PRELIMINARY DRAINAGE STUDY

For:

Anderson Ranch

SOUTH SIDE OF 102ND AVENUE BETWEEN
SABLE BOULEVARD AND CHAMBERS ROAD
COMMERCE CITY, COLORADO

Prepared for

ANDERSON DEVELOPMENT SERVICES
9537 SOUTH 700 EAST
SANDY, UT 84070
Attn: BROOKE ANDERSON

Submitted by: Atwell, LLC

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LAKEWOOD, CO 80228
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PROJECT NO. 23006912
February 12, 2024

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APPENDICES

A. OVERALL SUBMITTAL AND CERTIFICATION STATEMENTS

“I hereby certify that this preliminary study for the Anderson Ranch development was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Commerce City *Storm Drainage Design and Technical Criteria Manual* for the owners thereof.”

____

Daniel Madruga, PE
Licensed Professional Engineer
State of Colorado No. 36834
For and on Behalf of Atwell, LLC

The storm drainage design presented in this preliminary report relied on the City of Commerce City *Storm Drainage Design and Technical Criteria Manual*, released May 2023. No variances or deviations from City criteria are currently requested.

B. GENERAL LOCATION AND DESCRIPTION

1. Location

The Anderson Ranch property is located in Adams County between Sable Blvd and Chambers Road south of the E. 102nd Ave alignment. The southern limit of the site will be defined by an extension of 98th Avenue. The site is a part of the east half of Section 18, Township 2 South, Range 66 West of the 6th Principal Meridian, Adams County, Colorado. The property is currently in the application process to be annexed into the City of Commerce City. The site is currently NOT platted, but that will be the subject of future entitlement efforts.

The site is bisected by a ridge running in the northwest – southeast direction that forms the approximate basin divide between the DFA 0053 and Second Creek drainage basins. Other than the Ragweed draw or drainageway in the southwest corner of the property, there are no major drainageways or irrigation facilities on the site.

The existing Foxton Village development lies to the northwest of the site, and the existing High Pointe subdivision lies to the northeast. Existing Fronterra Village lies to the east, on the other side of Chambers Road, which forms the eastern limits of the project. Unplatted portions of future Reunion Village 9 lie to the west side of the Sable Blvd alignment and south of the E. 98 Ave alignment. A vicinity map is included in the appendices.

2. Description of Property

The total site encompasses approximately 120.9 acres. Based on available aerial photography, the majority of the site is covered with hay fields. There is a ranch house and associated outbuildings on the southeast corner of the site with a few trees and other shrubbery landscaping. It is the developer’s intent that the residence should remain and be converted to a pool & recreation center. The barn and other outbuildings will be removed.

The site generally flows in a southeast to northwest direction with prevailing slopes averaging 2 to 4%. The site exhibits natural low points or sumps, whereby storm runoff may be retained on site to infiltrate or evaporate, and generally may not immediately flow off site during smaller storms events. The Ragweed draw or drainageway would be the singular notable exception. Based on examination and available existing topography, it is an un-incised overland drainageway that transports upstream storm runoff from south of the E. 98th Ave alignment. The channel is not well-defined, and appears to be in a completely stable, fully vegetated condition.

As described in the current PUD Zone document, the site will be developed into a mix of various residential products, to include single-family attached and detached homes. Higher density products (such as townhomes) will be included in the development mix.

The existing soils are identified as a mix of Ascalon sandy loam (0-3% slopes) and Ascalon-Vona sandy loam (1-5% slopes), both of which make up nearly 90% of the in-situ soils. The remainder is made up of Truckton loamy sand (3-9% slopes). The Ascalon series found on site is classified as belonging to Hydrologic Soils Group B while the Truckton series belong to Group A. This means that site’s soils are well-drained, with moderate runoff potential and that are moderately susceptible to erosion until disturbed or exposed areas are established with vegetative cover or other permanent landscaping. While, as of the preparation date for this report, a preliminary geotechnical investigation has not been commissioned, we do not believe there to be any impediments or obstacles to future development. An NRCS Soils Map is included in the appendices.

To our knowledge, there is no history of flooding on the site. According to the following four (4) FEMA FIRM maps on which the site appears, the entire site is listed as Zone X (unshaded) *Area of Minimal Flood Hazard* or *Areas Outside the 0.2% Annual Chance Floodplain;* i.e. the so-called 500-year floodplain:

- 08001C0339H, effective 03/05/2007
- 08001C0343H, effective 03/05/2007
- 08001C0630H, effective 03/05/2007
- 08001C0635H, effective 03/05/2007

C. DRAINAGE BASINS AND SUB-BASINS

The northeast half of the site, as delineated by existing sub-basin H-1, lies in the Second Creek master basin while existing basins H-2 and H-3 lie within the Direct Flow Area (DFA) 0053 master basin.

The above master drainage basins are described in various Outfall Systems Planning studies but the most recent and relevant is the *Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning Study Update – Preliminary Design Report*; Kiowa Engineering Corp; August 2004.

The entire site is part of the South Platte River basin, and the South Platte would be the ultimate receiving water.

1. Major Drainage Basins

Since the site straddles the DFA 0053 / Second Creek basin divide and lies at the upper reaches of each runoff area, the various elements and improvements described in the *Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning Study Update – Preliminary Design Report* have no real impact and little relevance to the Anderson Ranch site.

The sub-basin described by historic basin H-3 is also included in the CoCC approved *Preliminary Drainage Report for Reunion Village 9*; JR Engineering, LLC; May 20, 2020. In that study, historic sub-basin H-3 is described as Basin 9OS1 and its runoff area is included in the study's Full Spectrum Detention & WQ Pond C under native (or 2% impervious) conditions.

2. Sub-basin Descriptions

Existing sub-basins:

Historic sub-basin H-1 lies at the top part of the previously described Second Creek master basin. The sub-basin encompasses about 72.2 acres. As shown in the existing / historic drainage map, that basin currently drains to an on-site low point or "sump" immediately east of Foxton Village and west of High Pointe. Based on the large area of the sump, coupled with the site's Type "B" (well drained) soils, it is possible that current runoff collects and simply evaporates or infiltrates into the ground and there is no existing direct surface hydraulic connection to downstream properties.

Historic sub-basin H-2 occupies most of the southwestern half on the site. It lies at the upper reaches of the DFA 0053 master basin. Based on existing topography, the 38.7 acres drain to a low point at the southeast corner of the Foxton Village development, east of the Sable Blvd alignment. The *Phase III Drainage Report for Foxton Village Subdivision*; Carroll & Lange, Inc; January 10, 2001 designed and described a 24" RCP storm pipe that was placed to presumably accommodate surface drainage in this area.

Historic sub-basin H-3 is also part of the DFA 0053 master basin. The 10 acre basin collects centrally in an overland surface drainageway known as the Ragweed drainageway or simply Ragweed draw. While it is an identified master drainageway, it also appears that all upstream / offsite areas will be re-routed south of the 98th Ave alignment as part the improvements described in the Reunion Village 9 Master Study by JR Engineering.

Proposed sub-basins:

Based on the current site plan layout and anticipated grading, under proposed conditions the project will be split into four proposed sub-basins.

Proposed 30.5 acre sub-basin A-1 will occupy the eastern corner of the site at the southwest corner of existing Chambers Road and E. 100th Ave. It will be defined by existing E. 100 Ave, existing Chambers Rd, proposed E. 98th Ave, and a "ridge" or basin divide that will split site drainage to the west and the east. A full spectrum EDB is envisioned at the northeast corner of the basin, near the 100th Ave / Chambers Road intersection. Said full spectrum EDB will outfall into an existing 30" storm pipe that was previously designed and installed with the High Pointe development.

The proposed 44.2 acre sub-basin A-2 occupies approximately that same area as defined by historic basin H-1. It will be directed via streets and storm sewer to a centrally located full spectrum EDB detention basin that will be placed in a location emulating existing "sump" conditions. The pond will outfall into a proposed storm sewer that will direct attenuated outfall towards E. 104th Ave.

The 37.1 acre sub-basin A-3 will occupy an area as roughly defined by historic sub-basin H-2. It will be directed via streets and storm sewer to a full spectrum EDB detention basin that will be placed east of the Sable Blvd alignment in a location emulating existing "sump" conditions. The pond will outfall into an existing 24" storm pipe that was designed and installed with the existing Foxton Village development. It includes a proposed 9.5 acre school dedication. As part of a land dedication, formal drainage improvements with this project will likely be deferred to the school district upon receipt and future development.

Sub-basin A-4 covers roughly 10.7 acres and it makes up that area previously defined by historic sub-basin H-3. While the Ragweed draw flows down the center of the sub-basin, tributary upstream improvements will be re-routed into the proposed Ragweed draw realignment as described in the approved Preliminary Drainage Report for Reunion Village 9; JR Engineering, LLC; May 20, 2020. With Ragweed draw effectively being relocated off the property, it would appear that no future regional drainage concerns need be considered with site development in this basin, and the depressed channel that makes up the existing draw could be regraded.

D. DRAINAGE DESIGN CRITERIA

This report has been prepared in accordance with the City of Commerce City *Storm Drainage Design and Technical Criteria Manual*; May 2023, available online. Where applicable or appropriate, it also uses references from the *Urban Storm Drainage Criteria Manual, Vol. 1 & Vol. 2;* Mile High Flood District; latest editions, available online.

1. Development Criteria References and Constraints

The site was described in the *Second Creek and DFA 0053 watersheds as part of Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning Study Update – Preliminary Design Report*; Kiowa Engineering Corp; August 2004. However, since the site is situated at the upper reaches of these two watersheds, there is little- to no- impact regarding regional improvements to the proposed development. In short, the OSP placed no real constraints or requirements on the project's development programming.

While sub-basin A-4 was described in the approved *Preliminary Drainage Report for Reunion Village 9;* JR Engineering, LLC; May 20, 2020, it placed no development constraints on this school dedication parcel. It also assumed that all tributary run-on from the school site would be based on an undeveloped condition. This would imply that any future sub-basin A-4 / school parcel development would need to provide its own detention and release in a manner emulating historic rates, at a bare minimum. If the school property were to develop before the regional drainage solutions proposed in the Reunion Village 9 study were implemented, the specific stormwater design requirements for the school dedication parcel would need to be reevaluated.

Upon examination, it appears that any regional Ragweed draw / drainageway solutions have been previously contemplated and all regional improvements will be made as part of the Reunion Village 9 development efforts. The Ragweed draw / drainageway channel and inline Det & WQ Pond C will all be sited south of the 98th Ave alignment, thus will not impact the school dedication property in sub-basin A-4.

2. Hydrologic Criteria

The minor event is defined as the 5-year storm as defined by the City of Commerce City *Storm Drainage Design and Technical Criteria Manual.* It also defines the major event as the 100-year storm, in typical Front Range fashion. One-hour rainfall P1 values were obtained from the UD-Rational and UD-Detention spreadsheets available from the Mile High Flood District.

The Rational Method, as presented in the City of Commerce City *Storm Drainage Design and Technical Criteria Manual,* has been used to calculate the projected maximum rate of runoff for the 5-year and 100-year minor and major storm events. "C" coefficients were taken from the Mile High Flood District UD-Rational spreadsheet. Rational Method calculation results, including preliminary assumed C-values, times of concentration, and flow rates can be found as-calculated using MHFD's UD-Rational spreadsheet. A copy can be found in the appendices.

MHFD's UD-Detention spreadsheets were used to determine recommended minimum required sizes for proposed full-spectrum EDB detention ponds and typical pre-development historic flows. The EDB's were designed to accept and detain flows from the entire site; i.e. no significant offsite untreated & un-detained flows are envisioned. Refer to the appendices for UD-Detention spreadsheet printouts.

As the project progresses, the initial proposed sub-basins will be subdivided into smaller units and runoff will be recalculated. At that time, gutter and street capacities will be analyzed, and inlets & storm sewer designed using the hydraulic criteria described below.

3. Hydraulic Criteria

Hydraulic capacity for proposed storm sewer system will be designed in accordance with the City of Commerce City *Storm Drainage Design and Technical Criteria Manual* and all Mile High Flood District manuals.

The Hydraulic Grade Line (HGL) and head losses in the proposed storm sewer system will be designed in accordance with all Commerce City and MHFD criteria. Storm sewer routing methods will also be designed in accordance with same. StormCAD software will be used for design calculations and in generating HGLs based on dynamic, timed flows. In general, all storm sewer will be sized to accommodate the 100-year storm event up to that portion of the 100-year runoff event captured in underground storm sewer in order to preserve street carrying capacities.

4. Stormwater Quality

Per the City of Commerce City *Storm Drainage Design and Technical Criteria Manual* and the CoCC current State MS4 permit, runoff reduction or minimizing directly connected impervious areas (MDCIA) is required for development sites with a total disturbance of greater than or equal to one acre. The Site will comply with the minimizing directly connected impervious area (MDCIA) standard by demonstrating that rooftop runoff over adjacent & receiving landscape areas satisfies this requirement. This is typical of single-family design, where downspouts drain across landscaped areas before running into the adjacent streets and ultimately into the MS4 storm sewer system.

In addition, all conceptual ponds presented in this report are proposed to be full-spectrum EDB’s, which will have a built-in water quality control features whereby the pollutant-laden “first flush” water quality components are released over an extended period, thus allowing water-borne pollutants to settle out.

E. DRAINAGE FACILITY DESIGN

1. General Concept

The proposed drainage design of the site will be completed in a manner maintaining flow patterns similar to historic flows. Flows from the developed portions of the site will be directed to streets, collected via inlets and conveyed through storm sewer infrastructure before discharging into any of the proposed full spectrum EDBs. The EDBs will attenuate flood waters, treat for water quality, and then release all attenuated flows at a rate approximating historic (pre-development) conditions or at a rate that does not exceed downstream capacities.

2. Specific Details

There are no existing stormwater conveyance or storage facilities currently on the site. Stormwater currently sheet flows overland and ultimately collects in low points defined in historic sub-basins H-1 or H-2. In the case of historic sub-basin H-3, runoff collects in Ragweed draw or drainageway (an MHFD-identified reach) to flow offsite towards the west.

Under proposed conditions, all collected runoff will be directed to proposed full spectrum EDBs. Arrows shown on the proposed drainage plan indicate anticipated direction of flow based on the currently envisioned site layout as per PUD Zone & Annexation documents.

The site is currently proposing at least three full spectrum EDB facilities. Proposed sub-basins A-1 through A-3 currently each have ponds sited at each basin's conceptual and envisioned low points. In siting the three proposed full spectrum extended detention basins Pond 1 through Pond 3, the land plan currently in use was used. However, as the land plan evolves, and proposed grading is established, the pond locations and or land use plan may be modified to ensure the following:

- Connections to adjacent and existing storm sewer outfalls can be established for detention pond attenuated / controlled releases,
- If necessary, new or expanded offsite storm connections can be established,
- Proposed site grading blends with proposed pond locations; and
- Each pond has a positive surface emergency overflow regimen in a manner that does not endanger downstream properties

Pond 1 is a proposed 3.2 acre-foot facility currently sited at the southwest corner of Chambers Road and E. 100th Ave. The pond will release attenuated storm sewer into an existing 30" storm pipe that was designed and constructed with the previous High Pointe development. That 30" storm sewer will guide water to the western Chambers Road channel towards E. 104th Ave and ultimately to the West 104th Ave Water Quality Pond as described in the *Final Drainage Study for 104th Avenue Corridor Improvements Phase 2*; JR Engineering, LLC; April 20, 2007. And while the JR study implies that the West 104th Ave pond supplies upstream regional water quality, the contributing runoff from sub-basin A-1 was assumed to be only 7% impervious. For this reason, we have assumed that a full spectrum EDB need be designed and installed with this project.

In the High Pointe and JR studies, the existing 30" storm and channel assumed a flow rate of ~ 46 cfs. The standard MHFD UD-Detention design protocols for this pond assume a regulated release rate of ~ 29 cfs – far below that assumed in the earlier studies.

Pond 2 is a proposed 4.6 acre-foot facility currently sited south of E. 102nd Ave between Sable Blvd and the High Pointe subdivision. In accordance with the current land plan, the pond will occupy the north / central area of the contributing sub-basin, in the same area as the current existing “sump” location. The pond will release attenuated storm sewer into a proposed (and as-yet undesigned) storm pipe that will direct runoff to the north down existing Sable Blvd towards E. 104th Ave and eventually to the Sable Water Quality Pond as described in the *Final Drainage Study for 104th Avenue Corridor Improvements Phase 2; JR Engineering, LLC*; April 20, 2007. The JR study originally assumed that storm runoff from Anderson Ranch would outfall further to the east, down the Altura Street alignment. However, Altura Street does not extend to the south beyond the PSCo transmission corridor, and there are no regional storm sewer facilities in that area. With the availability of existing Sable Blvd, Pond 2’s attenuated outfall will be directed via proposed storm sewer in Sable Blvd toward E. 104th Ave. Since the contribution from Pond 2 was NOT originally anticipated with JR’s Sable Water Quality Pond design, Pond 2 will be a full spectrum detention facility providing water quality treatment as well as flood attenuation.

Pond 3 is a proposed 3.8 acre-foot facility currently sited along the western boundary of the project, just south and east of existing Foxton Village. The pond will release attenuated storm water into an existing 24” storm pipe that was designed and constructed with the previous Foxton Village development. That 24” storm sewer will travel through the Foxton Village subdivision towards E. 104th Ave and ultimately to the Sable Blvd Water Quality Pond, consistent with, and as described in, the Final Drainage Study for 104th Avenue Corridor Improvements Phase 2; JR Engineering, LLC; April 20, 2007. While the JR study implies that the Sable Blvd Pond provides upstream regional water quality, the contributing runoff from sub-basin A-1 was assumed to be at existing (historic) impervious percentages. For this reason, we have assumed that a full spectrum EDB need be designed and installed. In the Foxton Village and JR studies, the existing 24” storm had an assumed capacity of ~17 cfs in the 100-year event. The standard MHFD UD-Detention design protocols for Pond 3 assume a regulated release rate of ~ 23 cfs. This implies that downstream capacity of the Foxton Village 24” storm may need to be further analyzed; or proposed Pond 3 may need to need to provide a slight amount of over-attenuation in order to decrease the design release and meet the hydraulic limitations of the downstream storm sewer. In this case, the advertised pond size will need to get slightly larger than that currently anticipated.

Pond 4, depicted in the southwest portion of this basin, will be required because the approved Preliminary Drainage Report for Reunion Village 9; JR Engineering, LLC based their calculations on an undeveloped site.

F. CONCLUSIONS

1. Compliance with Standards

This preliminary drainage study outlines the basic storm water management plan for the proposed development. The drainage design and report follow all appropriate and applicable City of Commerce City and Mile High Flood District criteria.

2. Drainage Concept

Downstream drainage facilities will not be negatively affected, as historic drainage patterns and allowable release rates shall be maintained. Furthermore, the proposed site includes conservative assumptions in hydrologic and hydraulic designs.

The proposed development will have no adverse drainage impacts on upstream or downstream properties.

3. Water Quality

The Site will meet the MDCIA post-construction design standard by demonstrating that rooftop runoff guided by downspouts and extensions across adjacent receiving landscape areas will satisfy the MDCIA requirements. Water quality treatment features provided in full spectrum EDB ponds will provide addition point treatment before attenuated stormwater is discharged offsite to waters of the City, County, State, or the US.

G. REFERENCES

1. *Urban Storm Drainage Criteria Manual Vol. 1*, Mile High Flood District; latest edition, available online

2. *Urban Storm Drainage Criteria Manual Vol. 2*, Mile High Flood District; latest edition, available online

3. City of Commerce City *Storm Drainage Design and Technical Criteria Manual*; May 2023, available online

4. Flood Insurance Rate Map; Federal Emergency Management Agency, Panels (available online):
    - 08001C0339H, effective 03/05/2007
    - 08001C0343H, effective 03/05/2007
    - 08001C0630H, effective 03/05/2007
    - 08001C0635H, effective 03/05/2007

5. *Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning Study Update – Preliminary Design Report*; Kiowa Engineering Corp; August 2004

6. *Preliminary Drainage Report for Reunion Village 9*; JR Engineering, LLC; May 20, 2020

7. *Phase III Drainage Report for Foxton Village Subdivision*; Carroll & Lange, Inc; January 10, 2001

8. *High Pointe Phase III Drainage Report*; Calibre Engineering, Inc; January 10, 2005

9. *Final Drainage Study for 104th Avenue Corridor Improvements Phase 2*; JR Engineering, LLC; April 20, 2007

APPENDIX A

VICINITY MAP

VICINITY MAP
1" = 1000'

APPENDIX B

SOILS SURVEY

United States
Department of
Agriculture

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 Adams County Area, Parts of Adams and Denver Counties, Colorado

November 13, 2023

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

Contents

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.

