	2.13	
162R	EX-CV	73.9	0.07	100.55	5.07	1.22	6.18	
162RB	IN-30	28.8	0.07	52.00	1.90	1.44	2.73	
168R	EX-CV-168	116.6	0.06	69.29	6.72	1.22	8.20	
61	CV-60	20.2	0.03	31.70	0.64	1.92	1.23	
62L	-	0.2	0.49	17.57	0.10	2.62	0.27	
63L	CV-63	0.1	0.50	6.28	0.06	4.33	0.26	
65L	CV-65	0.4	0.39	8.72	0.17	3.84	0.67	
189	RP-RDWN	0.5	0.86	6.88	0.40	4.33	1.75	
193R-A	RP-RDWN	3.4	0.45	18.52	1.54	2.57	3.97	
193R-B	RP-RDWN	5.9	0.45	19.14	2.65	2.52	6.67	
195	RP-RDWN	0.3	0.86	5.00	0.28	4.58	1.30	
197R	CV-197	20.9	0.12	33.12	2.42	1.87	4.53	
70	CV-70	0.1	0.35	5.00	0.03	4.58	0.16	
70B	CV-74	0.2	0.38	6.05	0.06	4.33	0.26	
75R	CV-75R	0.9	0.10	11.95	0.09	3.23	0.29	
74	CV-75L	0.1	0.49	5.00	0.03	4.58	0.16	
77	CV-77	0.1	0.01	6.20	0.00	4.33	0.00	
81L	D-81L	0.9	0.51	10.34	0.48	3.35	1.62	
85R	CV-85	0.2	0.01	8.86	0.00	3.84	0.00	
85L	D-85L	0.4	0.57	9.81	0.23	3.60	0.84	
200L	OS-DITCH	2.1	0.14	22.32	0.30	2.36	0.70	
202L	OS-DITCH	5.5	0.15	20.79	0.85	2.47	2.09	
202M	IN-207	0.4	0.75	6.77	0.32	4.33	1.41	
202R	FES-206N	3.8	0.16	29.98	0.59	1.99	1.17	
203L	D-203L	0.6	0.48	9.66	0.29	3.60	1.03	
204L	OS-DITCH	0.9	0.28	16.18	0.24	2.68	0.65	
208L	D-208L	1.5	0.07	24.33	0.11	2.26	0.25	
214R	D-219R	1.9	0.47	10.91	0.90	3.35	3.01	
217M	IN-217	1.2	0.63	12.40	0.75	3.10	2.33	
219M	IN-219	0.7	0.31	10.66	0.20	3.35	0.67	
219R	OS-DITCH	19.6	0.12	46.82	2.32	1.56	3.62	
221M	IN-221	0.2	0.41	9.22	0.10	3.60	0.34	
221W	FES-221W	2.6	0.13	29.34	0.33	1.99	0.66	
225L	CV-229	1.4	0.34	13.26	0.49	2.98	1.45	
226L	CV-229	2317.1	0.09	#VALUE!	214.22	#VALUE!	#VALUE!	For basin area info only
229R	OS-DITCH	24.2	0.02	54.83	0.50	1.36	0.68	
230L	SD-230L	0.2	0.86	5.00	0.19	4.58	0.86	
231L	EX-IN-605L	0.8	0.86	5.00	0.71	4.58	3.25	
231R	EX-OS-IN	0.4	0.86	7.30	0.38	4.09	1.56	
232R	EX-OS-IN	1.1	0.86	7.26	0.95	4.09	3.89	
232L	EX-IN-605R	0.4	0.86	5.00	0.35	4.58	1.58	
232C	CC-232	0.03	0.86	5.00	0.03	4.58	0.12	
233R	EX-OS-IN	2.1	0.10	14.98	0.21	2.85	0.60	
233R-B	IN-233R-B	0.3	0.86	7.56	0.28	4.09	1.16	
233L-B	CC-233LB	0.3	0.86	5.00	0.24	4.58	1.10	
235	IN-235	0.3	0.86	5.52	0.27	4.58	1.22	
235L	IN-235L	0.4	0.86	5.77	0.37	4.58	1.69	
236R	EX-OS-IN	9.6	0.27	15.87	2.59	2.73	7.07	
236L	D-236L	9.2	0.33	22.41	2.99	2.36	7.07	
237	IN-237	0.3	0.86	5.34	0.26	4.58	1.18	
237L	CC-238	0.4	0.86	5.07	0.30	4.58	1.38	
238R	EX-OS-IN	0.4	0.86	5.17	0.38	4.58	1.75	
238L	D-238L	22.2	0.61	20.84	13.49	2.47	33.31	
240R	EX-OS-CV	0.5	0.76	5.60	0.35	4.58	1.59	
242R	EX-OS-IN	7.7	0.20	16.56	1.53	2.68	4.10	
242L	IN-241	0.1	0.86	5.00	0.08	4.58	0.37	
242L-B	EX-OS-IN	0.05	0.86	5.00	0.04	4.58	0.19	
242L-C	CC-242	0.1	0.86	5.00	0.06	4.58	0.26	
242L-D	CC-241	0.1	0.86	5.00	0.09	4.58	0.42	

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Corridor: CDOT R2 US-24 Garrett to Woodmen | Computed: MGB | Date: 2/16/2026

System Name: Proposed | Checked: AJF | Date: 3/11/2026

Design Storm: 100-yr

BASIN ID	DESIGN POINT	DIRECT RUNOFF						REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	
(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)	(22)
113R	CV-113	81.1	0.15	42.05	12.33	3.35	41.31	
114M	IN-114	2.1	0.69	26.71	1.45	4.34	6.31	
124R	CV-124	10.9	0.16	35.27	1.79	3.68	6.60	
129R	CV-129	149.7	0.16	84.23	24.10	2.51	60.50	
146R	EX-CV-403	0.5	0.54	7.49	0.29	8.27	2.38	
35	CV-35	0.1	0.39	7.82	0.04	8.27	0.32	
36	CV-36	0.1	0.29	9.27	0.02	7.28	0.16	
38	-	0.3	0.27	11.07	0.07	6.53	0.45	
146RB	CV-146	0.7	0.61	6.59	0.42	8.76	3.72	
146M	IN-146	0.04	0.89	5.00	0.04	9.26	0.33	
147R	EX-CV-403	2.3	0.26	34.68	0.61	3.72	2.28	
152M	IN-152	0.5	0.68	11.29	0.36	6.53	2.32	
153L	-	352.2	0.14	#VALUE!	49.18	#VALUE!	#VALUE!	For basin area info only
156R	FES-151R	5.7	0.32	32.01	1.84	3.82	7.04	
160R	CV-160	9.1	0.22	43.37	2.01	3.30	6.63	
162M	IN-162	2.4	0.68	29.86	1.63	4.02	6.55	
162R	EX-CV	73.9	0.21	100.55	15.75	2.51	39.54	
162RB	IN-30	28.8	0.21	52.00	6.07	2.93	17.78	
168R	EX-CV-168	116.6	0.21	69.29	24.95	2.51	62.62	
61	CV-60	20.2	0.34	31.70	6.77	3.86	26.12	
62L	-	0.2	0.56	17.57	0.12	5.30	0.63	
63L	CV-63	0.1	0.57	6.28	0.07	8.76	0.60	
65L	CV-65	0.4	0.47	8.72	0.21	7.77	1.62	
189	RP-RDWN	0.5	0.89	6.88	0.42	8.76	3.66	
193R-A	RP-RDWN	3.4	0.68	18.52	2.35	5.19	12.22	
193R-B	RP-RDWN	5.9	0.68	19.14	4.04	5.08	20.52	
195	RP-RDWN	0.3	0.89	5.00	0.29	9.26	2.72	
197R	CV-197	20.9	0.24	33.12	4.96	3.77	18.71	
70	CV-70	0.1	0.43	5.00	0.04	9.26	0.40	
70B	CV-74	0.2	0.46	6.05	0.07	8.76	0.64	
75R	CV-75R	0.9	0.21	11.95	0.19	6.53	1.25	
74	CV-75L	0.1	0.56	5.00	0.04	9.26	0.36	
77	CV-77	0.1	0.13	6.20	0.01	8.76	0.07	
81L	D-81L	0.9	0.58	10.34	0.55	6.78	3.70	
85R	CV-85	0.2	0.13	8.86	0.02	7.77	0.19	
85L	D-85L	0.4	0.63	9.81	0.26	7.28	1.88	
200L	OS-DITCH	2.1	0.27	22.32	0.57	4.76	2.70	
202L	OS-DITCH	5.5	0.29	20.79	1.57	4.98	7.80	
202M	IN-207	0.4	0.84	6.77	0.36	8.76	3.15	
202R	FES-206N	3.8	0.26	29.98	0.98	4.02	3.92	
203L	D-203L	0.6	0.55	9.66	0.33	7.28	2.38	
204L	OS-DITCH	0.9	0.37	16.18	0.32	5.40	1.73	
208L	D-208L	1.5	0.18	24.33	0.28	4.55	1.30	
214R	D-219R	1.9	0.54	10.91	1.04	6.78	7.02	
217M	IN-217	1.2	0.68	12.40	0.82	6.27	5.11	
219M	IN-219	0.7	0.37	10.66	0.24	6.78	1.64	
219R	OS-DITCH	19.6	0.23	46.82	4.44	3.16	14.02	
221M	IN-221	0.2	0.49	9.22	0.11	7.28	0.82	
221W	FES-221W	2.6	0.24	29.34	0.61	4.02	2.43	
225L	CV-229	1.4	0.42	13.26	0.61	6.02	3.67	
226L	CV-229	2317.1	0.38	#VALUE!	883.87	#VALUE!	#VALUE!	For basin area info only
229R	OS-DITCH	24.2	0.14	54.83	3.36	2.79	9.39	
230L	SD-230L	0.2	0.89	5.00	0.19	9.26	1.80	
231L	EX-IN-605L	0.8	0.89	5.00	0.74	9.26	6.81	
231R	EX-OS-IN	0.4	0.89	7.30	0.39	8.27	3.26	
232R	EX-OS-IN	1.1	0.89	7.26	0.98	8.27	8.13	
232L	EX-IN-605R	0.4	0.89	5.00	0.36	9.26	3.31	
232C	CC-232	0.03	0.89	5.00	0.03	9.26	0.25	
233R	EX-OS-IN	2.1	0.23	14.98	0.48	5.76	2.79	
233R-B	IN-233R-B	0.3	0.89	7.56	0.29	8.27	2.43	
233L-B	CC-233LB	0.3	0.89	5.00	0.25	9.26	2.31	
235	IN-235	0.3	0.89	5.52	0.28	9.26	2.55	
235L	IN-235L	0.4	0.89	5.77	0.38	9.26	3.54	
236R	EX-OS-IN	9.6	0.58	15.87	5.54	5.51	30.51	
236L	D-236L	9.2	0.41	22.41	3.79	4.76	18.06	
237	IN-237	0.3	0.89	5.34	0.27	9.26	2.47	
237L	CC-238	0.4	0.89	5.07	0.31	9.26	2.88	
238R	EX-OS-IN	0.4	0.89	5.17	0.40	9.26	3.67	
238L	D-238L	22.2	0.70	20.84	15.62	4.98	77.80	
240R	EX-OS-CV	0.5	0.81	5.60	0.37	9.26	3.47	
242R	EX-OS-IN	7.7	0.33	16.56	2.54	5.40	13.70	
242L	IN-241	0.1	0.89	5.00	0.08	9.26	0.77	
242L-B	EX-OS-IN	0.05	0.89	5.00	0.04	9.26	0.40	
242L-C	CC-242	0.1	0.89	5.00	0.06	9.26	0.54	
242L-D	CC-241	0.1	0.89	5.00	0.10	9.26	0.89	

