CANVAS AT CASTLE ROCK

PHASE II DRAINAGE REPORT

LOT 1, HECKENDORF RANCH FILING NO. 2, AMENDMENT NO. 3

NORTH CORNER OF CRYSTAL VALLEY PKWY & PLUM CREEK BLVD

OCTOBER 2020

Developer / Owner:
Watermark Equity Group LLC.
206 N Main Street
Wheaton, IL 60187

By:
CAGE Civil Engineering
999 18th Street – Suite 2210
Denver, CO 80202

Contact: Dan Katz
Phone: 630.598.0007

ENGINEER'S CERTIFICATION STATEMENT:

This report and plan for the Phase II drainage design of the Canvas at Castle Rock development was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Castle Rock Drainage Design and Technical Criteria for the owners thereof. I understand that the Town of Castle Rock does not and will not assume liability for drainage facilities designed by others.

Daniel Katz, Register Professional Engineer Date
State of Colorado No. 52465
For and on behalf of CAGE Civil Engineering

DEVELOPER'S CERTIFICATION STATEMENT:

Watermark Equity Group, LLC. hereby certifies that the drainage facilities for the Canvas at Castle Rock development shall be constructed according to the design presented in this report. I understand that the Town of Castle Rock does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the Town of Castle Rock reviews drainage plans pursuant to the Municipal Code; but cannot, on behalf of the Canvas at Castle Rock, guarantee that final drainage design review will absolve Watermark Equity Group, LLC and/or their successors and/or assigns of future liability for improper design.

Authorized Signatory Date
Watermark Equity Group, LLC.

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APPENDICES

SCOPE

The purpose of this report is to present the drainage plan for the proposed Canvas at Castle Rock development, and to show compliance with the Castle Rock Storm Drainage Design and Technical Criteria Manual. The following report includes analysis and design of locations of proposed inlets and storm systems in general accordance with the standards and specifications of Castle Rock.

I. GENERAL LOCATION AND DESCRIPTION

A. Site Location

- The Canvas at Castle Rock development is located the southwest 1/4 of Section 23, Township 8 South, Range 67 West of the 6th Principal Meridian in the Town of Castle Rock, Douglas County, Colorado.
- The site is bordered to the to the north by the Douglas Lane Tributary, to the east by Plum Creek Blvd, the west by the Castle Rock Fire Station 152, and to the south by Crystal Valley Pkwy. Site address(s) have not been assigned at the time of report publication.
- The single-family development Heckendorf Ranch Filing No. 2 is north, east and south of the site. There is a Castle Rock Fire Station to the west of the site.
- See Appendix A for Vicinity Map.

B. Description of Property

- The site is a parcel of approximately 10.74 acres. The site consists of undeveloped land with native grasses and no trees. There is an existing dirt drive that provides access to the Douglas Lane Tributary.
- The proposed Canvas at Castle Rock development includes the construction of 102 townhome units and all the relevant infrastructure for the development. Access will be provided to the east along Plum Creek Blvd and to the south along Crystal Valley Pkwy. Internal streets, alleys, sidewalks and parking will also be constructed.
- From Crystal Valley Pkwy and Plum Creek Blvd the topography slopes up between 10-20% to a flatter area that slopes gently to the west at a 2-4% grade. On the northern edge of the site ground slopes down to the Douglas Lane Tributary at a 4:1 slope and to the west the ground slopes down to the Castle Rock Fire Station 152 at a 4:1 slope.
- Soil types on site as identified by the Natural Resources Conservation Service (NRCS) are as follows:

Hydrologic Soil Group— Summary by Map Unit — Castle Rock Area, Colorado (CO622)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
BtE	Bresser-Truckton sandy loams, 5 to 25 %	B	10.8	100%

- See Appendix A for soils map.
- The Douglas Lane Tributary is to the north of the site and runs east to west.

- There is no pollution or any known contamination existing at the site. Should any pollution or contamination be introduced to the site during construction the contractor will be responsible for remediation.
- There are no floodplains delineated by the Town of Castle Rock or FEMA on the site. Refer to the FIRM map in Appendix A.
- There are no known irrigation canals, ditches or geologic features within the project boundary.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Drainage Basins

- According to the FEMA FIRM map for this region, the site is in an area of minimal flood hazard, known as Zone X. Please refer to the FEMA FIRM map in Appendix A.
- There is a non FEMA mapped floodplain within the Douglas Lane Tributary that was identified by a Flood Hazard Area delineation for Gambel Ridge and Douglas Lane Tributary Watersheds by RESPEC in October 2014.
- The site's existing drainage is divided in two directions. Most onsite drainage will flow into the Douglas Lane Tributary to the northwest. Another portion will flow to the southwest into the curb and gutter of Crystal Valley Pkwy. Both flows eventually drain to the existing regional detention/water quality pond to the northwest.
- The site is part of Major Basin B from the Phase III Drainage Study for the Heckendorf Ranch Filing No. 2, January 2006. This basin discharges into the existing regional pond via the Douglas Lane Tributary.
- The Douglas Lane Tributary, which borders the site to the north, is in overall good condition having had some recent improvements completed in 2019. There are two isolated segments that have been identified to have potential for further erosion towards the project area. To stabilize these portions of the bank, soil riprap is proposed to be installed from the toe of slope up to the proposed top of bank at a slope not steeper than 2.5H:1V. At this time, no fill is proposed within the non FEMA mapped 100-year Floodplain.
- Per the Heckendorf Ranch Filing 2 Drainage Study, the Canvas at Castle Rock site is divided between three existing minor drainage basins. Most of the site is located in basin B2.19, with the rest of the site lying within portions of basins B2.12 and B2.16. All of these basis drain to the existing regional detention/water quality pond northeast of the project site (referred to as Pond 1 in the study).
- Because the proposed Canvas at Castle Rock development includes portions of a few existing basins from the study, a composite C value and peak flow have been calculated for this report. This analysis yielded the following results for the proposed site:

100-Year Storm Event	Heckendorf Ranch Filing 2 Drainage Study, January 2006	Canvas at Castle Rock Development
Composite C Value	0.57	0.66
Peak Discharge (cfs)	35.57	41.35

See Appendix B for hydrologic calculations from the Heckendorf Ranch Filing 2 Drainage Study as well as composite C value and peak flow calculations for the proposed site.

- Per the Heckendorf Ranch Filing 2 Drainage Study, the total 100-year flow rate into the regional pond is 776-cfs. The proposed Canvas at Castle Rock Development will increase the flow rate by 5.8 cfs resulting in a 0.75% increase. This minimal increase in flow will have an insignificant impact on the functionality of the existing regional pond.
- Off-site flow patterns will not be influenced by the development of this site.

B. Minor Drainage Basins

- The proposed project has been divided into 20 minor drainage basins. There are 4 basins that run offsite “OS” and 16 onsite “D” basins. All the runoff from the onsite and offsite basins eventually flow to the existing regional detention/water quality pond northwest of the site to be treated.
- Basin OS1 currently consists of an existing curb return on Plum Creek Blvd, asphalt pavement, sidewalk, a crosspan and open space with native vegetation. In the proposed condition it will consist of pavement, curb, gutter, sidewalk and a portion of the clubhouse for the site. Runoff from this basin flows offsite in the curb and gutter of Plum Creek Blvd.
- Basin OS2 currently consists of an existing meandering concrete sidewalk adjacent to Crystal Valley Pkwy, curb, gutter and open space with native vegetation. In the proposed condition, it will consist of pavement, curb, gutter, sidewalk and open space with native grasses. Runoff from this basin sheet flows offsite into the curb and gutter of Crystal Valley Pkwy.
- Basin OS3 currently consists of open space with native grasses. In the proposed condition it will consist of sidewalk, retaining walls and open space with native grasses. Runoff from this basin sheet flows off site where it eventually will flow into the existing regional pond northwest of the site.
- Basin OS4 currently consists of an existing meandering gravel trail and open space with native grasses. In the proposed condition, it will consist of sidewalk, retaining walls, open space, and a gravel maintenance access trail. All the runoff from this basin flows north offsite into the Douglas Lane Tributary.
- The existing condition of all “D” basins is open space with native grasses. There are no existing structures or infrastructure internal to the site.
- Basin D1 is proposed to consist of pavement, curb, gutter, sidewalk, concrete driveways and roofs of proposed buildings. Runoff from this basin flows in the curb and gutter until it is captured by a Type R Inlet at Design Point 1. In the event that this on-grade inlet is clogged, runoff will overflow into Basin D16.
- Basin D2 is proposed to consist of pavement, curb, gutter, sidewalk, concrete driveways and roofs of proposed buildings including the clubhouse. Runoff flows in swales, inverted crowed alleys, and the curb and gutter until it is combined with flows from DP10 at Design Point 2.
- Basin D3 is proposed to consist of sidewalk and native grasses. This small basin produces runoff that is captured in a Nyloplast Inlet at the low point of Design Point 3. In

the event that this inlet is clogged, runoff will pond ±1' before overflowing offsite into basin OS1 and then into Plum Valley Boulevard.

- Basin D4 is proposed to consist of sidewalk, roofs of proposed buildings and native grasses. This basin produces runoff that is captured in a Nyloplast Inlet at the low point of Design Point 4 where it is combined with flows from D5 and D3. In the event that this inlet is clogged, runoff will pond ±0.8' before overflowing into basin D5.
- Basin D5 is proposed to consist of sidewalk and native grasses. This small basin produces runoff that is captured in a Nyloplast Inlet at the low point of Design Point 5. In the event that this inlet is clogged, runoff will pond ±0.8' before overflowing into basin D6.
- Basin D6 is proposed to consist of roofs from proposed buildings, a concrete alley, pavement, sidewalks and curb and gutter. The runoff from this basin flows in the inverted crown of the alley and curb and gutter until it is captured in a Type R Inlet at Design Point 6. In the event that this inlet is clogged, runoff will pond ±0.3' before overflowing into basin D2.
- Basin D7 is proposed to consist of roofs, sidewalk and native grasses. Runoff from this basin is captured in a Nyloplast Inlet at the low point of Design Point 7. In the event that this inlet is clogged, runoff will pond ±0.8' before overflowing offsite into basin OS2 and then into Plum Valley Boulevard.
- Basin D8 is proposed to consist of roofs, sidewalk and native grasses. Runoff from this basin is captured in a Nyloplast Inlet at the low point of Design Point 8. In the event that this inlet is clogged, runoff will pond ±0.8' before overflowing into basin D9.
- Basin D9 is proposed to consist of roofs, concrete alleys, sidewalk and curb and gutter. The runoff that this basin produces is captured in the inverted crown of the alleys and curb and gutter. This drainage is conveyed to Design Point 9 where it is combined with flows from D2 and D10 and is captured in a Type R Inlet. In the event that this on-grade inlet is clogged, runoff will overflow into Basin D16.
- Basin D10 is proposed to consist of roofs, sidewalk, pavement and curb and gutter. The flows from this basin are conveyed in the curb and gutter to Design Point 10 where it is combined with flows from D2.
- Basin D11 is proposed to consist of roofs, sidewalk and native grasses. The runoff from this basin is captured in a Nyloplast Inlet at the low point of Design Point 11. In the event that this inlet is clogged, runoff will pond ±0.4' before overflowing into basin D9.
- Basin D12 is proposed to consist of roofs, sidewalk and native grasses. The runoff from this basin is captured in a Nyloplast Inlet at the low point of Design Point 12. In the event that this inlet is clogged, runoff will pond ±0.8' before overflowing into basin D16.
- Basin D13 is proposed to consist of a portion of roof from a townhome building. This runoff is conveyed in the gutter of the building and is eventually discharged into a roof drain system at Design Point 13.
- Basin D14 is proposed to consist of a portion of roof from a townhome building. This runoff is conveyed in the gutter of the building and is eventually discharged into a roof drain system at Design Point 14.

- Basin D15 is proposed to consist of roofs, sidewalk and native grasses. The runoff from this basin is captured in a Nyloplast Inlet at the low point of Design Point 15. In the event that this inlet is clogged, runoff will pond ±0.6' before overflowing offsite into basin OS4 and then into Douglas Lane Tributary.
- Basin D16 is proposed to consist of roofs, pavement, concrete alleys, sidewalk and curb and gutter. The runoff is conveyed in the inverted crown of the alleys and the curb and gutter to a Type R Inlet at Design Point 16. After the runoff is captured in the inlet, it is combined with the flows from all "D" basins and is conveyed via a storm sewer system to the existing regional pond northwest of the site to be treated. In the event that the Type R Inlet is clogged, runoff will pond ±0.3' before overflowing offsite into basin OS4 and then into Douglas Lane Tributary.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

- The site is designed in accordance with the *Town of Castle Rock Storm Drainage Design and Technical Criteria Manual*, updated June 2019 and the *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3* (UDFCD), Mile High Flood District, revised August 2018.

