

Phase II Drainage Report: Amendment 1

FOR

COSTCO WHOLESALE
TOWN OF CASTLE ROCK, COLORADO
CASE NO. SDP25-0021

Prepared for:

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December 23, 2025

Engineer's Statement:

I affirm that this report and plan for the Phase II drainage design of Costco Wholesale, 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.

Todd Wolma

Todd Wolma P.E.
Colorado Professional Engineer
License #59513



OWNER/DEVELOPER'S STATEMENT:

Town of Castle Rock hereby certifies that the drainage facilities for Costco Wholesale 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 Costco Wholesale, guarantee that final drainage design review will absolve ACM Dawson Trails VIII JV LLC and/or their successors and/or assigns of future liability for improper design.

Jabrey J. Schroeder

Print Name

J. Schroeder

Authorized Signature

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I. GENERAL LOCATION AND DESCRIPTION

A. Site Location

This drainage report supports the design of Costco Wholesale, a 162,050 square-foot retail warehouse with onsite fueling station, along with associated vehicle circulation drives and parking.

The project area is approximately centered within Section 22, Township 8 South, Range 67 West of the Sixth Principal Meridian. The property extends into all four quarter-sections of Sections 22.

The proposed Costco Wholesale warehouse is within the Dawson Trails planned development. At present, the site is vacant land and is not accessible by public roads. It is 0.05 miles west of the BNSF railway and 0.10 miles north of Territorial Road. The development parcel lies within Planning Area F-2, which designates single family attached, multifamily, and non-residential as allowable uses. Early phases of infrastructure around the site will construct the following improvements:

- An interchange on Interstate 25 with Crystal Valley Parkway south of the site
- Dawson Trails Boulevard along the west edge of the site
- Collector B along the east edge of the site
- Stabilization of Gambel Ridge Tributary along the south edge of the site
- Regional detention facility C1 on the south side of Crystal Valley Parkway
- Potable water and sanitary sewer improvements to support development of Dawson Trails
- Overlot grading of the portion of Dawson Trails north of Crystal Valley Parkway, including the Costco parcel
- Red Zone Tank and regional detention facility B1 in the Upper Gambel Ridge watershed

The above improvements will be constructed prior to or concurrent with the Costco project, and all are intended to be complete by the conclusion of construction on the Costco site.

B. Description of Property

The area of the development property is 19.66 acres.

Ground cover in the project area is entirely prairie grass, with only a few small, isolated trees on the site. Site topography is generally sloping west to east between 1.5% and 2.5% grade. Gambel Ridge Tributary runs 50 to 80 feet beyond the south property line, with slopes up to 10% along its fringes. Small areas of previous disturbance in the southwest corner of the property have short embankment slopes that approach 4:1. By the time construction commences on the Costco project, it is anticipated that the property will be overlot graded to within 2 feet of ultimate design grades and re-seeded post-grading.

Soils within the project area are detailed on the soils map in Appendix A. The northern $\frac{3}{4}$ of the project site contains hydrologic group A soil, while the southern quarter contains hydrologic group C soil.

Two major drainageways pass near the development site. Gambel Ridge Tributary has a drainage area of about 600 acres and parallels the south property line, 50 to 80 feet beyond the boundary. Gambel Ridge Tributary North has a drainage area of about 300 acres and passes 300 feet north of the northwest property corner. Neither drainageway has a base flow. Both Tributaries flow to East Plum Creek, which passes about 2000 feet east of the site. East Plum Creek is the major receiving drainageway of the area.

Gambel Ridge Tributary and Gambel Ridge Tributary North are analyzed in the FHAD study: *Flood Hazard Area Delineation -- Gambel Ridge and Douglas Lane Tributary Watershed* (Reference F). Gambel Ridge Tributary has recently been subject to a floodplain modification (FD24-0003) that accompanies improvements for the Crystal Valley Interchange. There are no floodplain or floodway encroachments into the Costco development lot with the newly accepted floodplain mapping. There are no floodplain or floodway encroachments into the property from Gambel Ridge Tributary North. The project area is contained within FIRM map panel 08035C0284G. There are no FEMA-designated flood areas from either tributary within the site boundary.

There are no irrigation canals within or near the project area.

There are no notable geologic features within or near the site.

Proposed use of the development site is a 161,000 square-foot retail warehouse with onsite fueling station, along with associated vehicle circulation drives and parking.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Drainage Basins

The Costco property is broken out into three primary on-site drainage basins, and five smaller drainage areas on the site periphery. Each Major basin is further subdivided into Minor Drainage Basins as discussed further below.

Major Basin A Basin covers the east half of the warehouse building, north and east perimeter drive lanes, and the south area of the parking lot. Basin A has an area of 5.87 acres and an overall imperviousness of 93.3%.

Major Basin B Basin covers the west half of the warehouse building, and the west and southwest areas of the parking lot. Basin B also includes the fuel station canopy, fueling area egress drive, and landscape drainage area that is diverted away the fueling area pavement. Basin B has an area of 10.76 acres and an overall imperviousness of 88.2%.

Basin D covers the water quality pond area. Basins E, F and G cover the south, southeast and northeast perimeter daylight slopes, respectively. Basin H covers the fuel area pavement. These small drainage areas are discussed in detail in the next section.

Off-site major drainage basins

There are two areas where offsite flow surface drains toward the northwest part of the site. These areas are conveyed through drainage channels and other storm infrastructure towards the northeast and Costco Way. These areas are described in Section II.B Elsewhere, grade breaks follow the west and north site boundaries to part flows, and high points are designed in the access drives where they cross the property line.

Major Drainageways

Gambel Ridge Tributary is a major drainageway that flows immediately south of the Costco site. Drainageway improvements and a Floodplain Modification Study are separately proposed by the concurrent Crystal Valley Interchange project. The channel improvements and their integration with the Costco site are further discussed in Section III.A of this report. The floodplain modification is discussed in Section IV.B

B. Minor Drainage BasinsOff-site sub-basins

Sub-basin O1 contains 2 acres of undeveloped Tract G area between the site's north property and Costco Way, east of Dawson Trails Boulevard. This area is overlotted graded in a previous work phase (CD22-0056). The Dawson Trails Filing 1 drainage plan anticipates that runoff from O1 will be conveyed to a future pond in the northeast corner of Tract G, ultimately discharging to North Gambel Tributary. A temporary swale and culvert will be installed with the Costco development to convey flows across the proposed eastern access drive from Costco Way.

Sub Basin O2 contains 100 feet of the eastern access from Costco Way, just north of the property boundary. This area drains to the north curb and the perimeter access drive and is captured in Inlet A1.

On-site sub-basins

On-site Basins A, B, and C are further broken out into sub-areas that describes as follows:

Basin A sub-basins

Sub-basins A1, A2, A3 and A4 collectively contain the north service drive. These basins each cover about a quarter of the drive lane's length and drain to curb inlets in local low points on the north side of the drive. Inlets A1, A2, A3 and A4 connect to the upper reaches of Storm Line A.

Sub-basins A5, A7, A9 and A10 collectively contain the east half of the warehouse roof area. Each of these roof areas drain through one or more 10" roof drain pipes that extend away from the building below grade and connect to Storm Line A.

Sub-basin A11 contains the ramp to the loading dock. The ramp drains to a trench drain at the building face that connects to the building's roof drain system.

Sub-basins A6, A8, A12 and A13 contain the eastern service drive, trash compactor pad and loading dock approach. These basins drain to curb inlets in the parking row east of the service drive.

Sub-basin A14 contains the junction area of the east service drive and east access. This area drains away from the building toward the south access drive. Runoff flows are intercepted as much as possible in an on-grade curb inlet on the south edge of the cross-sloped access drive.

Sub-basins A15, A16, A17 and A18 collectively contain the parking lot south of the warehouse building. Each basin covers 1 to 2 drive lanes with adjoining parking. A15, A16, A17 and A18 surface drain to curb inlets that occupy separate low points at the south edge of the lot.