LEGEND:

- PROPOSED BASIN BOUNDARY
- PROPOSED SUB-BASIN BOUNDARY
- FLOW ARROW
- SEPARATE PERVIOUS AREA
- UNCONNECTED IMPERVIOUS AREA
- RECEIVING PERVIOUS AREA SWALE/BUFFER

BSN 61-3
A3-UIA
AREA: 7,286 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 61-3
A2-RPA SWALE
AREA: 1,185 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-3
A1-SPA
AREA: 132,665 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-2
A3-UIA
AREA: 1,125 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 61-2
A4-RPA BUFFER
AREA: 582 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-2
A2-RPA SWALE
AREA: 218 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-2
A1-SPA
AREA: 304,700 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-1
A1-SPA
AREA: 286,564 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-1
A4-RPA BUFFER
AREA: 3,113 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-1
A2-RPA SWALE
AREA: 1,345 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-1
A3-UIA
AREA: 8,417 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 61-4
A3-UIA
AREA: 5,620 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 61-4
A4-RPA BUFFER
AREA: 3,141 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-4
A1-SPA
AREA: 117,070 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-4
A2-RPA SWALE
AREA: 671 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 75R
A1-SPA
AREA: 31,890 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 75R
A2-RPA SWALE
AREA: 587 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 75R
A3-UIA
AREA: 4,118 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 75R
A4-RPA BUFFER
AREA: 2,793 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 74
A1-UIA
AREA: 1,747 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 74
A2-RPA SWALE
AREA: 1,087 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 85L
A1-UIA
AREA: 11,639 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 85L
A2-RPA SWALE
AREA: 6,148 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 70B
A1-UIA
AREA: 2,993 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 81L
A2-RPA SWALE
AREA: 16,613 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 81L
A1-UIA
AREA: 24,213 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 70B
A2-RPA BUFFER
AREA: 1,805 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 70B
A3-RPA SWALE
AREA: 382 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 70B
A4-SPA
AREA: 1,796 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 70
A3-RPA SWALE
AREA: 177 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 70
A4-SPA
AREA: 1,321 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 70
A1-UIA
AREA: 1,616 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 70
A2-RPA BUFFER
AREA: 973 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-3
A4-RPA BUFFER
AREA: 3,940 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 65L
A3-RPA SWALE
AREA: 1,323 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 65L
A1-UIA
AREA: 8,645 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 65L
A4-SPA
AREA: 3,968 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 65L
A2-RPA BUFFER
AREA: 5,093 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 63L
A1-UIA
AREA: 2,264 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 63L
A2-RPA BUFFER
AREA: 1,167 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 63L
A4-SPA
AREA: 1,142 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 63L
A3-RPA SWALE
AREA: 466 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 62L
A1-UIA
AREA: 5,236 SF
MATERIAL: PAVEMENT
IMPERVIOUSNESS: 100%

BSN 62L
A3-RPA BUFFER
AREA: 1,895 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 62L
A2-RPA SWALE
AREA: 2,046 SF
MATERIAL: NATIVE GRASS
IMPERVIOUSNESS: 2%

BSN 61-2

BSN 61-1

BSN 61-4

BSN 61-3

BSN 75R

BSN 74

BSN 70B

BSN 70

BSN 65L

BSN 63L

BSN 62L

BSN 81L

BSN 85L

BLUESTEM RD

FALCON HWY

KANG SITE

TO US-24

811 Know what's below. Call before you dig.

0' 50' 100' 200'

5555 TECH CENTER DR, #310
COLORADO SPRINGS, CO, 80919
Phone: 719-272-8800
FAX: 303-860-7139

25094 - US24 GARRETT TO WOODMEN

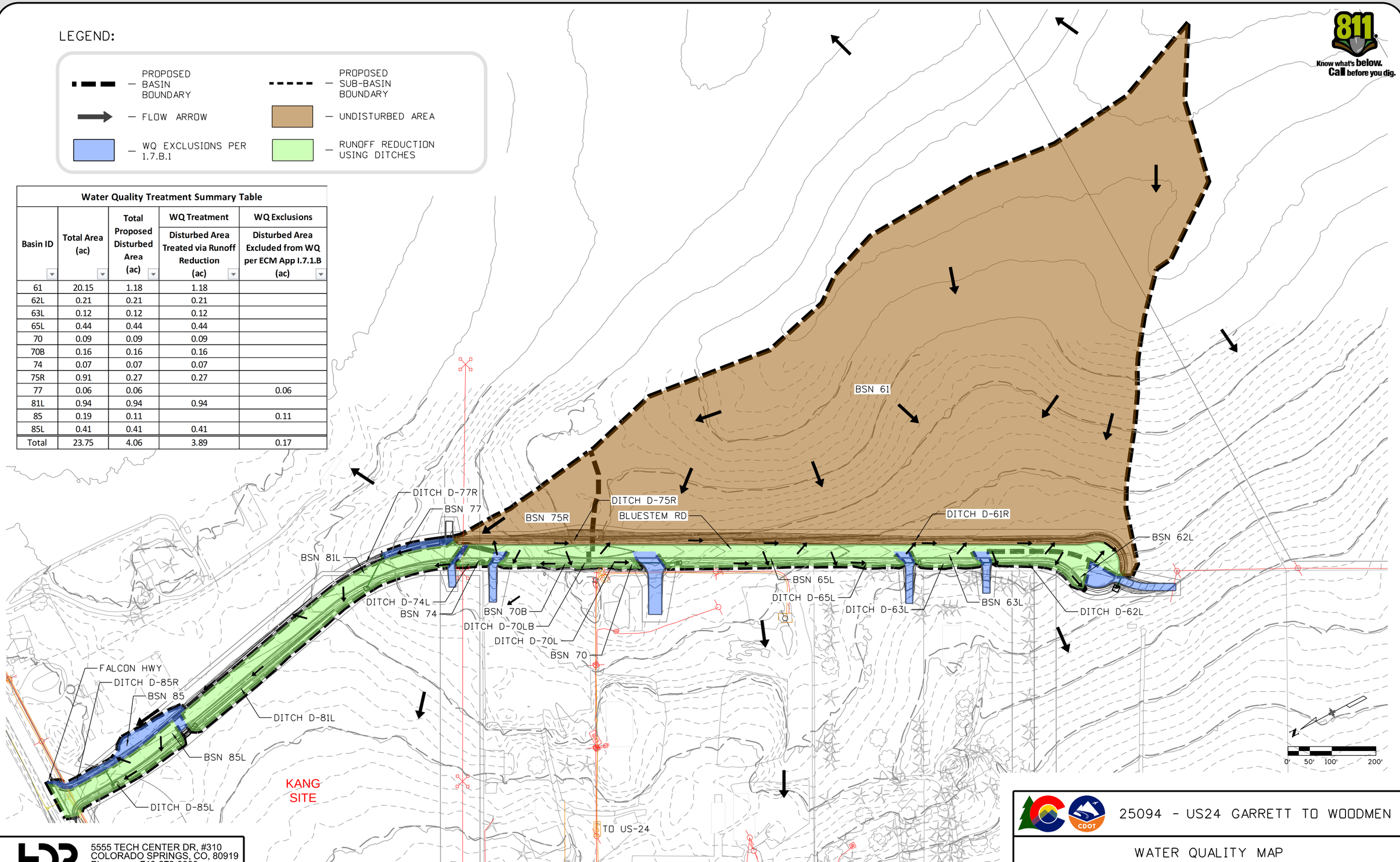
RUNOFF REDUCTION EXHIBIT
BLUESTEM ROAD-EL PASO COUNTY

LEGEND:

- PROPOSED BASIN BOUNDARY
- PROPOSED SUB-BASIN BOUNDARY
- FLOW ARROW
- UNDISTURBED AREA
- WQ EXCLUSIONS PER 1.7.B.1
- RUNOFF REDUCTION USING DITCHES

Water Quality Treatment Summary Table

Basin ID	Total Area (ac)	Total Proposed Disturbed Area (ac)	WQ Treatment	WQ Exclusions
			Disturbed Area Treated via Runoff Reduction (ac)	Disturbed Area Excluded from WQ per ECM App I.7.1.B (ac)
61	20.15	1.18	1.18	
62L	0.21	0.21	0.21	
63L	0.12	0.12	0.12	
65L	0.44	0.44	0.44	
70	0.09	0.09	0.09	
70B	0.16	0.16	0.16	
74	0.07	0.07	0.07	
75R	0.91	0.27	0.27	
77	0.06	0.06		0.06
81L	0.94	0.94	0.94	
85	0.19	0.11		0.11
85L	0.41	0.41	0.41	
Total	23.75	4.06	3.89	0.17