B. Drainage Studies, Master Plans, Site Constraints

- The project site is included in the Phase III Drainage Study for Heckendorf Ranch Filing 2 by EMK Consultants, Inc. The proposed development is in compliance with all drainage requirements set forth in the Phase II study. This study includes detention and water quality for the proposed site within the Heckendorf Regional Pond.
- See Appendix D for excerpts from the Phase III Drainage study for Heckendorf Ranch Filing 2 by EMK Consultants, Inc.

C. Hydrology

- Peak storm runoff was determined using the Rational Formula: Q=CIA
- Design storm recurrence intervals are the 5-year storm for the minor event and the 100-year storm for the major event.
- In accordance with the UDFCD and Table 6-1 in the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, NOAA Atlas was used to obtain rainfall depth-duration-frequency values for the project location. This corresponds to the following 1-hour point rainfall values (in): 5-yr = 1.43, 100-year = 2.60.
- Detention storage calculations and releases are provided in the Phase III Drainage Study for Heckendorf Ranch Filing 2 (see Appendix D). The proposed development does not exceed the assumptions used in calculations for that report.
- See Appendix B for all hydrologic calculations.

D. Hydraulics

- The UD-Inlet_v4.06 spreadsheet will be used to calculate inlet and street capacities throughout the site. These calculations will be provided in the Phase III report.

- Hydraulic Grade Lines (HGLs) for the minor event will be contained within the pipe and for major event will be a minimum of 1' below the proposed surface at the storm system structures. HGLs will be calculated using the Hydraflow Storm Sewers Extension for Civil 3D program with standard loss coefficients. These calculations will also be provided in the Phase III Report.
- See Appendix C for all hydraulic calculations.

E. Storage & Water Quality Enhancement

- Water Quality Best Management Practices (BMP's) for the site include detention and controlled release of the water quality capture volume (WQCV) by the existing Heckendorf Regional Pond.
- The WQCV was previously determined in the Phase III Drainage study for Heckendorf Ranch Filing 2 by EMK Consultants.

IV. STORMWATER MANAGEMENT FACILTY DESIGN

A. Storm Water Conveyance Facilities

- While the majority of the site's runoff will be conveyed directly to the regional detention/water quality pond, a small portion (Basin OS4, 1.74 AC) will discharge to the Douglas Lane Tributary, north of the site. This tributary runs from east to west and is vegetated with mostly native grasses and coniferous trees. It eventually conveys runoff to the existing regional pond.
- Runoff from the remainder of the site will be captured via proposed and existing drainage infrastructure that conveys runoff directly to the existing regional detention/water quality pond northwest of the site. The aforementioned drainage infrastructure includes a series of RCP storm sewer (ranging from 18"-30" dia.), inlets and manholes. Per the Phase III Drainage Study for Heckendorf Ranch Filing 2, the regional pond was designed to accommodate runoff for the proposed development in its developed condition.
- All storm sewer infrastructure has been designed to capture and convey peak runoff from the 100-year storm event to the existing regional pond.

B. Stormwater Storage Facilities

- As detailed in the Phase III Drainage report for Heckendorf Ranch Filing 2, a regional detention/water quality pond was designed to accommodate developed flows from this project site. This pond is located northwest of the site and provides 21.1 ac-ft of detention storage, 3.7 ac-ft of which is dedicated to water quality storage. Detained and treated water is released into East Plum Creek.
- See Appendix B for hydrologic computations showing the assumed fully developed flows for which the pond was designed to detain and treat per the Heckendorf Ranch Filing 2 Drainage Study.
- See Appendix D for related excerpts from the Heckendorf Filing 2 Drainage Study.

C. Water Quality Enhancement Best Management Practices

- As previously stated, treatment of the water quality capture volume (WQCV) for the proposed site is being provided by the existing Heckendorf Regional Pond.
- This site has been designed to adhere to the four step process for water quality laid out in the Town of Castle Rock Storm Drainage Design and Technical Criterial Manual:
    - Step 1: Efforts have been made in the site design to enhance water quality by minimizing directly connected impervious areas and minimizing the impervious area where possible. Basins D4, D7, D8, D11, D12 and D15 are all good examples showing runoff from roofs, sidewalk and pavement being run through vegetated areas before entering the storm sewer system.
    - Step 2: Water Quality Capture Volume (WQCV) and Flood Control Detention via Full-Spectrum Detention will be provided in the existing regional detention/water quality pond designed to include runoff from this site.
    - Step 3: Stream Channel Stabilization Techniques will be implanted along the Douglas Lane Tributary, which borders the site to the north. This channel is in overall good condition having had some recent improvements completed in 2019. There are two isolated segments that have been identified to have potential for further erosion towards the project area. To stabilize these portions of the bank, soil riprap is proposed to be installed from the toe of slope up to the proposed top of bank at a slope not steeper than 2.5H:1V. At this time, no fill is proposed within the non FEMA mapped 100-year Floodplain.
    - Step 4: Spill prevention techniques for potential chemicals, oils, fertiliers and other pollutants will be detailed in the Temporary Erosion & Sediment Control Plan and Report for this site. Structural measures will include covering of storage/handling areas, spill containment control, proper sanitary sewer connections, provision of designated storage material and handling areas and provision of proper waste receptacles. Non-Structural measure will include general good housekeeping practices, preventative maintenance, recycling programs, spill prevention and response and employee “awareness” education and training.
- The majority of the site’s runoff is being captured and conveyed to a proposed stilling basin enhancement to the regional pond forebay.

D. Floodplain Modification

- A floodplain modification is not anticipated for the construction of Canvas at Castle Rock.

E. Additional Permitting Requirements

- The proposed development will likely require a Colorado State Stormwater Discharge Permit for discharge into the Heckendorf Regional Pond.
- The Town of Castle Rock will require a Grading, Erosion, and Sediment Control (GESC) permit.

F. General

- All tables, figures, charts and drawings are in general compliance with the Town of Castle Rock's Storm Drainage Design and Technical Criteria Manual

V. CONCLUSIONS

A. Compliance with Standards

- The drainage design for the Canvas at Castle Rock site detailed within this report is in general compliance with the Town of Castle Rock Storm Drainage Design and Technical Criterial Manual, the Mile High Flood District Urban Storm Drainage Criteria Manual, and previous drainage studies prepared for this site.

B. Variances

- There are no variances requested for this project at this time.

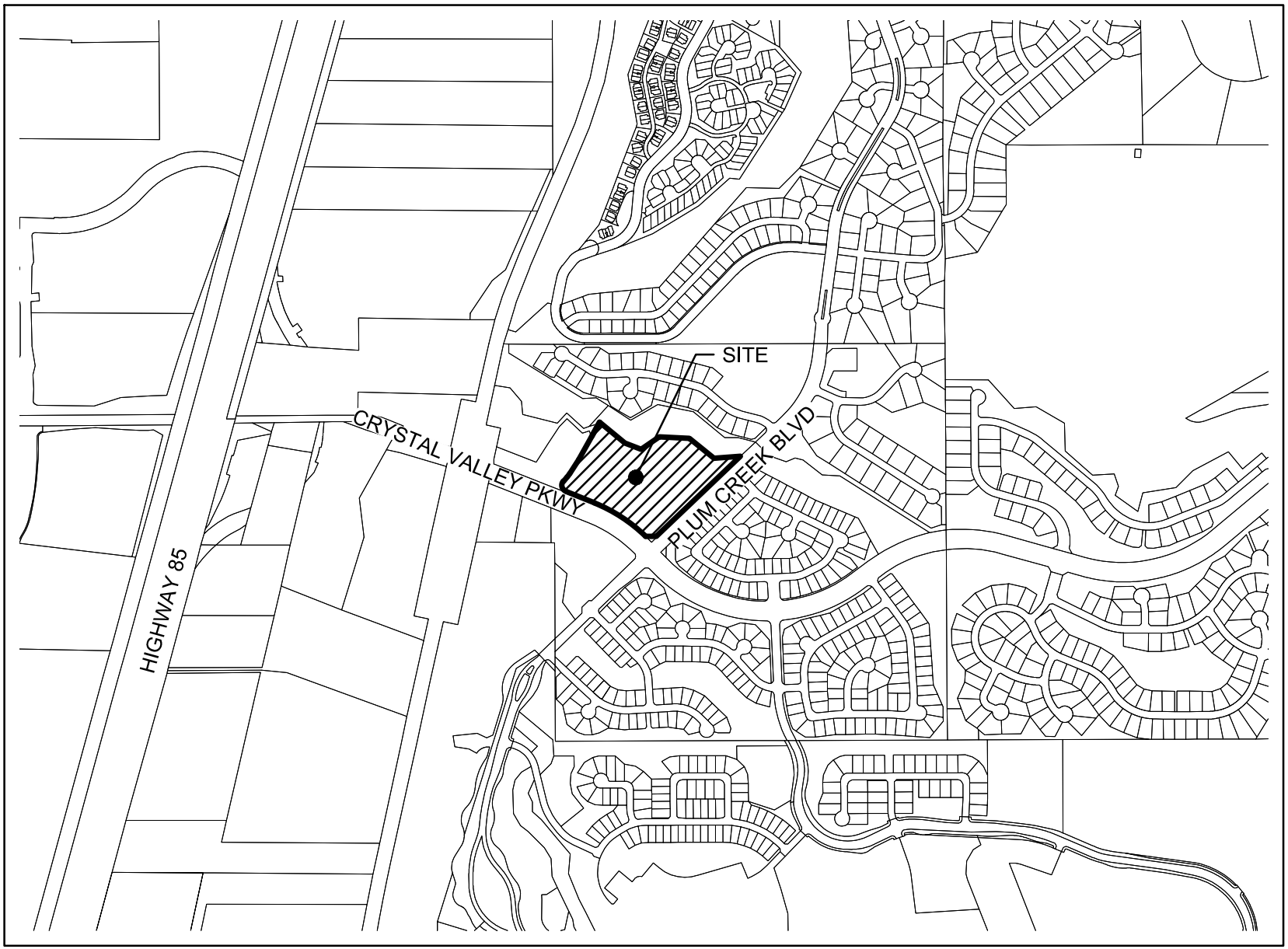
C. Drainage Concept

- The stormwater inlets and pipes designed with this report will safely and effectively convey runoff to the existing off-site Heckendorf regional detention and water quality pond designed for the Canvas at Castle Rock development. The proposed development will have no adverse impact to the downstream drainage system or adjacent properties.

VI. REFERENCES

- *Town of Castle Rock Storm Drainage Design and Technical Criteria Manual*, Revised June 2019
- *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3,* Mile High Flood District, Revised August 2018.
- *Phase III Drainage Study for Heckendorf Ranch Filing 2,* EMK Consultants, Inc., January 9, 2006

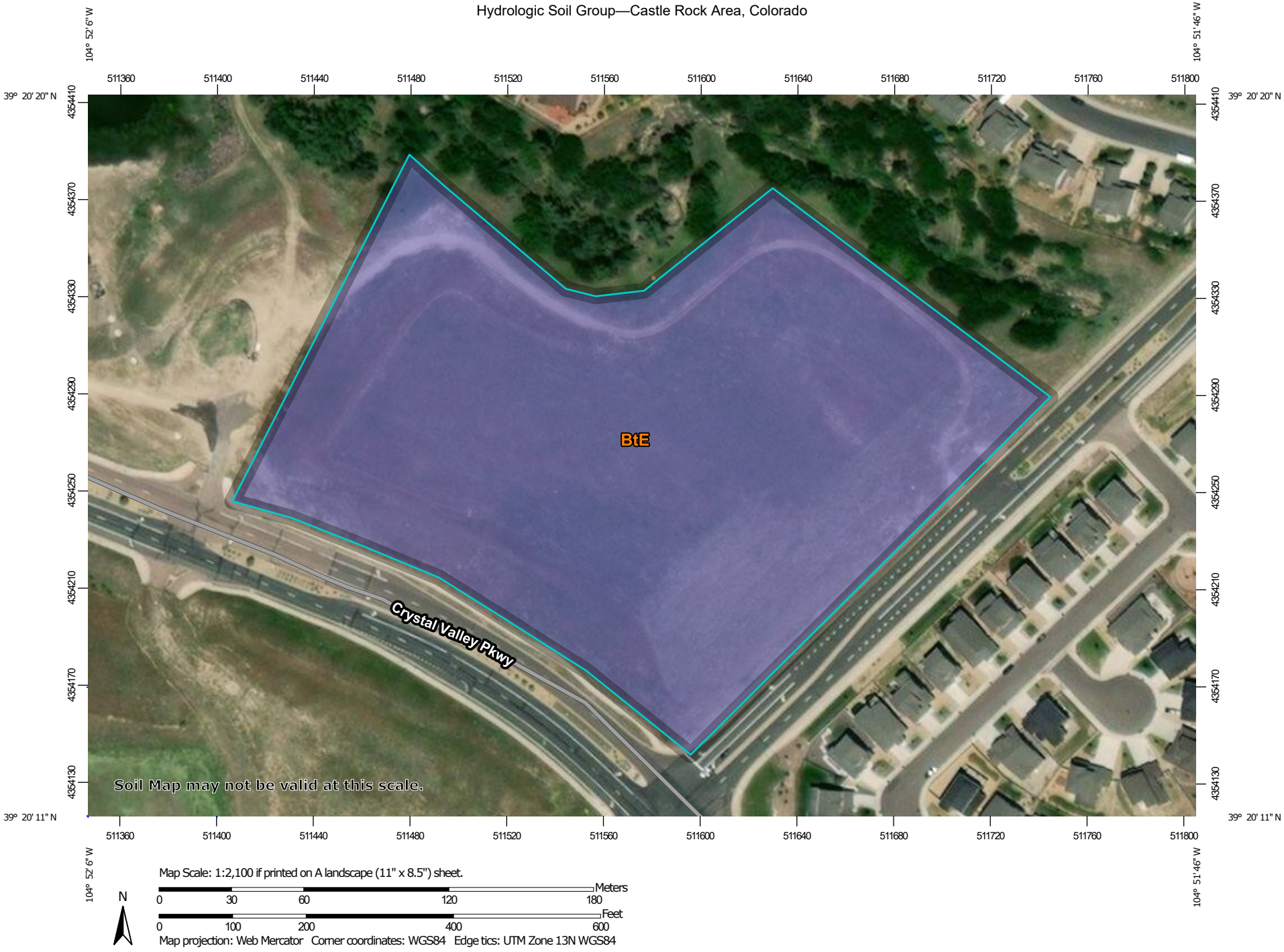
APPENDIX A - MAPS AND EXHIBITS



VICINITY MAP

SCALE: 1" = 1000'