Basin B sub-basins

Sub-basins B1, B3 and B9 collectively contain the parking lot west of the warehouse building. Each basin covers approximately 2 drive lanes with adjoining parking. B1, B3 and B9 surface drain to area inlets in drive lanes west of the building. Because Inlets B1, B3 and B9 are all located in a broad grade break between the warehouse building and Dawson Trails boulevard, they collect runoff from drives on both the east and west sides. Inlet B1 is the upstream end of Storm Line B. Grated manhole covers are used at storm sewer junctions each of Sub-basin B1, B3 and B9, about 25 feet east of each sub-basin's low point. The grated manhole covers assist in flow capture to reduce parking lot ponding in sump locations. They also serve as a redundant capture point in the event of significant clogging at the sump. For the purposes of on-grade interception analysis, sub-basins B1, B3 and B9 are further broken out into areas directly tributary to the grated manholes (B1.1, B3.1 and B9.1) and remaining area tributary to the basin's sump inlet (B1.2, B3.2 and B9.2).

Sub-basins B2, B4 and B10 collectively contain the west half of the warehouse roof area. Each of these roof areas drain through one or more 10" roof drain pipes that extend away from the building below grade and connect to Storm Line B.

Sub-basin B5 contains the western access drive off Dawson Trails Boulevard. The sub-basin drains to an on-grade curb inlet on the south side of the cross-sloped access drive. Drainage from the access drive is intercepted as much as possible to avoid dispersal of concentrated runoff into a high-traffic junction.

Sub-basins B6 and B7 contain the western far west portion of the parking lot, between the west access drive and fueling area. These sub-basins drain to on-grade grate inlets west of the primary north/south drive lane. Runoff from these areas is intercepted as much as possible to avoid dispersal of concentrated flows across into a high-traffic drive lane.

Sub-basins B8, B11, and B15 through B17 collectively contain the parking lot southwest of the warehouse building. B8, B11, B15 and B16 drain to area inlets in the parking area. B17 drains to a curb inlet at the south edge of the lot.

Sub-basin B13 exclusively contains the canopy over the fueling station. Roof drainage from the canopy is piped below grade into Storm Line C, at Inlet B13. The

fueling station pad itself—directly beneath the canopy—is not part of sub-basin B13. Due to the presence of hazardous substances in the fueling area, the fueling station pad drains to a containment pan which routes to the storm sewer system. The fueling pad area is further discussed in this section as Sub-basin C2.

Sub-basin B14 contains the fueling area egress drive and the small landscape area between the fueling station and the Dawson Trails Boulevard right-of-way. This area is beyond the containment pan that intercepts fueling pad runoff. The landscape area surface drains to the curb & gutter at the west of the fueling station. A high point along the west edge of the fueling station pad and canopy keep B14 runoff separated from the fueling station pad. Runoff from B14 is intercepted in a curb inlet on the south edge of the egress lane.

Basin C sub-basins

Sub-basin C1 contains the fuel tank pad and a small wedge of incidental run-on adjacent to the pad. C1 drains to a curb inlet at the north end of the fueling area. Flows from this inlet are routed to a sand/oil interceptor that connects to the storm sewer system, ultimately routing to Pond C3.

Sub-basin C2 includes the fueling station pad, which is shielded by an overhead canopy. C2 drains to a containment pan which routes to a curb inlet just east of the fueling pad. Flows from this inlet are routed to a sand/oil interceptor that connects to the storm sewer system, ultimately routing to Pond C3. Because the fuel area canopy collects essentially all the rainfall that would otherwise fall on sub-basin C2, the basins minor and major storm flows are set to zero. The function of Inlet C2 is to capture and treat incidental drip water and snowmelt that is brought to the fuel station pad by refueling vehicles.

Basin D

Basin D contains the water quality pond and all areas that are directly tributary via overland flow. The 100-year water surface area is treated as 100% impervious for runoff calculations.

E, F, and G sub-basins

Basin E contains the areas on the southern fringe of the site which cannot be practicably captured by the on-site storm system. These areas sheet flow across the south property line directly into Gambel Ridge Tributary.

Basin F contains the areas on the southeast fringe of the site which cannot be captured by the on-site storm system. These areas sheet flow across the east property line onto the Collector B right-of-way and ultimately to Gambel Ridge Tributary.

Basin G contains the areas on the northeast fringe of the site which cannot be practicably captured by the on-site storm system. These areas sheet flow across the east property line onto Collector B right-of-way and to Gambel Ridge Tributary North. Runoff from Basin G1 is conveyed to off-site full spectrum pond B, which is

part of the Dawson Trails Filing 1 improvements. The small areas that comprise Basin G are the only parts of the property that drain to Gambel Ridge Tributary North.

The combined area of Basins E, and F is 0.95 acres, which is 4.85% of the 19.58-acre development site. Neither of these areas can be practicably routed to the on-site Pond, as they all contain landscaped daylight slopes that fall way from the site along its perimeter. The site's water quality treatment requirement, with regard to Basins E and F, is documented in Section 3.3.2 of the Town's Permanent Water Quality Determination Worksheet and provided in Appendix C of this report.

Off-site areas

Sub-basin O2 contains a small area of access drive runoff that surface drains onto the property and is accounted for in the site's internal drainage design. There are no other areas of that surface drain onto the site; all boundaries are either high points or drain away from the site.

Areas of the site fringe in Basins E, F and G sheet flow directly onto adjacent curb and gutter or open drainageway. The flow magnitudes are minimal and have negligible impacts.

No irrigation facilities will be impacted by the project.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

The proposed stormwater facilities are designed to be compliant with Town of Castle Rock drainage criteria, specifically: design rainfall, allowable inlet ponding, pipe velocities, pond storage, freeboard and maintenance provisions.

The Urban Storm Drainage Criteria Manual (USDCM) is referenced for principles of Water Quality Capture Volume and 100-year detention where these functions separated out from a typical full-spectrum design.

Runoff analysis in this report references the 2024 (current) revisions of USDCM Chapter 6. In particular, surface imperviousness values reflect the current version of MHFD Criteria Manual Table 6-3.

Design criteria for pond features, such as forebay, low flow channel and outlet structure, reference the 2024 (current) revision of USDCM Volume 3.

All other analysis and design methods the reference portions of the USDCM are based on previous revisions that have not been subject to updates in 2024.

Private drainage improvements within the site are also guided by Costco Wholesale Development Requirements. The roof drainage system, separate fueling area collection system, and loading dock drainage are based on Costco standard templates. However, the hydraulic performance of these systems is still evaluated through methods compliant with Town criteria. Additionally, Costco development standards specify a typical inlet, grate and drainage layout for low points that occur

in the middle of parking areas. A variance is submitted to request use of a Costco-preferred, H-20-rated inlet for the 6 locations that require area drains.

B. Drainage Studies, Master Plans, Site Constraints

Dawson Trails Filing No. 2 Phase III Drainage Report

The Dawson Trails Filing 2 Phase III Drainage Report [Reference J] serves as a guiding document for the broader stormwater management strategies within the Dawson Trails portion of the Gambel Ridge watershed. This site's drainage design relies on other concurrently designed infrastructure, future iterations of this report will reference the Town's case numbers of formally submitted Phase III Drainage Reports as they become available. The Dawson Trails Filing 2 Phase III Drainage Report defines several of the post-development boundary conditions that demonstrate adherence of associated drainage designs to Town regulations and policies.