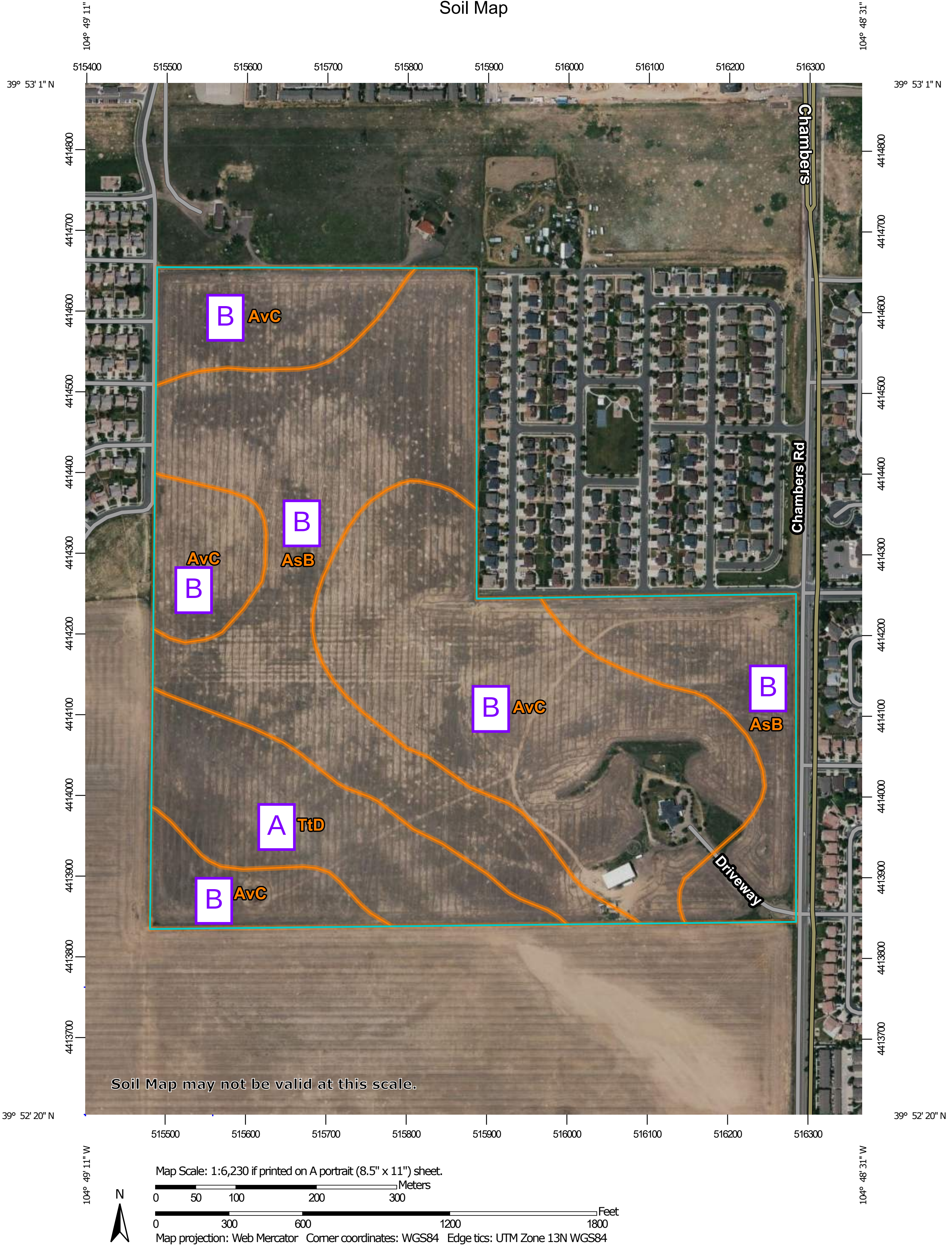
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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.

Soil Map



Map Scale: 1:6,230 if printed on A portrait (8.5" x 11") sheet.

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 1:20,000.

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: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 20, Aug 24, 2023

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AsB	Ascalon sandy loam, 0 to 3 percent slopes	50.4	41.5%
AvC	Ascalon-Vona sandy loams, 1 to 5 percent slopes	55.9	46.0%
TtD	Truckton loamy sand, 3 to 9 percent slopes	15.2	12.5%
Totals for Area of Interest		**121.5**	**100.0%**

HSG
B
B
A

Use HSG "B" for Preliminary Engineering (Conservative)

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.

Adams County Area, Parts of Adams and Denver Counties, Colorado

AsB—Ascalon sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2swl3
Elevation: 3,870 to 5,960 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

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

Description of Ascalon

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wind-reworked alluvium and/or calcareous sandy eolian deposits

Typical profile

Ap - 0 to 6 inches: sandy loam
Bt1 - 6 to 12 inches: sandy clay loam
Bt2 - 12 to 19 inches: sandy clay loam
Bk - 19 to 35 inches: sandy clay loam
C - 35 to 80 inches: sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Olnest

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Vona

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

AvC—Ascalon-Vona sandy loams, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2xst1
Elevation: 4,750 to 5,560 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Ascalon and similar soils: 45 percent
Vona and similar soils: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ascalon

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wind-reworked alluvium and/or calcareous sandy eolian deposits

Typical profile

Ap - 0 to 10 inches: sandy loam

Bt - 10 to 15 inches: sandy clay loam
Btk - 15 to 21 inches: sandy loam
Bk1 - 21 to 35 inches: sandy loam
Bk2 - 35 to 80 inches: sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Description of Vona

Setting

Landform: Interfluves
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian sands

Typical profile

Ap - 0 to 9 inches: sandy loam
Bt - 9 to 22 inches: sandy loam
Bk1 - 22 to 27 inches: sandy loam
Bk2 - 27 to 39 inches: sandy loam
Bk3 - 39 to 80 inches: loamy sand

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very 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: 15 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 3.0

Available water supply, 0 to 60 inches: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Vona, loamy sand surface

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Ascalon, loamy sand surface

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

TtD—Truckton loamy sand, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 34wz
Elevation: 4,400 to 6,000 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 125 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

Landform: Plains

Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits derived from mixed

Typical profile

H1 - 0 to 9 inches: loamy sand
H2 - 9 to 21 inches: sandy loam
H3 - 21 to 32 inches: loamy sand
H4 - 32 to 60 inches: coarse sand

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
Available water supply, 0 to 60 inches: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Vona

Percent of map unit: 8 percent
Hydric soil rating: No

Blakeland

Percent of map unit: 5 percent
Hydric soil rating: No

Loup

Percent of map unit: 1 percent
Landform: Swales
Ecological site: R067BY029CO - Sandy Meadow
Hydric soil rating: Yes

Tryon

Percent of map unit: 1 percent
Landform: Swales
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: Yes

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APPENDIX C

FEMA FIRMettes

1DWLRQDO)ORRG+D]DUG/D\HU)LUPHWWH

FEMA

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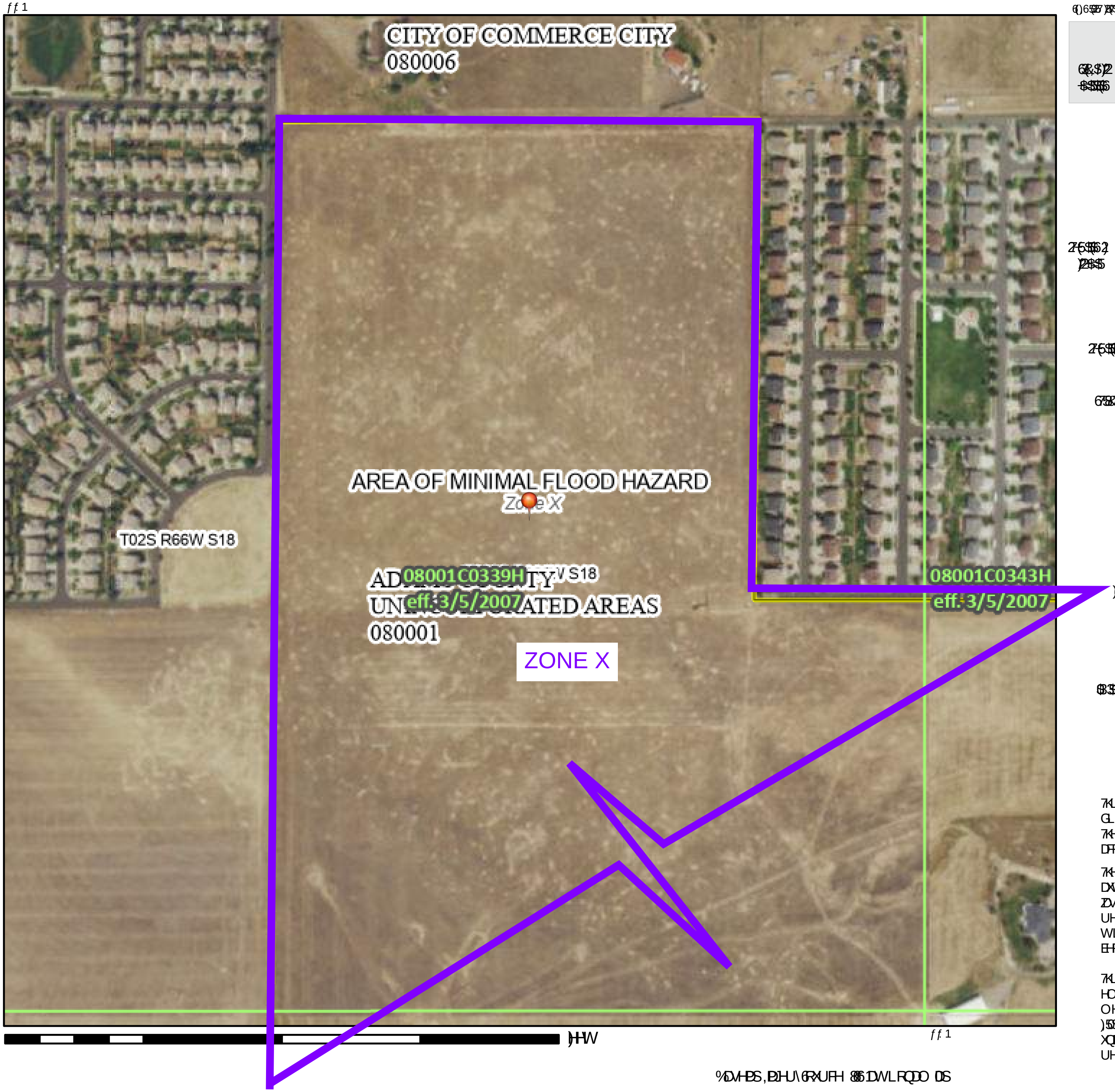

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		)XWXUH &RQGLWLRQV $QQXDO &KDQFH)ORRG +D]DUG =RQH ;
		$UHD ZLWK 5HGXFHG)ORRG 5LVN GXH WR /HYHH 6HH 1RWHV =RQH ;
		$UHD ZLWK)ORRG 5LVN GXH WR /HYHH =RQH '
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7KH IORRG KD]DUG LQIRUPDWLRQ LV GHULYHG GLUHFWO\ IURP WKH DXWKRULWDWLYH 1)+/ ZHE VHUYLFHV SURYLGHG E\ )(0$ 7KLV PDS ZDV H[SRUWHG RQ DW 30 DQG GRHV QRW UHIOHFW FKDQJHV RU DPHQGPHQWV VXEVHTXHQW WR WKLV GDWH DQG WLPH 7KH 1)+/ DQG HIIHFWLYH LQIRUPDWLRQ PD\ FKDQJH RU EHFRPH VXSHUVHGHG E\ QHZ GDWD RYHU WLPH

7KLV PDS LPDJH LV YRLG LI WKH RQH RU PRUH RI WKH IROORZLQJ PDS HOHPHQWV GR QRW DSSHDU EDVHPDS LPDJHU\ IORRG]RQH ODEHOV OHJHQG VFDOH EDU PDS FUHDWLRQ GDWH FRPPXQLW\ LGHQWLILHUV)650 SDQHO QXPEHU DQG)50 HIIHFWLYH GDWH DS LPDJHV IRU XQPDSSHG DQG XQPRGHUQL]HG DUHDV FDQQRW EH XVHG IRU UHJXODWRU\ SXUSRVHV

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FEMA

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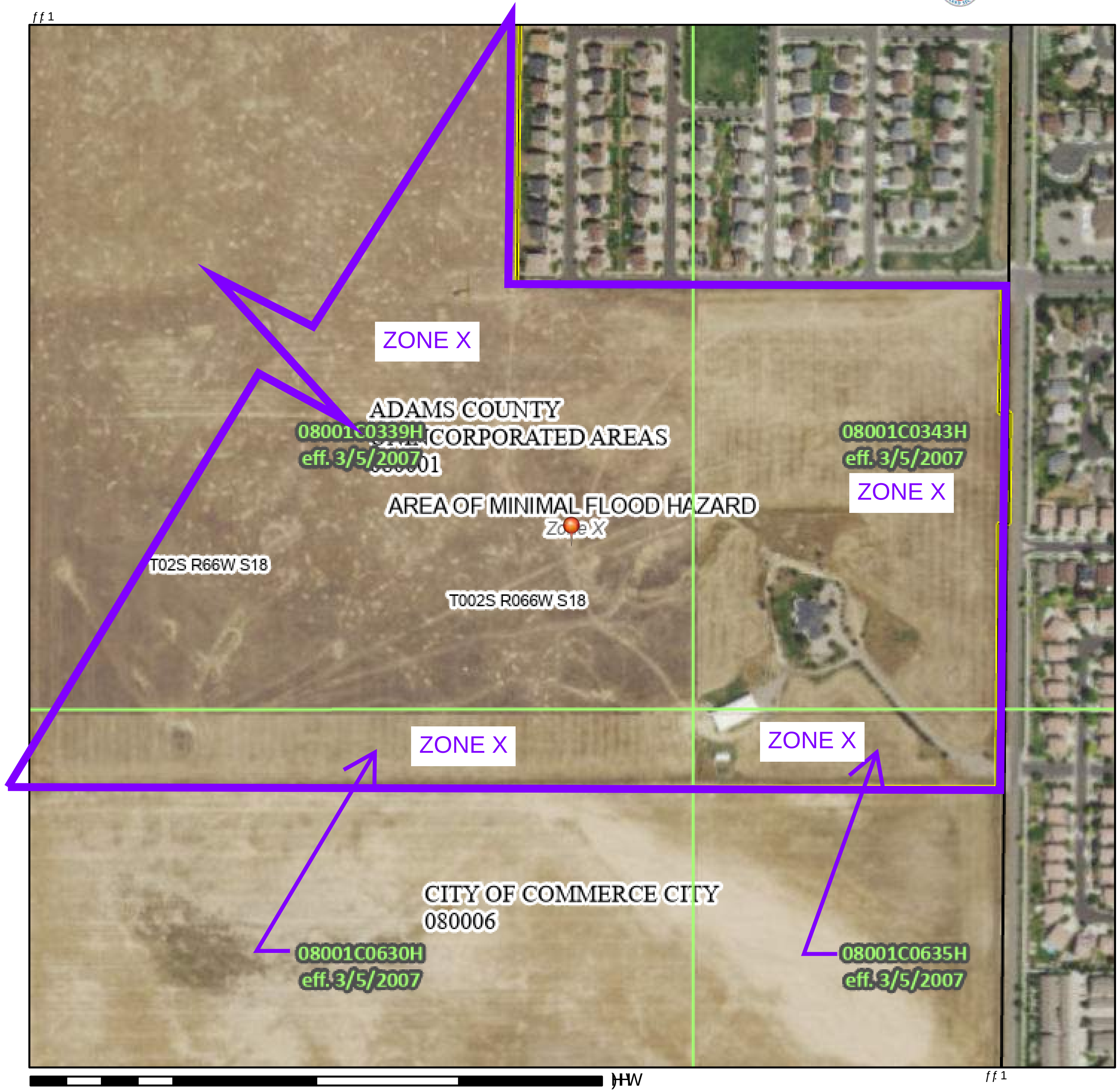

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7KLVPDSFRPSOLHVZLWK)(0\$'V VWDQGDUGV IRU WKHXVHRI GLJLWDO IORRGPDSVLI LW LVQRW YRLGDVGHVFULEHGEHORZ 7KHEDVHPDSVKRZQFRPSOLHVZLWK)(0\$'V EDVHPDS DFFXUDF\ VWDQGDUGV

7KHIORRGKD]DUGLQIRUPDWLRQLVGHULYHGGLUHFWO\IURPWKH DXWKRULWDWLYH1)+/ZHEVHUYLFHVSURYLGHGE\)(0\$ 7KLVPDS ZDVH[SRUWHGRQ DW 30 DQGGRHVQRW UHIOHFW FKDQJHVRU DPHQGPHQWV VXEVHTXHQW WRWKLVGDWHDQG WLPH 7KH1)+/DQGHIIHFWLYHLQIRUPDWLRQPD\FKDQJHRU EHFRPHVXSHUVHGHGE\QHZGDWDRYHU WLPH

7KLVPDSLPDJHLVYRLGLI WKHRQHRU PRUHRI WKHIROORZLQJPDS HOHPHQWV GRQRW DSSHDU EDVHPDSLPDJHU\ IORRG]RQHODEHOV OHJHQG VFDOHEDU PDSFUHDWLRQGDWH FRPPXQLW\LGHQWLILHUV)LUPSDQHO QXPEHU DQG),50 HIIHFWLYHGDWH 0DSLPDJHVIRU XQPDSSHGDQGXQPRGHUQL]HGDUHDV FDQQRW EHXVHGIRU UHJXODWRU\SXUSRVHV

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APPENDIX D

HYDROLOGICAL CALCULATIONS

Use 60% Imp for Preliminary (Conceptual) Basin-wide Planning Purposes

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential lots (lot area only)**:**	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

Use for Historic Drainage Analysis

7.0 Streets

7.1 Introduction

The criteria presented in this chapter must be used in the evaluation of the allowable drainage encroachment within public streets. The criteria, evaluation techniques, and design examples provided in the Streets/Inlets/Storm Drains chapter of the MHFD Manual are hereby incorporated by reference and not repeated herein. MHFD's Street Capacity and Inlet Sizing software program (downloadable from MHFD's website) may be used in the hydraulic evaluation of street flows and was used to prepare the figures that are presented in this chapter.

5-Year Minor Event
100-Year Major Event

7.2 Function of Streets in the Drainage System

The primary function of urban streets is for safe traffic movement; therefore, stormwater drainage and conveyance in streets is subservient to this function and must be properly designed to prevent interference with traffic, especially at intersections. When the drainage in the street exceeds allowable limits set forth in Section 7.3, a storm drain system (Chapter 9) or an open channel (Chapter 10) is required to convey the excess flows. Streets are also part of the major drainage system when they carry flows in excess of the minor storm, also subject to the limitations of Section 7.3.

7.3 Allowable Use of Streets for Storm Flows

Allowable use of streets for storm flows is summarized in Tables 7-1 through 7-3. The minor storm referenced in these tables is the 5-year event and the major storm is the 100-year event. No curb overtopping during the minor storm is allowed for any street regardless of classification. The maximum allowable street flow for the minor storm runoff is the product of the flow calculated at the "Maximum Theoretical Street Encroachment" and the required reduction factor, following the hydraulic evaluation techniques in the Streets/Inlets/Storm Drains chapter of the MHFD Manual, or 10 cfs, whichever is more restrictive.

Table 7-1. Allowable Use of Streets for Minor Storm Runoff

Street Classification	Maximum Street Encroachment
Local	No curb overtopping. Flow may spread to crown of street.
Collector	No curb overtopping. Flow spread must leave at least one lane free of water.
Arterial	No curb overtopping. Flow spread must leave at least one lane (10 feet) free of water in each direction, and should not flood more than two lanes in each direction.

Calculation of Peak Runoff using Rational Method

Designer: Scott Z **)0 releasec**
Company: Atwell. LLC
Date: 11/17/2023 Cells of this color are for
Project: Anderson Ranch PUD Cells of this color are for
Location: City of Commerce City Cells of this color are for

$t_i = \frac{0.3}{}$

$\text{Computed } t_c = t_i + t_t$

$t_t =$

$\text{Regional } t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{}}$

$t_{minimum} = 5$ (urban)
$t_{minimum} = 10$ (non-urban)

$\text{Selected } t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

\tlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained fror

	5-yr	100-yr
1-hour rainfall depth, P1 (in) =	1.12	2.43
	b	
ainfall Intensity Equation Coefficients =	10.00	

$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$

$Q(cfs)$ =

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C		Overland (Initial) Flow Time			Channelized (Travel) Flow Time					Time of Concentration			Rainfall Intensity, I (in/hr)		Peak Flow, Q (cfs)	
				5-yr	100-yr	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	5-yr	100-yr	5-yr	100-yr
H-1	72.182	B	2	0.01	0.44	470	0.0213	33.18	3100	0.0039	7	0.44	118.19	151.37	114.81	114.81	0.72	1.56	0.63	48.98
H-2	38.696	B	2	0.01	0.44	370	0.0270	27.22	1800	0.0067	7	0.57	52.36	79.58	65.15	65.15	1.07	2.32	0.50	39.12
H-3	10.025	B	2	0.01	0.44	460	0.0282	29.92	400	0.0200	7	0.99	6.73	36.65	30.74	30.74	1.73	3.76	0.21	16.40

Calculation of Peak Runoff using Rational Method

Designer: Scott Z
Company: Atwell. LLC
Date: 11/28/2023
Project: Anderson Ranch PUD Proposed
Location: City of Commerce City

)0 releasec

Cells of this color are for
Cells of this color are for
Cells of this color are for

$t_i = 0.3$

$\text{Computed } t_c = t_i + t_t$

$t_t =$

$\text{Regional } t_c = (26 - 17i) + \frac{L_t}{60(14i+9)\surd}$

$t_{minimum} = 5$ (urban)
$t_{minimum} = 10$ (non-urban)

$\text{Selected } t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

tlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained fror

	5-yr	100-yr
1-hour rainfall depth, P1 (in) =	1.12	2.43

ainfall Intensity Equation Coefficients = b: 10.00

$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$

$Q(cfs) =$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C		Overland (Initial) Flow Time			Channelized (Travel) Flow Time					Time of Concentration			Rainfall Intensity, I (in/hr)		Peak Flow, Q (cfs)	
				5-yr	100-yr	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	5-yr	100-yr	5-yr	100-yr
A-1	30.482	B	60	0.49	0.71	150	0.0200	10.70	1480	0.0075	20	1.73	14.24	24.94	32.17	24.94	1.95	4.24	29.28	91.12
A-2	44.208	B	60	0.49	0.71	150	0.0200	10.70	2300	0.0075	20	1.73	22.13	32.83	41.24	32.83	1.67	3.61	36.19	112.60
A-3	37.108	B	60	0.49	0.71	150	0.0200	10.70	2750	0.0075	20	1.73	26.46	37.16	46.22	37.16	1.54	3.35	28.16	87.63
A-4	10.685	B	60	0.49	0.71	200.0	0.040	9.83	700.00	0.030	20	3.46	3.37	13.20	19.67	13.20	2.70	5.85	14.16	44.07

APPENDIX E

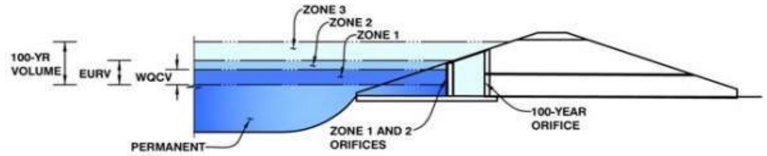
HYDRAULIC CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Anderson Ranch**