N



Map Scale: 1:2,100 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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: Castle Rock Area, Colorado
Survey Area Data: Version 13, Jun 5, 2020

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

Date(s) aerial images were photographed: Jul 4, 2010—Oct 16, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BtE	Bresser-Truckton sandy loams, 5 to 25 percent slopes	B	10.8	100.0%
Totals for Area of Interest			**10.8**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

National Flood Hazard Layer FIRMette

FEMA

104°52'15"W 39°20'30"N

104°51'38"W 39°20'2"N

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

1:6,000

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

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

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

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

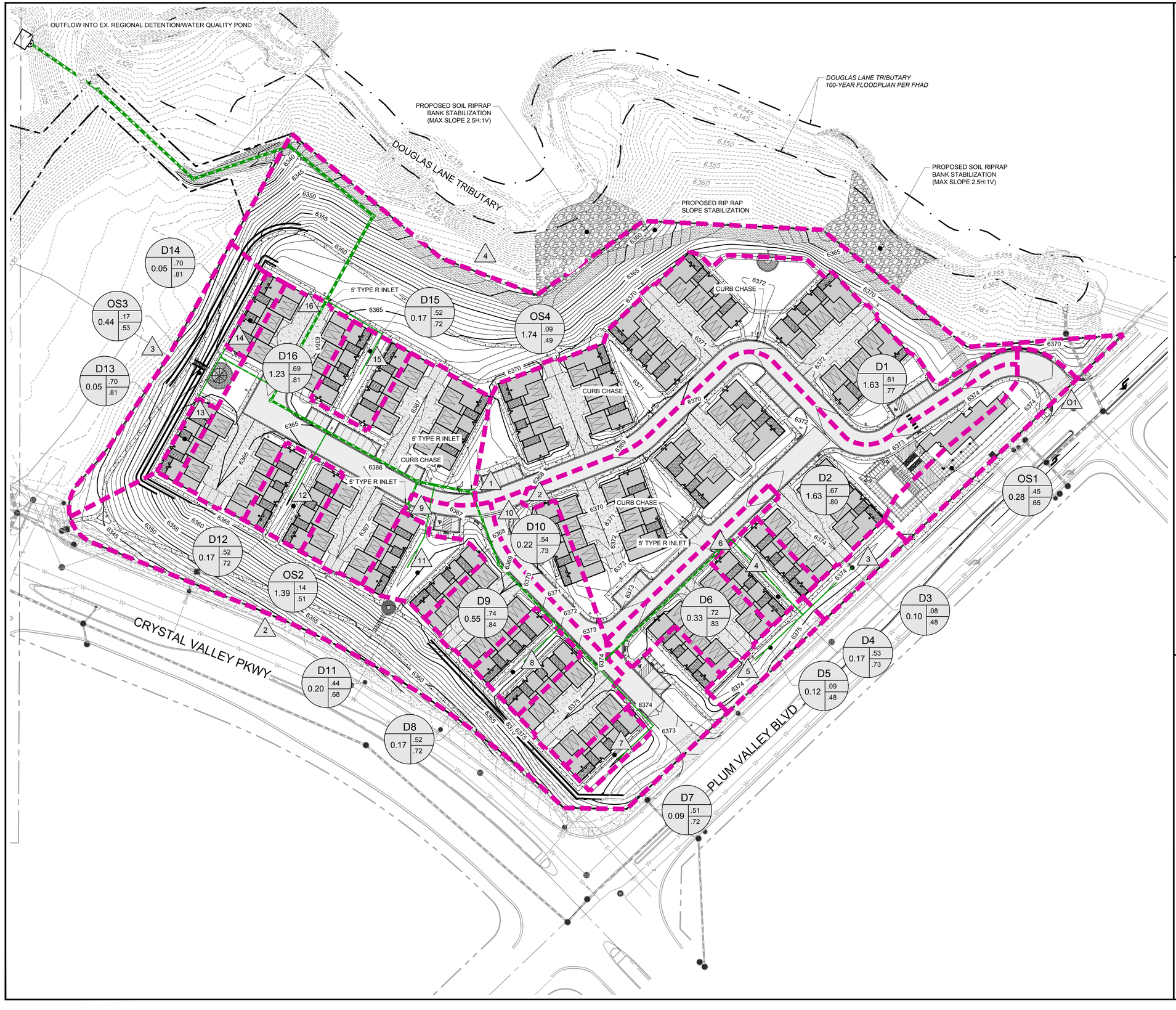
N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/15/2020 at 3:29 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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



BASIN SUMMARY TABLE

Basin Designation	Area (ac)	Q_2 (cfs)	Q_5 (cfs)	Q_{100} (cfs)
OS1	0.28	0.36	0.53	1.63
OS2	1.39	0.56	0.88	5.94
OS3	0.44	0.23	0.36	2.07
OS4	1.74	0.40	0.65	6.07
D1	1.63	2.74	3.88	8.91
D2	1.63	3.15	4.43	9.62
D3	0.10	0.03	0.04	0.44
D4	0.17	0.30	0.43	1.08
D5	0.12	0.03	0.05	0.53
D6	0.33	0.82	1.14	2.38
D7	0.09	0.15	0.21	0.55
D8	0.17	0.30	0.43	1.09
D9	0.55	1.41	1.97	4.04
D10	0.22	0.40	0.58	1.41
D11	0.20	0.29	0.42	1.20
D12	0.17	0.29	0.42	1.06
D13	0.05	0.13	0.18	0.39
D14	0.05	0.13	0.18	0.38
D15	0.17	0.30	0.43	1.08
D16	1.23	2.56	3.59	7.66

LEGEND

- BASIN DESIGNATION / BASIN AREA (ACRES) — OS1 / 0.28 / .42 / .67 — 5 YR RUNOFF COEFFICIENT / 100 YR RUNOFF COEFFICIENT
- DESIGN POINT
- DRAINAGE BASIN BOUNDARY
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- EXISTING MINOR SEWER

0 50' 100'
1" = 50' (HORIZONTAL)

CAGE CIVIL ENGINEERING

REV. NO.	DESCRIPTION	DATE

WATERMARK EQUITY GROUP

CANVAS AT CASTLE ROCK

DRAINAGE MAP

NORTH CORNER OF CRYSTAL VALLEY PKWY & PLUM CREEK BLVD
CASTLE ROCK, CO

PROJ NO: 200119
ENG : DDK
DATE : 08/14/2020

SHEET NUMBER
DR1
1 OF 1

APPENDIX B - HYDROLOGIC COMPUTATIONS

COMPOSITE "C" VALUES (DEVELOPED CONDITION) - BASIN B2

HECKENDORF RANCH FILING 2

Job No:	12145.00		
CALC. BY:	BCG		
CHKED BY:	BCG		
JOB DESC.:	Phase III drainage study		

Basin	B2.1	5 YEAR	
AREA	Area	"C"	
Res	0.5	0.45	0.225
	0.5 ac		0.225
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.2	5 YEAR	
AREA	Area	"C"	
Res	0.1	0.45	0.045
	0.1 ac		0.045
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.3	5 YEAR	
AREA	Area	"C"	
Res	1.6	0.45	0.72
	1.6 ac		0.72
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.4	5 YEAR	
AREA	Area	"C"	
Res	1.1	0.45	0.495
	1.1 ac		0.495
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.5	5 YEAR	
AREA	Area	"C"	
Res	0.4	0.45	0.18
	0.4 ac		0.18
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.1	100 YEAR	
AREA	Area	"C	
Res	0.5	0.6	0.3
	0.5 ac		0.3
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.2	100 YEAR	
AREA	Area	"C	
Res	0.1	0.6	0.06
	0.1 ac		0.1
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.3	100 YEAR	
AREA	Area	"C	
Res	1.6	0.6	0.96
	1.6 ac		0.96
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.4	100 YEAR	
AREA	Area	"C	
Res	1.1	0.6	0.66
	1.1 ac		0.66
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.5	100 YEAR	
AREA	Area	"C	
Res	0.4	0.6	0.24
	0.4 ac		0.24
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.6	5 YEAR	
AREA	Area	"C"	
Res	2.5	0.45	1.125
	2.5 ac		1.125
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.7	5 YEAR	
AREA	Area	"C"	
Res	2.1	0.45	0.945
	2.1 ac		0.945
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.8	5 YEAR	
AREA	Area	"C"	
Res	0.2	0.45	0.09
	0.2 ac		0.09
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.9	5 YEAR	
AREA	Area	"C"	
Res	0.3	0.45	0.135
	0.3 ac		0.135
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.10	5 YEAR	
AREA	Area	"C"	
Res	0.2	0.45	0.09
	0.2 ac		0.09
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.6	100 YEAR	
AREA	Area	"C	
Res	2.5	0.6	1.5
	2.5 ac		1.5
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.7	100 YEAR	
AREA	Area	"C	
Res	2.1	0.6	1.26
	2.1 ac		1.26
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.8	100 YEAR	
AREA	Area	"C	
Res	0.2	0.6	0.12
	0.2 ac		0.12
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.9	100 YEAR	
AREA	Area	"C	
Res	0.3	0.6	0.18
	0.3 ac		0.18
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.10	100 YEAR	
AREA	Area	"C	
Res	0.2	0.6	0.12
	0.2 ac		0.12
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.11	5 YEAR	
AREA	Area	"C"	
Res	0.8	0.45	0.36
	0.8 ac		0.36
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.12	5 YEAR	
AREA	Area	"C"	
Res	0.7	0.45	0.315
	0.7 ac		0.315
	WEIGHTED BASIN "C" VALUE =		0.45

Basin	B2.13	5 YEAR	
AREA	Area	"C"	
Commer.	4.0	0.87	3.48
	4.0 ac		3.48
	WEIGHTED BASIN "C" VALUE =		0.87

Basin	B2.14	5 YEAR	
AREA	Area	"C"	
Commer.	2.1	0.87	1.827
	2.1 ac		1.827
	WEIGHTED BASIN "C" VALUE =		0.87

Basin	B2.15	5 YEAR	
AREA	Area	"C"	
Pav't	1.6	0.88	1.408
Res	0.4	0.45	0.18
OS	0.3	0.2	0.06
	2.3 ac		1.648
	WEIGHTED BASIN "C" VALUE =		0.72

Basin	B2.11	100 YEAR	
AREA	Area	"C	
Res	0.8	0.6	0.48
	0.8 ac		0.48
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.12	100 YEAR	
AREA	Area	"C	
Res	0.7	0.6	0.42
	0.7 ac		0.42
	WEIGHTED BASIN "C" VALUE =		0.60

Basin	B2.13	100 YEAR	
AREA	Area	"C	
Commer.	4.0	0.89	3.56
	4.0 ac		3.56
	WEIGHTED BASIN "C" VALUE =		0.89

Basin	B2.14	100 YEAR	
AREA	Area	"C	
Commer.	2.1	0.89	1.869
	2.1 ac		1.869
	WEIGHTED BASIN "C" VALUE =		0.89

Basin	B2.15	100 YEAR	
AREA	Area	"C	
Pav't	1.6	0.93	1.488
Res	0.4	0.6	0.24
OS	0.3	0.2	0.06
	2.3 ac		1.788
	WEIGHTED BASIN "C" VALUE =		0.78

Basin	B2.16	5 YEAR	
AREA	Area	"C"	
Pav't	1.72	0.88	1.514
OS	1	0.2	0.2
	2.7 ac		1.714
	WEIGHTED BASIN "C" VALUE =		0.63

Basin	B2.17	5 YEAR	
AREA	Area	"C"	
Pav't	0.8	0.88	0.704
OS	0.1	0.2	0.02
	0.9 ac		0.724
	WEIGHTED BASIN "C" VALUE =		0.80

Basin	B2.18	5 YEAR	
AREA	Area	"C"	
Pav't	0.75	0.88	0.66
OS	0.8	0.2	0.16
	1.6 ac		0.82
	WEIGHTED BASIN "C" VALUE =		0.53

Basin	B2.19	5 YEAR	
AREA	Area	"C"	
Commer.	8.4	0.87	7.308
	8.4 ac		7.308
	WEIGHTED BASIN "C" VALUE =		0.87

Basin	B2.16	100 YEAR	
AREA	Area	"C	
Pav't	1.72	0.93	1.6
OS	1	0.2	0.2
	2.7 ac		1.8
	WEIGHTED BASIN "C" VALUE =		0.66

Basin	B2.17	100 YEAR	
AREA	Area	"C	
Pav't	0.8	0.93	0.744
OS	0.1	0.6	0.06
		0.2	
	0.9 ac		0.804
	WEIGHTED BASIN "C" VALUE =		0.89

Basin	B2.18	100 YEAR	
AREA	Area	"C	
Pav't	0.75	0.93	0.6975
OS	0.8	0.2	0.16
	1.6 ac		0.8575
	WEIGHTED BASIN "C" VALUE =		0.55

Basin	B2.19	100 YEAR	
AREA	Area	"C	
Commer.	8.4	0.89	7.476
	8.4 ac		7.476
	WEIGHTED BASIN "C" VALUE =		0.89

NOTE: See Fig. 6 for 'c' value information. Off-site and open space/ undeveloped areas in Basin A have 'c' values for a clayey loam soil (see Soil Survey for Castle Rock). Off-site and open space/ undeveloped areas in Basin B have 'c' values for a sandy loam soil.