Integrated drainage plan general concepts:

Several key components of the Filing 2 Phase III plan are critically important to the stormwater management strategy for Costco. These items are summarized below and described in greater detail later in this section:

1. The drainage strategy for the entirety of the Dawson Trails planned development is analyzed and guided by the Filing 2 Phase III Drainage plan. As a result, all areas of the site—including the Costco property—are integrated into a network of planned regional and sub-regional ponds.
2. A CUHP/SWMM model for all of Dawson Trails and tributary offsite area is used to model post-development hydrographs and peak flows exiting the planned development boundary.
3. Channel improvements for major drainageways crossing the site are an integral part of the Dawson Trails Filing 2 Phase III Drainage plan.
4. Existing drainage culverts under the BNSF railway and Interstate 25 are physical constraints between the site's outfall and East Plum Creek, the receiving major drainageway. Combined flows in the Gambel Ridge Tributary—both from on-site releases within the Dawson Trails Planned development and off-site flows from west of the development—must be adequately conveyed through the existing culverts, with consideration to their studied capacities, associated design storms and acceptable performance criteria.
5. Mile High Flood District drainage policy states that the maximum allowable 100-year release rate from detention ponds is 0.9 of the pre-development peak 100-year flows. However, to account for upstream drainageway flows while meeting the constraint described in (4) above, some 100-year detention release rates will need to be further restricted beyond 0.9 of pre-development peak.

The table below summarizes elements of the Costco drainage strategy that are coordinated with off-site improvements.

Off-site Design Coordination Element Summary				
Costco Design Element	Coordinating Off-site Element	Project	Consultant	Latest Reference
100-year Detention	Pond B1	Dawson Trails Filing 2	CORE	Phase III Drainage [Ref. J]
Regulation of total peak Gambel Ridge outflow	Floodplain Modification Study	Crystal Valley Interchange	Jacobs	FMS [Ref. M]
Gambel Floodplain historic encroachment	Floodplain Modification Study	Crystal Valley Interchange	Jacobs	FMS [Ref. M]
South property line match grading	Gambel Tributary Improvements	Crystal Valley Interchange	Jacobs	Phase III Drainage [Ref. I]
WQ Pond Outfall to Gambel Tributary	Floodplain Modification Study	Crystal Valley Interchange	Jacobs	FMS [Ref. M]
N/W property line drainage coordination	Dawson Trails Blvd/Parcel F2	Dawson Trails Filing 1	CORE	Phase III Drainage [Ref. L]
East property fringe runoff/outfall path	Collector B	Dawson Trails Filing 1	CORE	Phase III Drainage [Ref. L]

Outfall considerations

The ultimate outfall where runoff from the Costco site will exit the Dawson Trails development perimeter is the culvert crossing of Gambel Ridge Tributary under the BNSF railroad. There are two sequential culvert crossings in this location:

- A set of three 6' x 9' CMP culverts under the BNSF railway
- A 10' x 6' concrete box culvert under Interstate 25, immediately downstream.

The full analysis of the site outfall and the hydraulic properties of the improved drainageway is included in the Gambel Ridge Tributary Floodplain Modification Study (FD24-0003). The drainage and outfall design for the Costco site adheres to all of the drainageway constraints and boundary conditions set forth in that FMS.

Gambel Ridge Channel Improvements

The runoff analysis in the Dawson Trails Filing 2 Phase III Drainage Plan indicates that Gambel Ridge Tributary will see an increase of flow with anticipated development, and that channel stabilization improvements will be warranted.

The design of the Gambel Ridge Tributary improvements is not within the scope of the Costco project or within the scope of this drainage report.

Improvements to the 1000-foot segment of Gambel Ridge Tributary between the BNSF right-of-way and Dawson Trails boulevard are included in the design of the Crystal Valley Interchange by Jacobs Engineering Group. The Phase III drainage report for the Crystal Valley Interchange project [Ref. I] notes that the Gambel

Ridge improvements are guided by recommendations on the Gambel Ridge Master Plan [Reference G]. Relevant excerpts from that report are referenced Appendix D [G.11].

Regional Pond B1

100-year detention volume for the Costco site is provided in regional Pond B1. The required storage volume in Pond B1 is computed using a combined area of basins that are directly tributary to Pond B1, plus the area of the Costco site, which is also within the watershed but further downstream. A composite imperviousness of those directly tributary basins (B1-B8) and Costco site (C8) is also used to determine storage volumes. 100-year releases are limited to 90% of the combined predevelopment peak flows from both basin components (B1-B8) plus C8.

Regional Pond C1 (CVI West Pond)

Stormwater Management within the lower Gambel Ridge watershed relies on a regional detention facility, designated as Pond C1 and the Dawson Trail Filing 2 Report and as West Pond in the Crystal Valley Interchange Project. Pond C1 is located immediately south of Crystal Valley Parkway, between Dawson Trails Boulevard and Interstate 25. Because Pond C1 is responsible for detention and water quality treatment of the segment of Crystal Valley Parkway between Dawson Trails Boulevard and Interstate 25, its design is programmed with the Crystal Valley Interchange project, by Jacobs Engineering Group. However, Pond C1 also plays an important role in the Filing 2 Phase III Drainage Plan for Dawson Trails because it provides detention and water quality treatment for development parcels in the lower part of the Gambel Ridge watershed. Consequently, the design parameters for Pond C1 have been an item of continued coordination throughout the design process. The key role of Pond C1 in relation to Costco is over-detention to control peak flows exiting the Dawson Trails planned development.

Stormwater Detention and Water Quality

The Costco development site is considered in the Dawson Trails Filing 2 Phase III Drainage plan and is designated as Basin C8.

Regional over-detention will be provided by regional Ponds B1 and C1. The over detention is necessary to ensure that the combined flows in Gambel Ridge Tributary do not exceed the predevelopment 100-year flow rate of 640 cfs through the existing culverts under the BNSF railway and Interstate 25. The total discharge includes flows from the upper watershed and the 100-year release flows from Ponds C1 and C3 (Costco).

The elements of full-spectrum detention for the Costco site and the facilities that accommodate them are summarized below:

Detention Element Summary			
Detention Element	Facility	Designed by	Input parameters
Water Quality Capture Volume (WQCV)	Pond C3	CORE	Costco Site only (Basin C8) Area, %I
Excess Urban Runoff Volume (EURV)	Pond C3	CORE	Costco Site only (Basin C8) Area, %I
100-year detention volume	Pond B1	CORE	Costco Site + Upper Gambel Basins B1 – B8 Combined Area, %I
Q100 exiting Dawson Trails < predevelopment Q100	Ponds B1, C1	CORE/Jacobs	(C1 release + Costco release + B1 release + Gambel Offsite) < Existing Q100 at RR

Specific details on the input parameters, physical design, and outlet hydraulics of Pond B1 are referenced from the Dawson Trails Filing 2 Phase III Drainage Report [Ref. J] and are included in Appendix D.

Specific details on the input parameters, physical design, and outlet hydraulics of Pond C1 are referenced from the Crystal Valley Interchange Project Phase III Drainage Report [Ref. I] and are included in Appendix D.

SWMM

A Stormwater Management Model (SWMM) is used in regional hydrologic analyses to model the hydraulic performance of the developed Gambel Ridge Tributary drainage basin. A stormwater model that routes the watershed flows Gambel Ridge Tributary is not within the scope of this analysis. However, critical design points in the drainageway SWMM are referenced from the Gambel Ridge FMS (FD24-0003) and are adhered to with this design.

Separately, a SWMM for the upper portion of the Gambel Ridge watershed, west of the Twin Oaks Subdivisions, is within the scope of the Dawson Trails Filing 2 drainage design—currently in development. That report will adhere to all of the flow constraints and boundary conditions set forth in the FMS (FD24-0003) and in this report.

Dawson Trails Filing No.1

The perimeter roadways abutting Costco, including Dawson Trails Boulevard on the west and Collector B on the east, will be designed and constructed by the Dawson Trails Filing 1 project. This project is a comprehensive package that encompasses the portion of Dawson Trails development north of Crystal Valley parkway. It includes arterial and collector roads outlined in the preliminary plan, associated utility and drainage infrastructure, and overlot grading of the adjacent development parcels.