5555 TECH CENTER DR, #310
COLORADO SPRINGS, CO, 80919
Phone: 719-272-8800
FAX: 303-860-7139

25094 - US24 GARRETT TO WOODMEN

WATER QUALITY MAP
BLUESTEM ROAD-EL PASO COUNTY

APPENDIX C

HYDROLOGIC CALCULATIONS

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	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
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis--Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	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
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	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
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and 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
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	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

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

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

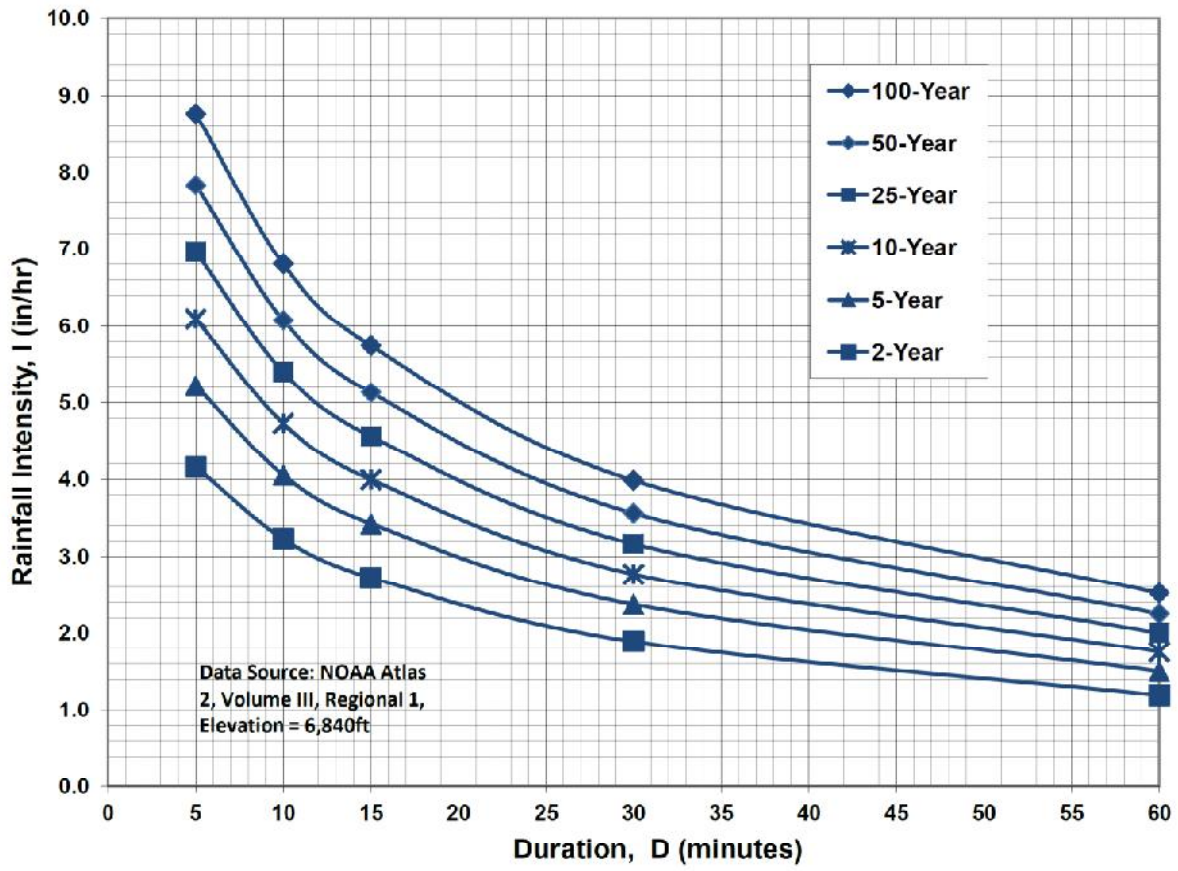
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

KANG PARCEL - CDOT BASINS COMPRISING "BASIN OA1" (BLUESTEM ROAD CORRIDOR ALONG EAST BOUNDARY OF KANG PARCEL)
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
77	0.06	0.000	PAVEMENT	0.9	0.000	GRAVEL	0.59	0.060	LANDSCAPED	0.08	0.080
81L	0.94	0.556	PAVEMENT	0.9	0.000	GRAVEL	0.59	0.384	LANDSCAPED	0.08	0.565
85R	0.19	0.000	PAVEMENT	0.9	0.000	GRAVEL	0.59	0.190	LANDSCAPED	0.08	0.080
85L	0.41	0.267	PAVEMENT	0.9	0.000	GRAVEL	0.59	0.143	LANDSCAPED	0.08	0.614
77,81L,85R,85L	1.60										0.502

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
77	0.06	0.000	PAVEMENT	0.96	0.000	GRAVEL	0.70	0.060	LANDSCAPED	0.35	0.350
81L	0.94	0.556	PAVEMENT	0.96	0.000	GRAVEL	0.70	0.384	LANDSCAPED	0.35	0.711
85R	0.19	0.000	PAVEMENT	0.96	0.000	GRAVEL	0.70	0.190	LANDSCAPED	0.35	0.350
85L	0.41	0.267	PAVEMENT	0.96	0.000	GRAVEL	0.70	0.143	LANDSCAPED	0.35	0.747
77,81L,85R,85L	1.60										0.664

KANG STORAGE
COMPOSITE IMPERVIOUS AREAS

IMPERVIOUS AREAS - INITIAL CONDITIONS

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
77	0.06	0.000	PAVEMENT	100	0.000	GRAVEL	80	0.060	LANDSCAPED	0	0.000
81L	0.94	0.556	PAVEMENT	100	0.000	GRAVEL	80	0.384	LANDSCAPED	0	59.149
85R	0.19	0.000	PAVEMENT	100	0.000	GRAVEL	80	0.190	LANDSCAPED	0	0.000
85L	0.41	0.267	PAVEMENT	100	0.000	GRAVEL	80	0.143	LANDSCAPED	0	65.122
77,81L,85R,85L	1.60										51.438

KANG PARCEL
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	1.60										0.502
A1	10.79	7.894	ASPHALT / CONCRETE	0.9	0.000	GRAVEL	0.59	2.896	LANDSCAPED	0.08	0.680
OA1,A1	12.39										0.657
A2	1.55	0.000	ASPHALT / CONCRETE	0.9	0.000	GRAVEL	0.59	1.550	LANDSCAPED	0.08	0.080
OA1,A1,A2	13.94										0.593

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	1.60										0.664
A1	10.79	7.894	ASPHALT / CONCRETE	0.96	0.000	GRAVEL	0.70	2.896	LANDSCAPED	0.35	0.796
OA1,A1	12.39										0.779
A2	1.55	0.000	ASPHALT / CONCRETE	0.96	0.000	GRAVEL	0.70	1.550	LANDSCAPED	0.35	0.350
OA1,A1,A2	13.94										0.731

KANG PARCEL - LOT 1, ABIDING WORD LUTHERAN SUBDIVISION
RATIONAL METHOD HYDROLOGIC CALCULATIONS

HISTORIC CONDITIONS

					Overland Flow			Channel flow									
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
OA1		1.60	0.080	0.350	100	0.010	18.7	185	15	0.008	1.34	2.3	21.0	21.0	3.02	5.07	0.39	2.84
A		12.4	0.080	0.350	100	0.020	14.8	735	15	0.013	1.71	7.2	22.0	22.0	2.95	4.95	2.91	21.40
OA1,A	**1**	**13.96**	**0.080**	**0.350**									**21.0**	**21.0**	**3.02**	**5.07**	**3.37**	**24.75**

DEVELOPED CONDITIONS

					Overland Flow			Channel flow									
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
OA1		1.60	0.502	0.664	100	0.010	10.9	185	20	0.008	1.79	1.7	12.7	12.7	3.77	6.34	3.03	6.73
Tt-A1 (OA1 to DP-A1)								685	20	0.015	2.45	4.7						
A1		10.79	0.680	0.796	100	0.020	6.1	735	20	0.013	2.28	5.4	11.5	11.5	3.92	6.59	28.78	56.56
OA1,A1	**A1**	**12.39**	**0.657**	**0.779**									**17.3**	**17.3**	**3.30**	**5.55**	**26.90**	**53.54**
Tt DP-A1 to DP1								145	20	0.007	1.67	1.4						
A2		1.55	0.080	0.350	100	0.020	14.8	515	15	0.030	2.60	3.3	18.1	18.1	3.24	5.43	0.40	2.95
OA1,A1,A2	**1**	**13.94**	**0.593**	**0.731**									**17.3**	**17.3**	**3.30**	**5.55**	**27.31**	**56.52**

**** NOTE: Tc AT DP-A1 = Tc (OA1) + Tt-A1***

DETAINED CONDITIONS

					Overland Flow			Channel flow									
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
POND A1 OUTFLOW		12.39															**0.3**	**7.1**
A2		1.55	0.080	0.350	100	0.020	14.8	515	15	0.030	2.60	3.3	18.1	18.1	3.24	5.43	0.40	2.95
A1,A2	1	13.94	0.438	0.598													**0.70**	**10.05**

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES
3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
I_5 = -1.5 * ln(Tc) + 7.583
I_{100} = -2.52 * ln(Tc) + 12.735
6) Q = CiA

APPENDIX D

HYDRAULIC CALCULATIONS

KANG STORAGE - 11401 E. HIGHWAY 24
STORM INLET SIZING SUMMARY

	BASIN FLOW			INLET FLOW					
INLET	DP	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET FLOW % OF BASIN	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET CONDITION / TYPE	INLET SIZE	INLET CAPACITY (CFS)
A1	A1	26.9	53.5	100	26.9	53.5	TYPE R (SUMP)	20'	54.8

MHFD-Inlet, Version 5.03 (August 2023)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Inlet A1
Site Type (Urban or Rural)	URBAN
Inlet Application (Street or Area)	STREET
Hydraulic Condition	In Sump
Inlet Type	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	26.9
Major Q_{Known} (cfs)	53.5

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (le

Receive Bypass Flow from:	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0
Major Bypass Flow Received, Q_b (cfs)	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_r (years)	
One-Hour Precipitation, P_1 (inches)	

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**26.9**
Major Total Design Peak Flow, Q (cfs)	**53.5**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A