JOB NO: 12145.00

PROJECT: HECKENDORF RANCH FILING 2
DSIN STRM: 5 year
CALC. BY: BCG
CHCKD BY BCG

RATIONAL METHOD
(5-YEAR DEVELOPED CONDITION)

I=28.5*P1/(10+T)^0.789

1 HR STORM= 1.43

				DIRECT RUNOFF				TOTAL RUNOFF				STREET FLOW		INLET					PIPE		TRAVEL TIME			
Design Point	Basin	Area	C	Tc	C*A	I	Q	Tc	C*A	I	Q	Design Q		TYPE	Intercept		Carryover		Design Q		Length	Vel.	Time	Notes
		Ac				IN/HR	CFS			IN/HR	CFS	C*A	CFS		C*A	CFS	C*A	CFS	C*A	CFS	ft	fps	min	
60	B2.1	0.5	0.45	6.8	0.23	4.4	1.0					0.2	1.0	5' CURB-G	0.2	0.7	0.1	0.3	0.2	0.7	46	3.09	0.2	DIRECT FLOW (TT 60-61)
61	B2.2	0.1	0.45	5.0	0.05	4.8	0.2					0.0	0.2	5' CURB-G	0.0	0.2								DIRECT FLOW
61	B2.1,B2.2	0.6	0.45					7.1	0.27	4.3	1.2								0.2	0.9	12	3.16	0.1	COMBINED FLOW (TT 61-62)
62	B2.3	1.6	0.45	8.5	0.72	4.1	2.9					0.7	2.9	5' CURB-G	0.4	1.5	0.3	1.4			85	3.20	0.4	DIRECT FLOW (TT 62-66)
62	B2.1-B2.3	2.2	0.45					8.5	0.99	4.1	4.0								0.6	2.3				COMBINED FLOW
62																					872	4.86	3.0	(TT 62-69)
63	B2.4	1.1	0.45	8.8	0.50	4.0	2.0					0.5	2.0	5' CURB-G	0.3	1.2	0.2	0.8	0.3	1.2	27	3.22	0.1	DIRECT FLOW (TT 63-65)
63																					860	4.70	3.1	(TT 63-67)
64	B2.5	0.4	0.45	5.0	0.18	4.8	0.9					0.2	0.9	5' CURB-G	0.1	0.7	0.0	0.2	0.1	0.7	18	3.33	0.1	DIRECT FLOW (TT 64-65)
64																					853	4.71	3.0	(TT 64-67)
65	B2.4,B2.5	1.5	0.45					8.9	0.68	4.0	2.7			MH					0.4	1.8	63	3.19	0.3	COMBINED FLOW (TT 65-66)
66	B2.1-B2.5	3.7	0.45					9.3	1.67	4.0	6.6			MH					1.0	4.0	798	3.17	4.2	COMBINED FLOW (TT 66-68)
67	B2.6	2.5	0.45	11.1	1.13	3.7	4.1																	DIRECT FLOW
67	B2.4-B2.6	4.0	0.45					11.1	1.80	3.7	6.6	1.4	5.0	5' CURB-G	0.5	1.9	0.8	3.1			1050	3.74	4.7	COMBINED FLOW (TT 67-82)
67	B2.4-B2.6, B2.8	4.2	0.45					11.1	1.89	3.7	6.9								0.6	2.2	180	3.46	0.9	COMBINED FLOW (TT 67-78)
68	DP66, DP67	7.9	0.45					13.5	3.56	3.4	12.0								1.6	5.4	165	3.48	0.8	COMBINED PIPE FLOW (TT68-78)
69	B2.7	2.1	0.45	9.3	0.95	4.0	3.7																	DIRECT FLOW
69	B2.1-B2.3,B2.7	4.3	0.45					11.5	1.94	3.6	7.0	1.4	4.9	10' CURB-G	0.8	3.0	0.5	1.9	0.8	3.0	144	3.45	0.7	COMBINED FLOW (TT 69-75)
69																					1037	3.61	4.8	(TT 69-83)
70	B2.8	0.2	0.45	5.0	0.09	4.8	0.4					0.1	0.4	5' CURB-S	0.1	0.4			0.1	0.4	11	3.44	0.1	DIRECT FLOW (TT 70-67)
72	B2.9	0.3	0.45	5.9	0.14	4.6	0.6					0.1	0.6	5' CURB-G	0.1	0.6			0.1	0.6	73	3.14	0.4	DIRECT FLOW (TT 72-74)
72																					964	3.32	4.9	(TT 72-82)
73	B2.10	0.2	0.45	5.0	0.09	4.8	0.4					0.1	0.4	5' CURB-G	0.1	0.4			0.1	0.4	30	3.27	0.2	DIRECT FLOW (TT 73-74)
73																					856	3.51	4.1	(TT 73-82)
74	B2.9,B2.10	0.5	0.45					6.3	0.23	4.5	1.0			MH					0.2	1.0	60	3.16	0.3	COMBINED FLOW (TT 74-78)
75	B2.11	0.8	0.45	6.7	0.36	4.4	1.6					0.4	1.6	5' CURB-G	0.2	1.0	0.1	0.6			37	3.12	0.2	DIRECT FLOW (TT 75-77)
75	DP69, B2.11	5.1	0.45					12.1	2.30	3.5	8.1								1.1	3.7	1029	3.41	5.0	(TT 75-83)
76	B2.12	0.7	0.45	5.0	0.32	4.8	1.5					0.3	1.5	5' CURB-G	0.2	1.0	0.1	0.5	0.2	1.0	35	3.21	0.2	DIRECT FLOW (TT 75-77)
77																					960	3.48	4.6	(TT 75-83)
78	DP75, DP76	5.8	0.45					12.3	2.61	3.5	9.2			MH					1.3	4.4	160	3.16	0.8	COMBINED FLOW (TT 77-78)
79	DP68, DP74, DP77	14.2	0.45					14.2	6.39	3.3	21.0			MH					3.1	10.2	773	3.16	4.1	COMBINED FLOW (TT 78-88)
80	B2.13	4.0	0.87	5.8	3.48	4.6	16.1														167	1.62	1.7	DIRECT FLOW (TT 79-81)
81	B2.14	2.1	0.87	6.1	1.83	4.5	8.3														127	2.02	1.0	DIRECT FLOW (TT 80-81)
82	B2.13,B2.14	6.1	0.87					7.2	5.31	4.3	22.9			MH					5.3	22.9	87	3.46	0.3	COMBINED FLOW (TT81-87)
82	B2.15	2.3	0.45	14.9	1.04	3.2	3.3														78	3.47	0.4	DIRECT FLOW (TT82-87)
83	DP67, DP72, DP73, B2.15	6.8	0.45					12.0	3.06	3.6	10.9	1.9	6.7	5' ON-GRADE	0.7	2.6	1.2	4.1	0.7	2.6	115	2.04	0.9	COMBINED FLOW (TT 82-84)
83	B2.16	2.7	0.63	12.2	1.71	3.5	6.1														74	3.45	0.4	DIRECT FLOW (TT83-89)
83	DP69, DP75, DP76, B2.16	8.5	0.51					16.2	4.32	3.1	13.4	2.5	7.7	5' ON-GRADE	0.9	2.7	1.6	5.0	0.9	2.7	168	1.95	1.4	DIRECT FLOW (TT83-85)
84	B2.17	0.9	0.80	5.0	0.72	4.8	3.5														25	3.46	0.1	DIRECT FLOW (TT 84-86)
84	DP82, B2.17	7.7	0.49					12.9	3.78	3.4	13.0	1.9	6.5	15' SUMP	1.9	6.5			1.9	6.5				COMBINED FLOW
85	B2.18	1.6	0.53	6.2	0.82	4.5	3.7														87	3.46	0.4	DIRECT FLOW (TT85-86)
85	DP83, B2.18	10.1	0.51					17.7	5.14	3.0	15.3	2.4	7.2	15' SUMP	2.4	7.2			2.4	7.2				COMBINED FLOW
85	DP84, DP85	17.8	0.50					17.7	8.93	3.0	26.5	4.3	12.8											COMBINED FLOW
86	DP84, DP85	17.8	0.50					17.7	8.93	3.0	26.5			MH					4.3	12.8	48	3.48	0.2	COMBINED PIPE FLOW (TT86-87)
87	DP81, DP82, DP86	30.7	0.56					17.9	17.29	2.9	51.0			MH					10.3	30.5	12	3.42	0.1	CONBINED PIPE FLOW (TT87-88)
88	DP78, DP87	44.9	0.53					18.0	23.68	2.9	68.7			MH					13.4	39.5	84	3.45	0.4	COMBINED PIPE FLOW (TT88-89)
89	DP83, DP88	53.4	0.52					18.4	28.01	2.9	81.5			MH					14.3	41.6	65	3.51	0.3	COMBINED PIPE FLOW (TT89-90)
90	B2.19	8.4	0.87	10.5	7.31	3.8	27.5																	DIRECT FLOW
90	DP89, B2.19	61.8	0.57					18.7	35.32	2.9	101.9			MH					21.6	62.4				COMBINED PIPE FLOW

JOB NO: 12145.00

PROJECT: HECKENDORF RANCH FILING 2
DSIN STRM: 100 year
CALC. BY: BCG
CHCKD BY: BCG

RATIONAL METHOD
(100-YEAR DEVELOPED CONDITION)