The stormwater strategy of the Dawson Trails Filing 1 infrastructure, as it relates to Costco, generally surface drains the Dawson Trails Boulevard right-of-way and most of Collector B right of way to full-spectrum facilities designated as Ponds A, B and C, which are constructed by that project. The overlot grading concept also

defines a linear high point on the Costco property's north boundary to shed runoff from the adjacent site northward, away from Costco. The southernmost leg of Collector B, between Costco's east access and the underpass beneath Crystal Valley Parkway, drains steeply south and cannot be captured for detention. The runoff from this area will discharge directly to Gamble Ridge Tributary and will be included in the 640 cfs allowable maximum. The uncaptured runoff on the eastern property fringe that define sub-basin F and G rely on Collector B's street drainage for conveyance to an outfall.

C. Hydrology

Rational method is used for on-site runoff calculations. Sub-basins range from 0.1 to 1.5 acres in size and are all fully developed. CUHP method is used for calculations of overall Gambel Ridge Tributary watershed flows, as referenced in the Dawson Trails Infrastructure I Phase III Drainage Report. Additionally, a SWMM models the drainageway flows with the consideration of future detention basin and channel improvements within the master plan area.

The 5-year mean recurrence interval is used for the minor drainage system design. The 100-year mean recurrence interval is used for the major drainage system design.

Design 1-hour rainfall amounts are 1.43 in. for the 5-year event and 2.60 in. for the 100-year event. These values are taken from Table 6-1 of the Town's drainage criteria.

Water Quality Capture Volume is determined from the MHFD-Detention_v4-05 spreadsheet, using the methods defined in MHFD Criteria Manual Volume 3. The MHFD-Detention_v4-05 spreadsheet is also used for pond storage and outflow calculations. MHFD-Detention_v4-05 is used to evaluate pond performance during significant storm events and sizing of flow-bypassing components.

D. Hydraulics

Curb/gutter conveyance capacities and curb inlet flow interception is calculated using MHFD-Inlet_v5.03 spreadsheet. A manning's n-value of 0.016 is assumed for all areas of asphalt parking lot paving.

Swale flows and surface drainage depths across parking lots are computed with Hydraflow Express Extension for Autodesk Civil 3D, Version 2022.

Area inlet interception in sump condition is computed using Equation 7-38 and Table 7-8 of the Mile High Flood District Criteria Manual [Reference B].

On-grade grate inlet interception calculations are based on Chapter 7, Section 3.2.1 and Table 7-6 of the Mile High Flood District Criteria Manual [Reference B]. Safety grates used within the project have bar widths, open areas and bar orientations are most similar to a Type 13 valley grate. Therefore, the empirical

splash-over parameters of the Type 13 valley grate are assumed for on-grade interception analysis.

Hydraulic grade lines for on-site, detained storm sewers and pond outfall pipes are computed through StormCAD software, version 10.03.04.53. Headloss coefficients are applied in accordance with the technical publication "Modeling Hydraulic and Energy Gradients in Storm Sewers: A Comparison of Computational Methods" by UDFCD (Urban Drainage & Flood Control District). Hydraulic performance of off-site culverts is evaluated through HY-8 software version 7.80.0.2. Inlet capacity will be evaluated via Mile High Flood District Street and Inlet Hydraulics Workbook. Inlets be designed Type A and comply to Town of Castle Rock's Storm Drainage Design and Technical Criteria Manual tables 7-2 and 7-3.

The MHFD-Detention_v4-06 spreadsheet is used for pond routing and outflow calculations.

E. Storage and Water Quality Enhancement

As described in section III.B, the detention strategy for the Costco site is uniquely integrated into the overall drainage concept for the Dawson Trails development.

Water quality enhancement and excess urban runoff attenuation are provided by an on-site pond sized for the water quality capture volume (WQCV) and excess urban runoff volume (EURV) per MHFD design criteria, as determined by the site's area and imperviousness.

Secondly, the 100-year detention volume is accommodated off-site in regional pond B1 in the Upper Gambel Ridge watershed. The minimum 100-year detention volume is determined from the combined basin area, composite imperviousness, and overall hydrologic characteristics of areas tributary to the pond and Costco, which is not tributary to the pond. The actual volume of the pond will be greater than the minimum required volume due to over-detention that will limit the release rate.

Adherence to the four-step process for water quality control is detailed in Section IV.C of this report.

IV. STORMWATER MANAGEMENT FACILITY DESIGN

A. Stormwater Conveyance Facilities

The stormwater conveyance scheme for the Costco project uses an onsite-storm sewer system to collect parking lot flows and roof drainage and an on-site pond for water quality treatment. Pavement runoff in the fuel station (Sub-basin C1 and C2) is routed to oil/water separators before piping to the on-site storm sewer system.

The site is served by two primary storm sewer runs: Lines A and B collect runoff from the east and west halves of the site. Roof drains connect directly to the storm sewer.

Parking lot runoff is generally allowed to sheet flow away from the building and intercepted by inlets in the parking area. The on-site storm systems convey converge into a single forebay in the water quality/ EURV pond in the southeast corner of the site.

Specific details on surface drainage patterns and interception points are described for each sub-basin and inlet in Section II.B.

A designed swale will be included in Basin B12. Per Mile High Flood District Figure 8-24, there will be a 6" deep designed swale.

B. Stormwater Storage Facilities

The WQCV/EURV pond is in the southeast corner of the site and outfalls to the improved Gambel Ridge Tributary immediately south. A riprap apron will be designed for the pipe outfall with the Phase III report.

An overflow spillway is designed for the south pond berm with capacity to convey 100-year fully developed, unattenuated flows directly to Gambel Ridge Tributary.

The WQCV/EURV Pond has sufficient excess depth to convey the 5-, 10- and 25-year events entirely through the top of the outlet box, with consideration of a 50% clogging factor. For the 50- and 100-year events, the overflow spillway may activate.

The spillway design has at least 1 foot of freeboard from the highest water depth over the spillway crest to the top of berm on the east, north and west sides of the pond. The entire south pond berm directly abuts the Gambel Ridge drainageway and can function as an emergency overflow path. All 50-, 100-, and 500-year routed flows can pass the 60-foot long "active" portions of the spillway (crest elevation 6364.50) with less than 0.50' feet of flow depth. The full, un-attenuated 100-year emergency design flow, which assumes a pond-full condition and complete blockage of the outlet works, passes over the spillway at a maximum depth of 0.50 feet. An additional 0.50 of height is provided between the emergency maximum water surface and the crest on the inactive portion of the overflow berm, which spills into the adjacent drainageway. The downstream face of the spillway is protected by a cutoff wall and armored with riprap, in accordance with Figure 13-7 of the Town's Drainage Criteria.

The pond design is verified to release 97% of runoff from a 5-year or lesser storm within 72 hours, and to release 99% of runoff from a storm greater than a 5-year event within 120 hours.

Maintenance accommodations are designed for the water quality pond constructed with this project. These accommodations include vehicle access paths to the pond's forebay and outlet structure, compliant with Town criteria.

100-year detention volume for the Costco site is provided in regional Pond B1, as detailed under Section III.B of this report.

C. Water Quality Enhancement Control Measures

Implementation of the four-step process of water quality control include the following features:

- 1) Runoff reduction. Efficient utilization of the on-site area the warehouse footprint and associated parking limits the coverage of pervious surfaces on site. However, a significant amount of runoff reduction occurs in the generous open space areas programmed into the greater Dawson Trails development plan.
- 2) The elements of full spectrum detention are collectively provided between the on-site water quality pond (Pond C3) and regional Pond B1. The water quality capture volume based on the Costco parcel's on-site drainage characteristics is treated in the onsite pond. The pond enables settlement of suspended particles within the captured water volume over a design release time of 40 hours. Nearly all precipitation events that will occur at the site will be entirely captured within the onsite pond.

The Costco parcel's required 100-year detention volume is provided in the B1 regional pond.

- 3) Stream stabilization. There are no streams on the property. However, the drainageway immediately south of the site will be stabilized through a separate project supporting regional development of Dawson Trails. The outfall of the Costco water quality pond C3 to the drainageway will be designed in a manner that will avoid bank erosion and adverse hydraulics.
- 4) Source Controls: The use of source control as a water quality enhancement measure is an important element of the site's design. Multiple locations on the site—the fueling area, the fuel tank filling area, the tire center, and the loading dock—are all designed with separate stormwater collection structures that route to sand/oil separators and ultimately to the on-site water quality pond. Additionally, a canopy structure above the fueling area prevents falling rainwater from mixing with substances that may have been incidentally spilled on the fueling pad.