Basin ID: **Conceptual Pond in Basin 1 - Req'd Vol Only**



Example Zone Configuration (Retention Pond)

Preliminary spreadsheet showing minimum detention volumes only. Grading used in the stage / storage matrix is to be determined

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	30.482	acres
Watershed Length =	1,480	ft
Watershed Length to Centroid =	800	ft
Watershed Slope =	0.0075	ft/ft
Watershed Imperviousness =	60%	percent
Percentage Hydrologic Soil Group A =	0%	percent
Percentage Hydrologic Soil Group B =	100%	percent
Percentage Hydrologic Soil Groups C/D =	0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Commerce City - Civic Center	

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) =	0.600	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.984	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	1.169	acre-feet		inches
5-yr Runoff Volume (P1 = 1.12 in.) =	1.660	acre-feet		inches
10-yr Runoff Volume (P1 = 1.37 in.) =	2.223	acre-feet		inches
25-yr Runoff Volume (P1 = 1.75 in.) =	3.287	acre-feet		inches
50-yr Runoff Volume (P1 = 2.08 in.) =	4.132	acre-feet		inches
100-yr Runoff Volume (P1 = 2.43 in.) =	5.137	acre-feet		inches
500-yr Runoff Volume (P1 = 3.35 in.) =	7.592	acre-feet		inches
Approximate 2-yr Detention Volume =	1.078	acre-feet		
Approximate 5-yr Detention Volume =	1.538	acre-feet		
Approximate 10-yr Detention Volume =	2.078	acre-feet		
Approximate 25-yr Detention Volume =	2.512	acre-feet		
Approximate 50-yr Detention Volume =	2.766	acre-feet		
Approximate 100-yr Detention Volume =	3.150	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.600	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.384	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.166	acre-feet
Total Detention Basin Volume =	3.150	acre-feet

Depth Increement = ft

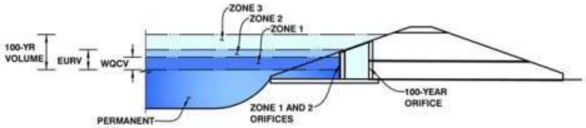
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Anderson Ranch

Basin ID: Conceptual Pond in Basin 1 - Req'd Vol Only



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)			
Zone 2 (EURV)			
Zone 3 (100-year)			
Total (all zones)			

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

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

Calculated Parameters for Underdrain

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

Calculated Parameters for Plate

Centroid of Lowest Orifice =		ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =		ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =		inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =		sq. inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (optional)	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)								
Orifice Area (sq. inches)								

	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)

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

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

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=		feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =		feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =		acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =		acre-ft

Routed Hydrograph Results

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

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	0.84	1.12	1.37	1.75	2.08	2.43	3.35
CUHP Runoff Volume (acre-ft) =	0.600	1.984	1.169	1.660	2.223	3.287	4.132	5.137	7.592
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.169	1.660	2.223	3.287	4.132	5.137	7.592
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.5	4.7	16.0	23.2	32.6	53.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.15	0.53	0.76	1.07	1.74
Peak Inflow Q (cfs) =	N/A	N/A	16.6	23.6	32.1	49.8	63.1	78.6	115.2
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

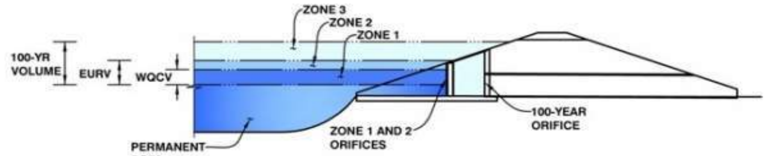
MHFD limits release to ~ 90% of predevelopment peaks, or ~ 29 cfs

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Anderson Ranch**

Basin ID: **Conceptual Pond in Basin 2 - Req'd Vol Only**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	44.208	acres
Watershed Length =	2,300	ft
Watershed Length to Centroid =	1,380	ft
Watershed Slope =	0.0075	ft/ft
Watershed Imperviousness =	60%	percent
Percentage Hydrologic Soil Group A =	0%	percent
Percentage Hydrologic Soil Group B =	100%	percent
Percentage Hydrologic Soil Groups C/D =	0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Commerce City - Civic Center	

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) =	0.870	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.877	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	1.700	acre-feet		inches
5-yr Runoff Volume (P1 = 1.12 in.) =	2.415	acre-feet		inches
10-yr Runoff Volume (P1 = 1.37 in.) =	3.233	acre-feet		inches
25-yr Runoff Volume (P1 = 1.75 in.) =	4.783	acre-feet		inches
50-yr Runoff Volume (P1 = 2.08 in.) =	6.012	acre-feet		inches
100-yr Runoff Volume (P1 = 2.43 in.) =	7.474	acre-feet		inches
500-yr Runoff Volume (P1 = 3.35 in.) =	11.047	acre-feet		inches
Approximate 2-yr Detention Volume =	1.564	acre-feet		
Approximate 5-yr Detention Volume =	2.230	acre-feet		
Approximate 10-yr Detention Volume =	3.013	acre-feet		
Approximate 25-yr Detention Volume =	3.642	acre-feet		
Approximate 50-yr Detention Volume =	4.012	acre-feet		
Approximate 100-yr Detention Volume =	4.568	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.870	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.007	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.691	acre-feet
Total Detention Basin Volume =	4.568	acre-feet

Depth Increement = | | ft

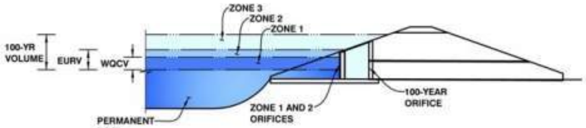
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

Preliminary spreadsheet showing minimum detention volumes only. Grading used in the stage / storage matrix is to be determined

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Anderson Ranch**
Basin ID: **Conceptual Pond in Basin 2 - Req'd Vol Only**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)			
Zone 2 (EURV)			
Zone 3 (100-year)			
Total (all zones)			

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

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

Calculated Parameters for Underdrain

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

Calculated Parameters for Plate

Centroid of Lowest Orifice =		ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =		ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =		inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =		sq. inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (optional)	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)								
Orifice Area (sq. inches)								

	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)

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

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

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=		feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =		feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =		acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =		acre-ft

Routed Hydrograph Results

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

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	0.84	1.12	1.37	1.75	2.08	2.43	3.35
CUHP Runoff Volume (acre-ft) =	0.870	2.877	1.700	2.415	3.233	4.783	6.012	7.474	11.047
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.700	2.415	3.233	4.783	6.012	7.474	11.047
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	0.6	5.1	18.2	26.6	37.7	61.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.11	0.41	0.60	0.85	1.40
Peak Inflow Q (cfs) =	N/A	N/A	19.5	27.6	37.3	60.2	75.8	94.1	137.8
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

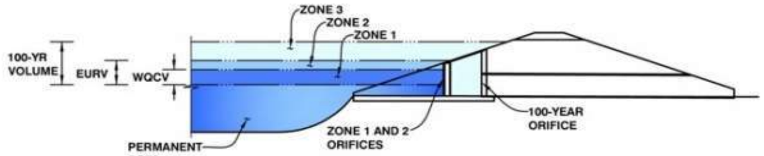
MHFD limits release to ~ 90% of predevelopment peaks, or ~ 34 cfs

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Anderson Ranch**

Basin ID: **Conceptual Pond in Basin 3 - Req'd Vol Only**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	37.108	acres
Watershed Length =	2,750	ft
Watershed Length to Centroid =	1,650	ft
Watershed Slope =	0.0075	ft/ft
Watershed Imperviousness =	60%	percent
Percentage Hydrologic Soil Group A =	0%	percent
Percentage Hydrologic Soil Group B =	100%	percent
Percentage Hydrologic Soil Groups C/D =	0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Commerce City - Civic Center	

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) =	0.730	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.415	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	1.430	acre-feet		inches
5-yr Runoff Volume (P1 = 1.12 in.) =	2.031	acre-feet		inches
10-yr Runoff Volume (P1 = 1.37 in.) =	2.719	acre-feet		inches
25-yr Runoff Volume (P1 = 1.75 in.) =	4.022	acre-feet		inches
50-yr Runoff Volume (P1 = 2.08 in.) =	5.054	acre-feet		inches
100-yr Runoff Volume (P1 = 2.43 in.) =	6.283	acre-feet		inches
500-yr Runoff Volume (P1 = 3.35 in.) =	9.287	acre-feet		inches
Approximate 2-yr Detention Volume =	1.312	acre-feet		
Approximate 5-yr Detention Volume =	1.872	acre-feet		
Approximate 10-yr Detention Volume =	2.529	acre-feet		
Approximate 25-yr Detention Volume =	3.057	acre-feet		
Approximate 50-yr Detention Volume =	3.367	acre-feet		
Approximate 100-yr Detention Volume =	3.835	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.730	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.685	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.420	acre-feet
Total Detention Basin Volume =	3.835	acre-feet

Depth Increement = ft

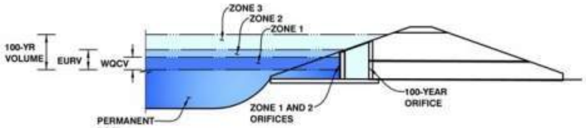
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

Preliminary spreadsheet showing minimum detention volumes only. Grading used in the stage / storage matrix is to be determined

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Anderson Ranch**
Basin ID: **Conceptual Pond in Basin 3 - Req'd Vol Only**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)			
Zone 2 (EURV)			
Zone 3 (100-year)			
Total (all zones)			

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

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

Calculated Parameters for Underdrain

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

Calculated Parameters for Plate

Centroid of Lowest Orifice =		ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =		ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =		inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =		sq. inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (optional)	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)								
Orifice Area (sq. inches)								

	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)

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

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

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=		feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =		feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =		acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =		acre-ft

Routed Hydrograph Results

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

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	0.84	1.12	1.37	1.75	2.08	2.43	3.35
CUHP Runoff Volume (acre-ft) =	0.730	2.415	1.430	2.031	2.719	4.022	5.054	6.283	9.287
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.430	2.031	2.719	4.022	5.054	6.283	9.287
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.4	3.4	12.3	18.0	25.9	42.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.09	0.33	0.49	0.70	1.15
Peak Inflow Q (cfs) =	N/A	N/A	13.6	19.2	26.0	41.9	52.9	66.3	97.1
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

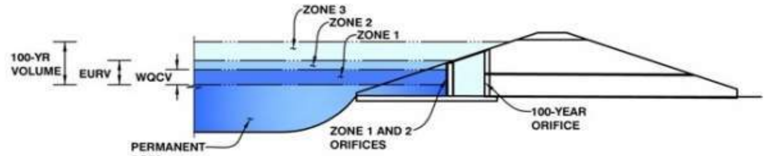
MHFD limits release to ~ 90% of predevelopment peaks, or ~ 23 cfs. This may need to be further limited to ~17 cfs due to smaller down stream connection at existing 24" storm as per Foxton Village

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Anderson Ranch**

Basin ID: **Conceptual Pond in Basin 4 - Req'd Vol Only**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	10.685	acres
Watershed Length =	700	ft
Watershed Length to Centroid =	420	ft
Watershed Slope =	0.0300	ft/ft
Watershed Imperviousness =	60%	percent
Percentage Hydrologic Soil Group A =	0%	percent
Percentage Hydrologic Soil Group B =	100%	percent
Percentage Hydrologic Soil Groups C/D =	0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Commerce City - Civic Center	

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) =	0.210	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.695	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	0.390	acre-feet		inches
5-yr Runoff Volume (P1 = 1.12 in.) =	0.554	acre-feet		inches
10-yr Runoff Volume (P1 = 1.37 in.) =	0.742	acre-feet		inches
25-yr Runoff Volume (P1 = 1.75 in.) =	1.097	acre-feet		inches
50-yr Runoff Volume (P1 = 2.08 in.) =	1.379	acre-feet		inches
100-yr Runoff Volume (P1 = 2.43 in.) =	1.714	acre-feet		inches
500-yr Runoff Volume (P1 = 3.35 in.) =	2.533	acre-feet		inches
Approximate 2-yr Detention Volume =	0.378	acre-feet		
Approximate 5-yr Detention Volume =	0.539	acre-feet		
Approximate 10-yr Detention Volume =	0.728	acre-feet		
Approximate 25-yr Detention Volume =	0.880	acre-feet		
Approximate 50-yr Detention Volume =	0.970	acre-feet		
Approximate 100-yr Detention Volume =	1.104	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.210	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.485	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.409	acre-feet
Total Detention Basin Volume =	1.104	acre-feet

Depth Increement = ft

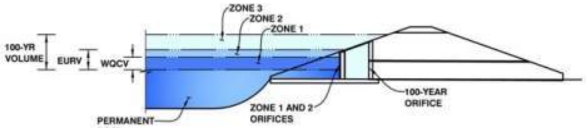
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

Preliminary spreadsheet showing minimum detention volumes only. Grading for the school dedication site to be determined by others during school site development

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Anderson Ranch**
Basin ID: **Conceptual Pond in Basin 4 - Req'd Vol Only**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)			
Zone 2 (EURV)			
Zone 3 (100-year)			
Total (all zones)			

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

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

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

Centroid of Lowest Orifice =		ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =		ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =		inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =		sq. inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (optional)	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)								
Orifice Area (sq. inches)								

	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) — Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal) — Calculated Parameters for Spillway

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=		feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =		feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =		acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =		acre-ft

Routed Hydrograph Results

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

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	0.84	1.12	1.37	1.75	2.08	2.43	3.35
CUHP Runoff Volume (acre-ft) =	0.210	0.695	0.390	0.554	0.742	1.097	1.379	1.714	2.533
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.390	0.554	0.742	1.097	1.379	1.714	2.533
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.3	2.6	8.4	12.1	16.5	26.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.03	0.24	0.78	1.13	1.55	2.50
Peak Inflow Q (cfs) =	N/A	N/A	7.7	10.7	14.7	22.3	28.0	35.5	51.5
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

MHFD limits release to ~ 90% of predevelopment peaks, or ~ 15 cfs

APPENDIX F

REFERENCE MATERIALS

Excerpts from Preliminary Drainage Report for Reunion Village 9

PRELIMINARY DRAINAGE REPORT
FOR
REUNION VILLAGE 9

May 20, 2020

Prepared For:
Reunion Metropolitan District
17910 East Parkside Drive North
Commerce City, Colorado 80022
Contact: Matt Urkoski

Prepared By:
JR ENGINEERING, LLC
7200 S Alton Way, Suite C400
Centennial, Colorado 80112
(303) 740-9393
Contact: Aaron Clutter, PE

DocuSigned by:
Brent Soderlin
8B8931E0FCC545B...
6/16/2020
City of Commerce City Engineering Approval

Project No. 14421.29
X:\1440000.all\1442129\Word\Reports\Preliminary Drainage Report\1442129_Preliminary Drainage Report_Reunion Village 9.docx

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Appendix B – Hydrologic Calculations and CUHP/SWMM Model Results
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Appendix D – Ragweed Draw Channel Hydraulic Calculations
Appendix E – Excerpts from Referenced Material
Appendix F – Drainage Maps

LIST OF TABLES

Sub-Basin 9OS1

Total Area (ac): 9.3	% Imperviousness: 2.0%

Description/Location:

An off-site sub-basin with primarily undeveloped land. The Sub-basin is located east of the Sable Boulevard and north of Sub-basin 9C0. The runoff flows west to the low point in Sable Boulevard (Node JB2) before discharging into Pond B.

Sub-Basin 9OS2b

Total Area (ac): 33.8	% Imperviousness: 25.0%

Description/Location:

An off-site sub-basin with primarily undeveloped land and is expected to be converted to a park/playground. The Sub-basin is located east of Potomac Street, west of the existing Foxton Village residential property and Sub-basin 9OS2c, and south of Sub-basin 9OS2a. The runoff is planned to flow south to the proposed Pond B.

Sub-Basin 9OS2c

Total Area (ac): 3.6	% Imperviousness: 55.0%

Description/Location:

An off-site sub-basin within the existing Foxton Village residential property. The Sub-basin is located east of Sub-basin 9OS2b and north of the proposed 100th Avenue. The runoff flows south to 100th Avenue before discharging into Pond B.

Sub-Basin 9OS4

Total Area (ac): 22.8	% Imperviousness: 2.0%

Description/Location:

An off-site sub-basin with primarily undeveloped land within the Rocky Mountain Arsenal. The Sub-basin is located south of 96th Avenue and Sub-basin 9E4. The runoff flows north and is expected to be routed to the low point in 96th Avenue (Node JB5) before discharging into Pond B.

Ragweed Draw Basin (Basin DFA 0053) – Full-Spectrum Detention Pond C

Sub-Basin 9C2

Total Area (ac): 40.1	% Imperviousness: 55.0%

Description/Location:

Planned to be single-family residential. The Sub-basin is located north of 96th Avenue, south of the existing property under Adams County jurisdiction, west of Chambers Road and east of Sub-basin 9C1. The runoff is expected to flow north/south to Ragweed Draw (Node JC2) before discharging into Pond C.

Sub-Basin 9C1

Total Area (ac): 22.7	% Imperviousness: 55.0%

Description/Location:

Planned to be single-family residential. The Sub-basin is located north of 96th Ave, south of the existing property under Adams County jurisdiction and Sub-basin 9OS1, east of Sable Blvd, and west of Sub-basin 9C2. The runoff is expected to flow north/south to Ragweed Draw (Node JC1) before discharging into Pond C.

Sub-Basin 9C0	
Total Area (ac): 4.1	% Imperviousness: 90.4%
Description/Location:	
Contains the full-spectrum detention Pond C tract and is located south Sub-Basin OS1. The runoff flows directly into Pond C.	

Sub-Basin 9E6	
Total Area (ac): 6.9	% Imperviousness: 59.3%
Description/Location:	
Includes a portion of the proposed 96th Ave Right-of-Way. The Sub-basin is located south of Sub-basins 9C1 and 9C2, north of the Rocky Mountain Arsenal, and east of Sub-basins 9E5 and 9E4. The runoff is expected to flow to the low point at Node JC4 and piped to Node JC3 before discharging into Ragweed Draw routed to Pond C.	

Sub-Basin 9OS3	
Total Area (ac): 23.9	% Imperviousness: 2.0%
Description/Location:	
An off-site sub-basin with primarily undeveloped land within the Rocky Mountain Arsenal. The Sub-basin is located south of 96th Avenue and Sub-basins E6. The runoff flows north to an existing low point and is expected to be piped under 96th Avenue (Node JC3) before discharging into Ragweed Draw and Pond C.	

Sub-Basin 9101b	
Total Area (ac): 22.6	% Imperviousness: 55.0%
Description/Location:	
Comprised of existing single-family residential in Fronterra Village. The Sub-basin is located north of 96th Avenue and east of Chambers Road. The runoff is expected to flow to the existing pond located within the site and then discharges into Ragweed Draw (Node JC5).	

Sub-Basin 9101a	
Total Area (ac): 4.3	% Imperviousness: 59.3%
Description/Location:	
Includes a portion of the Chambers Road Right-of-Way. The Sub-basin is located west of Sub-basin 9101b and east of Sub-basin 9C2. The runoff flows to an existing low point and inlet located in Chambers Road and piped directly to Ragweed Draw (Node JC5) before discharging into Pond C.	

Basin F5 (Basin DFA 0053) –Detention Pond F5

Sub-Basin 9F5	
Total Area (ac): 22.9	% Imperviousness: 60.3%
Description/Location:	
Planned to be a mixed use development and includes a portion of the PSCO Right-of-Way. The Sub-basin is located north of Sub-Basins 9A4a and 9A3a, south of 104th Ave, west of Potomac St and east of the proposed Vaughn Way. The runoff is expected to flow west to Pond F5 and will be detained in Pond F5 before discharging to Node JF3. The flows are then routed Pond F to be treated for water quality.	

Proposed Full-Spectrum Detention and Water Quality Pond C

In the proposed conditions, flows from the Ragweed Draw Basin of Reunion Village 9 (Sub-Basins 9C0, 9C1, 9C2, 9E6, 9101a, 9101b, and 9OS3) receive water quality and detention for peak attenuation in proposed Detention Pond C before releases are allowed to enter the proposed Ragweed Draw Channel. Pond C provides over-detention to minimize the flows entering Ragweed Draw and Pond B. The proposed pond will include a forebay and a trickle channel leading to an outlet structure. Flows will leave the pond via storm sewer and renter a storm sewer and ultimately a Ragweed Draw channel upstream of Pond B. The Pond C watershed area is 125 acres and the imperviousness is 46%.

As shown below, Pond C will release at approximately 5% of the pre-development peak runoff rate for the Pond C Basin. The WQCV and the EURV stages of the pond will still meet CRS §37-92-602 (8) drain times and the WQCV volume will meet the minimum 40-hour release.