I=28.5*P1/(10+T)^0.789

1 HR STORM= 2.60

				DIRECT RUNOFF				TOTAL RUNOFF				STREET FLOW		INLET						PIPE		TRAVEL TIME			
Design Point	Basin	Area	C	Tc	C*A	I	Q	Tc	C*A	I	Q	C*A	Q	TYPE	Intercept		Carryover		Design Q		Length	Vel.	Time	Notes
		Ac				IN/HR	CFS			IN/HR	CFS		CFS		C*A	CFS	C*A	CFS	C*A	CFS	ft	fps	min	
60	B2.1	0.5	0.60	6.8	0.30	8.0	2.4					0.3	2.4	5' CURB-G	0.1	1.1	0.2	1.3	0.1	1.1	46	3.09	0.2	DIRECT FLOW (TT 60-61)
61	B2.2	0.1	0.60	5.0	0.06	8.7	0.5					0.1	0.5	5' CURB-G	0.1	0.4	0.0	0.1						DIRECT FLOW
61	B2.1,B2.2	0.6	0.60					7.1	0.36	7.9	2.8								0.2	1.6	12	3.16	0.1	COMBINED FLOW (TT 61-62)
62	B2.3	1.6	0.60	8.5	0.95	7.4	7.1					1.0	7.1	5' CURB-G	0.3	2.3	0.6	4.8			86	3.20	0.4	DIRECT FLOW (TT 62-66)
62	B2.1-B2.3	2.2	0.60					8.5	1.32	7.4	9.8								0.5	3.8				COMBINED FLOW
62																					872	4.88	3.0	(TT 62-69)
63	B2.4	1.1	0.60	8.8	0.66	7.3	4.8					0.7	4.8	5' CURB-G	0.2	1.8	0.4	3.0	0.2	1.8	27	3.22	0.1	DIRECT FLOW (TT 63-65)
63																					860	4.70	3.1	(TT 63-67)
64	B2.5	0.4	0.60	5.0	0.24	8.7	2.1					0.2	2.1	5' CURB-G	0.1	1.2	0.1	0.9	0.1	1.2	18	3.33	0.1	DIRECT FLOW (TT 64-65)
64																					853	4.71	3.0	(TT 64-67)
65	B2.4,B2.5	1.5	0.60					8.9	0.90	7.3	6.6			MH					0.4	2.8	63	3.19	0.3	COMBINED FLOW (TT 65-66)
66	B2.1-B2.5	3.7	0.60					9.3	2.22	7.2	15.9			MH					0.9	6.4	798	3.17	4.2	COMBINED FLOW (TT 66-68)
67	B2.6	2.5	0.60	11.1	1.50	6.7	10.0																	DIRECT FLOW
67	B2.4-B2.6	4.0	0.60					11.1	2.40	6.7	16.0	2.0	13.5	5' CURB-G	0.4	2.9	1.6	10.6			1050	3.74	4.7	COMBINED FLOW (TT 67-82)
67	B2.4-B2.6, B2.8	4.2	0.60					11.1	2.52	6.7	16.8								0.6	3.7	180	3.46	0.9	COMBINED FLOW (TT 67-78)
68	DP66, DP67	7.9	0.60					13.5	4.74	6.1	29.1								1.4	8.9	165	3.48	0.8	COMBINED PIPE FLOW (TT68-78)
69	B2.7	2.1	0.60	9.3	1.26	7.2	9.0																	DIRECT FLOW
69	B2.1-B2.3,B2.7	4.3	0.60					11.5	2.58	6.6	17.0	2.1	13.6	10' CURB-G	0.7	4.9	1.3	8.7	0.7	4.9	144	3.46	0.7	COMBINED FLOW (TT 69-75)
69																					1037	3.61	4.8	(TT 69-83)
70	B2.8	0.2	0.60	5.0	0.12	8.7	1.0					0.1	1.0	5' CURB-S	0.1	1.0			0.1	1.0	11	3.44	0.1	DIRECT FLOW (TT 70-67)
72	B2.9	0.3	0.60	5.9	0.18	8.3	1.5					0.2	1.5	5' CURB-G	0.1	1.1	0.0	0.4	0.1	1.1	73	3.14	0.4	DIRECT FLOW (TT 72-74)
72																					984	3.32	4.9	(TT 72-82)
73	B2.10	0.2	0.60	5.0	0.12	8.7	1.0					0.1	1.0	5' CURB-G	0.1	0.8	0.0	0.2	0.1	0.8	30	3.27	0.2	DIRECT FLOW (TT 73-74)
73																					856	3.51	4.1	(TT 73-82)
74	B2.9,B2.10	0.5	0.60					6.3	0.30	8.2	2.5			MH					0.2	1.8	60	3.16	0.3	COMBINED FLOW (TT 74-78)
75	B2.11	0.8	0.60	6.7	0.48	8.0	3.9					0.5	3.9	5' CURB-G	0.2	2.0	0.2	1.9			37	3.12	0.2	DIRECT FLOW (TT 75-77)
75	DP69, B2.11	5.1	0.6					12.1	3.06	6.4	19.7								1.0	6.4	1029	3.41	5.0	(TT 75-83)
76	B2.12	0.7	0.60	5.0	0.42	8.7	3.7					0.4	3.7	5' CURB-G	0.2	1.6	0.2	2.1	0.2	1.6	35	3.21	0.2	DIRECT FLOW (TT 75-77)
76																					960	3.48	4.6	(TT 75-83)
77	DP75, DP76	5.8	0.60					12.3	3.48	6.4	22.2			MH					1.2	7.5	160	3.16	0.8	COMBINED FLOW (TT 77-78)
78	DP68, DP74, DP77	14.2	0.60					14.2	8.52	6.0	51.0			MH					2.8	17.0	773	3.16	4.1	COMBINED FLOW (TT 78-88)
79	B2.13	4.0	0.89	5.8	3.56	8.4	29.9														167	1.62	1.7	DIRECT FLOW (TT 79-81)
80	B2.14	2.1	0.89	6.1	1.87	8.3	15.4														127	2.02	1.0	DIRECT FLOW (TT 80-81)
81	B2.13,B2.14	6.1	0.89					7.2	5.43	7.9	42.7			MH					5.4	42.7	67	3.46	0.3	COMBINED FLOW (TT81-87)
82	B2.15	2.3	0.78	14.9	1.79	5.9	10.5														76	3.47	0.4	DIRECT FLOW (TT82-87)
82	DP67, DP72, DP73, B2.15	6.8	0.66					12.0	4.49	6.5	29.1	3.4	22.3	5' ON-GRADE	0.7	4.8	2.7	17.5	0.7	4.8	115	2.04	0.9	COMBINED FLOW (TT 82-84)
83	B2.16	2.7	0.66	12.2	1.80	6.4	11.6														74	3.45	0.4	DIRECT FLOW (TT83-89)
83	DP69, DP75, DP76, B2.16	8.5	0.62					16.2	5.28	5.6	29.7	3.6	20.2	5' ON-GRADE	0.8	4.6	2.8	15.6	0.8	4.6	168	1.95	1.4	DIRECT FLOW (TT83-85)
84	B2.17	0.9	0.89	5.0	0.80	8.7	7.0														25	3.46	0.1	DIRECT FLOW (TT 84-86)
84	DP82, B2.17	7.7	0.69					12.9	5.29	6.3	33.2	3.6	19.3	15' SUMP	3.6	19.3			3.6	19.3				COMBINED FLOW
85	B2.18	1.6	0.55	6.2	0.86	8.2	7.1														87	3.46	0.4	DIRECT FLOW (TT85-86)
85	DP83, B2.18	10.1	0.61					17.7	6.14	5.4	33.1	3.6	19.3	15' SUMP	3.6	19.3			3.6	19.3				COMBINED FLOW
85	DP84, DP85	17.8	0.64					17.7	11.43	5.4	61.7	7.1	38.5											COMBINED FLOW
86	DP84, DP85	17.8	0.64					17.7	11.43	5.4	61.7			MH					7.1	38.5	48	3.48	0.2	COMBINED PIPE FLOW (TT86
87	DP81, DP82, DP86	30.7	0.70					17.9	21.35	5.4	114.4			MH					13.3	71.3	12	3.42	0.1	CONBINED PIPE FLOW (TT87
88	DP78, DP87	44.8	0.67					18.0	29.87	5.4	159.8			MH					16.1	86.4	84	3.45	0.4	COMBINED PIPE FLOW (TT88
89	DP83, DP88	53.4	0.66					18.4	35.15	5.3	186.0			MH					17.0	89.8	65	3.51	0.3	COMBINED PIPE FLOW (TT89
90	B2.19	8.4	0.89	10.5	7.48	6.6	51.1																	DIRECT FLOW
90	DP89, B2.19	61.8	0.69					18.7	42.62	5.2	223.6			MH					24.4	128.2				COMBINED PIPE FLOW

OFFSITE AREA
10.25 AC, C=0.20

DESIGN POINT 4, REFERENCED FROM PHASE III DRAINAGE STUDY FOR HECKENDORF RANCH FILING 1, DECEMBER 2002, PREPARED BY EMK CONSULTANTS, INC.

KEY MAP

GRAPHIC SCALE
(IN FEET)
1 inch = 100 ft.

* PHASE III DRAINAGE STUDY FOR CRYSTAL VALLEY RANCH FILING 6 PREPARED BY LEGACY ENGINEERING , INC. 07/01/2005
** PHASE III DRAINAGE STUDY FOR CRYSTAL VALLEY PARKWAY PREPARED BY MANHARD CONSULTING, LTD 10/09/2003

EMK CONSULTANTS, INC.
ENGINEERS • SURVEYORS
7006 SOUTH ALTON WAY, BLDG. F
CENTENNIAL, COLORADO 80112-2019
(303) 694-1520

DRAWING SCALE 1" = 0 — 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

REVISIONS

NO	DATE	BY

DESIGNED DMD
DRAWN DSN
CHECKED BCG
APPROVED MJE

HECKENDORF RANCH FILING NO. 2

FINAL
DRAINAGE STUDY
RATIONAL METHOD
BASIN MAP

DATE: 4.22.05
JOB NO: 12145.01
SCALE
1" = 100'

1 of 3

CAGE
CIVIL ENGINEERING

Project: Canvas at Castle Rock
Location: Castle Rock, CO
Designer: IJL
Date: 8/14/2020
Latest Revision: 8/14/2020

PEAK RUNOFF ANALYSIS FROM PHASE III DRAINAGE STUDY FOR HECKENDORF FILING 2 FOR COMPARISON TO CANVAS AT CASTLE ROCK

C-VALUE SUMMARY FROM PHASE III DRAINAGE STUDY FOR HECKENDORF RANCH FILING 2

Basin Designation	Total Area (ac)	Pavement (C_{100}=0.93)	Commercial (C_{100}=0.89)	Residential (C_{100}=0.60)	Offsite (C_{100}=0.20)	Weighted
B2.12	0.70	0.00	0.00	0.70	0.00	0.60
B2.16	2.72	1.72	0.00	0.00	1.00	0.66
B2.19	8.40	0.00	8.40	0.00	0.00	0.89
Total/Composite	**11.82**	**1.72**	**8.40**	**0.70**	**1.00**	**0.82**
Offsite Area*	10.25	0.00	0.00	0.00	10.25	0.20
Total/Composite with Offsite Area	**22.07**	**1.72**	**8.40**	**0.70**	**11.25**	**0.53**

*Open space not inlcuded in Phase III Drainage Study For Heckendorf Ranch Filing 2. Assumed C value of 0.20 (open space).

C-VALUE SUMMARY FOR PORTIONS OF HECKENDORF BASINS WITHIN CANVAS AT CASTLE ROCK

Basin Designation	Total Area Within Canvas At Castle Rock Site (ac)	Pavement (C_{100}=0.93)	Commercial (C_{100}=0.89)	Residential (C_{100}=0.60)	Offsite (C_{100}=0.20)	Weighted
B2.12	0.29	0.00	0.00	0.29	0.00	0.60
B2.16	1.76	0.00	0.00	1.76	0.00	0.60
B2.19	7.91	0.00	0.00	7.91	0.00	0.60
Total/Composite	**9.96**	**0.00**	**0.00**	**9.96**	**0.00**	**0.60**
Offsite Area*	0.78	0.00	0.00	0.00	0.78	0.20
Total/Composite with Offsite Area	**10.74**	**0.00**	**0.00**	**9.96**	**0.78**	**0.57**

100-YEAR PEAK RUNOFF CALCULATIONS FOR PORTIONS OF HECKENDORF BASINS WITHIN CANVAS AT CASTLE ROCK

Basin Designation	Design Point	Total Area Within Canvas At Castle Rock Site (ac)	C_{100}	C X A	T_c (min)	Intensity (in/hr)	Peak Flow, Q (cfs)
B2.12	76	0.29	0.60	0.17	5.00	8.70	1.51
B2.16	83	1.76	0.60	1.06	12.20	6.40	6.76
B2.19	90	7.91	0.60	4.75	10.50	6.80	32.27
Offsite Area*	To Pond	0.78	0.20	0.16	15.00	5.80	0.90
Total	**To Pond**	**10.74**	**0.57**	**6.13**	**15.00**	**5.80**	**35.57**

CAGE CIVIL ENGINEERING

Project: Canvas at Castle Rock
Location: Castle Rock, CO
Designer: IJL
Date: 8/14/2020
Latest Revision: 8/14/2020

[1] From Table 6-3 in UDFCD Volume 1
[2] From Table 6-4 in UDFCD Volume 1

IMPERVIOUSNESS AND RUNOFF COEFFICIENT CALCULATIONS

				Roofs	Lawn	Pavement	Concrete	Gravel	Misc					
			Impervious %[1]	90%	2%	100%	90%	40%	0%					
Basin Designation	NRCS Hydrologic Soil Group	Total Area (ac)	Total Area (sf)	Roofs (sf)	Lawn (sf)	Pavement (sf)	Concrete (sf)	Gravel (sf)	Misc (sf)	Percent Impervious	Runoff Coefficients, C^2			
											C_2	C_5	C_{10}	C_{100}
OS1	B	0.28	12,292	893	5,539	1,658	4,203	0	0	51.70%	0.39	0.42	0.48	0.67
OS2	B	1.39	60,514	0	53,100	688	6,726	0	0	12.90%	0.08	0.09	0.16	0.49
OS3	B	0.44	19,267	0	15,907	0	3,360	0	0	17.35%	0.11	0.13	0.20	0.51
OS4	B	1.74	75,702	0	58,533	0	3,480	13,688	0	12.92%	0.08	0.09	0.16	0.49
D1	B	1.63	71,108	25,638	16,588	10,352	18,530	0	0	70.93%	0.56	0.59	0.63	0.76
D2	B	1.63	70,795	21,900	10,093	15,129	23,673	0	0	79.59%	0.64	0.67	0.70	0.80
D3	B	0.10	4,548	0	4,038	0	510	0	0	11.87%	0.07	0.08	0.15	0.48
D4	B	0.17	7,343	4,273	2,162	0	908	0	0	64.09%	0.50	0.53	0.58	0.73
D5	B	0.12	5,412	0	4,795	0	617	0	0	12.03%	0.07	0.09	0.15	0.48
D6	B	0.33	14,240	4,367	1,645	3,108	5,120	0	0	82.02%	0.67	0.69	0.72	0.81
D7	B	0.09	3,774	2,137	1,216	0	421	0	0	61.64%	0.48	0.51	0.56	0.72
D8	B	0.17	7,443	4,273	2,290	0	880	0	0	62.92%	0.49	0.52	0.57	0.72
D9	B	0.55	23,855	8,546	3,376	2,736	9,197	0	0	78.69%	0.63	0.66	0.69	0.80
D10	B	0.22	9,516	2,137	2,952	2,712	1,715	0	0	65.55%	0.51	0.54	0.59	0.73
D11	B	0.20	8,749	4,273	3,632	0	844	0	0	53.47%	0.40	0.44	0.49	0.68
D12	B	0.17	7,443	4,273	2,281	0	889	0	0	63.03%	0.49	0.52	0.57	0.72
D13	B	0.05	2,339	2,137	202	0	0	0	0	82.40%	0.67	0.70	0.72	0.81
D14	B	0.05	2,336	2,137	199	0	0	0	0	82.50%	0.67	0.70	0.73	0.81
D15	B	0.17	7,474	4,273	2,318	0	883	0	0	62.71%	0.49	0.52	0.56	0.72
D16	B	1.23	53,687	19,229	6,504	8,384	19,571	0	0	80.90%	0.66	0.68	0.71	0.81
Overall		**10.74**	**467,838**	**110,485**	**197,370**	**44,767**	**101,526**	**13,688**	**0**	52.37%	0.41	0.43	0.48	0.67