The on-site water quality pond outfalls directly to the Gambel Ridge Tributary major drainageway. The design details of this connection are described in Section IV.B

D. Floodplain Modification

A separately prepared floodplain modification study (FMS), by Jacobs Engineering Group [FD24-0003; Reference M] accompanies the channel improvement for Gambel Ridge Tributary adjacent to the site. It is anticipated that the channel improvements and floodplain modification will be in place before substantial completion of the Costco project.

The floodplain modification eliminates the previously mapped encroachments into the Costco property by the 100-year in 500-year flood that were delineated of the

2014 Gambel Ridge FHAD. Linework shown on the drainage plan is defined by the FMS (FD24-0003). Once complete, the channel improvements will confine the floodplain limits to the drainage tract immediately south of the Costco lot. The finished floor elevation for the Costco warehouse (6381.4') will be at least 7' higher than the developed 100-year water surface elevation on Gambel Ridge Tributary, which descends from 6374 to 6355 feet in elevation along the south property boundary. Since there is no flood hazard area shown along Gambel Ridge Tributary on the FIRM, there is no need for a map revision.

E. Geotechnical Investigation and Sub-surface Collection System Design

The site has no observed history of shallow groundwater or other sub-surface drainage issues. A geotechnical investigation has been initiated and its findings will be incorporated into the Phase III report.

F. Operation and Maintenance

The proposed stormwater conveyance and treatment facilities, including Pond C3, are private improvements that will be owned and maintained by Costco Wholesale.

Vehicle access to Pond C3's forebay and outlet structure are compliant with maintenance requirements in Section 13.6 of the Town's storm drainage criteria.

Recommended maintenance practices for extended detention basins in the Denver region are detailed in MHFD Criteria Manual Volume 3, Chapter 6, Section 7.

Regular maintenance of the stormwater facilities will include:

- Inspection and debris removal – twice annually
- Aeration – annually
- Sediment removal from forebay and trickle channel – annually

Occasional or as-needed maintenance activities will include:

- Sediment removal from basin bottom—when sediment volume reaches 20% WQCV (~15 to 25 years)
- Repair of eroded areas—as determined by inspection

Separately designed Pond B1 is a regional detention facility, with ownership and ongoing maintenance by the Town of Castle Rock.

G. Additional Permitting Requirements

There are no attributes of this project, associated disturbance areas, or impacted drainages that are expected to trigger additional permitting requirements.

H. General

The following published tables and charts have been used in the drainage design and are referenced in the Appendices:

- a. *Castle Rock Storm Drainage Design and Technical Criteria*, Figure 13-7, Embankment Protection Details and Rock Sizing Chart: This chart is used to determine appropriate riprap protection on pond embankments below spillways.
- b. *Mile High Flood District Criteria Manual Volume 1*, Figure 8-24, Swale Stability Chart: greater than 4-foot bottom width and side slopes between 5:1 and 10:1. This graph is used to determine the size of designed swales.
- c. *Castle Rock Storm Drainage and Technical Criteria*, Table 7-2, Minor Storm Allowable Flow Depth and Roadway Encroachment For Streets with Curb and Gutter. This chart classifies the maximum roadway encroachment for different drainage classifications.
- d. *Castle Rock Storm Drainage and Technical Criteria*, Table 7-3, Major Storm Allowable Flow Depth For Streets with Curb and Gutter. This table is used to specify allowable flow depth for different drainage calculations.

V. CONCLUSIONS

A. Compliance with Standards

The drainage infrastructure for the Costco Wholesale project has been designed to adhere to Town of Castle Rock criteria and standards. Some elements of the site's internal drainage design are also guided by published Costco development requirements.

A variance request is submitted to permit part of the site's required full-spectrum detention obligations to be fulfilled in an off-site facility. A second variance request is submitted to use H-20 rated area inlets in parking areas.

Stormwater conveyance and storage elements have been coordinated with currently proposed adjacent infrastructure projects in accordance with the overall vision of the Dawson Trails Infrastructure I Phase III Drainage Plan. This drainage plan also coordinates with the separately proposed improvements to the Gambel Ridge Tributary and the resulting elimination of floodplain encroachment into the site.

The project area and associated drainage areas lie within the Chatfield Reservoir Watershed. To date, the project has not been subjected to specific requirements regarding Regulation No. 73.

B. Variances

A variance request for section 13.1.1 of TOCR Storm Drainage Design and Technical Criteria Manual is submitted with this report. This project requires a variance from criteria to permit the site's 100-year detention responsibilities to be provided by regional Pond B1. From section 3B of Drainage Design Criteria of this report, the 100-year detention will be accounted for in the regional pond. The variance

request and supporting documentation will be submitted with the Phase III report after technical details of the off-site facility have been more thoroughly developed.

The project requires a second variance from the TOCR Storm Drainage Design and Technical Criteria Manual sections 8.2.2, Table 8-1 list of acceptable inlets to use an H-20 rated area inlet design from Costco's development standards that is regularly used by Costco in parking areas.

C. Drainage Concept

This drainage design detailed in this report effectively implements the stormwater management principles described below:

- a. Adherence to the regional drainage strategy outlined in the Dawson Trails Filing 2 Phase III Drainage Report
- b. Source control and a separate collection system for areas with high contaminant risk to protect downstream drainage ways
- c. Conveyance, capture and water quality treatment of on-site runoff
- d. Capture and controlled release of the site's excess urban runoff volume
- e. Fulfillment of the site's 100-year detention volume obligation by an off-site regional facility

VI. REFERENCES

- A. Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, June 2019.
- B. Mile High Flood District Urban Storm Drainage Criteria Manual, January 2021.
- C. Web Soil Survey, Soil Survey Staff (Natural Resources Conservation Service), United States Department of Agriculture. Available online at the following link:
<https://websoilsurvey.sc.egov.usda.gov/>. Accessed May 15, 2023.
- D. Flood Insurance Rate Map (FIRM) No. 08035C0284G, Federal Emergency Management Agency, Revised March 16, 2016. Available online at the following link:
<https://msc.fema.gov/portal/home>. Accessed May 15, 2023.
- E. Modeling Hydraulic and Energy Gradients in Storm Sewers: A Comparison of Computational Methods by AMEC, October 2009
- F. Flood Hazard Area – Delineation Gambel Ridge and Douglas Lane Tributary Watersheds by Respec Consulting and Service, July 2014
- G. Gambel Ridge and Douglas Lane Tributary Watersheds – Master Plan by Respec Consulting and Service, July 2014.
- H. Dawson Trails Planned Development Plan and Zoning Regulations by Norris Design, June 9, 2022 (PDP-05)
- I. Crystal Valley Interchange Project Package 2: Phase III Drainage Report, by Jacobs Engineering Group, October 2023
- J. Phase III Drainage Report for Dawson Trails Filing 2 by CORE Consultants, October 13, 2023
- K. Interstate 25 South Express Lanes: Castle Rock to Monument (The Gap) Hydrology and Hydraulics Report by ch2m, December 2020.
- L. Phase III Drainage Report for Dawson Trails Filing 1 by CORE Consultants, August 22, 2023
- M. Crystal Valley Interchange Project Packages 1 and 2 - Floodplain Modification Study - Gamble Ridge – E Plum Creek to Dawson Trails Boulevard, by Jacobs Engineering Group, April 2024 (FD24-0003)

Computer Modeling Programs:

- A. StormCAD by Bentley Systems, Inc., Version 10.03.04.53.
- B. Hydraflow Express Extension for Autodesk Civil 3D by Autodesk, Version 2022.
- C. Detention Basin Design Workbook (MHFD-Detention v4.04.xlsm) by Mile High Flood District, Version 4.04, February 2021.
- D. Street and Inlet Hydraulics Workbook (MHFD-Inlet v5.03.xlsm) by Mile High Flood District, Version 5.03, August 2023.
- E. HY-8 by Federal Highway Administration, Version 7.80.0.2, November 2022. APPENDICES