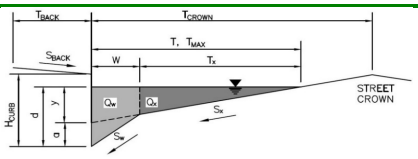
MHFD-Inlet, Version 5.03 (August 2023)

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

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

Project: **Kang Storage - 11401 E. Highway 24**

Inlet ID: **Inlet A1**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	4.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	120.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.010	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	100.0	100.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

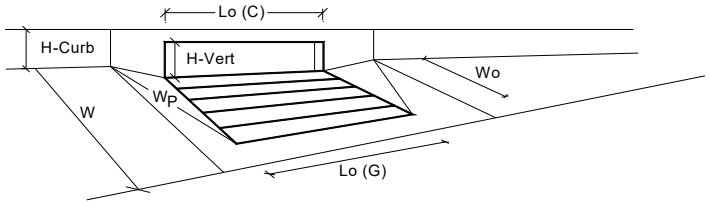
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

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

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	4	4	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	13.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.92	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.79	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**12.5**	**54.8**	**cfs**
WARNING: Inlet Capacity < Q Peak for Minor Storm	$Q_{PEAK\ REQUIRED}$ =	26.9	53.5	cfs

KANG STORAGE - 11401 E. HIGHWAY 24
STORM SEWER SIZING SUMMARY

	PIPE FLOW				PIPE CAPACITY		
PIPE	DESIGN POINT	Q5 FLOW (CFS)	Q100 FLOW (CFS)		MIN. PIPE SIZE	MIN. PIPE SLOPE	PIPE CAPACITY (CFS)
A1	A1(DEV)	26.9	53.5		30	3.0%	71.0
A1-OUTLET	A1(DET)	0.3	7.1		18	0.5%	7.4

ASSUMPTIONS:
1. STORM DRAIN PIPE ASSUMED TO BE RCP OR HDPE

Hydraulic Analysis Report

Project Data

Project Title: Project - Kang Storage

Designer: JPS

Project Date: Sunday, November 15, 2026

Project Units: U.S. Customary Units

Notes

Channel Analysis: SD-A1

Notes:

Input Parameters

Channel Type: : Circular

Pipe Diameter: 2.50 ft

Longitudinal Slope: 0.0300 ft/ft

Manning's n: : 0.0130

Depth: 2.5000 ft

Result Parameters

Flow: 71.0438 cfs

Area of Flow: 4.9087 ft^2

Wetted Perimeter: 7.8540 ft

Hydraulic Radius: 0.6250 ft

Average Velocity: 14.4729 ft/s

Top Width: 0.0000 ft

Froude Number: : 0.0000

Critical Depth: 2.4438 ft

Critical Velocity: 14.5555 ft/s

Critical Slope: 0.0267 ft/ft

Critical Top Width: 0.74 ft

Calculated Max Shear Stress: 4.6800 lb/ft^2

Calculated Avg Shear Stress: 1.1700 lb/ft^2

Channel Analysis: SD-A1-Pond Outlet

Notes:

Input Parameters

Channel Type: : Circular

Pipe Diameter: 1.50 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: : 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 7.4277 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 4.2032 ft/s

Top Width: 0.0000 ft

Froude Number: : 0.0000

Critical Depth: 1.0554 ft

Critical Velocity: 5.5902 ft/s

Critical Slope: 0.0070 ft/ft

Critical Top Width: 1.37 ft

Calculated Max Shear Stress: 0.4680 lb/ft^2

Calculated Avg Shear Stress: 0.1170 lb/ft^2

APPENDIX E

DETENTION POND CALCULATIONS

KANG STORAGE
COMPOSITE IMPERVIOUS AREAS

IMPERVIOUS AREAS - INITIAL CONDITIONS

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
OA1	1.60										51.438
A1	10.79	0.087	ASPHALT / CONCRETE	100	7.807	GRAVEL	80.00	2.896	LANDSCAPED	0	58.690
OA1,A1	**12.39**										**57.753**
A2	1.55	0.000	ASPHALT / CONCRETE	100	0.000	GRAVEL	80.00	1.550	LANDSCAPED	0	0.000
OA1,A1,A2	13.94										51.331

IMPERVIOUS AREAS - POTENTIAL ULTIMATE CONDITIONS (ON-SITE STORAGE AREA FULLY PAVED)

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
OA1	1.60										51.438
A1	10.79	7.894	ASPHALT / CONCRETE	100	0.000	GRAVEL	80.00	2.896	LANDSCAPED	0	73.160
OA1,A1	**12.39**										**70.355**
A2	1.55	0.000	BUILDING / CONCRETE	100	0.000	GRAVEL	80.00	1.550	LANDSCAPED	0	0.000
OA1,A1,A2	13.94										62.532

Water Quality Treatment Summary Table		
Basin ID(s)	**PCM Tributary Area (ac)**	**PCM ID**
A1	10.79	Detention Pond A1
A2	0.58	Excluded*

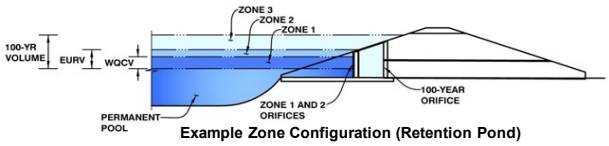
* Excluded based on ECM App I.7.1.C.1

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.07 (June 2025)

Project: **Kang Storage (11401 E. HIGHWAY 24)**

Basin ID: **Detention Pond A1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected SCM Type =	**EDB**	
Watershed Area =	12.39	acres
Watershed Length =	970	ft
Watershed Length to Centroid =	490	ft
Watershed Slope =	0.013	ft/ft
Watershed Imperviousness =	70.36%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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	
Water Quality Capture Volume (WQCV) =	0.286	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.106	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.785	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.025	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.217	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.458	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.693	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.974	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.593	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.722	acre-feet		
Approximate 5-yr Detention Volume =	0.942	acre-feet		
Approximate 10-yr Detention Volume =	1.131	acre-feet		
Approximate 25-yr Detention Volume =	1.355	acre-feet		
Approximate 50-yr Detention Volume =	1.487	acre-feet		
Approximate 100-yr Detention Volume =	1.620	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.286	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.820	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.514	acre-feet
Total Detention Basin Volume =	1.620	acre-feet

Depth Increment = ft

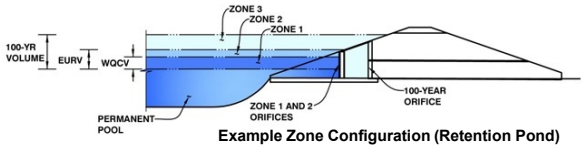
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Bot EL=6809.0	--	1.00	--	--	--	10,183	0.234	5,096	0.117
	--	2.00	--	--	--	20,733	0.476	20,554	0.472
Spillway=6812.0	--	4.00	--	--	--	36,176	0.830	77,463	1.778
Top Berm=6814.0	--	6.00	--	--	--	66,227	1.520	179,866	4.129
	--		--	--	--				
	--		--	--	--				
	--		--	--	--			

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.07 (June 2025)

Project: **Kang Storage (11401 E. HIGHWAY 24)**

Basin ID: **Detention Pond A1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.56	0.286	Orifice Plate
Zone 2 (EURV)	3.11	0.820	Orifice Plate
Zone 3 (100-year)	3.81	0.514	Weir&Pipe (Restrict)
Total (all zones)		1.620	

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

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

Underdrain Orifice Diameter = N/A inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = N/A ft^2

Underdrain Orifice Centroid = N/A feet

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

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = 3.11 ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = 9.60 inches

Orifice Plate: Orifice Area per Row = N/A sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row = N/A ft^2

Elliptical Half-Width = N/A feet

Elliptical Slot Centroid = N/A feet

Elliptical Slot Area = N/A ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.04	2.07					
Orifice Area (sq. inches)	2.31	2.31	3.14					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.20	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.20	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	13.56	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	8.50		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.82	N/A	ft^2
Outlet Orifice Centroid =	0.41	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.52	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= 4.00 ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = 11.00 feet

Spillway End Slopes = 4.00 H:V

Freeboard above Max Water Surface = 1.00 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth= 0.88 feet