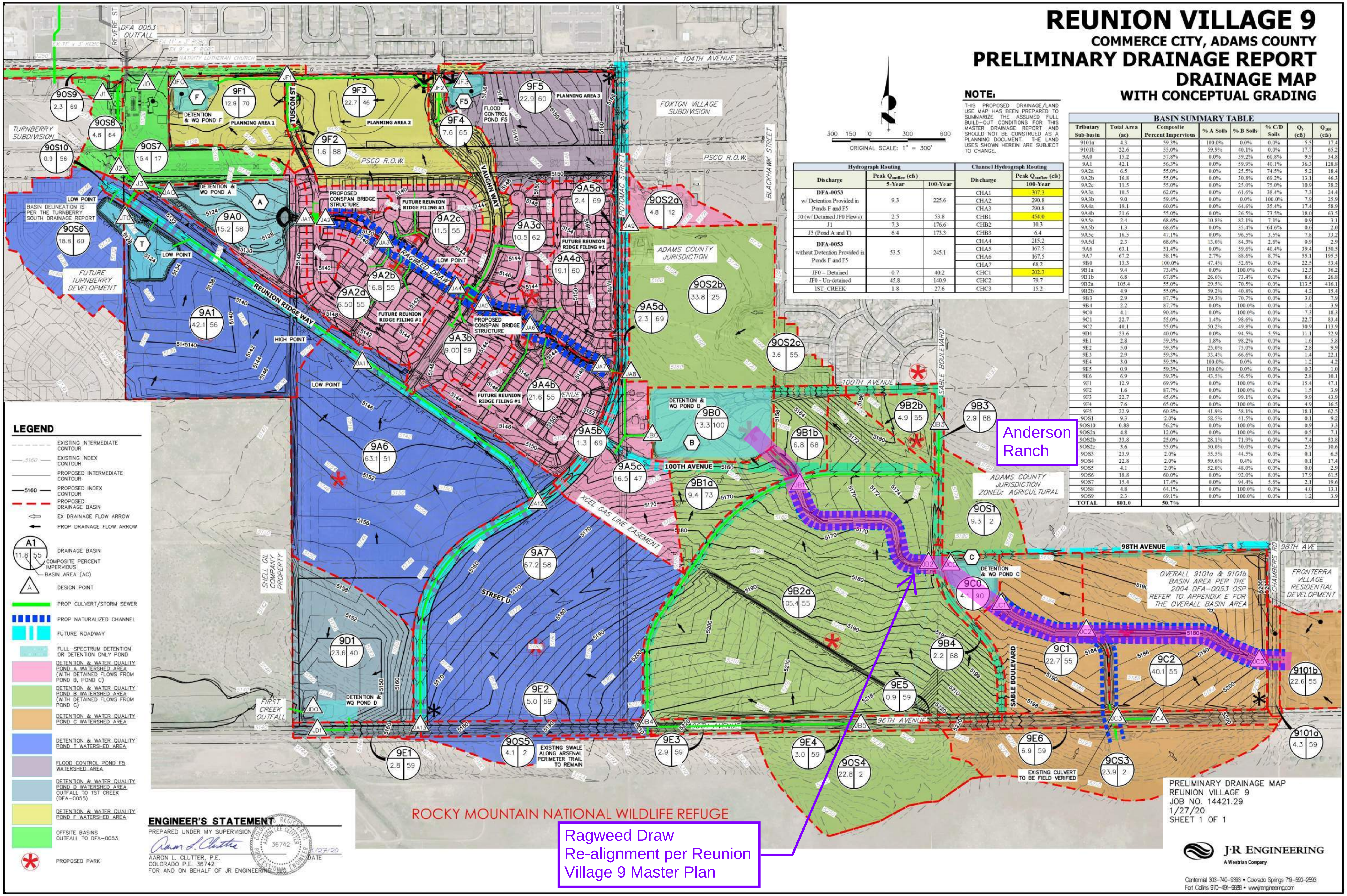
An existing detention pond located offsite, within the Fronterra Village subdivision east of Chambers Road just north of 96th Avenue, has not been included in this analysis. The offsite drainage area (Sub-Basin 9101b) is accounted for in the hydrologic routing, but no credit for the existing pond is taken.

Table 6 - Full-Spectrum Over-Detention Pond C Parameters

Hydrograph Routing / UD-Detention Workbook_v3.07							
	Inflow Volume (ac-ft)	Stored Volume (ac-ft)	Drain Time (99%) (hrs)	Stage (ft)	WSEL (ft)	Peak Q_{inflow} (cfs)	Peak $Q_{outflow}$ (cfs)
UD-Detention Workbook_v3.07							
WQCV	2.04	1.90	40	3.99	5172.81	35.7	0.9
EURV	6.27	5.74	71	6.13	5174.95	107.7	4.9
Hydrograph Routing - EPA-SWMM Version 5.1							
5-YR	5.03	4.70	68	5.61	5174.43	82.7	2.9
100-YR	18.44	16.22	97	10.66	5179.48	297.3	6.4

	Pre-development Release (cfs)	90% Pre-development Release (cfs)	Provided (%) Peak Discharge to Pre-development Release
100-YR	123.3	111.0	5.2%

REUNION VILLAGE 9
COMMERCE CITY, ADAMS COUNTY
PRELIMINARY DRAINAGE REPORT
DRAINAGE MAP
WITH CONCEPTUAL GRADING



Anderson Ranch

Ragweed Draw
Re-alignment per Reunion
Village 9 Master Plan

NOTE:

THIS PROPOSED DRAINAGE/LAND USE MAP HAS BEEN PREPARED TO SUMMARIZE THE ASSUMED FULL BUILD-OUT CONDITIONS FOR THIS MASTER DRAINAGE REPORT AND SHOULD NOT BE CONSTRUED AS A PLANNING DOCUMENT. THE LAND USES SHOWN HEREIN ARE SUBJECT TO CHANGE.

Hydrograph Routing			Channel Hydrograph Routing	
Discharge	Peak $Q_{outflow}$ (cfs)		Discharge	Peak $Q_{outflow}$ (cfs)
	5-Year	100-Year		100-Year
DFA-0053 w/ Detention Provided in Ponds F and F5	9.3	225.6	CHA1	307.3
			CHA2	290.8
			CHA3	290.8
J0 (w/ Detained JF0 Flows)	2.5	53.8	CHB1	454.0
J1	7.3	176.6	CHB2	10.3
J3 (Pond A and T)	6.4	173.3	CHB3	6.4
DFA-0053 without Detention Provided in Ponds F and F5	53.5	245.1	CHA4	215.2
			CHA5	167.5
			CHA6	167.5
			CHA7	68.2
JF0 – Detained	0.7	40.2	CHC1	202.3
JF0 - Un-detained	45.8	140.9	CHC2	79.7
1ST_CREEK	1.8	27.6	CHC3	15.2

BASIN SUMMARY TABLE							
Tributary Sub-basin	Total Area (ac)	Composite Percent Impervious	% A Soils	% B Soils	% C/D Soils	Q_5 (cfs)	Q_{100} (cfs)
9101a	4.3	59.3%	100.0%	0.0%	0.0%	5.5	17.4
9101b	22.6	55.0%	59.9%	40.1%	0.0%	17.7	65.2
9A0	15.2	57.8%	0.0%	39.2%	60.8%	9.9	34.8
9A1	42.1	56.3%	0.0%	59.9%	40.1%	36.3	128.8
9A2a	6.5	55.0%	0.0%	25.5%	74.5%	5.2	18.4
9A2b	16.8	55.0%	0.0%	30.8%	69.2%	13.1	46.3
9A2c	11.5	55.0%	0.0%	25.0%	75.0%	10.9	38.2
9A3a	10.5	62.0%	0.0%	61.6%	38.4%	7.3	24.4
9A3b	9.0	59.4%	0.0%	0.0%	100.0%	7.9	25.9
9A4a	19.1	60.0%	0.0%	64.6%	35.4%	17.4	58.9
9A4b	21.6	55.0%	0.0%	26.5%	73.5%	18.0	63.5
9A5a	2.4	68.6%	10.8%	82.1%	7.1%	0.9	3.1
9A5b	1.3	68.6%	0.0%	35.4%	64.6%	0.6	2.0
9A5c	16.5	47.1%	0.0%	96.5%	3.5%	7.8	33.2
9A5d	2.3	68.6%	13.0%	84.3%	2.6%	0.9	2.9
9A6	63.1	51.4%	0.0%	59.6%	40.4%	39.4	150.5
9A7	67.2	58.1%	2.7%	88.6%	8.7%	55.1	195.5
9B0	13.3	100.0%	47.4%	52.6%	0.0%	22.5	53.4
9B1a	9.4	73.4%	0.0%	100.0%	0.0%	12.3	36.2
9B1b	6.8	67.8%	26.6%	73.4%	0.0%	8.6	26.8
9B2a	105.4	55.0%	29.5%	70.5%	0.0%	113.5	416.1
9B2b	4.9	55.0%	59.2%	40.8%	0.0%	4.2	15.4
9B3	2.9	87.7%	29.3%	70.7%	0.0%	3.0	7.9
9B4	2.2	87.7%	0.0%	100.0%	0.0%	1.4	3.9
9C0	4.1	90.4%	0.0%	100.0%	0.0%	7.3	18.3
9C1	22.7	55.0%	1.4%	98.6%	0.0%	22.7	83.4
9C2	40.1	55.0%	50.2%	49.8%	0.0%	30.9	113.9
9D1	23.6	40.0%	0.0%	94.5%	5.5%	11.1	52.9
9E1	2.8	59.3%	1.8%	98.2%	0.0%	1.6	5.8
9E2	5.0	59.3%	25.0%	75.0%	0.0%	2.8	9.9
9E3	2.9	59.3%	33.4%	66.6%	0.0%	1.4	22.1
9E4	3.0	59.3%	100.0%	0.0%	0.0%	1.2	4.2
9E5	0.9	59.3%	100.0%	0.0%	0.0%	0.3	1.0
9E6	6.9	59.3%	43.5%	56.5%	0.0%	2.8	10.1
9F1	12.9	69.9%	0.0%	100.0%	0.0%	15.4	47.1
9F2	1.6	87.7%	0.0%	100.0%	0.0%	1.5	3.9
9F3	22.7	45.6%	0.0%	99.1%	0.9%	9.9	43.9
9F4	7.6	65.0%	0.0%	100.0%	0.0%	4.9	16.5
9F5	22.9	60.3%	41.9%	58.1%	0.0%	18.1	62.5
9OS1	9.3	2.0%	58.5%	41.5%	0.0%	0.1	9.2
9OS10	0.88	56.2%	0.0%	100.0%	0.0%	0.9	3.3
9OS2a	4.8	12.0%	0.0%	100.0%	0.0%	0.5	7.1
9OS2b	33.8	25.0%	28.1%	71.9%	0.0%	7.4	53.8
9OS2c	3.6	55.0%	50.0%	50.0%	0.0%	2.9	10.6
9OS3	23.9	2.0%	55.5%	44.5%	0.0%	0.1	6.5
9OS4	22.8	2.0%	99.6%	0.4%	0.0%	0.1	17.4
9OS5	4.1	2.0%	52.0%	48.0%	0.0%	0.0	2.9
9OS6	18.8	60.0%	0.0%	92.0%	8.0%	17.9	61.5
9OS7	15.4	17.4%	0.0%	94.4%	5.6%	2.1	19.6
9OS8	4.8	64.1%	0.0%	100.0%	0.0%	4.0	13.1
9OS9	2.3	69.1%	0.0%	100.0%	0.0%	1.2	3.9
TOTAL	**801.0**	**50.7%**					

LEGEND

- - - - - -	EXISTING INTERMEDIATE CONTOUR
— 5160 —	EXISTING INDEX CONTOUR
——	PROPOSED INTERMEDIATE CONTOUR
—5160—	PROPOSED INDEX CONTOUR
🟥 — — —	PROPOSED DRAINAGE BASIN
⇦	EX DRAINAGE FLOW ARROW
←	PROP DRAINAGE FLOW ARROW
A1 / 11.8 / 55	DRAINAGE BASIN COMPOSITE PERCENT IMPERVIOUS BASIN AREA (AC)
△ A	DESIGN POINT
🟩	PROP CULVERT/STORM SEWER
▮▮▮▮▮▮	PROP NATURALIZED CHANNEL
▨	FUTURE ROADWAY
▨	FULL-SPECTRUM DETENTION OR DETENTION ONLY POND
▨	DETENTION & WATER QUALITY POND A WATERSHED AREA (WITH DETAINED FLOWS FROM POND B, POND C)
🟩	DETENTION & WATER QUALITY POND B WATERSHED AREA (WITH DETAINED FLOWS FROM POND C)
🟧	DETENTION & WATER QUALITY POND C WATERSHED AREA
🟦	DETENTION & WATER QUALITY POND T WATERSHED AREA
🟪	FLOOD CONTROL POND F5 WATERSHED AREA
▨	DETENTION & WATER QUALITY POND D WATERSHED AREA OUTFALL TO 1ST CREEK (DFA-0055)
🟨	DETENTION & WATER QUALITY POND F WATERSHED AREA
🟩	OFFSITE BASINS OUTFALL TO DFA-0053
*	PROPOSED PARK

ENGINEER'S STATEMENT

PREPARED UNDER MY SUPERVISION

Aaron L. Clutter 1/27/20

AARON L. CLUTTER, P.E. DATE
COLORADO P.E. 36742
FOR AND ON BEHALF OF JR ENGINEERING, LLC

36742

PRELIMINARY DRAINAGE MAP
REUNION VILLAGE 9
JOB NO. 14421.29
1/27/20
SHEET 1 OF 1

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

Excerpts from Foxton Village Final Drainage Report

PHASE III DRAINAGE REPORT
FOR
FOXTON VILLAGE SUBDIVISION

JN: 2195

July 6, 2000
Revised September 11, 2000
Revised November 10, 2000
Revised January 10, 2001

Prepared for:

Gateway American Properties, L.L.C.
9145 East Kenyon Avenue, Suite 202
Denver, CO 80237
303-843-9742

Prepared by:

Chris Corwin, E.I.

Reviewed by:

COLORADO REGISTERED PROFESSIONAL ENGINEER
RICHARD J. WEED
22076
1/12/01

Richard J. Weed, P.E.

Carroll & Lange, Inc.
165 South Union Blvd., Suite 156
Lakewood, Colorado 80228
(Fax) 303-980-0917
303-980-0200

City of Commerce City Engineering
APPROVED
JAN 16 2001

17.0 cfs capacity for FES serving Basin OS2 under FES / culvert conditions.

Culvert Design Report

Trial-1

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	N/A	ft	Storm Event	Design	
Computed Headwater Elevation	81.95	ft	Discharge	17.00	cfs
Headwater Depth/ Height	1.26		Tailwater Elevation	76.87	ft
Inlet Control HW Elev	81.93	ft	Control Type	Outlet Control	
Outlet Control HW Elev	81.95	ft			

Grades

Upstream Invert	79.42	ft	Downstream Invert	77.37	ft
Length	361.00	ft	Constructed Slope	0.005679	ft/ft

Hydraulic Profile

Profile	M2		Depth, Downstream	1.49	ft
Slope Type	Mild		Normal Depth	1.63	ft
Flow Regime	Subcritical		Critical Depth	1.49	ft
Velocity Downstream	6.79	ft/s	Critical Slope	0.006937	ft/ft

Section

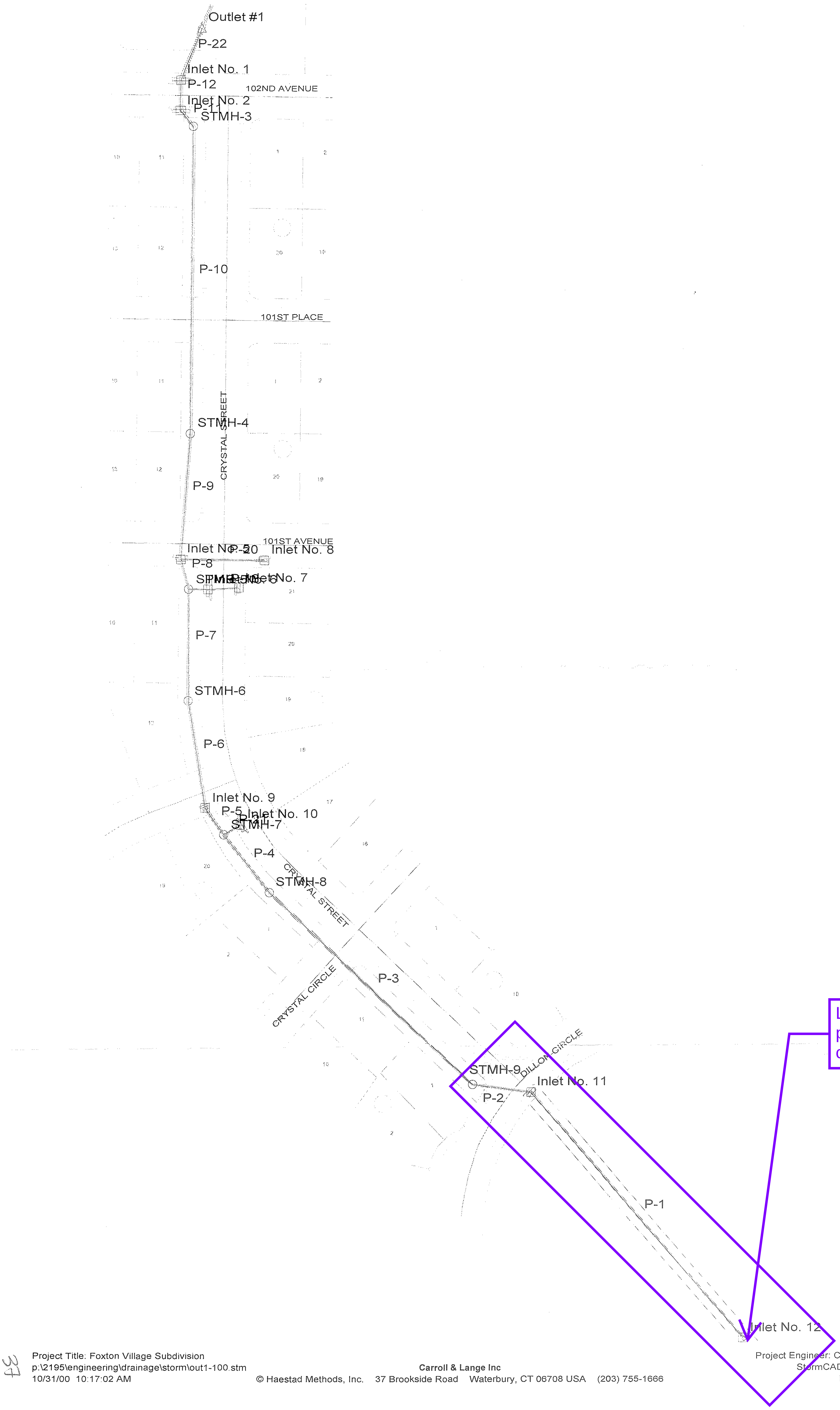
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev	81.95	ft	Upstream Velocity Head	0.59	ft
Ke	0.50		Entrance Loss	0.30	ft

Inlet Control Properties

Inlet Control HW Elev	81.93	ft	Flow Control	Transition	
Inlet Type	End-Section Conforming to fill slope		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				



Likely Anderson Ranch pond / storm outfall connection point

Project Title: Foxton Village Subdivision
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Project Engineer: Chris Corwin
StormCAD v1.5 [158]
Page 1 of 1

C&L Report

Pipe	Upstream Node	Downstream Node	Section Size	Length (ft)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Invert Slope (%)	Discharge (cfs)	Capacity (cfs)	Average Velocity (ft/s)	Upstream HGL (ft)	Downstream HGL (ft)	Upstream Energy Grade (ft)	Downstream Energy Grade (ft)	Upstream Ground Elevation (ft)
P-1	Inlet No. 12	Inlet No. 11	24 inch	364.00	79.42	77.37	0.56	0.00	16.98	0.00	79.42	78.06	79.42	78.06	85.00
P-2	Inlet No. 1	STMH-9	30 inch	66.00	76.87	76.54	0.50	8.99	29.00	5.06	77.87	77.50	78.24	77.92	83.11
P-3	STMH-9	STMH-8	30 inch	313.00	76.34	74.55	0.57	8.92	31.02	5.18	77.34	75.47	77.71	75.93	83.70
P-21	Inlet No. 10	STMH-7	18 inch	22.00	74.79	74.68	0.50	6.27	7.43	4.99	75.83	75.65	76.19	76.07	79.81
P-4	STMH-8	STMH-7	30 inch	82.00	74.35	73.88	0.57	8.62	31.05	3.96	75.33	75.27	75.69	75.41	81.20
P-5	STMH-7	Inlet No. 9	30 inch	36.00	73.68	73.48	0.56	14.21	30.57	4.94	74.99	75.04	75.45	75.34	80.60
P-18	Inlet No. 7	Inlet No. 6	18 inch	35.00	72.97	72.79	0.51	5.17	7.53	2.93	74.49	74.41	74.63	74.54	77.71
P-6	Inlet No. 9	STMH-6	30 inch	121.00	73.28	72.59	0.57	17.44	30.97	5.90	74.69	74.08	75.27	74.59	79.81
P-19	Inlet No. 6	STMH-5	18 inch	22.00	72.59	72.48	0.50	10.99	7.43	6.48	74.11	73.78	74.71	74.49	77.73
P-7	STMH-6	STMH-5	30 inch	125.00	72.39	71.68	0.57	17.27	30.91	5.00	73.80	73.78	74.37	74.02	79.50
P-8	STMH-5	Inlet No. 5	30 inch	35.00	71.48	71.28	0.57	27.21	31.00	6.88	73.32	73.20	74.09	73.90	78.50
P-20	Inlet No. 8	Inlet No. 5	18 inch	95.00	72.75	72.28	0.49	3.62	7.39	3.68	73.49	73.20	73.76	73.36	77.78
P-9	Inlet No. 5	STMH-4	36 inch	141.00	70.78	69.97	0.57	34.88	50.55	6.92	72.70	72.09	73.53	72.75	77.74
P-10	STMH-4	STMH-3	36 inch	341.00	69.77	67.83	0.57	34.57	50.31	6.08	71.68	71.16	72.50	71.53	77.10
P-11	STMH-3	Inlet No. 2	36 inch	23.00	67.63	67.50	0.57	33.75	50.14	4.77	70.95	70.89	71.30	71.24	74.40
P-12	Inlet No. 2	Inlet No. 1	48 inch	34.00	66.50	66.31	0.56	74.49	107.37	5.93	70.56	70.47	71.11	71.02	73.02
P-22	Inlet No. 1	Outlet #1	48 inch	61.00	66.11	65.80	0.51	117.90	102.39	10.30	69.71	69.07	71.23	70.86	73.02