APPENDIX A

HYDROLOGIC COMPUTATIONS

Costco Wholesale, Castle Rock, CO

CORE Project #: 20-224-05

Prepared By: LCC

IMPERVIOUS CALCULATIONS**-REFERENCE UDFCD Vol.1 RUNOFF Table 6-3**

		Residential & Commercial												Soil Type		
		Single Family		Multi-Family	Soil Type A Area									Soil Type B Area	Soil Type C/D Area	
		0.25 acres or less	0.25 - 0.75 acres	2.5 acres or larger	Attached	Roof/ Concrete	Asphalt/ Ponded Water	Extended Detenion Basin	Newly Graded/ Gravel	Landscape Area	Historic					
% Imperv.	Design Point	45.00%	30.00%	12.00%	75.00%	95.00%	95.00%	25.00%	65.00%	20.00%	5.00%	Total Area (ac)	Percent Impervious			
BASIN		Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)			Area (ac)	Area (ac)	Area (ac)
O1	O1	-	-	-	-	-	-	-	1.98	-	-	1.98	65.0%	-	-	1.98
O2	O2	-	-	-	-	-	0.06	-	-	-	-	0.06	95.0%	-	-	0.06
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
A1	A1	-	-	-	-	-	0.15	-	-	-	-	0.15	95.0%	-	-	0.15
A2	A2	-	-	-	-	-	0.13	-	-	-	-	0.13	95.0%	-	-	0.13
A3	A3	-	-	-	-	-	0.12	-	-	-	-	0.12	95.0%	-	-	0.12
A4	A4	-	-	-	-	-	0.12	-	-	-	-	0.12	95.0%	-	-	0.12
A5	A5	-	-	-	-	0.30	-	-	-	-	-	0.31	95.0%	-	-	0.30
A6	A6	-	-	-	-	-	0.18	-	-	-	-	0.18	95.0%	-	-	0.18
A7	A7	-	-	-	-	0.60	-	-	-	-	-	0.60	95.0%	-	-	0.60
A8	A8	-	-	-	-	-	0.25	-	-	-	-	0.25	95.0%	-	-	0.25
A9	A9	-	-	-	-	0.57	-	-	-	-	-	0.57	95.0%	-	-	0.57
A10	A10	-	-	-	-	0.30	-	-	-	-	-	0.30	95.0%	-	-	0.30
A11	A11	-	-	-	-	-	0.12	-	-	-	-	0.12	95.0%	-	-	0.12
A12	A12	-	-	-	-	-	0.16	-	-	-	-	0.16	95.0%	-	-	0.16
A13	A13	-	-	-	-	-	0.15	-	-	-	-	0.15	95.0%	-	-	0.15
A14	A14	-	-	-	-	-	0.28	-	-	-	-	0.28	95.0%	-	-	0.28
A15	A15	-	-	-	-	-	0.35	-	-	-	-	0.35	95.0%	-	-	0.35
A16	A16	-	-	-	-	-	0.88	-	-	0.06	-	0.93	90.4%	-	-	0.93
A17	A17	-	-	-	-	-	1.01	-	-	0.04	-	1.05	92.4%	-	-	1.05
A18	A18	-	-	-	-	-	0.48	-	-	0.05	-	0.53	88.5%	-	-	0.53

		Residential & Commercial												Soil Type		
		Single Family		Multi-Family												
		0.25 acres or less	0.25 - 0.75 acres	2.5 acres or larger	Attached	Roof/ Concrete	Asphalt/ Ponded Water	Extended Detention Basin	Newly Graded/ Gravel	Landscape Area	Historic			Soil Type A Area	Soil Type B Area	Soil Type C/D Area
		% Imperv.	Design Point	45.00%	30.00%	12.00%	75.00%	95.00%	95.00%	25.00%	65.00%			20.00%	5.00%	Total Area (ac)
BASIN		Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)	Area (ac)			Area (ac)	Area (ac)	Area (ac)
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
B1.1	B1.1	-	-	-	-	-	0.36	-	-	-	-	0.36	95.0%	-	-	0.36
B1.2	B1.2	-	-	-	-	-	0.78	-	-	0.24	-	1.01	77.4%	-	-	1.01
B2	B2	-	-	-	-	0.57	-	-	-	-	-	0.57	95.0%	-	-	0.57
B3.1	B3.1	-	-	-	-	0.35	-	-	-	-	-	0.35	95.0%	-	-	0.35
B3.2	B3.2	-	-	-	-	-	0.88	-	-	0.24	-	1.12	79.0%	-	-	1.12
B4	B4	-	-	-	-	0.57	-	-	-	-	-	0.57	95.0%	-	-	0.57
B5	B5	-	-	-	-	-	0.13	-	-	-	-	0.13	95.0%	-	-	0.13
B6	B6	-	-	-	-	-	0.87	-	-	0.02	-	0.88	93.5%	-	-	0.88
B7	B7	-	-	-	-	-	0.25	-	-	0.13	-	0.38	68.8%	-	-	0.38
B8	B8	-	-	-	-	-	0.52	-	-	0.03	-	0.55	90.9%	-	-	0.55
B9.1	B9.1	-	-	-	-	-	0.37	-	-	-	-	0.37	95.0%	-	-	0.37
B9.2	B9.2	-	-	-	-	-	0.48	-	-	0.03	-	0.51	90.1%	-	-	0.51
B10	B10	-	-	-	-	0.79	-	-	-	-	-	0.79	95.0%	-	-	0.79
B11	B11	-	-	-	-	-	0.64	-	-	0.05	-	0.69	90.1%	-	-	0.69
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
B13	B13	-	-	-	-	0.44	-	-	-	-	-	0.44	95.0%	-	-	0.44
B14	B14	-	-	-	-	-	0.26	-	-	0.13	-	0.39	70.1%	-	-	0.39
B15	B15	-	-	-	-	-	0.42	-	-	0.03	-	0.45	89.9%	-	-	0.45
B16	B16	-	-	-	-	-	0.47	-	-	0.01	-	0.48	94.1%	-	-	0.48
B17	B17	-	-	-	-	-	0.69	-	-	0.03	-	0.72	91.9%	-	-	0.72
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
C1	C1	-	-	-	-	-	0.29	-	-	-	-	0.29	95.0%	-	-	0.29
C2	C2	-	-	-	-	-	0.44	-	-	-	-	0.44	95.0%	-	-	0.44
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
Pond Forebay	B	-	-	-	-	4.51	11.84	-	-	1.07	-	17.42	90.4%	-	-	17.42
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
D	D	-	-	-	-	-	-	0.49	0.16	0.48	-	1.12	28.4%	-	-	1.12
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
EURV Pond (C3)	D0	-	-	-	-	4.51	11.84	0.49	0.16	1.55	-	18.54	86.6%	-	-	18.54
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
E	E	-	-	-	-	-	-	-	-	0.68	-	0.68	20.0%	-	-	0.68
F	F	-	-	-	-	-	0.03	-	-	0.27	-	0.31	28.0%	-	-	0.31
G	G	-	-	-	-	-	-	-	-	0.42	-	0.42	20.0%	-	-	0.42
		-	-	-	-	-	-	-	-	-	-	-		-	-	-
Total Site		-	-	-	-	4.51	11.81	0.49	0.16	2.92	-	19.89	82.0%	-	-	19.89