CAGE CIVIL ENGINEERING

Project: Canvas at Castle Rock
Location: Castle Rock, CO
Designer: IJL
Date: 8/14/2020
Latest Revision: 8/14/2020

NRCS Conveyance Factors, K[2]	
Type of Land Surface	**K**
Heavy Meadow	2.5
Tillage/Field	5
Short Pasture/Lawns	7
Nearly Bare Ground	10
Grassed Waterway	15
Paved Areas	20

[1]Max 300 ft in Urban areas and 500 ft in rural areas
[2]From Table 6-2 in UDFCD Volume 1
Minimum T_c 5

TIME OF CONCENTRATION CALCULATIONS

			Initial/Overland Flow Time, T_i			Channelized Flow/Travel Time, T_t					Time of Concentration, T_c (Check)		
Basin Designation	**Imperviousness (%)**	**C_5**	**Length (ft)[1]**	**Slope (%)**	**T_i (min)**	**Land Surface**	**Length (ft)**	**Slope (%)**	**Velocity (ft/sec)**	**T_t (min)**	**Computed T_c (min)**	**First Design Point T_c (min)**	**Selected T_c (min)**
OS1	51.70%	0.42	15	2.00	3.72	Paved Areas	71	0.45	1.34	0.88	4.60	18.30	5.00
OS2	12.90%	0.09	99	23.00	6.43	Grassed Waterway	1	2.00	2.12	0.01	6.44	N/A	6.44
OS3	17.35%	0.13	61	35.00	4.24	Grassed Waterway	1	2.00	2.12	0.01	4.25	N/A	5.00
OS4	12.92%	0.09	143	12.00	9.58	Grassed Waterway	1	2.00	2.12	0.01	9.59	N/A	9.59
D1	70.93%	0.59	96	2.30	6.83	Paved Areas	372	1.00	2.00	3.10	9.93	17.22	9.93
D2	79.59%	0.67	71	3.10	4.48	Paved Areas	526	1.06	2.06	4.26	8.74	16.70	8.74
D3	11.87%	0.08	12	9.75	3.00	Grassed Waterway	64	2.40	2.32	0.46	3.45	N/A	5.00
D4	64.09%	0.53	14	6.30	2.07	Grassed Waterway	47	1.90	2.07	0.38	2.45	15.42	5.00
D5	12.03%	0.09	12	9.75	2.99	Grassed Waterway	90	2.12	2.18	0.69	3.68	N/A	5.00
D6	82.40%	0.69	35	4.30	2.67	Paved Areas	130	0.78	1.77	1.23	3.89	13.19	5.00
D7	82.50%	0.51	10	5.70	1.90	Grassed Waterway	44	2.00	2.12	0.35	2.25	12.23	5.00
D8	62.71%	0.52	10	4.30	2.05	Grassed Waterway	44	1.95	2.09	0.35	2.40	15.64	5.00
D9	80.90%	0.66	22	5.00	2.18	Paved Areas	406	2.17	2.95	2.30	4.47	14.51	5.00
D10	52.37%	0.54	32	10.90	2.59	Paved Areas	128	2.90	3.41	0.63	3.21	17.86	5.00
D11	0.00%	0.44	39	7.70	3.82	Grassed Waterway	27	1.80	2.01	0.22	4.05	N/A	5.00
D12	0.00%	0.52	54	2.70	5.54	Grassed Waterway	1	1.20	1.64	0.01	5.55	N/A	5.55
D13	0.00%	0.70	25	1.15	3.48	Paved Areas	1	1.20	2.19	0.01	3.48	N/A	5.00
D14	0.00%	0.70	25	1.15	3.47	Paved Areas	1	1.20	2.19	0.01	3.48	N/A	5.00
D15	0.00%	0.52	57	3.67	5.15	Grassed Waterway	1	1.20	1.64	0.01	5.16	N/A	5.16
D16	0.00%	0.68	97	2.96	5.18	Paved Areas	357	1.10	2.10	2.84	8.02	N/A	8.02

2.4.1 Initial or Overland Flow Time

The initial or overland flow time, t_i, may be calculated using Equation 6-3:

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$ Equation 6-3

Where:

t_i = overland (initial) flow time (minutes)
C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
L_i = length of overland flow (ft)
S_o = average slope along the overland flow path (ft/ft).

2.4.2 Channelized Flow Time

The channelized flow time (travel time) is calculated using the hydraulic properties of the conveyance element. The channelized flow time, t_t, is estimated by dividing the length of conveyance by the velocity. The following equation, Equation 6-4 (Guo 2013), can be used to determine the flow velocity in conjunction with Table 6-2 for the conveyance factor.

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$ Equation 6-4

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

$$t_c = t_i + t_t$$ Equation 6

Where:

t_c = computed time of concentration (minutes)
t_i = overland (initial) flow time (minutes)
t_t = channelized flow time (minutes).

2.4.3 First Design Point Time of Concentration in Urban Catchments

Equation 6-4 was solely determined by the waterway characteristics and using a set of empirical formulas. A calibration study between the Rational Method and the Colorado Urban Hydrograph Procedure (CUHP) suggests that the time of concentration shall be the lesser of the values calculated by Equation 6-2 and Equation 6-5 (Guo and Urbonas 2013).

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$ Equation 6-5

Where:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
L_t = length of channelized flow path (ft)
i = imperviousness (expressed as a decimal)
S_t = slope of the channelized flow path (ft/ft).

2.4.4 Minimum Time of Concentration

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

set of one hour design point rainfall values, indicated in Table 6-1, apply to the Town.

TABLE 6-1
1-HOUR POINT RAINFALL VALUES FOR
THE TOWN OF CASTLE ROCK (INCHES)

2- YR	5-YR	10-YR	50-YR	100-YR
1.06	1.43	1.66	2.26	2.60

The one-hour rainfall depths are the basis of the Town's intensity-duration rainfall curves and are used to formulate design storm distributions.

6.1.2 Intensity-Duration Curves. Rainfall intensity based on storm duration for a variety of storm return periods can be found on Figure 6-1 at the end of this chapter. These curves were developed using distribution factors provided in the NOAA Atlas and also provided in Table RA-4 of the UDFCD Manual. These Intensity-Duration curves are based on Equation RA-3 in the Rainfall Section of the UDFCD Manual.

6.1.3 Six-hour Rainfall. In order to use the Colorado Urban Hydrograph Procedure (CUHP), two, three or six-hour rainfall distributions are required, depending on watershed area. Table RA-1 in the UDFCD Manual summarizes storm durations, area adjustments, and incremental rainfall depths to be used in CUHP based on watershed area. The UD-Raincurve Spreadsheet included in the UDFCD Manual shall be used to generate the rainfall distribution curves necessary for a CUHP model. In order to generate these distribution curves, the one-hour and six-hour rainfall depths for the design return periods are necessary. Since the Town of Castle Rock is not located within UDFCD boundaries, the rainfall depth-duration-frequency curves provided in the UDFCD Manual do not provide rainfall values for the entire Town. Therefore these values are provided in these Criteria. The 1-hour point values can be found in Table 6-1 of this chapter. The six-hour point values are as follows:

TABLE 6-2
6-HOUR POINT RAINFALL VALUES FOR
THE TOWN OF CASTLE ROCK (INCHES)

2- YR	5-YR	10-YR	50-YR	100-YR
1.5	2.0	2.2	3.0	3.4

The UD-Raincurve spreadsheet shall be used for all portions of the Town. Once the rainfall distribution curves are generated using the UDFCD UD-Raincurve Spreadsheet, the CUHP model is to be set up following the procedures provided in the Runoff chapter in Volume 1 of the UDFCD Manual.

CAGE
CIVIL ENGINEERING

Project: Canvas at Castle Rock
Location: Castle Rock, CO
Designer: IJL
Date: 8/14/2020
Latest Revision: 8/14/2020

Design Storm:	2-Yr
1-hr Design Point Rainfall (in):	1.06

2-YEAR PEAK RUNOFF CALCULATIONS

Basin Designation	Design Point	Area (ac)	C_2	C X A	T_c (min)	Intensity (in/hr)	Peak Flow, Q (cfs)
OS1	O1	0.28	0.39	0.11	5.00	3.60	0.39
OS2	O2	1.39	0.08	0.11	6.44	3.35	0.36
OS3	O3	0.44	0.11	0.05	5.00	3.60	0.17
OS4	O4	1.74	0.08	0.13	9.59	2.92	0.39
D1	1	1.63	0.56	0.92	9.93	2.88	2.64
D2	2	1.63	0.64	1.05	8.74	3.02	3.16
D3	3	0.10	0.07	0.01	5.00	3.60	0.03
D4	4	0.17	0.50	0.08	5.00	3.60	0.30
D5	5	0.12	0.07	0.01	5.00	3.60	0.03
D6	6	0.33	0.67	0.22	5.00	3.60	0.78
D7	7	0.09	0.48	0.04	5.00	3.60	0.15
D8	8	0.17	0.49	0.08	5.00	3.60	0.30
D9	9	0.55	0.63	0.35	5.00	3.60	1.25
D10	10	0.22	0.51	0.11	5.00	3.60	0.40
D11	11	0.20	0.40	0.08	5.00	3.60	0.29
D12	12	0.17	0.49	0.08	5.55	3.49	0.29
D13	13	0.05	0.67	0.04	5.00	3.60	0.13
D14	14	0.05	0.67	0.04	5.00	3.60	0.13
D15	15	0.17	0.49	0.08	5.16	3.57	0.30
D16	16	1.23	0.66	0.81	8.02	3.11	2.52

CAGE
CIVIL ENGINEERING

Project: Canvas at Castle Rock
Location: Castle Rock, CO
Designer: IJL
Date: 8/14/2020
Latest Revision: 8/14/2020

Design Storm:	5-Yr
1-hr Design Point Rainfall (in):	1.43

5-YEAR PEAK RUNOFF CALCULATIONS

Basin Designation	Design Point	Area (ac)	C_5	C X A	T_c (min)	Intensity (in/hr)	Peak Flow, Q (cfs)
OS1	O1	0.28	0.42	0.12	5.00	4.85	0.57
OS2	O2	1.39	0.09	0.13	6.44	4.51	0.58
OS3	O3	0.44	0.13	0.06	5.00	4.85	0.27
OS4	O4	1.74	0.09	0.16	9.59	3.93	0.63
D1	1	1.63	0.59	0.97	9.93	3.88	3.75
D2	2	1.63	0.67	1.09	8.74	4.07	4.44
D3	3	0.10	0.08	0.01	5.00	4.85	0.04
D4	4	0.17	0.53	0.09	5.00	4.85	0.43
D5	5	0.12	0.09	0.01	5.00	4.85	0.05
D6	6	0.33	0.69	0.23	5.00	4.85	1.10
D7	7	0.09	0.51	0.04	5.00	4.85	0.21
D8	8	0.17	0.52	0.09	5.00	4.85	0.43
D9	9	0.55	0.66	0.36	5.00	4.85	1.76
D10	10	0.22	0.54	0.12	5.00	4.85	0.58
D11	11	0.20	0.44	0.09	5.00	4.85	0.42
D12	12	0.17	0.52	0.09	5.55	4.71	0.42
D13	13	0.05	0.70	0.04	5.00	4.85	0.18
D14	14	0.05	0.70	0.04	5.00	4.85	0.18
D15	15	0.17	0.52	0.09	5.16	4.81	0.43
D16	16	1.23	0.68	0.84	8.02	4.20	3.53