14

Project Title: Foxton Village Subdivision
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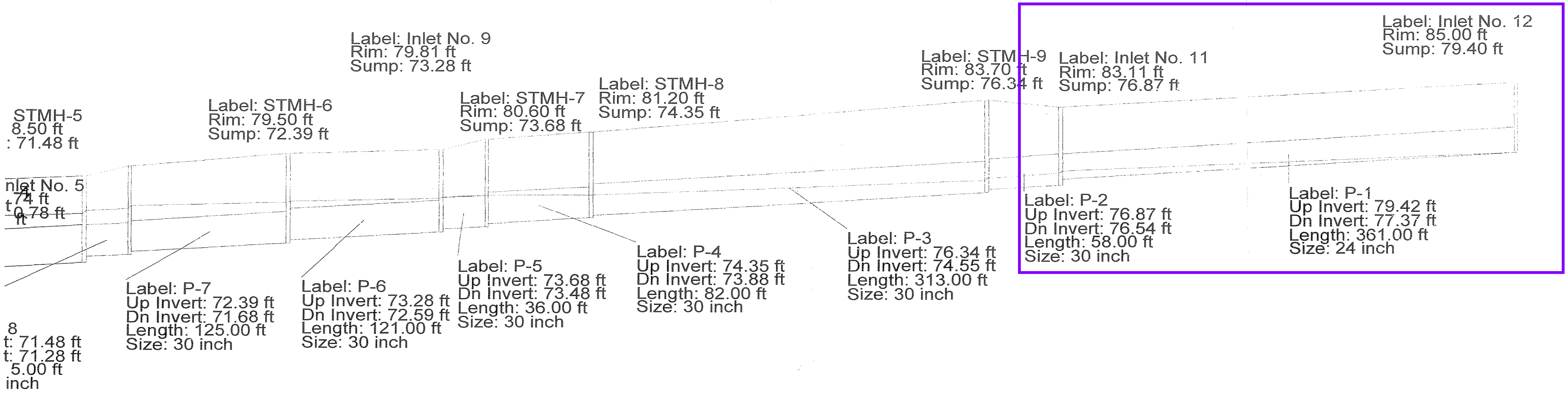
Carroll & Lange Inc

Project Engineer: Chris Corwin
StormCAD v1.5 [158]



43

Project Title: Foxton Village Subdivision
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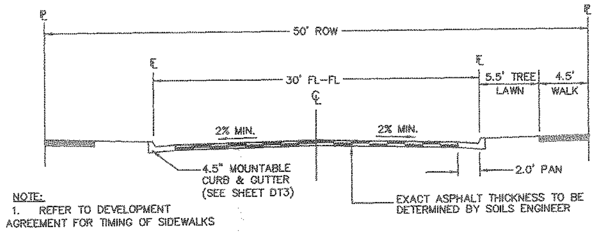
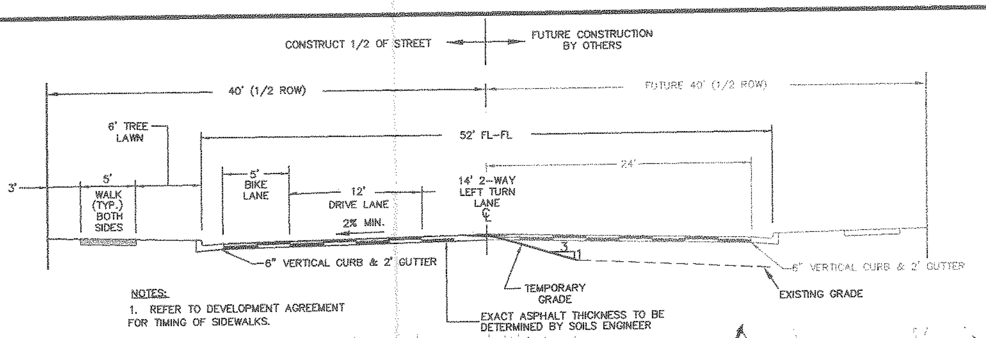
Project Engineer: Chris Corwin
StormCAD v1.5 [158]



NOTE:
1. REFER TO DEVELOPMENT AGREEMENT FOR TIMING OF SIDEWALKS

LOCAL RESIDENTIAL WITH DETACHED WALKS

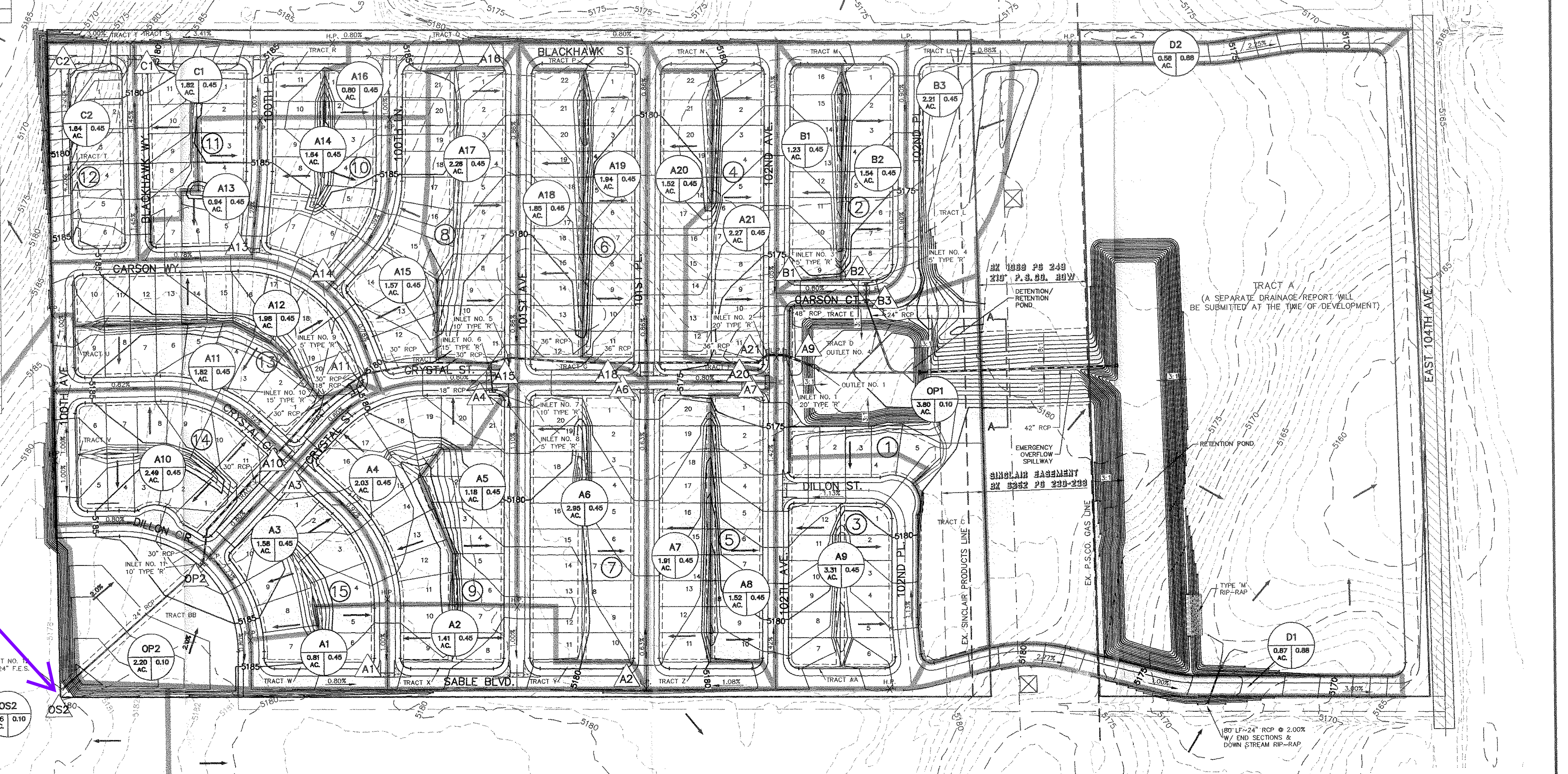
NOT TO SCALE



NOTES:
1. REFER TO DEVELOPMENT AGREEMENT FOR TIMING OF SIDEWALKS.

H1
1.90 AC.
0.60
4.80

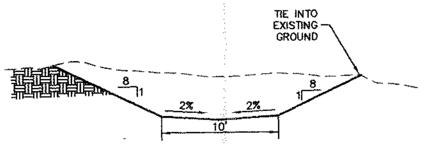
DISCHARGE SUMMARY TABLE			
FOXTON			
Basin ID	Area, (ac)	Q_5 (CFS)	Q_{100} (CFS)
A1	0.8	1.3	3.3
A2	1.4	2.1	5.2
A3	1.6	2.6	6.4
A4	2.0	2.9	7.2
A5	1.2	1.9	4.8
A6	3.0	4.3	10.8
A7	1.9	2.7	6.8
A8	1.5	2.3	5.8
A9	3.0	4.2	10.6
A10	2.5	3.7	9.2
A11	1.8	2.6	6.6
A12	2.0	2.9	7.2
A13	0.9	1.5	3.8
A14	1.6	2.7	6.7
A16	0.8	1.3	3.3
A17	2.3	3.3	8.2
A18	1.9	2.7	6.8
A19	1.9	2.8	7.1
A20	1.5	2.2	5.6
A21	2.3	3.3	8.3
B1	1.2	1.9	4.7
B2	1.5	2.3	5.8
B3	2.2	0.7	8.2
C1	1.8	3.1	7.7
C2	1.6	2.5	6.3
D1	0.9	3.3	6.5
D2	0.6	2.4	4.8
OP1	3.8	1.3	14.6
OP2	2.2	0.8	8.6



Existing 24" RCP for Anderson Ranch Tributary Drainage Q_{cap}=17.0 cfs

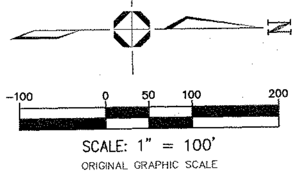
LEGEND

A / B / C	A = DEVELOPED BASIN DESIGNATION B = BASIN AREA (ACRES) C = 5 YEAR COMPOSITE RUNOFF COEFFICIENT
△2	DESIGN POINT
→	PROPOSED FLOW DIRECTION
6.00%	STREET SLOPE
▬	PROPOSED STORM SEWER W/FES
▭	PROPOSED TYPE 'R' INLET
▨	BASIN BOUNDARY
8059	PROPOSED GRADE CONTOUR (1')
8060	PROPOSED GRADE CONTOUR (5')
8054	EXISTING GRADE CONTOUR (1')
8055	EXISTING GRADE CONTOUR (5')
HP	HIGH POINT
LP	LOW POINT
⊓	8' CROSSPAN
H1	HISTORIC BASIN DESIGNATION
1.90 AC.	BASIN AREA, ACRES
0.60	5 YEAR RUNOFF, CFS
4.80	100 YEAR RUNOFF, CFS



EMERGENCY OVERFLOW SPILLWAY
SECTION A–A
N.T.S.

TRACT D–DETENTION POND			
RETURN PERIOD	STAGE	MIN. STORAGE	DISCHARGE
5 YEAR	5167.3 FT	1.41 AC*FT	10.7 CFS
100 YEAR	5170.0 FT	3.30 AC*FT	69.8 CFS



SCALE: 1" = 100'
ORIGINAL GRAPHIC SCALE

100 YEAR RETENTION POND		
POND	MIN. STORAGE	STAGE
TRACT A	18.3 AC.FT.	5171.0 FT.
TRACT D	4.7 AC.FT.	5171.0 FT.

City of Commerce City Engineering
APPROVED
JAN 16 2001

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.

PREPARED UNDER THE DIRECT SUPERVISON OF
22078
1/12/01
FOR AND ON BEHALF OF CARROLL & LANGE, INC.

No.	Revisions	Date	By	Chk
9				
8				
7				
6				
5				
4				
3				
2	CITY AND DISTRICT COMMENTS	12/15/00	SEB	
1	CITY COMMENTS	11/10/00	CEC	CJC

SEE MASTER REVISION/TRACKING TABULATION

Carroll & Lange Inc
Professional Engineers & Land Surveyors
165 South Union Blvd., Suite 156
Lakewood, Colorado 80228
(303) 980-0200
PRINTED
JAN 15 2001

Project: FOXTON VILLAGE SUBDIVISION		
Title: PHASE III DRAINAGE MAP		
Designed By: CJC	Scale: 1" = 100'	Sheet 1 of 1
Drawn By: CEC		Job No. 2195
Checked By:	Date: 9/11/00	File No. 2195–DRN

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Calibre
ENGINEERING

Excerpts from Phase III (Final) Drainage Report for High Pointe

HIGH POINTE

PHASE III DRAINAGE REPORT

September 9, 2004
Revised November 1, 2004
Revised January 10, 2005

For:
SW Begold LLC
333 West Hampden Avenue
Suite 810
Englewood, CO 80110

City of Commerce City Engineering
APPROVED
JAN 15 2005

Calibre Engineering, Inc.
8000 South Lincoln Street, Unit 206, Littleton, CO
303-730-0434 fax 303-730-1139
Municipal Engineering Development Master Planning

2.1.2. **Major Basin Drainage Characteristics**: The runoff from the existing northeasternmost one-fourth of the site currently drains northeasterly towards 104th Avenue and Chambers Road, and then eastward to Second Creek, in Reed Run. The existing runoff from the remaining majority of the site generally flows to the center of the site, and then to an existing large sump, covering an area of roughly 50 acres located along the western boundary and offsite to the west. In the event that this sump were to ever overtop, the flows would flow northward to 104th Avenue, and then eastward to Second Creek, in Reed Run.

2.1.3. **Irrigation Facilities**: There are no irrigation facilities on the site.

2.2. Sub-Basin Description

2.2.1. **Historic Drainage Patterns**: Please refer to Section 2.1.2 above.

2.2.2. **Offsite Drainage**: The site has a berm along a portion of the south property line. However, the site has the potential to receive runoff from the south, directed to the southeast corner, around the east end of the berm. Due to the flatness of the land immediately south, some of this runoff may be directed west by the berm to the existing sump area west of the site. In order to be conservative, this design assumes the flow will reach the southeast corner (see basin OS1).

3. DRAINAGE DESIGN CRITERIA

3.1. Regulations

3.1.1. This drainage plan and report were designed using the City of Commerce City Storm Drainage Design and Technical Criteria Manual.

3.2. Development Criteria Reference and Constraints

3.2.1. **Previous Drainage Studies**: References for this report include the *Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems, Planning Study Update, Preliminary Design Report* by Kiowa Engineering Corporation, dated February 2004.

3.2.2. **Adjacent Drainage Studies**: none

3.2.3. **Site Constraints**: Historic and developed flows were determined using SWMM and CUHP. Water Quality Capture Volume (WQCV) will be provided and combined with the detention pond design.

XP-SWMM and CUHP was used to model the pond and offsite outfall system.

4. DRAINAGE FACILITY DESIGN

4.1. General Concept

4.1.1. **Concept and Typical Drainage Patterns**: Proposed grading will allow developed drainage patterns to match the overall historic patterns. However, instead of allowing the majority of the runoff to drain to the existing sump at the western border of the site, the grading has been designed so that runoff from all but 1.5 acres (back of lots along Altura) of the site is directed to the northeast pond and its associated storm sewer to Second Creek. This should improve the drainage situation for the neighboring property located directly to the west of this site, on which the majority of the existing sump is located.

Whereas runoff from the northeast corner of the site historically flowed overland north and east to 104th Avenue or Chambers Road, the runoff from the site will now be conveyed by a storm drainage outfall system, to Second Creek.

On-site runoff will be conveyed via surface flow or storm drains.

4.1.2. **Offsite Runoff Considerations**: The offsite basin located south of the site will be diverted via proposed culverts and a diversion swale along the eastern border of the site to the northeast corner of the site, where it will enter the proposed offsite storm sewer outfall system.

NOTE: The proposed on-site High Point drainage system is not designed for any additional offsite runoff from south of the 100th Avenue centerline. Any future development of the area south of 100th Avenue will need to direct all allowable runoff to the pipes and diversion swale along Chambers.

4.1.3. **Tables, Charts, Figures and Drawings**: The Appendix includes a Drainage Map, vicinity map, copies of the SWMM & CUHP input and output files, and Hydraflow results for the storm sewer hydraulics.

4.1.4. **Anticipated and Proposed Drainage Patterns**: (See Sections 4.1.1 and 4.1.2 above.)

4.2. Specific Details

4.2.1. **Drainage Problems and Solutions**: Two main challenges to the development of the site were the existence of the large sump located at the western boundary of the

Basins B1 and B2 drain to DP 2, with runoff from these basins approaching the inlet from the west and east sides, respectively. At DP2, the runoff from these basins in combined with the runoff from Basins C1, C2, D, E, F, G, and H.

Basin A drains to DP1, where it is combined with the runoff from Basins B1, B2, C1, C2, D, E, F, G, and H.

From DP1, the runoff is conveyed by pipe into the detention/WQ area. A small amount (5 cfs) will exceed the inlet capacity and overtop into the pond. Riprap is provided up the pond bank for overflow protection.

4.2.4.2. Eastern Diversion Swale System (modeled in SWMM):

This system conveys 100-year offsite flows around the eastern boundary of the site.

Runoff from off-site Basin OS1 is captured in a proposed flared end section located at the southwest corner of Chambers Road and 100th Avenue, and then conveyed northward under 100th Avenue to the proposed Type R inlet located at the northwest corner of the same street intersection. The flared end section is set down to a depth that will allow the low point in Chambers, approximately 1800 feet south, to drain north when the future widening of the west side of Chambers occurs.

Runoff from Basin N1 is captured in the inlet at the northwest corner of the Chambers and 100th Avenue intersection, where it is combined with the runoff from Basin OS1. From this junction, the flows are conveyed by pipe to the proposed north-south diversion swale located along the eastern boundary of the site.

The runoff then travels northward in the diversion swale and through a proposed culvert at the intersection of Chambers Road and the 101st Avenue site entrance.

The runoff then continues northward in the diversion swale to the northeasternmost corner of the site, where it enters the proposed outfall drainage system and also combines with the stormwater flows released from the on-site detention/WQ area.

4.2.5. **Proposed Off-Site Drainage Outfall to Second Creek** (modeled in SWMM):

This system conveys the flows from the above two systems to Second Creek. Flows from the pond outfall and the eastern diversion swale are

BASIN N4	AREA (sf)	C2	C5	C100	% IMPERV
RESIDENTIAL	0	0.40	0.45	0.60	45
STREETS (PAVED)	57172	0.87	0.88	0.93	100
ROOFS	0	0.80	0.85	0.90	90
DRIVES AND WALKS	0	0.87	0.87	0.88	96
PARKS	0	0.10	0.10	0.60	7
LAWNS (CLAYEY)	19057	0.05	0.10	0.40	0

AREA INCL FUTURE CHAMBERS WIDENING

C2= 0.67
C5= 0.69
C100= 0.80

Total Basin Area
1.75 ac
Basin Impervious
75%

PROP. HOGAN DEV.	AREA (sf)	C2	C5	C100	% IMPERV
RESIDENTIAL	449811	0.40	0.45	0.60	45
COMMERCIAL	305020	0.87	0.87	0.89	95
ROOFS	0	0.80	0.85	0.90	90
DRIVES AND WALKS	0	0.87	0.87	0.88	96
PARKS	0	0.10	0.10	0.60	7
LAWNS (CLAYEY)	0	0.05	0.10	0.40	0

AREA INCL. FRONTERRA "B" LOTS

C2= 0.59
C5= 0.62
C100= 0.72

Total Basin Area
17.33 ac
Basin Impervious
65%

OS1	AREA (sf)	C2	C5	C100	% IMPERV
RESIDENTIAL		0.40	0.45	0.60	45
STREETS (PAVED)	76080	0.87	0.88	0.93	100
ROOFS		0.80	0.85	0.90	90
DRIVES AND WALKS	0	0.87	0.87	0.88	96
PARKS		0.10	0.10	0.60	7
LAWNS (CLAYEY)	965000	0.05	0.10	0.40	0

AREA INCL FUTURE CHAMBERS WIDENING

C2= 0.11
C5= 0.16
C100= 0.44

Total Basin Area
23.90 ac
Basin Impervious
7%

OS2	AREA (sf)	C2	C5	C100	% IMPERV
RESIDENTIAL		0.40	0.45	0.60	45
STREETS (PAVED)	126423	0.87	0.88	0.93	100
ROOFS		0.80	0.85	0.90	90
DRIVES AND WALKS	0	0.87	0.87	0.88	96
PARKS		0.10	0.10	0.60	7
LAWNS (CLAYEY)	1920897	0.05	0.10	0.40	0