Basin ID	% Imperv.	i	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
O1	65.0%	0.65	A	0.48	0.50	0.51	0.62	1.98	1.98	0.51	0.57	0.61	0.75
			B	0.51	0.54	0.58	0.73						
			C or D	0.51	0.57	0.61	0.75						
O2	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.06	0.06	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
										-	-	-	-
A1	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.15	0.15	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A2	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.13	0.13	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A3	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.12	0.12	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A4	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.12	0.12	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A5	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.30	0.30	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A6	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.18	0.18	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A7	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.60	0.60	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A8	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.25	0.25	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A9	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.57	0.57	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A10	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.30	0.30	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A11	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.12	0.12	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A12	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.16	0.16	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A13	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.15	0.15	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A14	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.28	0.28	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A15	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.35	0.35	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
A16	90.4%	0.90	A	0.74	0.76	0.77	0.82	0.93	0.93	0.74	0.78	0.80	0.85
			B	0.75	0.77	0.79	0.85						
			C or D	0.74	0.78	0.80	0.85						
A17	92.4%	0.92	A	0.76	0.78	0.79	0.83	1.05	1.05	0.76	0.79	0.82	0.86
			B	0.77	0.79	0.81	0.86						
			C or D	0.76	0.79	0.82	0.86						
A18	88.5%	0.88	A	0.72	0.74	0.75	0.80	0.53	0.53	0.72	0.76	0.79	0.85
			B	0.73	0.75	0.77	0.84						
			C or D	0.72	0.76	0.79	0.85						

Basin ID	% Imperv.	i	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
B1.1	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.36	0.36	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
B1.2	77.4%	0.77	A	0.60	0.62	0.63	0.71	1.01	1.01	0.62	0.67	0.70	0.80
			B	0.62	0.65	0.68	0.79						
			C or D	0.62	0.67	0.70	0.80						
B2	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.57	0.57	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
B3.1	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.35	0.35	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
B3.2	79.0%	0.79	A	0.62	0.64	0.65	0.73	1.12	1.12	0.64	0.68	0.72	0.81
			B	0.64	0.67	0.70	0.80						
			C or D	0.64	0.68	0.72	0.81						
B4	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.57	0.57	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
B5	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.13	0.13	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
B6	93.5%	0.93	A	0.77	0.79	0.80	0.84	0.88	0.88	0.77	0.80	0.82	0.87
			B	0.78	0.80	0.81	0.87						
			C or D	0.77	0.80	0.82	0.87						
B7	68.8%	0.69	A	0.52	0.53	0.55	0.65	0.38	0.38	0.55	0.60	0.64	0.77
			B	0.54	0.57	0.61	0.75						
			C or D	0.55	0.60	0.64	0.77						
B8	90.9%	0.91	A	0.74	0.76	0.77	0.82	0.55	0.55	0.75	0.78	0.80	0.86
			B	0.75	0.78	0.79	0.85						
			C or D	0.75	0.78	0.80	0.86						
B9.1	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.37	0.37	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
B9.2	90.1%	0.90	A	0.73	0.75	0.77	0.81	0.51	0.51	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85						
B10	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.79	0.79	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
B11	90.1%	0.90	A	0.73	0.75	0.77	0.81	0.69	0.69	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85						
										-	-	-	-
B13	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.44	0.44	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
B14	70.1%	0.70	A	0.53	0.55	0.56	0.66	0.39	0.39	0.56	0.61	0.65	0.77
			B	0.55	0.58	0.63	0.76						
			C or D	0.56	0.61	0.65	0.77						
B15	89.9%	0.90	A	0.73	0.75	0.76	0.81	0.45	0.45	0.74	0.77	0.80	0.85
			B	0.74	0.77	0.79	0.85						
			C or D	0.74	0.77	0.80	0.85						
B16	94.1%	0.94	A	0.78	0.80	0.81	0.84	0.48	0.48	0.77	0.81	0.83	0.87
			B	0.78	0.80	0.82	0.87						
			C or D	0.77	0.81	0.83	0.87						
B17	91.9%	0.92	A	0.75	0.77	0.78	0.83	0.72	0.72	0.75	0.79	0.81	0.86
			B	0.76	0.78	0.80	0.86						
			C or D	0.75	0.79	0.81	0.86						
C1	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.29	0.29	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
C2	95.0%	0.95	A	0.79	0.81	0.82	0.85	0.44	0.44	0.78	0.81	0.84	0.87
			B	0.79	0.81	0.83	0.87						
			C or D	0.78	0.81	0.84	0.87						
D	28.4%	0.28	A	0.16	0.17	0.18	0.33	1.12	1.12	0.20	0.27	0.34	0.60
			B	0.19	0.22	0.29	0.56						
			C or D	0.20	0.27	0.34	0.60						
E	20.0%	0.20	A	0.10	0.11	0.12	0.27	0.68	0.68	0.14	0.20	0.28	0.57
			B	0.13	0.15	0.22	0.52						
			C or D	0.14	0.20	0.28	0.57						
F	28.0%	0.28	A	0.16	0.17	0.18	0.33	0.31	0.31	0.20	0.26	0.34	0.60
			B	0.19	0.22	0.28	0.56						
			C or D	0.20	0.26	0.34	0.60						
G	20.0%	0.20	A	0.10	0.11	0.12	0.27	0.42	0.42	0.14	0.20	0.28	0.57
			B	0.13	0.15	0.22	0.52						
			C or D	0.14	0.20	0.28	0.57						

SUB-BASIN DATA			INITIAL / OVERLAND TIME			CHANNEL / TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPERVIOUS	USDCM Eq . 6-5	min.
B1.1	0.36	0.81	80	1.3	4.3	100	1.2	20	2.2	0.8	5.1	95.0%	10.5	5.1
B1.2	1.01	0.67	100	1.8	6.4	150	1.7	20	2.6	1.0	7.4	77.4%	13.8	7.4
B2	0.57	0.81	50	1.0	3.7	200	0.5	20	1.4	2.4	6.0	95.0%	12.0	6.0
B3.1	0.35	0.81	80	1.3	4.3	100	1.2	20	2.2	0.8	5.1	95.0%	10.5	5.1
B3.2	1.12	0.68	100	1.8	6.2	150	1.7	20	2.6	1.0	7.2	79.0%	13.5	7.2
B4	0.57	0.81	50	1.0	3.7	200	0.5	20	1.4	2.4	6.0	95.0%	12.0	6.0
B5	0.13	0.81	40	2.5	2.4	180	3.3	20	3.7	0.8	3.2	95.0%	10.6	5.0
B6	0.88	0.80	100	1.2	5.1	150	1.2	20	2.2	1.1	6.2	93.5%	11.1	6.2
B7	0.38	0.60	80	1.5	7.1	100	1.0	20	2.0	0.8	7.9	68.8%	15.2	7.9
B8	0.55	0.78	80	1.3	4.8	100	1.2	20	2.2	0.8	5.6	90.9%	11.2	5.6
B9.1	0.37	0.81	80	1.3	4.3	100	1.2	20	2.2	0.8	5.1	95.0%	10.5	5.1
B9.2	0.51	0.77	80	1.5	4.6	150	1.2	20	2.2	1.1	5.7	90.1%	11.7	5.7
B10	0.79	0.81	50	1.0	3.7	200	0.5	20	1.4	2.4	6.0	95.0%	12.0	6.0
B11	0.69	0.77	50	1.6	3.6	100	1.6	20	2.5	0.7	4.2	90.1%	11.3	5.0
B13	0.44	0.81	20	2.0	1.8	30	2.0	20	2.8	0.2	2.0	95.0%	10.0	5.0
B14	0.39	0.61	40	1.3	5.2	280	0.7	20	1.7	2.8	8.0	70.1%	17.0	8.0
B15	0.45	0.77	50	1.6	3.6	100	1.6	20	2.5	0.7	4.2	89.9%	11.3	5.0
B16	0.48	0.81	40	1.3	3.1	120	1.0	20	2.0	1.0	4.1	94.1%	10.9	5.0
B17	0.72	0.79	50	1.8	3.3	160	1.5	20	2.4	1.1	4.4	91.9%	11.4	5.0
C1	0.29	0.81	100	1.2	4.9	100	0.9	20	1.9	0.9	5.7	95.0%	10.6	5.7
C2	0.44	0.81	100	1.2	4.9	60	1.0	20	2.0	0.5	5.4	95.0%	10.3	5.4
D	1.12	0.27	80	17.5	5.2						5.2	28.4%		5.2
E	0.68	0.20	30	16.7	3.5						3.5	20.0%		5.0
F	0.31	0.26	40	20.0	3.5						3.5	28.0%		5.0
G	0.42	0.20	70	14.3	5.7						5.7	20.0%		5.7