CAGE
CIVIL ENGINEERING

Project: Canvas at Castle Rock
Location: Castle Rock, CO
Designer: IJL
Date: 8/14/2020
Latest Revision: 8/14/2020

Design Storm:	100-Yr
1-hr Design Point Rainfall (in):	2.60

100-YEAR PEAK RUNOFF CALCULATIONS

Basin Designation	Design Point	Area (ac)	C_{100}	C X A	T_c (min)	Intensity (in/hr)	Peak Flow, Q (cfs)
OS1	O1	0.28	0.67	0.19	5.00	8.82	1.66
OS2	O2	1.39	0.49	0.68	6.44	8.21	5.55
OS3	O3	0.44	0.51	0.22	5.00	8.82	1.98
OS4	O4	1.74	0.49	0.85	9.59	7.15	6.05
D1	1	1.63	0.76	1.24	9.93	7.05	8.74
D2	2	1.63	0.80	1.30	8.74	7.40	9.63
D3	3	0.10	0.48	0.05	5.00	8.82	0.44
D4	4	0.17	0.73	0.12	5.00	8.82	1.08
D5	5	0.12	0.48	0.06	5.00	8.82	0.53
D6	6	0.33	0.81	0.27	5.00	8.82	2.34
D7	7	0.09	0.72	0.06	5.00	8.82	0.55
D8	8	0.17	0.72	0.12	5.00	8.82	1.09
D9	9	0.55	0.80	0.44	5.00	8.82	3.84
D10	10	0.22	0.73	0.16	5.00	8.82	1.41
D11	11	0.20	0.68	0.14	5.00	8.82	1.20
D12	12	0.17	0.72	0.12	5.55	8.57	1.06
D13	13	0.05	0.81	0.04	5.00	8.82	0.39
D14	14	0.05	0.81	0.04	5.00	8.82	0.38
D15	15	0.17	0.72	0.12	5.16	8.75	1.08
D16	16	1.23	0.81	0.99	8.02	7.63	7.59

Total 100 Year Peak Flow = 41.35

APPENDIX C - HYDRAULIC COMPUTATIONS

Hydraulic analysis and calculations will be provided with the Phase III Drainage Report.

APPENDIX D - REFERENCED MATERIALS

PHASE III DRAINAGE STUDY
FOR
HECKENDORF RANCH FILING 2

VOLUME 1
Drainage Report

Castle Rock, Colorado

January 9, 2006

Job. No. 12145.01

PREPARED FOR

CASTLE STAR DEVELOPMENT CO., LLC

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Englewood, Colorado 80111
(303) 771-7400
Attn: Clarence Hughes

PREPARED BY

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II. DRAINAGE BASINS AND SUB-BASINS

A. MAJOR BASIN DESCRIPTION

The area encompassed by Major Basin B in Heckendorf Ranch Filing 2 drains entirely into an unnamed gulch along the northern boundary of the property and into proposed Pond 1 (Regional Pond). As stated earlier, the unnamed gulch, which does not have a Regulatory Floodplain, is tributary to East Plum Creek (see Fig. 2). The area encompassed by Major Basin A in Heckendorf Ranch Filing 2 drains into proposed Ponds 2 and 3. Off-site drainage entering the site is limited to the southern part of the property, where a portion of The Lanterns and Crystal Valley Ranch drain onto the site (see Drainage Plan). The existing drainage patterns will remain generally intact with the proposed grading activities.

The Heckendorf Ranch property is located within the lower reaches of the drainage basin containing it. Dranage Plan Sheet 2of 2 identifies the basins which encompass the Heckendorf Ranch property and drain toward East Plum Creek. Existing drainage patterns within these basins will generally be maintained with this development. Only the imperviousness of the basins is being altered. Basin 3, as analyzed in the Phase III Drainage Study for Heckendorf Ranch Filing 1 (Reference 6) has been divided into Basins 3A, 3B, and 3C. This was done to properly evaluate the existing condition of Basin 3A, which contains the existing Crystal Valley Ranch Filing No. 1 subdivision with an existing detention pond. The storage-release parameters of the existing detention pond was taken from Phase III Drainage Study For Crystal Valley Ranch Filing 1 (Reference 9) for inclusion into the USWMM model. Flows from Heckendorf Ranch will be released at or below the current rates by providing a regional detention/water quality pond (Pond 1) near the northwest corner of the site for Major Basin B and two ponds for Major Basin A, a detention pond (Pond 2) and a detention/water quality pond (Pond 3). Pond 1 will provide detention and water quality for Basins 3A, 3B, 3C, and11-15 (see Sheet 2 of 2). Ponds 2 and 3 will provide detention and detention/water quality for Basins 4 and 21-23 (see Sheet 2 of 3). The detention volume for Ponds 1, 2, and 3 was determined using CUHP and SWMM. It was assumed (since offsite detention will be present) that offsite flows coming onto the Heckendorf site would have runoff peaks at or below the existing peaks. Pond 1 will have a capacity of 15.4 ac-ft., Pond 2 will have a capacity of 7.6 ac-ft, and Pond 3 will have a capacity of 3.1 ac-ft.

The predominant soil types for the site include Bresser-Truckton sandy loams, Fondis-Kutch, and Peyton-Pring-Crowfoot sandy loams (see Fig. 3 and Ref. 4). Bresser-Truckton sandy loams (BtE)

have medium to rapid runoff with slight to moderate erosion potential and have a "B" hydrologic soils group classification. Fondis-Kutch association (Fu) has medium to rapid runoff with moderate to severe erosion and a soil classification of "C". Peyton-Pring-Crowfoot sandy loams (PpE) have medium to rapid runoff with moderate to high erosion potential and are classified as soil group "B".

B. SUB-BASIN DESCRIPTION

Heckendorf Ranch 2 is located south of the unnamed gulch which crosses the Heckendorf site. The Drainage Plan Sheets identify two major basins. Basin A drains to the west under the railroad tracks and into East Plum Creek, located south of Crystal Valley Parkway. Basin B drains to the northwest, into an unnamed gulch. The unnamed gulch drains into proposed Pond 1, which releases flows into East Plum Creek. Existing drainage patterns within the two basins will generally be retained with this development. Only the imperviousness of the basins is being altered. Flows from Heckendorf Ranch will be release at or below the current rates due to proposed Ponds 1, 2 , and 3. Pond 1 is located northwest of the site and handles the runoff from major Basin B. Ponds 2 and 3 are located along the southwest area of the sitea and handles the runoff from major Basin A. The detention volumes for the proposed ponds was determined in this darainage study using the CUHP/UDSWMM analysis.

III. DRAINAGE DESIGN CRITERIA

A. REGULATIONS

Storm drainage analysis and design criteria are to be taken from the "Town of Castle Rock Public Works Regulations" (TCRPWR), Reference 1, and the "Urban Storm Drainage Criteria Manual" (USDCM), Reference 2.

B. DEVELOPMENT CRITERIA REFERENCE AND CONSTRAINTS

Development criteria shall be in accordance with Castle Rock Planning Department. Lower density residential lots are proposed for the site. The most significant constraint is conveyance of onsite runoff through the unnamed gulch, the detention and water quality ponds and into East Plum Creek.

C. HYDROLOGICAL CRITERIA

The Rational Method was utilized to analyze and quantify runoff from the developed basins. Design

Points were used to determine total flows at key points of interest. The 5-year storm event was used for the initial storm analysis within residential areas and the 100-year storm frequency was analyzed for the major storm. Detention for Heckendorf Ranch Filing 2 was determined using the CUHP/SWMM method. Water quality requirements were claculated using Town of Castle Rock methods.

D. HYDRAULIC CRITERIA

Street and inlet capacities, and storm sewer calculations are contained in Appendix C of this report. Street capacities have been determined based upon no curb over-topping during the 5-year storm and a maximum depth of 12 inches at flowline during the 100-year storm. On-grade inlets and the adjacent downstream storm sewer have been sized for the design storm (5-year). Sump inlets at lowpoints and the corresponding downstream storm sewer are sized to accomodate the 100-year storm. Exit velocities from storm sewer pipes are a maximum of 12 fps.

IV. DRAINAGE FACILITY DESIGN

A. GENERAL CONCEPT

The general concept is to convey storm water via natural drainageway, curb and gutter, and storm pipe to the detention ponds and ultimately to East Plum Creek without exceeding the current discharge levels. Storm inlet for Filing 2 is designed to intercept flows when street capacity is exceeded during the 5-year storm and intercept all of the 100-year storm at roadway low points. The site is comprised of basins A and B. Basins A and B consist of developed lots, roadways, natural drainageways and open space. Detention and water quality for basin B is provided by a regional detention pond labeled as " Pond 1" on the Drainage Plan sheet 2 of 2 in the back pocket. Water quality storage is provided by "Pond 3" for basin A and detention by ponds 2 and 3 together..

Figure 1 is a vicinity map showing approximately where the Heckendorf Ranch development is located. Figure 2 is a FIRM panel showing the relationship between mapped floodplains and the site location. Figure 3 presents the soil classifications found within the site. Figure 4 is the design point rainfall for Castle Rock. Figure 5 contains the time-intensity-frequency curves for Castle Rock. Figure 6 lists runoff coefficients required for the rational method. Figure 7 presents average flow velocities. Figure 8 contains storm sewer energy loss coefficients and manhole & junction losses. Figure 9 contains the Low Tailwater Riprap Basins For Storm Sewer Pipe Outlets' figures and charts. Figure 10 contains the Water Quality Orifice Plate design tables.

B. SPECIFIC DETAILS (see Plan Sheets for Rational Method Drainage Plans for design points and basin identification)

Basins A

Developed flows from Basins OS1.1-OS1.4 and A1.1 - A1.9 are routed via overland, curb, gutter, and street system into Pond 2. Basins OS1.1-OS1.4 are tributary basins from The Lanterns subdivision. Basin OS1.1 consists mainly of undetained residential flows to design point 9. Basins OS1.2 and OS1.3 are developed flows to be routed to a future pond within The Lanterns, prior to discharging into Pond 2. Basin OS1.4 is undetained overland residential flows into Pond 2. Basins A.1.1 - A1.5 are residential runoffs to design point 7 and are routed to Pond 2 via curb, gutter and street system. Basins A1.6-A1.8 and including OS1.1 are residential runoff to sump location along Ranch Road at design point 11 and are routed to Pond 2 via curb, gutter, and street system. Discharge from Pond 2 is conveyed into a wide grass lined channel to design point 23 and piped into Pond 3.

Basins OS2.1-OS2.2 and A2.1-A2.12 are routed via overland, curb, gutter, and street system into Pond 3. Basins OS2.12 and A2.1-A2.2 are routed via overland, inlets, and street system to design point 22 and piped into Pond 3. Basins A2.3-A2.5 are routed via overland, inlets, and street system to design point 22 and piped into Pond 3. Basins OS2.2, A2.2, and A2.6-A2.7 are routed via overland, inlets, and street system to design point 31 and piped into Pond 3. Basins A2.8 and A2.9 are routed via street and sump inlets to design point 33 and piped into Pond 3. Basins A2.10 and A2.11 are routed via street and sump inlets to design point 35 and piped into Pond 3. The discharge to pond 3 is piped and conveyed into an existing channel, located within both Heckendorf Ranch and Lanterns subdivision, and ultimately to East Plum Creek.

Basins B

Undetained runoff from Basins B1.1-B1.7, 17(See Ref. 10), and 18(See Ref. 11) are routed via overland flow, curb, gutter, and street system to design point 49. Design point 49 has an existing pipe connected to an existing twin 72" culvert that discharges into the unnamed gulch that outfalls into Pond 1. Basin 17's contribution also includes flows from Detention Pond B(See Ref. 10) which is located in Crystal Valley Ranch Filing 6. Basin 18 is located east of Design Point 46 and its' runoff is mainly generated by the southern portion of Crystal Valley Parkway.

B2.12
B2.16
B2.19

Basins B2.1 - B2.17 consists of residential, commercial, and Crystal Valley Parkway runoff. The runoffs are conveyed via overland flow and existing/proposed curb, gutter, and street system to design point 85. Flows to design point 85 are routed into an existing twin 42" rcp that are extended

into Pond 1 (Regional Pond)

Basins B3.1-B3.5 and B3.10-B3.11 are routed via overland flow, curb, gutter, and street system to design point 110 and piped into the riprap area of an existing twin 72" culvert.within the unnamed gulch and outfalls into Pond 1.

Pond 1 (Regional Pond)

Pond 1 is a regional, on-stream pond serving Major Basin B. Major Basin B includes Heckendorf Ranch Filing 1, which currently has an existing temporary detention and water quality pond. This existing pond will be filled-in and all runoff from Heckendorf Ranch Filing 1 will discharge into Pond 1. Pond 1 is a detention and water quality pond that will release at historic rates into East Plum Creek. The pond is designed to accommodate 21.1 ac-ft of detention storage, which includes 3.7 ac-ft of water quality storage (see Appendix D for calculations).