Stage at Top of Freeboard = 5.88 feet

Basin Area at Top of Freeboard = 1.48 acres

Basin Volume at Top of Freeboard = 3.95 acre-ft

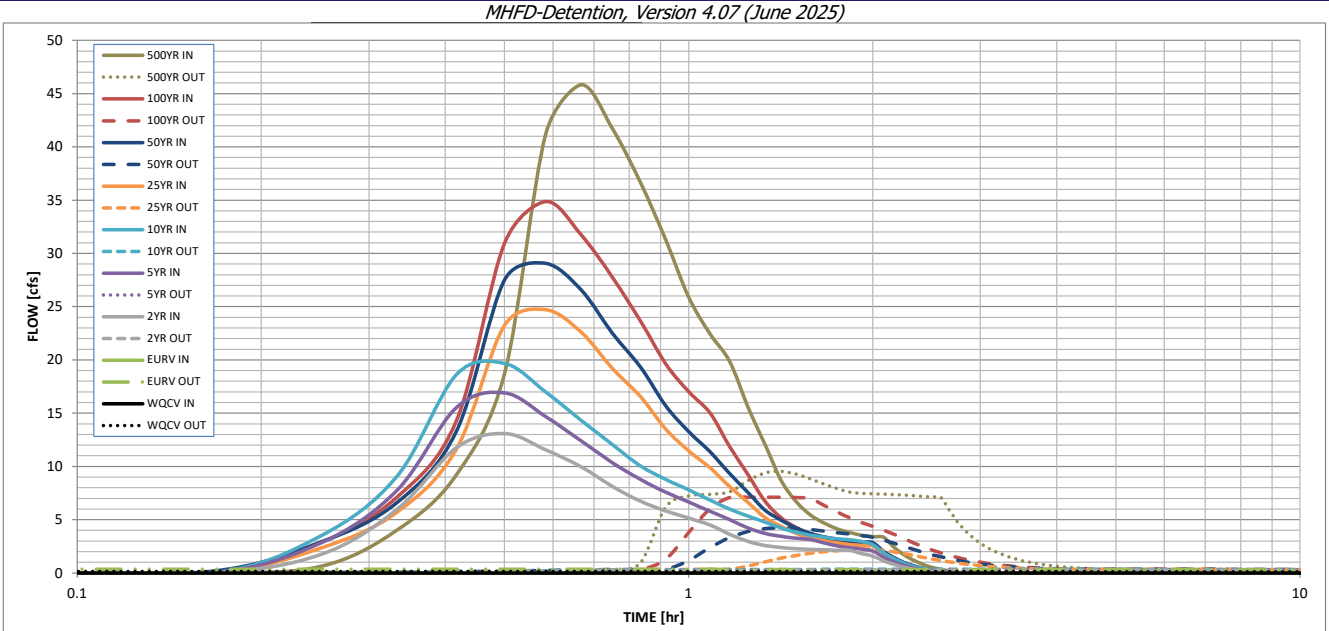
Routed Hydrograph Results

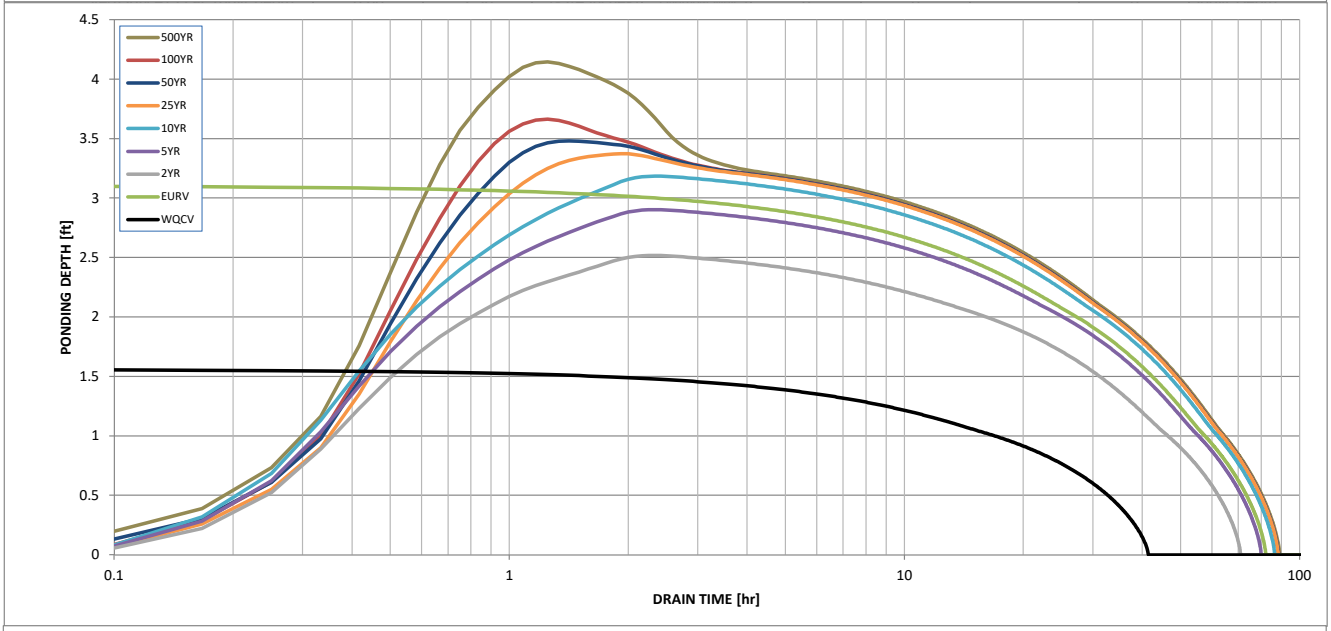
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

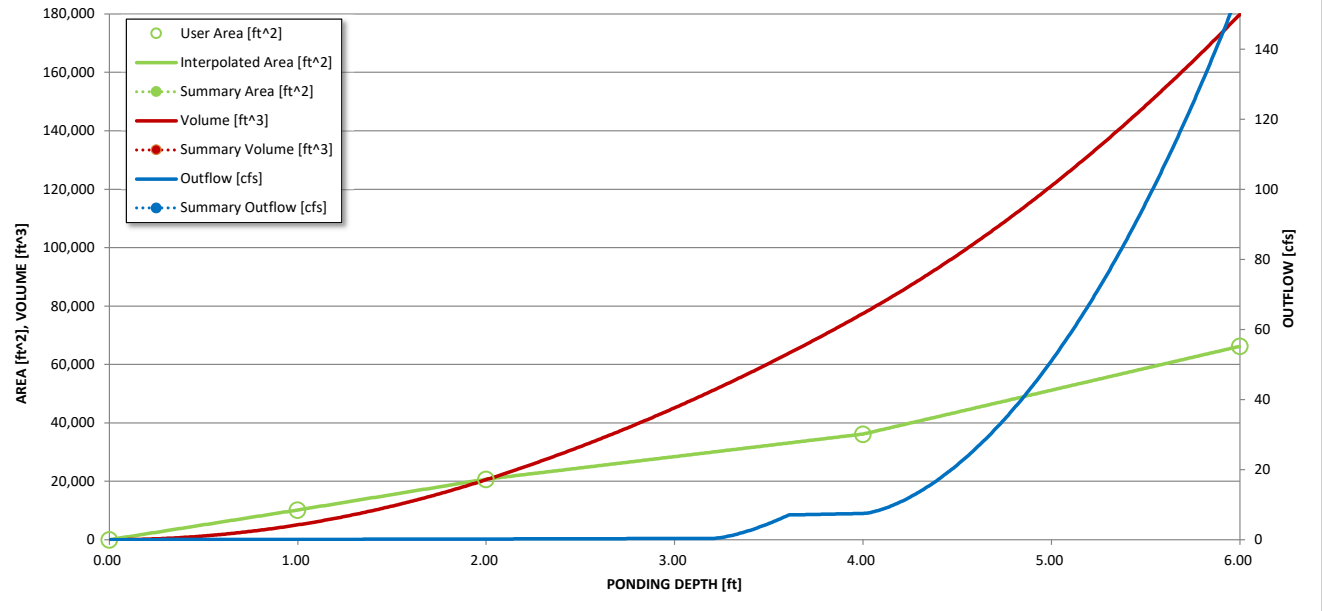
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.286	1.106	0.785	1.025	1.217	1.458	1.693	1.974	2.593
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.785	1.025	1.217	1.458	1.693	1.974	2.593
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.4	0.6	2.7	4.9	7.8	13.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.04	0.05	0.22	0.40	0.63	1.09
Peak Inflow Q (cfs) =	N/A	N/A	13.1	16.9	19.7	24.7	29.1	34.9	45.8
Peak Outflow Q (cfs) =	0.2	0.4	0.3	0.3	0.4	2.2	4.2	7.1	9.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.6	0.8	0.9	0.9	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.2	0.3	0.6	0.6
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	73	64	71	76	77	75	74	71
Time to Drain 99% of Inflow Volume (hours) =	**40**	78	68	76	82	83	83	82	81
Maximum Ponding Depth (ft) =	1.57	3.11	2.52	2.90	3.18	3.37	3.48	3.66	4.15
Area at Maximum Ponding Depth (acres) =	0.37	0.67	0.57	0.64	0.69	0.72	0.74	0.77	0.88
Maximum Volume Stored (acre-ft) =	0.290	1.109	0.738	0.972	1.157	1.290	1.370	1.506	1.898

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.07 (June 2025)







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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0	0.00	0.00	0.00	0.00	0.00	0.20	0.02	0.63
	0:15:00	0	0.00	1.74	2.83	3.50	2.35	2.91	2.86	4.03
	0:20:00	0	0.00	5.97	7.76	9.09	5.71	6.63	7.13	9.23
	0:25:00	0	0.00	11.77	15.55	18.63	11.64	13.32	14.29	18.79
	0:30:00	0	0.00	13.10	16.91	19.68	23.29	27.54	31.01	41.18
	0:35:00	0	0.00	11.58	14.69	17.00	24.73	29.07	34.88	45.83
	0:40:00	0	0.00	9.99	12.43	14.34	22.61	26.58	31.74	41.75
	0:45:00	0	0.00	8.15	10.38	12.07	19.22	22.54	27.80	36.67
	0:50:00	0	0.00	6.75	8.80	10.06	16.58	19.36	23.67	31.29
	0:55:00	0	0.00	5.85	7.59	8.80	13.52	15.70	19.64	25.91
	1:00:00	0	0.00	5.16	6.67	7.81	11.48	13.28	17.02	22.45
	1:05:00	0	0.00	4.51	5.79	6.85	9.88	11.39	15.03	19.87
	1:10:00	0	0.00	3.64	5.02	6.00	8.13	9.33	11.87	15.58
	1:15:00	0	0.00	2.97	4.24	5.35	6.63	7.57	9.25	12.04
	1:20:00	0	0.00	2.60	3.73	4.79	5.21	5.90	6.72	8.70
	1:25:00	0	0.00	2.40	3.45	4.23	4.40	4.97	5.19	6.67
	1:30:00	0	0.00	2.29	3.27	3.84	3.73	4.21	4.27	5.45
	1:35:00	0	0.00	2.23	3.15	3.56	3.31	3.72	3.69	4.68
	1:40:00	0	0.00	2.19	2.82	3.36	3.01	3.38	3.30	4.16
	1:45:00	0	0.00	2.15	2.57	3.22	2.82	3.17	3.04	3.81
	1:50:00	0	0.00	2.13	2.39	3.13	2.69	3.02	2.85	3.56
	1:55:00	0	0.00	1.83	2.25	2.97	2.60	2.92	2.74	3.41
	2:00:00	0	0.00	1.60	2.08	2.67	2.54	2.86	2.70	3.37
	2:05:00	0	0.00	1.15	1.50	1.91	1.82	2.05	1.94	2.41
	2:10:00	0	0.00	0.81	1.05	1.34	1.28	1.44	1.37	1.71
	2:15:00	0	0.00	0.56	0.73	0.93	0.90	1.01	0.96	1.20
	2:20:00	0	0.00	0.38	0.48	0.63	0.61	0.68	0.65	0.81
	2:25:00	0	0.00	0.25	0.32	0.42	0.40	0.45	0.43	0.54
	2:30:00	0	0.00	0.15	0.21	0.27	0.27	0.30	0.29	0.36
	2:35:00	0	0.00	0.08	0.13	0.16	0.16	0.18	0.17	0.21
	2:40:00	0	0.00	0.04	0.06	0.08	0.08	0.09	0.09	0.11
	2:45:00	0	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.04
	2:50:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Site Layout