AREA INCL FUTURE CHAMBERS & 104TH WIDENING

C2= 0.10
C5= 0.15
C100= 0.43

Total Basin Area
47.00 ac
Basin Impervious
6%

CUHP & SWWM MODEL AND RESULTS

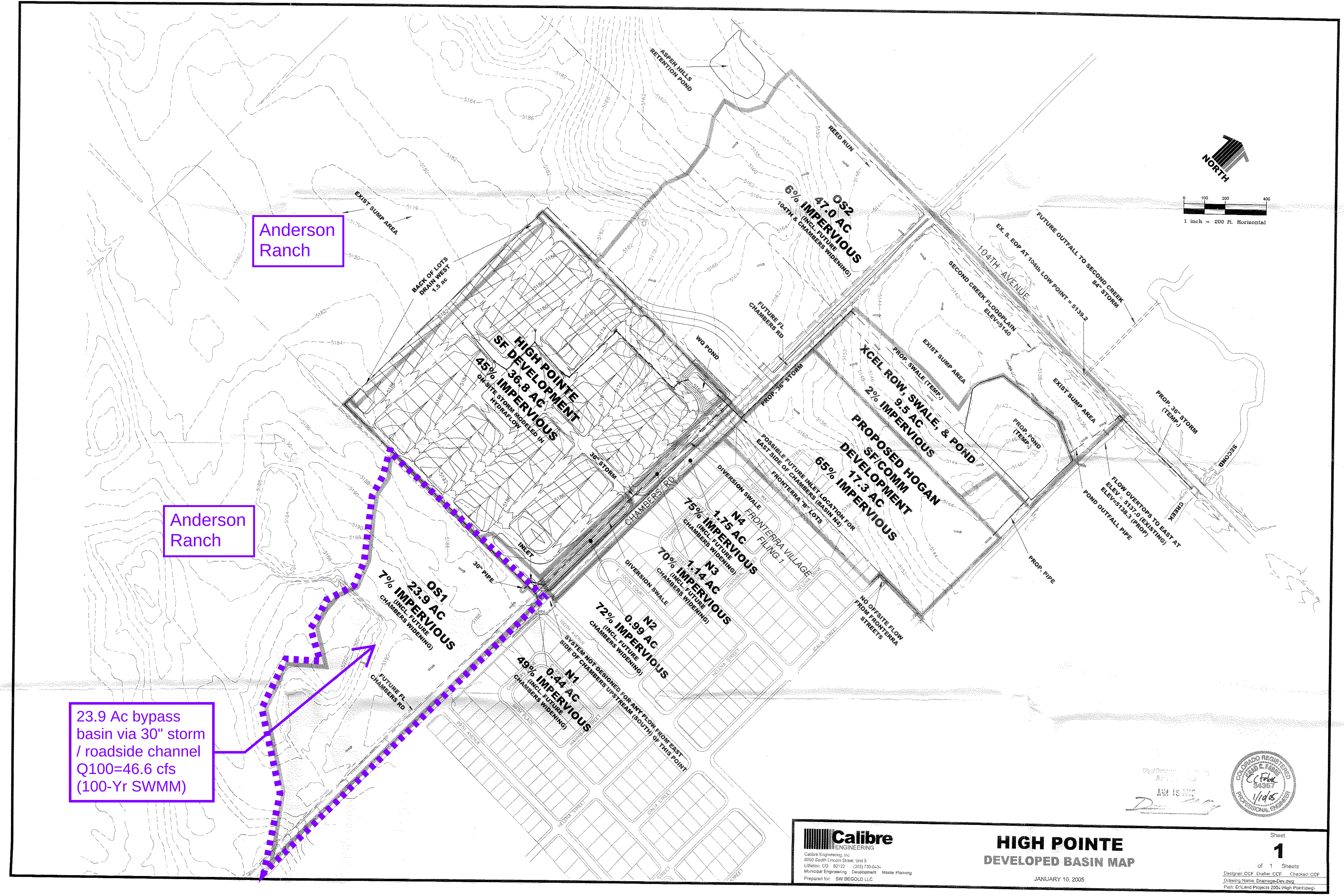
Basin OS1

52.6 cfs Max to 30" pipe, per CUHP model

```
U.D.F.C.D. CUHP RUNOFF ANALYSIS     EXECUTED ON DATE 11/ 1/2004 AT TIME  7:58

 CUHPF/PC RELEASE 2A (32-BIT VER) SEPTEMBER 10, 1998

 PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS  2

 High Pointe

 BASIN ID: OS1     --  BASIN COMMENT:

 AREA  LENGTH OF BASIN  DIST TO CENTROID  IMPERV. AREA  SLOPE  UNIT DURATION
(SQMI)      (MI)              (MI)            (PCT)     (FT/FT)     (MIN)

0.04       0.32              0.11              7.00     0.0100      5.00

                  COEFFICIENT                        COEFFICIENT
          (REFLECTING TIME TO PEAK)   (RELATED TO PEAK RATE OF RUNOFF)

                     0.137                               0.184

 THIS BASIN USES TRADITIONAL DRAINAGE PRACTICES

          FRACTION OF PERVIOUS          FRACTION OF IMPERVIOUS
            AREA RECEIVING              AREA DIRECTLY CONNECTED
          IMPERVIOUS DRAINAGE           TO DRAINAGE SYSTEM
              ( DEFAULT )                     ( DEFAULT )
                R= 0.07                       D=   0.14

                             CALCULATED UNIT HYDROGRAPH

   TIME TO PEAK  TIME OF CONCENTRATION  PEAK RATE OF RUNOFF  UNIT HYDROGRAPH PEAK  VOLUME OF RUNOFF
     (MIN)               (MIN)              (CFS/SQMI)              (CFS)              (AF)

      7.50               20.00               1411.16                52.64              1.99

   *** NOTE : THE TIME TO PEAK IS CALCULATED BASED ON THE TIME OF CONCENTRATION PROVIDED BY THE USER,
              REPLACING THE ONE COMPUTED BY CUHPF (TP=  7.48)

   WIDTH AT 50 =  21. MIN.   WIDTH AT 75 =  11. MIN.  K50 =0.21  K75 =0.29

             RAINFALL LOSSES INPUT W/ BASIN DATA

   MAX. PERVIOUS RET. =0.35 IN.    MAX. IMPERVIOUS RET. =0.05 IN.
 INFILTRATION = 4.50 IN./HR.   DECAY = 0.00180/SECOND    FNINFL = 0.60 IN./HR.

  TIME        UNIT       |    TIME       UNIT       |    TIME       UNIT       |
           HYDROGRAPH    |            HYDROGRAPH    |            HYDROGRAPH    |
                         |                          |                          |
                         |                          |                          |
   0.             0.     |    25.          26.      |    50.          12.      |
   5.            45.     |    30.          22.      |    55.          11.      |
  10.            48.     |    35.          19.      |    60.           9.      |
  15.            39.     |    40.          17.      |    65.           8.      |
  20.            33.     |    45.          14.      |    70.           0.      |
1           BASIN ID:  OS1      --  BASIN COMMENT:

 **** STORM NO. =    1   ****      DATE OR RETURN PERIOD = 100-yr

         TOTAL PRECIP. =   2.98 (1-HOUR RAIN =   2.58)      EXCESS PRECIP. = 1.494  INCHES
         VOLUME OF EXCESS PRECIP =     2.97   ACRE-FEET
         PEAK Q =     47. CFS        TIME OF PEAK =    40. MIN.
         INFILT.= 4.50 IN/HR      DECAY =0.00180     FNINF = 0.60 IN/HR
         MAX.PERV.RET.=0.35 IN.      MAX.IMP.RET.=0.05 IN.

         RATIONAL FORMULA C =        0.50
                          I =        5.1 INCHES/HOUR
                          A =       23.9 ACRES
                          Q =        61. CFS
```

```
           pipe     44.3168 678160.0449         9.0350        173.5857   ##               OS1  5180.0000      5185.1812
      WQorifice      0.4883  15813.5476        10.8457         15.4703   ##               N12  5156.9900      5167.4672
           WEIR     63.1983 234783.8187         0.0000          0.0000   ##             N10.1  5140.4900      5142.5098
       FREE # 1     47.1518 800282.8617         0.0000          0.0000   ##

*====================================================*
|     Table E15a - SPREADSHEET REACH LIST             |
| Peak flow and Total Flow listed by Reach or those  |
|          conduits or diversions having the same     |
|          upstream and downstream nodes.             |
*====================================================*

       Upstream        Downstream     Maximum          Total
           Node              Node        Flow           Flow
                                        (cfs)         (ft^3)

--------------- ---------------- ----------     ----------
           N2.2              N2.1     47.1540     800114.160
            OS2              N2.2     47.1393     799879.755
          HOGAN              POND     70.1239     140815.048
            N10             N10.1     85.2141     458789.308
            N11                N4     82.0630     435336.924
            N2A                N3     42.6362     164688.023
           N2.1           OUTFALL     47.1519     800236.094
           N4.1               OS2     44.3125     678377.807
             N4           N11.1.1     85.2148     458791.368
             N3               N11     46.2274     184983.110
        N11.1.1               N10     85.2149     458757.001
             N2               N2A     42.6476     164375.240
            N1A                N2     47.4636     147258.357
             N1               N1A     47.8316     145744.489
            OS1                N1     46.5955     134984.550
            N12               N11     62.6883     250819.777
          N10.1              POND     85.6451     450660.532
           POND              N4.1     44.3168     678160.045
             HP               N12     63.2684     250597.366

#########################################################
# Table E16. New Conduit Information Section            #
#            Conduit Invert (IE) Elevation and Conduit  #
#            Maximum Water Surface (WS) Elevations      #
#########################################################

   Conduit Name   Upstream Node Downstream Node     IE Up     IE Dn     WS Up     WS Dn  Conduit Type
--------------- ---------------- ---------------- --------- --------- --------- --------- -------------
             L2            N2.2             N2.1 5133.2200 5131.6400 5136.4716 5134.4761 Circular
             L3             OS2             N2.2 5135.1800 5135.0400 5138.3000 5137.2749 Circular
             L6           HOGAN             POND 5142.3000 5139.3000 5144.9446 5141.9297 Circular
             L7             N10            N10.1 5140.6300 5140.4900 5143.0767 5142.5098 Circular
            L10             N11               N4 5156.4100 5155.7000 5167.1553 5164.3272 Circular
            L16             N2A               N3 5176.1000 5164.4000 5177.1675 5168.1719 Trapezoid
             L1            N2.1          OUTFALL 5131.6400 5131.0000 5134.4761 5133.2352 Circular
             L4            N4.1              OS2 5136.0000 5135.1800 5138.3851 5138.3000 Trapezoid
             L9              N4          N11.1.1 5155.6000 5154.7000 5164.3272 5157.5032 Circular
            L15              N3              N11 5164.4000 5164.0000 5168.1719 5167.1553 Circular
             L8         N11.1.1              N10 5142.5100 5140.6300 5149.7946 5143.0767 Circular
            L17              N2              N2A 5176.6000 5176.1000 5180.9921 5177.1675 Circular
            L22             N1A               N2 5179.5000 5176.6000 5181.3060 5180.9921 Trapezoid
            L23              N1              N1A 5179.7600 5179.5000 5183.4710 5181.3060 Circular
            L24             OS1               N1 5180.0000 5179.7600 5185.1809 5183.4711 Circular
            L11             N12              N11 5157.0000 5156.6100 5167.4672 5167.1553 Circular
           L7.1           N10.1             POND 5140.4900 5137.7700 5142.5098 5139.9849 Trapezoid
           pipe            POND             N4.1 5136.1200 5136.0000 5139.9849 5138.3851 Circular
      WQorifice              HP              N12 5157.0000 5156.9900 5167.5030 5167.4672 Circ Orif
```

46.6 cfs max Q for Basin OS 1 in 100-yr SWMM Model



JAN 19 2005

34357
1/10/05

Calibre ENGINEERING

Calibre Engineering, Inc.
8060 South Lincoln Street, Unit 5
Littleton, CO. 80122 (303) 730-0434
Municipal Engineering Development Master Planning
Prepared for: SW BEGOLD LLC

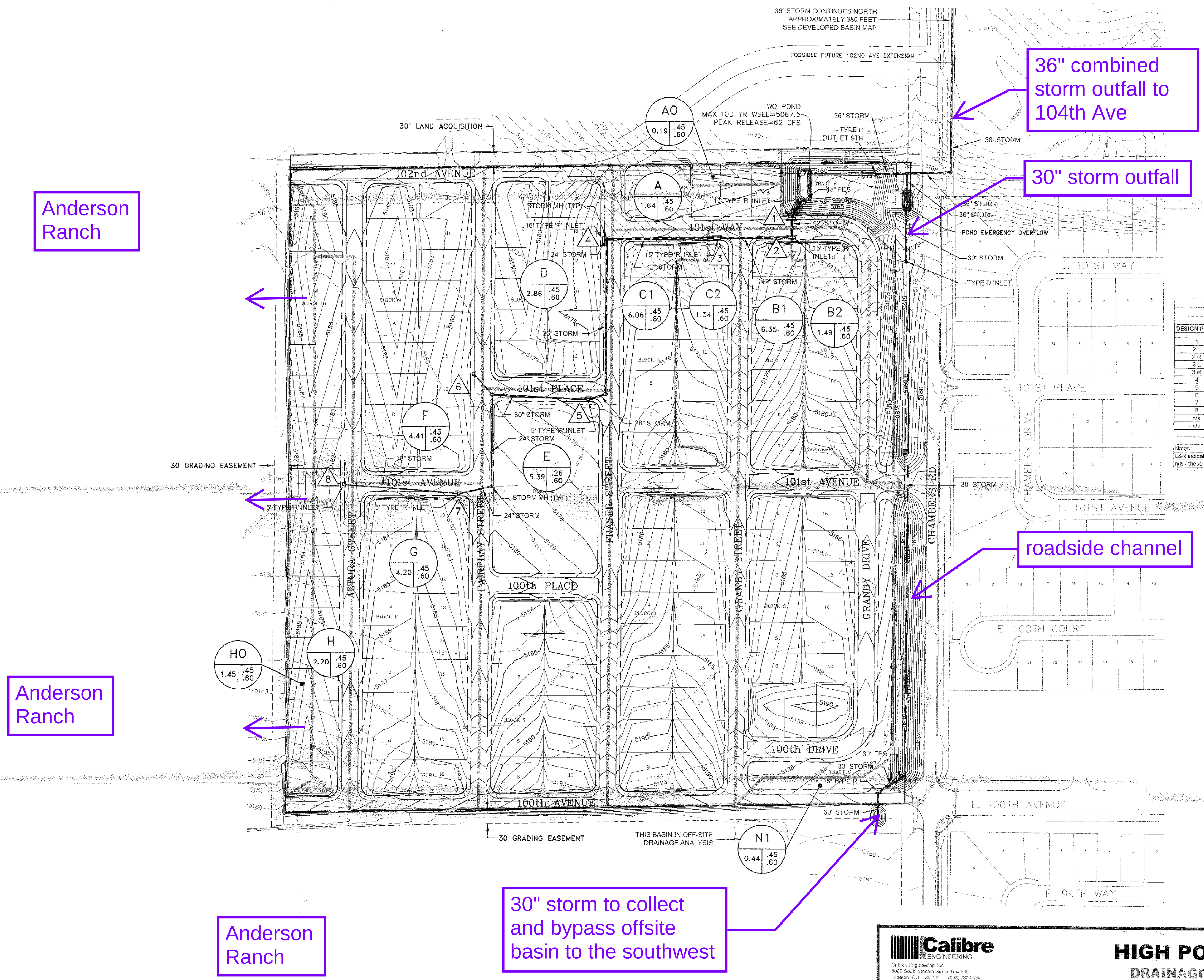
HIGH POINTE

DEVELOPED BASIN MAP

JANUARY 10, 2005

Sheet
1
of 1 Sheets

Designer: CCF Drafter: CCF Checked: CCF
Drawing Name: Drainage-Dev.dwg
Path: D:\Land Projects 2004\High Point\dwg\



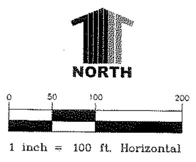


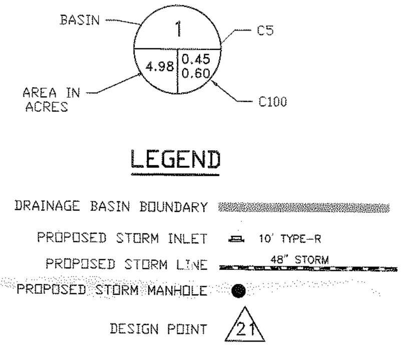
Table II

Calculated Peak Flows for Basins

HIGH POINTE (Commerce City)

DESIGN POINT	BASIN NO.	AREA (acres)	C5	C100	Tc (min)	I5	I100	Q5 (cfs)	Q100 (cfs)
1	A	1.64	0.45	0.60	9.0	3.9	7.4	2.9	7.2
2 L	B1	6.35	0.45	0.60	17.3	3.0	5.6	8.5	21.3
2 R	B2	1.49	0.45	0.60	13.0	3.4	6.3	2.3	5.6
3 L	C1	6.06	0.45	0.60	18.9	2.9	5.4	7.8	19.7
3 R	C2	1.34	0.45	0.60	12.3	3.4	6.5	2.1	5.2
4	D	2.86	0.45	0.60	14.7	3.2	5.9	4.1	10.2
5	E	5.39	0.26	0.60	16.1	3.0	5.7	4.3	18.6
6	F	4.41	0.45	0.60	14.2	3.2	6.0	6.4	16.0
7	G	4.20	0.45	0.60	14.6	3.2	6.0	6.0	15.0
8	H	2.20	0.45	0.60	13.1	3.4	6.3	3.3	8.3
n/a	AO	0.19	0.45	0.60	5.0	4.8	9.0	0.4	1.0
n/a	HO	1.45	0.45	0.60	6.0	4.6	8.6	3.0	7.5

Notes:
L&R indicate left and right side of inlet. Only shown where street capacities must be checked from each direction
n/a - these basins drain offsite



LEGEND

DRAINAGE BASIN BOUNDARY	▨
PROPOSED STORM INLET	10' TYPE-R
PROPOSED STORM LINE	48" STORM
PROPOSED STORM MANHOLE	●
DESIGN POINT	△ 21

JAN 15 2005

CHAD C. FABER
34357
1/10/05

Calibre ENGINEERING
Calibre Engineering, Inc.
8000 South Lincoln Street, Unit 206
Littleton, CO. 80122 (303) 730-0434
Municipal Engineering Development Master Planning
Prepared for: SW BEGOLD LLC

HIGH POINTE

DRAINAGE MAP

JANUARY 10, 2005

Sheet
1
of 1 Sheets
Designer: CCF Drafter: CCF Checked: CCF
Drawing Name: Drainage-HP.dwg
Path: D:\Land Projects 2004\High Point\dwg\

Excerpts from Final Drainage Report
for 104th Ave Corridor Improvements

FINAL DRAINAGE STUDY
for
104TH AVENUE CORRIDOR IMPROVEMENTS PHASE 2

Prepared for:

City of Commerce City
8602 Rosemary Street
Commerce City, Colorado 80022
Attn: Glenn Ellis

City of Commerce City Engineering
APPROVED
AUG 10 2007

Prepared By:

JR ENGINEERING, L.L.C.
6020 Greenwood Plaza Boulevard
Englewood, Colorado 80111
(303) 740-9393
Contact: Aaron Clutter

Project Number 15280.00
Revised June 15, 2007
April 20, 2007

The site is located in the Second Creek and Direct Flow Area 0053 drainage basins. The existing and proposed subdivisions adjacent to this section of 104th Avenue have been covered by three Outfall Systems Planning studies that determined the overall storm drainage system for the basin. The "Second Creek and Direct Flow Area 0053 Outfall Planning Study Preliminary Design," May, 1990 (1990 OSP), "Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning Study Update Alternatives Development and Evaluation Report," October, 2002 (2002 OSP), and "Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning Study Update Preliminary Design Report," August, 2004 (2004 OSP), all three reports were prepared by Kiowa Engineering Corporation. The existing and proposed properties adjacent to 104th Avenue have utilized one or more of the OSP reports depending on the timing of their respective drainage reports.

In 104th Avenue, Blackhawk Street is the separating line between the Second Creek and the DFA 0053 drainage basins. As indicated in the 2004 OSP, the DFA 0053 area is to drain northwesterly via proposed channels to designated future regional detention facilities adjacent to SH-2, I-76 and US-85 before being released under these roadways to continue northwesterly in their respective proposed channels to the South Platte River. The Second Creek area is to drain northeasterly through Water Quality facilities on individual sites or through proposed regional water quality facilities prior to discharging into Second Creek. Second Creek flows northwesterly through designated future regional detention facilities adjacent to Chambers Road and 112th Avenue before being released under these roadways to continue northwesterly in a proposed improved channel to the South Platte River.

According to the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map (FIRM) number 08001C0075 G, dated August 16, 1995, a portion of 104th Avenue at Second Creek is located in Zone A, which is within a 100-year floodplain with "no base flood elevations determined" (see Figure 3). Included in this phase of improvements for 104th Avenue is a replacement bridge structure over Second Creek. A CLOMR was prepared for this replacement bridge structure over Second Creek at 104th Avenue. The CLOMR has been submitted to FEMA and assigned Case No.07-08-0081R.

There are no irrigation facilities within 100 feet of the 104th Avenue improvements.

Sub-Basin Descriptions

A

B

This Phase 2 section of 104th Avenue has been broken down into five outfalls. Four of these five outfalls are associated with water quality ponds proposed with this 104th Ave. Phase 2 project. The five outfalls are: Potomac Farms Retention/Detention Pond, Sable Water Quality Pond, Chambers Water Quality Pond, Second Creek West Water Quality Pond and Second Creek East Water Quality Pond.

C

D

Basin A consists of approximately 14.5 acres divided into 21 sub-basins (A1a through A17b) and includes 104th Ave. from the west end of the project to Blackhawk Street. Runoff from Basin A drains to two outfalls. The major outfall is at Uvalda Street where the 104th Avenue storm drain system will tie into an existing storm drain system at Potomac Farms. The Potomac Farms storm drain system outfalls into an existing retention pond. The second outfall is on the south side of 104th Ave. at Vaughn Way. The street flows will outfall onto Basin F at a future proposed access, which is currently undeveloped. Detention for the portion of Basin A that outfalls into Potomac Farms will be handled at the Potomac Farms Retention Pond, which will be converted into a detention pond in the future by others.

Basin B consists of approximately 10.8 acres divided into 17 sub-basins (B1a through B10) and includes 104th Ave. from Blackhawk Street to Sable Boulevard. Basin G consists of approximately 29.2 acres, and outfalls east into the 104th Ave. storm drain system through a detention facility (to be provided at the time of development). Basin H is partially developed (Foxton Village Filing 1, existing single-family residential, and Foxton Village Filing 2, future multi-family residential) and consists of approximately 73.8 acres, and outfalls into the 104th Ave. storm drain system. Basin I is the South Adams County Water and Sanitation District's (SACWSD) Sable Pump Station. Basin I consists of approximately 4.1 acres. Currently some of the runoff from Basin I flows onto 104th Ave., some into Foxton Filing No. 2 via a culvert under Sable Blvd. and the remainder enters the existing retention pond. With the proposed expansion of 104th Ave. the existing pond will be converted to a detention pond by installing an outlet structure. In the future, another water tank will be added to the site and the runoff flows from the tank are assumed to be directed into the existing pond via a roof drain system and will be included in the design calculations for the detention pond size and outlet structure. Basin T is currently farmland with future mixed-use designation. Basin T consists of approximately 148.0 acres and will in the future outfall into the Sable storm drain system. Basin U is currently farmland with no future designation. Basin U consists of approximately 20.0 acres and will in the future outfall into the Sable storm drain system. The runoff from Basins B, G, H, and I will be collected in the 104th Ave. storm drain system where it will outfall into the temporary channel at Sable Blvd. The temporary channel will collect runoff from Basins T and U and will outfall into the Sable Water Quality Pond. The 112th Avenue Regional Detention Pond will provide detention for Foxton Village Filing 2 and Basins B, T and U.