Costco Wholesale, Castle Rock, CO

CORE Project #: 20-224-05

Prepared By: LCC

RATIONAL METHOD PEAK RUNOFF

5-Year STORM Rainfall Depth-Duration-Frequency (1-hr) = 1.43
SF-3

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATION				DIRECT RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr Runoff COEFF	T(c) min	C x A	I in/hr	Q cfs
O1	O1	1.98	0.57	10.4	1.13	3.80	4.28
O2	O2	0.06	0.81	5.0	0.05	4.85	0.24
A1	A1	0.15	0.81	5.0	0.12	4.85	0.58
A2	A2	0.13	0.81	5.0	0.10	4.85	0.50
A3	A3	0.12	0.81	5.0	0.10	4.85	0.49
A4	A4	0.12	0.81	5.0	0.10	4.85	0.48
A5	A5	0.31	0.81	6.0	0.25	4.61	1.14
A6	A6	0.18	0.81	5.1	0.15	4.81	0.72
A7	A7	0.60	0.81	6.0	0.49	4.61	2.27
A8	A8	0.25	0.81	5.1	0.20	4.81	0.98
A9	A9	0.57	0.81	6.0	0.47	4.61	2.15
A10	A10	0.30	0.81	6.0	0.25	4.61	1.14
A11	A11	0.12	0.81	5.0	0.10	4.85	0.47
A12	A12	0.16	0.81	5.0	0.13	4.85	0.62
A13	A13	0.15	0.81	5.0	0.12	4.85	0.59
A14	A14	0.28	0.81	5.0	0.22	4.85	1.09
A15	A15	0.35	0.81	5.1	0.29	4.83	1.38
A16	A16	0.93	0.78	7.6	0.72	4.28	3.10
A17	A17	1.05	0.79	6.7	0.83	4.46	3.72
A18	A18	0.53	0.76	7.2	0.40	4.36	1.74
B1.1	B1.1	0.36	0.81	5.1	0.29	4.84	1.40
B1.2	B1.2	1.01	0.67	7.4	0.68	4.32	2.94
B2	B2	0.57	0.81	6.0	0.47	4.61	2.15
B3.1	B3.1	0.35	0.81	5.1	0.29	4.84	1.39
B3.2	B3.2	1.12	0.68	7.2	0.77	4.36	3.34
B4	B4	0.57	0.81	6.0	0.46	4.61	2.13
B5	B5	0.13	0.81	5.0	0.11	4.85	0.53
B6	B6	0.88	0.80	6.2	0.71	4.56	3.23
B7	B7	0.38	0.60	7.9	0.23	4.22	0.96
B8	B8	0.55	0.78	5.6	0.43	4.71	2.04
B9.1	B9.1	0.37	0.81	5.1	0.30	4.84	1.47
B9.2	B9.2	0.51	0.77	5.7	0.39	4.67	1.84
B10	B10	0.79	0.81	6.0	0.64	4.61	2.96
B11	B11	0.69	0.77	5.0	0.53	4.85	2.59
B13	B13	0.44	0.81	5.0	0.36	4.85	1.75
B14	B14	0.39	0.61	8.0	0.24	4.21	1.01
B15	B15	0.45	0.77	5.0	0.34	4.85	1.67
B16	B16	0.48	0.81	5.0	0.38	4.85	1.86
B17	B17	0.72	0.79	5.0	0.57	4.85	2.76
C1	C1	0.29	0.81	5.7	0.23	4.67	1.08
C2	C2	0.44	0.81	5.4	0.36	4.76	1.71
D	D	1.12	0.27	5.2	0.30	4.79	1.44
E	E	0.68	0.20	5.0	0.14	4.85	0.66
F	F	0.31	0.26	5.0	0.08	4.85	0.39
G	G	0.42	0.20	5.7	0.08	4.69	0.39

Costco Wholesale, Castle Rock, CO

CORE Project #: 20-224-05

Prepared By: LCC

RATIONAL METHOD PEAK RUNOFF

100-YR STORM

SF-3

Rainfall Depth-Duration-Frequency (1-hr) = 2.60

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATION				DIRECT RUNOFF			
DESIGN POINT	DRAIN BASIN	AREA ac.	100YR RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs
O1	O1	1.98	0.75	10.4	1.49	6.91	10.28
O2	O2	0.06	0.87	5.0	0.05	8.82	0.46
A1	A1	0.15	0.87	5.0	0.13	8.82	1.14
A2	A2	0.13	0.87	5.0	0.11	8.82	0.97
A3	A3	0.12	0.87	5.0	0.11	8.82	0.96
A4	A4	0.12	0.87	5.0	0.11	8.82	0.94
A5	A5	0.31	0.87	6.0	0.27	8.38	2.23
A6	A6	0.18	0.87	5.1	0.16	8.75	1.40
A7	A7	0.60	0.87	6.0	0.53	8.38	4.42
A8	A8	0.25	0.87	5.1	0.22	8.75	1.90
A9	A9	0.57	0.87	6.0	0.50	8.38	4.20
A10	A10	0.30	0.87	6.0	0.27	8.38	2.23
A11	A11	0.12	0.87	5.0	0.10	8.82	0.91
A12	A12	0.16	0.87	5.0	0.14	8.82	1.22
A13	A13	0.15	0.87	5.0	0.13	8.82	1.16
A14	A14	0.28	0.87	5.0	0.24	8.82	2.12
A15	A15	0.35	0.87	5.1	0.31	8.77	2.69
A16	A16	0.93	0.85	7.6	0.80	7.77	6.20
A17	A17	1.05	0.86	6.7	0.91	8.12	7.36
A18	A18	0.53	0.85	7.2	0.44	7.92	3.52
B1.1	B1.1	0.36	0.87	5.1	0.31	8.80	2.73
B1.2	B1.2	1.01	0.80	7.4	0.81	7.86	6.39
B2	B2	0.57	0.87	6.0	0.50	8.38	4.19
B3.1	B3.1	0.35	0.87	5.1	0.31	8.80	2.70
B3.2	B3.2	1.12	0.81	7.2	0.91	7.93	7.19
B4	B4	0.57	0.87	6.0	0.50	8.38	4.16
B5	B5	0.13	0.87	5.0	0.12	8.82	1.02
B6	B6	0.88	0.87	6.2	0.77	8.29	6.36
B7	B7	0.38	0.77	7.9	0.29	7.67	2.23
B8	B8	0.55	0.86	5.6	0.47	8.57	4.07
B9.1	B9.1	0.37	0.87	5.1	0.33	8.80	2.87
B9.2	B9.2	0.51	0.85	5.7	0.43	8.49	3.68
B10	B10	0.79	0.87	6.0	0.69	8.38	5.77
B11	B11	0.69	0.85	5.0	0.59	8.82	5.19
B13	B13	0.44	0.87	5.0	0.39	8.82	3.40
B14	B14	0.39	0.77	8.0	0.30	7.66	2.33
B15	B15	0.45	0.85	5.0	0.38	8.82	3.35
B16	B16	0.48	0.87	5.0	0.41	8.82	3.65
B17	B17	0.72	0.86	5.0	0.62	8.82	5.49
C1	C1	0.29	0.87	5.7	0.25	8.49	2.11
C2	C2	0.44	0.87	5.4	0.39	8.65	3.34
D	D	1.12	0.60	5.2	0.67	8.72	5.88
E	E	0.68	0.57	5.0	0.39	8.82	3.40
F	F	0.31	0.60	5.0	0.18	8.82	1.62
G	G	0.42	0.57	5.7	0.24	8.53	2.02

BACK POCKET

DRAINAGE MAPS