Ponds 2 and 3

Water quality storage is provided by "Pond 3" for Major Basin A and detention by ponds 2 and 3 together. Ponds 2 and 3 together will detain runoff from Major Basin A and will release well below historic rates. Pond 2 is designed to detain the 10 year and 100 year storm without water quality. Pond 2 will accommodate 7.6 ac-ft of detention storage (see Appendix D for calculations). Pond 3 is designed to accommodate 3.9 ac-ft of detention storage, which includes 1.1 ac-ft of water quality storage (see Appendix D for calculations).

Unnamed Gulch

The unnamed gulch, which is tributary to East Plum Creek, does not have a base flow and has not been mapped previously. The HEC-RAS analysis done for the Phase III Draiange Study For Heckendorf Ranch Filing 1 (Reference 6) provides an approximate mapping of the 100-year water surface elevation (Non-regulatory floodplain) for the unnamed gulch. The HEC-RAS analysis of the unnamed gulch for this Phase III Drainage Study in Appendix C provides an approximate comparison of Historic versus Developed flows tributary to the unnamed gulch. This analysis indicates that the historic flows in the unnamed gulch had velocities exceeding 5 fps and froude numbers greater than 0.8. In comparison, the developed flows in the unnamed gulch had minimal differences to the existing velocities and froude numbers of the historic analysis.

In regards to the longitudinal slope, cross-section, and flows within the unnamed gulch, general field observations for the past two years indicate no severe erosion has occurred within the channel (see photos in Appendix C). Recent site visits this past summer indicate severe erosions in areas other

DEVELOPED CONDITION

Heckendorf Ranch Filing No. 2
% IMPERVIOUS (From Figure 6)

Basin	Description	% of Basin	% Impervious	Total % Impervious
3A	Historic - Offsite (Detention)	100%	2%	2%
3B	Existing Crystal Valley Ranch F1 (Exist. Detention)	100%	26%	26%
3C	Historic - Offsite (Detention)	100%	2%	2%
11	3.2 DU/Ac (3000 SF, 2 Story)	100%	40%	40%
12	Historic - Offsite	40%	2%	16%
	1.2 DU/Ac (4000 SF)	60%	25%	
13	4.2 DU/Ac (3000 SF)	90%	47%	43%
	Open Space	10%	2%	
14	Multi-Family	50%	70%	59%
	4.2 DU/Ac (3000 SF)	10%	47%	
	Commercial	20%	95%	
	Open Space	20%	2%	
15	2.8 DU/Ac (3000 SF)	60%	38%	24%
	Open Space	40%	2%	
21	3.2 DU/Ac (3000 SF)	100%	40%	40%
22	2.9 DU/Ac (3000 SF)	100%	39%	39%
23	2.9 DU/Ac (3000 SF)	100%	39%	39%
4	Historic - Offsite (Detention)	100%	2%	2%

Heckendorf Ranch Filing No. 2
5-Year C Values

C5	Weighted C5
0.08	0.08
0.45	0.45
0.08	0.08
0.45	0.45
0.08	0.30
0.45	
0.45	0.41
0.08	
0.65	0.57
0.45	
0.87	
0.08	
0.45	0.30
0.08	
0.45	0.45
0.45	0.45
0.45	0.45
0.08	0.08

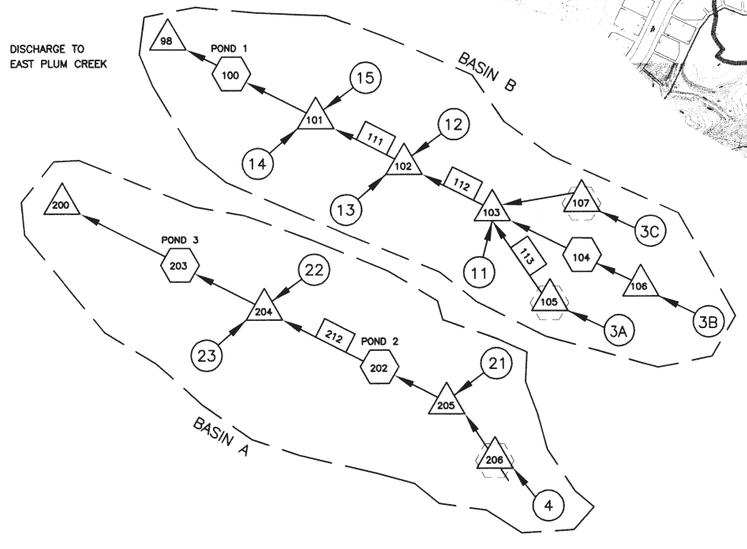
Basin 14 is 44.0 acres encompassing the 10.74-acre Epoque Site

APPROXIMATE 100 YR. FLOODPLAIN BASED ON FIRM (FLOOD INSURANCE RATE MAP & STUDY REPORT) DOUGLAS COUNTY COLORADO. PANEL 303 OF 500 COMMUNITY PANEL NUMBER 080049 0303C, MAP REVISED SEPT. 30, 1987
NOTE: ELEVATIONS ADJUSTED FOR DATUM DIFFERENCE.

DEVELOPED FLOW SUMMARY
(NOTE: OFFSITE DETENTION WILL BE REQUIRED FOR BASINS 3A, 3C, & 4)

SWMM ROUTING ELEMENT	DEVELOPED 5-YEAR (cfs)	DEVELOPED 10-YEAR (cfs)	DEVELOPED 100-YEAR (cfs)
106	68	91	243
105	21	35	135
107	23	34	101
104	51	68	230
113	19	33	135
206	16	23	69
103	103	146	508
205	30	41	108
112	101	144	512
202	1	2	4
102	137	193	645
212	1	2	4
111	134	190	636
204	38	50	111
101	176	245	776
203*	27	32	65
100	94	159	596
200	27	32	65
98*	94	159	596

* DESIGN RELEASE RATES



SWMM SYMBOLS

- FUTURE POND
- 101 POND
- 16 BASIN NUMBER
- 105 ROUTING NODE
- 112 ROUTING FLOWPATH
- BASIN BOUNDARY

GRAPHIC SCALE
300 0 150 300 600 1200
(IN FEET)
1 inch = 300 ft.

EMK CONSULTANTS, INC.
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7006 SOUTH ALTON WAY, BLDG. F
CENTENNIAL, COLORADO 80112-2019

CALL 1-800-922-1987 | 0 — 1"

REUSE OF DOCUMENT

REVISIONS

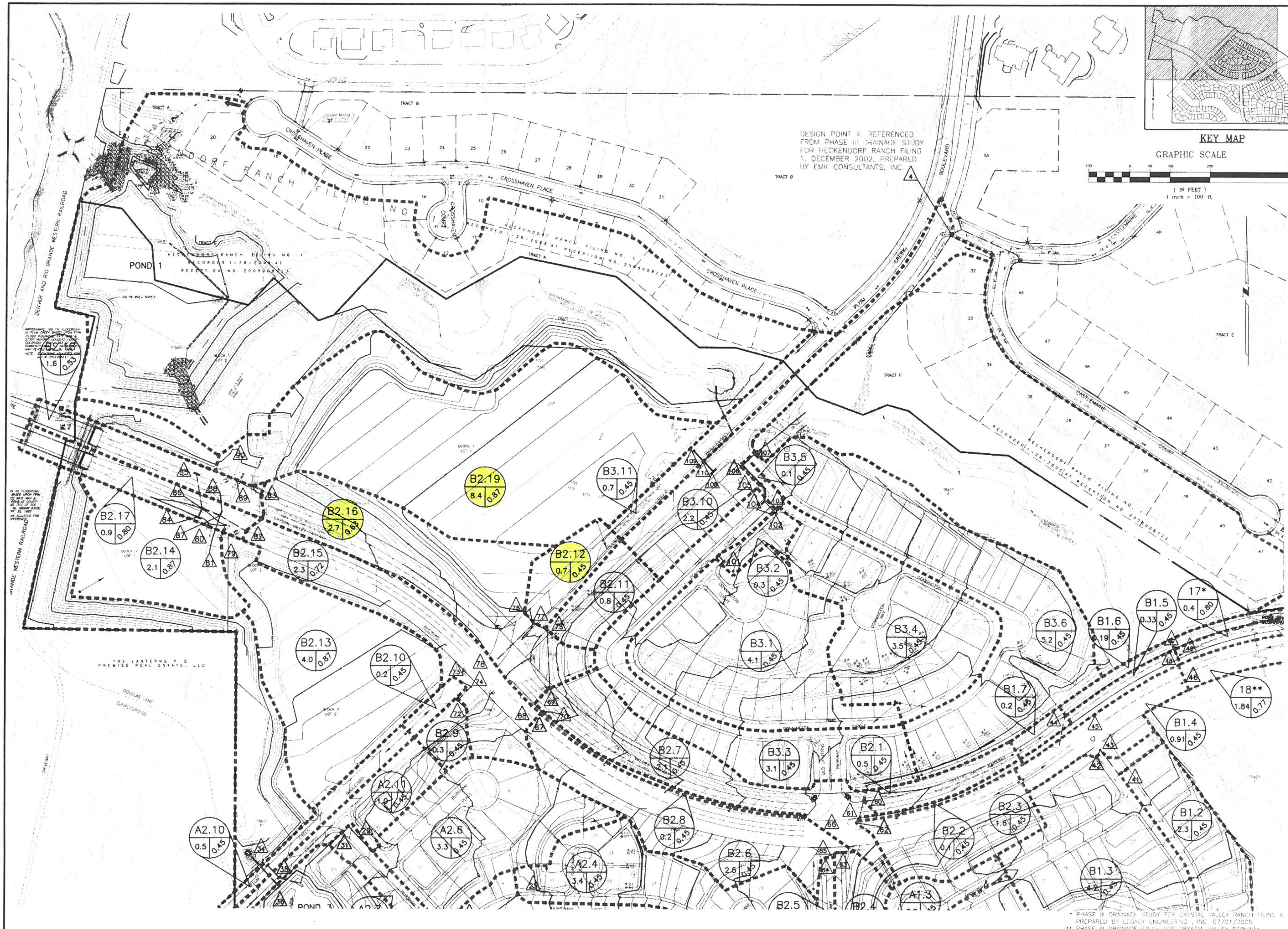
BCG	DMD	JDJ	MJE

HECKENDORF RANCH FILING No. 2

DEVELOPED CUHP/SWMM DRAINAGE PLAN

DATE: 8/18/04
JOB NO: 12145
SCALE 1" = 300'

F:\12145\Heck\Ranch Fil 2\Drainage\CUHP-SWMM\developed\hr2-dph.dwg, 1/6/2006 1:12:47 PM, bgonzales, 1:300



EMK CONSULTANTS, INC.
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7006 SOUTH ALTON WAY, BLDG. F
CENTENNIAL, COLORADO 80112-2019

CALL 1-800-922-1987

REUSE OF DOCUMENT

REVISIONS

DESIGNED BY: DMD
DRAWN BY: DSN
CHECKED BY: BCG
APPROVED BY: MJE

HECKENDORF RANCH FILING NO. 2

FINAL DRAINAGE STUDY RATIONAL METHOD BASIN MAP

DATE: 4.22.05
JOB NO: 12145.01
SCALE
1" = 100'

Summary of Water Quality Conformance to MS4 Permit

The purpose of this worksheet is to verify that proposed site plan is in conformance with the Town of Castle Rock's MS4 permit and to track any exclusions made.

Project Name Canvas at Castle Rock

Project Owner Watermark Equity Group, LLC

Project Address North Corner of Crystal Valley Pkwy. and Plum Creek Blvd.

Name of Project Canvas at Castle Rock

1. Was an exclusion to water quality applied? ❒ Yes ☑ No

- If yes, please select:
  - ❒ Part I.A.4.a.i(A) Pavement management site
  - ❒ Part I.A.4.a.i(B) Excluded roadway redevelopment
  - ❒ Part I.A.4.a.i(C) Excluded existing roadway areas
  - ❒ Part I.A.4.a.i(D) Above ground and below ground utilities
  - ❒ Part I.A.4.a.i(E) Large lot single family home
  - ❒ Part I.A.4.a.i(F) Non-residential and non-commercial infiltration
  - ❒ Part I.A.4.a.i(G) Land disturbance for land to remain undeveloped
- If yes, was the exclusion applied to the entire site?
  - ❒ Yes
  - ❒ No, the exclusion was only applied to the _____ portion of the site

2. Which design standards were applied to meet conformance with the MS4?

- ❒ Part I.A.4.a.iv(A) WQCV standard
- ❒ Part I.A.4.a.iv(B) Pollutant removal standard
- ❒ Part I.A.4.a.iv(C) Runoff reduction standard
- ☑ Part I.A.4.a.iv(D) Applicable site draining to regional WQVC control measure
- ❒ Part I.A.4.a.iv(E) Applicable site draining to regional WQVC control facility
- ❒ Part I.A.4.a.iv(F) Constrained redevelopment sites standard
- ❒ Part I.A.4.a.iv(G) Pervious permit term standard
- ❒ No control measures provided – please provide reason