Basin C consists of approximately 24.7 acres divided into 27 sub-basins (C1a through C22), which includes 104th Ave. from Sable Blvd. to Chambers Road. It also includes Chambers Rd. from the High Pointe site on the south side of 104th Ave. to Second Creek on the north side of 104th Ave. Basin J, Aspen Hills Residential, is currently developed as multifamily residential. Basin J consists of approximately 11.9 acres, and outfalls into the 104th Ave. storm drain system, through an existing detention pond. Basin K is currently undeveloped with no future designation. Basin K consists of approximately 125.0 acres, and will outfall northeast into Altura St. through a future detention facility (to be provided at the time of development), which will tie into the 104th Ave. storm drain system in the future. Basin L, Aspen Hills Commercial, is currently undeveloped with plans for future commercial development. Basin L consists of approximately 21.6 acres, and outfalls north into the 104th Ave. storm drain system. Basin M is currently undeveloped with no future designation. Basin M consists of 12.6 acres, and will outfall into Chambers Rd. through a future detention facility (to be provided at the time of development) which ties into the 104th Ave. storm drain system in the future. Basin R is currently undeveloped with a future designation for mixed-use development. Basin R consists of approximately 19.9 acres, and outfalls to the east into the 104th Ave. storm drain system in Chambers Rd. The runoff from Basins C, J, K, L, M, and R will be collected in the 104th Ave. storm drain system where it will outfall into the Chambers Road Water Quality Pond. Basin V is currently undeveloped with no future designation. Basin V consists of approximately 13.2 acres, and outfalls to the north directly into the Chambers Road Water Quality Pond forebay. The sub-basins that flow to future low point sump inlets in Chambers Road (sub-basins C19, C20, C21, and C22) will outfall west directly into the Chambers Road Water Quality Pond forebay. The 112th Avenue Regional Detention Pond will provide detention for Basins C, L, R, and V.

Basin D consists of approximately 6.3 acres divided into 10 sub-basins (D1 through D6), which includes 104th Ave. from Chambers Rd. to Second Creek. Basin O is currently undeveloped with no future designation. Basin O consists of approximately 23.9 acres, and outfalls to the north into the High Pointe site through a future detention facility (to be provided at the time of development) per the High Pointe drainage report. Basin N, High Pointe, is currently developed with single family residential. Basin N consists of approximately 37.2 acres, and outfalls to the northeast into the North Range Town Center site through an existing detention pond. Basin Q, Hogan Residential, is currently undeveloped with future plans of residential development. Basin Q consists of approximately 17.3 acres, and outfalls to the northeast into the North Range Town Center. Basin P, North Range Town Center, is currently under construction for commercial development. Basin P consists of approximately 22.8 acres, and outfalls north into the 104th Ave. storm drain system. The runoff from basins D, N, O, P, and Q will be collected in the 104th Ave, storm drain system where it will outfall into the Second Creek West Water Quality Pond. Detention will be provided at the future planned regional detention facility east of Chambers Rd. for Basins D, P, and Q.

Basin E consists of approximately 20.2 acres divided into 15 sub-basins (E1 through E15), which includes 104th Ave. from Second Creek to Landmark Drive. Basin W consists of 81.0 acres that includes portions of currently developed Reunion Phase 1, Filings 1, 2 and 3 (single-family residential) and the improved section of 104th Avenue adjacent to Reunion Phase 1. Basin W outfalls into the existing 104th Ave. storm drain system. Runoff from Basins E and W will be collected in the existing 104th Ave. storm drain system and the existing outfall directly into Second Creek will be eliminated replacing it with an outfall further east into the Second Creek East Water Quality Pond. Detention will be provided at the future planned regional detention facility east of Chambers Rd. for Basins E and W.

Within Basin E there are three sites (Basins E12, E13 & E14) that have a potential to redevelop in the future. The developed condition is assumed to be commercial for conservative design and runoff flows from these future sites are included the storm drain system design for Basin E.

Basin F is currently an undeveloped parcel with a mixed-use designation. Basin F consists of approximately 64.4 acres, and outfalls west into the Turnberry Meadows Project.

Basin S is currently undeveloped with no future designation. Basin S consists of approximately 47.2 acres, and will outfall into Second Creek. Water Quality will need to be provided on-site, however detention may be provided at the future planned regional detention facility east of Chambers Road.

DRAINAGE DESIGN CRITERIA

Regulations

Storm drainage analysis and design criteria used for this project was taken from the "Storm Drainage Design and Technical Criteria Manual" by the City of Commerce City and the "Urban Storm Drainage Criteria Manual (USDCM)" by Urban Drainage and Flood Control District.

Development Criteria Reference and Constraints

The project area is part of the Second Creek and DFA 0053 Outfall Systems Planning drainage studies mentioned previously. The proposed plan takes into account the OSP planned facilities, the Potomac Farms Subdivision existing drainage facilities and planned future detention pond (currently a retention pond), the Foxton Village (Filings 1 and 2) development and planned detention pond release rates (Filing 1 currently utilizes a retention pond on the Filing 2 site), the Aspen Hills Residential Subdivision development and existing detention pond release rates, the North Range Town Center Subdivision development and planned release rates that include the High Pointe and Hogan Residential Subdivisions storm drainage releases piped into this site, the developed portion of 104th Avenue east of Basin E existing release rates that include the Reunion Phase 1 Subdivision development Filings 1, 2 and 3 storm drainage releases piped into the 104th Avenue drainage system, and the Buffalo Mesa Subdivision development existing releases onto 104th Avenue.

Basins G, K, L M, T, U, and V do not have any preliminary designs at this time. Therefore, the discharge rates from these basins will be based on the 100-year historical (undeveloped) condition (Basin G), the 100-year developed condition (Basin L), or the 5-year developed condition (Basins K and M), which is approximately equivalent to the 100-year historical rate for these hydrological class B soils. The discharge rate for Basin O was determined (100-year historical) and accounted for in the storm drain system design for the High Pointe Subdivision. The discharge rate for Basins T and U were determined (100-year developed *residential) and* accounted for in the Sable Water Quality Pond design. The discharge rate for Basin V was determined (100-year developed commercial) and accounted for in the Chambers Road Water Quality Pond design. Therefore, Basins G, K, M and O will be detained releases into the storm drain system, *and Basins L, T, U, and V will be undetained* releases into the 104th Ave. storm drain system (see Water Quality Exhibits).

Hydrologic Criteria

The Rational Method was used for the site hydrology. Rainfall data and runoff coefficients were obtained from the Commerce City Criteria Manual. The 5-year runoff was analyzed as the minor storm and the 100-year runoff was analyzed as the major storm. Peak flow rates, times of concentration for runoff and detention pond release rates were used per their respective drainage reports for Foxton Village (Filings 1 and 2), Aspen Hills Residential Subdivision, the North Range Town Center Subdivision which includes the High Pointe and Hogan Residential Subdivisions storm drainage releases piped into this site, the developed portion of 104th Avenue east of Basin E existing release rates which includes the Reunion Phase 1 Subdivision development Filings 1, 2 and 3 storm drainage releases piped into the 104th Avenue drainage system, and the Buffalo Mesa Subdivision development existing releases onto 104th Avenue.

the access point into the North Range Town Center. The placement of the access points into the North Range Town Center also limited the placement of the inlets along 104th Ave.

The third area of concern is at DP-58B, which is on the south side of 104th Ave. at Kittredge Dr. The open lane width is 10.6' with a corresponding depth of 0.3" at the edge of the 11' lane. This is due to the inability to effectively locate an inlet upstream of the design point in question. The effective placement would either create a larger construction cost, or would be hydraulically inefficient.

DRAINAGE FACILITY DESIGN

General Concept

As discussed previously, the site is located in the Second Creek and DFA 0053 drainage basins that discharge to the northwest into the South Platte River. In 104th Avenue, Blackhawk Street is the separating line between the Second Creek and the DFA 0053 drainage basins. As indicated in the 2004 OSP, the DFA 0053 area is to drain northwesterly via proposed channels to designated future regional detention facilities adjacent to SH-2, I-76 and US-85 before being released under these roadways to continue northwesterly in their respective proposed channels to the South Platte River. The Second Creek area is to drain northeasterly through Water Quality facilities on individual sites or through proposed regional water quality facilities prior to discharging into Second Creek. Second Creek flows northwesterly through designated future regional detention facilities adjacent to Chambers Road and 112th Avenue before being released under these roadways to continue northwesterly in a proposed channel to the South Platte River.

Basins A, F and G are designated in the DFA 0053 drainage basin and are to drain northwesterly across 104th Avenue to detention areas adjacent to SH-2. Basins B through D and H through Q are designated in the Second Creek drainage basin and are to drain northerly across 104th Avenue to Second Creek. Basin E is designated in the Second Creek drainage basin and is to drain west in 104th Avenue to Second Creek. As mentioned previously, storm runoff from these basins will either pass through water quality facilities on their respective sites or through regional water quality facilities prior to discharging into Second Creek.

The five Basins (A through E) that cover 104th Avenue take into account the areas adjacent to the roadway that drain onto the roadway from the existing and proposed developments and the side roads. The storm drainage system was designed for the ultimate build out of 104th Avenue, the side roads and the planned & future anticipated runoff flows from the various parcels on the south side of 104th Avenue.

Those parcels that have existing detention facilities, Foxton Village Filing 1, Aspen Hills Residential and High Pointe, should maintain these facilities. However, with Commerce City's recently approved drainage policy within the Second Creek drainage basin that permits undetained discharges from developments to Second Creek and requires that the developer pay a drainage impact fee for use by the City to pay for regional drainage improvements. Those undeveloped developments adjacent to 104th Avenue should have the option to construct or not construct detention facilities on their respective sites. This would apply to

Basin H (Foxton Village Filing 2 only), Basin L (Aspen Hills Commercial), Basin R, and Basin P (North Range Town Center) including those flows piped into this Basin from Basin N (High Pointe), Basin O, and Basin Q (Hogan Residential). Those developments that are adjacent to Second Creek can discharge undetained flows directly into the regional water quality ponds adjacent to Second Creek. However, those developments that are removed from Second Creek have the option of constructing on-site detention to reduce their sites discharge to detained flows or pay the upsizing costs for the drainage system that will transport their sites undetained discharges to the regional water quality ponds adjacent to Second Creek.

It is recommended that undeveloped Basins K and M, which are not immediately adjacent to 104th Avenue, storm runoff flows be detained on-site and the major storm release rate be restricted to the minor developed runoff rate that is approximately equal to the historical runoff rate. Runoff flows, detained and released at historic rates, from the undeveloped Basin O have already been accounted for in the High Pointe Subdivision drainage report, subsequent storm drainage infrastructure construction, and is a portion of the total flows piped into Basin P—North Range Town Center.

Basin G in the DFA 0053 drainage basin will be detained on-site and the major storm release rate shall be reduced to or below the historical rate. The primary reason is due to the site being outside of Commerce City Limits. As mentioned earlier, the final drainage reports for the Potomac Farms and the North Range Village Subdivisions were both approved when the 1990 OSP was in force at the time, that indicated Basin G was to drain to a proposed storm drainage system east of Blackhawk Street, whereas the 2004 OSP indicates it is to drain into the Potomac Farms Subdivision. Both of these drainage reports did not address any storm runoff flows from south and east of the 104th Avenue and Potomac Street intersection. However, the Potomac Farms drainage report did address storm runoff flows from a 71-acre area on the south side of 104th Avenue and west of Potomac Street. In the future, the storm runoff from this area (Basin F) will be directed to the west discharging into the storm drain system that will be constructed at 104th Avenue and Revere Street for the Turnberry Meadows Project. When reviewing the existing one-foot contours for Basin G, the area tends to drain to the northwest. Potomac Farms has provided a storm drain pipeline to the south side of 104th Avenue at Uvalda Street to intercept the minor historic runoff flows from the 71-acre area while allowing excess runoff flows to overtop the existing 104th Avenue. The proposed drainage system for this phase of the 104th Avenue improvements investigated the use of this existing storm drain pipe line to pass the accumulated storm runoff from Basin A (104th Avenue roadway) and the historic discharge rates from Basin G. It was determined that the existing 30" pipe at Uvalda Street could not handle the accumulated runoff flows from both Basins A and G. Therefore, Basin G releases will be piped east to the Sable Boulevard storm drain system.

Specific Details

Throughout the entire Phase 2 project a series of on-grade and sump inlets intercept the street flows and deliver them to their respective outfalls. All sump inlets intercept 100% of the major storm reporting to them.

Storm runoff flows from Basin H will consist of detained flows from Foxton Village Filing 1 & undetained flows from Foxton Village Filing 2. Storm runoff flows from Basin I will consist of some site runoff into 104th Avenue and flows from their on-site retention/emergency reservoir overflow storage pond, which is to be converted to a detention pond, located adjacent to 104th Avenue. Storm runoff flows from Basin G will consist of detained flows. Storm runoff from Basins B, G, H and I will be combined and piped north in Sable Boulevard. The storm pipe will discharge into a temporary drainage channel approximately 400 feet north of 104th Avenue. The drainage channel will terminate in a water quality facility, Sable Water Quality Pond, on the south side of Second Creek that will discharge north into the creek. The temporary channel will collect runoff from Basins T and U. This water quality facility has been sized for the entire area of Basins B, G, H, I, T and U. The temporary drainage swale will be designed as a grass-lined channel to maintain flow velocities less than or equal to 5.0 fps and a Froude Number less than 0.50. Several temporary "drop structures" are required for grade control along the channel's length. These "drop structures" have been designed as Grouted Sloping Boulder Drops per the USDCM. A couple of variances for the design of the temporary channel and boulder drops have been requested in the Variances section of this report. In the future, when the area becomes fully developed, the drainage channel will be replaced with a permanent storm drain system.

Basin I, SACWSD Sable Pump Station, has an existing retention pond for the site's storm runoff and emergency overflow from the pump station's reservoir. The pond will be converted to a detention pond by installing an outlet structure that will restrict the minor and major storm event releases to their allowable rates (0.13 cfs/ac and 0.85 cfs/ac for the 5-yr and 100-yr releases). The structure will also help prevent the inundation of the storm drain system during a flush from the pump station reservoir or an emergency overflow event. The structure was designed for detention volumes only, not requiring water quality that is provided by the Sable Water Quality Pond. The 5-year detention volume was applied to the existing pond in order to set the top of the outlet structure. The minor storm opening in the front of the structure was then sized to accept the minor runoff flow rate. The major event was planned to overtop the outlet structure. The 100-year detention volume was used to determine the maximum water surface elevation in the major storm event to design the size of the opening in the top of the structure and the major storm release orifice plate. Both the minor storm opening and the top of the structure will be protected with trash screens.

There is one exception to the entire area of Basin B being accepted into the storm drain system that outfalls into the Sable Channel. An inlet placed at DP-23B, east of Sable Blvd., will intercept some of the street flows, however the carryover from this inlet will be collected at a sump in Basin C. The flows intercepted will be piped west to outfall into the Sable Channel.

Detained storm runoff flows from Basins J, K and M will combine with undetained flows from Basins C, L, and R and be piped north in Chambers Road to discharge west into the Chambers Road Water Quality Pond that discharges north into Second Creek. Basin V will discharge directly into this water quality facility. This water quality facility was sized for the entire area of Basins C, J, K, L, M, R, and V. The Aspen Hills Residential, Basin J, existing detention pond has a water quality feature, however the major storm release from this pond is designed to overtop the emergency overflow weir into Altura Street. An existing inlet in

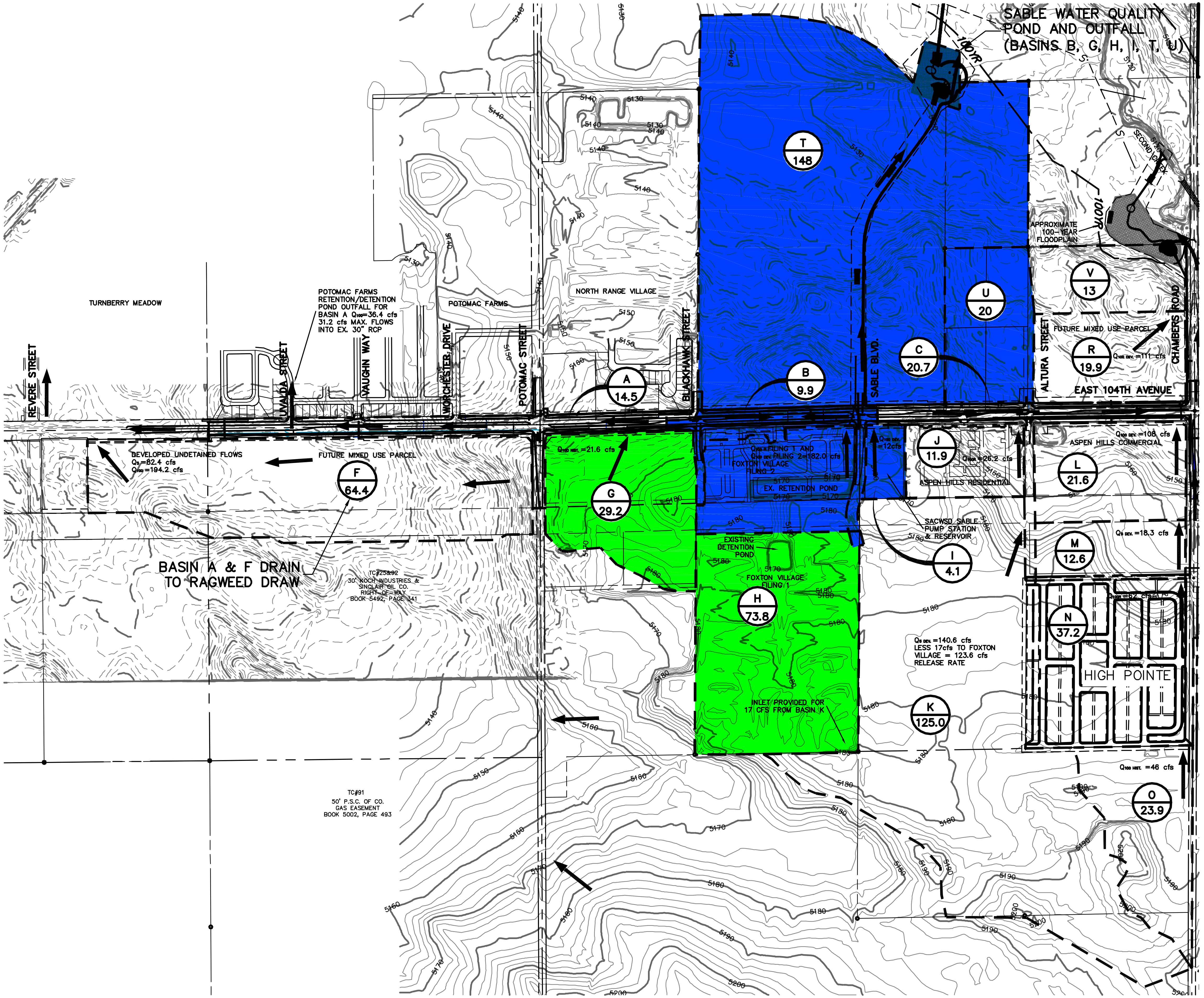
Altura Street intercepts a portion of these flows, however the bypassed flows will enter 104th Avenue. These bypassed flows when added to the street flows in 104th Avenue exceed the major storm street capacity for 104th Avenue. To eliminate this problem, the water quality feature and associated volume will be removed from the pond in order to prevent the major storm from overtopping the pond. The existing orifice plate in the existing minor storm outlet structure will be replaced to adequately restrict the minor storm release rate due to the change in the head values on the outlet structure. Another outlet structure will be added to detain and intercept the major storm in the pond. After reviewing survey information and site visits it is not known whether or not the original 100-yr overflow weir was installed. An emergency overflow weir has been designed if it is deemed necessary for the pond.

Basin R releasing undetained developed flows, the developed condition was assumed to be commercial per the Reunion PUD, has been included in the design for the storm drain system flowing north in Chambers Road. In the existing condition flows from this site will enter Chambers Road just north of 104th Ave. or pool just to the west of Chambers Road. Due to an existing waterline conflict at the sump on Chambers Road a temporary modified Type D Inlet will be placed at the sump offset from the actual road. It will be used to collect street flows from 104th Ave. as well as the flows from the existing portion of Basin R (sub-basin R-ex, see drainage map in appendix) that reports to this sump. At the time when Chambers Road is improved a permanent solution will need to be obtained to replace the temporary Type D Inlet.

Per the final drainage reports for the High Pointe and Hogan Residential subdivisions, historic discharge from Basin O, detained developed discharge from Basin N (High Pointe) and undetained developed discharge from Basin Q (Hogan Residential) will be piped into the North Range Town Center Subdivision (Basin P). These runoff flows and the undetained developed flows for Basin P are combined and piped to the northeast corner of the North Range Town Center site. These flows and the storm runoff flows from the 104th Avenue Basin D will be combined and piped to a water quality facility that will be located west of Second Creek on the north side of 104th Avenue (Second Creek West Water Quality Pond) and will discharge north into the creek. The water quality facility will be sized for Basins D, N, O, P and Q. Basin N has water quality features within its existing detention pond; however, water quality will also be provided at the regional water quality pond.

The existing undetained developed storm runoff flows from portions of Reunion Phase 1, Filings 1, 2 and 3, the undetained flows from the improved section of 104th Avenue adjacent to Reunion Phase 1 and the developed runoff flows from the 104th Avenue Basin E will be combined and piped into a water quality facility that will be located east of Second Creek on the north side of 104th Avenue (Second Creek East Water Quality Pond) and will discharge west into the creek. The water quality facility will be sized for the entire drainage area that these runoff flows are collected from.

Within Basin E there are three sites that have a potential to redevelop in the future (sub-basins E12, E13, and E14). The inlets in this area have been sized for the largest discharge into the street from the current condition of the sites. However, the pipes have been sized for developed undetained flows that would be piped from these sites. The developed condition was assumed to be commercial for conservative design.