SCM Design, Version 4.00 (April 2024)

Designer: JPS
Company: JPS
Date: November 15, 2026
Project: Kang Storage
Location: Kang Storage - 11401 E. Highway 24 - Detention Pond A1

SITE LAYOUT INFO (User Input in Blue Cells)

Water Quality Event (WQE): 0.60 inches

Outfall ID	A1											
Total Tributary Area (ft^2)	539,708											
Imperviousness (%)	70.4%											
MS4 Design Standard	WQCV											
SCM Type	EDB											

Notes:

OUTFALL RESULTS

SCM Worksheet Name	EDB_A1											
Untreated Area (ft^3)	0											
Default WQCV (ft^3)	12,443											
WQCV Reduction (ft^3)	0											
Remaining WQCV (ft^3)	12,443											
WQCV Reduction (%)	0%											
Design WQCV of SCM (ft^3)	3,872											
Pollutant Removal (ft^3)	0											
Untreated WQCV (ft^3)	8,571											

TOTAL SITE RESULTS (Sums results from all Outfalls)

Total Site Area	539,708	ft^2	12.39	acres
Treated Area	539,708	ft^2	12.39	acres
Untreated Area	0	ft^2	0.00	acres
Total Site Imperviousness	70.4%	%		
Default WQCV	12,443	ft^3	0.286	acre-feet
Remaining WQCV	12,443	ft^3	0.286	acre-feet
WQCV Reduction	0%	%		
Design WQCV	3,872	ft^3	0.089	acre-feet
Untreated WQCV	8,571	ft^3	0.197	acre-feet

Extended Detention Basin (EDB)

SCM Design, Version 4.00 (April 2024)

Designer: JPS
Company: JPS
Date: November 15, 2026
Project: Kang Storage
Location: Kang Storage - 11401 E. Highway 24 - Detention Pond A1
Outfall ID: A1

1. Inlet and Forebay

A) Is RPA (GB/GS) used for Runoff Reduction upstream of SCM? NO

Define inflow points for all areas tributary to the SCM below.

B) Inflow Points contributing to SCM (max 8)

Inflow Design Point ID	A1	A1-NW						
Tributary Area to Inflow Point (ft^2)	528,893	10,815						
Imperviousness above Inflow Point (%)	70.4%	70.4%						
Default WQCV for Inflow Point (ft^3)	12,202	250						
WQCV Reduction above Inflow Point (ft^3)	0	0						
Remaining WQCV at Inflow Point (ft^3)	12,202	250						
Will pretreatment be provided with a Sedimentation MTD (HDS)	NO	NO						
Paired Pretreatment HDS Worksheet Name		--						
Sheet or Concentrated Flow	Conc	Sheet						

C) Sheet Flow

Select sheet flow inflow feature	--	Other						
Is Concrete Edger used?	--	--						
Spacing between slots, recommend ≤ 2 ft on center (ft)	--	--						
Slot Opening Length, recommend 1.5 (in)	--	--						
Select type of blind swale used to distribute flow	--	--						
Select energy dissipation method for level spreader	--	--						
Height of drop, recommend 2 to 3 (in)	--	--						
Is concrete mowing strip provided to facilitate maintenance?	--	--						

D) Concentrated Flow

Select concentrated flow inflow feature	Pipe	--						
Is downspout extension needed to bridge backfill zone?	--	--						
Depth of gutter flow line depression for curb opening, recommend 3 (in)	--	--						
Curb opening inlet width (ft)	--	--						
Height of drop to sediment pad/forebay, recommend ≥ 1 (in)	--	--						
Select energy dissipation method for downspouts and/or curb openings.	--	--						
Select energy dissipation method for swales, channels, and piped outfalls	Other	--						

Concrete Forebay A1

v) Forebay

Impervious area tributary to concentrated inflow location (ft^2)	372,341	--						
Forebay Type (Concrete Sediment Pad sufficient for Imp Area ≤ 2 acre)	Forebay	--						
Minimum Forebay Volume (ft^3)	122	--						
Design Forebay Volume (ft^3)	144	--						
Maximum Forebay Depth (in)	18.00	--						
Design Forebay Depth (in)	18.00	--						
Rectangular Weir Notch Width to Empty Forebay in 5-minutes (in)	2.04	--						
Design Notch Width (in)	2.04	--						
Forebay Drain Time (minutes)	5.0	--						

Extended Detention Basin (EDB)

SCM Design, Version 4.00 (April 2024)

Designer:	**JPS**
Company:	**JPS**
Date:	**November 15, 2026**
Project:	**Kang Storage**
Location:	**Kang Storage - 11401 E. Highway 24 - Detention Pond A1**
Outfall ID:	**A1**

Inflow Points above should be fully defined before proceeding below

2. Design Storage Volume

A) Contributing Watershed Area (including EDB area)
Area = 539,708 ft²
Area = 12.39 ac

For area < 20 impervious acres, consider filtration/infiltration SCMs to avoid small orifices prone to clogging.

B) Imperviousness of Tributary Area
i = 70.4% %

C) Default WQCV
$V_{WQCV\ Default}$ = 12,443 ft³

D) WQCV Reduction resulting from Upstream RPA (GB/GS)
WQCV Reduction = 0 ft³

E) Remaining WQCV
$V_{WQCV\ Remaining}$ = 12,443 ft³

F) Design WQCV (based on actual design geometry)
$V_{WQCV\ Design}$ = 12,458 ft³

G) Describe additional storage volume provided (e.g. EURV/100yr)
Describe why EDB was selected over other SCMs based on Table EDB-3 considerations related to contributing impervious area.

3. EDB Shape

A) Basin Length-to-Width Ratio
(measured along the low flow channel from inlet to outlet)
$R_{L/W}$ = 4

B) Discuss how the design considered community values

4. Side Slopes

When designing basin slopes, consider requirements for access and vegetation management.

A) Max. Side Slope (Z = 4:1 or flatter, horiz. dist per unit vertical)
(Use "0" if EDB has vertical walls)
Z = 3.00 ft / ft **Steeper than 4:1**

5. Low Flow Channels and Basin Bottom Grading

A) Type of low flow channel
Concrete Pan

B) Depth of low flow channel (recommend 18")
D_{LFC} = 6.00 in **Recommend > 18 inches**

C) Depth of concrete curb (recommend 6")
D_{Curb} = 6.00 in

D) Side Slopes of low flow channel (Z = 2 min.)
Z_{LFC} = 4.00 ft / ft

E) Bottom width of low flow channel (as needed for equipment)
Bottom Width $_{LFC}$ = 0.00 ft

F) Longitudinal Slope (recommend 0.004 to 0.01 ft/ft for concrete)
Slope $_{LFC}$ = 0.005 ft / ft

G) Typical Bottom Slope toward low flow channel (min. 0.02 ft/ft)
Slope $_{Basin\ Bottom}$ = 0.020 ft / ft

H) Describe any non-typical low flow channel features (if applicable)

Extended Detention Basin (EDB)

SCM Design, Version 4.00 (April 2024)

Designer: JPS
Company: JPS
Date: November 15, 2026
Project: Kang Storage
Location: Kang Storage - 11401 E. Highway 24 - Detention Pond A1
Outfall ID: A1

6. Initial Surcharge Volume

A) Initial Surcharge Depth (recommend 4 inches minimum) — ISD = 4.00 in

7. Outlet Structure

A) Micropool Type — Internal

B) Depth of Micropool (recommend 2.5 feet minimum) — D_{MP} = 2.50 ft

C) Surface Area of Micropool (recommend 15 square feet minimum) — A_{MP} = 16.0 ft^2

D) Describe Micropool configuration

E) Minimum dimension of opening in water quality orifice plate based on 40-hour drain time and hydrograph routing in MHFD-Detention. — Orifice D_{Min} = 1.06 in **Well Screen necessary to protect small orifice opening**

F) Describe orifice plate configuration

G) Trash Rack Type — Well Screen & Bar Grating

H) Trash Rack Configuration — Vertical

I) Describe Outlet Structure(s) for events larger than WQCV. (EURV, full-spectrum detention, safety grating, etc.)

Full-spectrum detention

8. Emergency Spillway and Overflow Embankment

A) Describe spillway configuration, spillway capacity, and embankment protection.

Buried riprap spillway sized for 100-year event

9. Vegetation

A) Has a vegetation management plan been developed? — YES

B) Has a landscape management plan been developed? — YES

C) Describe vegetation/landscaping considerations:
- Specify plants that support the water quality function of the EDB? (e.g. wetland, wetland fringe, riparian, upland, trees)
- Include drought tolerant native plants?
- Consider soil assessment, preparation, and erosion mitigation?
- Include plants that enhance within context of the site?
- Address alternative hydraulic regimes?
- Consider required maintenance activities and intervals?
- Consider short and long-term irrigation needs?
- Consider irrigation head placement?

Seeding with native grass

Extended Detention Basin (EDB)

SCM Design, Version 4.00 (April 2024)

Designer: JPS
Company: JPS
Date: November 15, 2026
Project: Kang Storage
Location: Kang Storage - 11401 E. Highway 24 - Detention Pond A1
Outfall ID: A1

10. Maintenance Access

A) Describe maintenance access into forebay(s) and area adjacent to and within outlet structure:
- minimum access path width of 10 feet
- maximum 10% grade for haul road surface
- maximum 20% grade for skid-loader and backhoe access
- cross-slope of 2% for access path
- stabilized access materials (concrete, block, grid, reinforced turf)
- access stairs inside outlet structure

Gravel access ramp extended to pond outlet structure

Notes:

Hydraulic Analysis Report

Project Data

Project Title: Project - Kang Storage - Trickle Channel

Designer: JPS

Project Date: Sunday, November 15, 2026

Project Units: U.S. Customary Units

Notes

Channel Analysis: Channel Analysis - Trickle Channel

Notes:

Input Parameters

Channel Type: : Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: : 0.0130

Flow: 2.1400 cfs

Forebay Discharge Design Flow	**= 0.02 * Q100 (per MHFD UD-BMP_3.07)**
	= 0.02 (53.5 cfs) = 1.07 cfs
Trickle Channel Design Flow	**= 2 * (Forebay Discharge Design Flow)**
	= 2 * (1.07 cfs) = 2.14 cfs

Result Parameters

Depth: 0.4329 ft

Area of Flow: 0.7495 ft^2

Wetted Perimeter: 3.5694 ft

Hydraulic Radius: 0.2100 ft

Average Velocity: 2.8554 ft/s

Top Width: 3.4629 ft

Froude Number: : 1.0816

Critical Depth: 0.4467 ft

Critical Velocity: 2.6816 ft/s

Critical Slope: 0.0042 ft/ft

Critical Top Width: 3.57 ft

Calculated Max Shear Stress: 0.1351 lb/ft^2

Calculated Avg Shear Stress: 0.0655 lb/ft^2

Kang Storage
Detention Pond A1 Spillway

Figure 13-12c. Emergency Spillway Protection

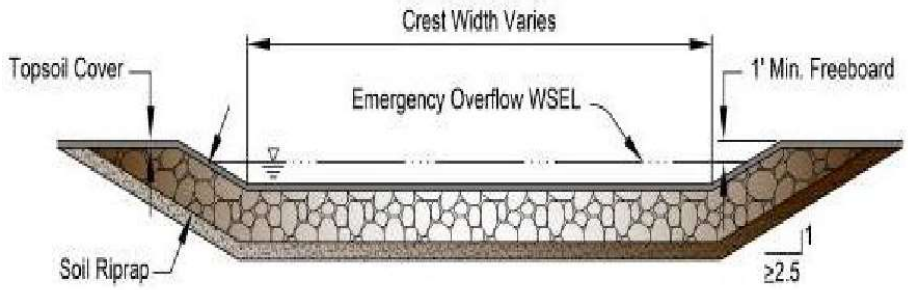
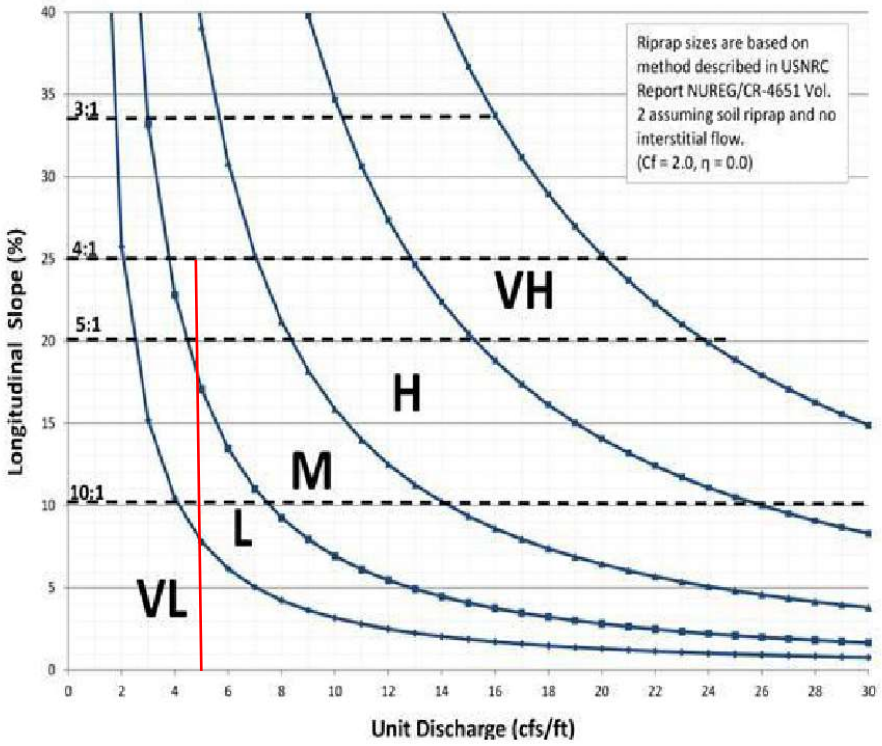


Figure 13-12d. Riprap Types for Emergency Spillway Protection



Spillway Q100 = 53.5 cfs (Undetained DP-A1)
Unit Discharge = (53.5 cfs / 11 ft) = 4.9
....Use Type M Riprap

Q100 (Pond Discharge) = 7.1 cfs; D = 1.5 ft
Q / D^1.5 = 7.1 / (1.5^1.5) = 3.2

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

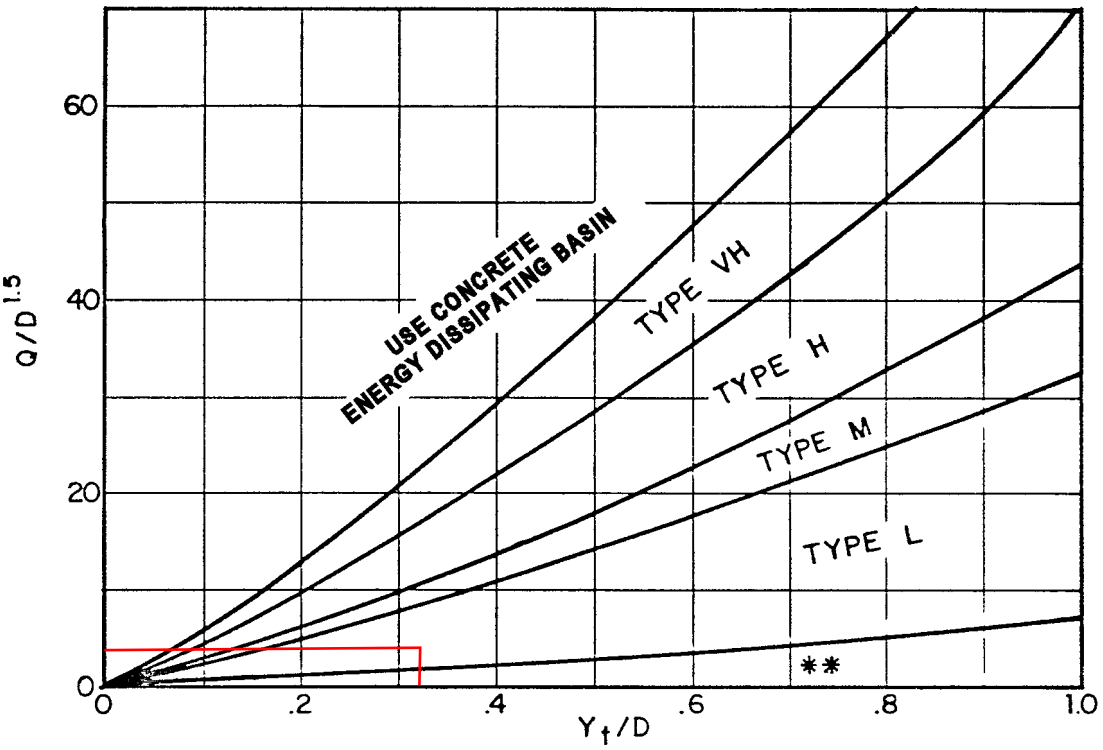
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)



Yt = 0.5 ft; Yt / D = (0.5 / 1.5) = 0.33

Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Use Type M (Conservative)

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

KANG STORAGE - 11401 E. HIGHWAY 24
ENGINEER'S COST ESTIMATE
DRAINAGE IMPROVEMENTS - FULL-SPECTRUM DETENTION FACILITY (PRIVATE)

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	PRIVATE DRAINAGE FACILITIES (NON-REIMBURSABLE)				
	Aggregate Base Course (Access Drive / Ramp)	46	CY	$61	$2,806
	Concrete Trickle Channel	220	SY	$40	$8,800
	Concrete Forebay	1	LS	$3,500	$3,500
	Detention Basin Outlet Structure	1	LS	$8,000	$8,000
	Buried Riprap Spillway	20	CY	$65	$1,300
	TOTAL				**$24,406**

The cost estimate submitted herein is based on time-honored practices within the construction industry. As such the engineer does not control the cost of labor, materials, equipment or a contractor's method of determining prices and competitive bidding practices or market conditions. The estimate represents our best judgement as design professionals using current information available at the time of the preparation. The engineer cannot guarantee that proposals, bids and/or construction costs will not vary from this cost estimate.

APPENDIX F

FIGURES

National Flood Hazard Layer FIRMette

FEMA

104°37'21"W 38°55'45"N



104°36'43"W 38°55'17"N

Feet

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

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
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 — Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