800 400 0 800 1600

SCALE: 1" = 800'

LEGEND

🟩 ON-SITE DETENTION REQUIRED OFF SITE WATER QUALITY PROVIDED

🟦 REGIONAL DETENTION & WATER QUALITY PROVIDED (No On-Site Detention Required)

SABLE OUTFALL
DETENTION AND
WATER QUALITY EXHIBIT
104TH AVENUE
JOB NO. 15280.00
JANUARY 12, 2007
SHEET 1 OF 4

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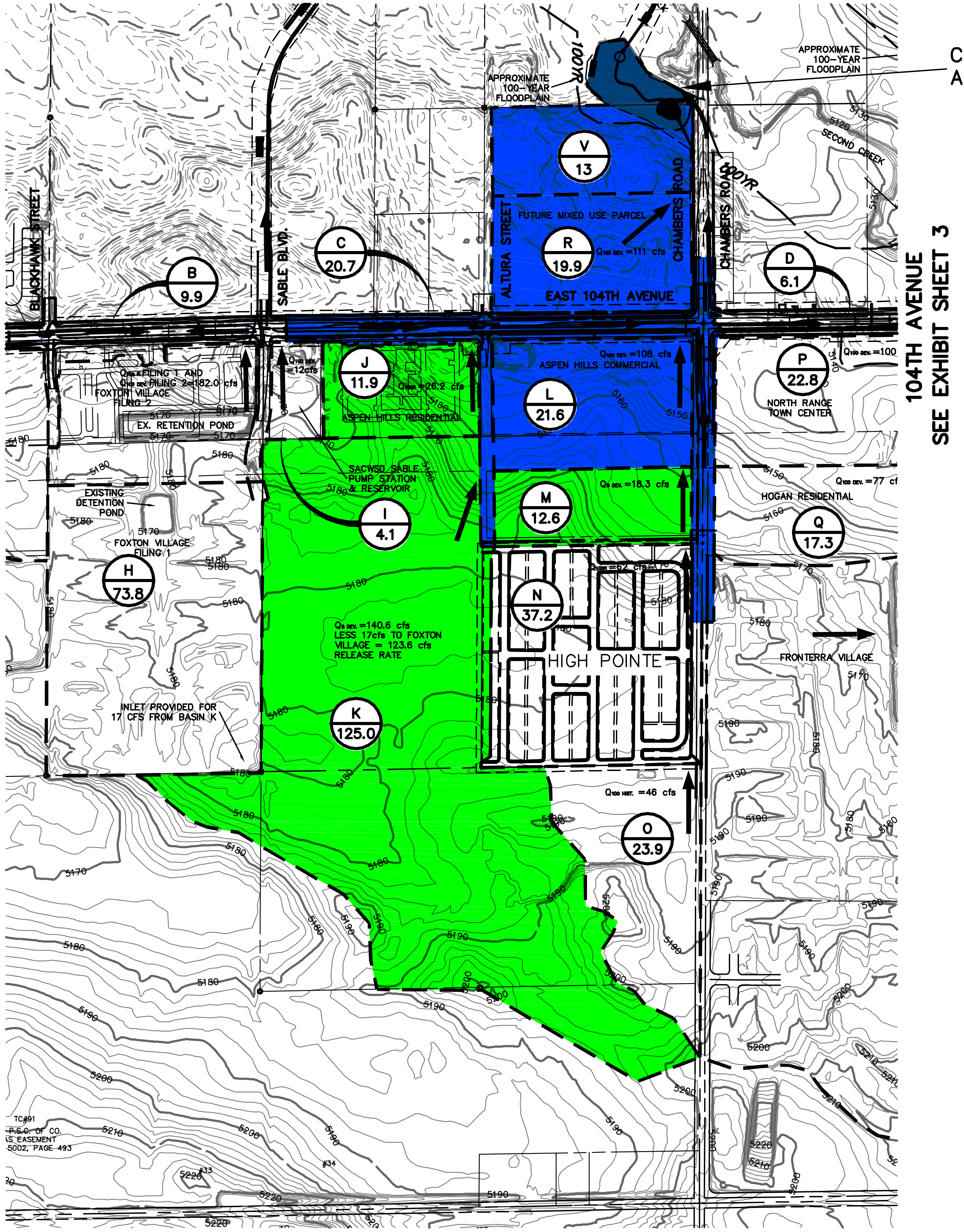

CHAMBERS WATER QUALITY POND
AND OUTFALL (BASINS C, J, K, L, M, R, V)

N

800 400 0 800 1600

SCALE: 1" = 800'

LEGEND

🟩 ON-SITE DETENTION REQUIRED
OFF SITE WATER QUALITY
PROVIDED

🟦 REGIONAL DETENTION & WATER
QUALITY PROVIDED
(No On-Site Detention Required)

CHAMBERS OUTFALL
DETENTION AND
WATER QUALITY EXHIBIT
104TH AVENUE
JOB NO. 15280.00
JANUARY 12, 2007
SHEET 2 OF 4

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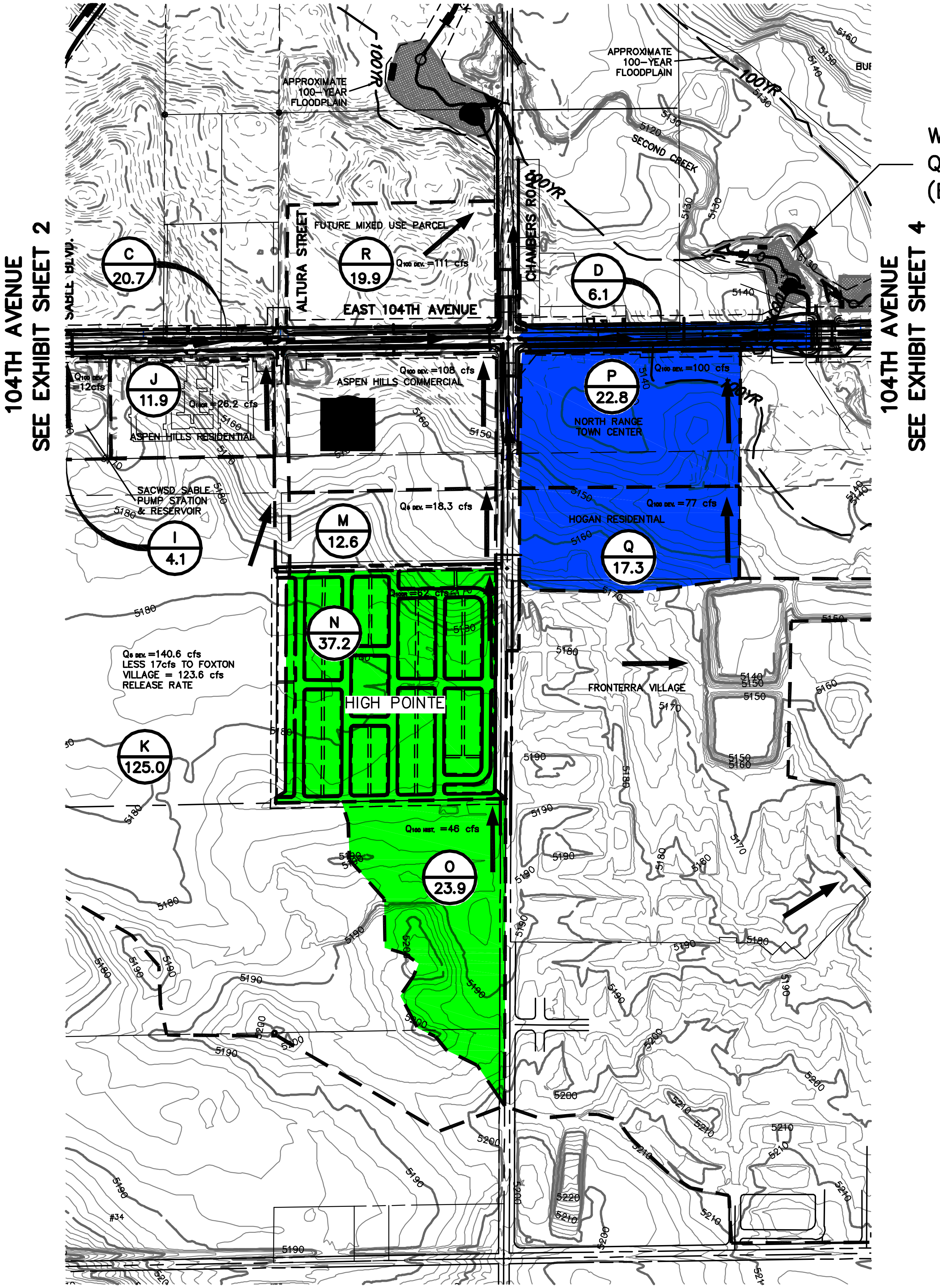
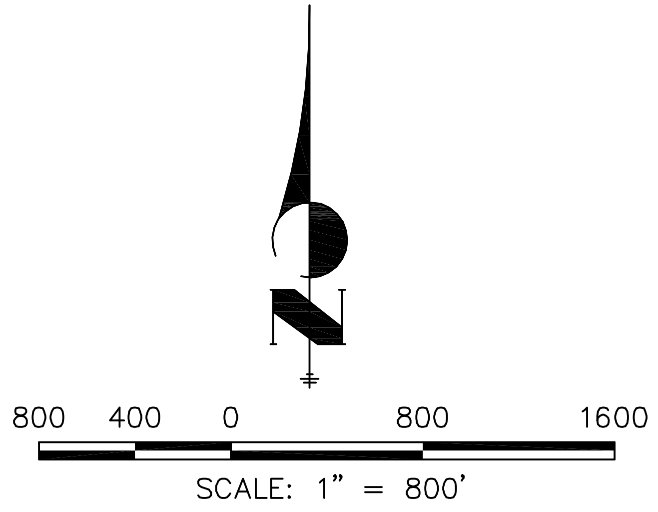


WEST 104TH AVE WATER
QUALITY POND AND OUTFALL
(BASINS D, N, O, P, Q)



SCALE: 1" = 800'

LEGEND

🟩	ON-SITE DETENTION REQUIRED OFF SITE WATER QUALITY PROVIDED
🟦	REGIONAL DETENTION & WATER QUALITY PROVIDED (No On-Site Detention Required)

104TH AVE WEST OUTFALL
DETENTION AND
WATER QUALITY EXHIBIT
104TH AVENUE
JOB NO. 15280.00
JANUARY 12, 2007
SHEET 3 OF 4

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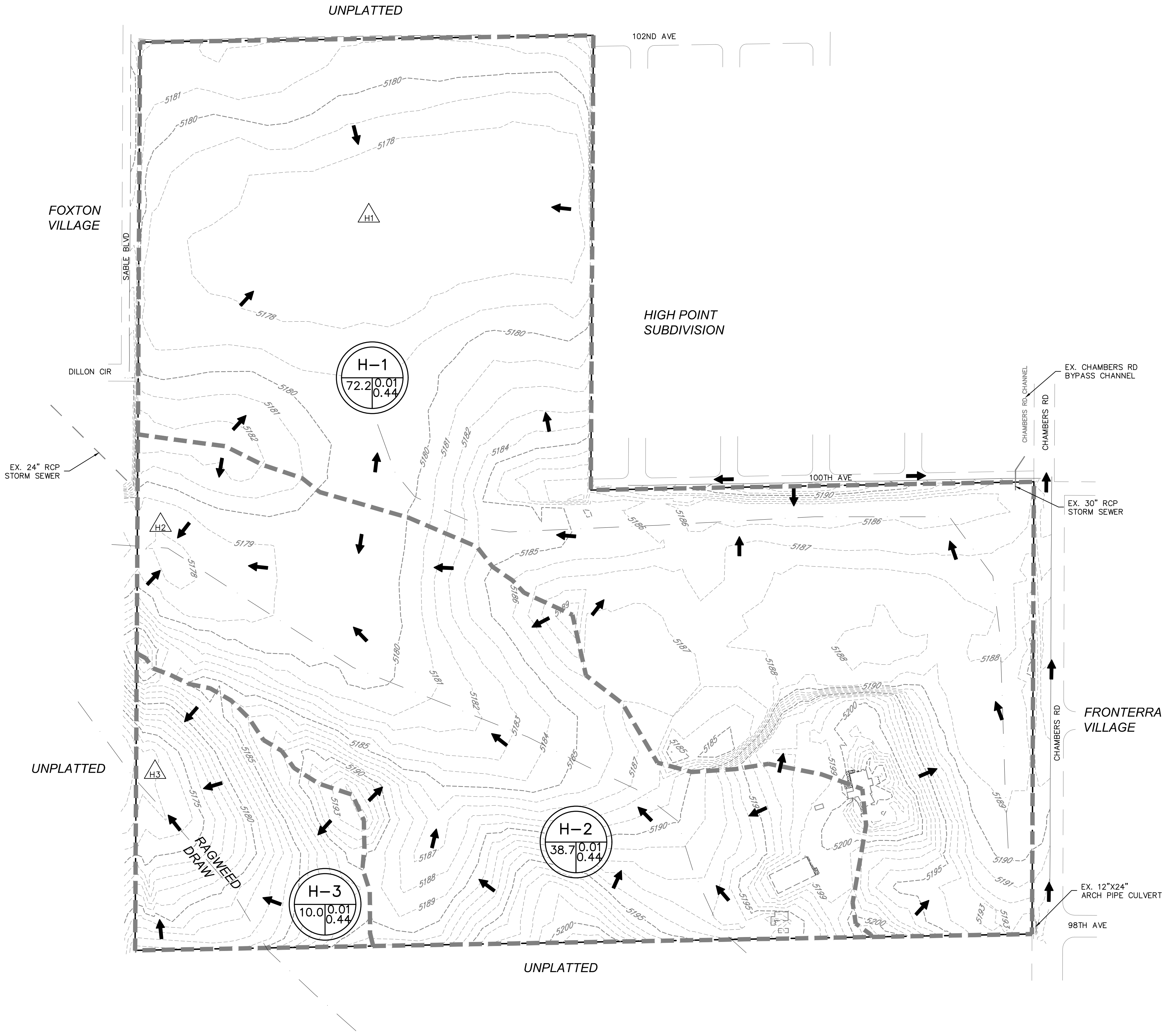
APPENDIX G

DRAINAGE MAPS



LEGEND

- PROPERTY BOUNDARY
- PROPOSED CURB & GUTTER
- EXISTING CURB & GUTTER
- PROPOSED EASEMENT
- EXISTING EASEMENT

A = MAJOR BASIN DESIGNATION
B = AREA IN ACRES
C = 5 YR RUNOFF COEFFICIENT
D = 100 YR RUNOFF COEFFICIENT

- DESIGN POINT
- MAJOR DRAINAGE BASIN BOUNDARY
- MINOR DRAINAGE BASIN BOUNDARY
- 4930 EXISTING CONTOUR
- → FLOW DIRECTION

SUMMARY RUNOFF TABLE

BASIN	AREA (AC.)	DESIGN POINT	Q–5 (CFS)	Q–100 (CFS)
H–1	72.18	H1	0.6	49.0
H–2	38.70	H2	0.5	39.1
H–3	10.03	H3	0.2	16.4

150 0 150 300
(IN FEET)
1 inch = 150 ft.

BENCHMARK
N.W. COR. N.1/2 S.E.1/4
SEC. 18, T.2S., R.66W.
3–1/4" ALUMINUM CAP, 1999,
L.S. 25379

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

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ITS REPRESENTATIVE. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NOTICE:
CONSTRUCTION SITE SAFETY IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR; NEITHER THE OWNER NOR THE ENGINEER SHALL BE EXPECTED TO ASSUME ANY RESPONSIBILITY FOR SAFETY OF THE WORK, OF PERSONS ENGAGED IN THE WORK, OF ANY NEARBY STRUCTURES, OR OF ANY OTHER PERSONS.

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CITY OF COMMERCE CITY, COLORADO
ANNEXATION / ZONING / PUD
PRELIMINARY DRAINAGE REPORT
EXISTING / HISTORIC DRAINAGE MAP

DATE 11/14/2023

A 1st SUBMITTAL TO COMM. CITY 11/29/2023 – DJM

REVISIONS

DR. AD CH. SZ
P.M. DM
JOB 23006912
SHEET NO. 01 OF 02

CAD FILE: 23006912–HIST PDR.DWG

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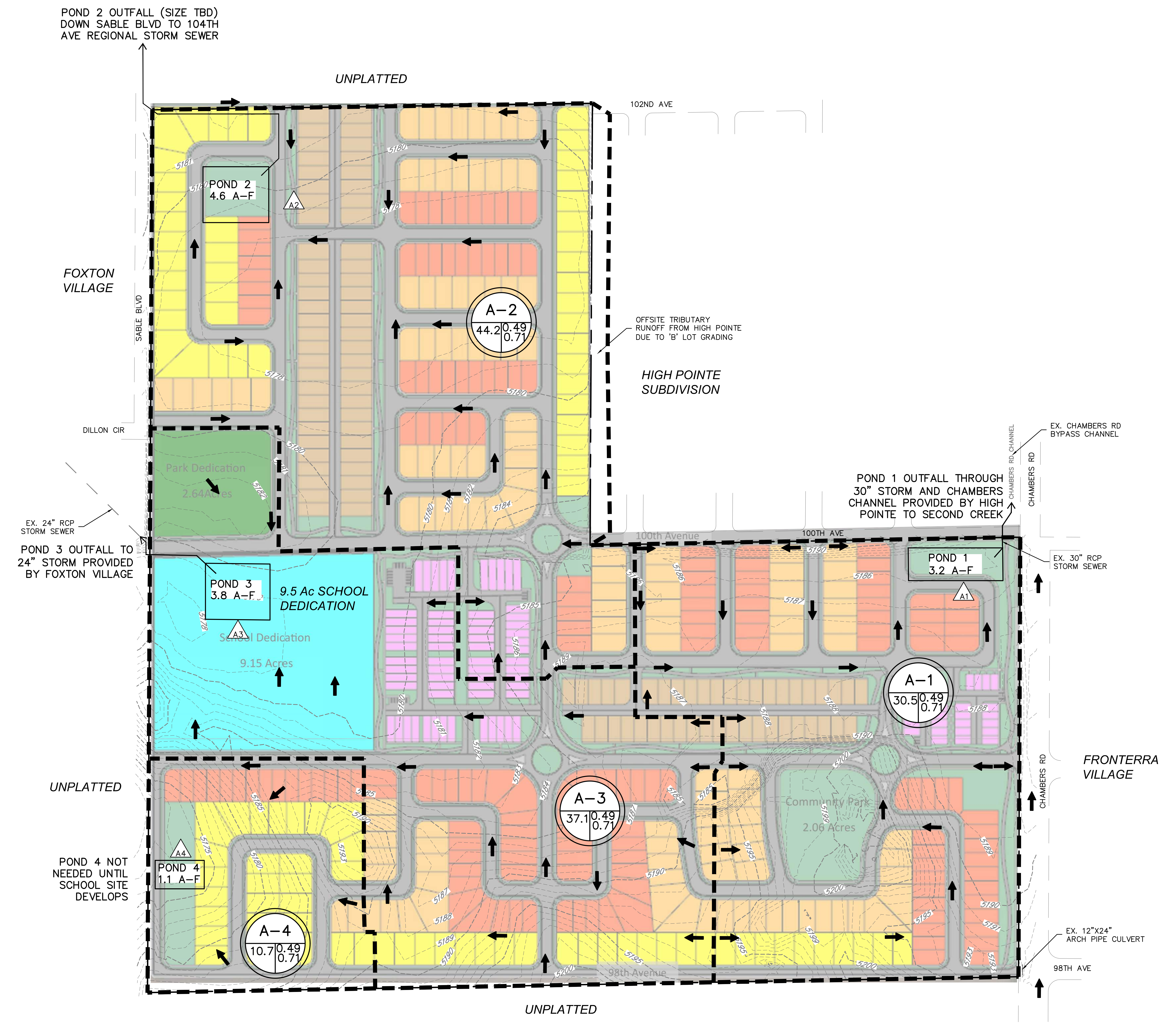

LEGEND

— - — - —	PROPERTY BOUNDARY
═══	PROPOSED CURB & GUTTER
┅┅┅	EXISTING CURB & GUTTER
— — —	PROPOSED EASEMENT
- - - -	EXISTING EASEMENT
A / B / C D	A = MAJOR BASIN DESIGNATION B = AREA IN ACRES C = 5 YR RUNOFF COEFFICIENT D = 100 YR RUNOFF COEFFICIENT
△	DESIGN POINT
▬ ▬ ▬	MAJOR DRAINAGE BASIN BOUNDARY
▬ ▬ ▬	MINOR DRAINAGE BASIN BOUNDARY
4930	EXISTING CONTOUR
➡	FLOW DIRECTION

SUMMARY RUNOFF TABLE

BASIN	AREA (AC.)	DESIGN POINT	Q–5 (CFS)	Q–100 (CFS)
A–1	30.48	A1	29.3	91.1
A–2	44.21	A2	36.2	112.6
A–3	37.11	A3	28.2	87.6
A–4	10.69	A4	14.2	44.1

NOTE:

POND SIZES AND LOCATIONS ARE APPROXIMATE AND MAY CHANGE DURING FINAL ENGINEERING AND PREPARATION OF CONSTRUCTION DOCUMENTS.

150 0 150 300

(IN FEET)
1 inch = 150 ft.

BENCHMARK
N.W. COR. N.1/2 S.E.1/4
SEC. 18, T.2S., R.66W.
3-1/4" ALUMINUM CAP, 1999,
L.S. 25379

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

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ITS REPRESENTATIVE. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NOTICE:
CONSTRUCTION SITE SAFETY IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR; NEITHER THE OWNER NOR THE ENGINEER SHALL BE EXPECTED TO ASSUME ANY RESPONSIBILITY FOR SAFETY OF THE WORK, OF PERSONS ENGAGED IN THE WORK, OF ANY NEARBY STRUCTURES, OR OF ANY OTHER PERSONS.

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CITY OF COMMERCE CITY, COLORADO
ANNEXATION / ZONING / PUD
PRELIMINARY DRAINAGE REPORT
PROPOSED CONDITIONS DRAINAGE MAP

DATE 11/14/2023

A	1st SUBMITTAL TO COMM. CITY 11/29/2023 – DJM
B	REVISED LAND PLAN 12/28/2023 – SAZ

REVISIONS

DR. AD CH. SZ
P.M. DM
JOB 23006912
SHEET NO. 02 OF 02

CAD FILE: 23006912–PROP PDR.DWG