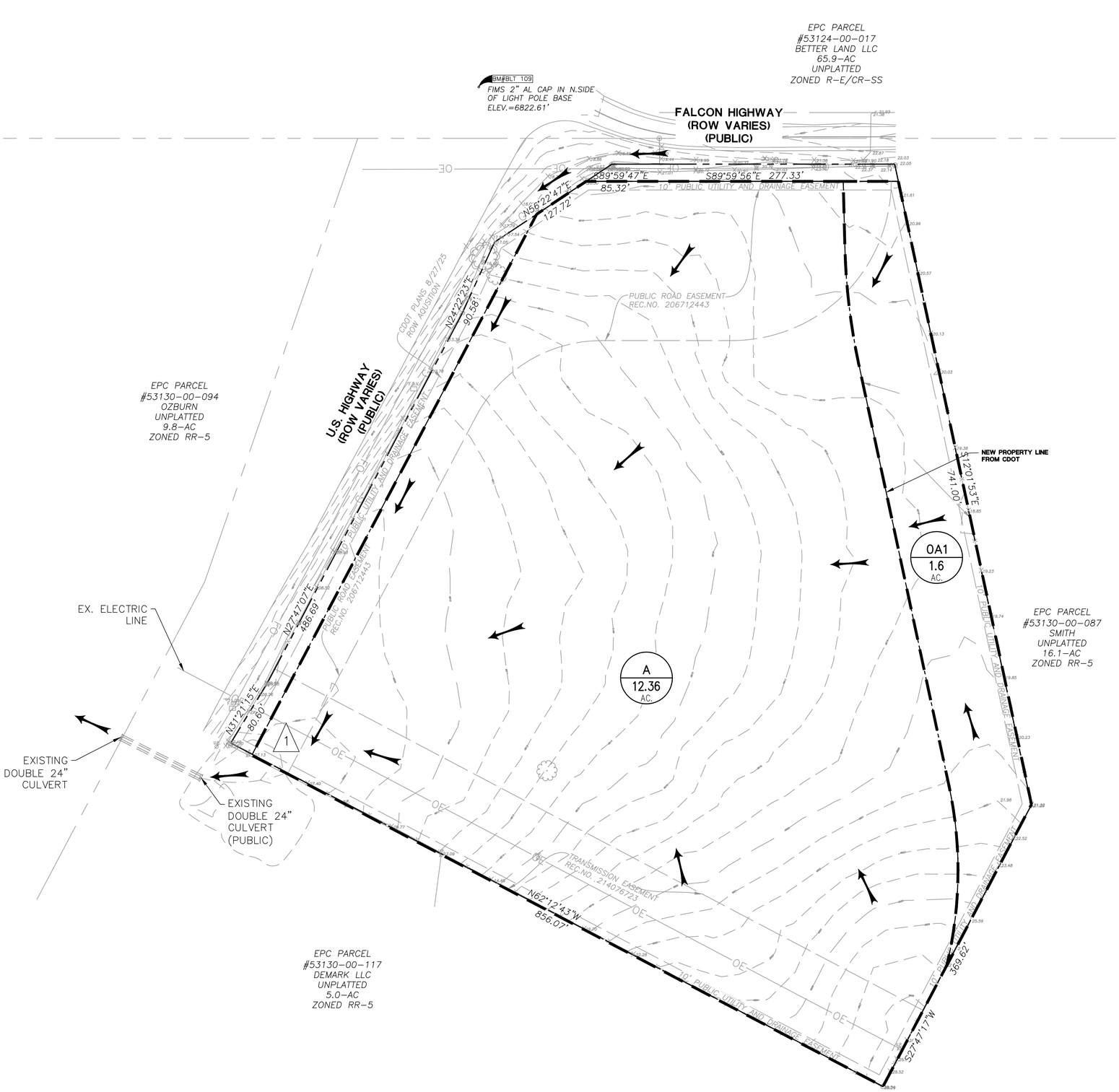
N

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 6/21/2026 at 7:33 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.



N

60' 0 60' 120'

ORIGINAL SCALE: 1"=60' (24"x36" SHEET)
CONTOUR INTERVAL: 2'

LEGEND

- FEMA 100-YEAR FLOODWAY
- FEMA 100-YR FLOODPLAIN
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- 6815 PROPOSED CONTOUR
- 6815 EXISTING CONTOUR
- FLOWLINE
- FLOW DIRECTION ARROW
- 1 DESIGN POINT
- A / 0.5 AC BASIN DESIGNATION / BASIN AREA (ACRES)
- (E) EXISTING
- (P) PROPOSED

BASIN SUMMARY TABLE

BASIN	Q5 (CFS)	Q100 (CFS)
0A1	0.4	2.8
A	2.9	21.4

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
1	3.4	24.8

BENCHMARK:
FIMS 2" AL CAP IN N. SIDE OF LIGHT POLE ELEV.=6822.61'

KANG STORAGE - 11401 E. HIGHWAY 24
LOT 1, ABIDING WORD LUTHERAN CHURCH SUBDIVISION

EXISTING CONDITIONS
DRAINAGE PLAN

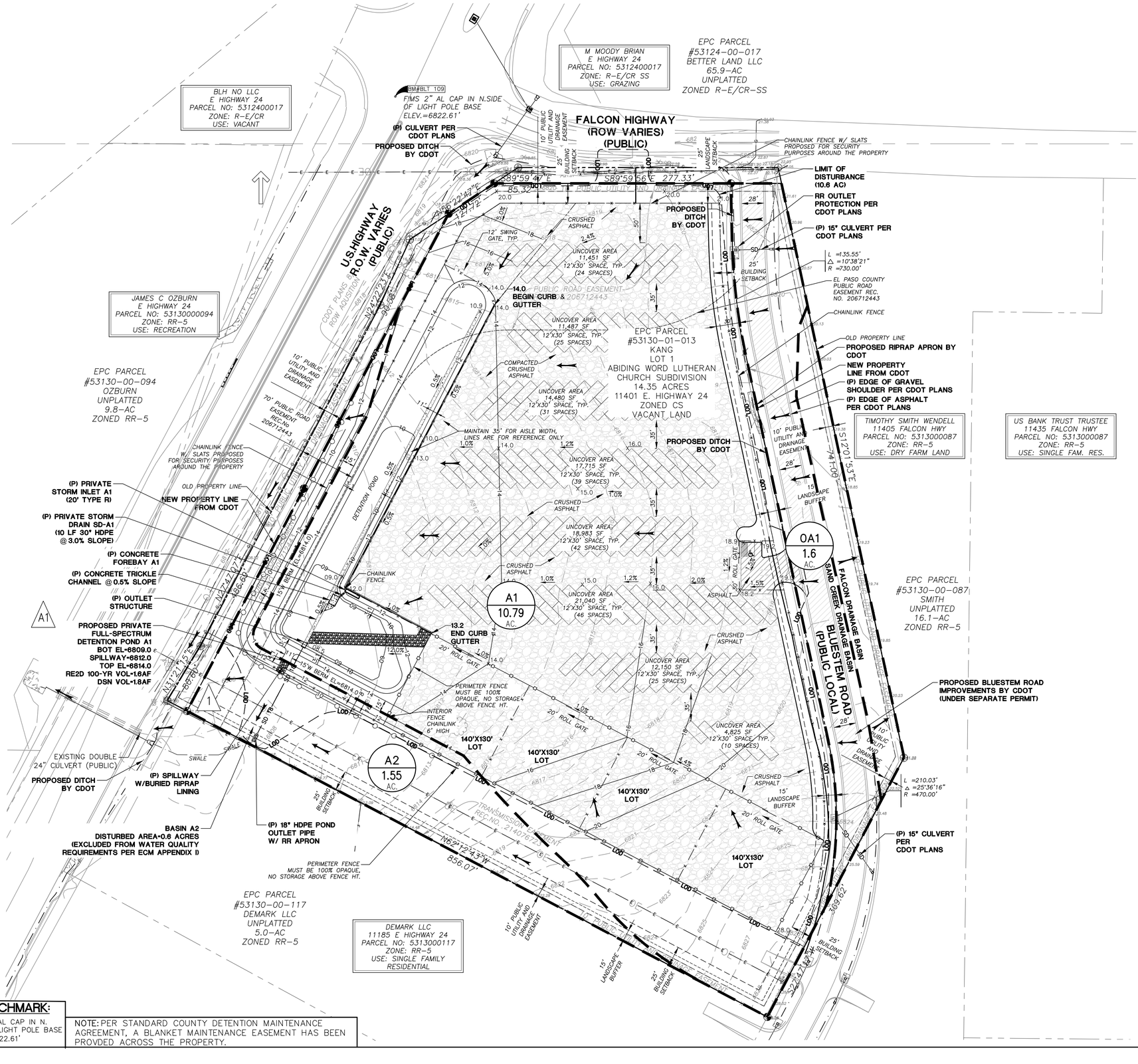
JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO
80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

NO.	REVISION	BY	DATE

HORZ. SCALE:	1"=60'
VERT. SCALE:	N/A
SURVEYED:	RIDGELINE
CREATED:	03/12/26
PROJECT NO:	022601
DRAWN:	PV
DESIGNED:	JPS
CHECKED:	JPS
LAST MODIFIED:	11/16/26
MODIFIED BY:	PV

SHEET: EX1



60′ 0 60′ 120′

ORIGINAL SCALE: 1"=60' (24"x36" SHEET)
CONTOUR INTERVAL:1'

LEGEND

- FEMA 100-YEAR FLOODWAY
- FEMA 100-YR FLOODPLAIN
- PROPERTY LINE
- DRAINAGE BASIN BOUNDARY
- EASEMENT LINE
- 6820 PROPOSED CONTOUR
- 6820 EXISTING CONTOUR
- 49.0 PROPOSED SPOT ELEVATION (FLOWLINE)
- 74.5 EXIST. SPOT ELEVATION
- 1.0% PROPOSED SLOPE
- TW TOP OF RETAINING WALL
- BW BOTTOM OF RETAINING WALL
- (E) EXISTING
- (P) PROPOSED
- PVT PRIVATE
- LOD LIMIT OF DISTURBANCE
- FLOWLINE
- FLOW DIRECTION ARROW
- BUILDINGS
- ASPHALT
- CONCRETE
- GRAVEL/CRUSHED ASPHALT
- GRASS/LANDSCAPED
- 1 DESIGN POINT
- A / XX AC BASIN DESIGNATION
- BASIN AREA (ACRES)

BASIN SUMMARY TABLE

BASIN	Q5 (CFS)	Q100 (CFS)
0A1	3.0	6.7
A1	28.8	56.6
A2	0.4	3.0

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
A1	26.9	53.5
1 (DEV)	27.3	56.5
1 (DET)	0.7	10.1

IMPERVIOUS AREA CALCULATIONS:

BASIN A1 AREA = 10.79 AC.

SURFACE TYPE	AREA
ASPHALT	3,784 SF
CRUSHED ASPHALT/PAVEMENT (340,058 SF @ 80% IMPERVIOUS)	272,046 SF
BUILDING	0 SF
TOTAL IMPERVIOUS AREA	275,830 SF = 6.33 AC
	= 58.67%

BENCHMARK:
FIMS 2" AL CAP IN N. SIDE OF LIGHT POLE BASE ELEV.=6822.61'

NOTE: PER STANDARD COUNTY DETENTION MAINTENANCE AGREEMENT, A BLANKET MAINTENANCE EASEMENT HAS BEEN PROVDED ACROSS THE PROPERTY.

KANG STORAGE - 11401 E. HIGHWAY 24
LOT 1, ABIDING WORD LUTHERAN CHURCH SUBDIVISION

DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
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CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

HORZ. SCALE: 1"=60'	DRAWN: PV
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RIDGELINE	CHECKED: JPS
CREATED: 04/23/26	LAST MODIFIED: 11/16/26
PROJECT NO: 022601	MODIFIED BY: PV

SHEET: D1